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1895 – 1898

Philadelphia.

ARTIFICIAL ANÆSTHESIA.

A Manual

OF

ANÆSTHETIC AGENTS

AND THEIR

EMPLOYMENT IN THE TREATMENT OF DISEASE.

BY

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THIRD EDITION. REVISED AND ENLARGED.

WITH ILLUSTRATIONS.

Al mio Amico

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1890.

In 1847, OLIVER WENDELL HOLMES created the words artificial anæsthesia, and wrote: "Nature herself is working out the primal curse which doomed the tenderest of her creatures to the sharpest of her trials; but the fierce extremity of suffering has been steeped in the waters of forgetfulness, and the deepest furrow in the knotted brow of agony has been smoothed forever."

"If America had contributed nothing more to the stock of human happiness than anæsthetics, the world would owe her an everlasting debt of gratitude."—*The late Professor Samuel D. Gross.*

PREFACE TO THE THIRD EDITION.

THE Author has endeavored, in this the Third Edition of his Manual, to make a thorough revision of the whole subject of Artificial Anæsthesia. The time, he thinks has arrived, after forty-five years' (1844–1889) trials, of these most wonderful and beneficent agents, by the medical and surgical profession, to have some definite and positive opinion, as to their relative safety in the various operations, and the risks and responsibility attending their use, in the healthy and diseased conditions of the human body.

By a careful and conscientious study of each agent, its natural and physiological characteristics, and peculiarities, each and every medical man can, and should, select the one, which he knows and feels will be just suitable in the peculiar case on hand.

By the discovery of true and positive local anæsthetics, and by their careful use in all minor operations in surgery, much of the risk to life is prevented

All hopes have passed away—for the time being at least—that any one of the systemic anæsthetics, is absolutely free from risk to life, for we now know, full well, that anæsthesia carried to the effect of a profound impression on the human subject, sufficient for a capital operation, is but a step from death.

It has been proven in numerous cases that it requires but a slight excess in the quantity employed, perhaps a lack of atmospheric air, great fear or dread concerning operation or anæsthetic, the faulty or non-action of a deranged kidney, or heart, perchance a careless administration—and the patient is dead. In making the additions and alterations to our Manual, necessary at the present day, many changes have led to an increase in the size of this book.

We would advise all who are obliged to use anæsthetics, to memorize the prominent points, so that when a case of emergency arises, it will not be necessary to seek information in the book, and all unnecessary haste, worry, and confusion, would be avoided, knowing just what to do for the best interest of the suffering patient, nigh unto death.

The indiscriminate and careless administration of the most powerful anæsthetic agents, is the crying evil of the present day, and we feel sure that in the near future, legislative action will be taken, to prevent, under heavy penalty, any one from giving an anæsthetic, unless he or she be provided with a certificate that they fully understand the chemical, physiological, and medical agents they are about to employ, and have had experience in their use, under a competent surgeon, and have been subjected to a careful examination of the knowledge they have thus acquired.

Human life is too valuable, at the present day, to be destroyed by incompetent administrators of such beneficent, yet death-giving agents.

The following is the most recent warning on this subject: "The announcement that the anæsthetist in a fatal case of chloroform narcosis, at Sidney, Australia, has been found guilty and sentenced to pay two hundred pounds damages, on the ground that the anæsthetic had been improperly administered, comes with rather a startling effect. While no conscientious man, be he lay or medical, will dispute the justice of such a verdict, when negligence is clearly proven, difficulties arise when such matters are adjudicated upon by a jury of persons, who, whatever their intelligence, are profoundly ignorant of what constitutes negligence in this respect.

"It would be but a step further for juries to enforce the opinion, which has been gaining ground, as to the advisability of giving chloroform at all, unless specially indicated. Still, this is a matter well within the discretion of the medical man, and it would be impolitic, as well as unjust, to fetter the exercise of that discretion by a fear of legal consequences.

"Short of negligence, amounting to a criminal act, we cannot conceive of such a verdict in this country (England), and we sincerely hope that the example will not be the means of imposing an additional horror to the life of medical men who have enough to attend to, in guarding themselves against vexatious actions for having signed lunacy certificates, and in avoiding the wiles of designing women, with an eye to blackmail." *

The subject of the administrations of ether per rectum, still claims some interest. The author retains part of the literature on that subject, modifying, and giving the most recent cases which have been reported. The application of such powerful agents by the rectum, offers many objections to general use, although in some rare cases, it can be resorted to with success when cocaine is neither admissible, nor sufficiently powerful.

In this edition of the work, the author has retained the description, and illustrations of the various inhalers. Some are not recommended as highly as others, but all have certain merits, and demerits; still, this department has been found of practical use, in the saving of time, to those who are not familiar with the various modifications made, or work performed. The author desires to return thanks to Dr. Buxton for his kind-

* Dr. E. Hart, *British Medical Journal.*

ness in allowing his publishers to furnish several illustrations of instruments, and one of tracings; the former being in constant use, and highly thought of by the physicians, surgeons and dentists of Great Britain. Here, also, he makes a general acknowledgment of having freely availed himself of Dr. Buxton's labor in original communications sent to him, knowing how much they will be appreciated by his professional brethren in this country, he "being Administrator of Anæsthetics in several London hospitals."

The author desires to acknowledge many courtesies at the hands of several members of the medical profession.

He is also indebted to the liberality of the S. S. White Dental Manufacturing Co. of this city, for the use of valuable cuts of instruments and apparatus. Also to Parke, Davis & Co., Detroit, Michigan.

The author's sole object has been to make this work a scientific, yet practical, and safe guide, no labor nor expense having been spared in attempting to accomplish this object.

1502 WALNUT STREET, PHILADELPHIA,
December, 1889.

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PREFACE TO THE SECOND EDITION.

THE rapid sale of a large edition of this work in the short period of one year, shows the appreciation with which it has been received by the medical and dental press and professions. Its success has induced the author to revise the subject-matter and rewrite several of the articles. To make the volume more worthy of the favor of the profession, a number of new and original experiments have been made; especially with hydrobromic ether. The boiling points and relative time of evaporation of the several agents employed in mixed anæsthetics, and the best proportion in which ether, alcohol, and chloroform should be united, have been determined; also a continuation of the experiments on the action of anæsthetics on the blood, the use of the spectroscope in relation to anæsthetics, more especially nitrous oxide.

In this second edition there will be found many more practical suggestions as to the employment of anæsthetics that are safe, and the rules for their adoption or reasons for the rejection of some of them in different cases, grouped, and made convenient, so that the student can memorize them, and be fully prepared for any emergency. As has been well observed in a review of this work by the distinguished editor of the *Dental Cosmos*, "When trouble comes to a patient from any cause during the anæsthetic state, it is not a good time to hunt up information."

The new table of deaths from chloroform which has been added, and in the preparation of which much time and labor has been expended, will be found of special interest and vital importance in regard to the sex, age, character of operation, time at which the patient died, quantity of chloroform used, and form of apparatus employed, general condition of patient, prominent symptoms of chloroform-poisoning, causes of death and post-mortem appearances. A new ether inhaler has been described and illustrated, which has been, and is now, employed in the clinical service of Jefferson College Hospital.

A bibliography published in the first edition has been omitted, but additional old or new works which were not then introduced, or cannot be found mentioned in the body of this work, have been printed for reference.

A historical sketch of the discovery of anæsthesia at the end of the previous edition has also been omitted, as more space has been devoted to the subject in our introduction, but full references to all the authorities on the subject have been given.

There has been introduced a notice of the metric system in accordance with the recommendations of the "American Medical Association" at its last meeting, at Atlanta, in May, 1879; also a table of the Centigrade, and Fahrenheit thermometric scales. More space has likewise been assigned to the physiological and therapeutic action of anæsthetics in disease. In most of the instances where a remedy has been recommended, the authority has been quoted, or we have tested its therapeutic value in an extensive private practice, or in the daily clinics of two large public institutions.

It was found impossible to acknowledge, in every instance, the source from which all contained facts have been obtained, but in the majority of instances we have endeavored to give credit to every original worker in the field of progress. The Author desires to acknowledge many courtesies at the hands of several eminent members of the profession; but he is especially indebted to his son, Dr. Charles S. Turnbull, and others.

1502 WALNUT STREET,
June, 1879.

PREFACE TO THE FIRST EDITION.

This little work was originally written by the Author as a report for a medical society, and was subsequently extended to its present form to supply a want that evidently exists at the present day, for a convenient hand-book on the administration of the various anæsthetics, that the practitioner of medicine or dentistry can consult, to enable him to decide which one he can best employ. Many valuable books have, unquestionably, been written on the subject of anæsthetics, but as far as the writer's observations extend, none of a practical character have appeared within the last few years. Much useful matter in relation to sulphuric ether, "nitrous oxide," and chloroform, employed as anæsthetics, has accumulated within this period, but this valuable information is contained in various monographs, journals, etc., where, associated with what is extraneous, it is unprofitable to the busy practitioner.

The object of this work may be stated to be:—

First. To give in as concise a manner as possible a description of the most available agents that may be successfully and safely employed as anæsthetics.

Second. To present the chief chemical tests of the purity of each substance considered, with its composition, physical characters, and medical properties.

Third. To exhibit the best methods of administering the various anæsthetics, to give careful directions, and to state the precautions to be taken to avoid risk to the life of the patient.

Fourth. To note the personal experience of the author, his assistants and friends, with anæsthetics and the various forms of inhalers in use, with a selection of the most approved, not withholding, however, the objections, but noting the experiments of other reliable investigators.

Fifth. To compare the relative mortality from all the anæsthetics now employed, endeavoring to assist the reader in forming a fair and candid opinion of this most important subject, which is now, and has for so long a period, occupied the attention of the public as well as of the medical profession.

To conclude are added practical hints on Local Anæsthesia, the use of the various Anæsthetics in the practice of medicine; the Medico-Legal Nature and Importance of Anæsthetics, with a brief History of the Discovery of Artificial Anæsthesia.

1502 WALNUT STREET,
March, 1878.

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ARTIFICIAL ANÆSTHESIA.

PART FIRST.

CHAPTER I.

History of Ancient and Modern Anæsthetics.

THE Ancient Greeks, it is stated, possessed a plant called mandrake. It belonged to the same family of plants as belladonna, or deadly night-shade. From the root of this plant was extracted, by means of wine, a narcotic which was employed by them as an anæsthetic. Lucius Apuleius, who lived about 160 A.D., and of whose works eleven editions were republished in the fourteenth and fifteenth centuries, says, "that if a man has to have a limb mutilated, sawn, or burnt, he may take half an ounce of mandragora wine, and whilst he sleeps the member may be cut off without pain or sense." To prove that this was true, Dr. B. W. Richardson, of London, after a lapse of five centuries, obtained a fine specimen of mandragora root, and after making wine from it and testing it, found it was a narcotic having precisely the properties that were anciently ascribed to it. He discovered that in animals it would produce even the sleep of Juliet, not for thirty or forty hours, a term that must be accepted as a poetical license, but for the four hours named by Dioscorides; and that on awakening, there was an excitement which tallied with the same phenomenon that was observed by the older physicians. Another fact was noticed by the ancients that many volatile substances acted more promptly by inhalation than by the stomach, and this form of medication was employed in Greece, Rome and Arabia. By the works published in these countries the knowledge of these facts was extended to other parts of the world. "He has eaten mandrake," was said of a very indolent and sleepy man, from the narcotic and stupefying properties of the plant, well known to the ancients.

> *Cleopatra.*—"Give me to drink mandragora
> * * * * * *
> That I might sleep out this great gap of time
> My Anthony is away."
>
> —*Shakespeare*, "*Anthony and Cleopatra*," act i. scene 5.

In China, in ancient times, the word ma-yo meant not only Indian hemp, but anæsthetic medicine; other substances besides hemp entered into these benumbing recipes, such as the datura, a solanaceous or soothing plant, probably identical with the atropia mandragora; also aconite, hyoscyamus, etc. Some of these drugs form constituents of the formula said to be employed by kidnappers of children, and by robbers; consequently their sale or employment is, at the present, prohibited in China. Dr. Dudgeon, of Pekin, writing in 1877, gave a flat contradiction to the extravagant stories current in Europe respecting the skillful use made by the early Chinese of benumbing drugs, and probably a more exact acquaintance with the facts would show that the practice of Greece and Rome was not less elementary. Only in modern times, and in the light of scientific teaching, was it possible for anæsthetics to take their proper place as the helpmate of the surgeon in his art, and as the grand alleviator of human suffering.

Theodoric, about the year 1298, gives elaborate directions how to prepare a "spongia somnifera" by boiling it dry in numerous strong narcotics, and afterwards moistening it for inhalation before operations.

Opium was also employed in later years (prior to surgical operations), and was found the best narcotic for the relief of pain and for producing insensibility, but was not free from danger.

History of Modern Anæsthesia and Anæsthetics.

On September 3, 1828, M. Girardin read to the Academy of

Medicine, of Paris, a letter addressed to His Majesty, Charles X., describing surgical anæsthesia by means of "inhaled gases."

A strong impulse was given to the study and application of the "different kinds of airs and gases" by the discovery of oxygen by Priestly and Scheele in the middle of the last century, and numerous experiments were made by physicians with it.

Pneumatic chemistry called into existence a new branch of therapeutics—pneumatic medicine, as it was named by its founders, who hoped to cure diseases, especially consumption, by the inhalation of various gases and vapors. This has been again revived in our day. A "Medical Pneumatic Institution" was set up at Clifton, in 1798, by Dr. Beddoes, with huge reservoirs of gases for the use of patients. The celebrated Humphrey Davy, then just out of his apprenticeship, was appointed superintendent. Though not successful in the immediate object for which it was founded, it was so in another sense; for here, Davy made his researches concerning nitrous oxide gas. In 1800 he discovered that when inhaled, it produced a peculiar intoxicating effect, with irresistible propensity to muscular exertion, and often to laughter, whence its popular name of "laughing gas." He also discovered its anæsthetic properties, and successfully inhaled it himself to relieve the pain of cutting a wisdom tooth. He made numerous experiments with it on animals. In his account of these experiments there occurs this memorable and oft-quoted sentence: "As nitrous oxide in its extensive operation, appears capable of destroying physical pain, it may probably be used to advantage during surgical operations in which no great effusion of blood takes place." Those desirous of pursuing the subject further should read his work entitled "Researches, Chemical and Philosophical, chiefly concerning Nitrous Oxide." Strange to relate, notwithstanding their completeness, nothing came of these remarkable observations. Their real import was not understood until nearly half a century later.

The modern practice of anæsthesia, though it may have benefited indirectly by these experiments, was not the immediate outcome of any of them; it originated to a large extent independently. The honor of making this discovery rests chiefly with four Americans,—Horace Wells, William Morton, Charles Jackson and Crawford W. Long.

One winter's night in December, 1844, a number of the inhabitants of Hartford, Connecticut, assembled to hear a lecture on nitrous oxide and other gases, from Dr. Colton, a well-known popular lecturer, who tried the effect of the first-named gas on several of the audience. Among those present were Horace Wells and his friend John M. Riggs, dentists of that city. They noticed that a person under its influence sustained a severe injury of his leg, without apparently feeling any pain. Wells was so impressed with this fact, that next day he got the lecturer to give him the gas, and whilst under its influence he had a molar tooth extracted, without feeling the least pain. As he recovered from the effects of the gas his first words were: "A new era in tooth-pulling."

The modern practice of anæsthesia dates from this operation. Wells appears to have been unaware of Sir Humphrey Davy's experiments. He found the peculiar intoxicating effects described by Davy due to mixture of the gas with atmospheric air; for when precautions had been taken to exclude the latter, only anæsthetic effects ensued from its inhalation.

He gave the gas to more than a dozen of his patients, and with complete success. Elated with this good fortune, he quickly obtained permission to make public trial of it at the Massachusetts General Hospital. Unfortunately, the bag was removed too soon, and in the extraction of the tooth the patient uttered a piercing cry. The skeptical audience rudely hooted and hissed, and he was laughed at as an ignorant pretender. Now, Wells was a modest and retiring man; he felt the insult deeply. Home he went, mortified and disgusted, yet both Wells and Riggs continued in their practice to administer the gas, but never afterwards resumed their experiments in public. After a few years Wells fell ill from vexation, and retired from his profession. Subsequently, he visited Europe as a picture dealer, then returned to the United States, became more and more unsettled in his mind, and finally died by his own hand in January, 1848. For a long time Wells' just claims as the discoverer of modern anæsthesia were ignored; indeed, we are only now beginning to do justice to his memory. He, at least, never attempted to make a secret of his great discovery, nor to use it for his selfish ends. "On making the discovery," says Wells, "I was so much elated respecting it, that I expended my money freely, and devoted my whole time for several weeks, in order to present it to those who were best qualified to investigate and decide upon its merits, not asking or expecting anything for my services. I was desirous that it should be as free as the air we breathe. Judge, therefore, of my surprise, after the lapse of many months, when I was informed that two individuals (Drs. Jackson and Morton) had claimed the discovery, and made application for a patent in their own names."

We are happy to state that a chaste and handsome monument, with a statue of Wells, has been erected at Hartford, Connecticut, with the following inscription:

"HORACE WELLS, who discovered Anæsthesia,
December 10th, 1844."

Much credit is due to Dr. McManus and friends of Wells for their praiseworthy efforts in this matter.

The use of nitrous oxide as an anæsthetic, for the time being, died with Wells; and the discovery was again in danger of being lost. Dr. Colton's praiseworthy efforts to re-introduce it were vain until 1863, when he succeeded in getting a few practitioners to try it. Its use spread rapidly, so that in 1867—the year of the International Exhibition in London—he was able to visit Paris with a record of 20,000 administrations without a single accident. He met with very little encouragement from the Paris faculty; however, in the spring of the following year, his apparatus was brought to London by Dr. Evans, the American dentist resident in Paris, who administered the gas before the staff of the Dental Hospital, and thus introduced the practice into that country.* In the United States it was well received; and in 1870 Dr. Colton published, in a medical

* *The Journal of the British Dental Association.*

journal and afterwards in pamphlet form, the result of the physiological action of the gas in practical application of the original discoveries of Davy, Wells and others, with a very large record of successful extraction of teeth.

Unfortunately, owing to its comparative feebleness of action (the result of its large gaseous bulk), it can only be maintained for a very limited period. Hence, its employment has hitherto necessarily been restricted to short surgical operations. The late M. Paul Bert, has partially succeeded in overcoming the above objection by giving, instead of the pure gas, a mixture of it with oxygen gas, in the proportion of 85 volumes of the former to 15 volumes of the latter, under increased atmospheric pressure in a special chamber constructed for this purpose. The necessity for the latter part of this provision arises from the fact that when the mixture of the gases is inhaled alone, complete anæsthesia cannot be produced, owing to the full complement of nitrous oxide (45 volumes to 100 volumes of oxygen) not being taken into the lungs during respiration. Under the above-mentioned increased pressure, sufficient nitrous oxide is inhaled to produce anæsthesia, and sufficient oxygen to prevent the supervention of asphyxia. Thus, prolonged anæsthesia can be maintained. After many experiments on animals, this method has been tried at the Paris Hospital, by Peau and others, and with partial success. It is not known whether it is employed in this country. The requisite apparatus in its present form is too cumbrous and expensive for general use.

CHAPTER II.

The Discovery of Special Anæsthetics, and the Theory of their Action—Local Anæsthesia and Anæsthetics.

Ether.

"PEREIRA," in his famous work, then as now a familiar text-book, states, "the vapor of ether is inhaled . . . to relieve the effects caused by the accidental inhalation of chlorine gas."

Again, he writes, "If the air be too strongly impregnated with ether, stupefaction ensues." The crowning result, however, was obtained in 1846, by Dr. Morton, in the Massachusetts General Hospital, when it was demonstrated successfully that the inhalation of ether was so capable of deadening the sensibility of the nervous system, that an operation, no matter how painful, could be performed without suffering to the patient. In the use of ether as an anæsthetic, the first capital operation —that is, one involving one of the larger joints—was performed on October 17, 1846, by Dr. Warren, of Boston.

Dr. Jackson, of Boston, claims to have suggested to Dr. Morton the use of ether as an anæsthetic, in place of nitrous oxide. With regard to this, it may be stated, that at a meeting of the Boston Academy of Arts and Sciences, where the matter was being discussed, the late Professor Louis Agassiz said to Dr. Jackson, "Did you make even one little experiment with ether?" and, after receiving a negative reply, added, dryly, "It would have been better if you had." On another occasion Professor Agassiz said, "If Dr. Morton had killed his first patient, would you (Jackson) have accepted the blame, just as now you ask for the honor?" Dr. Jackson was silent. The names of Jackson and Morton were, however, associated in an attempt to obtain a patent for the process, which was frowned upon by every right-minded physician and dentist.

It seems that, among other after-claimants, one, an estimable physician of Georgia, Dr. Crawford W. Long, wakened to the fact, only so late as 1849 (three years after anæsthetic inhalation by ether—1846—had been in universal practice), that it would be well to record in some medical journal the statement that he had "used ether by inhalation in surgical operations on several occasions" (as many as five in the course of as many years), prior to 1846. He accordingly, in December, 1849, published "an account of the first use of ether by inhalation as an anæsthetic in surgical operations." This communication, tardy as it was, Dr. Long very properly made, in simple justice to himself. No special attention was paid to it, for reasons which will soon become apparent. He seems, indeed, merely to have desired to place himself on record, in connection with this subject in 1849. In 1877, this forgotten record is dragged from its obscurity, and amplified and adorned into a patent of discovery. The interests of truth will be best served by referring to Dr. Long's original text. One quotation will establish these points. We shall be brought straightway to the very pith of the case by the following summary, as given by himself, of his communication of 1849, already referred to: "The result of my second experiment in etherization was such, as led me to believe that the anæsthetic state was of such short duration, that ether would only be applicable in cases in which its effects could be kept up by constant inhalation, during the time of the performance of the operation. Under this impression, up to January, 1847, I had not used ether in but one case, in extracting teeth, and thus deprived myself of experimenting in the only class of cases which are of frequent occurrence in a country practice." Now, in the first place, the remarkable admissions contained in this sentence would be valueless, if any subsequent experiments had taught Dr. Long more than he here enunciates; but he never, of himself, learned more than this—for he distinctly states that he "was under the impression" embodied in this quotation until January, 1847, three months after the announcement of universal and practical anæsthesia in 1846.

It is somewhat remarkable that the fate of almost all these claimants to the discovery of anæsthesia was so tragical. We have already referred to the sad end of Dr. Wells. Dr. Charles T Jackson died at Somerville, Mass., August 30th, after a seven years' illness, a disappointed man, although receiving an honorarium and medal from the Government of France. Morton, having been reduced to poverty during the long twelve years in which he endeavored to wring from Congress and the courts recognition of his rights, died suddenly in New York City, in 1868, of cerebral congestion, brought on, it is said, by reading a work attacking his claims. How much more fortunate was Professor Simpson, of Edinburgh, whose introduction of chloroform won for him a baronetcy, the highest honors of his profession, a statue in Edinburgh and a memorial bust in Westminster Abbey!

Long was the happiest. He died, comparatively little known, in 1878, a poor man, though now his statue, with that of Oglethorpe, will represent Georgia in the National Gallery at the Capitol. Owing to the bitter controversy that resulted from the claims of Wells, Morton and Jackson, to the discovery of ether anæsthesia, a monument was erected in Boston, with only the following inscription:

"To commemorate the discovery that the inhalation of ether causes insensibility to pain. First proved to the world at the Massachusetts General Hospital, in Boston, October, A.D. MDCCCXLVI."

Chloroform.

During the close of the year 1847, Professor Simpson, of Edinburgh, brought by his courage and perseverance a new and valuable anæsthetic agent into use, namely, chloroform. This was the suggestion of Dr. Waldie, a chemist of Liverpool. He had found, by experience, that a much smaller quantity was required to produce profound anæsthesia, it being more prompt in its action and more agreeable to the patient both in taste and odor. Chloroform had, however, a great drawback in general use as an anæsthetic, in that it would cause very sudden death.

The True Value of Anæsthetics.

No one can form, even at the present day, a just estimate of the true value of the various anæsthetics, or express in words their wonderful and extended application to the relief of human suffering. To the general surgeon it gives the opportunity of operating in grave cases of disease and injury, without which the death of the patient would be inevitable. It also affords, by the immediate relief from pain, the power to manipulate the broken or injured parts with facility, and thus obtain a correct diagnosis in the most obscure diseases and painful accidents.

To the obstetrician and gynæcologist, it is most valuable in assuaging the terrific pain of labor, and makes the dreaded instruments a blessing in disguise. In the diagnosis and treatment of abdominal diseases, it gives precision and almost marvelous results, and in the removal of large masses or ovarian tumors, great freedom from the dreadful effects of shock to the nervous system. For the ophthalmic surgeon the anæsthetic reduces the sensibility of the eye so that it can be touched and cut with impunity, and severe and dangerous operations can be performed upon this delicate and sensitive organ without pain and with much less risk.

Again, in the removal of foreign bodies from the eye or ear, particularly in children, by the use of the anæsthetic, all spasm is relieved, and the act is accomplished without injury. The profound sleep gives a most favorable opportunity to the aural surgeon to perforate the membrana tympani, cut the minute tendon of the tensor tympani muscle, or perforate the mastoid cells.

Theories of the Manner in which Anæsthetics Produce their Effects.

At the present day only four theories are received to explain the effects of general anæsthetics on the system.

1. That they act by retarding oxidation and inducing a partial asphyxia.
2. That they produce actual changes in the blood, thus causing secondary inhibition of the function of the sensory nerve cells.
3. That they merely bring about cerebral anæmia, from which condition anæsthesia results.
4. That they have a direct action upon the nervous tissue itself.

There is no true similarity between the phenomena of true anæsthesia and those of asphyxia; the conditions are not identical, and when true asphyxia takes place it is a complication which is to be avoided with all anæsthetics, especially nitrous oxide and ether.

In regard to the second theory, it is admitted that certain anæsthetics, like chloroform, produce changes in the blood, and if carried too far, these changes will become permanent; they, however, are neither necessary nor essential to the production of true anæsthesia. Dr. H. C. Wood, in his recent edition of his work (on Therapeutics, 1888), holds that the only theory at all compatible with our present knowledge is, that anæsthesia is in most cases due to a direct action, of the agent inducing it, upon the cortex cerebri.

Local Anæsthesia and Anæsthetics.

Anæsthetics are now divided into local and general, and in that order we shall take them up. The local are those which abolish the sensibility of the peripheral or surface nerves of a particular area for a time.

The general, or systemic anæsthetics are those which temporarily suspend sensation of the entire economy, or, if carried to their full power, destroy sensation and life.

To diminish or abolish the sensibility of the skin and mucous membranes in regions where surgical operations are to be performed, and to avoid the dangers of general anæsthesia, is a matter of the greatest importance. One of the earliest and most efficient means of accomplishing local anæsthesia is cold —either ice or snow, with or without a mixture of the chloride of sodium, potassium, ammonium or calcium—or through the rapid evaporation of chloroform, ether, bromide of ethyl, rhigolene, carbon bisulphide, absolute alcohol, benzol and many other like substances, the action of which are expedited if they are applied in a fine spray.

Chloroform, ether and the other allied substances before mentioned, not only act on the peripheral nerves of the skin, and produce local anæsthesia, but anæsthesia may be caused by these agents by direct action on the nerve cells themselves applied to the brain or nerve. Thus Prevost found that chloroform applied directly to the brain of a frog, narcotized it when the aorta was tied. When the aorta was released, so that the current of blood could wash the chloroform away, the narcosis disappeared.

The limitation of the anæsthetus to a part of the body is much safer to the patient's life, and the local anæsthetic, is preferred when we wish to produce anæsthesia in the genito-anal region, as operations in and about these parts require more ether and chloroform than other cases. This is also the case in the extremities, as in the fingers and toes. In proof of which see the number of deaths following the use of systemic anæsthetics in operations on the abdomen, womb, rectum, in hernia, and for the simple removal of hemorrhoids.

At a meeting of the Société de Biologie, of Paris, on April 14, 1888, M. Oscar Liebreich read a communication on substances which cause local anæsthesia. Having been led to experiment on a large number of substances, either natural or produced by synthesis, he found that there were a great many more capable of causing local anæsthesia than had beeu supposed. Some of these substances have an effect on animals, but not on man, for many of them act, not by entering the general circulation, but by their direct effect upon the tissues with which they come into contact. With regard to the cornea, it must be remembered that there are two kinds of anæsthesia. M. Liebreich operated by subcutaneous injection of the dorsal region in rabbits and guinea-pigs. For the eye, he merely allowed a few drops of the substance in solution to fall on the cornea. Among the substances producing local anæsthesia the principal are hydrochlorate of ammonia and the bromide and sulphate of ammonia; the carbonate and nitrate are without effect. Sulphate of copper is inactive, but the iron salts, particularly the sesquioxide, have an anæsthetic action without producing coagulation at the point of introduction. Acetate of lead is anæsthetic; zinc salts are not. Among organic substances, hydroquinine, resorcin, antipyrin, substances belonging to the digitalis group, and serpent venom, in small doses are active. Thallin, alcohol, ether, and glycerine, have no action. Essential oils, such as oil of turpentine, hydrate of terebene, eucalyptol, oil of chamomile flowers and a number of others have a remarkable effect. According to Dr. Liebreich, these substances act by destroying the nerve-ends and by irritating the neighboring parts, causing what has been called "painful anæsthesia." Some substances, such as cocaine, do not cause painful anæsthesia, and are followed by contraction of the vessels, whereas substances that cause painful anæsthesia lead, on the contrary, to vascular dilation. Substances causing painful anæsthesia have a caustic action, particularly hydroquinine. This anæsthetic and caustic action is also observed in distilled water, the action of which, on the nerves, is already known. In general a very great number of substances produce local anæsthesia, but in their application to man it is necessary to examine, first, whether they act as caustics, producing painful anæsthesia. The objections to some of these agents are, that when the application has been made, and the operation performed without pain, there is a reaction, if too freely used, by the return of the blood, with great force, pressing upon the nerves; or there may be a partial death of the parts if frozen completely, so that the pain following is intense and prolonged. At times there is loss of the parts, also profuse hemorrhages. Still, with all these drawbacks, they can at times be employed with success, when no other agents are at hand.

Carbolic acid, painted over the surface of the skin, or applied to a nerve exposed in a tooth, will cause it to become white and lose its sensibility, producing local anæsthesia. In 1772, Percival introduced carbonic acid as a local anæsthetic to relieve pain, and the late Professor Dewees, of Philadelphia, recommended it in carcinoma uteri, also in cancer of the rectum. In 1856, the late Professor Simpson improved the apparatus so as to apply it with more efficiency.

The pain felt during the extraction of a tooth is lessened by the employment of rapid respiration (Bonwell's method), violent muscular effort, or vibration. A still more powerful adjunct is electricity applied along the course of the nerves. The Faradaic, or interrupted galvanic current, was at one time employed in this city to produce a local anæsthesia. This employment of electricity has been revived by Dr. I. Corning, of New York, by first perforating the skin with needles, with the instrument of "Baunschiedt," and then applying over the surface a sponge electrode, saturated with a two per cent. solution of hydrochlorate of cocaine. This should be kept connected with the battery from three to four minutes, and be of sufficient intensity to cause a slight sensation of heat. It has been suggested that the method can be made more efficient, if the surface be rendered bloodless by the pressure of Esmarch's bandage.

CHAPTER III.

Coca Plant, Leaves—Preparations, more especially the Wine made from the Leaves, also from the Active Principle—Cocaine: Its Action as a Stimulant of the Nervous System and Retarder of Metamorphosis—Cocaine and its Salts, Solutions, Tests of Purity, Solution in Camphor Water, etc.—The Amount Manufactured.

Erythroxylon Coca; Folia Cocæ. The Leaves. Nat. Order: Erythroxylaceæ. Lamark. U. S. P. The coca is a small tree

Plate 1—(Figs. 1-13).*

4 to 6 feet high, indigenous to the mountains of Peru and Bolivia, and cultivated in both these countries on the eastern

*The entire illustration is that of branch with young foliage and flowers. No 2, entire flower; between 2 and 3, petal; 3, petal; 4, flower with petals removed; 5, calyx and pistil; 6, vertical section ovary; 7 and 8, transverse sections ovary; 9 and 10, fruit; 11, transverse section of fruit; 12, section of stem with leaves removed; 13, apex of leaf.

slope of the Andes, in damp, warm valleys. The leaves are chewed by the natives to satisfy hunger, to strengthen the weak, to stimulate the nerves and to remove depression or melancholy. The extract obtained by alcohol of 21° and 56° has all the gummy and resinous principles of the coca leaf, as well as the fatty, nitrogenous principles, the tannin, the chlorophyl and the alkaloid. It is this extract which represents best, and in exact proportion, the *constituent principles of coca.*

Like tea and coffee, coca is used in nervous headache, and as a substitute for opium in opium habit. A similar use has suggested itself in the treatment of alcoholism, spermatorrhœa, generative debility, granular pharyngitis, and relaxation of the muscles of the larynx, pharynx and middle ear.

There is a wine of coca made from the fresh and dry leaves with sherry or claret wine.

Wine of Coca, from Cocaine.

We have been disappointed in the results of the administration of the ordinary wine of coca in the market, and it has been suggested the preparing of this wine so that it will contain a fixed proportion of cocaine, and at the same time be free from the tannin, resin, and other inert or deleterious substances present in the leaves.

To a good-bodied wine—not sherry—add five grains of the hydrochlorate of cocaine to the pint, the dose being half a wineglassful, which will contain about a twelfth of a grain, repeated at each meal. We have found this wine of special value as a tonic to the vocal apparatus, or in cerebral hyperæmia, the result of excessive mental or physical disturbance. It has also been found useful in hysteria, and as a tonic and stimulant in weakened and exhausted nervous system.

Therapeutical Uses of Coca Leaves.

We have employed the coca and found it useful, first, in our own case, and also in that of several of our patients. The first effect of our experiments with the elixir and fluid extract of coca in full doses was a somewhat irregular muscular action or co-ordination, and if given in large doses walking becomes irregular. Soon after the moderate dose there comes a feeling of comfort, and as the effects pass off there is a slight irregularity of the rhythm of the heart; this is followed after a certain time, if taken at night, by a pleasant sleep. If taken through the day and not immediately before meals by a person with no desire for food, or if taken after meals, it passes off before the next regular meal and the appetite is not affected. The wine was the first preparation recommended to us, but after using that made in this city with sherry wine, we found it objectionable to certain of our patients, causing headache and dyspeptic symptoms; so that in Jefferson Medical College Hospital we resorted to a preparation of the elixir in doses of sixty drops, three times a day. One week after a patient with tinnitus reported the noises were much less, throat less irritable, able to obtain a view of the vocal cords, which were found white, but still somewhat relaxed in the act of phonation. The only objection to its continued use in this form was the constipation. This constipation, it is stated by our patients, does not follow the use of the elixir made with glycerine, or the lime-water infusion. Still the peculiar tannin which it contains is one of its important agents, and should not be omitted, as it unites with the active principle; therefore it is best to use the active preparation, for the constipation can be readily obviated by adding a mild laxative.

In man, the coca suspends the appetite for food for some hours, and at the same time greatly increases the muscular strength and endurance. The celebrated traveler, "Tschudi," found, when coca leaves were taken in infusion, it conferred a singular immunity from suffering, and prevented the hemorrhages which were apt to occur in the elevated passes of the Andes, some of which are 17,000 feet high. The experiments of Mason, of Boston, upon himself, with the fluid extract of coca, confirm some of the above observations. If used to excess, coca deranges the digestion and causes habitual constipation.

Cocaine and its Salts.

In 1855, Gaedeke discovered in coca an alkaloid to which he gave the name erythroxyline; but this principle was first thoroughly studied by Dr. Albert Niemann, from whom it received the name cocaine, and was an anæsthetic, but used in the eye by Dr. Karl Koller, of Vienna.

The hydrated alkaloid cocaine is in light, white, spongy fragments, or in light amorphous powder, very much like magnesia. It is not perfectly white, but very nearly so. It is nearly insoluble in water, but very soluble in acids, giving solutions that are not quite colorless. When a very small particle is laid upon the tongue, and the tongue then held against the roof of the mouth, a moderately bitter taste is perceived. In a few seconds more the bitterness gives place to numbness and insensibility of the surfaces, as though scalded by hot liquid, except that there is no pain. This numbness increases for a few minutes, and then diminishes slowly, and disappears in from ten to twenty minutes in proportion to the quantity applied. The hydrochlorate of cocaine is an almost white crystalline powder, though the fragments of crystals are so small that it appears to be an amorphous powder, even under a glass of low power. The powder when dry is loose and mobile, but when exposed to damp air becomes a little damp and clammy, although it does not appear to be deliquescent. It is soluble in all proportions in hot water, in alcohol, and in somewhat less than half its weight of water at ordinary temperatures. Its solutions are not always colorless, but appear to be nearly so when seen in small vials, even up to the strength of 20 per cent. Solutions of 50 or 60 per cent. strength are, however, even in small vials, of a greenish-yellow tint. The solutions are neutral to test-paper. When tested with solution of chloride of barium they give, after a moment or two, the faintest cloud (limit of sulphates). With test solution of oxalate of ammonium the result is negative (absence of lime). When the salt is burnt on a platinum surface, there is merely a trace of residue (limit of inorganic matter), and the spot moistened with water scarcely affects the color of neutral litmus paper (limit of inorganic alkalies).

According to Dr. Niemann, the discoverer of cocaine, the alkaloid, when heated in a tube, decomposes, with the evolution of a dense sublimate of benzoic acid. Wohler and Losson found, upon heating cocaine several hours in a sealed glass tube with concentrated hydrochloric acid, that the cocaine resolved itself into benzoic acid, methyl alcohol and ecgonine.

Cocaine and its Impurities.

The presence of hygrine and ecgonine in the hydrochlorate of cocaine may be detected by treating the salt with cold concentrated sulphuric acid. If the salt is pure, the result is a completely colorless solution. The impurities will stain the solution.

The Instability of Cocaine.

The great instability of cocaine is now well known, the simple contact of the free alkaloid with water being sufficient to decompose it. (Paul and Flieckegen.) The hydrochlorate, which is much more stable, should be absolutely neutral; volatilized completely, forms a colorless or slightly turbid solution in water, gives a colorless solution with strong sulphuric acid, and should not reduce permanganate of potassium immediately. (Beckurts.)

Cocaine has the composition $C_{17}H_{21}NO_4$. It is slightly soluble in water, more so in alcohol and freely in ether. In addition to it coca leaves contain cocatannic acid, wax and a pale, yellow, oily volatile alkaloid, *hygrine*. *Ecgonine*, which is obtained by the action of hydrochloric acid on cocaine, has the composition $C_9H_{15}NO_3$, and is insoluble in ether.

The Hydrochlorate of Cocaine in Solution of Camphor-Water.

While in Glasgow, Scotland, attending the session of the British Medical Association, Dr. Barr, the distinguished otologist, informed us that McMillan, the pharmacist, had made the solutions of the hydrochlorate of cocaine with camphor-water, and had found it sufficient to prevent the formation of fungi. He had found it valuable in affections of the nose and ear, and had used it both before and after operation in a five per cent. solution applied with a brush.

Dr. Geisel's test for cocaine is potassium permanganate, producing a permanganate salt, and when heated there is a distinct odor of bitter almonds.

Chloride of gold produces a distinct precipitate of small fern frond-shaped crystals arranged in stellate groups. A solution of iodide of potassium and picric acid produces precipitates of color, etc., which are peculiar to cocaine. The physiological tests are its anæsthetic influence on the eye, dilatation of the pupil and benumbing sensation on the tongue.

To show the enormous amount of cocaine and its salts made and sold by one manufacturing chemist, it is stated by Dr. Squibb, of New York, in the *Ephemeris* for October, 1889, p. 987 (a journal which he publishes), that he has used since his last report (January, 1887) 238 bales of coca; total, 41,858 pounds. This was manufactured into hydrochlorate of cocaine by his process on p. 908, January number of *Ephemeris* issue, and gave a total yield as sold in stock of 922,917 grains, or 131 pounds, 13½ ounces.*

* Crude Cocaine.—(From the *Ephemeris*, vol. iii, No. 4, 1889).—It is there stated that the importation of coca leaves into this country and Europe for the manufacture of cocaine is nearly at an end. For more than a year past crude or raw cocaine has been sent from Peru. During 1888 it improved in quality, reaching 90 to 96 per cent. Some idea of the very large quantities produced may be had from the circumstance that one maker has a single contract with a European house for 70 kilos or about 154 pounds per month.

The test for pure cocaine (Stockman's), or pure hydrochlorate of pure cocaine is, that when heated with strong hydrochloric acid in a sealed glass tube, in the water bath, it splits up into its components without any change of color, except a very light yellow tint (from the HCI). When isatropylococine is so treated, it splits up into ecgonine and a brown oily-looking body, which is decomposed isatropic acid.

Cocaine salts are now made synthetically on a large scale.

CHAPTER IV.

Experiments with Cocaine on Animals and Men.

The Physiological Action of Cocaine upon the Animal System, more especially upon Dogs.

THROUGH the courtesy of Professor Reichert, of the University of Pennsylvania, the following experiments were performed in his laboratory May 14, 1889:

A dog, weighing 8 pounds, was injected with 1½ grains of Merck's cocaine. Pulse 172, temperature R. 38.9, being at the rate of 2 centigrammes per kilo. Soon after he became restless, moving his tongue in and out of his mouth, showing an extra secretion of saliva. Then followed jerking movements of the muscles, more especially of the neck and head, being unable to stand on his feet, as though intoxicated. The pupils became dilated, balls very prominent and hard from increased intraocular pressure. In the course of ten minutes or more convulsions supervened. Temperature increased to 39.4°, pulse to 124. After 15 minutes there were both clonic and tonic convulsions. His bodily movements were in a circle, swaying his head from side to side. This motion of the head continued for several hours—even after the movement of the limbs, which had been lost, had been regained. A pinch was felt, showing no want of reflex excitability. When fully under the influence of the cocaine, sight and hearing seemed unimpaired until convulsions set in. At times there was great difficulty in co-ordination, but there was no up and down motion of the head, and the convulsive motions were almost always rotary and to and fro.

SECOND EXPERIMENT.—Weight, 16½ pounds, pulse 120, temperature 38.9°. Dose for his weight, 10 centigrammes. A much more timid animal than the first, and after 15 minutes became very restless, with his head at times between his feet, having a weaving motion, his mouth making a snapping movement. The grain and a half of cocaine which he received by injection did not appear to produce the desired intense physiological effects, so that $1\frac{1}{2}$ grains extra was introduced over the spine. Now his brain became evidently very much affected, and his delirium overcame his timidity. When under great excitement he began by running around the laboratory, battering himself at intervals against anything that was in his way. Respiration increased, causing him to pant. Ears were thrown back, eyes protruding, balls hard, pupils dilated, but not to the same degree as the first animal.

It was early noticed that heat is increased in the human body by the use of cocaine. In 1887, Mosso, of Turin, demonstrated by experiment that this drug possessed a remarkable power over the bodily temperature, raising it independently of convulsions *or section of the spinal column*, and this is owing, according to Mosso, to direct changes in the tissue, or the action of cocaine on the heat centres supposed to exist in the spinal cord. These facts in regard to the section of the spinal cord have not been confirmed by Professor Reichert (see p. 53). In the experiments of Dr. Hare, upon dogs only, one is noted as having violent convulsions. A portion of cocaine employed by him varied from $\frac{1}{2}$ a grain in a dog weighing 9 pounds, to $\frac{3}{4}$ of a grain to a dog weighing 17 pounds. In every instance the cocaine was injected into the jugular vein. Animals, like human beings, are affected differently.

The following are the most recent conclusions of Professor Reichert on the action of cocaine on animal heat functions: "There are comparatively few drugs known to therapeutists that are capable of causing a notable increase of bodily temperature, and even of these a large percentage is supposed to owe this activity largely or wholly to accompanying motor disturbances. It is at least a curious circumstance, that all poisons which appreciably increase temperature are pronounced convulsants. Among the most decided of the physiological actions of cocaine is that of producing a rise of temperature which, even in moderate doses, may be quite remarkable. Von Anrep* states that the temperature of the skin was always decidedly increased from the first, while the rectal

* Pflüger's Archiv., Bd. XXI. s. 68.

temperature at the same time remained unaltered, or was decreased from 0.5° to 1° C., the latter rising, however, during the convulsions, to a similar extent. Danini (quoted by Anrep) notes that a rise amounting to 1° C. occurs during, and is dependent upon, the convulsions. Mosso * always observed a rise, amounting to as much at times as 3.1° C., and, contrary to Danini, being independent of convulsions, since it occurred in animals rendered motionless by curare. Hare,† in ten experiments in which the drug was injected intravenously, records a rise varying from 2° to 7.5° F. (1.11° to 4.17° C.), the average being 4.14° F. (2.3° C.). Dose for dose the action is more powerful and prompt when intravenously injected than when hypodermatically."

In Reichert's studies, comprising about twenty experiments on dogs, a marked increase was always noted. "In all, Merck's hydrochlorate of cocaine was used and injected hypodermatically. The fatal dose in dogs is about 0.03 gram per kilo. Doses of 0.0025 gram per kilo elicit fairly well-defined symptoms of cocaine poisoning, dilation of the pupils, restlessness, salivation, increased frequency of respiration, more frequent and forcible pulse, increased temperature, etc. With such doses the temperature is increased about from 0.2° to 0.5° C. Doses of 0.01 gram per kilo cause a rise of from 1° to 2° C. Doses of 0.02 gram per kilo, a rise of from 2° to 4° C. The increase is, however, not always in proportion to the dose, relatively small doses sometimes causing a considerable rise, and *vice versa*. The potency of cocaine in this respect is altogether remarkable, and places the drug in the foremost rank of pyrogenic agents; indeed, so powerful is it at times that animals suffer from heat dyspnœa. Moreover, the action is one of notable permanency, the temperature after large, but sublethal doses, remaining above normal for six or eight hours or more.

"Following the rise of temperature, and subsequent return to the normal, a fall ensues, which, even after moderate doses, lasts for some hours.

* Archiv. f. Exp. Path. u. Phar., Bd. XXIII. s. 153.

† *University Medical Magazine*, Vol. I., p. 358.

"The results of my experiments are not in accord with Von Anrep's statements, above referred to, since in every instance a marked rise of temperature occurred, from the first simultaneously in the rectum and axilla (skin), the thermometers at both points of observation in our experiments being placed in position before giving the drugs, being allowed to settle, and not being removed during the entire time of observation. The alterations in temperature progressed *pari passu* in both cases. The rectal temperature rises more rapidly than that of the skin, this being due to a large extent, if not wholly, to the quicker reaction of the thermometer in the former position. The thermometers used, when placed in the rectum, settle in from three to five minutes, but from ten to fifteen minutes are required in the axilla, although the thermometers were identical in make and sensitiveness." We cannot give the full details of Dr. Reichert's experiments, but he showed that a rise in temperature does not occur after section of the spinal cord.

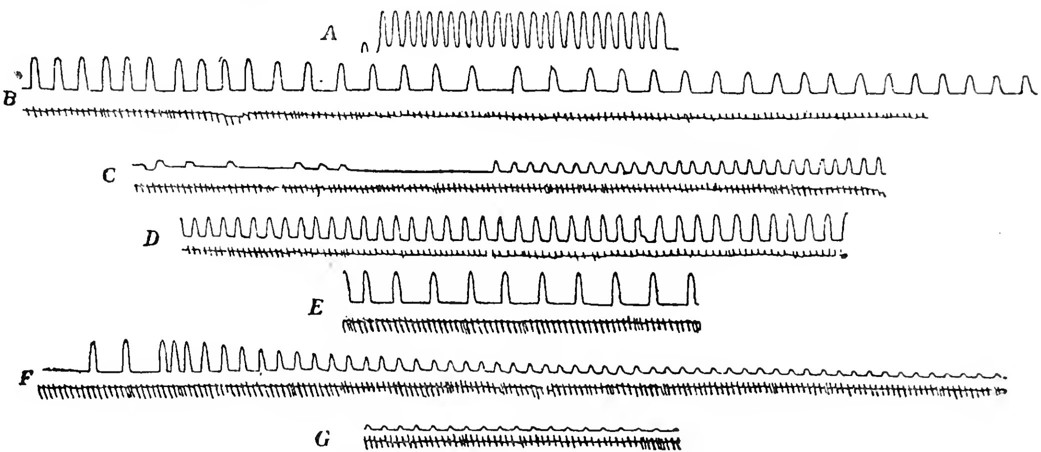
We have shown by the above experiments on dogs, the action of cocaine. The accompanying trace (Plate 2, p. 40), of the detached heart of a frog, being circulated with solution of cocaine 1 in 2000, shows the power of this drug as a cardiac depressant in cold-blooded animals, depressing the beat, and finally arresting the heart in diastole. (Buxton.)

On the Action of Cocaine on the Eye.

On September 15, 1884, Dr. Karl Koller, of Vienna, first exhibited to the profession the anæsthetic effects of cocaine on the eye. When introduced into the eye, it causes local anæsthesia, with dilatation of the pupil, paralysis of accommodation, slight lachrymation, and enlargement of the palpebral fissure.

When injected into the back of the orbit, it causes protrusion of the eyeball. Its effects appear to be due to stimulation of the peripheral ends of the sympathetic. Subcutaneous injections also produce local anæsthesia at the point of application, so that subsequent irritation at that spot produces no sensation in man and no reflex action in animals. When taken internally, it appears to have in small doses a stimulating, and in

Plate 2.



CARDIOGRAMS OF FROG'S HEART (EFFECT OF COCAINE).

A. Normal trace.
B. After addition of cocaine.
C. Cocaine removed, nutrient fluid re-circulating.
D. Cocaine removed, nutrient fluid re-circulating.
E. Recovery to normal.
F. Cocaine again circulated.
G. Extreme heart failure, no recovery.

large doses a paralyzing action on the nerve centres. It affects first the cerebral hemisphere, next the medulla, and afterwards the spinal cord.

The writer has performed numerous experiments on himself and others to determine the action of the alkaloid cocaine and its chief salt, the hydrochlorate.

In moderate doses of the hydrochlorate it can be administered in from one-fifth to even one-quarter of a grain every hour, until the patient is relieved, or the peculiar constitutional symptoms show themselves; these doses acting as a stimulant on the peripheral ends of the sympathetic. In larger doses it has an action on the nerve centres, affecting first the cerebrum, next the medulla, afterwards the spinal cord. If employed in still larger doses there is intense exhilaration, or intoxication, more or less loss of consciousness, followed by palpitation and even death, although this is rare.

The average therapeutic dose has not yet been determined.

On the Hypodermic Employment of the Hydrochlorate of Cocaine.

To prevent syncope and nausea, while using the hydrochlorate of cocaine in subcutaneous injections, the patient should, in almost every instance, recline. This is absolutely necessary if the patient is anæmic or very feeble. Cerebral anæmia may be produced in certain individuals by the use of even ten drops of a two per cent. solution.

The strength of the solutions for local use varies as follows: From two to twenty per cent.—that is, one grain to every hundred grains of distilled water—but it is wiser to begin with the weaker solution. To prevent alterations or the formation of fungi in these solutions we have to resort to certain antiseptic agents, which are as follows: Boracic acid, two to four grains to the ounce. Salicylic acid, a quarter or a half a grain to the ounce of solution. Two centigrammes of bichloride of mercury in one hundred grains of water.

The great advantage in the hypodermic use of the injection of the hydrochlorate of cocaine, in this form, is its rapidity of action, making its impression very promptly, say, in from three to five minutes.

Peculiar effects: a nervous thrill or tingling sensation, increase of pulse, dryness of the tongue, relief of pain or gastric disturbance, sensation of fulness in the head or heat of the face, at times producing wakefulness, followed by frontal headache; in other cases there is dilatation of the pupil, with a tendency to sleep, the patient awaking in his ordinary condition of mind. If larger doses are required, the symptoms are similar in character, only increased in intensity, great mental excitement, increased irregularity in rhythm or force of the heart, insomnia, or being unable to sleep, and invariably headache the following morning.

Fatal Dose of Hydrochlorate of Cocaine.

The fatal dose is usually from eighteen to twenty grains, but from idiosyncrasy or peculiarity of constitution, a much smaller dose may produce fatal symptoms. Dr. Hammond, of New York, took very much larger doses. Before the last injection, the pulsations of the heart were 140 to the minute, and characteristically irregular. He found his mind passing beyond his control, and he was becoming an irresponsible agent. He lost all consciousness half an hour after administering the last dose, remaining so until nine o'clock next morning, when he awoke with an intense headache with a great deal of cardiac and respiratory disturbance.

No marked influence appeared to be exercised upon his spinal cord or upon the ganglia at the base of the brain.

There were no disturbances of sensibility (no anæsthesia, no hyperæsthesia), and no interference with mobility except that some of the muscles, especially those of the face, were subjected to slight twitchings.

In regard to sight and hearing he noticed that both were affected; but that while the sharpness of vision was decidedly lessened, the hearing was increased in acuteness. At no time were there any hallucinations.

(1) The exciting action of cocaine on the brain is extremely

prominent among its physiological peculiarities,—much more so than its anæsthetic influence.

(2) Montegazy's statements we look upon as a mass of gross and utterly inexcusable exaggerations.

(3) The first noticeable effect on the lower animals is restlessness, gradually increasing to more or less intense excitement.

(4) In animals the cerebellum is more or less affected.

(5) Chloral is certainly antagonistic—so with chloroform, also ether—during anæsthetic stage, but not during its primary stage of excitement.

(6) There is some evidence to indicate that the semi-circular canals are affected, as shown by the vertiginous movements.

(7) The convulsions seem to be both of cerebral and spinal origin, but chiefly cerebral.

(8) The motor or sensory nerves do not seem to be affected until late in the poisoning.

(9) The action on circulation is complex: pneumogastric nerves primarily stimulated, secondarily depressed. Blood pressure similarly affected. Therapeutic doses probably act as circulatory stimulant.

(10) The pupils in all of the experiments were dilated and intra-ocular pressure increased. We have never noticed any injurious effects on animals in any way after using non-lethal doses. They naturally suffer some after-depression because of the intense mental and muscular excitement during the action of the poison.

(11) Bodily temperature is increased.

(12) Pupils dilated, and, in dogs, intra-ocular pressure increased.

(13) Tissue metamorphosis, as is indicated by Dr. Reichert's experiments, is probably increased.

(14) The fatal dose for animals is about 0.03 grammes per kilo of body-weight. The fatal dose for man varies within very wide limits.

(15) It is claimed that it at times interferes with the healing of the wound after operations, and to be less efficient on other membranes than the conjunctiva.

CHAPTER V.

Cocaine Inebriation and Habit—Treatment—Deaths from Cocaine—Morbid Changes in Poisoning by Cocaine.

THE experience of T. D. Crothers, M.D., Superintendent Walnut Lodge, Hartford, Conn., in cocaine inebriety, is limited to seven cases. Two were under his care for treatment; three came personally for advice, and two consulted him by letter.

In the cases under his care a correct history was obtained; in the five cases who sought advice by person and letter, their own personal statements were the chief sources of information. In two cases, statements were confirmed by others, and where such statements corresponded with the facts in other cases, they were accepted as probably true. The following are some of the facts which appeared from the history of these cases:

Alcohol, opium, chloral, bromides and other narcotics had been used more or less to excess in all these cases before cocaine was taken. In four of these cases, coca had been used for months before cocaine was tried. Hence, they were all literally drug maniacs, or inebriates, whose special symptom of disease is a morbid impulse for narcotic drugs, which will bring rest and relief to the organism. He is also persuaded to believe that cocaine inebriety, or coca mania, will never become prominent, and will be confined to a class of neurotics who, by the use of other drugs, have prepared the soil for this new drug-mania. It will never take the place of alcohol or opium in common use. Its action is too uncertain and transient. The present novelty and glamour about its effects will die away when its real value is ascertained. The element of contagion in these cases presents a curious psychological phase; thus some extravagant newspaper statement of the terrible effects of this drug will rouse curiosity to test it, or the printed history of a case appearing as daily news draws the attention of neurotics, and it is safe to say that a large per cent. not only purchase, but test this drug on themselves. Cocaine should not be used as a substitute in breaking away from the use of other narcotics. It should not be used in large or long-continued doses. It cannot be used indiscriminately. However valuable it may be, there is a certain limit to its power and practical use.

The treatment of cocaine inebriety is the same as that of alcohol or opium cases. *Forced abstinence from the drug, rest and building up the system are the general methods pursued.* More profound degeneration and debility exist than in other forms of inebriety, requiring a longer time for successful treatment.

States of mania and melancholy often continue for some time after the use of the drug is given up, and disappear very slowly. It is for these states that special surroundings and care are essential. The prognosis is always uncertain. The craving for drugs that their effects may be broken up, and restoration follow; but such cases generally are unable to bear much exposure, and not unfrequently relapse on the slightest temptation. The cases under our care recovered, but will probably relapse, using the same or some other drug in future.

The Cocaine Habit.

The cocaine habit is yet rare. There are opium and morphine-eaters, who having heard that cocaine is an antidote to the morphine habit, have endeavored to cure themselves with it, and being deprived of full power and judgment of will, have ingrafted the so-called cocaine on the morphine habit.

Dr. Bosworth, of New York, took between 500 and 600 grains, and stopped without any inconvenience.

"PERSONAL EXPERIENCE," BY DR. FRANK W. RING—Dr. Ring made use of a solution of hydrochlorate of cocaine nightly for ten months in the form of a 4 per cent. solution applied to the nasal mucous membrane by means of an atomizer. About two grains were used at each application. The account of his experience is exceedingly interesting, but we shall not touch upon that portion of his paper at present. We will, however, quote from him this paragraph, stating that during the ten months he had taken more than 600 grains:

"July 9th, I came to the conclusion that the medicine was getting to be a necessity; that it might become a source of injury to my well-being, and I calmly decided to stop it, which I did. The inclination for it often seizes me, but I crush it with the perfect confidence that I shall never again indulge in its enchantments.

"And now I come to another stage of my personal experience, which I think is both interesting and instructive. About the first of March last I was attacked by a *violent rhinitis*, different in character and of far greater intensity than any rhinologist I have consulted has ever witnessed, and of a form not laid down in the books. There was great swelling of the nose and face, the discharge during the first stage of an exceedingly acrid and thin fluid, and the formation subsequently of a membraniform substance not very unlike that present in diphtheria, but very loosely attached to the membrane, and showing no disposition to extend beyond the nasal cavities. Nothing gave me such relief as the application of a solution of the hydrochlorate of cocaine by means of cotton-holders, camel's hair pencils and atomizers. Generally I used a 4 per cent. solution, but not infrequently one of 10 per cent., and occasionally one of 20 per cent. I used it night and day almost continuously during the months of March, April, May, June, and to the middle of July. From the 16th of July to the 24th of August I was absent from New York, at Mackinac, Michigan. During that period I had no rhinitis, and I took no cocaine. From the 1st of March to the 16th of July, I applied an average of 20 grains a day to the nasal mucous membranes. Of course nothing like this quantity entered the system, but I was careful to carry it far enough back till I tasted it in the throat, when it was generally swallowed. I used, therefore, about 600 grains a month. The effects of it upon the system besides its local influence were a slight mental exhilaration, and sometimes an indisposition to sleep when I had taken more than my usual quantity. I was not confined to bed a single day, nor did I fail any day to discharge all my professional duties. I missed four lectures at the Medical College, but that was not from any effect of the cocaine, but solely from the nature of the disease with which I was affected, and which prevented me from speaking clearly.

"On the 16th of July, I stopped the use of cocaine without the slightest difficulty, nor did I resume it again for six weeks.

"But two days after my return, August 26th, I had another of my old attacks, and I again began the use of cocaine. From that date to October 1st I have used nearly 800 grains in application to the nasal mucous membrane. On the 1st of October I ceased taking it, and again without the slightest difficulty. On neither occasion of my stopping its administration did I experience the slightest craving for it or inconvenience.

"So far as I know, I shall not take it again unless I should be the subject of another attack of rhinitis, when I shall certainly resort to it as the one agent capable of affording relief to an inflamed, painful, turgid and altogether uncomfortable mucous membrane."

On making inquiry of Dr. Osler, one of the attending physicians of the largest hospitals in Philadelphia, as to how many cases he had ever seen of cocaine habit, he stated but one or two, and of opium or morphia habit during his term of service of four months, there were but four cases. In what dose did he give cocaine? As a rule one-quarter of a grain was the usual dose, and the strength of the solution for hypodermic application was two per cent. If this rule is followed, we think that it is as safe as morphine, atropine and agents of a like character.

In carefully looking over a list of the recent cases of cocaine toxæmia, by Dr. J. B. Mattison,* of Brooklyn, N. Y., we find of the thirty-two cases, the cocaine was given in twenty cases or employed hypodermically in the strength of a four per cent. solution up to a twenty per cent. Caution should be exercised in the first administration of the drug, as in the use of all potent alkaloids, such as morphia, etc., there are certain individuals who are very sensitive to the smallest dose. It is better to begin with $\frac{1}{12}$ of a grain, and gradually increase when given internally.

Treatment of Nervous Symptoms from Cocaine.

Should nervous symptoms occur, such as temporary deafness, blindness, loss of taste or smell, place the patient on a lounge or sofa, open the windows and admit plenty of pure air, then employ from five to ten drops of the nitrate of amyl in capsules, broken on a handkerchief, to be inhaled by the nostrils. Should

* *Therapeutic Gazette*, Jan. 16, 1888.

the patient become covered with cold perspiration, livid in color, apply dry friction to the skin, with twenty drops of aromatic spirits of ammonia, in water, repeated at intervals. Should the patient suffer from gastric cramps, give a teaspoonful of compound spirits of lavender, or, if not relieved, brandy. Use morphine, hypodermically, one-eighth of a grain. If the pulse be irregular or intermittent, with shallow, gasping, irregular, convulsive or suspended breathing, artificial respiration should be resorted to, with hypodermic injections of ether or chloroform, and even the galvanic battery, to prevent a fatal result.

Further Treatment of Cases of Poisoning from Cocaine.

In cases of poisoning, the nitrate of amyl is the best antidote. Claude Bernard has demonstrated by his experiments, that cocaine in its action on the cerebral circulation was exactly the antagonist of nitrate of amyl. Under the effects of amyl, the cerebral arteries contract, anæmia of the brain develops, the arterial pressure is increased, and the face looks pale. Cocaine causes a dilatation of the vessels of the heart, hyperæmia with diminished arterial pressure sets in in the encephalon, and the face appears flushed and in a general state of venous congestion. Cocaine is antagonistic in its action to ether and chloroform. The convulsive seizures induced by the action of poisonous doses of cocaine can be at once allayed by the inhalation of either of these agents. In cases of cocaine poisoning in man, we therefore recommend that ether or chloroform should be administered to allay the first and severer symptoms, chloral being afterward given in small doses to keep up the effect.

We have seen symptoms of cocaine poisoning in subjects of morphia habit rapidly removed by a hypodermic injection of morphia, and in one case, five grains of cocaine had been taken hypodermically within ten minutes; and we have frequently seen the same antagonistic effect produced by a small quantity of cocaine in an overdose of morphia. The symptoms of poisoning are controlled by the use of ether and chloroform, which are both antagonistic to cocaine, and the symptoms often subside in two or three hours, without the use of any antidote.

The Toxic Action of Cocaine in Certain Operations.

It has been found that cocaine is more toxic when used in operations on the head or face, than when used on other parts of the body. In operations on the extremities, sixteen minims of a five per cent. solution may be injected without unpleasant symptoms arising, except in the face, urethra and rectum, which are, with the head and neck, more sensitive to its toxic action. Toxic symptoms in this region will be observed, if more than one-third of a grain be used.

Death from Cocaine in a Lady with Tuberculous Ulcer of the Uterus.

"In order to produce anæsthesia, a Russian surgeon had fifty grammes of a five per cent. solution of hydrochlorate of cocaine prepared; of this, thirty grammes were brought into use, containing exactly twenty-four Russian grains of the salt, or twenty-three English grains—the Russian grain is exactly one-sixteenth of a gramme—six grains being injected at a time into the rectum. After the third of these injections, it was found on examination that the part was still sensitive. A speculum was then introduced, the ulcer soaked with a dry sponge, and then the fourth injection given, making twenty-four grains in all. After this the parts were tolerably anæsthetised. The ulcer was scraped, and a tampon saturated with oil inserted. The pulse was then accelerated. During the operation the patient groaned, so that even the twenty-four grains had not produced complete anæsthesia.

"After the operation, Kolomnin went round his ward, and in three-quarters of an hour a message was sent to him that the patient was very low. He found the pulse very weak, the face and hands cyanotic, and the respiration labored. He considered that she was in a toxic state, and used every means to bring her round, Prof. Sushchinski being also invited to a consultation. Faradization, artificial respiration, hypodermatic injection of ether, administration of ammonia, tracheotomy for the inhalation of oxygen, stimulating and nutrient enemata—all were tried, but without success. Kolomnin had no doubt that death was due to cocaine."

Dr. W. H. Long, U. S. Marine Hospital Service, reports in the *American Lancet* the case of a man aged thirty-three, to whose larynx he applied three times a four per cent. solution of cocaine. Prompt relief was given, but three and one-halt hours later the patient was found unconscious; breathing labored; respirations, twenty; pulse, ninety; general condition, one of profound anæsthesia. Diagnosis, cocaine poisoning. Several doses of whiskey were given subcutaneously. In half an hour consciousness partially restored, then gradual and full improvement save a feeling ot great exhaustion.

Four days later cocaine was again used. Thinking the former toxic effect due to swallowing some of the solution, and probable absorption by larynx, extra precaution was taken to have it expelled and the pharynx well rinsed. Two applications of a two per cent. solution were made. Relief was again complete, but three and one-half hours after the patient was in the same condition as before, except the anæsthesia not so profound. Frequent injections of whiskey were again used with partial success—could swallow and answer questions—but, soon after, he suddenly ceased to breathe. The heart beat a short time longer. All efforts at resuscitation failed. The probable immediate cause of death was paralysis of the respiratory centre due to cocaine.

Dr. F. M. Thomas, of Leonardsville, Kansas, reported to Prof. R. Ogden Doremus as follows:

"Friday morning, October 23d, 1885, I was called to see Mrs. ——, aged thirty-nine, whom the messenger reported as dying. I found her unconscious; breathing heavily and irregularly; pulse thirty-five, intermittent; temperature normal; left pupil largely dilated, right, natural; right arm and lower limbs motionless; face spasmodically drawn upwards towards the dilated eye.

"Spasmodic action of the left arm and upper part of the body came on regularly at intervals of a few minutes, during which she clutched the bed-clothing, and seemed to be trying to vomit. Twice during my attendance she ejected small portions of the previous evening's meal. Salivation was excessive; retained a dorsal decubitus; would not lie on either side; heart seemed almost exhausted.

"I saw her at 5 A.M., and was with her nearly all the time until she expired, apparently completely exhausted, about 8.30 A.M."

On inquiry, the doctor learned that Mrs. —— had been freely using a four per cent. solution of cocaine for toothache, due to several much-decayed left upper molars. His diagnosis was cocaine poisoning.

Dr. Knabe, of Berlin, records the case of a girl, aged eleven, who was given from four to twelve drops—the exact amount was not determined—of a four per cent. solution of cocaine, by injection over the deltoid, to remedy frequent fainting fits—she having cardiac degeneration, sequeling scarlatina. In less than forty seconds the girl took a deep breath, became deadly pale, and dropped unconscious. One minute later she was dead.

FATAL ACCIDENT FOLLOWING A HYPODERMATIC INJECTION OF COCAINE (Abadie).—The author reported at a recent meeting of the Ophthalmological Society of Paris, the case of a woman, seventy-one years of age, upon whose eye he was operating, and whose death occurred so soon after the use of the cocaine as to lead to the belief that the cocaine was somehow the cause. Instead of a 2 per cent. solution, which he was accustomed to using, he happened to employ a 5 per cent. solution, but had only injected about three-fourths of the syringeful, when he noticed that he was using the stronger; thus about four centigrammes of the cocaine were injected into the cellular tissue under the skin of the lower eyelid. This was about 3 P.M. During the operation there were no disturbances of any note, but upon rising from the chair the patient exhibited marked titubation. When she was assisted into a neighboring room syncope came on. Soon the respiration seemed to stop, the face became cyanosed, the lips blue, as though the patient were asphyxiated, but the air-passages were freely open. With manipulations and injections of ether the respiration was partially re-established; but the face remained congested, and unconsciousness continued. At the end of a half-hour some words were uttered, and the patient was placed in bed. Caffeine was administered, but in spite of all efforts death occurred about 8 o'clock in the evening. No autopsy.—*Recueil d' Ophthalmologie.*

THE INJECTION OF A SOLUTION OF COCAINE INTO THE URETHRA FOLLOWED BY DEATH.*—"A. M. was admitted to the surgical ward of the Episcopal Hospital on February 23, 1888. Age, twenty-nine years; English. He gave a history of having suffered from stricture of the urethra some years before, for which the operation of external urethrotomy had evidently been performed. At the time of admission there was some difficulty in passing water, and the urine, he said, 'comes out of an opening between the legs.' Upon examination there was found the cicatrix of a perineal section, having a small fistula communicating with the urethra. The urethra was examined, and the existence of a stricture was ascertained, situated about four and a half inches from the meatus. The stricture admitted a No. 11 French bougie.

"Gradual dilatation, by means of sounds introduced every other day, was the treatment under which the patient was placed for two weeks. Favorable progress was made and the urethra now easily admitted a No. 20 sound. Internal urethrotomy was determined upon, in order to remove all hindrance to the passage of urine through the urethra, and permit the healing of the perineal fistula. On March 3d, the day I had intended to perform the operation, the patient complained of sore throat, had a slight chill, and there was a slight increase of temperature. This proved to be nothing more than a mild attack of bronchitis. On March 9th, he was feeling quite well, and I had him removed to the operating-room for operation.

"Previously to performing internal urethrotomy, I have, for the past year or two, injected into the urethra a solution of muriate of cocaine, which has lessened the pain of the operation, although not completely rendering the parts insensible to the cutting. The strength of the solution used in my previous cases had been five per cent.

* By J. Henry C. Simes, M.D., surgeon of the Episcopal Hospital of Philadelphia Read before the Philadelphia Academy of Surgery, June 4, 1888.

"The man was placed upon the operating-table, one drachm of a twenty per cent. solution of muriate of cocaine was introduced into his urethra by means of a long-nozzled urethral syringe which passed about four inches into the canal. The instrument had scarcely been taken out of the urethra when the patient made a foolish remark, the muscles of the face began to twitch, the eyes staring, pupils dilated, frothing at the mouth, face much congested, respiration interfered with, and ending in a violent epileptiform convulsion, lasting for some seconds. These convulsions were continued with increasing violence, several times a minute, the whole muscular system taking part in the spasms, requiring considerable force to keep him from falling off the table. The action of the heart was not much interfered with, and only appeared to be secondarily affected. It was the respiratory function that seemed first to fail, and then the heart's action became irregular and slow. The breathing was gradually more and more interfered with, the face—in fact, the entire surface of the body—became deeply cyanosed, the pulse slow, and at the end of twenty minutes from the first convulsion, had ceased to beat. The man was dead.

"The means employed to relieve the patient were all useless; nothing had any effect in controlling, lessening, or in any way influencing the ultimate result, and I may say everything was promptly and efficiently done; the entire staff of resident physicians of the Hospital ably assisted me in my efforts, which unfortunately were futile.

"The *post-mortem* was made by Dr. Grimm, Resident Surgeon at the Hospital. *Thorax:* Lungs normal, but much congested; heart normal, right side empty, left side filled with currant-jelly clots. *Abdomen:* Liver much congested; spleen presented on its surface several stellate cicatrices; kidneys much congested and also cicatrices similar to those seen on the surface of the spleen; they were thought possibly to be syphilitic in nature. The *urethra* was examined to ascertain if there had been a rupture made in introducing the syringe, but no such lesion was found. The *brain* showed the blood-vessels very much congested; its membranes on either side of the longitudinal sinus at the vertex, covering a space of two square inches, were thickened and closely attached to the brain-substance; this probably was the result of some previous inflammatory action."

ZAMIBIANCHI AND MENTALTI, ON TWO FATAL CASES OF COCAINE POISONING.—A lady suffering from recurrent cancer of the breast, had three and seven-tenths grains of cocaine injected hypodermically near the proposed site of operation. Immediately after she was seized with epileptiform convulsions, which lasted fifteen minutes. Artificial respiration was performed, and she rallied for a moment, but the convulsions came on again, and in five minutes more she died. The second case was that of a woman suffering from phthisis of one lung, to whom 22 grains of the hydrochlorate were given internally by mistake. Fifteen minutes afterwards she began to wander in mind, complaining that a morsel of food had stuck in her throat, and making fruitless efforts to vomit; at the same time she became so cold that she had to be wrapped in hot blankets. The delirium increased, her face was pale, the pupils dilated, the lips cyanotic, and the pulse imperceptible. Unconsciousness supervened, and in a short time she died. On autopsy there was found intense congestion of the brain and spinal cord, as well as of their membranes. The surface of the brain was covered with a thin layer of sanguinolent fluid, while the subarachnoid space was full of serum. Sections of the brain-substance in various directions showed everywhere innumerable minute bleeding points, the drops being confluent, so as to give the whole cut surface a reddish appearance. There were some recent hæmorrhagic infracts in the healthy lung; the heart was firmly contracted, both ventricles containing a little blood; the spleen, liver, stomach and small intestine were excessively congested; the kidneys and the bladder were normal. Precisely similar conditions were found in rabbits in which poisonous doses of hydrochlorate of cocaine were injected hypodermically.—*Lo Sperimentale.* Quoted in *Br. Med. Jour.*, Feb. 16, 1889.

In a careful reading of Dr. Mattison's before-referred-to monograph, we found a few points on which we wanted a little more definite information, and wrote to him for that purpose, but received no reply except from his wife, acknowledging the receipt of the letter: The name of the journal in which the details of the Russian surgeon's case is reported? Might not the operation of scraping and cauterizing a tuberculous ulcer have caused the death of the young woman? Was not three-quarters of an hour a long time before the cocaine had developed its toxic effects? We find as a rule they are decided in five minutes. We cannot find the number of the *American Lancet* in which the case is reported by Dr. Long. What was the disease of the larynx? The case of Dr. F. M. Thomas was not reported in any medical journal. We applied to Dr. Thomas by letter, addressing him Leonardsville, Kansas, for some further information in regard to his case, but received no reply. Judging from the symptoms, the woman died from paralysis, and had been under treatment for the same. We were unable to find where Dr. Knabe's case was published. Such cases frequently die from cardiac degeneration followed by dropsy, the result of scarlatina; the dose was so small, only four to twelve drops—the exact amount not determined—of a four per cent. solution. Now we come to Dr. Simes' case. In reading this case over carefully, we are of the opinion, from the symptoms and the post-mortem record, that the man had been an epileptic; and again a twenty per cent. solution is too strong, and should never be employed in the urethra or rectum, as it enters the veins by endosmosis, and it also acts upon the spinal nerve and has been found a true cerebro-spinal excitant in large doses. The dose internally is one-sixth, one-fourth, one-third of a grain. We find that with a two per cent. solution with acid carbolic gr. x to the oz., we obtain all the results we desire if repeated, and if possible controlled by position, or a ligature as suggested by Corning, of a rubber tube.

The case reported by Abadie is very imperfect in its details, and cannot be received until further information is obtained; still, we consider it our duty to publish all the cases of alleged deaths, so as to induce a proper caution in persons who have never employed the drug, just as we would do in prescribing morphia and other powerful alkaloids.

In the two cases reported by Zamibianchi and Mentalti, the first was an epileptic, and the second one afflicted with phthisis. In both cases the doses were too large.

Morbid Changes in Acute and Chronic Poisoning of Dogs by Cocaine.

Dr. Vasily M. Zautchevsky, of St. Petersburg, has published an Inaugural Dissertation, 1888, p. 39, analyzed by Dr. V. Idelson, *London Medical Recorder*, December 20, 1888. These experiments were conducted under the guidance of Prof. N. P. Ivanovsky, and were made on healthy adult dogs. In one group the effects of lethal doses, and in another chronic poisoning were studied.

I. Acute poisoning was induced in five animals whose body's weight varied from five thousand to nine thousand one hundred grammes (about ten pounds) by injecting from .15 (about 2 grains) to .27 gramme (or .03 per one kilo) of cocaine, the animal dying in from five to sixty minutes after the injection. The train of toxic symptoms was fairly uniform. For a few minutes after the injection the dog either did not present anything abnormal, or fell into a kind of stupor; then there appeared dilatation of pupils, restlessness, extreme dyspnœa and acceleration of the pulse, and in fifteen minutes attacks of clonic spasm, lasting for half a minute or so, and alternating with paroxysms of typical Cheyne-Stokes breathing; later, there supervened complete general anæsthesia, dilatation of the palpebral slit, congestion of the conjunctiva, lachrymation, cyanosis, loss of consciousness, incontinence of urine and fæces, stertorous breathing, tremor of the whole body, progressive failure, and retardation of cardiac action.

II. Chronic poisoning was brought about in four dogs (weighing from five thousand six hundred to eight thousand two hundred grammes) by injecting cocaine in doses gradually ascending from three or four (about .5 per one kilo) to ten or sixteen centigrammes a day, the whole amount taken during the experiment varying from 1.08 to 7.8 grammes, and death ensuing in from forty-three to one hundred and seven days. The initial small doses gave rise to acceleration of breathing and pulse, fleeting (fifteen minutes) general restlessness, also consecutive weakness of the animal's hind limbs, followed by rise of the rectal temperature (3° to 5° C.) the symptoms disappearing in about three hours. Increased doses produced the same and even more pronounced and prolonged symptoms. The 7 centigramme doses induced sometimes manege movements of two or three minutes' duration, with extreme restlessness, followed in four hours or so, by extreme weakness, and lassitude. The 8 centigramme doses gave rise to stupor, with high dyspnœa, acceleration of the pulse, and mydriasis of two or three hours' duration. The 1 decigramme doses caused complete narcosis, rise of the rectal temperature (1° C.), decreasing sensibility, and other symptoms of acute poisoning. In two of the animals, there occurred several attacks of clonic spasm. Both of them died suddenly after a convulsive paroxysm, with consecutive profound prostration. The other two sank gradually from progressive extreme cachexia (which, however, was more or less pronounced also in the two former dogs).

III. Morbid lesions, either in acute or in chronic poisoning by cocaine, did not represent anything characteristic or pathognomonic.

A. Microscopical Examination.—In acute poisoning there were invariably found all those alterations which occur in cases of fatal asphyxia, such as dark fluid blood, engorgement of the thoracic veins, dilatation of the right auricle and ventricle of the heart, venous congestion and œdema of the lungs, extravasations under the pleuræ, pericardium, endocardium and gastric mucous membrane, cyanotic liver, contracted spleen, moderate hyperæmia of the brain and spinal cord, and a more intense one of the meninges. The same changes also were present in these two cases of chronic poisoning which had terminated suddenly, while in the eminently cachectic two cases there were detected extreme anæmia and dryness of all the organs, except the brain, medulla oblongata, spinal cord and cerebro-spinal meninges, which were intensely congested.

B. Microscopical Examination.—Blood did not present any structural changes.

Lungs.—In acute cases there were present dilatation of the alveolar vessels, with extravasations and occasional collapse of the alveoli; opaque swelling of the alveolar epithelium, hyperæmia and extravasation in bronchioles.

Liver.—In acute poisoning there were found opaque swelling and granularity of hepatic cell, hydropic and granular degeneration of the epithelium of gall ducts, serous infiltration of the interlobular connective tissue, engorgement of the interlobular and central veins, with occasional small-sized extravasations in their neighborhood, and a distinct increase of glycogen in hepatic cells. [The latter statement is in accord with Professor Tarkhau-Mouravoff's observations, according to which large doses of cocaine rapidly gave rise in dogs to glycouria of about five hours' duration; *vide* the Iürnal dla nomali Patolog., Heslolog., etc., Vol. VI.] In chronic intoxication, Dr. Zautchevsky found atrophy and albuminoid degeneration of hepatic cells, atrophy of the interstitial tissue and atrophic attenuation of vascular walls. Heart presented considerable lesions in every one of the cases. In acute poisoning there were found initial signs of albuminoid degeneration of muscular fibres, minute extravasation in the sub-pericardial and a lesser in the sub-endocardial and interstitial connective tissue, tumefaction of the endothelium of capillaries, opaque swelling and (non-fatty) granularity of many cardiac ganglia, with indistinctness of their nuclei. In cachectic chronic cases the degenerative (albuminoid and fatty) changes were still more pronounced, the muscular fibres having lost their striæ, being intensely granular, while the vessels were empty and their walls atrophied; the cardiac ganglia presented extreme fatty degeneration and atrophy of their cells, with changes in the protoplasm, their nuclei being extremely indistinct. The medulla oblongata, especially the spinal cord, proved to have undergone still more profound alterations. In acute cases there was invariably albuminoid degeneration of ganglionic cells of the medulla oblongata, anterior and posterior horns, Clarke's columns and Roland's gelatinous substance, and the spinal changes being especially pronounced in the regions of the cervical and lumbar enlargements.

There were found, further, dilatation of perivascular spaces, small extravasations in the gray matter, and occasionally mucoid degeneration of the epithelium of the central canal. In chronic poisoning, side by side with the same (but more intense, and more extensive,) degenerative lesions, there were detected hyaline degeneration of nerve-cells in the spinal gray matter, engorgement of veins and capillaries, (especially in the gray substance) and such changes of vascular walls as proliferation of their nuclei and hyaline degeneration, with consecutive varicosity of the diseased vessels. All those lesions in the medulla and spinal cord had a circumscribed character—that is, were scattered in a patch-like manner over various districts of the organs. Dr. Zautchevsky is inclined to think "the degenerative changes arising in the nerve-centres, under the influence of cocaine, may be partly explained (apart from a still obscure specific action of the alkaloid on the nerve elements) by a disturbance in the circulation of the central nervous system which is caused by the drug." In acute poisoning, cocaine brings about, in the first instance, a rise of the blood-tension, with a consecutive diminution in the supply of arterial blood; a subsequent fall of the blood-tension and a synchronic disturbance of breathing, leading to a profound alteration of the blood in regard to its gaseous ingredients; hence the altered blood becomes an additional irritant agent, and there arise disturbances in the nutrition and degenerative changes of the nerve-cells. It would be superfluous, of course, to dwell on an extreme sensibility of the nerve tissue towards any slight deviation in the circulation or the composition of blood.

In conclusion, Dr. Zautchevsky draws attention to a close similarity between the morbid lessons in the nerve-centres as found by him in cases of cocaine poisoning, and those detected by Dr. Cziz in cases of acute and chronic poisoning by morphia and atropia (*Meditz. Prebaul. K'Morsk. Sborn*, May and June, 1883), the difference being only a quantitative one; the former are somewhat milder, comparatively, with the latter. Perhaps there exists a still greater similarity between the alterations caused by cocaine and those found in the nerve-centres and their blood-vessels in starvation (as described by Dr. V. Mankovsky, The *London Medical Record*, Feb. 7, 1886, p. 73 and V. Rosenbach, in his "St. Petersburg Inaugural Dissertation," 1883).

Judging from that analogy, Dr. Zautchevsky arrives at the general conclusion that "the cause of those degenerative changes as occur in chronic poisoning by cocaine should be sought in disturbed nutrition of cellular elements, which in its turn depends upon lesions of vascular walls, caused by direct action of the alkaloid." (*Therac. Gazette*, Feb. 15, 1889.)

CHAPTER VI.

Cocaine in Surgery, also in Obstetrics and Gynæcology.

Cocaine Anæsthesia in Femoral Supra-condyloid Osteotomy and Excision of the Hip-Joint.*

Dr. Roberts had obtained anæsthesia for one hour and three-quarters, over a segment four inches broad, with three grains. He had experimented upon a healthy person prior to the operations upon the patients. He had injected only a one per cent. solution, and had been able afterwards to pass needles right through the fleshy part of the arm.

The cocaine employed, was by Corning's method, as follows: Dr. Corning, of New York, first mapped out the course of the veins, rendering them prominent by a moderately tight rubber bandage on the limb, which obstructed the return circulation. He then rendered the limb bloodless by means of an Esmarch bandage. The injection was made very superficial at first, to avoid pain from the needle, and after partial anæsthetization, the extent of the injection could be enlarged. Before sufficient time had elapsed for the fluid to be carried away into the general circulation, the tourniquet was applied at the upper edge of the anæsthetized zone, thus incarcerating the liquid in the field of the operation. If the tourniquet could not be employed on the part operated upon, he made use of hæmostatic rings. By making pressure upon these, the circulation

* Dr. M. J. Roberts reported cases. (See *New York Medical Journal*, October 24, 1885, p. 459.)

could be markedly decreased in the part injected. This method has now been employed by a number of physicians and surgeons in this city, who would testify to its excellent effects. A one, a one-half, a one-third, and even a one-fifth per cent. solution of hydrochlorate of cocaine was sufficiently strong to produce local anæsthesia by this method. But a one-fifth per cent. solution was not reliable. A one or a half per cent. solution was usually preferable.

Cocaine in Minor Surgery and Major Surgery.

If current reports are to be credited, there is apparently no limit to the beneficent action of cocaine. In the *London Lancet*, Dr. J. Herbert Simpson reports the following case:

"Miss B——, whose breast I removed for scirrhus in February, 1884, found a week ago that two small nodules of the disease, each about the size of a pea, very hard and painful, had appeared near the cicatrix of the operation wound. The nodules were about three inches apart. On January 23, I injected three minims of a four per cent. solution of the hydrochlorate of cocaine on either side of one nodule; and, finding that after waiting ten minutes there was no pain on pinching the part, I cut down and removed the nodule, having to make an incision an inch and a half long. The patient felt absolutely nothing of the operation until I inserted the sutures, and that, she said, was hardly to be called pain. After closing the wound, I injected another three minims near the second nodule, and operated in the same way; and although a little pain was felt, owing, I believe, to my not having waited sufficiently long for the third injection to take effect, it was very trifling; and from beginning to end, this operation under cocaine was a decided success. There were no after-effects from the drug, and both wounds are healing by first intention."

About the last use which we have seen recommended for cocaine is its employment as an anæsthetic for the operation of avulsion of ingrowing toe-nails. Dr. F. Peyre Porcher (*Medical News*, July 11, 1885) reports a case in which the instillation of a four per cent. solution of hydrochlorate of cocaine, from the point of a hypodermic needle upon the slightly raw surfaces on each side of the ingrowing nail of the big toe, was perfectly successful in producing complete anæsthesia; a rag wet with the same solution being kept pressed against the upper surface of the toe, and three injections of the same solution being made subcutaneously at the base of the nail. Probably not more than ten or fifteen drops in all were received and absorbed. After the lapse of fifteen minutes the narrow blade of a fine-pointed pair of scissors was passed under the nail, which was divided to the matrix, when the two portions of nail were forcibly extracted without causing any suffering.

The Status of Cocaine in Surgery.*

After a note or two on the history of cocaine as a surgical anæsthetic, in which he accords to Dr. Karl Koller, now of New York city, but five years ago of Vienna, the credit due for its introduction for eye surgery, and to Dr. J. Leonard Corning, of New York City, the credit for its practical application to other surgical purposes, Dr. Wyeth proceeds:

"For hypodermic purposes, take twenty grains of cocaine and three grains of boracic acid and dissolve in an ounce of distilled water—approximately, a four per cent. solution. A stronger aseptic solution is equal parts of distilled water and saturated solution of salicylic acid. Always dissolve cocaine in water free from lime.

"In operations upon the extremities, the circulation may be temporarily arrested. For example, in amputation of the last phalanx of the finger, first immerse the hand for half an hour in a 1:2000 solution of corrosive sublimate. It is best not to Esmarch the finger, but to constrict it with a piece of rubber tubing. *Direct* injections (in the line of incision) retard to a slight degree union and repair of wounds. Hence, employ the *indirect* method (injection about the nerves at the base of the finger) when possible, although this method requires a little longer time and a little more of the cocaine solution. Just before applying the rubber, insert the smallest size hypodermic needle through the skin on the lateral aspect of the dorsum of

* An Abstract of a Paper by Dr. John A. Wyeth, of New York, in *Virginia Medical Monthly*, October, 1889.

the digit, about an inch from and on the distal side of the ligature. Inject about two minims; push the needle a quarter inch farther, and inject two minims more, etc., until the needle-point rests just beneath the skin, on the plantar aspect of the finger, when the same quantity is injected. Thus one-half of the finger is injected, and the operation is immediately repeated on the other half—the entire operation not occupying more than 30 seconds. A smarting, burning pain is felt as the fluid enters. Tighten the tourniquet at once, thus holding the solution at a standstill for absorption, which may be hastened by massage over the injected area. Insensibility supervenes in about two minutes. Usually about 15 minims are sufficient, but 30 minims may be thus used safely.

"The operation being finished, loosen the band *for only a minute*, which restores the circulation, and (under sublimate solution) the wounds bleed freely, thus giving escape to whatever of the solution the arterioles may have absorbed; but of course a certain amount is carried into the general circulation. Tighten the rubber again for about two or three minutes, and insert sutures and apply the dressing. Gradually accustom the general circulation to the cocaine by alternately loosening and tightening the tourniquet. The heart and nerve centres might be overwhelmed if the entire excess is suddenly let loose into the general circulation.

"The advantages of the *direct* method are: Rapidity of anæsthesia; the small quantity of cocaine used; escape of much of the solution through the wound of incision. This method is preferable for incising felons, removing diseased nails, foreign bodies, etc. Indeed, any procedure where the necessary anæsthesia can be obtained by not more than a drachm of a four per cent. solution may be safely done with this agent by the direct method.

"In operations upon the trunk, the immediate absorption of the solution renders greater precaution necessary. For instance, if a fatty tumor is to be removed, insert the needle into the deepest layers of the skin (not subcutaneous fat) along the line of proposed incision, and inject half-minim or minim; advance the needle a quarter of an inch, and repeat the injection, and so on as far as the needle will reach from the original puncture. Repeat the injections, if necessary, for a length of three inches until anæsthesia is established. The anæsthesia is evident by the pallor of the overlying cuticle. Divide the skin through the middle of the anæsthetized line, and continue the dissection laterally until pain is experienced. Insensibility often spreads an inch or more on either side of this line. Inject a half minim or more at all sensitive points in the line of incision.

"Since scars are to be avoided, cocaine is not so free from objections on the face and neck as elsewhere. In eye surgery, the uses of this agent are too well known to require remark. In the buccal cavity, it has a wider range of application. Tumors of a half inch to not more than an inch can be painlessly excised. Small epitheliomata or suspicious ulcers are painlessly removed from tongue, when 5 to 20 minims of a 4 per cent. solution are injected beneath and around their bases. He has twice dissected out ranulæ successfully. Complete cleft of the soft palate in the adult can be painlessly closed by applying the solution to the mucous surface with a brush. Cocaine is in every day use for the larynx, nose and nasopharynx.

"For internal urethrotomy, regardless of location, he rarely employs general anæsthesia now. Disinfect the urethra with boracic acid solution (gr. x to ℥j); inject ʒj—ij of a 4 per cent. solution of cocaine with the ordinary P syringe. At the end of a minute or so, let all of the cocaine solution that will run out of the urethra run out. If the operation is to be in the membranous portion, pass the long curved tube of Otis into the part, and inject from 20 to 30 minims. For the introduction of the sound on the third day after urethrotomy, be careful not to over-distend the canal with the preliminary cocaine injection; about a drachm of the solution is then as much as should be used. For bladder examinations, cocaine is very useful.

"Circumcision in adults no longer requires general narcosis. Constrict the penis near the pubes, pull forward the prepuce, and enter the hypodermic needle at the free border in the middle line on top, *between* the mucous and cutaneous layers. Then carry the point of the needle back as far as the proposed line of section, and force out one minim of the 4 per cent.

solution. Withdraw the needle half way, carry forward again to the right and left, and force out a minim for every quarter of an inch of the line of section. On account of the sensitiveness about the frenum, it is best to inject two or three minims here.

"In Levis' operation for hydrocele, cocainize the point where the trochar is to enter. If the hydrocele is small, Volkman's operation may also be done with cocaine anæsthesia. In the open operation for varicocele, cocaine is not sufficient; nor is it sufficieut for external urethrotomy, cystotomy, hernia, etc. But small hemorrhoids may be injected or cut away after cocaine injections. Cocaine is sufficient, also, for fissures and ulcers of the anus and rectum. It is, also, sufficient for a single and superficial anal and rectal fistulæ."

Cocaine in Hemorrhoids, Fissures, Fistulas, and Diseases of the Anus.

The use of cocaine in diseases of the anus, hemorrhoids, fissures, and fistulas, has not always been a success, as proven by the use of the drug by Dr. James Collins, surgeon to the German Hospital in this city, in operating for bleeding piles; and Dr. P. D. Keyser, in a case of fissure of the anus. The first found it had no anæsthetic properties in relieving the pain of the operation, and the latter, that the pain and burning sensation were increased by its use in his case of fissure. Yet, on the other hand, surgeons have reported its successful use in this country, and abroad, the most recent being with Dr. Bettelheim, of Vienna, who reports the case of a patient, aged seventy-four, who had a well-marked anginal attack (*London Lancet*, January 17, 1885), who also had rectal and vesical tenesmus, with enlarged prostate. Cocoa-butter suppositories were ordered, each containing half a grain of muriate of cocaine. One of these was introduced into the rectum at bed-time, and the patient slept well, and was not troubled during the night. The beneficial effects were apparent the whole of the following day. The suppository was not given that evening and the patient passed an uncomfortable night, being very restless. The next day another suppository was ordered, and acted as well as the first.

In the operation for hemorrhoids by Dr. Joseph M. Mathews, of Louisville, Kentucky,* it is stated as his experience, after one thousand operations "in the removal of external piles, much benefit is derived from cocaine, strength not given, from throwing the solution under the growth." In the operation for internal piles he has found it of little value.

A more recent communication on the subject:

KENTUCKY SCHOOL OF MEDICINE,
Louisville, Ky., Dec. 25, 1888.

DR. LAURENCE TURNBULL, Philadelphia.

Dear Doctor:—Your favor received. In answer to the question "what anæsthetic I prefer in operating for hemorrhoids?" would say that it is invariably my custom to use chloroform. I have used it in many hundred cases and never had a death. It is always my custom to precede its use by a good drink of whiskey. I employ very seldom cocaine in operations around the rectum and anus, for the reason that I regard it as both dangerous and of little service. Where a superfluous amount of skin has to be removed from around the anus, I sometimes inject from ten to twenty drops of a four per cent. solution into and under the same. In operating for internal hemorrhoids I never employ it.

Cocaine in Operations on the Bladder and Urethra.

We would call attention to the value of cocaine in operations upon the bladder and urethra, in preventing damage to an unhealthy kidney, also in the differential diagnosis of urinary disease. If a real pain is relieved by cocaine, the neuralgia is probably due to a slight irritation such as that experienced in lithiasis congestion or grit. The editor of the *Lancet* states, that cocaine is now being largely used in these affections, in ointments and suppositories, in many of the London Hospitals.

Cocaine being insoluble in oily and fatty substances, it is advisable, in cases where it has to form an ingredient of a pomade or suppositories, to first dissolve it in oleic acid by small quantities at the time. Treated in this manner, the cocaine will assimilate itself with the greasy substance and a homogeneous preparation will be obtained.

* Trans. Am. Med. Assn.

Circumcision Under Cocaine Anæsthesia.*

"In the imagination, a few operations like the following may have occurred, but as far as recorded instances of the kind are concerned, we believe there are none. In the first place a subject is required possessing age, liberal scientific views, sound mind and excellent health. The subject of this sketch is a gentleman possessing all these requisites, with the chief requisite necessitating the operation for phimosis. His recent life has shown remarkable strength of mind and body. Naturally jovial, and quite delighted to impart the knowledge he possesses regarding the earlier history of this city, he can dilate upon its growth, commercially, financially and politically.

"He has suffered severely at times during micturition,—from the prepuce adhering to and about the meatus urinarius; the penis was usually, with the preputial folds included, drawn down at least one-third and frequently one-half an inch below the abdominal surface of the surrounding pubes; the pain was necessarily mischievous, from irritation, during micturition; the preputial adherent folds about the meatus caused a divided and frequently a spraylike stream, which now and then—say every six or eight weeks—would cause a 'spell' that frequently lasted several days; recently one of these 'spells' became so troublesome that medical aid was summoned, and it was decided to perform circumcision. The gentleman's age being considered, and feeling that three heads are better than one, Dr. William Stevens called Dr. William M. McLaury as counsel in the case, and invited Dr. M. Josiah Roberts to perform the operation, which was beautifully done, and the patient is at present—two months after the operation—in fine condition, with a splendid chance of a much longer life, without further inconvenience from the penis that should have been treated in like manner just ninety years and ten days before.

"Only a local anæsthetic was used in this operation. A two per centum solution of hydrochlorate of cocaine was hypo-

* *New York Monthly*, Nov., 1886, p. 107.

dermically injected into the preputial folds, anterior to the rubber-cord bandaging at the base of the penis; the local anæsthesia being so perfect that telling anecdotes was the manner the patient passed the entire time until the operation was completed; no untoward symptoms occurred, and perfect healing of the parts by first intention, with complete recovery, followed within a few days."

Cocaine in Obstetrics and Gynæcology.

ANALGESIA OF THE GENITAL PASSAGES OBTAINED BY THE LOCAL APPLICATION OF COCAINE DURING LABOR.— Dr. Doleris, having a case of placental polypus (?) occurring in consequence of abortion, and having to deal with an uncontrollable vaginal spasm, making examination very difficult, succeeded in completely suppressing the pain and irritability by the application of cocaine, used a quarter of an hour before the operation. (He used hydrochlorate of cocaine in solution of 5 : 100.) This encouraged him to undertake, with Mr. Dubois, a series of analogous experiments upon women in labor. They used a solution of hydrochlorate of cocaine 4 per cent. : 100, mixed with lard in eight cases. In six of these cases the result was very marked. With a case of a primipara, in which dilatation of the cervix caused severe pain, after one or two minutes following the painting of the cervix with cocaine, perfect relief was afforded. With the others, during the period of expulsion, the pain was only in the uterus, and allowed them to assist freely by muscular contractions. With two of the cases there was no effect produced, showing that there are unknown factors which retard or prevent the action of cocaine. These cases received before and at the beginning of labor, injections of corrosive sublimate—1 to 2000 solution. The genital mucous membrane became thoroughly saturated with this solution, a part necessarily remaining in the vagina. The sublimate decomposes the alkaloids very rapidly, and there is no doubt but this fact exerted a strong influence in these two cases. The amount of the preparation of cocaine necessary for the purpose was from 50 to 60 drops of the 4 : 100 solution, or 3 to 4 grammes of the ointment, which was absolutely free from danger. The regular progress of the labor was not retarded, and it was only the general sensibility that was blunted; the reflex sensibility remained normal. The uterine contractions continued with their usual intensity, duration and frequency. These observations were communicated by Dr. Doleris to the Société de Biologie (Seance du 17 Janvier, 1885). Since then he has added seven cases to his list and concludes:

1. That cocaine exerts no influence on the pains of uterine contractions, but they do not become excessive.

2. That but little pain exists after analgesia, the cocaine affording relief to that pain which occurs in consequence of distension and irritation of the nerves of the supravaginal and intravaginal portions of the neck of the uterus and of the vagina itself.

3. That no relief is afforded against the severe pain which is due to compression of the nerve trunks of the pelvis.

4. That the pain felt in the mucous membrane and in the vulva on expulsion is perfectly relieved. Expulsion is painless and very rapid, lasting from ten to fifteen or twenty-five minutes. Dr. Doleris intends to continue his observations by studying the influence, as an analgesic, of bromide of potassium alone or combined with cocaine. (*Archives de Tocologie*, etc., Feb., 1885. *Journal Am. Med. Assocn.*, April 11, 1885.)

Cocaine in Dysmenorrhœa.

In the *Medical News*, Dr. John Forrest relates the case of a patient who had suffered for years from painful menstruation, accompanying a retroflexion of the uterus, complicated with adhesions. The deformity of the uterus had been rectified by treatment, but the pain during the menstrual period was still as agonizing as ever. The most acute and intolerable anguish was felt in the left inguinal region, and was accompanied by a wind colic that caused the sufferer to writhe in agony. Nausea and vomiting added to her distress, and she seemed at times ready to go out of her mind with suffering.

While attempting to effect a permanent cure of this condition by appropriate treatment, temporary relief by the administration of morphine was all that could be afforded; at the same time, that drug produced such disagreeable effects, that the remedy was only not quite so bad as the disease. But on one occasion, instead of morphine, Dr. Forrest used cocaine, injecting subcutaneously over the left ovary at first three, increased afterwards to five, mimims of a four per cent. solution. Almost immediately after each injection the pain in the inguinal region ceased to be felt, the nausea and wind colic were relieved, and, instead of nervous excitement and wakefulness, a soothing effect inclining to sleep was experienced. Five mimims of a four per cent. solution were sufficient to afford complete relief for five or six hours, and comparative immunity for a much longer period.

While, however, the drug acted thus admirably, both locally and generally, it had no effect, apparently, on the bearing-down pains and pain in the back, but only upon the local pain in the neighborhood of the spot where it was injected. It was also noticed that, while it relieved the nausea and vomiting of reflex origin, it sometimes caused slight nausea itself, but this was only temporary. No other unpleasant effect was experienced, if we except a slightly bitter taste imparted to the tongue.

If cocaine can thus be made to supersede morphine in such cases, it will certainly prove an inestimable boon to many an unfortunate sufferer. And if it is able to relieve that excruciating intestinal pain usually called wind-colic, which in so many cases is sure to follow the slightest surgical interference with the uterus, this of itself will be no mean trophy added to its many wonderful triumphs over human suffering.

Cocaine in Vaginismus.

In the *Medical Press*, we read that Dr. G. De G. Griffith has found this new and greatly-vaunted remedy useful, in the above condition. Speaking of a case of vaginismus and dysparæmia, he says:

"The patient came to me suffering very acutely; not only was pressure on the perineum exquisitely painful, but the bare touching it was pain; indeed, blowing on it produced distress, and so intolerable was the suffering that examination had to be completed under chloroform. On the third occasion of attending the patient, I mopped the perineum, fourchette and lower part of the vagina with a solution of the cocaine, after which I was able to introduce the large-sized Fergusson's speculum, which was retained for about two hours, as steady, continuous pressure had been found to give relief. I wish particularly to draw attention to the ease procured by the cocaine, although it was transient."

Mr. John Phillips publishes in the *London Lancet*, Nov. 26, 1887, *Jur. Gazatten*, Jan. 7, 1887, an analysis of the more important contributions to the subject of cocaine in obstetrics, with the practical conclusions which we give in brief: 1. That cocaine in whatever way administered, for uncontrollable vomiting in pregnancy, is a superior drug to those at present in vogue. 2. That during the earlier painful stages of labor, especially in primipara, it materially assuages the pains, but neither quickens nor retards their onset, and hence has no effect on the actual dilatation. 3. That it is useless in mitigating the pains of expulsion and those caused by pressure on the perineum. 4. That in the case of sore nipples it relieves the pain attendant on suckling, though the duration of its effects is not sufficiently long to be of material service. It is, however, without any apparent detrimental effect upon the suckling.

The French and Italians allege, and with good cause, that they have met with brilliant success in the employment of cocaine for the alleviation of pain, in diseases of, or operations on, the uterus, pelvic or external organs in the following cases: Vaginismus, ulceration of the cervix, advanced cancer, alleviating the pain caused by caustic in sub-cutaneous injection in such cases. Simultaneous injections of cocaine and morphia produced even better results.

Means to Prevent the Injurious Effects from Cocaine by Local Anæsthesia in Dentistry and Minor Surgery.*

Dr. Aubeau, of Paris, employs in his experiments a solution of cocaine, 5%, that is to say, that in every Pravaz syringe containing a gramme of distilled water, he dissolves only 5 centigrammes of cocaine, an insufficient quantity for cases where the roots of the teeth are firmly set in the alveolar process.

Mr. Telschow injects 10 centigrammes of cocaine, evidently too powerful a dose, as it produces general trouble in a number of cases.

Prof. Viau combines another local anæsthetic with a small quantity of cocaine, 5 centigrammes, which unites in acting with the cocaine without affecting the general health. This second substance is pure crystallized phenic or carbolic acid. This acid neutralizes the effect of the solution of cocaine, and has been used with success. Mr. Telschow weakens his solution of cocaine with the phenic acid to neutralize it. The author finds an important agent in the acid, the anæsthetic properties of the pure or concentrated acid being known to all who have used it. It is the anæsthetic, *par excellence*, of intelligent dentistry. The author now describes his two modes of administering anæsthetics:

"1. Anæsthesia by the aid of sub-mucous injections with a mixture of cocaine and phenic acid.

"2. Anæsthesia by the aid of sub-mucous injections with a solution simply of phenic acid.

"LOCAL ANÆSTHESIA OBTAINED BY THE AID OF COCAINE AND PHENIC ACID MIXED.—Before beginning to describe this process, I should relate an experiment that I made for the purpose of investigating the properties of a solution of pure cocaine (alkaloid) in the pure crystallized phenic acid. In mixing one part of phenic acid and two parts of cocaine,

*Extract from a monograph by Prof. George Viau, officer of the Academy, Professor of the Dental School and Hospital, Paris; Secretary General Association of Dentists in France; Member of the Council for the Direction of the Dental School.

heating it very slightly, a product of a syrupy quality is obtained, which retains the color of the pure phenic acid, but dissolved; that is to say, rosy; and the odor weakened by the acid. The taste on the contrary is decidedly modified. The phenic acid has lost its causticity, and its peculiar taste. In using this product upon the gums or tongue, a sensation of warmth is perceived with the taste of the weakened phenic acid, allowing the bitterness of the cocaine to penetrate. At the end of several seconds the taste and the odor of the phenic acid disappear completely, at the same time that the sensation of heat is perceived at the moment of contact; the taste of the cocaine alone remains, with complete insensibility to pain.

"Have I obtained in this manner a phenate of cocaine, or have I produced a simple solution? I leave to those more competent the solution of this question.

"However it may be, I have a product which fully answers my requirements. Below is a succinct description of my operative procedure, thus:

"1. The filtered solution:

Crystallized phenic acid	2 gr.
Distilled water	100 gr.

"2. Packages of hydrochlorate of cocaine. A syringe of Pravaz, containing a gramme of water, in which I made a slight modification by adding to the opposite side of the canula a shoulder-piece, enabling me to hold it with greater ease and strength, with the index and middle finger, whilst I press the stem of the piston with the thumb. I have also invented sharp canulas of different lengths, which are absolutely necessary, in difficult cases of contraction of the jaws, to reach the wisdom teeth. I dissolve, when required, 5 centigrammes (or 1 grain) of cocaine in 50 centigrammes (10 drops) of phenic solution, and inject slowly half of the mixture into the 'labial face,' half into the lingual or palatine—at a point situated between the neck of the tooth and the presumed place of the extremity of the root, to within 2 or 3 millimetres of that extremity. I am careful to hold a finger, of the left hand, upon the puncture, to prevent the liquid from flowing backwards. The patient must then wash out the mouth with fresh water. At the end of three minutes the soft parts are completely insensible. A very deep puncture is no longer felt. Between the fifth and sixth minute I operate. This process has always given me complete results, as regards anæsthesia. As to general troubles I have never tried them. Sex and age appear to have no influence on the anæsthetic results. I have operated upon 30 males and 56 females—total, 86 subjects. It will be seen in the table * of observations that several subjects have received the anæsthetic twice at the same sitting, without having been otherwise affected. These patients have, however, absorbed, in a lapse of some minutes, 10 centigrammes of cocaine in a gramme of phenic solution. Other patients have undergone, with several hours' interval, two or three operations, always with success. I have also observed that the patients upon whom I operate for the second or third time have lost all fear. In submitting thus to the operation, it is evident that this facilitates many anæsthetic injections—a work requiring great precision. Observations show that the half of the ordinary dose of anæsthetic—that is to say, about 2 centigrammes, ½ gr. of cocaine in 25 centigrammes of phenic solution—has sufficed to produce anæsthesia."

In conclusion, he thinks he will be able to diminish hereafter the quantity of cocaine, and to inject less liquid under the gums; altogether, obtaining a complete local anæsthesia for the extraction of teeth.

We were highly delighted to find, from the pamphlet of Prof. Viau, that he had been able to modify the hydrochlorate of cocaine in solution with pure phenol, so as to prevent, in 87 cases, any unpleasant results from its use in the extraction of teeth. The solution was prepared as directed by the Paris Dental Surgeon, and before a class of about 200 students, the mixture was injected into the jaw, in a case of diseased antrum in a young lady. She was then operated upon by Dr. Garretson, who removed the diseased bone with the dental engine. She bore the operation with great equanimity, and

* Not given on account of the want of space.

with so little pain as to be unnoticed by the students; and when asked at the completion of the operation, she stated that she experienced some slight pain. The case was an interesting one, in its freedom from excitement and haste, and the quiet way in which she would rise, expectorate the blood, and be cleansed from the horrible disfigurement, avoiding the great risk produced by profound anæsthesia, which is so nigh unto death, required in such an important operation.

A little girl was also operated upon, for the extraction of teeth; she cried when the hypodermic syringe pricked her, yet in seven minutes the very much decayed tooth was extracted without the slightest evidence of pain. We think this combination has a wonderful future, and we have used it continuously in office work and in operations with success.

Cocaine in Intra-nasal Surgery.

(1) We have found cocaine is useful in intra-nasal surgery, as a local anæsthetic, for the removal of deep as well as superficial tissue abnormalities.

(2) Repeated applications are required for the removal of the deeper structures, the time requisite for anæsthesia always being shorter after the first effect has been obtained.

(3) By promoting quiet and preventing secretion, hemorrhage and sneezing, it facilitates the employment of cutting instruments within the nasal cavity.

(4) The action of cocaine for profound anæsthesia depends upon the quality and the quantity of the salt.

CHAPTER VII.

Therapeutics of Cocaine—Gastritis produced by Poisoning treated by Cocaine, and Affections of the Stomach, Tetanus, Skin Disease.

Cocaine in Gastritis Produced by Poisoning.

In a recent case published by a physician* in Scranton, Pa., a young girl, after an unsuccessful attempt at suicide by laudanum, took "Rough on Rats." She was given ipecac and

* Dr. J. Emmet O'Brien.

sulphate of zinc, also large quantities of dialized iron and lime water. Two grains of morphine were administered hypodermatically in divided doses during the night, and the woman was kept anæsthetized by means of chloroform and ether for twelve hours. Whenever the anæsthetic was withdrawn, the patient would rebel, and was with difficulty held by three persons when not profoundly under the influence of ether. Twelve hours after the poison had been taken, the girl was still in terrible agony, and showed signs of collapse. It was suggested by another physician that over half an ounce of a four per cent. solution of cocaine hydrochlorate (about ten grains) should be administered, it being supposed that all the arsenic had been vomited or neutralized, and that gastritis had set in. In a few minutes the patient ceased to complain of her stomach, the mania subsided, and the anæsthesia was discontinued. The pulse grew stronger, and the woman was soon able to walk with assistance.

Cocaine in Affections of the Stomach.

Cocaine has been found most useful in certain affections of the stomach. From the researches and clinical observations we arrive at the following conclusions: 1. That cocaine exerts on the mucous membrane of the stomach, and that of the digestive tube, an action as certain as on the external mucous membranes; 2. That for this action to be as complete as possible, one must facilitate the impregnation of the gastric and intestinal mucous membranes by promoting their secretions. Hence the advantage of associating cocaine with alkalies.* For the action to attain its maximum duration, one must add to this mixture very small doses of morphine.

Cocaine in Persistent or Uncontrollable Vomiting.

From the peculiar action of cocaine upon mucous membranes and vascular tissue, it was supposed, theoretically, to be capable of diminishing the sickness of pregnancy and other severe irritation of the stomach of a reflex character. It has been tested in a number of cases with more or less success.

* It must be remembered that caustic alkalies decompose the cocaine.

Cocaine in Lavage or Gavage.

In the act of inserting the stomach pump or tube, there is almost always pain and spasm, due to the contractions which take place on the isthmus of the fauces, which may be obviated by painting with a two per cent. solution of cocaine. It has been found very valuable in certain spasmodic and even permanent stricture of the œsophagus; where dilatation is required, a two per cent. ointment is applied to the tube.

Cocaine in Boulimie or Insatiable Hunger.

This peculiar intense and insatiable hunger or canine appetite is peculiar to pregnancy, and can in some cases be relieved by small doses of hydrochlorate of cocaine, $\frac{1}{20}$ to $\frac{1}{10}$ or even $\frac{1}{4}$ of a grain taken at intervals, in pill form, while in the recumbent posture.

Tetanus treated by Morphia and Cocaine.

Lopez is quoted by the *Journal of Nervous and Mental Diseases*, for December, 1887 (*Medical News*, January 28, 1888), as reporting in an Italian journal, the following case: M. G., fifty years old, having worked in the cold and wet, complained of rheumatic pains in the back and extremities. Three days after, he had an attack of opisthotonus, painful spasms, and all the symptoms of idiopathic tetanus. Morphine and chloral hydrate were prescribed. For three days the patient, under the influence of these medicines, had little pain; but there was increased muscular rigidity and spasms. At last he was unable to swallow, and death was believed imminent. Injections of morphine were without effect. Then the writer injected three syringefuls of a mixture of morphia and cocaine, five per cent. of each. The effect was immediate. After two hours he could move the extremities, open his mouth and turn himself in bed. The next day he continued to improve. There remained a slight trismus, and a little rigidity of the neck. A quarter of a syringeful of the same solution was injected in each side of the neck, and the day after all the symptoms had disappeared.

Cocaine in Skin Diseases.

Lustgarten (*Wiener Med. Wochenschrift*, November 12, 1887) states, what we demonstrated soon after cocaine was discovered, that where the epidermis is in contact, cocaine applied to the skin is not absorbed; but where the horny layer is thin, absent (removed by alkalies, alcohol or chloroform), it acts. A two per cent. solution used several times daily, allays the itching in acute and sub-acute eczema, being especially valuable in eczema of the anus and genital regions of both sexes. In the form of ointment he employs oleate of cocaine, from 6 to 15 grains; lanolin, 4½ drachms; followed by the use of a dusting powder (two of the best are finely-powdered talc or lycopodium). In pruritis ani, suppositories may be made containing three-fourths of a grain of oleate of cocaine. The author cautions against the toxic effects of cocaine, three cases of this kind having been encountered when only three-fourths of a grain had been used.

Treatment of Chilblain.

Apply with cotton or wool a four per cent. solution of cocaine for ten minutes; then remove the cotton, and cover the parts with compound tincture of benzoin. This repeated a few times will entirely relieve the pain and irritation. A valuable ointment for the same disease is equal parts of oil of turpentine and compound rosin ointment. Apply by rubbing in the ointment near a hot fire at bed-time. Another salve is recommended by Dr. Lassar:

℞	Acid carbolic cryst.	gr. xv.	
	Ung. plumbi	ʒ v.	
	Lanolin . . . . āā	ʒ iiss.	
	Oil Amygdal. } Oil lavend. } . . . āā	xx.	M.

Cocaine in Intense Itching of the Skin.

In the various forms of pruriginous affections of the skin, cocaine with vaseline or a two per cent. solution in alcohol will allay the distressing itching of the skin.

Cocaine in Burns.

Either the solution or ointment of cocaine has the great advantage of dissipating the intense pain of severe burns when in a two per cent. solution.

Cocaine in Anal or Vulval Pruriency or Painful Herpes.

℞ Cocaine oleat. . . . 40 to ½ gramme (gr. viiss. to xvss).
Lanolini . . . . 18 grammes (℥ v.).
Ol. oliv. . . . . 2 grammes (gr. xxxi.).

To be used several times a day.

—*Gaz. Hebe. des Sci. Mede.*, Montpellier, Jan. 14, 1888.

Cocaine in Cracked Nipples.

A two per cent. powder of hydrochlorate of cocaine and starch, applied to the fissure in the nipple of nursing women, covered with collodion, will relieve the distressing pain. The same good results follow fissures of the skin of the hands during very cold weather. A few inveterate cases require first to touch the fissure with a fine pencil of nitrate of silver, very gently.

CHAPTER VIII.

Cocaine in Acute Catarrh, Coryza, or Cold in the Head, Hay Fever, Whooping-Cough, Pharyngitis, Paroxysmal Sneezing, Asthma.

Cocaine in Acute Catarrh, Coryza, or Cold in the Head.

In acute catarrh, or cold in the head, we have a condition of engorgement of the blood-vessels in the nasal mucous membrane, and the secretion, which at first is thin and watery through hyperstimulation of the glands, soon becomes more charged with broken-down epithelial cells, lymph corpuscles, pus globules, etc., until it assumes the character of thick, tenacious mucus, or muco-pus. If cocaine be applied early to the membrane in a case of acute coryza, its constringing influence on the membrane must diminish the blood supply, and thus prevent the engorgement and transudation. We have tested its abortive action in an attack of coryza occurring in ourselves.

As soon as the initial stage has passed over, and secretion commenced, a four per cent. solution should be applied freely over the interior turbinated bones of each side.

As is well known, the coryza of nursing infants and young children may, by preventing suckling, prove a very serious affection. It can be cured, however, by the introduction into the nasal cavity, six times daily, of a one per cent. solution of the hydrochlorate of cocaine on cotton for five minutes. According to the author, children who previously had obstinately refused to nurse, will commence to suckle a few minutes after the first application of the cocaine, and the coryza is ordinarily cured after about four days of this treatment.*

℞ Hydrochlorate of cocaine . . . . ½ gr.
Very finely powdered starch . . . . 49 grs.
Mix intimately.

Sig.—Use at intervals of about an hour until relieved.

Cocaine in Hay Fever.

Sir Andrew Clark prefers to use a solution of five per cent., applying it to the interior of the nose and back of the soft palate, by means of a large camel's-hair pencil attached to an aluminium shank, and bent at an appropriate angle. For use in the form of nasal bougies, a quarter of a grain or more of the hydrochlorate of cocaine is dissolved in a mixture of gelatine and glycerine, and made of different weights and shapes, according to the peculiarities of the case on which they are to be employed.

Cocaine and Phosphate of Lime in Laryngeal Tuberculosis.

Professor John Schnetzler used phosphoric acid in different degrees of concentration, and even in full strength, applied by means of a brush or the syringe to the larynx, producing pain

* This treatment is made more successful by the spray of the antiseptic tablets of Dr. Seiler; also useful in hay fever to cleanse the parts.

in some cases, which he obviates by the use of the following powder:

℞ Cocaine mur. . . . . 0.1 (gram).
Calci. phosphor. 100
Ol. Menth. pip. . . . . gtt v. M.

Use by insufflations.

Though the remedy has no specific influence on the tubercular process, relief (and under favorable conditions also recovery) has been obtained in several cases; it is also an excellent remedy in all catarrh affections of the upper air passages.—*Jour. Am. Med. Association,* Jan. 21, '88.

Cocaine in Whooping-Cough.

Dr. Weintraub, of Eydknhuen, prescribes the following formula, with good results:

℞ Cocin muriat. . . . . gr. j. ½ to 1 gr.
Aqu.-amygd. amar. . . . . ℥ iiss. M.

Sig.—Ten to fifteen drops several times a day.

—*Alg. Med. Central Ztg.*, 91, 1887.

Cocaine and Resorcin in Whooping-Cough.

Resorcin has been found one of the most available remedies in pertussis, relieving in the bacterial origin of the disease. Since 1885, cocaine has been used as a preliminary to the resorcin, as he found that it lessened the intensity and frequency of the cough before the resorcin had time to destroy the morbific germs. We use a four per cent. solution and an eight per cent. solution of resorcin; and this combination constitutes the best treatment for whooping-cough now at our command.

Cocaine Mixture for Relief of Cough and of Chronic Pharyngitis.

The following formula has been recommended for the relief of the cough in chronic pharyngitis:

℞ Cocaine . . . . gr. iss
Glycerine . . . . f℥ i.

Aquæ dest. . . . . f ℥ x ʒ ii.
Acid carbol. . . . . gr. $\frac{1}{6}$.

SIG.—Apply morning and evening with a suitable brush.

—*Medical News*, April 11, '85.

Cocaine by Insufflation and Inhalation.

A. Inhalation.

℞ Cocaine hydrochlor. . . . . gr. iij.
Potassii chlorat. . . . . ʒ ii.
Aquæ laurocerasi . . . . f ℥ xii. M.

B. Insufflation.

℞ Cocaine hydrochlorat . . . . gr. i.
Morphiæ hydrochlorat . . . . gr. i.
Bismuth sub-nitrate
Sacch. alb. . . . . āā . . . . ʒ i. ij.

Cocaine in Paroxysmal Sneezing.

℞ Sol. of hydrochlorate of cocaine (4 per cent.) ʒ i.
Acid carbolic . . . . ʒ i.
Tinct. camphora . . . . ʒ iss.
Aquæ . . . . ʒ ii. M.

Lotion. Syringe or spray the nostrils each morning with posterior nasal syringe or spray apparatus.

Dr. Da Costa (*Med. and Surg. Reporter*, Nov. 7, 1885), having found solutions of cocaine favorable in rose cold or hay fever, concludes as follows: That the remedy is not radical and, strictly speaking, curative. He has found that it gives great comfort, converts severe into light cases, enables them to remain in their homes who otherwise are obliged to flee to hay fever resorts, and relieves much suffering and distress.

After the suffering and distress are relieved by the cocaine, we have found permanent relief from the spray of a solution of peroxide of hydrogen, one-half ounce to half a pint of pure water. The spray apparatus must be of glass or rubber, as all metallic contact destroys the per oxide of hydrogen.

Cocaine in Asthma.

Mosler, of Greefswald (*Birin. Med. Review*, p. 236, Nov., 1886), points out that cocaine has a central as well as a peripheric local action on the sensory nerve endings, and this central action is at first stimulating, but afterward sedative or narcotic. By both these reactions cocaine ought to be of use in asthma. Beschorner has published two cases in which it was of service, and Mosler in three cases has obtained excellent results. All these were uncomplicated, and occurred in young people of twenty-three to twenty-five years of age. The drug was given subcutaneously in two per cent. solution.

CHAPTER IX.

Cocaine in Diseases of the Eye and Ear.

THE best antiseptic solution, containing a minute quantity (gr. $\frac{1}{20000}$) of bichloride of mercury, may be employed after keeping a few days, if made with pure distilled water. *The injurious results* which were published * from the use of hydrochlorate of cocaine in the practice of Drs. Keyser and Strawbridge, were owing either to the impurities in the solution or to its being too strong. I have found that a strong solution will cause a feeling of roughening and will detach the epithelium of the eye. This will require an infusion of pith of sassafras, with camphorated tincture of opium (a teaspoonful in a coffee cup of the tea), to relieve the disagreeable symptoms. The following is an extract from Dr. Keyser's letter and his mode of using cocaine:

"NOVEMBER 29, 1886.

"I have had no further mishaps with cocaine, and use it constantly for everything. I use only a 2 per cent. solution, and have it made in a saturated solution of boric acid." †

The question of using a *freshly-prepared solution* is of the utmost importance. Cases of irritation and inflammation often occur after using solutions too strong or containing mould. Likewise the syringe must be kept scrupulously clean, and after wash-

* The New Anæsthetic, etc. By Laurence Turnbull, pp. 53. Pamphlet of 76 pages, published by P. Blakiston, Son & Co., Philadelphia, 1885.

† The only objection to the boric acid is that the variety of mould termed penicillum will very soon form in the solution, unfitting it for use, unless made fresh each time it is employed.

ing and wiping, draw a few drops of equal parts of olive oil and liquid carbolic acid up and down the needle, then wipe it dry.

Cocaine in Diseases of the Eye.

Five cases of ordinary catarrhal conjunctivitis were treated successfully, but not worthy of being reported in detail.

Case Sixth. Case of clyclitis, in a young lady of sixteen, C. G., at school, with extreme pericorneal congestion. The pain in the eye was very much relieved by dropping in a 2 per cent. solution of the hydrochlorate of cocaine, and congestion disappeared as if by magic. She was directed colored glasses and not to use her eyes; when the pain returned, to drop in one or two drops of the same solution.

Case Seventh. A gentleman, T. L., aged sixty years, with catarrhal conjunctivitis, which attacks him during autumn and remains most of the winter, increased by cold winds and reading by gaslight. He was suffering from a discharge in the morning and burning through the day. I applied a 2 per cent. solution to the eye with a brush, when he complained of a smarting for a few seconds, but much less than a former solution, which was made with alcohol and water. (McKesson & Robbins' solution is more agreeable, containing a minute percentage of salicylic acid which keeps and makes it antiseptic.) After the smarting had disappeared, he bore without flinching a solution of boro-glyceride, to get rid of the excessive secretions which blurred his vision at night. It also removed the red and irritable appearance of the edges of the eyelid.

Case Eighth. This case is similar to No. 6, only in a lady of 39, who has a great deal of writing to do, and is employed in a book-bindery; but a few applications of the 2 per cent. solution relieved her.

In two of the eye cases, dilatation of the pupil took place; but not for some time after full application; it caused slight dryness, but did not interfere with the vision.

Case Ninth. Case of acute coryza, without pain, but sneezing, complained that when the solution was applied by means of a dropper it caused her pain, but there was no return of painful sneezing, which is in certain families the forerunner of the swelling of the mucous membrane with cold in the head.

Case Tenth. A gentleman aged 37, who has a broken nose and a hypertrophic catarrh on very slight exposure, was attacked on the evening of the 23d of January, with great oppression. Having to ride in the country in an open carriage and stand in mud and ice for some hours, he returned in the evening with a feeling of great distress, and pain in his head, and mucous membrane of the nasal passages much swollen. Two applications of a 2 per cent. solution of the hydrochlorate to the whole surface of the posterior nares at intervals of five minutes, followed with a 5 per cent. solution of the alkaloid in oleic acid, gave him great relief, so that he could breathe and blow with comfort and satisfaction. He was then directed $\frac{1}{8}$ grain of morphia sulphas, and one-hundredth of atropine, to be taken at bed-time.

24th. Still suffering somewhat from the difficulty of the breathing through the nostrils, but a repetition of the application of the oleate relieved him entirely.

Jan. 26. Discharged the patient, cured.

Jan. 27. *Case Eleventh.* Catarrhal inflammation of the eyelids, known as Blepharitis Marginalis, with defective vision, in a school girl, aged 10 years. The crusts around the eyelids were removed twice with a warm 2 per cent. solution of cocaine, after resting for a time; then the eyelids were painted with a solution of boro-glyceride; these two preparations used together entirely removed the redness and gave great relief to the little patient. She was directed to continue the use of the solution of boro-glyceride for some time, not to use her eyes, and wear smoked glasses when in the sun.

Cocaine in the Treatment of Gonorrhœal Ophthalmia.

Mr. A. Leahy reports (in the *Indian Med. Gazette,* July, 1886) two cases of gonorrhœal ophthalmia, in both of which the greatest benefit was derived from application of cocaine. As it is well known, in gonorrhœal ophthalmia it is of primary importance to lessen the inflammation rapidly, to relieve the intense congestion of the conjunctival vessels and reduce chemosis, and by so doing prevent ulceration and sloughing of the cornea. Last, but not least, is the relief of the ocular and circum-orbital pain, which, by its persistence, greatly depresses the patient and prevents sleep. Mr. Leahy employed a mixture composed of one-half grain of sulphate of atropine and four grains of sulphate of cocaine incorporated with 100 grains of vaseline. This mixture was introduced beneath the upper eyelids; and after three days' treatment the chemosis rapidly became less, the discharge diminished in quantity, the pain completely disappeared, and the cornea, which had been hidden by the chemosis, became visible.

Cocaine and Atropia for Iritis.

Guaiaila gives the following as used by many ophthalmologists:

℞ Cocaine hydrochlor	gr. $\frac{1}{2}$.	
Atrop. sulphat	gr. 1.	
Acid boric	gr. iv.	
Aquæ destillat	℥ iiss.	M.

SIG.—One or two drops in the eye every half hour until the pupil dilates.

—*L'union Medicale*, June 25, 1887.

On the Use of the Solution of Cocaine Hydrochlorate in Ear Disease.

Nov. 20, G. B. M., M.D., applied for deafness in both ears, but especially the right. On examination found the sides of meatus and lumen filled with separated masses of scales several millimeters in length, firmly attached to the parts, which on removal by the forceps gave him great pain. He also found the pressure of the ear speculum painful. This was explained after the removal of a portion of these diseased scales by finding the under surface inflamed, reddened and ready to bleed at the slightest touch of the instrument. To obviate this pain and allow the entire removal of this desquamated material, a 4 per cent. solution of hydrochlorate of cocaine was instilled into the ear every five minutes for fifteen minutes. At the end of this period, again began removing the offending material without so much pain; still it was not a true anæsthesia, and if we made strong pressure with the speculum in introducing it, it also gave him slight pain; still he was able to bear it much better with the solution, until all was removed from the right ear. He was then directed a sol. zinci sulpho-carbolate, grs. iv; morphia sulphas, grs. i; iv. oz. of aqua destillata. For the left ear, after the use of the forceps, gave an alkaline solution to drop in ten drops 3 or 4 times a day and rest for fifteen minutes so as to remove what scales were on the m. tympani. November 23, washed out the remaining scales, and inflated the middle ear, with great improvement of hearing in both ears.

Nov. 25, H. F. M., aged 29, bank clerk, suffering from deafness and constant "rattling or buzzing," from congestion and hypertrophy of the pharyngeal tonsils and mucous membrane of the post-nasal spaces, which required cutting freely with a tenotomy knife. Before doing so, I applied a 4 per cent. solution of the cocaine, and although I made five different incisions into the enlargement, he was not aware that it was accomplished until he found a few drops of blood passing into his œsophagus. One week after he reported by letter of improvement in hearing. In this operation not one-fourth the amount of blood was lost as in such cases without the cocaine, the parts remaining quite rigid for some time after the operation.

November 29. Applied the 4 per cent. solution to a lady suffering from excessive secretions of glands of the throat, and passing into the Eustachian tube causing noises of a variable character. She suffered also from swelling and hypertrophic conditions of the posterior portion of the nasal mucous membrane and turbinated bodies. The parts were cleansed with spray of Dobell's solution, and a strong current of dry condensed air was employed to free them from moisture, a flexible silver catheter was introduced first into the right side of the nose and a nozzle was fitted to it, and then the elastic tube of the condensed air chamber, and a few drops of the solution of hydrochlorate of cocaine were introduced into the catheter, and the parts sprayed by forcing the air through it. In the same operation performed upon the opposite ear, there being a deviation of the septum, there was more pain, but very much less than when we introduced the instrument before. The spraying was repeated at three different times, when in about ten minutes she felt the peculiar apparent swelling and drying effects, and great relief from the noises, by the freedom with which air passed through the Eustachian tubes. The lady reported, a week after, improvement of hearing and more freedom from the noises.

On the same day a patient, W. C. D., aged 16, suffering from the peculiar sniffling from swelling of the mucous membrane of the nasal cavities, from what was termed "a cold in the head," was relieved by painting the parts; three applications of a 4 per cent. solution reduced the swelling as if by magic.

Nov. 30, C. R. W., aged 21, a case similar to the one described above, but the stuffing and sniffling more intense and distressing, was treated in a similar manner, but before I applied the cocaine, the parts were cleansed, through the nose and throat, by Dobell's solution, and slightly stimulated by a spray of a diluted tincture of galangula. The only addition was that a 4 per cent. solution of cocaine was directed to be employed at home, so as to rid him promptly of this disagreeable feeling. He reported December 7th, and 13th, feeling greatly relieved.

December 3, D. C. M., West Virginia, applied with a history of acquired syphilis by inoculation several years ago, in the finger from an obstetric case. There were two points of ulceration of the mucous membrane of the naso-pharynx, one and a half inches above the edge of the soft palate, and one behind the right tonsil, with enlargement of the gland and discharge of pus. After drying the parts with absorbent cotton, we introduced a 4 per cent. solution of cocaine, up and back into the point of ulceration, and applied the crystal of chromic acid to the first ulcer without the slightest pain.

December 4. After cleansing, again applied the solution, and introduced a delicate Eustachian forceps, with a pledget of cotton wool charged with pure powdered sulphate of copper, to the second ulcer, which bled on being touched, but without giving the patient any pain. December 5, made a third application with more freedom; no blood followed, and he stated he had seen no pus since the first application.

Directed to spray the part with the mercuric chloride, one tablet to make a one one-thousandth of a grain solution dissolved in a pint of distilled water, also to use internally after meals a tablespoonful of elixir of coca (strength 20 grains extract of coca to the ounce).

Deafness from Coryza.

This form of deafness is directly traceable to nasal, nasopharyngeal or pharyngeal disease of the lining membrane.

The openings of the Eustachian tubes, which lead directly to the middle ear, are to be found just above and in front of the tonsils, and behind, and lying close to the posterior nares or openings of the nose. As the orifices of these ducts are widely opened every time we swallow, it can be seen how readily mucous and muco-purulent matter from the nose and throat, in case of inflammation or acute or even chronic coryza existing, may enter and light up an inflammation of its lining membrane, which will in some cases extend to the delicate structures of the middle ear. Plugging of the openings of these tubes, viewed from a purely mechanical stand-point, will certainly cause or aggravate deafness. Hence it is of the utmost importance that prompt and efficient means should be used in order to relieve the patient, and ultimately to cure the disease, so as to prevent and cure the deafness. This deafness is sure to follow or be increased by these recurring attacks, the result of cold air applied to the moist skin of any part of the body. The application of a four per cent. solution of the hydrochlorate of cocaine to the nose will cause the swelling from acute coryza to disappear for hours, and if repeated two or three times will entirely relieve the occlusion of the nostril, and check the discharge (see cases reported). If the case is a chronic one, with hypertrophy of the nasal mucous membrane, it causes, when applied, a most remarkable change of color and contraction of the swollen tissue. The great advantage of this local anæsthetic, as we have shown, is that when necessary, we are able to apply local remedies without pain of a more potent character (see also cases reported).

More recent information, and various trials, have caused us to modify our opinion in regard to the use of a hot four per cent. solution of the hydrochlorate of cocaine, in relieving pain in the ear prior to perforation of the membrana tympani. We have received several cases of the history of acute attacks of myringitis or neuralgia of the ear, from most reliable sources; two of these cases we had the opportunity of seeing, after being relieved temporarily (for two hours), and which were not examined at the time when the application was made. When the cases were seen, we found that a discharge had followed the same evening, and perforation of the membrane had taken place in both cases. It is a well-known fact, that prior to perforation there is an elevation of the cuticular layer, with a softening process, whereby any liquid applied to the part might pass in by imbibition, and influence the sodden layers of the membrana tympani, and if it had anæsthetic properties, would impress the branch of the chorda tympani nerve, and relieve pain.

We have since extended its use to ear cases, with subjective aural sounds, as in the peculiar form of ear disease depending on pressure affecting the labyrinth, first upon the tympani and handle of the malleus, extending to the stapes and fenestra ovalis, and also from other causes, such as shortening from contraction of the tensor-tympani, or in irritation of the pharyngeal mucous membrane propagated through the Eustachian tube to the tympanum or middle ear, or from spasm of the muscles or temporary hyperæmia. It would not, in all cases, permanently remove these sounds, only relieve them in intensity, especially if from tympanic adhesion or anchylosis of the joints of the ossicles *of the ear*. These latter cases are to be treated by the exhauster of Seigle, or Woakes, of London.

CHAPTER X.

Local Anæsthetics—Oil of Eucalyptus, Ether, Rhigolene, Methyl and its Chloride, Hydrastine, Homatropine and Ephedrine, Brucine, Lewenin, Apomorphine, Drumine, Gledelschine, Erythrophleine, Caffeine, Helleborine, Canadol, Menthol, Iodoform, Iodol, Bromide of Ethyl and Potassium, Carbolic Acid, Quinine, Antipyrine, Antifibrin.

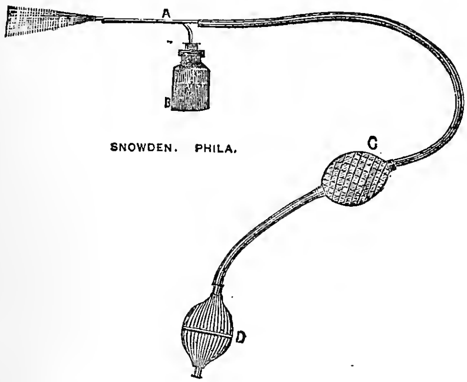
HAVING given briefly the most important results of the recent observations and experiments with cocaine, I now pass to the second part of our subject, the more recently introduced new local anæsthetics.

Oil of Eucalyptus.

This agent is recommended as a local anæsthetic in dental operations and toothache. Apply one drop or more on cotton to the sensitive dentine just before excavating for filling.*

Ether as a Local Anæsthetic.

Plate 3.



The apparatus, Plate 3, is employed for local anæsthesia, and produces so much cold by atomizing ether that it freezes the skin, and even the deeper tissues. It was first used by Dr. B. W. Richardson, of London, or with rhigolene as described by Dr. H. J. Bigelow, of Boston, or with gasoline as

* The oil has also decided antiperiodic powers, as well as being one of the best stimulating expectorants, in acute, and chronic bronchitis. From one-half to one drachm a day may be given in divided doses, in capsules or mucilage.

employed in Philadelphia. It consists of the elastic bulb D, which, with its valves, serve to force air into the elastic chamber C, which, alternately expanding and contracting, supplies a steady stream of air to the atomizing tubes A, which are of metal, one branch of which dips into the bottle B, containing the ether, and the inner tube for delivering the ether runs upwards to the extremity of the outer tube. The ether must be directed on the surface, and must be the strongest, therefore free from alcohol and water. When the parts are properly frozen they become pale, shrunken and tallowy-looking, and when cut, like frozen fat.

When the rubber bag D is compressed by the hand, the reservoir bulb is filled, and a double current of air is produced; one current descending and pressing upon the ether, forcing it along the inner tube, and the other ascending through the outer tube, and playing upon the column of ether as it passes from the inner tube. The ether which is used in England for producing local anæsthesia is a mixture of amyl hydrate and anhydrous ether; it has a low boiling-point and specific gravity, and is dangerous when inhaled. The best form of ether to employ for local anæsthesia is Dr. Squibb's anhydrous, which is almost free from alcohol and water, and gives the best results.

Local Anæsthetics.—Rhigolene in Spray.

Rhigolene.—This is one of the most volatile of liquids, and is obtained by the distillation of petroleum. Its specific gravity is 0.625, and it will boil in the hand. It was first introduced by Dr. Bigelow, of Boston.

A superficial layer of the skin has been successfully frozen by rhigolene without injury. Not only on the skin, but Dr. Jarvis and others have used it in inter-nasal surgery by means of an atomizing apparatus, which will freeze the tissues in less than one minute. Cartilage and mucous membrane can, when thus frozen, be deeply and freely divided without much pain or hemorrhage.

Drs. Edes, Dana and Jacobi had used rhigolene spray with benefit in the treatment of neuralgia; but it had been found objectionable, because of the intense degree of cold produced, and also because it could not be applied to a sufficiently large space.*

* *New York Medical Journal*, July 31, 1887.

In cases requiring extensive operative interference, cocaine has been partially utilized in conjunction with the rhigolene.

At one time rhigolene was considered very explosive; this is not the case unless mixed with air, and brought near to an open light, or the incandescent cautery.

Dr. Richardson, of London, has found rhigolene to dissolve camphor and spermaceti, which solution, applied with cotton and wool, he found an excellent dressing to burns. This same fluid would also dissolve iodine, and was valuable in diseases of the respiratory tract by inhalation. The strength of the iodine solution which he uses, is five grains to a fluid ounce of rhigolene.

Methyl.

This is another new local anæsthetic, so stated, but obtained from an old agent, namely, methyl alcohol. This is the alcohol obtained from wood spirit, and much employed in England, but not in this country. The new agent is stated to be neutral, volatile, with an ethereal odor and pungent taste.

The subcutaneous injection of methyl, induces more or less anæsthesia, but it is of short duration. (*Vratch*, No. X., 1887, *Bull. Gen. de Therap.* July 15, 1887, and *Amer. J. Med. Sci.* October, 1887, p. 527.)

Chloride of Methyl.

Dr. Jacobi has found the chloride of methyl an analgesic or local anæsthetic, which did not affect the general condition of the patient, and that it was invaluable in the treatment of neuralgia, for the immediate relief of severe pain. It was used in the form of spray under high pressure. The objection was the expense of the apparatus, and the difficulties of getting the drug (pure).

(See *Med. & Surg. Reporter*, vol. lvii., July 2, '78, our observations on this drug, and its analogy to chloroform as usually obtained.)

From his experience in the use of condensed carbolic acid, his conclusions were, that in the absence of chloride of methyl, it was able to take the place of that remedy in sciatica.

Drumine was discovered in Australia, but as yet has not, in the hands of the profession, realized its superiority to cocaine, and in a recent chemical examination of it nothing was found but a salt of lime.

Hydrastis Canadensis (Golden Seal) and Hydrastine.

The white alkaloid contained in *Hydrastis canadensis* (Golden Seal). Experiment shows that it is to this alkaloid, rather than its more obtrusive neighbor, berberine (yellow alkaloid), that the valuable properties of Golden Seal are due. Its physiological action, as determined by experiment on the lower animals is briefly, as follows:

"In small doses it elevates and in large doses depresses the blood pressure; that in small doses it produces contraction, and in large doses dilation of the vascular walls; that in the period of elevated blood pressure, it inhibits cardiac action; that in small doses it produces anæmia, and in large doses hyperæmia of the alimentary surface; that it induces uterine contractions; that it enhances the irritability of the motor and depresses that of the sensory nerves; and that it exercises its control over all these organs through a central, and not through a peripheral influence."

Experiments on man confirm the preceding. It dilates slightly the pupil of the eye, and as a local anæsthetic has value, though its action is not so marked as that of cocaine or brucine applied locally, or theine injected hypodermically. Hydrastine is most applicable in catarrhal states of the stomach, bowels, eye, ear, nose and throat, though it is indicated in many other diseased conditions. Amongst the diseases for which it has been found a valuable topical application, may be mentioned hyperidosis, seborrhœa, acne, eczema, ulcers, gonorrhœa, certain forms of gleet, various forms of conjunctivitis, and in the ear to arrest or modify irritating catarrhal and purulent discharges. Its effect of contracting the uterus so powerfully, may be of special value in obstetrics, and its marked action on the spinal nervous system indicates it as a valuable tonic to this portion of the body. Probably hydrastine possesses much of the therapy internally, as well as externally, of the drug from which it is obtained, such as being indicated in dyspepsia, constipation, hemorrhoids, jaundice and other functional disorders of the liver, etc.

Dose, $\frac{1}{16}$ to $\frac{1}{4}$ grain.

Mr. I. N. Bredin found the following formula, used as an injection 4 times daily, gives beneficial results in gonorrhœa, and leucorrhœa, when every other treatment, local and internal, failed :

℞ Hydrastin	ʒi.	
Sol. morphiæ (B. P.)	ʒii.	
Mucil. acaciæ, ad	f℥iv.	M.

SIG.—Use as an injection 4 times daily.

Care should be taken to distinguish the resinoid of the eclectics, hydrastin, which consists chiefly of hydrochlorate of berberine, from the crystalline alkaloid hydrastine (hydrastina).

Homatropine.

Discovered by Ladenburg. It is a derivative of tropeine, which latter is produced by heating tropine gently, in contact with organic acids, and dilute hydrochloric acid. Tropine is a derivative of hyoscyamine, also of atropine. Merck has succeeded in crystallizing it in transparent colorless prisms. The most useful salt has been shown to be the hydrobromate, which is crystallizable and not hygroscopic. Its action is similar to that of atropine, being mydriatic, narcotic, sedative and anæsthetic. The dilatation of the pupil takes place very energetically with homatropine, the action beginning in from fifteen to twenty minutes, and reaching its height after from sixty to seventy minutes; while the recovery takes place in a comparatively short time, usually from six to ten hours. It is generally indicated in the same complications, as atropine, and other alkaloids of this class.

Chlorohydrate of Ephedrine.

Tweedy and Ringer have proved by experimentation, that homatropine acts upon the heart in the same way as atropia, but is much milder and safer. Dr. Frommuler prefers homatropine to atropine, for checking the night sweats of phthisis.

He also found it an immediate and certain antidote to pilocarpin. Dose, $\frac{1}{3}$ to $\frac{1}{4}$ of a grain.

Homatropine has been employed in a large number of cases in this city, of the strength of eight grains to the ounce of distilled water, with the $\frac{1}{10000}$ of bichloride of mercury. The instillations have been made every hour until full dilatation takes place, and with satisfactory results, passing away soon, unless, as will sometimes happen, the druggist substitutes atropine, not having the homatropine on hand.

The chlorohydrate of ephedrine is a new mydriatic alkaloid obtained from *Ephedra vulgaris* by M. Kinnossuke Menra. It should be employed in a solution ten times more concentrated than homatropine, but it is much less costly. It does not paralyze the accommodation for near version.

Hydrobromate of Homatropine.

($C_{16}H_{21}NO_3HB$. Soluble in 10 parts of water.)

A careful study of the action of hydrobromate of homatropine by Risley and Jackson, has proved to them, that this drug is entirely satisfactory for the correction of anomalies of refraction, and is an efficient and reliable mydriatic.

Brucine.

Dr. Mays, of this city, introduced pure brucine as a local anæsthetic, and kindly furnished us with a solution in oleic acid. We made a number of careful experiments with it, and found it had some slight anæsthetic properties, but with the objection that when used freely on a mucous membrane or abraded surface, it produced some of the symptoms of strychnia poisoning. It is true, it is less powerful, and eliminated more rapidly than strychnia, but it has one serious objection. The old idea was, that the effect of brucine, in producing convulsions, was said to depend on admixture with strychnia, but Dr. L. Brunton found that pure brucine would produce convulsions and death in rabbits when injected subcutaneously.

Lewinin is an alkaloid, allied to cocaine, but much inferior to it.

Apomorphiæ Hydrochloras.

The objection to apomorphia is that it causes very profuse secretions from the mucous membranes. It also acts as a poison on the muscular fibre of the ventricle of the heart, like an acid when employed internally. Yet there are ophthalmic surgeons of this city who use it with success, applying it every ten or fifteen minutes to the eye, one drop at a time.

Erythrophleine, or Haya.

(The active principle of *Erythrophlœum Guineense.*)

From a most interesting paper, read a month ago (January 11th, 1888), before the Medical Society of Berlin, by Dr. L. Lewein, we extract the following, concerning a drug that promises much:

"The hydrochloride of erythrophleine (made by E. Merck, of Darmstadt) is readily soluble in water. A *two per cent.* solution in a dog's eye, renders it insensible for from 10 *to* 24 *hours.* This solution is *much stronger than need be* for anæsthetic uses, as will be seen as we proceed; for Dr. Lewein states that 'solutions of the strength of one-fourth or one-tenth or one-twentieth of one per cent. produce anæsthesia of the cornea and conjunctiva, continuing for from several hours up to two days, and gradually decreasing in intensity during that time.' The action is altogether local, and if a solution of it be injected into the *eyelid* of an animal, it becomes so insensible that touch does not induce motion, while the eye itself retains perfectly its sensibility.

"To give an idea of the powerful action of this substance. If we make a solution of the proportion of $\frac{1}{10}$ gramme to 100 grammes of water, *i. e.*, $\frac{1}{10}$ gramme to 2000 drops of water (approximately $\frac{3}{8}$ of a grain to one fluid ounce or a solution of about $\frac{8}{100}$ of one per cent.), and of this inject three full drops into the eye, full anæsthesia is produced (by 0.00015 grammes erythrophleine hydrochloride) (or twenty-three ten-thousandths of a grain). If from 0.0005 grammes to 0.0015 grammes of this solution be injected into a guinea-pig, such an insensibility is produced in the injected part, that one can cut these otherwise so sensitive animals deeply, down to the muscles, without observing any symptom of pain."

According to "Karewski," *Medical Press*, March 4, 1888, complete anæsthesia was never obtained, but its action was much heightened by the local production of anæmia. Its action was not uniform in all cases. Subcutaneous injection of at least $\frac{1}{25}$ of a grain was necessary to produce analgesia.

The after-effects were very disagreeable, amongst them violent pain at the point of insertion, coming on in a few minutes afterwards, and becoming intolerable, lasting several days.

Caffeina—Caffeine.

A crystalline principle occurring in tea and coffee. Various trials of caffeine have not been satisfactory as a powerful local anæsthetic. It is valuable in slight operations, but much inferior to cocaine.

Theine, which chemically is the same as caffeine, has also slight anæsthetic properties. They are both most valuable diuretics.

Helleborine.

The *Helleborus niger* contains two active principles, helleborine and helleborin. Both of the substances are glucosides. The first has been employed as a local anæsthetic. Internally they are both narcotics and active cardiac poisons.

Canadol.

This is a volatile product obtained from naphtha. Liquid, limpid, very volatile, easily inflammable, benzoine odor. It has been used as a substitute for ether as a local anæsthetic, and is employed by means of Richardson's spray apparatus.

Menthol.*

Has been found useful as a rubefacient, like mustard, but unless combined with some hypnotic, it has but slight anæsthetic properties. It is useful combined with cocaine.

Iodoform. (CHI_3, 392-8.)

Iodoform is employed as a local anæsthetic and antiseptic, as a dressing after operations. Preparation: Mix an alcoholic

* Menthol, or oil of peppermint camphor, is employed in diseases of the throat and ear; dissolved in ether, or olive oil, from 10 to 50 per cent.

solution of potash with tincture of iodine, and evaporate it. Character: Small, lemon-yellow, lustrous crystals of the hexagonal system, having a saffron-like and disagreeable odor, very difficult to overcome, and unpleasant iodine-like taste. Not perceptibly soluble in water, soluble in eighty parts of alcohol at 59° F., in 5 parts of ether, and in chloroform, benzol, benzine, and in the fixed and volatile oils, lard, lanoline or vaseline. Dose, 1–3 grains.

It is given in the form of a pill or in a capsule, or mixed with tragacanth, sugar of milk and glycerine, or better, sugar-coated; by the rectum in the form of a suppository or vaginal capsule. The disagreeable smell may be in part covered by Tonquin bean, coumarin, or roasted coffee in powder.

As an inhalation in phthisis a solution may be used containing 20 grains of iodoform, 20 minims of oil of eucalyptus, or 10 of creasote, ½ fl. oz. rectified spirit, and ½ fl. oz. ether. This is used with an inhaler of horse-hair matting, lined with cotton wool, on the interior of which the solution is dropped. (Dreschfeld.)

As an external application, it is dusted over the abraded skin, ulcer or mucous membrane. An old favorite preparation for topical application, is the ethereal solution of iodoform (ʒi ℥v.) applied with absorbent cotton to the affected parts in the nares, post-pharyngeal space, mouth, fauces, larynx and trachea. The nozzle of the spray producer is apt to become choked and must be washed out frequently with pure ether. It may also be applied to the nose in the form of a bougie, containing ⅙ to ½ grain made with gelatine and glycerine.

Actions: Iodoform destroys bacilli, and is an antiseptic deodorizer and local anæsthetic. It also destroys leucocytes. If given in large doses it weakens the circulation, or if long continued in moderate doses, it has the same action. If absorbed from a large raw surface or employed too freely, it produces muscular rigidity, anæsthesia, sleep followed by sleeplessness, headache, irritability, hallucinations, loss of memory, melancholia and even death. These disagreeable effects are diminished by bicarbonate of potash, 10-grain doses every hour or two, in water.

It has a most extraordinary power to prevent the development of giant cells, and may thus prevent the growth of morbid tissue, as cancer, etc. After death from iodoform the heart, liver, kidneys and muscles exhibit fatty degeneration.

Iodoform. (Cotton Wick.)

Gersung, of Vienna, has found cotton wick impregnated with iodoform an excellent material for tampons in the drainage of wounds whose secretion is moderate; Bellroth's clinic wick, saturated with tannin and iodoform, is used with excellent results. Its removal is much less painful and inconvenient than that of gauze. (*Centralblatt für Chirurgie*, July 30, '87.)

Deodorized Iodoform and Ointment.

Mr. Louis Genois, has advocated the use of the purified naphthaline to mask the odor of the iodoform, as follows:

Purified naphthaline	7½ grains.
Powdered turmeric	1½ grains.
Iodoform	91 grains.

Rub together until thoroughly mixed.

Ointment Iodoform.

Deodorized iodoform (as above)	ʒ ii.
Oil of almond	ʒ ss.
Lanoline	ʒ vss. M.

We have tried this preparation, but the strong odor of the naphthaline is one objection.

Iodoform in Variola.

Colleville has had excellent results in preventing severe scarring, and lessening pain in variola by the local use of:

Iodoform	1 part.
Vaseline	20 parts.

Although used freely in cases of confluent variola, no ill effects were observed.—*Revue de Therapeutic*, Nov. 5, 1889.

Iodoform Deodorized.

Cantrella, pharmacist, Paris, has found of all the ways devised for hiding the odor of iodoform, the following combination is the best:

Iodoform	gr. xv.
Menthol	gr. $\frac{3}{4}$.
Essence of lavender (of best quality)	gtt. 1.

In addition, the hands may be washed in water containing a little lavender brandy or essence. Cocaine may be added to the mixture, when instant anæsthesia is required, as follows:

Iodoform	gr. xv.
Cocaine	gr. $\frac{3}{8}$.

—*Bulletin General de Therapeutic*, Nov. 15, 1887.

For deodorization of hands or any other part of the body impregnated with iodoform, Doux, in the *Bulletin* of the Pharmaceutical Society of Bordeaux, advises, first, vigorous soaping of the hands, then washing them in water to which is added tincture of iris (blue or white flag), when the odor disappears completely.

Increasing the Antiseptic Powers of Iodoform.

G. de Ruyter (*Arch. f. Kl. Chirurg.* Bd. xxxv., Hft. 1) states that solutions of iodoform in ether and alcohol have greater antiseptic properties than the powdered drug, owing to the production of free iodine. The following solution was found an excellent antiseptic, and much superior to the ethereal one:

Iodoform	1 part.
Ether	2 parts.
Alcohol	8 parts.

The author confesses that outside of the body iodoform has little power over the greater number of disease germs. It has, however, been shown that when in contact with the fluids of the body the iodoform is decomposed, and is then capable of acting on bacteria.

An Antidote for Iodoform.

The *Rep. de Farms* states, that Dr. Behring recently gave a twenty per cent. solution of bicarbonate of potassium, in a case of severe iodoform poisoning. The best results followed its use, it seeming to act as a direct antidote to iodoform. Fortunately, cases of iodoform poisoning are rare; so much so indeed, that they are termed "idiosyncrasies."

Treatment of Diarrhœa by Iodoform and Charcoal.

℞	Iodoform	grs. 9.
	Ether	ʒ 3⅛
	Vegetable charcoal, finely powdered . . .	℥ 3⅛
	Glycerin	℥ 12.

The iodoform must be dissolved in the ether, and the powdered charcoal thoroughly mixed. After the ether has evaporated, the glycerine should be added. It is given in teaspoonful or tablespoonful doses, suspended in a glass of water.

On the Local Use of Iodoform in Ear Diseases and Dental Operations.

The following were the conclusions of our friend, the late Dr. Cassell, after using this agent in the treatment of ear diseases for some years.

"Iodoform is of service alone in cases of ear disease, in which there is a lesion of tissue (ulceration), and notably in those of caries of the mastoid, complicated with polypus granulations. After these are removed the local application of iodoform, as a fine, dry powder, generally acts capitally, and, I may add, successfully. I intend, however, to give it a trial as an internal remedy, not with much hope of success, resulting, I confess, in those cases of deafness following eye disease, having keratitis and scooped (Hutchinson's) teeth, and other outward signs of hereditary syphilis.

"Nerve Paste.—A preparation for devitalizing dental pulps, composed as follows: ℞ Iodoform pulv., cocaine hydrochlorat. āā gr. xx; menthol crust., gr. v; glycerina, q.s. to make a stiff paste.

"Iodoform has not been much used by the dental practitioner, but I think in it we have a remedy that exactly meets the requirements of some cases. It possesses the alterative properties of iodine, without its caustic qualities; indeed, it is a very soothing application to inflamed and irritated parts. It has been used with the happiest result in the treatment of old abscesses, its alterative and anodyne qualities rendering it just the thing for those cases in which, from the ravages of calculus or from abscess, the socket cells are involved, and that peculiarly annoying neuralgia results, from which, the patient finds slow relief. In these cases even the extraction of the tooth does not always bring the immunity sought for some time.

"To apply the paste, take a probe armed with cotton, and take up some of the compound paste, introduce it into the cavity, or under the gum and around the roots.

"It can be introduced into the crown and roots, to relieve neuralgia, or to cure persistent abscess. In the treatment of antral disease, it is regarded as one of the very best remedies. Used as above directed, its effect is very soothing, and it will speedily diffuse itself, and its influence, over the seat of irritation. If some persons should object to the odor, the iodol may be substituted in the place of the iodoform."

Iodoform Gauze Tampons.

Iodoform gauze tampons have been found useful in rectal disease. They are stated to be painless and antiseptic. The mode of preparation of the iodoform gauze is given by Dr. Weir, as follows ("Antiseptics: How Used, and How Made," *Med. News*, Dec. 17, '87):

Pour over 5 yards of absorbent gauze, a mixture of

Iodoform	℥iiiss.	
Resin	℥iss.	
Alcohol	℥iv.	
Glycerin	ʒvi.	M.

The Anti-Bacterial Action of Iodoform.

In a recent article by I. Amory Jeffries, M.D., of Boston (*Amer. J. Med. Sci.*, January, 1887), he states that iodol and salol gave prompt results of anti-bacterial action, but iodoform, he concludes, from numerous experiments, has no direct action as a germicide, a result agreeing with Heyn and Roosing. Looked at from the clinical side, the ultimate object of all medical research, he gives the following rules:

1. Iodoform, not being a germicide, is not a fit substance to use to procure asepsis of instruments, materials or wounds.

2. Iodoform is allowable in the present state of our pharmacopœia, in inflicted wounds where the true germicides are contra-indicated, as by danger of poisoning or impracticability.

3. As has long been known, iodoform has a decided tendency to stop serous oozing, and therefore may be indicated in wounds where the moisture threatens the integrity of the aseptic or antiseptic dressing. Laboratory tests are not always what occurs in the body, and different observers produce different results. Dr. Robert T. Weir, of New York, with his friend, Dr. Weeks, has published in *Med. News*, Dec. 17, '87, the following observations on antiseptics: Iodoform in powder only retarded development of germs after twelve hours' exposure. Iodol in powder exerted no effect. Whoever has kept abreast with the current literature, will not be surprised at two things: First, that the fact taught us several years ago by Kock, has been confirmed by Dr. Weeks, that only solutions or mixtures of the various antiseptics have no value other than is slowly exerted by the fatty matters themselves; and, second, that iodoform—concerning the power of which in germs much has lately been written—exerts its germicide action but slowly. On this point of the value of iodoform in controlling inflammation—ordinary and tuberculous—Dr. Weir says, that the clinical experience of surgeons is in favor of its usefulness, and is decidedly opposed to the laboratory deductions. The discussion of this subject, however, has developed the fact that this substance, in dry powder, often contains germs, and that it works best when acted upon and changed by wound secretions. Practically, it is nearly always used in a dampened condition, by him, in the New York Hospital, in conjunction with the moist sublimate gauze. In this combination it is depended upon as a supporter of antiseptics.

Iodol.

"Iodol, (CINH) is produced by the action of iodine on pyrol in the presence of caustic potash. It has an acid reaction, is free from the disagreeable odor of iodoform, and contains 88.9

per cent. of iodine. It is a yellowish brown powder, insoluble in water, slightly soluble in cold alcohol, and readily soluble in oil. According to Mazzoni, it is a more powerful antiseptic than iodoform; it acts as a local anæsthetic and favors granulation; administered internally in doses of two grains, it produces no intestinal disturbance. It may be used in the same way as iodoform.

"I have been using this agent in the place of iodoform. Very many of my patients object to the odor of iodoform; iodol, being odorless, has this great advantage, though its cost at present is much greater than that of the iodoform. I have found it as useful as iodoform in ear and throat affections. It has been stated that it is not so valuable in intra-uterine affections as iodoform.

"Dr. Assaky, of Bucharest, Roumania, said that wounds unite under iodol by first intention. This union, however, being the result of various and complex conditions attending operation, it is not possible to attribute to iodol alone the absence of suppuration and inflammatory conditions. In wounds which gape and suppurate, iodol is an excellent antiseptic. It rapidly retards suppuration, renders it inodorous, reduces the frequency of dressing, and hastens considerably cicatrization. In ulcerating, or gangrenous wounds, iodol aids to resist the destructive process, and changes the wound, after a variable time, to a healthy granulating condition. This action of iodol extends itself to hard chancres. In case of soft chancres the result is variable. Sometimes it transforms them into a simple wound with brief delay; at others it is insufficient for this purpose, and it becomes necessary to employ in addition, locally, antiseptic lotions. The same is true with reference to open venereal buboes of the groin. The powdered iodol has this advantage over iodoform, that it is free from odor and is not toxic in its effect.

"Doses of iodol of from one-sixteenth of a grain to three grains daily produce no functional trouble, even if continued a long time. These doses give marvelous results in tertiary syphilis and in scrofulous affections. In the secondary stage of syphilis, taken internally, it rapidly destroys the syphilitic manifestations. Iodol seems to aid the general nutrition and increase strength and flesh. It is indicated in all cases of specific malnutrition. Iodol is an antipyretic. In acute infectious diseases, such as erysipelas, etc., it causes a rapid fall of temperature.

"(1) POWDER OF IODOL.—The pure powder may be used; it is readily dusted over a raw surface, or insufflated into the throat. Possessing no toxic power, it is of more importance to cover the diseased surface than to measure the dose. For all laryngeal, pharyngeal, post-nasal and oral conditions, this is, perhaps, the most generally useful application.

"(2) A SOLUTION IN ALCOHOL AND GLYCERINE.—This was Mazzoni's original application: Iodol, one part; alcohol, sixteen parts; glycerine, thirty-four parts. This forms a good application by means of the brush, or may be used as a very coarse spray.

"(3) IODOL, ONE DRACHM; ETHER, ONE OUNCE.—This forms a clear brown solution, useful for application either by the spray or brush. The ether quickly evaporating, leaves the powder *in situ*. It is useful for naso-pharyngeal atrophic conditions.

"(4) IODOL, ONE DRACHM; GLYCERINE, ONE DRACHM; VASELINE, SEVEN DRACHMS.—This is a modification of one of Rumbold's sprays. It is a very soothing application for pharyngeal conditions. It requires to be warm before using.

"(5) IODOL PASTILLES.—Iodol, one grain; glycerine, one minim; glycogelatine, eighteen grains. These are very useful for chronic pharyngeal conditions, and are much preferable to iodoform pastilles.

"(6) IODOL BOUGIES, containing half grain of iodol in each. These are made for me, for use in diseased nasal conditions.

"(7) IODOL WOOL, ten per cent., for tampons, etc.

"(8) IODOL GAUZE for dressings.

"I have used iodol in a number of cases of laryngeal phthisis, with very beneficial results. Adopting Lublinski's method, I have applied it as an insufflation of the pure powder, in some cases once daily, in others three times a week.

"Ulcerations in the inter-arytenoid region have cleansed and healed up completely, and the characteristic arytenoid œdema has diminished under its influence. Tuberculous ulcerations of the epiglottis and pharynx, have been benefited by it and been arrested, and the distressing pains on deglutition which accompany this condition are much relieved by iodol. In some patients, to whom solid food was entirely interdicted by reason of the pain on swallowing, deglutition has become comparatively easy, under daily laryngeal insufflations of iodol. If the iodol is carefully and accurately applied over the ulcerations, it will completely heal them. I have cases under treatment where there was originally extensive laryngeal ulceration, but at present all active mischief is arrested. Iodol remarkably diminishes the cough of this condition. It is not to be supposed, of course, that insufflations of iodol, or of any other substance, will cure extensive phthisical disease of the larynx, but they will certainly arrest ulceration, relieve pain and cough, and allow the patient comparative comfort. The iodol remains for a long time in contact with an ulcerated surface. Sprays of chloride of zinc (gr. xxx ad ℥i) have, in some cases, been combined with the iodol treatment. For ozæna, I find that iodol tampons are effective in arresting the foul smell of nasal caries, or for the true ozænic conditions independent of carious bone.

"As a spray or brush application it is very beneficial for naso-pharyngeal atrophic catarrhs. For the ordinary forms of pharyngitis, accompanied or not with follicular disease, I find it a very serviceable insufflation, and one which, moreover, is not unpleasant to the patient. The pastilles are also grateful in these conditions. It is important that the application of iodol, as of any other medicament, to the nasal, pharyngeal or laryngeal mucous membrane, should be preceded by thorough cleansing of these parts with the alkaline lotion, so as to insure the bringing of the powder into direct contact with the diseased tissue, and not merely to lay it on the surface of the mucus. I have found it produce excellent effect in extensive ulcerations of the inside of the cheek, dusted over the exposed surface twice daily. In cases where there is great pain, the addition of one-eighth to one-quarter grain morphine to the iodol insufflated will be found very advantageous.

"To summarize: iodol is odorless or nearly so, tasteless, produces no constitutional effects, contains nearly as much iodine as iodoform, and parts with it more readily; it is antiseptic, anæsthetic, a promoter of granulation and healing; arrests suppuration, and deodorizes foul secretions. Possessing thus all the virtues of iodoform, it is surely preferable on account of its pleasant and slight odor and the absence of taste. It does not disturb the stomach as iodoform does."—R. Norris Wolfenden, M.D., in the *Practitioner*.

Iodoform and Iodol.

Is iodol perfectly safe given internally and employed locally? The experiments of Marcus and Pahl (*Maug. Dess. Berlin, Ther. Gazette*, January 16, 1888) show that when iodol was given in sufficient doses to animals, it caused emaciation, albuminous urine, fall of temperature, general loss of muscular power, and finally death from fatty degeneration of the liver, kidney and other tissues. In a case published in the *Ther. Gazette* (see Vol. XI., p. 768), iodol caused, when used as a surgical dressing, symptoms of poisoning. Still it is less poisonous than iodoform, but the post-mortem appearances are the same. It has been found valuable in a number of cases of tubercular laryngitis, throwing the pure powder into the larynx once a week; also in ozæna with good results, alone or combined with creasote and glycerine and boracic acid.

Iodol in Diphtheria.

In order to test the statements of Dr. Mazzoni, Dr. L. L. Stembo, of Vilna, tried ("Proceedings of the Vilna Medical Society," No. V., 1887, p. 114) the local use of iodol in seven cases of diphtheria, two of which were severe. The drug was applied either alone, in powder, or in the form of a solution. (℞ Iodoli. ℈ss; liq. vini ʒss; glycerine, ʒiiiss.) All the patients recovered after treatment lasting from four to six days. The advantages claimed by Dr. Stembo for iodol, are its complete harmlessness, its freedom from unpleasant smell or taste, the painlessness of its application, and the absence of any untoward or secondary effects, such as loss of appetite, nausea, vomiting, etc.—*British Medical Journal*, April 9, 1888.

Trousseau has found the following formula useful:

For an ointment:

Vaselin	℥ $2\frac{1}{2}$.
Iodol	gr. 30 to 60.

In solution:

Iodol	3 parts.
Alcohol	35 parts.
Glycerine	62 parts.

In disease of the ducts, as the lachrymal, etc., the following was found useful:

Liquid vaseline	℥ $7\frac{1}{2}$.
Iodol	gr. 45.

(*Revue Gen. de Clin. et Ther.*, December 29, 1887; *Med. News*, January 28, 1888).

Mazzoni, who first proposed the use of iodol in practical medicine, employed a solution composed of iodol, one part; alcohol, sixteen parts; and glycerine, thirty-four parts.

The dose of iodol is from two to three grains a day, but both Pick and Assaky have given as high as thirty grains a day, without injury. Pick asserts that iodol is absorbed much less freely than iodoform, requiring from twelve to eighteen hours for the full elimination of the iodine in the urine, when tested by a solution of starch.

Dr. Harlan, of Chicago, uses iodol in combination with pure terebene, as a topical application to lacerated edges of the gums, after the removal of necrosed bone. It has been also found beneficial in the treatment of pyorrhœa alveolus. Combined with oleum gaultheriæ, it forms an excellent antiseptic in destroying the odors in the cavities of diseased teeth, and controlling pain.

Bromide of Ethyl as a Local Anæsthetic.

The bromide of ethyl has advantages as a local anæsthetic, a pleasant odor, not inflammable, and has been used in France and this country with good results. The ordinary atomizer produces a satisfactory spray with the bromide of ethyl, ether and rhigolene.

Bromide of Potassium as a Local Anæsthetic for the Urinary and Sexual Apparatus.

Bromide of potassium has long been used as a local application to the throat and larynx to diminish sensibility. Acting upon this suggestion, J. Kijanizyer (St. Petersburg *Med. Wochenschr.*, No. 51, 1879—*Medical Record*) applies it in a similar manner, and with similar effects to the genito-urinary apparatus. He injects a solution of salt into the urethra, when the latter is the seat of painful, acute or chronic inflammation in strictures, and in cases of frequent pollutions. In urethritis, he says, that the pain, redness and tumefaction of the mucous membrane decreased rapidly, the discharge diminished, and soon disappeared entirely with the aid of mild astringents. In a case of stricture, with chronic urethritis and painful micturition, where the urethra was extremely sensitive, and the severe pain prevented the introduction of bougies, in spite of the use of cannabis indica and belladonna salve, a bougie was introduced with scarcely any pain after the use of bromide of potassium injections for seven days. Kijanizyer uses eight grammes of potassium bromide dissolved in 180 grammes of water. Four grammes of the fluid are injected two or three times a day, and the fluid retained in the urethra a few minutes. From his observations he concludes that the injections are of decided use in all cases where the indication is to diminish sensibility in the urethra and neck of the bladder; in the treatment of strictures with bougies, in inflammations of the urethra and their complications; in chordee, dysuria, neurosis, etc., and for pollutions depending upon peripheral causes. He also recommends the local use of the salt, as indicated in catarrh of the bladder and of its neck, in increased sensibility of the latter, and for cystic calculi and the like. He considers the effects to be due to the diminished irritation and lessened quantity of blood in the inflamed tissue.

Ethyl Iodide.

This agent has been found useful as a local anæsthetic, and anti-spasmodic in hay fever, and cold in the head. It is most effectively applied by means of glass capsules broken in a handkerchief, and then inhaled from it, covering the face. Another method is by means of a half-filled glass bottle, which s enclosed in the hand, the heat vaporizing the liquid.

Chloral and Camphor as a Local Anæsthetic.

Equal parts of chloral and camphor were recommended years ago by Dr. Fordyce Barker, to stop the secretion of milk, and now we note from the *Canada Med. and Surg. Jour.*, March, 1885, that before the Medico-Chirurgical Society of Montreal, Dr. Lapthorn Smith read a paper, on the use of a mixture of about equal parts of chloral hydrate and camphor, as a local anæsthetic. He stated that when placed in the solid form together in a bottle they soon produced a clear, thick liquid, which, when applied on a piece of lint, covered with oil-silk, to a painful surface, complete analgesia resulted. He reported three cases in which he tried it with good success. The first was a whitlow of the finger, which the patient refused to have opened. Shortly after applying it the pain disappeared, and three days later it was lanced, and the pus let out without the patient, a young lady, experiencing any pain whatever. The second case was a very painful bubo, which completely disabled the patient, a gentleman, from doing his work. The mixture of chloral hydrate and camphor was applied frequently on a piece of lint, with the result that a few hours after the first application he was so much relieved that he returned to his duties next day, and fluctuation becoming evident a few days later, it was opened, the operation causing only about a quarter of the usual amount of pain. The third case was an operation, for the removal of a large sebaceous cyst of the face, which was accomplished after the frequent application of the local anæsthetic for several hours previously by means of a brush. The incision in the skin was almost painless, but it produced no effect upon the deeper structures, to which the cyst was firmly adherent. The action of the anæsthetic is much less marked on healthy than on inflamed and painful skin.

Piper Methysticum, and the Cocaine Molecule.

Filehn remarks (*Berl. Klin. Woch.*, vii., 1887), that for a time cocaine seemed to stand alone in its local anæsthetic action. Then a similar property was found to belong to the resin, from *Piper methysticum* (Kava). All the ordinary alkaloids have been tested in reference to this point by Bergmeester and E. Ludwig, with negative results. Searching after a substitute, Filehn directed his attention to the chemical constitution of the cocaine molecule. Just as atropine can be split up into, and reconstituted from, tropic and acid tropin, so cocaine into benzoic acid and ecgonine.

Naphthalin.

Naphthalin (C_{10} H_8) is the product of the distillation of coal tar, of which it possesses the disagreeable odor. It should be carefully used on account of its irritant effects on the renal tissues, and the peculiar modifications in the nutrition of the eye.

Carbolic Acid.

Carbolic Acid (*carbo*, and *oleum*, "oil").—Carbolic acid, impure (*acidum carbolicum*), a liquid obtained from coal tar oil, by treating it first with an alkali, then with an acid, and finally distilling it. It is of a brownish shade, becoming reddish brown on exposure. It consists of carbolic acid and cresylic acid, with impurities derived from the coal tar.

This form is only used externally, or for disinfecting purposes, and at the iron works mixed with oil for relieving burns.

Pure Carbolic Acid (*Acidum carbolicum purificatum*).—When pure, and while it is in crystals or liquid, it is also termed phenic acid, or phenol. Its odor and taste is like creasote, fusible at from 93 to 104, forming an oily liquid, soluble in from 20 to 33 parts of water, and in alcohol ether, glycerine and the essential oils. Carbolic acid, if applied to the skin, produces pain and local anæsthesia, so that the actual cautery and other irritating substances can be applied, or incision made with comparative impunity. In the form of slightly carbolized oil, it is most valuable in burns over a large area of skin, yet care must be observed for fear of absorption, if there is much loss of the skin. It is also used in treating surgical diseases by hypodermic injections, as hydrocele and hemorrhoids. Carbolic acid prevents or corrects putrefaction in cases of purulent infection. dissecting wounds, hospital gangrene, and parasitical diseases of the skin, as scabies, prurigo, thrush. Internally it may be given in doses of from ½ to 2 grains, in a tablespoonful of some bland liquid every hour, in cases of yeasty vomiting, flatulence, dependent on fermentation in undigested food. Its salts, as the carbolate of soda, of potash, zinc, have been used externally for local application and for disinfecting purposes; also in various aqueous, alcoholic and ethereal solutions, and in the form of liniment and ointments.

It has been ascertained that if animals, to whom carbolic acid had been previously administered, are treated by sodi sulphate, a harmless compound of phenol and sulphuric acid is formed. Thus it has been found that the symptoms of carbolic acid poisoning are relieved by the free use of this agent. If this, or even the common Glauber salt is given when the urine becomes dark-colored, it will arrest the toxic phenomena from slow poisoning. In these sudden cases, when the carbolic acid is swallowed in such large quantities, it has been advised to resort to zinci sulphate, sulphate of magnesia, Epsom salts, or any sulphate. After the evacuation of the stomach, the free use of lime water, and olive or linseed oil is useful, to soothe the burnt mucous membrane, and when this is not at hand, resort to flour starch, eggs or milk with warm water. While a resident physician at the Philadelphia Hospital, a fatal case of poisoning took place from swallowing the ordinary liquid acid, which is of a brown color, resembling brandy; the individual mistaking it for that agent, swallowed it, and collapse followed, death was almost immediate. Several similar cases have occurred since. The seventh case occurred at Liverpool quite recently, the acid being mistaken for spirits, reported in a Glasgow paper while we were on a visit to that city. In the case which we first had the opportunity of seeing there was a post-mortem made, and the whole tissue, from the throat to the rectum, was of a brown color, and changed to a leather-like consistency, while the urine and other secretions were black.

Carbolic acid has produced poisoning both by its local application and by its being swallowed. Children and delicate women have been the sufferers by its free local application. It produces a species of intoxication. The symptoms are, in the case of adults, nausea, vomiting and headache; but in children the symptoms are more severe, the temperature falling below normal, the pulse being extremely weak, and the body covered with a cold sweat.

Death from Carbolic Acid.—At Milton, Ohio, on October 6th, a three-year old child secured a bottle of carbolic acid and a teaspoon, and began feeding it to the baby brother in the cradle. The screams of the baby attracted the mother, who was outside, and when she reached its side it was gasping for breath, and died in a few minutes.—The *Journal of the Am. Med. Association*, October 13, 1888.

Fatality in a Belfast Hospital.—A patient in Belfast Hospital, named James Jeffers, was accidentally poisoned in that institution, through taking a draught of carbolic acid, which the nurse of the ward in which he was located, gave him in mistake for a black draught. After drinking a portion of the stuff, Jeffers remarked, "You have given me the wrong medicine," and fell back insensible. The nurse having discovered the mistake by testing the liquid, rushed wildly for the house physician, who was promptly in attendance. Antidotes were administered, but the man died an hour afterwards. Miss Torrens, who was taken seriously ill shortly after tasting the poison, was placed under arrest. She was not aware of the death of the patient, and the doctors considered it would be injudicious to inform her of the fact. The affair created quite a sensation in Belfast, where Miss Torrens' friends move in the best society.

Another.—Another death from carbolic acid poisoning—the eighth in a few weeks—occurred at Liverpool, a woman drinking the poison in mistake, as usual, for spirits.

Quinine, Antipyrin and Antifebrin are Antipyretic and Anæsthetic.

The first and best known of the agents is the active principle of cinchona, or quinia, and its various salts, but chiefly the sulphate, which is now so extensively employed. This valuable medical agent, some twenty years ago, was most employed by Fenner, of New Orleans, and in enormous doses as a sedative in all kinds of fever; but it was found that in many instances it depressed the nervous system and acted most injuriously upon the patient—so that at the present day it is no longer employed in such poisonous doses. Soon after, the Germans took up this same drug, and described it as an antipyretic, and with it endeavored to reduce the temperature of all fevers, especially that of typhoid fever. In thus endeavoring to cure the disease by the simple reduction of temperature, they did not effect a cure, but frequently the immense doses of quinine acted as a poison upon the nervous system as an anæsthetic, and caused the death of the patient.

At the present day it is resorted to chiefly as an antiseptic to combat or destroy the various forms of bacteria, or micrococci, and diseases of a remittent or intermittent type. To obviate its injurious effects upon the nervous system, it is combined with the bromide or hydrobromic acid, or extract of ergot.

Antipyrin.

Another new and important agent which has been introduced as a temperature reducer, is the antipyrin, which is termed an analgesic febrifuge and hæmostatic:

$$C_6HsN \left\langle \begin{array}{l} CO\text{-}CH \\ \text{—}NO \\ \text{—}CH_3\text{-}CH_3 \end{array} \right.$$

Antipyrin is a febrifuge, lowering the temperature for about five or six hours. By many it is preferred to quinine in typhoid; but care should be employed, else its depressing effects act injuriously; and it is well to give with it small quantities of alcohol or wine. It is not so useful as quinine in intermittent fever. The dose is five grains, repeated every hour, in a compressed pill or tabloid. This is the quantity usually required in cases of pain pyrexia, until fifteen grains are given; then it is well to omit it for a time. The drug is free from the tinnitus aurium of quinine, and its peculiar action on the brain; but acts injuriously if too long continued as a cardiac depressant, and will cause death in delicate individuals by anæsthesia of the nervous system. In children with diphtheria, it is not to be recommended, and should not be employed in large doses, not more than a half-grain dose, if the child is five years old. It may be given hourly until pain is relieved and fever lowered.

It is a valuable agent in erysipelas, and relieves the pain in sub-acute rheumatism and dysmenorrhœa. If it occasions nausea by the mouth, it may be given hypodermically, or in enemata. Five grains is considered by us as equal to one-third of a grain of sulphate of morphia. It has been given with excellent results in migraine, facial neuralgia, lumbago, sciatica, biliary and renal colic, administered in five-grain doses every half-hour, until fifteen grains are taken, or relief obtained; or, it may with advantage be combined with a pill of two grains each of quinine and one-sixth of a grain of the hydrochlorate of cocaine. It has been found useful by us in certain forms of bronchial catarrh, of a rheumatic origin; also in whooping-cough, asthma, dyspnœa of bronchitis, and pains of locomotor ataxia. In severe attacks of migraine, from ten to fifteen grain doses are given every twenty minutes or half-hour, and three doses taken consecutively almost always remove the pain. A single dose, if given during the premonitory signs, will ward off an attack. Antipyrin, when given to certain young females for migraine, sometimes produces dyspnœa, with blueness of the lips and skin; and in other cases a species of intoxication; so that it is well to be on one's guard. It should be given mixed with sugar or gumarabic, as it is of a disagreeable taste, or may be dissolved in water, wine or lemonade. An eruption sometimes occurs from its use. The antifebrin has much the same composition, and has very analogous action as that of antipyrin, and is used in the same doses and requires the same caution in its use.

Antipyrin as an Anæsthetic.

Guerel (*L'Art Medical*) has given subcutaneous injections of twenty-five centigrammes of antipyrin to twenty patients. Fifteen out of the twenty had perfect anæsthesia, and felt a remarkable diminution of pain while in labor, nor did it interfere in any way with its normal course.

Local Anæsthetic Action of Antipyrin.

Hypodermic injection of antipyrin has been strongly recommended for the relief of pain by "See" and others. "See" considers that it rivals morphine in the extent of its action, that it has not the unpleasant after-effects of that drug, and that it does not interfere with nutrition or lead to a "craving." Berdach has lately been experimenting with the drug in this way at Professor Bamberger's clinic at Vienna. He uses a fifty per cent. solution in distilled water, and has experienced nothing but favorable results. All kinds of painful conditions were so treated, the injection being made at the most painful spot. For a few seconds after administration there is a local pain and burning, but this soon passes off, and is followed by analgesia over an area of more than a centimetre round the point of injection. Frankel, and others, had previously noticed this. The most important point in Berdach's observations is, that the pain is relieved in a few seconds after the injection, the relief lasting for at least six hours. No disagreeable effects, such as vomiting, sweating, rash on the skin, or depression of the heart or pulse were noticed, and in those patients who were febrile the temperature remained uninfluenced. This is too favorable an account, and we cannot endorse these statements and would advise caution in its use.*

Antipyrin in Dysmenorrhœa.

In five-grain doses it will relieve the pain of dysmenorrhœa and wearing pains during the first stage of labor. It sometimes checks the menstrual flow, and produces headache during the first two or three days. In almost all cases in which antipyrin or antifebrin are employed, a little wine is added to counteract the depressing influeuce upon the heart.

*It is also valuable in chronic catarrh in the form of spray, dissolved in hot water from 10 to 40 grains to the ounce.

PART SECOND.

NITROGEN MONOXIDE—NITROUS OXIDE GAS ($NO—N_2O$).

CHAPTER XI.

Nitrous Oxide Gas—Mode of Preparation and Chemical Composition —Gasometer and Inhaling from it—Liquid Nitrous Oxide and Inhalers—Anæsthesia from Nitrous Oxide—Physiological Action of Nitrous Oxide Gas—Experiments with the Gas—Additional Facts in Reference to the Physiological Action of Nitrous Oxide.

Nitrous Oxide Gas, its Mode of Preparation and Chemical Composition.

Nitrogen monoxide, or nitrous gas ($NO—N_2O$) is prepared from the nitrate of ammonia, (this is now obtained from the waste product of gas works by the action of nitric acid and is then purified), which resolves itself into the gas and water, thus:—

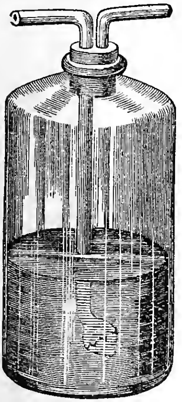
$$NO_3NH_4 = O = N_2O + 2\,H_2O.$$

The nitrate of ammonia is a crystalline salt, but for convenience of introduction into the retorts should be in a granulated form, which can be obtained of the manufacturing chemist, or of The S. S. White Dental Manufacturing Co., Philadelphia, New York, Boston, Chicago and Brooklyn.

Gasometer for Preparing Nitrous Oxide Gas.

The second important matter is to be furnished with a convenient gasometer, an illustration of which, is seen at Plate 5, with Nos. 1, 2 and 3, and these can be obtained from the dental depots. Care is required in the selection of the bottles for washing and purifying the gas. Plate 4, represents a very good form, which is furnished with perforated rubber cork, and glass tubes, bent at right angles. The long tube is pierced with small holes at the bottom, to compel the breaking up of gas, and so insure its more thorough washing. In purifying the gas some employ a solution of sulphate of iron in one bottle, and pure water in the other two. To remove chlorine gas, which is sometimes present, and can be noticed by its green color, and irritating vapor upon the respiration, a small stick of caustic potash is added to one of the bottles containing the water. When no chemical agents are employed in the purification of the gas, it should be well washed through fresh water, and allowed to stand for some hours over the water in the gasometer, to remove any impurities that may have passed over. Plate 5, represents the gasometer in position. The holder is first filled with water, to within one and a half or two inches of the top; while this is being done, take off the weights and open all the spigots, to allow the air to pass out, and the receiver to remain in position.

Plate 4.



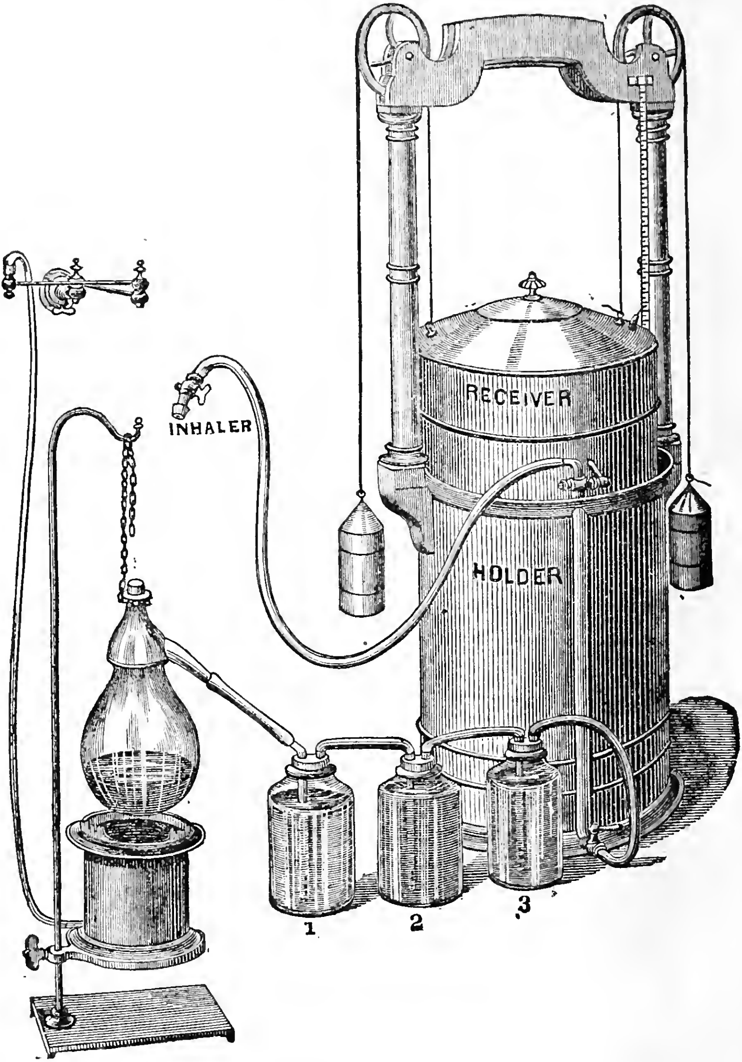
The long pipe of bottle No. 1, must not dip under the water, for the tubing thereby becomes choked with dense vapor, and the free passage of air is interrupted.

Into wash-bottle No. 2, place about four ounces of sulphate of iron, and add sufficient water to cover the end of the dip-pipe, about one and a half to two inches.

Into the wash-bottle No. 3, it is unnecessary to place anything but fresh water; yet some, fearing the chlorine, add a stick of caustic potash. Sufficient water should be employed to cause the pipe, which dips into the water, to sink the same depth as it does in No. 2.

When bottles are prepared, connect them with a piece of rubber tubing, and to the spigot of the gasometer. If they are arranged properly a current of air blown into the tube, intended to connect with the

Plate 5—(Figs. 1–3).



GASOMETER AND INHALER.

retort, will cause the water to bubble in the wash-bottles Nos. 2, and 3, and if the spigot A is open, the receiver will commence to ascend.

Having the bottles in readiness, and properly connected, place the quantity of nitrate of ammonia which will be required into the retort (one pound of the granulated salts will produce about thirty gallons of the gas).

There is a stove-like arrangement heated by gas-burners, with a sand-bath for holding and heating the retort. Connect the retort with the long pipe of the first bottle by the rubber tubing, and then open the spigot of the gasometer.

The heat must be applied gradually, first to melt the ammonia, about 226° F., and then to cause it to boil and give off gas at 460° F. to 480° F. until it is nearly all decomposed. When the gas has ceased to come over, take a cloth and disconnect the retort from the tubing, and close the spigot of the gasometer.

The inhaling-tube is attached to the spigot at the top of the holder. There is a register which shows the number of gallons of the gas in the receiver. When the holder is filled, close the spigot and arrange the weights; it is then ready to receive the gas. The wash-bottles are placed as represented in Nos. 1, 2, 3, which are connected one with the other, and to the retort and gasometer, by means of rubber tubing. The first bottle, No. 1, is placed next to the retort, and is simply used to catch the drip resulting from condensed vapor.

The water and solutions contained in the wash-bottles should be changed once in a month. When nitrous oxide gas is thus obtained, it is colorless, almost inodorous, and of a sweetish taste. The chemical decomposition is as follows:—nitrate of ammonia resolves itself into nitrous oxide gas and water; thus $NO_3NH_4 = N_2O + 2\ H_2O$. The heat necessary to cause active evolution of gas is stated to be 460° F., and this heat should be kept up, else a portion of the salt will sublime. The heat should never be allowed to rise above 482° F., as the nitric oxide is apt to be given off in the form of an orange-colored vapor. In infinitesimal explosions, nitric oxide is a dangerous impurity, as it cannot be breathed unless very much diluted, and tends to suspend respiration and produce spasm of the muscles of inspiration. To determine the proper temperature, a thermometer is prepared which can be passed into the cork, and into the retort, so that no risk need be incurred by the introduction of poisonous materials into the gas.

After the gas is made, it should stand over water a few hours, not longer, else endosmotic action will take place and weaken the gas before using. But this will do little toward insuring absolute purity of the gas; neither will washing it through solution of iron and potash purify it perfectly. Should there be chlorine present (which is the poisonous element) in the nitrate of ammonia, no amount of washing through solutions will obliterate it. The ammonia should always be tested before using, which is done by dissolving about a teaspoonful in a half-tumbler of distilled water, and applying a few crystals of the nitrate of silver. If the ammonia be pure the solution will remain perfectly clear; but should chlorine be present, it will show a clouded appearance, and the ammonia must be discarded altogether.

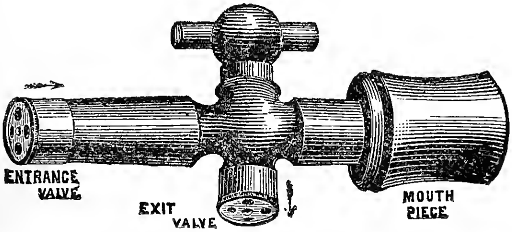
Iron Retorts for Making Protoxide of Nitrogen Gas.

Nitrous oxide for dental operations has now come into general use, and dentists making their own nitrous oxide, must have doubtless met with great difficulties in consequence of the breaking of the glass retorts. To obviate this inconvenience, the idea has been suggested to use iron retorts. One can be made of rolled iron, fourteen inches long by six inches wide, outside measure, of a quarter of an inch thick, the joints being brazed together and perfectly air-tight. The bottom of the bottle is convex outside and concave inside, and the top opening is one inch wide, with a threaded screw inside the mouth of the bottle. To this is attached a tube two feet long with a threaded screw, to enable the unscrewing of the tube, in order to put the nitrate of ammonia into the bottle. The iron tube is bent at a curve just above the mouth of the bottle, and is two feet long, and the other end of the tube being on a level with the mouth of the bottle, the bottle can be either suspended or placed over a gas-burner, or on a fire, and the receiver remain in position. The iron retort must be lined with porcelain, and the gas must be purified before being employed, by the same method as above directed.

Inhalers.

Next to pure gas, a perfect inhaler is the most essential thing to the successful administration of nitrous oxide.

Plate 6.



THOMAS' NITROUS OXIDE INHALER.

The Thomas Inhaler, Plate 6, used with gasometer, is turned from a piece of vulcanized rubber, eight inches long by three inches square, leaving the mouth-piece one inch and a half across. The diameter of the opening is a little more than one-half an inch, with stop-cock in the centre, in which is the inhaling valve, being constructed of a simple piece of rubber dam secured by a pin to a stopple, in which are three oblong apertures, as is the inhaling valve at the extremity of the inhaler. The aperture, being of sufficient size, is made not to obstruct the free passage of the nitrous oxide gas; the valves are three-quarters of an inch in diameter, and the stoppie is of vulcanized rubber.

It must have a tube, large enough to admit the gas so freely that the most nervous, as well as patients with weak lungs, can inhale through it without exertion, and it must be perfectly air-tight.

Some inhalers are so constructed that it is only by using great effort that patients can supply air to the lungs to their natural capacity, causing them to struggle or go into the anæsthetic sleep with such feelings of suffocation and depression, that they will drift into dreams of the most frightful character, and become almost unmanageable in their excitement.

Plate 7—(Figs. 1–2).

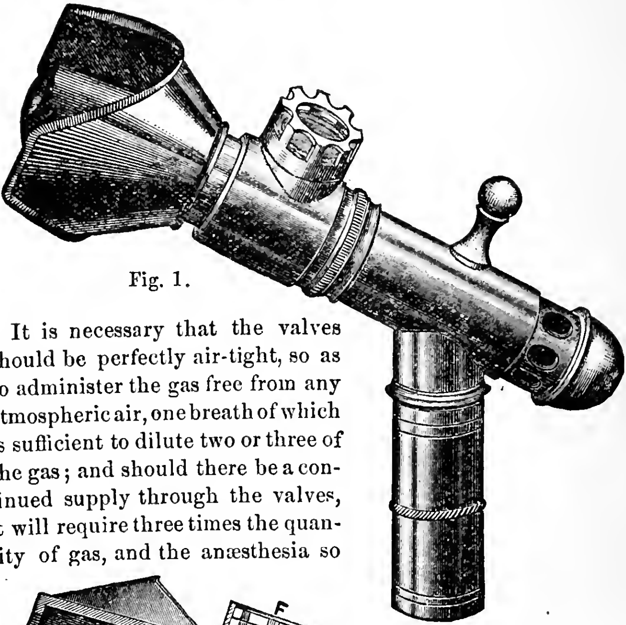


Fig. 1.

It is necessary that the valves should be perfectly air-tight, so as to administer the gas free from any atmospheric air, one breath of which is sufficient to dilute two or three of the gas; and should there be a continued supply through the valves, it will require three times the quantity of gas, and the anæsthesia so

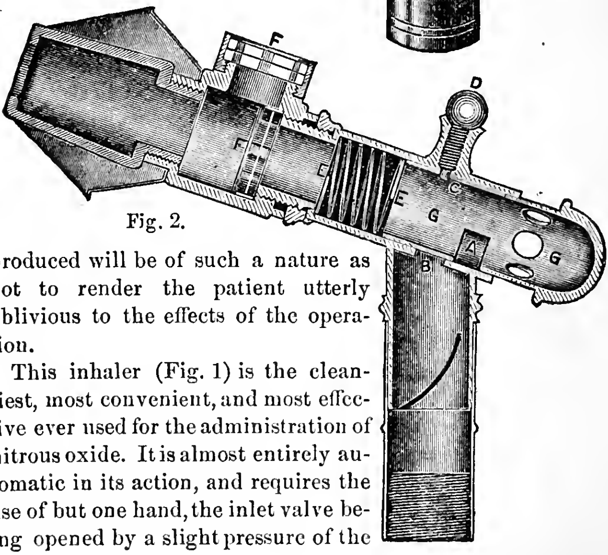


Fig. 2.

produced will be of such a nature as not to render the patient utterly oblivious to the effects of the operation.

This inhaler (Fig. 1) is the cleanliest, most convenient, and most effective ever used for the administration of nitrous oxide. It is almost entirely automatic in its action, and requires the use of but one hand, the inlet valve being opened by a slight pressure of the thumb, so that the gas can be turned on without the patient's knowledge. Upon the removal of the pressure, the valve closes automatically and shuts off the gas.

The sectional view (Fig. 2) shows the internal construction. An opening, B, underneath the body of the inhaler, admits the gas through a similar opening A, in a sliding tube GG, fitted inside of, and projecting beyond the rear portion of the main body. The projecting portion is perforated for the admission of air, and its outer end is closed by a cap. At the inner end of the sliding tube, is a coil spring, EE, abutting against a shoulder in the body of the inhaler. This spring holds the sliding tube in the position shown in the cuts, closing the inlet B, when the gas is not being used. Pressure on the cap compresses the spring, closes the perforations for the admission of air, and brings the opening A, over B, affording a free flow of gas to the mouth-piece through the inhaling valve. The sliding tube is prevented from rotating by the screw-pin D, which works in a slot, C. The inhaling and exhaling valves—the former internal, the latter external—consist of two thin disks of mica, F F, which are inclosed in circular open cages. The inhaling valve is opened in respiration, by being drawn against the front of the cage, the exhaling valve being closed by the pressure of the outside air. In expiration, both disks are thrown against the further ends of the cage, opening the exhaling, and closing the inhaling.

The entire inhaler, except the mouth-piece, and the two valve-disks, is of metal, smoothly finished, the outside polished and nickel-plated. It is readily taken apart for cleaning. The illustrations are half-size.

In this form of face-piece, the oval shape is maintained by the peculiar metal fittings, as shown in detail.

The inhalers which cover the entire face are sometimes objectionable to delicate patients. In cases of gentlemen with beards it is impossible to give the gas without the admission of air. It must be remembered that the color of the blood, as shown through the mucous membrane of the lips, is one of the principal guides to the condition of the patient, during the inhalation of gas; and if they are covered from view by the hood or otherwise, we have lost that means of diagnosis. In instances of hare-lip, or where, from swelling or other causes, the muscles of the jaw become so contracted, as to render it impossible to pass the mouth-piece between the teeth, a rubber covering is recommended.

Inflatable Face-piece for Inhaler.

The Inflatable Face-piece consists of a soft rubber hood with an inflatable edge-cushion, attached to a metal frame which is screwed into the inhaler. The frame, which preserves the shape of the hood, may be readily detached for cleansing, by unscrewing the nut which holds it to the neck of the inhaler. The cushion is inflated through the little tube. The best adaptation to the face is obtained when it is only partially distended.

Liquid Nitrous Oxide.*

This form has been found so convenient, that with many physicians and dentists it has taken the place of the gaseous form. One of the best forms of valve is the Johnston Gas-Valve (Plate 8).

DESCRIPTION.—The seat, A (shown by the V-shaped dotted line), is made of a soft alloy, which easily receives the impress of the plug, and of course the impress must exactly fit the point which makes it. It can be easily operated by a child with a small wrench.

The plug is made in two pieces, B and C, united by a ball-and-socket joint, so that the moment the point touches the seat, it is prevented from revolving, and the rotary motion takes place at the ball joint, thus preventing any wear or grinding on the seat.

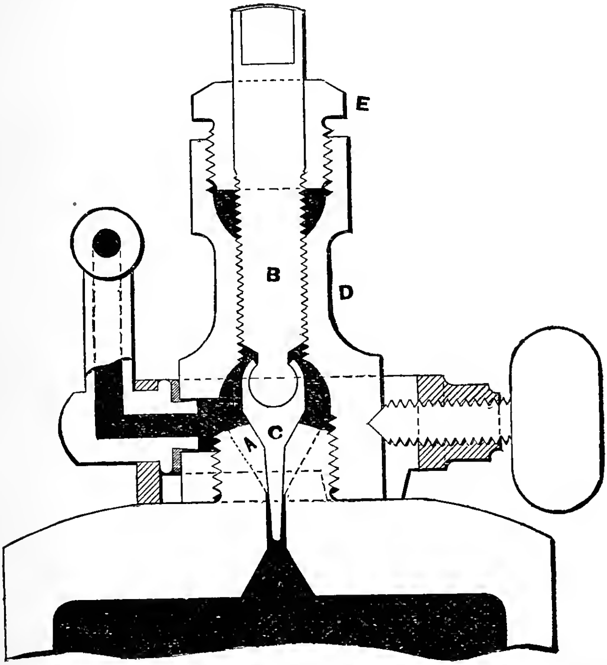
The cock, D, unscrews from the seat, exposing the latter for inspection or repair.

Projecting from the end of the plug, down into the gas passage, is a long and slightly-tapering point; this nearly closes off the opening, even after the plug is raised from its seat, and there is no annoying rush of gas, even when the plug is raised several turns.

* Under a pressure of 50 atmospheres, at 45° F., the nitrous oxide gas is condensed by a pump into a clear, transparent liquid, while the cylinders are kept in ice.

The valve is handsomely finished and nickel-plated externally, and discharges through the yoke in a manner readily understood from the cut. It is operated by a small hand-wheel or

Plate 8.



wheel-key, which is provided with a set-screw to secure it in position, and thus avoid all danger of its dropping off, which might otherwise occur at the most critical moment in an operation.

By the use of a prop, one has a fair opportunity to perform the operation to his entire satisfaction; but without it, there is danger of the patient bruising, and possibly breaking the front teeth, by biting so hard upon the mouth-piece, when recovering from the effects of the gas, before the mouth can be opened sufficiently wide to admit of the extraction of a tooth, or an operation upon the mouth.

Nitrous oxide must always be pure to insure success, though some have recommended it after it has stood over water one or two weeks, and even a month; but it is impracticable. This is obviated in the liquid gas.

Nickel-plated Gasometer and Ornamental Stand.

Plate 9, represents a nickel-plated gasometer, mounted on a stand, with a 500-gallon cylinder in position for those who may desire a highly ornamental piece of office furniture, coupled with a really economical gas apparatus.

In employing liquid gas, allow a certain amount of space above the liquid for expansion of the gas when subjected to varying temperatures. The S. S. White Dental Manufacturing Co., has found that in a cylinder containing 512 gallons of gas, submitted to a temperature of 95° Fahrenheit, the pressure indicated on the gauge was 3200 lbs., and that in the same cylinder, when the quantity of gas was reduced to 452 gallons, and subjected to the same temperature, the pressure was reduced to 1725 pounds to the square inch.

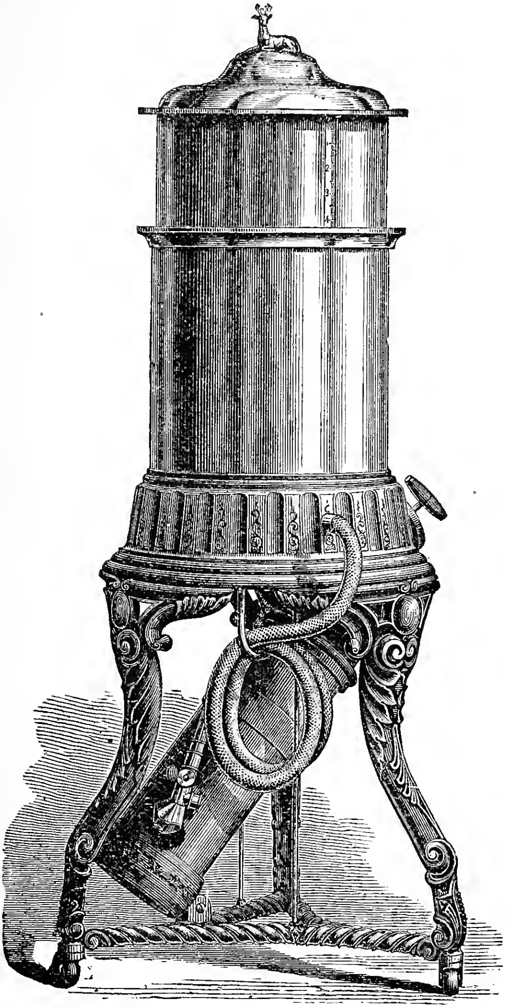
They, for this reason, refuse to put more than from 450 to 452 gallons in 500-gallon cylinders. These 500-gallon cylinders, are designed for those who use large quantities of nitrous oxide.

Directions.—Use a single leather washer on the coupling-joint of the yoke attachment.

The valve is the only proper and sufficient means of retaining the gas; neither the bag nor the inhalers will prevent its escape if the valve is left open.

After detaching the bag from the cylinder, test the valve to be sure that it is closed. This may be readily ascertained in a very simple way, as follows: Take a little saliva from the mouth on the finger, and gently pass it over the outlet of the valve, so as to form a film over the opening. If, because of imperfect closure of the valve, there is any escape of gas, the film will be forced outward in the form of a bubble. A slight turn more of the hand-wheel, and the film will remain stationary or show a tendency to sink inward from the pressure of the

Plate 9.



NICKEL-PLATED GASOMETER AND ORNAMENTAL STAND.

external air, proving that there is no escape of gas. Should any difficulty be experienced, the cylinder should be returned at once.

Cylinders containing gas should never be exposed to heat, as that greatly increases the pressure.

Always close the valve after emptying the cylinder.

The usual quantity of gas given to a patient, is from 3 to 5 gallons.

If it is desirable to keep the patient under the influence of the anæsthetic for a prolonged period, (as in a surgical operation) the operator, has under his control 500 gallons of gas, by merely turning the key, seen in the cut at the right.

On the bell of the gasometer, there is a scale, graduated in gallons, and fractions of a gallon, so that the operator can readily see how much gas he has administered.

Another valuable feature of this gasometer is a peculiar water-check or valve, so arranged that though the gas flows freely on the slightest inspiration at the inhaler, it is instantly and automatically shut off by the water, when the patient stops breathing. This prevents all waste of gas; it also saves the surgeon's or dentist's time at the most critical moment, as he has only, after having administered the gas, to lay aside the inhaler and proceed at once to operate without the necessity of shutting any stop-cock. The stand is so constructed that a small (10-gallon) cylinder can be used while the larger cylinder is being refilled.

We also call attention to the fact, that there is no liability to loss of gas from leakage, caused by the operator's leaving the valve of the cylinder open, for, if there is such escape from the cylinder, the bell of the gasometer will rise, and the operator having his attention called to the waste, will be enabled to correct the difficulty at once.

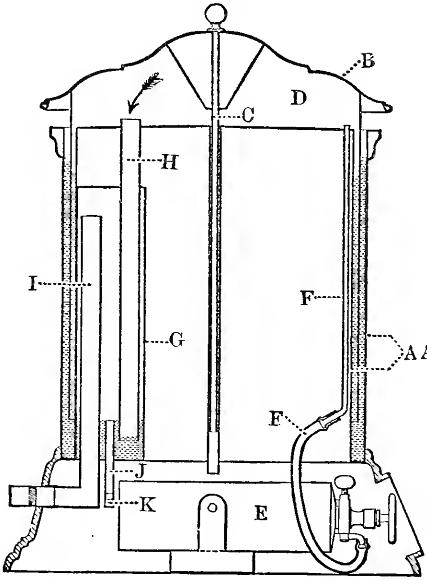
The gas can be kept for any length of time, and is constantly on hand *and always of the best quality.*

The diagram (Plate 10) represents a sectional view of a nickel-plated gasometer.

Two metallic cylinders, AA, are arranged concentrically to form a water-holding space between their approximating walls, while a third cylinder, having a cover with a guide-rod, C, attached to the cover, is lowered into the water-space as a seal between the cylinders, and to form a gas-chamber, D, at the top. The inner cylinder is provided with a central tubular cavity, closed at the bottom, to receive the guide-rod of the cover.

It is obvious that the chamber, D, will be enlarged or diminished according to the volume and pressure of the gas, which rises to the chamber from the iron cylinder, E, beneath the

Plate 10.



gasometer, when the valve is opened, through the connecting tube and pipe, FF. The gas is conducted to the inhaler from the chamber, D, through a closed cylindrical water-vessel, G, attached to the wall of the inner cylinder, and provided with an inlet pipe, H, and an outlet pipe, I, which latter is carried to the outside at right angles to the gasometer, and receives the tubing which conducts the gas to the inhaler. This closed vessel G, is also provided with a water outlet or overflow, J, and the whole forms a very simple and effective trap for shutting off the gas when not inhaled. In operation, it is only necessary, before the cover is placed in position, to pour into the water-space between the cylinders, enough water to nearly fill it, and into the inlet pipe, H, sufficient water to overflow the outlet, J, or the trap, the rubber stopper, K, of the latter being removed for that purpose and replaced when the overflow has ceased. Then insert the cover, and open the valve of the iron cylinder beneath.

The vacuum in the vessel, G, produced by each inhalation is immediately filled by the gas, passing through the water and upward to the outlet, I; the instant that inhalation ceases, the gas is arrested and confined at the water-level in the trap.

Directions for Setting Up and Using the Gasometer.—Unpack carefully the two boxes, removing all the hay from the smaller one before trying to lift the gasometer from the box. Lift the top (bell) of the gasometer clear of the water-tank, and set the plated tank on top of the iron stand, placing it so that the tube underneath, to which the inhaler tubing is to be attached, shall come *exactly* opposite the small hole provided in the iron base. With a cup or dipper, fill the annular space in the body of the gasometer (tank) with water to within three inches of the top, and pour about a pint of water into the trap through the large tube seen in the top of the gasometer.

To Adjust for a 500-gallon Cylinder.—Secure the wider of the two iron rings in position near one of the feet of the stand by means of the screw provided for the purpose. Keeping the large cylinder horizontal (the stop-cock end may rest on the floor), place the bottom of the cylinder in the ring, being careful, of course, not to drop the cylinder, and observing that the delivery opening of the stop-cock is to the right.

Now slide the other iron ring over the top of the cylinder, and elevate this end, at the same time adjusting the ring so that the projection on its side will enter the slot provided for it under the centre of the gasometer, and allow the pin to be put in place, securing it in position. Tighten the set-screws in the upper ring against the cylinder, using the key sent with the apparatus, so that it cannot turn around when the stop-cock is opened or closed.

To Adjust for a 100-*gallon Cylinder.*—It is only necessary to slide the cylinder to its place horizontally through the opening in the side of the iron base, keeping the delivery opening of the stop-cock toward the right, fastening it in position by means of the long set-screw which projects though the side of the iron base.

In either case (whether a 100- or a 500-gallon cylinder) screw the yoke which will be found attached to a rubber tube under the gasometer to its place on the stop-cock of the cylinder, being sure that there is a leather washer properly placed on the union tube. A leather washer will be found attached to every cylinder. *This must be attended to every time a new cylinder is placed in position.*

Draw the small rubber stopper from the end of the tube under the gasometer, and allow all the water that will, to flow from the tube into a basin or pail, and then replace the cork *tight.*

Now (and not before) return the bell to its place, being careful to enter the central rod and the graduated scale into their respective guides. After the slight spluttering around the edge of the bell is over, if the foregoing directions have been followed properly, the bell will remain balanced, and a very slight (a few ounces only) pressure of the hand on its top, will cause it to settle gradually.

Before letting gas into the gasometer, force the bell entirely down, to remove all air. It is well to let in a few gallons of gas, and to force this out also, so as to expel the last traces of air from the gasometer. Now attach the inhaler and tubing to the gasometer, by sliding the connection on the end of the tubing firmly to its place through the hole in the side of the iron base; then with the nickel-plated cap cover the opening through which the 100-gallon cylinder goes to its place, and the apparatus is complete.

Directions for Using.—To let gas into the gasometer, open the stop-cock on top of the cylinder with the key. The stop-cock of both the 100- and 500-gallon cylinders can be reached through the hole in the centre of the nickel-plated cap mentioned above.

The numbers on the graduated scale indicate gallons, and enable one to determine the amount of gas used by each patient; thus, if 10 appears just at the top of the water-tank when beginning to administer the gas, and after the administration 6 stands at the same place, 4 gallons of gas have been used.

We would suggest that in beginning the use of this apparatus a record be kept of the number of gallons of gas used by each patient.

When liquid gas is used, 5 gallons is sufficient for ordinary dental operations.

When the ordinary gas as made by dentists is used, an average quantity of about eight gallons is necessary.

After administering the gas, it is unnecessary to stop, to shut the stop-cock of the inhaler before commencing the operation, as the trap will shut off the gas automatically; it is well, however, to shut the stop-cock immediately upon completing the operation, as otherwise the tubing will fill with air, which will interfere with the next administration.

A large hook will be found under the gasometer, upon which the coiled inhaler tubing may be hung, when it is desired to set the apparatus out of the way.

Cautions.—1st. Do not blow into the inhaler tubing when the inhaler is not in place, as it will derange the water-trap.

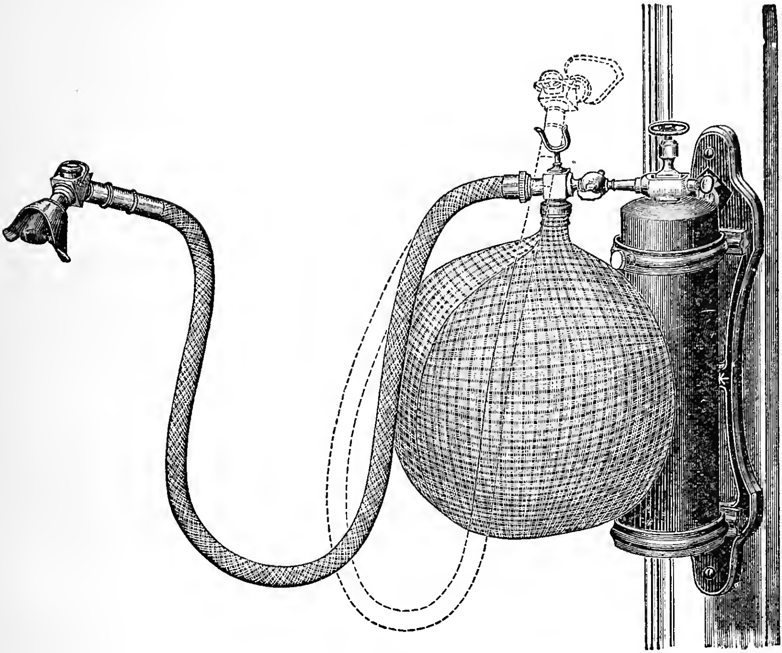
2d. If, for any reason, it is necessary to remove the bell from its place, first disconnect the union from the cylinder, so as to admit air to the gasometer, and then raise the bell gently and slowly.

Wall-Bracket for Gas Cylinders.—(Plate 11.)

This is an excellent device for use in offices where the gas is administered frequently. The bracket may be attached to the window-casing or other wood-work. As the wall bracket has a yoke attachment, it can be arranged to a stand on the floor of the office.*

* For greater convenience a small cylinder is made, containing bag, inhaler and tubing, in a metal case for carrying by the surgeon to the patient's house.

Plate 11.



Nitrous Oxide Gas.

This anæsthetic can be employed in a few operations in surgery; these are, extraction and surgical operations on the teeth and gums. With it the ophthalmic surgeon can operate for ordinary strabismus, or removal of small tumors, or enucleate the diseased eyeball. It is very valuable in examining the urethra for stricture, and even the cutting of an impervious stricture has been performed under its influence with success. Necessary manipulation in stiff joint, and tenotomy of tendons for the relief of club foot, etc., have all been performed while under its influence, and in conjunction with sulphuric ether, bromide of ethyl, oxygen and chloroform, almost all surgical operations can be performed, even when prolonged.

NITROUS OXIDE IN PROLONGED SURGICAL OPERATIONS.—At the recent meeting of the American Medical Association, at Newport, R. I., we had a long and interesting conversation with Dr. C. A. Brackett, the well-known distinguished dentist of that city, on various matters concerning the discovery and introduction of nitrous oxide. The doctor called my attention to a number of cases of the prolonged use of this agent in various surgical operations by Dr. Goodwillie, of New York. ("Johnston's Dental Miscellany," vols. 1 & 3, p. 85.) They were sixteen in number—comprising amputation of the thigh, removal of breast and ovarian tumor, with other less important operations, all successful. There was also an attempt at reduction of the hip joint, but this failed. Owing to its not relaxing the muscles sufficiently, it was discontinued, and ether substituted. The following were his conclusions:

The average amount of gas used in prolonged anæsthesia, is about two gallons per minute.

To keep up prolonged anæsthesia, requires great care and judgment on the part of the anæsthetist. Anæsthesia on the one hand, and consciousness of pain on the other, are conditions of the body with respect to time, that bear close relations to each other, and so judgment, and prompt action in administering the gas is required. The anæsthetist, in any case, *must* not allow his attention to be distracted by the patient. Dr. Goodwillie employed the liquid gas, and states, that the first case reported of the use of the liquid nitrous oxide (from cylinders) in this country, was on October 13, 1871. The inhaler which he found most efficient, covers both mouth and nose.

We give the case of Dr. Brackett in full, as it has never before been published:

A COPY FROM PRIVATE RECORD OF C. A. BRACKETT, M.D., D.D.S.—"April 20th, 1875, Mrs. R. S., administered nitrous oxide, and kept patient under its influence about thirty minutes, while Dr. Squier removed cancer of the breast. Grand success. Patient not conscious of operation. I believe this is the first such achievement of the kind in New England. Not all of one 100-gallon cylinder used of *Johnston's Liquid Gas.*"

The patient receiving impure gas, will generally have some undefined impression of the operation, and will often complain of giddiness, a fulness in the head, and a feeling generally of malaise for the balance of the day. With pure gas, sickness is not apt to occur, except with patients of very delicate organizations, such as are easily disturbed by nervous excitement, and those who are affected by the sight of blood, or the contemplation of a wound of any kind.

Brief Hints as to the Proper Method of Administering Nitrous Oxide Gas as an Anæsthetic.

The most important matter is to have an intelligent male or female assistant. It is never safe to be without one, or the other. Artificial teeth must be removed, and if the patient is very old or feeble, or there is a fatty heart, or diseased lungs, the reclining posture is the safest. The ordinary position is the sitting-up or half-reclining.

The operator stands on one side, and carefully introduces between the teeth a prop of wood or hard rubber, to which is attached a string. The patient's dress, if a female, is opened and the cravat is loosened in the male. Everything should be done without undue haste. Nor should any noise or loud talking be allowed in the operating-room. The inhaler is then placed between the lips and teeth of the individual to be operated upon, and the nose is clasped between the two fingers, if there is no face-piece employed. The gas is now turned on, and the patient is directed to let the mind dwell on some pleasant object—occasionally we have found a few notes from a musical-box very agreeable when the patient is reviving. If there is a face-piece to the inhaler, it is to be gently applied, with just sufficient pressure to prevent the escape of the gas, and the patient is directed to make slow and deep breathing. Keep the bag full of gas. Let the assistant watch carefully the pulse and respiration, opening the ingress of the gas during inspiration, and closing it during expiration.

Usually it requires from twenty to twenty-five seconds to fill the lungs with the gas; then appears pallor of the skin, with darkening of the nails and finger tips, yet consciousness may be still present, and the inhalation may have to be continued from five to ten seconds longer. In about half to three quarters of a minute, the patient's consciousness is lost, and soon after the pupils will dilate, the eyes becoming dull, with loss of expression, and there may be strabismus. This is the primary condition of anæsthesia, when if the conjunctiva is touched, the reflex is still there, and yet at this stage, a single tooth, or a very slight operation can be performed. If, however, the inhalation is continued for a minute longer, the breathing becomes stertorous, muscular movements of the hands and feet take place, and the conjunctiva can be touched without any movement. Should the breathing stop for more than ten seconds air must be given. This is the period of deep anæsthesia, and should the heart intermit, and pulse at the wrist not be felt, air must be introduced and the gas stopped. If everything remains in good condition, now is the time for operation.

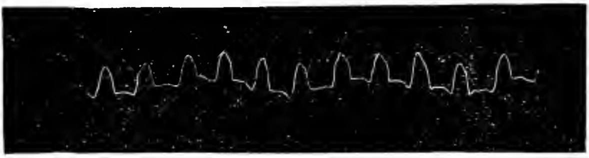
Sphygmographic Tracings from Patients under the Influence of Nitrous Oxide Gas.*

"It is well known that as soon as the inhaler is placed over the mouth and nose of the patient, he begins to respire more quickly

Plate 12—(Figs. 1–3.)

1

NORMAL PULSE.



2

FULLY UNDER NITROUS OXIDE WITH LOWERING OF ARTERIAL TENSION.

* Abstract—"The Effects of Nitrous Oxide on the Pulse," by Daniel Mowat, M.B. and C. M. Edin, *Journal British Dental Association*, March 1887, p. 144.


3

TIDAL WAVE APPEARING.

and his pulse increases in speed. This, however, is due to excitement resulting from the fear which usually accompanies the inhalation. As soon as inhalation begins respiration becomes slow, the tension of the pulse falls, the number of beats per minute is increased, the tidal or predicrotic wave is slightly better marked, and the dicrotic wave becomes so well marked as to constitute that pulse which is known as fully dicrotic; sometimes, indeed, it is even slightly hyperdicrotic. As anæsthesia proceeds the tension of the pulse falls considerably, whilst the number of pulsations increases. The tidal and dicrotic waves still remain very well marked. When the mouthpiece is removed and any operation is to be performed, the pulse undergoes a marked change. This is probably due to a reflex action through the vagus to the heart. Immediately after the operation the pulse gradually assumes its normal condition, passing (in the reverse order) through the stages it had undergone when the nitrous oxide gas was applied.

As a matter of course, every patient is a law unto himself as regards the time required to come fully under the influence of the anæsthetic, and even the same individual will differ at different conditions of the system.

The Committee appointed by the Odontological Society of Great Britain, found the following averages in a large number of administrations of the gas: (Buxton.)

	Time going off.	Duration.	Time from commencement to recovery.
Males, ...	1 min. 21 sec.	24 sec.	1 min. 55 sec.
Females, ...	1 " 16 "	28 "	2 "
Children (under 15),	1 " 3 "	22 "	1 " 49 "

For emergencies, the operator or his assistant should have within reach a napkin to draw out the tongue, an artery forceps to hold it if necessary, nitrite of amyl in case of extreme paleness, but not if much flushed. Above all, to be able to invert the patient so that the blood will reach the anæmic brain, or place him on the floor, opening the windows and performing artificial respiration. Stertor, with slight jactitation, are signs that the patient is ready for operation, and is caused by vibration of the arytæno-epiglottidean folds. This comes on after at least a minute, and must not be confounded with the "snoring" of patients who suffer from enlarged tonsils or post-nasal adenoid growths.

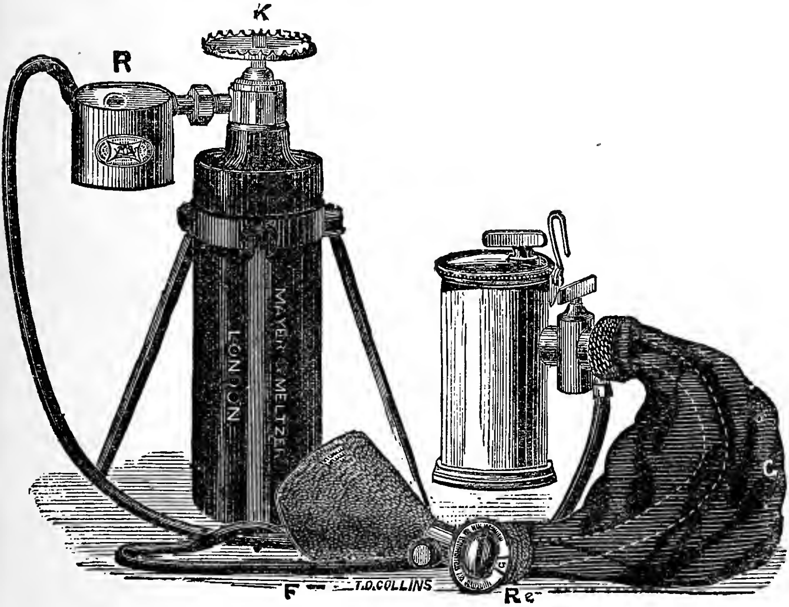
The evidence of returning consciousness is the normal color in the face and lips, with a cry or movement of the hands. For long-continued operations in dental surgery, or any surgical operation, a combination of ether and nitrous oxide is one of the best.

The following is the improved apparatus of Clover for nitrous oxide and ether. This is seen in Plate 13. (Buxton.)

It consists of a tripod supporting a cast-iron bottle containing fifty gallons of nitrous oxide gas, the bottle being gripped firmly by a screw. The supply is regulated by the administrator's foot, which is placed upon the foot-piece, K. This is provided with teeth which bite into the boot, and enable the administrator, by turning his foot to the left, to open the outlet of the gas. R is the connection between the bottle and the Cattlin bag, G.

The small metallic receiver can be filled with warm water to obviate freezing of the gas in cold weather. The India-rubber tube will be seen to fix on a stop-cock in front of the ether receiver, which latter is suspended by a hook from the administrator's coat. When only gas is to be given, the stop-cock on the ether vessel is put at right angles to the long axis of the bag; when ether is to be used, this stop-cock is turned into the long axis of the bag. The stop-cock in front of the ether-receiver is more conveniently placed just above where the tube is seen to end. The Cattlin bag is so arranged as to allow of pure nitrous oxide, pure ether, or a mixture of these two substances to be administered. The supply is regulated directly by the stop-cocks above-mentioned, but more immediately by an arrangement represented, though not very clearly, at Re. It consists of a semi-circle of plated metal, upon which are engraved at opposite ends the letters G and E. An indicating rod plays upon this by simply shifting the indicator, so that it revolves free of the semi-disc, and the air is inspired. When the

Plate 13.



indicator points to G, nitrous oxide passes into the face-piece, and as the indicator travels toward F, ether vapor is permitted to mix with the gas until arriving fully at E, when pure ether is inhaled. The cushioned face-piece is used by Clover, and is supplied with a simple expiratory valve.

Should a supplemental bag be used, the face-piece must be provided with an aperture to which this accessory can be adjusted. The stop-cock in this arrangement is kept shut until the residual air of the lungs is presumably exhausted, when it is opened, the finger placed upon the expiratory valve, and the patient allowed to breathe backwards and forwards into the bag.

When desirable, according to "Buxton," it is a simple matter to convert the Cattlin bag, into a supplemental bag, by placing a finger upon the expiratory valve, and so causing the patient to expire back into the Cattlin, as well as inspiring from it.

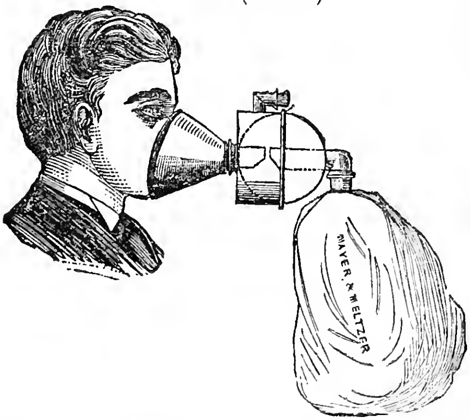
Where a gasometer is employed, as in the case of Dr. Thomas, of Philadelphia, and others, a modification of the above apparatus may be used.

A long tube screws on to the efferent pipe of the gasometer, conveying the gas to a bag of two or three gallons' capacity. This may be connected directly with a face-piece, or conveyed to it by another length of tubing, and by using a three-way cock, it is easy to combine this apparatus in gear with Clover's smaller ether inhaler.

Clover's Small Portable Ether Apparatus.

(For description, see Inhalers).

Plate 14 (Buxton).



Attachments for gas cylinders have been devised in this country by Lewis, of Buffalo, and by Dr. A. M. Long, in which the gas is made to combine with the vapor of other anæsthetics, such as chloroform, ether, etc. The latter has a combining-chamber through which the gas passes from the cylinder on its way to the gasometer. There is a receptacle for the liquid agent. When a handle below is turned half-way round, the two separate tubes meet, and drop by drop the liquid passes into the combining-chamber.

In the following statements, published by "Guilford" (p. 82, Nitrous Oxide), we omit those on chloroform, as we consider such a combination highly dangerous, but in the case of ether, there is so much less danger, that we favor at times a mixture, as in the following cases.

A gentleman writes (name not given, but known to Dr. Guilford):

"I have used nitrous oxide for eighteen years, and during the past five years have given it in combination with chloroform or ether. For the last two years I have used 'Squibb's' ether instead of chloroform, and prefer it. I combine from fifteen to twenty-five drops of the ether with five gallons of the gas. By using the combination, I can extract as many as sixteen teeth and roots, at one time, whereas, with the gas, I have seldom been able to remove more than five or seven. Patients seem to recover from the effects of the combination as quickly, as from the gas. I have had no nausea or other unpleasant effects to follow its administration. I cannot suppose a case where it would be proper to give the gas, in which I would hesitate to administer the combination."

Codman & Shurtleff, of Boston, have devised an inhaler for nitrous oxide gas or ether. This is accomplished by simply changing the arrangement of the mouth-pieces, and is described and figured under inhalers.

The Physical Properties and Physiological Action of Nitrogen Monoxide—Nitrous Oxide (NO-N_2O).

Nitrous oxide gas, when pure, should be free from color or odor. It has a sweetish taste. It is an active supporter of combustion. A taper will burn in it, but the decomposition of the nitrous oxide, is due to the high heat, for at the ordinary temperature of the body it is not decomposed. Seeds will not germinate in it, and animals live no longer in this atmosphere, than in one of nitrogen. During nitrous oxide narcosis, the amount of carbonic acid exhaled from the lungs, is only two-thirds of that eliminated before the inhalation. It has, however, the one quality of producing a sense of exhilaration and true anæsthesia, which no other mixture of nitrogen, carbonic acid, air or of oxygen, can produce, proving that the theory of asphyxia is not the true one, the circulation having been found very differently affected by mechanical or chemical agents, than by nitrous oxide.

Nitrous oxide gas should be kept in a liquid state, or made freshly, for it is a well-known and recognized fact that if kept over water, it absorbs nearly its own bulk. We have before expressed our opinion, that when the gas is administered in its pure state, it enters the air-cells of the lungs and circulates in the blood. In confirmation of the above, Dr. C. A. MacMunn ("The Spectroscope in Medicine," London, 1880, pp. 73–75) finds that when an animal is killed by nitrous oxide the arterial blood gives only spectrum lines of reduced hæmoglobin, while after chloroform those of oxyhæmoglobin are very apparent.

The marked resemblance between the effects produced by nitrous oxide, and those resulting from asphyxia, were observed by the earlier experimenters with ether, and a few eminent physiologists at once expressed the opinion, that the physiological action was the same; but at the present day this is not generally entertained.

The following is a summary of the various facts bearing on the subject, *i.e.*, in regard to the physiological action of nitrous oxide.

It would seem that this accumulated evidence is not sufficient to show that the anæsthesia produced by the inhalation of nitrous oxide, is simply asphyxia. Nitrous oxide gas produces in man, even when mixed with air, a feeling of exhilaration, and stimulation, which would indicate that it is not merely a passive agent, and then acts as a narcotic. The discolored appearance of the patient while under its influence is, to a great extent, due to the accumulation of carbonic acid in the biood.

Nitrogen, when inhaled, acts upon the animal economy, not solely by the exclusion of oxygen. When nitrogen is taken into the lungs it gives rise to no feeling of exhilaration, but sometimes to malaise, and a sense of impending suffocation.

After death, which has been very rare from nitrous oxide, the following is the condition of the lungs: these organs are found neither voluminous, nor collapsed; of a light pink or rose color, and generally with one or more small circular, well-defined ecchymotic spots, usually on their posterior surface.

The lungs are moderately crepitant, and the blood which escapes from an incision, is more or less full of gas bubbles. These bubbles will be found in the bronchial ramifications mixed with mucus, and in one or two instances, the trachea was filled with rusty, frothy fluid, so common after drowning.

The local effects of nitrous oxide were found to be like those produced by carbonic acid.

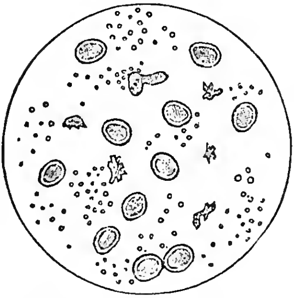
They both act upon the blood-corpuscles so as to darken them. The lividity upon the lips, and the darkening of the mucous surfaces, seen every day in the operating-room, after administration of nitrous oxide, are the result of this action. The inhalation of nitrous oxide, is followed by an increased exhalation of carbonic acid, until a certain point is reached, when it diminishes; so also is the inhalation of ether, chloroform, etc.

The conditions which are obtained after the inhalation of nitrous oxide, ether, chloroform, and other anæsthetics, are specific toxical properties, which *first* stimulate, then narcotize, then destroy nervous action—by (*a*) an interference, more or less marked, with the oxygenation of the blood, and the consequent imperfect accomplishment of certain chemico-vital processes; by (*b*) a retention in the blood of a portion of the usual pulmonary exhalations, carbonic acid, etc., these secondary conditions always finally co-operating with the specific action of the anæsthetic in the production of narcosis, the arrest of innervation, and in the suspension of every functional movement for a time, with a rapid return to health. Latterly it has been proved, both by experiment and observation, that the theory which for a time prevailed in the United States, "that nitrous oxide acts upon the blood as an oxygenating agent," is incorrect. No experimental proof has yet been furnished that nitrous oxide is decomposed in the blood, or forms chemical combinations with it. It enters into the blood as nitrous oxide, and as such is eliminated. It will naturally be inferred from this statement, that the presence of nitrous oxide in the blood is not indicated by the appearance (except change of color), as before stated. This was first very conclusively proven by the late Dr. J. H. McQuillen, Professor of Physiology, in the Philadelphia Dental College, which proofs, are here given with the illustrations.

The late Dr. F. R. Thomas, of this city, placed his whole apparatus, with a large supply of recently-made pure nitrous oxide gas, at the disposal of Dr. McQuillen and the writer, and we repeated the experiments in confirmation of the facts: that the gas had no positive poisonous qualities; second, that the blood-corpuscles were changed, neither in form nor color, under the microscope, and nitrous oxide is only known by the change of color, and even this varies much in individuals.

First Series.—The experiments were as follows:—In our examinations of the blood of man and animals, when ether and chloroform were brought in direct contact with it out of the body, under a fifth objective, the discharge of the nuclei and the disintegration of the corpuscles have invariably occurred, and in the frog leaving a result similar to that which is presented in the accompanying drawing (Plate 15) from one of my specimens, wherein it will be observed that the field is occupied by the nuclei, débris of disintegrated globuline and corpuscles, in which the change of form, size and other characteristics are most striking.

Plate 15.

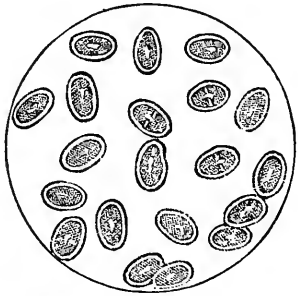


Frog's blood placed upon the slide, and chloroform brought in direct contact with it.

Second Series.—On placing, however, two glass slides containing frog's blood over watch-crystals, one holding chloroform and the other ether, and covering them with glass finger-bowls for half an hour, thus exposing one to an atmosphere of ether, and the other of chloroform, we found, on removing the bowls, and permitting the bloody sides of the slides to remain downward, until all the ether and chloroform had evaporated, that no disintegration or marked change in the form of the corpuscles was observable under the microscope, on comparing them with the blood of a frog unaffected by an anæsthetic. This forcibly demonstrates the difference between exposure of the blood to *direct contact* and the *vapor* of chloroform or ether, even out of the body.

Third Series.—Over and again, in the presence of a number of gentlemen, we have placed frogs under the influence of ether, chloroform and nitrous oxide, and examined their blood-corpuscles immediately after, without finding any disintegration or change in the form of the corpuscle. In one instance, a frog was so completely narcotized by chloroform that it died; the thorax of the animal was opened, the lungs cut out, and the blood obtained directly from that organ, and even here, where, if the inference of an altered blood was correct, there should have been discharge of nuclei, disintegration, or *marked* change in the form of the corpuscle, nothing of the kind was evident, as will be seen by the accompanying illustration, drawn from the slide on which the blood was placed. (Plate 16.) As already intimated, the experiments in this direction have been prosecuted on every available occasion within the past few months; and we have not confined our experiments to frogs, but, in the course of vivisections on a large number of animals (rabbits, dogs, cats and pigeons), to illustrate our winter course of lectures on physiology, when these animals have

Plate 16.

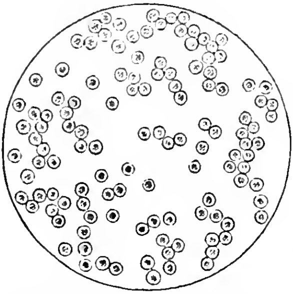


Corpuscles from the lungs of a frog which died under the influence of chloroform.

been placed under the influence of ether or chloroform, their blood has been examined, and no change in the form of the corpuscle has been evident.

Fourth Series.—The examination of the blood of a number of human beings, drawn prior to, and after having been under the influence of ether, chloroform or nitrous oxide, has yielded similar results, as will be evident from the accompanying illustration of the blood, obtained from a patient (Plate 17) while under the influence of chloroform. Any one accustomed to microscopical examinations will recognize the normal character of the corpuscles, so far as it is possible to present them in a woodcut.

Plate 17.



Corpuscles of a patient under the influence of chloroform.

In conclusion, although it is not our intention in this communication to engage in an extended inquiry, relative to how anæsthetics produced their effects, it seems to us that the above experiments demonstrate that we are not warranted in denying that these agents act directly upon the nerve centres. All the phenomena, indeed, attendant upon their administration, the gradual exaltation of the cerebral functions, followed by the progressive impairment and temporary suspension of the special senses, the loss of co-ordination on the part of the cerebellum, and when the agent is pushed too far, the arrest of respiration and circulation through the decided impression made upon the medulla oblongata, seem to favor this hypothesis, in contradistinction to the theory that anæsthesia is due to suspension of oxygenation. In 1877, there was another series of

Experiments with Nitrous Oxide, by the late Dr. McQuillen, and Doctors J. D. Thomas and Turnbull.—December, 1877.—A large-sized frog was placed under a glass jar holding five quarts of pure nitrous oxide, and kept there sixteen minutes. With the exception of some change in the color of the skin, there was no apparent impression made the first five minutes, as he jumped about when the jar was moved in the pneumatic trough. After that he assumed the position of sitting on the bottom of the jar, and maintained it until removed from the jar, when he was found in a semi-torpid state, with the eyes wide open. On touching the eyes gently, the lids closed, and then opened immediately, and the leg retracted on pricking. Two minutes after removal from the jar, he moved slowly about the floor, and ten minutes later, he hopped from a table on to the floor.

After remaining out for thirty-five minutes, he was again placed under the jar, in a fresh supply of gas and kept there for thirty minutes; on being removed he presented the same semi-torpid condition, and recovered from it in two minutes. In twenty minutes, he was a third time placed in fresh nitrous oxide, and remained there fifteen minutes, with the same result as the previous trials; the confinement for one hour, in all, to the influence of nitrous oxide, not having made any marked impression on him. Examined under one-fifth objective, and B, eye-piece, the blood-corpuscles presented no disintegrative discharge of nuclei or change of form.

A small-sized rabbit was kept under the influence of nitrous oxide for two minutes, and in one minute after, was completely restored to consciousness. He was then kept under the gas for five minutes consecutively and recovered in one and a half minutes. After this, for twenty minutes, off and on, the animal was under the influence of the gas. In three minutes after removal from it, he was running around the room as though nothing had occurred. The blood examined under the microscope gave no evidence of disintegration of the blood corpuscles. "There is reason* to conclude that the inhalation of either nitrous oxide or nitrogen, causes an accumulation of carbonic acid in the blood. To produce oxidation of the brain, there must be (1) a free current of blood through the capillaries of the brain; (2) the blood must be duly aerated or oxygenized; (3) the blood must be unmixed with any material which prevents or impedes the giving up of oxygen from the blood to tissues."

* As well observed by Buxton: "But whatever union does take place, it is very unstable, as blood parts at once with nitrous oxide when left in free contact with oxygen or air."

The Spectroscope and its Relations to Anæsthetics.*

It has been stated that "Through the agency of the spectroscope, has been supplied, the missing link to our chain of reasoning. *The shadowy field of theories has been cleared up, the laws governing the relations of anæsthetics in contact with the blood current, have been ascertained, and rational progress has been made to insure safe anæsthetics.* I have abiding faith in the progress of chemical science, that it will finally point out an agent, from the almost inexhaustible materials at its command, that will satisfy all ends of surgical requirements,—an anæsthetic that, while it will annihilate temporarily all sensation, will leave consciousness and vitality intact."

We shall now pass to the article on nitrous oxide gas, and let our readers judge for themselves of the rational progress made, and the clearing up of theories by positive experiments justifying or not, the condemnation of this, the only anæsthetic as yet discovered which possesses such a wonderful record. We will give our experiments and observations, and while quoting from others in regard to the injurious effects, have not withheld any of all the well-authenticated cases of deaths from this agent.

"It has been demonstrated by Herrman, and verified by Hoppe Seyler, Gorup Besanez and W. Preyer, that nitrous oxide gas possesses a keen affinity for oxodized blood, as well as for artificial oxy-hæmato-crystalline in solution. The affinity is so strong, that when a current of this gas is passed through a solution saturated with carbonic oxide hæmato-crystalline, the carbonic oxide is driven out by the nitrous oxide, which takes its place, volume for volume.

"When a current of nitrous oxide gas is forced through a slightly alkaline solution of hæmato-crystalline, the solution loses its dichroism and assumes a slight cormoisin red color. When the solution is placed before the spectroscope, we ob-

* The Beauties of the Spectroscope, and its Relations to Anæsthetics. Proceedings of Am. Den. Con. and Southern Den. Ass. and the Den. Ass. of Md. Held at Oakland, Garrett County, Md., August, 1877. Baltimore: Innes & Co., Printers.

serve that in proportion as the gas exerts its influence, the two bands between D, and E, fade away, and disappear finally altogether; and there is a moment, says Preyer, 'when the spectrum is continuous.'

"The disappearance of these blood-bands means here, as it means in other instances, disappearance of oxygen from the blood, or complete deoxidation, and unless a fresh supply is speedily furnished, suffocation must ensue.

"As the action of nitrous oxide gas upon the blood solution continues, soon after the fading away of the two bands, two new bands appear resembling the oxy-blood bands, but differing from them in position and depth of shading,—they are paler and more blurred in outlines.

"I before told you, that when blood is simply deprived of its oxygen, the blood reduction band would follow the disappearance of the two oxidized broad bands, and that then the simple contact of atmospheric air, with such deoxidized blood solution, would suffice to cause the reappearance of the two oxygen blood-bands.

"But we see here, that instead of Stokes' band, two entirely new bands have made their appearance, and when the blood, saturated with the nitrous oxide, is then submitted to the action of reducing agents, the broad band of Stokes, as a reduction band, can no longer be produced at all, proving that a more permanent change has taken place in the vital chemistry of the blood.

"When a current of nitrous oxide gas is passed through a solution not made previously alkaline, still further change takes place. Here a portion of the nitrous oxide gas rapidly oxidizes at the expense of the oxygen of the blood, and forms hyponitric acid. Preyer, holds, that this hyponitric acid unites with the hæmato-cryst of the blood in its nascent state. Like all acids, it alters and suspends the coagulability of the blood, and initiates other important chemical and optical changes. This event, is marked by the appearance of an absorption in red to the left of D, from the 53° on Preyer's scales towards D, and another one between b, and F. I look upon the appearance of this absorption in red, as an indication that hyponitric acid has formed, and has united with the blood. We already learned that all acids, cyanic acid excepted, cause a decomposition of the blood, and its product is hæmatine.

"Now let us logically apply all these ascertained facts to our case in hand, in order to learn how this gas produces its effects upon the economy.

"In Preyer's experiments, we have seen that dogs, when permitted to inhale oxygen at the highest stage of the dyspnœa, become rapidly, as well as ever. Not so after the inhalation of nitrous oxide gas. A certain effect upon the blood has taken place, often unimportant and transient, at other times more permanent and grave, sufficient at times to endanger life itself. We have also seen, that under favorable conditions, hyponitric acid is formed, which causes a decomposition of the hæmato-crystalline into hæmatine,—a substance which is not capable of sustaining life. Thus, we are forced to acknowledge, that the application of this gas is far from being safe and harmless; that on the contrary it is pregnant with grave consequences.

"Having fully pointed out to you the manner in which nitrous oxide gas affects the blood, it must serve you as a type for all those agents which deprive the blood of its oxygen, and form stable crystalline compounds with the hæmato-crystalline, whereby its life-function is gravely impaired, and under certain conditions forever lost.

"In case of accident with nitrous oxide, our indications are confined to narrow limits. We must try to economize the still intact blood-corpuscles, and by transfusion, and especially by artificial respiration, to favor a full and long supply of oxygen to sustain the little flame of life. Electricity may be used to keep up the muscular action of the heart and lungs. We may thus succeed to ozonize the accumulated nitrous oxide, and to eliminate it from the system. Porowsky, has thus succeeded in some almost hopeless cases of poisoning with carbonic oxide, and the procedure seems to me well adapted also in cases of poisoning with nitrous oxide gas."

Has the gentleman proven the proposition he has started with? We think not. If experiments are carefully made, and facts proven, we are bound to receive those facts, but not the theories in which he states that nitrous oxide gas "deprives the blood of its oxygen, and enters into a close combination with its crystallizable material; so bound, it disables this latter to absorb oxygen from the air, or to supply it to the oxidizable tissues of the economy." The following experiments were undertaken to prove or disprove the results Dr. Waterman describes, as being obtained by the spectroscope.

These experiments in the course of spectroscopic studies of the blood by the action of reagents, were made by the writer and the late Prof. J. G. Richardson, of the University of Pennsylvania; Dr. Wm. M. Hodges, of New York; and the author's son, Dr. C. S. Turnbull, of Philadelphia:

Pigeon, under the anæsthetic influence of nitrous oxide gas.—Respiration, thirty-eight; pulse—unable to count—from one hundred and eighty-two to two hundred and ten. Was rendered insensible in twenty seconds, and had quite recovered in one minute.

Rabbit.—Blood identical with human blood under micro-spectroscope previous to nitrous oxide administration. Respiration, one hundred and thirty-eight; pulse, one hundred and sixty. Was affected in forty seconds, and completely insensible in two minutes. All heart action ceased in one minute and forty-five seconds. There was no change in the blood under the spectrum after death; little or no change in the brain, perhaps slightly anæmic; heart's color natural.

Dr. L. Turnbull, and Dr. J. D. Thomas, took the gas and went fully under its influence, and their blood showed no change. By passing nitrous oxide through the blood, the death-line spoken of was barely visible, but after adding sulphide of ammonium, it was clearly seen.

From the above we may conclude that the amount of pure nitrous oxide, necessary to induce anæsthesia in man, by inhalation, does not so affect the blood as to cause any alteration of the two well-known bands, in the green portion of the spectrum. In other words, that the micro-spectroscope gives no evidence that radical change in the hæmato-crystalline is produced by the inhalation of nitrous oxide gas.

Additional Facts in Reference to the Physiological Action of Nitrous Oxide.

Some valuable facts have recently been brought before the profession * in regard to this anæsthetic confirmatory of the views which we have before published in our work as early as 1878.

Nitrous Oxide (*a*) is said to produce a state which we term *anæsthesia*—a loss of sensation;

(*b*) it initiates certain emotional states, provoking a sensation of exhilaration and well-being—in fact, it plays the *rôle* of a stimulant;

(*c*) it gives rise to modifications of the respiratory, and

(*d*) circulatory systems;

(*e*) and provokes marked muscular movements, which may be roughly classed as (i) rigidity or contracture and (ii) jactitations.

These are, speaking broadly, the effects of nitrous oxide upon the mammalian organism, and in attempting to explain them, we must ascertain their relations among themselves.

A further fact is that Dr. Buxton has observed, and his views are in harmony with most of the authorities upon the subject, that during the stage immediately anterior to the loss of consciousness, persons under the influence of nitrous oxide, are *hyperæsthetic.*

Nitrous oxide does induce hyperæsthesia; the cerebro-spinal axis—at least as far as sensation goes—is the seat of the changes which nitrous oxide induce, and which culminate in the complete abeyance of consciousness. In this connection he draws attention to the convenience of grouping the brain phenomena, due to nitrous oxide, in three periods: the period before unconsciousness, which he contends is the hyperæsthetic period, the

*On the Physiological Action of Nitrous Oxide. By Dudley W. Buxton, M.D., B. S. Lond., M.R.C.P., Administrator of Anæsthetics in University College Hospital, the Hospital for Women, Soho Square, and the Dental Hospital of London, etc., 1886. Pamphlet, pp. 22. Harrison & Sons, St. Mark's Lane, London.

period of unconsciousness, and the period of returning consciousness, in which hallucinations take their origin.

(*a*) The nitrous oxide may either give rise to other bodies by change in its own chemical form ; or (*b*) Acting purely in a mechanical fashion, it may upset the normal equilibrium of the functions of respiration, and so give rise to accumulation of aërial fluids in the blood, which would normally be excreted. (*c*) It may act *per se*, and exercise a specific action, just as strychnine or any other body.

At one period it was believed that nitrous oxide acted as an oxidizing agent, by splitting up the body or tissues into oxygen and a residuum of nitrogen compounds, and hence came into vogue the Apnœal or Hyperoxygenation theory of Colton. In support of this theory, Stillé, and Maisch, urge that venous blood is arterialized by shaking it with nitrous oxide, that phosphorus burns in it, and that seeds germinate under bell-jars of nitrous oxide. Zimmerman, whose paper we have not been able to consult, is pledged by Stillé and Maisch to the statement, that pigeons and rabbits will recover after being placed in the gas for eight hours. Of course, were such theories true, we should have to admit that nitrous oxide is a respirable gas. In 1872, Dr. Frankland, came to the conclusion that nitrous oxide was not decomposed during its sojourn in the body, basing his opinion upon analyses made of air expired by rabbits, when confined in an atmosphere of mixed air and nitrous oxide.

Jolyet, and Blanche, who published their results in Brown-Sequard's "Archives de Physiologie," find vegetables, as well as animals, die incontinently when placed in an atmosphere of nitrous oxide. And in the case of certain seeds, Dr. Buxton has failed to induce germination in an atmosphere of pure nitrous oxide. Of course combustion will take place in nitrous oxide, provided the heat be sufficient to produce "the mode of motion" in the molecules of the gas, which leads to their disintegration ; but experiment has shown that the heat of the blood is insufficient to initiate such a dissociation. Bonwill's suggestion of rapid breathing to produce anæsthesia, probably acts rather through the changes it produces in the blood-pressure of the cerebral circulation or nervous exhaustion, than by dint of hyperoxygenation. When an animal is killed by nitrous oxide, the blood, if examined within two minutes after death, gives the well-known spectrum of reduced hæmoglobin, while the muscles give the corresponding one of reduced myohæmatin, but not during the anæsthetic stage. Here we are dealing, not with nitrous oxide blood effects, but these complicated and probably overridden by asphyxial effects. Another possible way by which nitrous oxide may be introduced into the organism is by means of the nitrites, and form combinations with the coloring matter of the blood, oxyhæmoglobin.

Bernard, whose classical work on asphyxia gives the fullest account of that condition, speaks of three forms of asphyxia:

(1). That arising from inhalation of irrespirable gases which are themselves harmless. To this class, many authorities would relegate nitrous oxide.

(2). That due to poisonous vapors, such as carbonic monoxide, sulphuretted hydrogen, and

(3). Asphyxia from want of air, such, for example, as would ensue upon the ligature of the trachea. He subsequently points out, with justice, that asphyxia resulting from inhalation of an indifferent irrespirable gas, and that due to want of access to air, are in fact one and the same condition.

The arterial blood, becoming gradually deoxidized by parting with its oxygen to the tissues, acts upon the medulla respiratory centres; hence follows hyperapnœa. This, in the case of some persons subjected to experiments by Drs. Burdon Sanderson, John Murray and Mr. J. Smith Turner (who caused them to respire pure nitrogen), did not occur for about two minutes after commencement of inhalation.

The Phenomena of the so-called Asphyxia of Nitrous Oxide Narcosis.—In the first place we find a tolerably uniform increase in the number and depth of respirations. Dr. Buxton has not yet succeeded in detecting any excess of expiratory, over inspiratory movements. The respirations are, more correctly speaking, simply an exaggeration of the normal, quite regular, but hurried in rhythm, and increased in depth. This begins certainly within half a minute—usually within fifteen seconds—

from the commencement of nitrous oxide inhalation. The respirations, however, become slower as narcosis proceeds, and finally stertor supervenes, which frequently is followed by a period of complete respiratory calm, no thoracic movements appearing. A few seconds more, and respirations are recommenced, and the person passes quietly into ordinary breathing. He has never observed anything, which in the slightest degree resembles the expiratory convulsions one is so familiar with, in the case of the lower animals killed by asphyxia. These results will go to strengthen the present theory, that nitrous oxide, pushed to the extent of narcosis, does not give rise to circulatory changes, at all comparable to those occurring in the course of asphyxia. The results obtained by the cardiograph in the human subject, have not been encouraging, and Dr. Buxton is determined to investigate the exposed hearts of mammals, as likely to render a more reliable record. In this connection, the experiments of Amory, Krishaber, Goldstein and Kuntz, are of interest. These observers found, that animals, when subjected to the vapors of nitrous oxide, after a time died. Now it is important to notice that the animals, when made the subject of a post-mortem examination, revealed the usual signs of asphyxial poisoning. But this is, of course, wholly different from death from nitrous oxide. In these animals, nitrous oxide narcosis was followed by suffocation, air was excluded, and hence asphyxia ensued. It has happened to skilled anæsthetists, to have a necessity of maintaining nitrous oxide narcosis, for a considerable time. This has been done, by allowing the patient to respire air at long intervals. In this way a really prolonged narcosis can be effected, while we are seeking only to promote the action of nitrous oxide upon the nervous centres.

The true test, and one of great value, is the examination of the blood shed during anæsthesia, performed by the writer in conjunction with the late Professors McQuillen, Richardson and Turnbull, gas being administered by Dr. Thomas. We may then conclude that nitrous oxide produces narcosis, by virtue of other than asphyxiating qualities.

This gas, then, enters the blood through the lungs and exercises a certain specific action upon the nervous centres. And here we have a ready explanation of an otherwise most anomalous circumstance, viz.: that in a certain number of cases, persons evince the utmost toleration of nitrous oxide, and resist the nepenthal action for a minute or more. Were nitrous oxide purely an asphyxiant, we should invariably narcotize our patients when replaced by oxygen, but such is not the case—in fact, they are narcotized *before this oxygen is exhausted.*

Nitrous oxide enters the blood by producing anæsthesia with no combinations with either the oxyhæmoglobin or the globulins, unless it is employed without air. It then passes to the nerve centres as venous blood, plus some stimulating and narcotic influence, and gives rise to subjective exhilaration. Upon the heart it acts as an accelerator. At this time the inhibitory centres are in a state of at least lessened activity, as is evidenced by involuntary movements, micturition, etc.; later the reflexes are lost. During this stage the blood-pressure would appear to be lessened, the action of the heart accelerated and the respiratory rhythm, at first quickened, subsequently slowed to a standstill. This state of things persists for a while, and is accompanied by relaxation of some muscles, *e. g.*, the palatine and faucal muscles, while other muscles are the seat of arhythmic clonic and tonic contractions. Following upon this stage we usually meet with the phenomena of recovery. During the period of recovery a further stage of excitement appears, and it is commonly associated with haliucinations—sometimes pleasant, sometimes extravagant. The sense soon becomes keenly upon the alert—and operative measures prolonged into this period give rise to the most intense pain. Patients will declare the pain in such cases transcends that where no gas is given.

In a preliminary communication made before the Odontological Society, Dr. Buxton attempted to review some of the more authoritative views which have from time to time been advanced with regard to the physiological action of nitrous oxide upon the organism. It remains to consider the evidence which experimental research has placed in our hands, and to attempt as briefly as may be to formulate what conclusions are warranted by the results of such researches; and further, to adduce from these conclusions, practical rules such as may guide in the employment of nitrous oxide gas as an anæsthetizing agent.

Researches made by means of the spectroscope upon blood when it is impregnated with nitrous oxide, do not, at least, afford evidence of value. MacMunn, whom Dr. Buxton before quoted, failed to obtain any characteristic spectrum from the blood of animals poisoned with nitrous oxide. He repeatedly made the attempt to obtain a spectrum peculiar to this agent, but was also unsuccessful, the only bands discernible being the broad one between Fraunhofer's D and E lines, which of course merely represents the spectrum of reduced hæmoglobin. Dr. Halliburton, Assistant Professor of Physiology in University College, was good enough to examine some blood for Dr. Buxton, and he concurs in the results given above. These confirm our own experiments and observations.

It appeared evident that nitrous oxide gas exerted a very considerable effect upon the nervous system (see experiments of Amory), and Dr. Buxton was anxious to undertake experiments in the direction of the ascertainment, whether or not it produced physical changes in the condition of the brain. One way in which it was possible to investigate this point was to examine the actual changes, if any, in the brain whilst the animal was placed under nitrous oxide.

Accordingly the experiments were made, by the kindness of Professor Victor Horsley, at the Brown Institution, London.

The skull of a medium-sized dog was trephined, and nitrous oxide gas given through a tracheal tube fitted with a very freely-acting expiration valve. The trephine hole exposed the outer third of the sigmoid gyrus on the right side. Under normal conditions the brain was seen some measurable distance beneath the bone, pulsating quietly and synchronously with the respiration. The color of the brain covered with pia mater was pinky-red, or, more exactly, vermilion.

As soon as the animal began to breathe nitrous oxide, the respiratory rhythm being interfered with, the brain pulsations became more notable and somewhat hurried. When the gas was pushed, and the animal made to take it in freely, the brain substance was seen to swell up and gradually reach the trephine hole. The color now began to change, and a dark, blue-red shade appeared to creep over the exposed brain, robbing the brightness of the vermilion and replacing it by a laky purple. The brain undulations were at this stage, found to lessen in frequency and amplitude. The brain substance still increased in volume, and even protruded without the trephine hole, almost motionless, and of a pearly, glistening lustre of bluish hue. The vessels, examined with a strong lens, presented the well-known look of commencing stasis. At this stage the nitrous oxide was stopped and the animal allowed to inspire air freely. Quietly and gradually with each successive breath of air the brain receded, the undulations returning, and resuming their normal rhythm and range. With these changes came a return of the vermilion tinge which characterizes the healthy brain substance. This experiment was repeated; in some cases the animal was anæsthetized by means of a face-piece with an expiration valve, and in others a tracheal tube was introduced, but the phenomena observed were strikingly uniform. It was next determined to conduct a control experiment, first pushing the nitrous oxide to the verge of death, and subsequently producing asphyxia by deprivation of all air.

In the experiment in which nitrous oxide was given, the brain being exposed as in the last research, the gas was pushed until respiratory movements completely ceased. In a little over a minute (1 min. 10 secs.) the brain substance had become livid and swollen to above the calvarial edge; the animal was absolutely insensitive to painful sensation; his limbs showed marked jactitations. In about 1 min. 30 secs. normal respiratory movements had ceased. Artificial respiration was promptly resorted to, and speedily the natural thoracic movements were resumed. The trachea was then occluded and the brain observed. In about a minute the brain substance assumed a deep purple dull hue, which in another half-minute became very intense; the brain then began to recede, sinking deeply from the trephine hole. In two minutes the sphincters became relaxed and further sinking of the brain took place. In three minutes the respiratory movements were very profoundly interfered with, only manifesting themselves by long-drawn gasps which were separated by long intervals. In five minutes, although all respiratory movements had ceased, the heart still beat. In six minutes access of air was allowed, but artificial respiration failed to effect recovery.

These experiments appear peculiarly instructive, firstly, as showing in a very marked way the difference between the brain condition when fed with nitrous oxide-laden blood, and when supplied with deoxidized blood containing tissue refuse; and secondly, when viewed in relation with the clinical phenomena of nitrous oxide narcosis. As Dr. Buxton pointed out in his last communication to the Society, there is a zone of hyperæsthesia which separates the normal consciousness from the absolute loss of sensation on the one hand, and on the other which unites the stage of oblivion, or sleep, with the return to full mental activity. It is presumably at this epoch that the dreams of mental exaltation and physical joy occur, and it is then that slight external physical stimuli—*e. g.*, a flash of light, a noise, a movement—will become a thousandfold magnified and perverted in the patient's brain. The peculiar filling of the brain would seem to offer a physical counterpart for these mental conditions, and apparently so rapidly modifies the brain cells that they are incapable of further reception or ideation: an initial increased exaltation gives way to a complete abeyance of function.

Experiments in the same lines were also made with regard to the action of nitrous oxide upon the spinal cord.* The animal being under the influence of chloroform and curare, the laminæ of the lower dorsal and lumbar vertebræ were removed and the cord exposed lying in the spinal canal. The animal was then made to respire nitrous oxide, only expiring through a slit in the canula. A very marked effect soon showed itself: the cord gradually enlarged and cerebro-spinal fluid began to well out, showing the enlargement of the whole length of the

* These experiments were made at the University College Physiological Laboratory, and Dr. Buxton was indebted to Mr. John Rose Bradford, B.Sc., for their execution and to Professor Schäfer for the use of the Laboratory.

cord. This experiment was repeated, and the same result was always obtained. However, as will readily occur to you, two causes might have conceivably produced this effect, namely—(1) the exclusion of oxygen, *i.e.*, the asphyxia, or (2) the presence of nitrous oxide. To test which of these possible factors was really responsible for the swelling up of the cord, the animal was deprived of air, and no nitrous oxide given. At first the cord remained unchanged—at least no swelling took place, and no escape of cerebro-spinal fluid occurred. Soon, however, as the blood became more and more deoxygenized, the cord grew smaller, shrinking below its former level in the spinal canal. There was no doubt but that while in nitrous oxide administration the cord, like the brain, grew larger, in asphyxia it shrank. To test this effect further, the following crucial experiment was tried. The animal was subjected to asphyxia, and the cord was watched until it had perceptibly shrunk, when nitrous oxide was allowed to enter the lungs. If, as we assumed, nitrous oxide was capable of dilating the vessels of the cord when acting upon them in a normal condition, it was thought that it should produce a like effect when the cord vessels were contracted by asphyxia. The experiment confirmed this supposition, for as soon as the animal had its lungs well saturated with nitrous oxide, the cord was seen to expand and the cerebro-spinal fluid began to escape.

We may now briefly consider the conclusions these experiments upon the brain and spinal cord appear to justify. In brain and cord alike, we meet with dilatation of the vessels, with of course an increased blood supply to the nerve centres. Such a condition would be favorable to the dissociation of nervous energy, but this would soon be followed by over-distension and interference with due regularity of the cerebral and cerebellar circulation subversive of ideation and the performance of adjusted muscular action. The interference to the cord circulation must also interfere with the due conduction along its paths as well as with the correlation between its parts and the higher brain centres. At present we may not be in a position to theorize beyond the broad general statements given above, but Dr. Buxton thinks we may justly recognize in the interference with the circulation of the brain and spinal cord, produced by the inhalation of nitrous oxide, a phenomenon which accounts for not only the every-day experience we meet with in giving the gas to human beings, but also to those aberrant cases which occur more rarely, and evince marked nervous exhaustion or irregular outbursts of nervous energy. But of these states we will speak again.

The development of nervous symptoms certainly varies largely with the initial state of the nerve protoplasm, for while in some persons nitrous oxide induces marked nerve disturbance, in others it brings about none whatever. Dr. Buxton introduces a brief note upon ankle clonus as revealed under nitrous oxide. This phenomenon is in a certain percentage of cases produced when the patient is deeply under the gas.

Among reflexes it is usual to consider two classes, skin or superficial reflexes, of which a familiar example is found in the conjunctival reflex, and deep, of which we have examples in ankle clonus and the patellar jerk and front tap reaction. In health, and under normal functional conditions, the superficial and the patellar reflex are present; certain pathological conditions lessen or exaggerate these reflexes, and cause the development of ankle clonus. The presence of ankle clonus points always to disease or functional derangement of the spinal cord. Now nitrous oxide produces very marked derangement of the reflexes. In October, 1883, Professor Horsley * drew attention to the persistence of the patellar phenomena under profound anæsthesia, and long after the disappearance of the superficial reflexes. Clonus has been found to be developed in a number of cases, although it is not a constant phenomenon of nitrous oxide narcosis; hence this gas not only abrogates the function of the brain centres, but also produces marked disturbance in the cord, while it blunts or obliterates peripheral sense. What the exact nature of this derangement of the cord function is, we cannot venture at present to offer an opinion; we can only study it by means of the phenomena it reveals. These also are various, differing, it would appear, according to the stability of

* "Brain," vol. vi., p. 369 *et seq.*

the nervous centres of the individual subjected to observation. Nor is this surprising when we remember that the effects are very transitory, and must be largely influenced by collateral circumstances. The more constant cord phenomena are—rigidity of the muscles, which passes into complete flaccidity; jactitations which appear rhythmic and general; loss of superficial reflexes; persistence of knee jerk. Among the occasional phenomena we may reckon—ankle clonus; opisthotonus and emprosthotonus; paralysis of the bladder and defæcation centres, and involuntary and unconscious passage of urine and fæces; probably, excitation of the sexual centres, and abolition of the normal checks imposed upon the production of orgasm. Further, we must reckon the secondary results apparently due to a more lasting cord effect, as seen in paresis or even paraplegia following nitrous oxide inhalation. Many of these phenomena are confessedly rare, and are perhaps only elicited in nervous systems predisposed to take on the condition, whatever it may be, which nitrous oxide induces. In some respects nitrous oxide would appear to hold comparison with strychnine. The rigidity, with the occasional liberation of irregular and disorderly explosions of nerve energy, occur, although with different degrees of persistence, alike with one and the other drug. This would perhaps give a clue, and suggest that under nitrous oxide the higher ideomotor centres lose control, the resistances throughout the cord are lessened, and the cells, deprived of the normal restraints imposed by habitual and associated action, tend to irregular explosive outbursts. It seems at least probable that under nitrous oxide not only do we meet with a stage of preliminary exaltation of function, misdirected indeed, and unconstrained by judgment, in the brain centres, exemplified by the stage of hyperæsthesia spoken of above, but that in the lower cord centres we recognize a similar initial heightening of activity, also irregular and disorderly, followed by cessation of their functionation. Indeed, Dr. Buxton ventures to think the same sequence of events happens in the vital centres, and that this explains much of what follows in the remarks made upon blood pressure, cardiac, and respiratory rhythm. But although we may not as yet go far enough to dogmatize upon what is the nature of this action upon the cerebro-spinal axis, yet it seems consonant with our facts to regard it as a sedative, which, while provoking an initial exaltation of function, eventually plunges the tissues into a sleep, or state like the long dose of hibernation. Certain it is in some cases one meets with a quiet prolongation of nitrous oxide narcosis, unaccompanied by the wild convulsions of asphyxia, when the breathing absolutely stops while the heart still beats on. In this state presumably the cord centres have gradually yielded, and, the medulla reached, the respiratory centre has also peacefully ceased from work, and the patient is entranced alike in his mental and vegetative functions. In these cases artificial respiration, conducted for one or two admissions of air, restores the patient to animation, and all goes well. No danger is, in fact, incurred unless the anæsthetist is either incompetent or negligent of his solemn charge. It seems hardly worth while to do more than to beg you to compare mentally these phenomena with those afforded when asphyxia terminates life. To contrast what has just been described with the mental activity persisting almost to the last gasp, the purposeful struggles, the wild, chaotic respiratory efforts, the frantic writhings of the voluntary muscles, and at length the general massive convulsions passing into a false quiet, marked by an occasional gathering together of the failing nervous energy to effect a spasmodic explosion of muscular force.

Knowing that one of the greatest and gravest dangers which besets the induction of anæsthesia is heart failure, it becomes a matter of very great importance for us to determine the behavior of nitrous oxide towards the heart and vascular system in general. Dr. Buxton's and our own investigations in this direction have been made to ascertain the action of the heart and the variations of blood pressure under nitrous oxide; and further, to determine how far the variations seen when nitrous oxide was exhibited were due to that body, and how far to the coincident deprivation of oxygen.

The animals selected were dogs and cats; but as the results were practically uniform, it is unnecessary to particularize the experiments. Dr. Buxton dwells on his great indebtedness to his friends Professor Victor Horsley, Mr. Bradford, and Professor Schäfer, through whose kindness alone the research was practicable.

The heart's action does not become much affected under nitrous oxide, and even in cases in which that gas is pushed until complete cessation of respiratory movements occurs, the heart still continues to beat, its action gradually growing weaker. In no case have we seen any tumultuous action of the heart or a sudden cessation, only the gradual sinking to rest noticed above. The attempt at narcotizing animals and timid persons produces a temporary acceleration of heart-beat, but as soon as the intellect becomes under the influence of the narcotic this acceleration passes off and the heart-beats become regular, strong and somewhat slowed. It will be remembered that these results are in accord with the statements already published, and based upon numerous sphygmographic tracings taken of the human radial pulse.

The blood pressure under nitrous oxide inhalation has the following peculiarities. For the first period it shows little change; but subsequently a fall of pressure takes place. Upon allowing the animal to inhale air, the blood pressure recovered itself, but only gradually, and by passing through a phase of somewhat irregular curves. These curves are not respiratory, as they take place even when the animal is completely paralyzed with curare, and artificial respiration is maintained. In some cases a slight, but very slight, rise in the blood pressure took place, but a rise of blood pressure which persists for a notable time appears always to follow the nitrous oxide inhalation. Control experiments were conducted to test the effect upon blood pressure when the animal is deprived of air. These were done upon curarized animals in order to avoid the interference caused by dyspnœic convulsions. As soon as the air supply was cut off, the blood pressure began to go up, and rapidly increased until the heart's action, which lessened in force *pari passu* with the heightened blood pressure, became so weak that it was necessary to allow air to enter the lungs. The blood pressure then resumed its normal height very quickly; but the rise which follows after nitrous oxide administration does not appear to ensue after asphyxia.

"It seems, upon reviewing the nitrous oxide experiments, and controlling them by the asphyxia experiments, that nitrous oxide itself has no very marked influence upon the heart or vessels; that what action it has is to steady and slow the heart, and if anything to strengthen it, and that the action is somewhat prolonged. The vessels, at first almost unaffected, later undergo a peripheral dilatation leading to a lowering of blood pressure. This, however, is true only when reservation is made; for, as we shall see, the splanchnic vascular areas are contracted at first. Upon this last statement I have some additional evidence to offer. A good-sized frog (*Rana temporaria*) was placed beneath a dome-shaped glass vessel, so arranged that the web of one foot was outside the vessel and could be examined under the microscope. The dome was emptied of air and kept full of nitrous oxide, and the frog carefully noted while the web was examined. It was necessary to keep the whole animal in nitrous oxide, as cutaneous respiration is very active in the frog. At first the circulation in the web was found to be slowed; at the same time the minute vessels were seen to dilate, and this slowing and dilatation both became more marked as time went on. Changes also appeared to develop in the corpuscles, by which they took on a flattened, compressed appearance. At length the respirations, which had become slower and slower, became almost extinguished, the capillary circulation in some areas was almost in a condition of stasis, whilst throughout the field extreme slowing had occurred. At this point the frog was allowed free access to air, and at once the respiration quickened, the blood-flow increased in rapidity, becoming many times more rapid than under the gas. The corpuscles resumed their normal aspect. The results of such experiments upon the frog point to a peripheral dilatation of capillaries, and of this further evidence has yet to be adduced. It needs no argument to show that a vascular viscus, like either the kidney or the spleen, must, under variations of blood supply, undergo variations in size. If, therefore, it were possible to enclose either viscus in an air-tight receiver communicating with an oil manometer, it would give indications of increase or diminution of size according as the blood supply were increased or lessened. Mr. Bradford has kindly enabled me to investigate this point pretty fully.

"The experiments made upon the kidney were tolerably numerous, and were singularly uniform in their results. The kidney in an animal narcotized with nitrous oxide speedily undergoes contraction, which corresponds of course with the contraction of the renal arteries. This contraction continues as long as the nitrous oxide is given, but as soon as that is cut off and the animal respires air the kidney speedily recovers its normal size, but no dilatation of vessels beyond normal takes place. With this condition we have to compare the behavior of the kidney in an animal subjected to asphyxia. Here the kidney undergoes a dilatation as soon as air is cut off. This corresponds with dilatation of the renal arteries. and is probably due to increased heart action called into being by the venosity of the blood. Later, when the heart fails, the kidney suddenly contracts, a very rapid fall in the kidney curve occurring. Thus a singularly striking contrast in the behavior of the kidney reveals itself according as that viscus is influenced by nitrous oxide or asphyxia. This effect upon the renal circulation must not be taken as militating against the statements made above with regard to the general blood pressure as shown by the carotid artery and about the circulation in the brain and cord. It is well known that certain sedatives—morphine, for example—dilate the vessels in one area while they contract those of other areas.

"Passing to the effects produced by nitrous oxide upon respiratory rhythm.

"The chest movement will, as is well known, continue without any air entering if a sufficiently long and small elastic tube be attached to the tracheal canula, so that one can easily compare asphyxia with nitrous oxide narcosis. In the last condition the respirations are at first quickened, but not lessened in depth ; later they grow slower and deeper, and still later they become very slow and somewhat more shallow; finally they cease. The time in which this cessation comes about varies considerably in animals. I have not seen the dyspnœic struggles under nitrous oxide which asphyxia brings about.

In human beings I have seen, especially in children, complete cessation of respiration without the slightest preliminary struggle. Alike in the lower animals and man the breathing recommences if pressure is made on the chest. These changes in respiration are, I am inclined to think, due wholly to the action of nitrous oxide upon the nerve centres presiding over respiration."

In conclusion, there are various practical considerations which Dr. Buxton and the writer think may well be taken into review while studying the physiology of nitrous oxide narcosis.

If nitrous oxide acts as a sedative in virtue of its own inherent properties, and does not owe its value as an anæsthetic to asphyxial processes called into play by concurrent privation of oxygen, it should be our aim to push the gas and give free vent to expired gas. We should see that our patient changes as freely as possible his residual air during inspiration, and expires as freely as possible the refuse-laden nitrous oxide which has been stationary within the air-spaces during the last respiration. We cannot but think that, whatever may be the saving of gas brought about by employing supplemental bags wherein the nitrous oxide is collected and re-inspired again and again, the patient suffers by their use from the double evil of breathing diluted and impure nitrous oxide, and further, is not favorably placed for exhaling the refuse of the lungs. We should incline to attribute to this method the cases one occasionally meets with of severe headache, vertigo, dizziness, and other untoward symptoms consecutive upon nitrous oxide inhalation. It is a very important point to induce very free inspirations of *pure* nitrous oxide, and to avoid anything like inducing partial asphyxia, and in practice this gives the best and the most satisfactory results.

The behavior of the heart, under nitrous oxide, should encourage us to use this agent freely, and during its administration to watch rather the respiration than the pulse; since it would appear that syncope, if it occurs, occurs secondarily through the lulling to sleep of the respiratory centres. The cases in which nitrous oxide has been said to kill by heart failure are few, and even in these we are not at all sure that the fatal faint was not due to fear or shock incurred by a nervous system already shaken by suffering, and rendered still more obnoxious to shock by an imperfect narcosis. When we remember the period of heightened sensibility which precedes complete restitution of consciousness, we can easily comprehend the terrible jars a debilitated nervous system must sustain, if operative procedure be carried on into this stage. Clover long ago pointed out from his vast clinical experience, that patients may be allowed to cease breathing, and yet no fear need be entertained, as a few vigorous pressures upon the thoracic parietes will reinitiate respirations. Now we accept his statement, and explain it under physiological laws.

There are other practical points that are suggested by knowledge of the action of nitrous oxide. Of these not the least important, is that the erotism called into existence in a fairly large proportion of patients, and controlled only in a few by the restraints of habitual thought and judgment, should render all persons most careful, to avoid possible incrimination through hallucination. For the sake alike of patient and operator a witness should always be within earshot, or within sight, whenever nitrous oxide is administered.

Again, the decided action this anæsthetic has upon the nerve centres, and its tendency to call forth irregular explosions of nervous energy, might by some be taken as contra-indicatory to its employment for patients who are the subjects of epileptiform seizures. We do not, however, think we can with justice say, that the giving the gas renders a fit more likely to occur than the operation. We are aware any strong excitant, will call forth a seizure, whereas the sedative action of the nitrous oxide will, by lessening stimulation from without, be less inclined to provoke the attack.

Conclusions.

Nitrous oxide is not decomposed in the blood, nor does it form a chemical combination with it. Our own experiments and those of others have proven that it enters the blood in its pure state, and is eliminated in the same condition by the skin, kidneys and lungs, with only a diminution in quantity. It has no positive poisonous action on the blood-corpuscles, their color not being in the least altered under the microscope, nor does it cause any chemical decomposition. It does not produce death by preventing the escape of carbonic acid gas, for if the expired air, loaded with nitrous oxide, be passed into lime-water, a carbonate of lime is precipitated.

It is, however, stated by some observers that it combines with the hæmaglobin, and this is said to be proven by the spectroscope.

After numerous experiments and observations on man and animals, we have arrived at the following conclusions:

1st. Nitrous oxide gas has a very limited range when given alone, owing to the rapidity of its action and still more rapid elimination.

2d. It acts directly upon the cerebrum and muscular apparatus almost simultaneously.

3d. It produces regular and progressive modification in the action of the heart and capillaries of the skin, and if carried to a greater extent it affects the spinal axis, and lastly the cerebellum and medulla oblongata with suspension of respiration, circulation and finally, death.

4th. Death in no case occurs without premonitory symptoms, and if respiration should cease for even a half to one minute, resuscitation is yet possible.

The rapidity of the pulse is generally increased, as shown by a record of one hundred cases, it having reached as high as one hundred and forty-four in one case, and one hundred and twenty-eight in several others. In a few there was little or no change.

CHAPTER XII.

On the Safety of Nitrous Oxide—Death from Nitrous Oxide—Therapeutic Application of Nitrous Oxide—Nitrous Oxide and Oxygen as an Anæsthetic in Labor—Clover's Inhaler for Nitrous Gas and Ether—How shall Nitrous Oxide and Ether be Administered? Drs. Silk and Hewett—Death from Nitrous Oxide and Ether—Inhaler of Codman and Shurtleff for Nitrous Oxide and Ether—Dr. Thomas' Nitrous Oxide Inhaler—Mixtures of Nitrous Oxide, Ethers, Chloroform and Alcohol for Inhalation—Oxygen, Nitrogen and Hydrogen Gases as Anæsthetics.

NITROUS OXIDE GAS, when recently prepared and free from chlorine or nitric oxide gas, is one of the safest systemic anæsthetics that has yet been discovered; but to state that it is absolutely free from danger would not be true, as evidence, in our work will prove. From a recent letter from J. D. Thomas, graduate in dentistry, of long experience, devoted to the exclusive administration of this anæsthetic, we have the following statement: "Philadelphia, December 12, 1887. The administration of nitrous oxide gas in my hands and those of my assistant has now reached over one hundred and fifty thousand (150,000) persons." When you take into consideration the many conditions of health and ill-health, and the various phases of temperament with which one must come in contact in a practice such as his, it must be considered remarkable that this great number of people could be taken, indiscriminately, and placed under an anæsthetic without fatality.

The success attending his mode of administering the gas can be attributed only to the great care to have it absolutely pure and fresh, and the perfect system to which he has reduced his method of operation.

The After-Effects of Nitrous Oxide Gas.

In a discussion (*Dental Office and Laboratory*, July, 1885) on a paper of Dr. J. D. Thomas', on Extraction of Teeth with Nitrous Oxide, he made the following reply:

"Dr. Guilford. There is another point the paper did not touch on, and that is the after-effects upon the patient. The society would be glad to hear from Dr. Thomas or any other member in reference to it. It is a question that has been largely discussed in the journals at different times, more so formerly than at present. Cases have been reported of ill effects following the administration of the gas, but in the course of my twenty years' practice (part of it in a rural village), during which time I have given gas several thousand times, I have never known of any evil effects. Many present will remember that both Dr. Barker and Dr. Webb, while living, declared that they felt such ill effects in their own persons.

"Dr. Thomas. From experience in the administering of nitrous oxide gas, I do not believe there is any ill effect whatever. I have never known any which could be traced to the gas. I have had probably half a dozen cases where people have made complaint that they were not well after taking it, or that some serious effect had taken place which was ascribed to the gas, but I do not believe that such was the case. In the office we do not have a patient sick at the stomach once in six months —and then it will be such a person as will sicken at the sight of blood—or one with whom any nervous excitement will disturb the stomach or cause him to faint. There is another class of people, whose stomachs become disordered from long suffering, with a loss of appetite and general prostration. I have known such cases where sickness has followed, subsequent to the extraction of the teeth, and was attributed to the effects of the gas, when it really was the result of the previous prostration and nervous excitement, or a severe bilious attack, which culminated after the operation.

"I had a patient, a lady, who came on a Tuesday during the heated term of the Centennial year. I gave her gas and took her tooth out. The day preceding, her menses had started. On Thursday night her mother came and said her daughter was in a terrible state; she was out of her mind, and she was sure the gas was the cause of it. At first I thought it was a case where the gas had had some ill effect, and I felt very much exercised about it. I went for a physician in whom I had a great deal of confidence. Upon questioning her and her mother he found that during the previous afternoon she had taken a cold shower-bath, which had checked the menstrual flow and caused cerebral derangement.

"In another instance a lady came to see me about her little girl. Two weeks before, she had taken the gas and now complained that her child was feverish and sick, and had been so from within two or three days after she had taken the gas. I did not understand it, but I did not question her statement. After inquiring minutely after the symptoms, I told her to consult a physician about it. She did so and found that the child was just being taken down with scarlet fever. Of course there are many people who take the gas when on the eve of some constitutional change, so that it is impossible to tell what may happen at any time, but I have never known a case in which the ill effects ascribed to the gas has not been capable of satisfactory explanation to some other cause. Take the case which has been mentioned in the little book published by my brother, in which a patient sent for us. We were asked in the afternoon to go to the house and administer the gas, and we could not do so until the next morning. We got there only to find that the patient had died during the night. Suppose we had gone the afternoon previous and given the gas to the patient when they really wanted us to do so, it would have been the gas that killed the patient, in the family's estimation. To me it is really remarkable that there are not more cases of that kind happening, because people die in the street. They are dying all the time. They go through a great deal of nervous excitement attending the suffering beforehand, and coming to the operation is itself calculated to produce great excitement, and it is a wonder to me that persons having heart and other affections do not have more trouble than they do. I have investigated a great many cases where the gas was complained of as being the cause of trouble, and in every case it was found that it was something else.

"Dr. Guilford. Do you not think, in the cases reported years ago, these effects were mostly due to the fact that the gas was either not pure or improperly administered?

"Dr. Thomas. We do not hear of it nowadays. Then we had the gas kept as long as we pleased, and sometimes it was stated to have produced asphyxia. As far as the cases of death which have occurred, I do not believe that one that has been reported could be ascribed to the gas—that is, to the gas itself, made right and properly administered."

No one can read the full account which we have given of the physiological action of this gas upon the nervous system, more especially the brain and spinal cord, without perceiving the powerful impressions which it makes upon these important organs, and how near unto death it may bring the patient. In our own experiments and those of Dr. Buxton on the brain and spinal cord, we have met with dilatation of the vessels, with of course an increased blood supply, to the nerve centres.

Such a state would indicate a condition favorable to nervous energy, but this is soon followed by interference with the due regularity of the cerebral and cerebellum circulation, if carried too far, producing irregular muscular action, rigidity and nervous exhaustion, also disturbance producing marked reflex action and even ankle clonus. Amongst the occasional phenomena which occur, are opisthotonus, paralysis of the bladder and involuntary action of the urinary and rectal secretions.

Another distressing class of symptoms are the excitation of the sexual centres, and abolition of the normal checks imposed upon the production of orgasm.

In some cases there is a quiet prolongation of nitrous oxide narcosis, unaccompanied by the wild convulsions of asphyxia, when the breathing absolutely stops while the heart beats on.

Fortunately in these cases artificial respiration, conducted for one or two admissions of air, restores the patient to animation, and all goes well.

No danger is, in fact, incurred unless the anæsthetist is incompetent, or negligent of his solemn charge.

The inhalation of nitrous oxide gas, long continued, causes progressive depression of the vital functions, which, like all systemic anæsthetics, tends to death. This must never be forgotten.

Accidents in Extracting Teeth under Nitrous Oxide.

Buxton gives some important hints in extracting teeth while under the influence of nitrous oxide gas. "The mouth should be cleared of artificial dentures, especially small plates. Accidents have arisen from teeth or portions of teeth, being allowed to fall from the beaks of forceps back over the glottis, a deep inspiration then drawing the tooth into the trachea. The tooth forceps have, in recorded cases, broken and a fragment become lodged in the trachea. All instruments used for the mouth should be carefully examined for flaws, and all gags, props, etc., should be secured by fishing gut or some strong, cleanly material and attached outside the mouth.

"In extracting teeth, the forceps after each extraction should be wiped *twice*, as taught by Clover, before attacking another tooth. Fragments of teeth should never be left in the mouth, even with the object of gaining time; each fragment should be removed before any further proceedings by bending the head forward and sweeping the finger around the mouth. The tongue must not be drawn forward, as by so doing the larynx will be left exposed, the epiglottis being dragged from it, while the patient is thereby induced to take a deep inspiration, which will probably cause the foreign body to enter the air passage."

In its pure state the gas may be given to almost any one, if judiciously administered.

Among the difficulties which may be met with as having the appearance of danger in administering nitrous oxide, the most common is constriction or spasm of the glottis or "swallowing the tongue."* The use of the prop cannot be overestimated in such cases. The patient becomes very dark in the face; there is a violent exertion of the diaphragm, and he presents every indication of approaching asphyxia, which, by having the mouth well propped open, is very readily relieved by catching hold of the tongue with a dry napkin and pulling it out of the mouth, and at the same time raising the body forward. As soon as the patient has taken two or three inspirations of pure air the tension is relaxed, and recovery will take

* See experiments by Drs. Hare and Martin under "Artificial Respiration," article on chloroform.

place. Another formidable symptom of danger is when your patient is attacked with syncope while under the influence of the gas. Be sure the air passages are open by pulling the tongue forward. Then, the patient being in a sitting posture, bring the head and body forward with considerable violence, which will generally prove sufficient. You may, however, meet cases which will require more effective remedies. The object is first to get the head on a level with or below the heart, so the blood may flow freely to the brain, which is done by laying the patient on the floor; then throw cold water violently in the face. The most effectual remedy is to place the finger far down the throat, which will produce involuntary retching, and is the most efficient action to bring about restoration, after which treat the patient as in any ordinary case of fainting, giving a little brandy, ammoniated tincture of valerian or aromatic spirits of ammonia, ten to twenty drops doses in water, and allowing the patient to lie on the lounge until strong enough to walk in the fresh air, when he or she will soon recover completely.

In the hands of a skillful and careful operator no great risk attends the employment of this anæsthetic; but those who are less skillful, and are inexperienced, should reject cases of great physical exhaustion, or patients with a feeble or fatty heart, indicated by pain and flushed face. The distension of the right cavities, which accompanies the disappearance of the radial pulse, and the general lividity of the features, may be attended with some degree of risk, and the danger is increased when, the muscles of the trunk and limbs being convulsed, the pressure of the contracting muscles upon the veins drives the blood forcibly towards the right cavities of the heart, and so adds to their distension.

Administering Nitrous Oxide to Children.

Dr. Buxton states that in giving nitrous oxide to children, the face-piece (not so much employed in this country) should be removed with the first sign of jactitation; otherwise these small bodies become so convulsed that it is difficult to keep them still for operation, and much valuable time is lost in the attempt to place them in a convenient position.

Deaths from the Inhalation of Nitrous Oxide.

First Case.—In one instance in this city of supposed death from this anæsthetic agent, it was subsequently discovered by a *post-mortem* examination, that one of the cork props which had no securing-string attached, was found in the larynx of the patient. Cases have also occurred in which a root or piece of tooth has been drawn into the trachea and dislodged by vomiting or paroxysmal coughing. In one case the root of a tooth was passed into the bronchia, and produced all the symptoms of phthisis; fortunately, at a later period, the root of the tooth was caught up, and the patient recovered.

Second Case.—In 1872 a death was alleged to have resulted from the inhalation of nitrous oxide gas administered by Dr. Newbrough, of New York, at whose office the death occurred and by whom the following summary of evidence was made before the coroner's jury:

The patient, a middle-aged lady, desired the extraction of seven or eight front teeth, which were loose. Dr. Newbrough advised that their removal would be so easy that an anæsthetic would be unnecessary; but the patient insisted that she could not submit to the operation without it. Dr. Newbrough then procured a six-gallon bag of nitrous oxide gas; but the patient seemed equally fearful of anæsthesia as well as pain—and, as soon as she had made the inhalation, rejected the bag and declared her willingness to have the operation performed without it. At sight of the forceps her courage again failed her, and she decided once more to try the gas. She took one inhalation, and again rejected it. By this time so much of the gas had escaped from the bag that the doctor replenished it. Of this she took two inhalations, and peremptorily refused to have anything more to do with it, declaring her determination to submit to the operation. The teeth were then extracted. "Immediately," says the doctor, "she fainted; her head dropping over sideways." The face rapidly became livid, and finally purple; respiration falling to about fifteen per minute. In about *thirteen* minutes, notwithstanding the prompt application of the galvanic battery and efforts to assist respiration, death ensued.

Dr. Otis, summoned by Dr. Newbrough, arriving in about ten minutes after the fainting, testified that he continued the usual restorative treatment for *forty-five* minutes, when death ensued. At *post-mortem*, found no disease of the heart; brain perfectly exsanguined in every part; no fluid in any of the ventricles; one lung was more engorged than the other, but healthy. As the testimony was very discordant in several particulars, we shall give only the conclusions of Dr. J. W. White, who carefully sifted the whole testimony:—

"Of the case under discussion, the inference seems entirely justified, that death was not caused by nitrous oxide gas, for the simple reason (if the evidence can be relied upon), that not enough was inhaled to produce such a result on any theory of its action. Nor was there any fact established by the *post-mortem* to justify such a conclusion; while the testimony renders it entirely probable that the cause of death was nervous shock, from dread of pain and apprehension of fatal effect from the inhalation of an anæsthetic agent.

"It may be remarked, however, that an examination by the coroner as to the possible lodgment of an extracted tooth in the air-passages would have eliminated that from the list of uncertainties."

Third Case.—The following case is reported in the London *Medical Times and Gazette* of April 7th, 1877. As it is of considerable importance, on account of the extended use of the anæsthetic, we quote it in full:—

"An inquest was held last week, at Manchester, on the body of Mr. George Morley Harrison, aged fifty-three, a surgeon in good practice and formerly lecturer on Medical Jurisprudence at the Manchester Royal School of Medicine, who died whilst under the influence of nitrous oxide gas, administered at his own request, previous to having a tooth extracted by a neighboring dentist. Mr. Harrison, it appears, being unnerved and excited, partly from the suffering he had undergone and partly owing to the want of proper food, which the condition of his mouth had prevented him from taking, insisted on the inhalation being pushed until he should snore, and—for at any rate, part of the time—held the mouth-piece in his own hand,

and inspired very vigorously. The first attempt at extraction was made before he was fully insensible, and was abandoned until more of the gas had been given. Eventually, however, two teeth were removed. The patient did not appear to be coming round properly after the operation, and the dentist, taking alarm, sent for medical assistance. On the arrival of a surgeon, Mr. Harrison was pronounced to be quite dead. At the *post-mortem* examination there was found some fat about the heart; the cavities on the right side were distended with blood, while those on the left side were empty. The lungs on both sides were gorged with dark blood. All the other organs were healthy.

"The jury came to the conclusion that the deceased 'died from syncope, during the administration of nitrous oxide gas for the extraction of teeth, whilst laboring under fatty degeneration of the heart.'"

"A more full and careful *post-mortem* was made in the above case of death from nitrous oxide.* The examination of the body took place seventeen hours after death. Rigor mortis was well marked, and there was considerable *post-mortem* lividity. There was a good deal of fat beneath the skin, in the omentum, upon the external surface of the heart, and in the usual localities. The heart and pulmonary artery were opened *in situ*. The right side of the heart was distended with fluid blood; the left side was empty. There were two or three slight patches of atheroma in the aorta, and upon one of the aortic valves. There was some little evidence of fatty changes in the slightly altered color and consistence of the walls of the heart. The coronary arteries were examined and found free from disease. The mucous membrane lining the trachea and bronchi was congested. Some mucus was found in these tubes, but no blood or other foreign body. There was distinct thickening of the aryteno-epiglottidean folds and of the vocal cords. The lungs on both sides were gorged with dark fluid blood; at the left apex there was an old fibrous cicatrix. The liver was enlarged—its tissue

* *Medical Times and Gazette*, April 27th, 1877.

was very friable and of a dirty yellowish-white color. The kidneys were full of blood; otherwise perfectly healthy. The bones of the skull were of unusual thickness. The visceral arachnoid was thickened and opaque. On removing the brain a large quantity of cerebro-spinal fluid made its escape, and the cornua of the ventricles were found dilated. The brain-substance was healthy, and its vessels full of blood."

In this sad case a most valuable life was sacrificed almost at the patient's own request. No man has any right to do as a patient desires, or allow him to be the judge of the quantity of an anæsthetic he should inhale, as a patient under such circumstances is not a competent judge.

The following are some observations of that veteran chloroformist, Mr. J. F. Clover, on this interesting case, addressed to the editor of the *British Medical Journal*:—

"SIR: In the *Times* of Good Friday last, there appeared a notice taken from the *Manchester Examiner* of a death under nitrous oxide gas. The following was the verdict of the coroner's jury:—'Died from syncope, during the administration of nitrous oxide gas for the extraction of teeth, while laboring under fatty degeneration of the heart.'

"The details of so unusual an event would be highly interesting to the medical profession, to enable them to judge of the safety or danger of the anæsthetic used. To form a correct opinion, we should at least know how long the inhaler was applied, the order and manner in which the movements of the heart and respiration became affected, and what had been swallowed previously.

"The verdict was probably inaccurate in stating that the syncope occurred *during the administration* of the gas, as no symptoms of danger were noticed until after the extraction of the second tooth.

"The most probable explanation of this sad case is that the extractions were difficult, and that the patient, on recovering from the effect of the gas, was susceptible to the shock of a severe operation; and that this shock, and not the gas, was the cause of the syncope, which structural disease of the heart rendered fatal. Unfortunately, it appears that no third person was present, and we cannot expect the necessary evidence from the operator, whose attention was otherwise directed.

"Those whose opinions of the effects of nitrous oxide are formed by inferences from Reid's *Experiments on Asphyxia*, and some cases of cardiac distress, first complained of after inhaling gas, will blame the latter. Those who daily witness the continuance of the circulation, in spite of the blood being black from the gas, and the cheerful and speedy recovery from it, will conclude that so unusual a result must have depended upon the peculiarity of the patient, whose heart was found in a state sufficiently diseased to account for sudden death."

Fourth Case.—Fatal results following the inhalation of nitrous oxide in the case of Mr. Samuel P. Sears, the operator being Mr. Jose R. Brunet, D.D.S.* No particulars.

Fifth Case.—Death from nitrous oxide occurred at Exeter, England. The gas was administered by Dr. F. F. Mason for the purpose of the painless extraction of a large upper molar tooth. The lady, Miss Wyndham, was about thirty-eight years of age, in good health. Her physician, Dr. Pattison, was present. Gas from the same source had been administered to other patients, so that its quality could not be impugned. She took the gas in the usual way, without any symptoms to excite uneasiness. At the proper degree of insensibility, the gas was stopped, and the tooth extracted. It was not until after the operation was completed that anything unusual happened; her face suddenly became livid, and the features began to swell, and she seemed to be quite unconscious. She breathed two or three times, and in a few moments her pulse ceased to beat. All attempts to restore her were fruitless.

"There was no obstruction to the air-passages, and the tongue was protruded, while she still respired."

Sixth Case.—Tribunal Correctional de la Seine (Fe Chambre) —Homicide through carelessness—Anæsthesia by means of Nitrous Oxide Gas—Death of Patient—Sentence.—It has been

* *Dental Times*, vol. 1, page 157, New York, 1864.

shown in the course of the inquiry and trial that on the 25th of November, 1884, M. Lejeune went to Duchesne's for the purpose of having a tooth extracted—that at the patient's request the dentist made him inhale nitrous oxide gas for the purpose of rendering him insensible during the operation; that as a result of these inhalations M. Lejeune had a syncopal attack and died. Considering, that for this operation, Duchesne made the mistake of not having a doctor of medicine to assist him; that for the administration of nitrous oxide gas, it is absolutely necessary, that the operator should possess a thorough knowledge of physiology so as to be able to examine beforehand, and with great care, the state of the organs of the patient who desires to be anæsthetized; that whatever may be the experience of the accused, an experience which may have sufficed in most of the cases, but not in all, Duchesne appears to be lacking in special knowledge, and that he was neither a doctor of medicine, nor an *Officier de Santé,* though he falsely assumes the title of doctor of medicine.

Allowing that one of the medical experts appointed by the tribunal, Dr. Brouardel, who gave evidence at the trial, considers that for the administration of anæsthetics two competent persons are required, one of whom should be a doctor of medicine, and that it is most imprudent to administer an anæsthetic, as did Duchesne, without fulfilling these conditions.

Considering that if, of all surgical operations, the extraction of a tooth may be looked upon as an operation usually of slight importance, and which only requires some dexterity of hand, and may be thus performed by any dentist, even one who holds no diploma, the case is not the same when the operation is performed during anæsthesia—that in the latter case, according also to the opinion of the experts, it belongs uncontestably to the class of major operations that under these circumstances, according to the provisions of Article 29 of the Law of Ventôre au XI., *Officiers de Santé,* and with still more reason dentists who hold no diploma have no right to perform it except under the superintendence and in the presence of a doctor.

Considering, also, that the present director of the *Ecole*

Dentaire de Paris does not hesitate to acknowledge that the help of a doctor is absolutely required during the administration of anæsthetics by dentists.

That it thus appears, from all that precedes, that Duchesne in November, 1884, through his imprudence, negligence or non-observation of the laws, was guilty, unintentionally, of homicide on the person of M. Lejeune, a misdemeanor foreseen and punished by Article 319 of the *Code Pénal.*

As regards the damages claimed by the *partie civilie* (relatives).

That the death of M. Lejeune must be looked upon as due not only to Duchesne's fault, but also to the imprudence of the victim himself, who made the mistake of requesting to have an anæsthetic administered to him without having previously consulted his ordinary medical attendant, and without requiring the assistance of any doctor.

For these reasons, condemns Duchesne to pay a fine of 600 francs, and also to pay to the widow of Lejeune the sum of 3000 francs as damages.

Annexed are the views of Dr. Th. David, director of the Ecole Dentaire of Paris, on this subject, and he has come to the following conclusions:

I. Anæsthesia is to be looked upon as one of the major surgical operations which, by the terms of the Law of Ventôre, are only to be performed by doctors of medicine.

II. *Officiers de Santé* are only entitled to administer anæsthetics under the guidance and in the presence of a doctor of medicine.

III. No one can pretend that an operation which even *Officiers de Santé* are not allowed to perform, can be considered to form part of the practice of the dental art, and be permitted to people who possess no medical qualification of any kind.

IV. Dentists who do not hold a diploma and who administer anæsthetics alone, incur the penalties edicted against illegal practice of medicine (Arts. 35 and 36 of the Law of Ventôre au XI), and in the event of an accident, the penalties edicted by Article 319, of the Code Pénal, for accidental homicide (*homicide par imprudence*).

Seventh Case.—It has been reported by Dr. L. P. Tawdell, in

The Louisville Medical News, October 23, 1880, that a death resulting from nitrous oxide had occurred in that place ten or twelve years ago, but no details have been given.

A Death after the Use of Nitrous Oxide Gas.—Samuel J. Cresswell, a well-known citizen, and proprietor of the iron foundry and machine-shop at Twenty-third and Cherry Streets, Philadelphia, was stricken with paralysis while sitting in a dental chair at the establishment of Dr. John D. Thomas, No. 912 Walnut Street.

About 12 o'clock, Mr. Cresswell, who had been suffering for several days with two painful teeth, went to Dr. Thomas' office to have the troublesome molars drawn. He was apparently in the best of health at the time, and after waiting a few minutes was ushered into the doctor's operating department and laid back in the chair. Dr. Thomas, who is an expert in his line, administered the gas (nitrous oxide), and in less time than it takes to write it a pair of ugly-looking ivories were on the stand at his side.

Mr. Cresswell revived very quickly from the influence of the gas, and was straightening himself up in his chair, when one of his hands began shaking as though palsied.

"Why, look, doctor, what can be the matter with me?" he said, and then his speech began to thicken, and an instant after he fell back again in the chair unconscious. All efforts to bring him to his senses proved unavailing, and Dr. Thomas summoned Dr. Hobart Hare and Dr. Drysdale, of Sixteenth and Arch Streets. Mr. Cresswell was quickly bled, and then, by orders of the physicians, was carried up to a bed-chamber on the third floor of the premises, where the doctors labored with him for some time without noticing any improvement in his condition. Mr. Cresswell died at five o'clock October 12, 1889, aged forty-six years.

Therapeutic Application of Nitrous Oxide.

Neuralgia, uncomplicated, will sometimes be relieved by a few inhalations of nitrous oxide gas; on the other hand, if a disordered condition of the stomach cause the neuralgic pains, instead of proving a relief, it will only aggravate the trouble.

NERVOUS APHONIA.—This peculiar form of loss of the power over the voice, usually the result of hysteria, will be much improved by the patient inhaling a sufficient amount of the nitrous oxide gas to produce a partial loss of sensation and muscular relaxation.

LOCAL PARALYSIS has been benefited, where there was no brain lesion, by the gentle stimulation of the first stage of the gas, or the tingling and stimulating effect on the muscles.

ASTHMA.—This disease, when of a spasmodic character, is often much improved, by causing the patient to pass into the stage of relaxation, employing it every other day for a week or two.

EPILEPSY.—When this disease is not the result of an organic change in the brain, spine or other portion of the nervous system, but the result of some peripheral or reflex action, benefit will ensue by the use of the gas for weeks. It should be administered two or three times a week only, to produce the stimulating effects of the first stage of anæsthesia.

Dr. George J. Zigler,* a friend of the writer, has found the solution of the gas in water of much utility in the treatment of diseased conditions of certain organs of the body.

This gas, we understand, either alone or mixed with oxygen, is employed by certain individuals as a secret remedy—a plausible form of quackery kept up by the most extensive and persistent advertising.

Therapeutics of Nitrous Oxide Gas according to Dr. A. M'Lane Hamilton.

"For the relief of severe paroxysms of neuralgic pain, this gas stands high as a remedial agent. I have used it in cases of severe and persistent facial neuralgia and in common sciatica. When hypodermic injections of morphia have done little or no good, this agent offered relief, not only temporarily, but in another way. Just as oxygen was useful in the hands of Hooper, La Passe, Hill, Demarquay and others, so is dilute nitrous oxide in neuralgic affections, and in such cases the chemical hæmatic action is that which it produces.

* See his work on this subject.

"As yet I have not used the gas in the treatment of Epilepsy, though I have no reason to doubt its value in a disease which is essentially an anæmia. Dr. Smith alludes to a case reported by Wallihan, who had used mixed nitrous oxide and oxygen with great success.

"There is a variety of insomnia which depends upon overwork and general prostration. Such a case came under my care, in the person of the President of a college who was on his way to Bermuda, in pursuit of a change of air and scene. He was persuaded to come to me by a patient who had taken the gas. He had not slept for some time, except for a few hours, and then he was tortured by bad dreams. After daily taking four gallons of gas he slept soundly three nights out of four, and there would have been no exception had he not excited himself in preparing for his trip. In other cases the gas acted very badly when it was given at night, for, although drowsiness succeeded the administration, there was a secondary stage of excitement of a disagreeable kind; I therefore followed the suggestion of my friend, Dr. Blake, and administered the gas in the middle of the day, and found, as a consequence, that the insomnia was overcome. Probably the beneficial effects arose from a general equalization of the circulation, and the removal of effete nervous tissue from the perivascular spaces. In such examples of insomnia dependent upon slow removal of waste products of cerebral action, the circulation of vitiated blood in consequence of hepatic or renal disease, or depressed tone of the cerebral vessels, nitrous oxide gas was indicated and tried with success. In clearly asthenic cases, however, in which the sleeplessness depended upon excitement, vascular engorgement of a congestive character, or active cerebral hyperæmia in connection with hypertrophy of the left side of the heart, and increased vascular tension, the employment of nitrous oxide was contra-indicated, and did no good. In fact, in one case it aggravated the wakefulness.

"In some forms of functional heart disorder I have witnessed results which fulfilled all my anticipations. In cases connected with hypochondriasis, its virtues were most apparent, and many an imaginary trouble ceased to annoy the patient when his intellectual functions were restored to a normal condition.

"In one case of functional heart trouble, attended by palpitation, depression, sinking feelings and an indescribable pang which followed physical exercise, in the person of a well-known literary gentleman of middle age, whose sufferings were dependent upon many years of hard intellectual labor, I was glad to find that, after two or three days, his trouble disappeared to a great extent, and probably in a younger subject would have vanished altogether. In his case, however, there were probably deeper troubles. For chlorotic young women who suffer from ovarian irregularities, head troubles and palpitation, nitrous oxide does much good.

"The vague muscular pains, irregularity of heart action, loss of appetite, tremor, sinking sensations and nervous irritability, so common among those who use tobacco to excess, form a train of symptoms which disappear very rapidly under the influence of gas, and the irritability of opium-eaters, and those who drink to a degree that brings them to the verge of acute alcoholism, subsides very quickly. For this reason dilute nitrous oxide may be given to persons who suddenly part with their accustomed opium or alcohol, and with a fair show of permanent success—for an agent which not only supplies oxygen, but improves the nutrition of worn-out tissue, and supplies at the same time a stimulant without reaction, cannot fail to bridge the patient over the period of acute suffering and intense irritability in the beginning."

Dr. Colton on the Safety in Disease of Nitrous Oxide Gas.

"Is it safe in the various organic diseases, such as those of the heart, lungs, brain, &c.? Thousands of invalids have suffered torture for months and years because they dreaded the surgeon's knife, and in like manner, other thousands suffering from some organic or functional disorder of the system, have dreaded the dentist's forceps, and fearing to take an anæsthetic, have for years carried in their mouths a mass of filth, a fruitful cause of disease, which has not only ruined their health and destroyed their happiness, but made them objects of repugnance to all who are so unfortunate as to be associated with them.

"If the above question can be answered in the affirmative ; if nitrous oxide is safe for such afflicted ones, it is, certainly, a great boon to suffering humanity.

"Having used it almost indiscriminately for years, I present below the results of my experience:

"DISEASE OF LUNGS.—It is a well-established fact that pure nitrous oxide gas is entirely non-irritating to the lungs, and as we have already shown, its action upon the blood is to increase the property of coagulation. A person who is predisposed to hæmorrhage can inhale the gas with entire immunity from danger—indeed, I think with less danger than would attend the operation if no anæsthetic were administered, since the shock to the system is thereby avoided, and there is but a slight increase in the force of the circulation. In a large number of such cases where the gas has been administered for tooth-extraction, I have never met with one where any hæmorrhage followed immediately succeeding the operation, nor any in which the after-effects proved unpropitious; and this, notwithstanding a large number have had hæmorrhages previous to the operation, and some immediately preceding it. I should state here that, in all cases of disease, the effects of the gas are watched with the greatest care, and if any untoward symptoms present themselves, it has been discontinued, although this has never, in a single case, been found necessary until the patient was sufficiently under its influence to permit of a momentary operation; as for instance, the extraction of a tooth.

"HEART-DISEASE.—In this disease the effects should be watched with care, and there will be no danger. The cumulative action of the gas is only for a few seconds, so that if it be withdrawn at any time during the process, a reaction takes place in a moment, we might almost say before the patient has time to die; while with ether and chloroform there is a cumulative action for from 20 to 50 seconds after they have been discontinued, and several minutes may elapse before consciousness returns. Although its evanescent character is a great obstacle to its use for long operations, still, that is the great safeguard against accident, for the heart's action may be under your control, as the engine is under the control of the engineer. If the pressure is too great, he lets off the steam; if the heart's action is either increased or diminished inordinately, remove the gas and in a moment it resumes its wonted action.

"In two recorded cases the condition of the patient was so critical, that I should scarcely have dared to extract a tooth without the use of an anæsthetic, fearing the shock to the system incident to the operation, there being in one case a complexity of diseases,—hypertrophy, dilatation and valvular disease, which had been continued for 12 years. He had formerly followed the sea, but had not been able to go upon the streets, without assistance, for several years. He was pale and anæmic, with an irregular and intermittent pulse.

"The administration of the gas was continued only to near the close of the second stage; the patient recovered without any untoward symptoms, and left the office in a few moments declaring he felt better than when he came in. He certainly looked much better, having lost that deathly pallor of face which he had when he sat in our operating chair. The danger in such cases is that the feebleness of the heart's contractile power, may cause its action to cease altogether during the period when this power is partially destroyed by the paralyzing action of the anæsthetic, while the safety lies in the instantaneous reaction after the withdrawal of the gas.

"In CHOREA, HYSTERIA, EPILEPSY and other diseases dependent upon a disordered condition of the nervous system, it is productive of no bad results, unless it be pushed too far; while if only the second stage of anæsthesia be produced, so that it shall act as a stimulant to the nervous system, and not as a depressing agent, it will in many such cases prove a most valuable remedial agent.

"Uncomplicated Neuralgia is oftentimes instantly relieved. I could adduce a hundred instances of the kind, where the patient has sat down with a severe headache, and been entirely relieved by a few inhalations of the gas. On the other hand, if a disordered condition of the stomach cause the neuralgic pains, instead of proving a relief, it will only aggravate the trouble.

"A lady who had inhaled ether a half-hour previously, for the extraction of some teeth, and had been unsuccessful, came to the office with a severe headache; she inhaled the gas, her teeth were drawn, and upon recovery she stated that her headache was entirely relieved.

"HYSTERIA.—The gas, by its stimulating action upon the nerves, has oftentimes proved beneficial in cases that have come under my observation.

"Such patients generally leave the office with hysterical symptoms much less aggravated than before the inhalation. During the operation, the friend in attendance sometimes expresses fears that the patient may have one of her 'nervous spells,' noticing some contortion of the face or movement of the hand as she is waking from a dream; but in a few moments, as soon as complete recovery has taken place, there is usually a calmness of the patient, quite surprising to the attendant, she being able to write her name with as steady a hand as usual, within five minutes of the commencement of inhalation.

"I have the record of an interesting case of a young lady, who had not been able to speak above a whisper for several months previous to taking the gas, who, a few days subsequent, called and informed me with the greatest delight, that she had been cured, as she could talk now as well as ever.

"The fact that she awoke after the operation crying out, may have had some agency in effecting the cure, as she thus learned that she possessed vocal organs and could use them.

"Still, this case, in connection with very many others of a like character, has convinced me that pure nitrous oxide may be employed with great advantage in cases of hysteria; while, on the other hand, if it be impure, either on account of its being prepared so recently, or for too long a period, or, if persisted in beyond the third stage, it is absolutely injurious.

"ASTHMA.—Asthmatic patients express a sense of relief after inhaling the gas, which in some instances, at least, seems to be of a permanent character. A gentleman of sixty years, whose disease was inherited, and who had been a severe sufferer for many years, was almost entirely relieved for a whole winter by inhaling for a few successive days, once or twice each day, a quantity sufficient to produce the second stage of anæsthesia, although he had not been free from the disease, at this season of the year, for about twenty years.

"PARALYSIS.—Quite a number of patients afflicted with paralysis in a greater or less degree, have come under my observation, upon whom the gas has had a very pleasing effect, in stimulating the nervous system to action, and thus restoring the tone of the paralyzed parts, more or less completely.

"One such case was that of a gentleman who had, for a long time, been afflicted with paralysis of the bladder. He inhaled the gas upon several occasions, for the relief of neuralgia. After a few inhalations, the paralyzed condition was much improved, as was evinced by his freedom from incontinence. It is necessary in such cases to produce only the second stage of anæsthesia.

"EPILEPSY.—The following cases of epilepsy are of considerable interest:

"*Case* 1.—A young man, 28 years of age, who had inherited the disease, inhaled the gas for six weeks, two or three times in a week. During the first week he had three epileptic attacks; during the second week, two; during the third, one, and for the three weeks succeeding, not any.

"I presented the case, at the time, at the University clinics, but have never been able to obtain its subsequent history. Previous to inhaling the gas, he had had two or three attacks daily, and he had not been free from them for so long a time, for several years. Two years previously he had inhaled the gas for tooth extraction, with a favorable result, which he at the time attributed to the bromide of potassium which he was taking.

"*Case* 2.—A young lady inhaled the gas as a remedy in the same disease. She recently informed me that she had not had an attack for several months, although before this she had experienced them frequently. She attributes her freedom from attacks to the remedial efficacy of the gas."

Nitrous Oxide and Oxygen as an Anæsthetic in Labor.

The great advantages of nitrous oxide as an anæsthetic, have induced various observers to endeavor to find a method of administering the gas continuously, so as to keep up the anæsthetic influence for a sufficient length of time for the performance of surgical operations.

Paul Bert, some years ago, made experiments with animals in a chamber of compressed air, a mixture of nitrous oxide and oxygen being inhaled.

He found that anæsthesia could be kept up for a long period, and he urged the construction of such chambers for operating upon the human subject.

Some few experiments were made in minor surgery, but nothing on a large scale was attempted on account of the expense, etc.

In 1881, Dr. Si Klikovich, in St. Petersburg, made some experiments on himself with a mixture of nitrous oxide and oxygen, in the proportion of 80 to 20, without any increase of atmospheric pressure, with a satisfactory result. He also used it for alleviating the pains of labor, and found it very successful and perfectly safe, the great objection to it being its expense, and the cumbersome nature of the required apparatus.

Professor Zweifel, of Erlangen, erected the necessary apparatus for the supply of the mixed gases to the accouchement ward of his obstetric clinic. He finds it best to administer the gases continuously during the latter part of the labor, when the pains are most severe, not, as was practiced by Klikovich, merely giving the gases when signs of approaching pain appeared.

Though this treatment had been adopted in sixty patients, no retardation of the process was observed.—*B. Med. Journal, Nov.* 7, 1885.

Clover's Inhaler for Nitrous Oxide Gas and Ether.

(See illustration, page 141.)

The following is a description of the apparatus of Dr. Clover, and his valuable conclusions:—

The apparatus consists of a thin bag, oval in shape, and fifteen inches long; at one end connected with the ether vessel, at the other with the face-piece. Inside the bag there is a flexible tube also connected with the face-piece and ether vessel.

By turning the regulator (Re) the patient is made to breathe ether directly into the bag, or indirectly through the tube or ether vessel.

When the letter G is visible, the way to the gas-bag is open; when the letter E is visible, the only way to the bag is through the tube and ether vessel; so that the more the regulator is turned toward E, the more ether is given, and *vice versa*.

The other vessel contains a reservoir of water to prevent the temperature of the ether becoming too low; this is to be kept full.

The ether vessel is to be rather more than half filled, the precise point being marked against the glass gauge. A thermometer inside this gauge tells the temperature of the ether. Before using it, the vessel should be dipped into a basin of warm water, and rotated until the thermometer stands at about 68°.

If the room be cold, and if the patient have thin cheeks and large whiskers, the temperature may be 73°.

It is important that the face-piece should fit closely against the face. Those made by Mayer, of solid leather framework supporting a collar of inflated india-rubber, are the best, but sometimes they require to be warmed before using. For giving nitrous oxide only, the regulator is turned to G. The stopcock of the ether vessel is closed.

This vessel is hooked upon the strap around the neck. The strap is adjusted so that the ether vessel stands at a higher level than the face-piece.

The gas being turned on by rotating the foot key with the foot, the gas-bag is kept filled as fast as it is emptied by the patient. When the latter breathes out, the supply of the gas is stopped, and after the bag is fully distended, the escape-valve opens, and allows the expired gas to escape.

If the shape of the patient's face prevents the face-pieces from fitting closely, the escape-valve should be closed by pressing it with the finger. Enough gas will escape beneath the face-piece during the expiration. But the bag, being slightly distended, will yield the gas so abundantly, that no air will be drawn in at the same place during the inspiration.

If ether is to be used without gas, the gas-tube should be taken off the ether vessel, the regulator should be turned to G, and the face-piece should be first applied to the face during an expiration, and be held rather closer during expiration than during inspiration.

It is important not to oblige the patient to inhale after the bag is empty, because the barometric pressure of air on the ether being diminished, the vapor would increase in strength, and make the patient cough or perhaps vomit.

The regulator is gradually turned towards E, and thus the way is opened to the inner tube. The air breathed through it carries vapor from the vessel into the distal end of the bag.

As soon as one-half of the air passes through the ether vessel, the vapor becomes strong enough to cause insensibility in about two minutes, usually without any coughing. As the movement of swallowing is excited by a too strong, although less pungent, atmosphere than is generally needed to excite coughing, it should be watched for, and the regulator slightly turned back if it occur.

By far the easiest and least unpleasant way of getting a patient ready for a surgical operation, is to use gas and ether combined, the gas being given pure during four or five respirations, and the ether gradually added as above described.

The supply of gas should cease when the ether is turned on; but if, during the operation, we have admitted so much fresh air that the patient seems conscious of the taste of ether, we may, instead of increasing the ether, give a liberal supply of gas until the patient is tranquil.

We find less sickness and less complaint of the taste of ether afterwards, than when ether is used alone.

In operations on the eye, the muscular twitching and panting character of the breathing during the first few minutes of insensibility, are objectionable; but if the operation be not commenced for five minutes, and the ether given as strong as it can be taken without exciting a cough, the patient begins to breathe stertorously, and now the face-piece may be removed every third or fourth inspiration, and as the stertor goes off, the eye will become quite steady.

He is so well satisfied with a modification of his chloroform apparatus, by which he can give as much of ether or chloroform as he likes, that when he has a choice he prefers using these for cataract operations, and for the ligature of deep-seated arteries, etc.

With respect to vomiting, it is most important that the patient should have an empty stomach, and prefer that neither food nor drink of any kind should be taken, for from four to six hours beforehand.

There is less sickness after operations, if done before breakfast.

In using this apparatus, as in using others, the breathing and the pulse should be kept under observation.

Whenever a patient is seen to swallow, it is probable he is taking the vapor stronger than is necessary, and the regulator should be turned back slightly.

If the patient cough violently, remove the face-piece, and be sure that the apparatus has not been overheated or filled with ether above the proper level.

As soon as any muscular twitchings, like those of paralysis agitans, are seen, give about a fourth of an inspiration of fresh air, and do not keep the face-piece quite close to the face till the twitchings have nearly ceased.

He has never seen any harm result from the condition which causes these movements. If air were not given, they would increase, and then stop; the respiration would become intermittent, and some time after this the heart would cease to beat.

The fact that *death* may be produced, if signs of danger are disregarded, applies to *all anæsthetics.*

Whenever the breathing becomes jerking, sobbing, or intermittent, the face-piece should be removed, but applied directly the breathing loses that character, unless the pulse is much depressed.

It is much less important to watch the pulse whilst giving gas and ether, than in giving chloroform; but it is desirable, for when it decidedly loses power, we may safely admit a little fresh air, and thus anticipate the need of removing the face-piece to a greater extent on account of muscular twitching or stertor.

If the finger be taken from the pulse to do something else, it is well to give a little air, unless the patient had only just begun to inhale, or was evidently but slightly under the anæsthetic.

Practical suggestions:—

As the apparatus would be injured by an excited patient taking hold of it, it is as well to have an assistant near in case of need.

It is a good plan to place a handkerchief over a patient's eyes, and keep it there until he is asleep, and apply it again when he is about to awake.

In operations on the rectum, it is desirable that the bandage required for keeping him on his side should be applied before giving the gas.

Sudden distension and bursting of the gas-bag, or gas-tube, can scarcely happen when the gas rarefier is used; but if this be not used, or if the gas-bottle has become frozen, it is desirable to warm the bottle, and in doing so, the top end should be more warmed than the other.

Whenever there is much difficulty in getting the face-piece adjusted, it may be necessary to arrange a handkerchief or towel so that the air drawn in under the face-piece may be nearly the same as that which was breathed out.

In conclusion, the advantages of the apparatus are these:—

1. It lessens the waste of ether, and consequently the odor of ether about the house.

2. The patient usually goes to sleep without any struggling, and is ready to be operated on in from one to two minutes.

3. The percentage of ether need not be so high as to produce coughing or swallowing, and it can be made stronger or weaker, as we wish, by merely turning a regulator.

Lastly, patients recover rapidly, with less delirious excitement and less sickness, than if ether be given in the usual way.

Dr. F. N. Otis, of New York, exhibited Clover's apparatus for administering ether and nitrous oxide, and remarked that it had given him the best satisfaction of any apparatus he had ever employed, for anæsthesia was readily produced without a struggle upon the part of the patient. It could be used for the administration of laughing-gas without producing any of that dreadfully suffocative appearance so commonly attending its use by the methods usually employed. He thought well of prefacing the ether by the use of a moderate amount of nitrous oxide.

HOW SHALL NITROUS OXIDE AND ETHER BE ADMINISTERED? —Dr. Frederick W. Silk, of London, an anæsthetist of wide experience, has invented a useful apparatus for the production of anæsthesia by the combined method. In placing his invention before the profession, Dr. Silk, himself, comments on the striking similarity in the principle applied by him and that of Dr. Hewitt, who had pursued an independent line of work. The only difference between the apparatus of Dr. Silk, and that of Dr. Hewitt, is, that the valve arrangement between the face-piece and the ether-chamber in Dr. Hewitt's apparatus, has been transferred by Dr. Silk, to the face-piece itself, where it is controlled by the fingers of the hand holding the face-piece in position. Dr. Silk and Dr. Hewitt have both attained a method greatly superior to the usual one of an ether chamber suspended around the neck, and connected with a face-piece by means of the bag enclosing the tube. Dr. Silk, however, considers the new method still defective, because of the difficulty of administering nitrous oxide with a mere "whiff" of ether, as in dental work. The ether chamber, when charged so that the indicator stands at 0, is so constructed that it is almost impossible, in warm weather especially, to prevent a very distinct and disagreeable odor of ether from pervading the face-piece at all times. Dr. Silk says that this apparently trifling objection becomes a serious one in the treatment of nervous and excitable patients.

Another difficulty is the total exclusion of air, which is so important a feature in the administration of nitrous oxide. Complicated mechanism—valves, stopcocks, chamber and pipe adjustments—renders this total exclusion difficult just so soon as the effects of wear and changes of temperament are manifest in the apparatus, and notably toward the close of the administration, when the bag is becoming empty, and the inspiratory effort is greater. Dr. Silk says that the gas reservoir should be brought as near the mouth as possible in all cases, and especially when it is narrow, with various divisions made by joints, valves, etc. There is always the possibility of leakage, and gas is moreover, but feebly mobile.

In cases where nitrous oxide and ether are administered in succession, Dr. Silk finds his apparatus often useful in abolishing the pulmonary spasm, and the struggling which is manifest in the later stages of narcosis; but he expresses disappointment that these phases have not been entirely abolished, and that in some instances they have seemed to be intensified. This he attributes largely to the greater rapidity with which nitrous oxide narcosis is produced, as compared with that following ether, the former growing quite profound before the latter has reached the first stage. The consequent necessity for admitting air at that period, retards the development of the final stages of ether narcosis, and prolongs or even intensifies the stage of struggling and excitement. In commenting on Dr. Hewitt's and his own apparatus, Dr. Silk says: "I am bound to confess, however, that it is a very distinct improvement on old methods, and that I still continue its use."—*Medical Register, Oct.*, 298.

DEATH UNDER THE ADMINISTRATION OF NITROUS OXIDE AND ETHER.—" A death has taken place in London, at University College Hospital, during anæsthesia from nitrous oxide gas and ether, being, we believe, the first fatal case which has occurred that can be attributed to this combination of anæsthetics. The patient was a woman fifty-five years of age, who was admitted to the hospital in consequence of strangulated femoral hernia. When admitted, she was in a very weak and exhausted condition from constant vomiting, the hernia having been strangulated for over forty-eight hours. She was taken into the operating-theatre, and gas and ether administered by means of Clover's apparatus. In about four minutes she was well under the influence of the anæsthetic, without having exhibited any previous excitement. Taxis was then applied, when almost immediately the patient became pale, and recommenced vomiting stercoraceous matter. At the same time the respiration became weak, and the pulse at the wrist imperceptible. The doors and windows of the theatre were at once thrown open, and artificial respiration was carried on for a few minutes. As no obvious benefit resulted, an enema, containing three ounces of brandy was administered. Fumes of strong ammonia were applied to the nostrils, and ammonia injected into the right median basilic vein, but all without any good result, and the patient died within about ten minutes from the onset of the alarming symptoms. At the autopsy, stercoraceous matter was found in the trachea and right bronchus. The right side of the heart and the large veins were full of dark fluid blood. The ventricular walls were thin and flabby, and the cavities slightly dilated. The left ventricle was empty. The arch of the aorta presented numerous patches of atheroma." *

Sir Henry Thompson recommends Mr. Clover's plan of administering nitrous oxide gas for thirty seconds, and then ether.†

Mixtures of Nitrous Oxide, Ethers, Chloroform and Alcohol for Inhalation.

In our numerous experiments with the various anæsthetic agents, we have always found it difficult to make any true chemical combination. Most of the vapors differ very much in density, and are given off at different temperatures, the vapor of chloroform being four times heavier than air; and unless some means are employed to keep them in motion, the denser vapor will gravitate to the bottom. Such is also the case with the liquid anæsthetics. They will, when shaken up, look, for the time, a perfect mixture; but if allowed to stand, the heavier liquid, like chloroform, will sink to the

* *Medical Times and Gazette*, March 17th, 1877.

† *London Lancet*, January 8th, 1876.

bottom, and if the bottle is not well shaken each time when used, the patient is apt, during the conclusion of a tedious operation, to receive the chloroform almost pure. The combination of nitrous oxide with ether had been carried out in England for many years, and we have given a description of Clover's apparatus, with his careful directions for use. Then we have the useful inhaling apparatus of Dr. Buxton, of London, with a reference to that of Drs. Silk and Hewitt; also that of Drs. Codman and Shurtleff, of Boston. Another convenient attachment has been arranged by Dr. A. M. Long, by which the nitrous oxide gas is condensed into a liquid, and then mixed with ether, drop by drop, in a combining chamber. This apparatus has been employed, to a limited extent, at the Philadelphia Dental College, combining from twenty to thirty drops of ether to five gallons of the gas. It is well known that both nitrous oxide gas and ether are stimulants, and this combination should never be given to persons of full habit or flushed face, for fear of overaction of the vessels of the brain, producing convulsion or apoplexy. Mixtures of chloroform and nitrous oxide, or chloroform, alcohol and nitrous oxide, in the proportions of from five to six drops, to five gallons of the gas, have been employed; but the fear is, that unscrupulous persons would not limit themselves to this quantity, but would use a larger proportion, running the risk of destroying their patient.

We have already given our opinion of preparatory anæsthetic combinations of various agents to disguise the taste and smell of the anæsthetic, under bromide of ethyl, and would advise all persons administering anæsthetics to be sure of the agent they employ, so as to be able to counteract any dangerous element.

A mixture of nitrous oxide and ether vapor would explode on contact with flame or even a spark. It would not be spontaneously explosive, and would not be more dangerous than a mixture of ether vapor and air.

Oxygen Gas as an Anæsthetic.

Dr. Gray, of Richmond, Va., published in August, 1874, some observations regarding pure oxygen as an anæsthetic for short operations.

The Doctor made six experiments with the gas, the only test cases being in two patients. The first, a colored boy, took three gallons; pulse 80, respiration 24, temperature 98° F. In one minute and a half, the pulse rose to 104, very feeble and intermitting; patient profoundly unconscious. Dr. Wood extracted one root, a superior molar; no complaint whatever was made, nor was there the slightest evidence or symptom of pain. The remaining two roots were now quickly taken out, with a scarcely audible groan on the part of the patient. In two and a half minutes he was fully reinstated, and said he did not know when the tooth was taken out; that his first sensation "was pleasant," the last "like that other gas," alluding to nitrous oxide, which he had taken on a former occasion. He remained seated in the dental chair, and in ten minutes his pulse was 80, regular; respiration 16, temperature (interclavicular space) 101° F.

In the sixth experiment, Dr. Wood administered to Mrs. A. B. two gallons of the same gas, and while under its influence, extracted eight anterior inferior teeth (temperature, pulse or respiration not taken). The lady declared she "suffered no pain whatever."

These were the only minor surgical operations undertaken under the influence of the gas. In the other four cases, the true effects of the gas were manifest, *i.e.*, slight exhilaration, but no intoxication, lips and forehead purple, partial asphyxia, and in one case great cardiac excitement, differing from that of nitrous oxide gas, with which the gentleman was very familiar, having frequently inhaled it.

I feel satisfied from these experiments, and those of Pflüger and others, reported by Prof. Carpenter, that pure oxygen gas is not a true anæsthetic. He states: * "The respiration of pure oxygen for short periods, seven to seventeen minutes in man,

* Effects of respiration of pure oxygen. Carpenter's "Principles of Human Physiology," 1876, p. 403.

produces no effect either in the rapidity of the pulse or upon the temperature of the body, and scarcely any more of this gas is absorbed, than under ordinary circumstances, which, as Pflüger has shown, is owing to the fact that arterial blood is charged, normally, with nine-tenths of the whole amount of oxygen it can take up. In small chambers the whole of the oxygen is used; but if the chamber be large, the amount of carbonic acid produced proves fatal before the complete consumption of the oxygen. Thus, Bert observed that when an animal was placed in an atmosphere of pure oxygen, with no provision for the removal of the carbonic acid eliminated, death took place when the proportion of this gas amounted to from twenty-six to thirty per cent., although the quantity of oxygen (seventy to eighty per cent.) was still found; when all the carbonic acid eliminated was removed, death occurred in mammals when the amount of oxygen had fallen to two per cent., and in birds when it was reduced to between three and four per cent. He further found, that animals made to breathe oxygen at a pressure of five or six atmospheres, or which are exposed to ordinary air at a pressure of twenty atmospheres, fall into violent convulsions, which last, even after the pressure has been reduced to the normal. It would therefore appear that the oxygen, in entering the body at this high pressure, forms one or more compounds with some of its constituents, acting like strychnia."

Nitrogen and hydrogen may be considered as indifferent gases, proving fatal in a state of purity by permitting the accumulation of carbonic acid in the blood; as the carbonic acid replaces the oxygen, patients become livid, and to every external sign utterly insensible. All the true anæsthetics produce more or less asphyxia, but must have another property, that of producing exhilaration or intoxication.

Having read with pleasure the experiments of Dr. A. H. Smith, of New York, on oxygen gas, I addressed him a note, and received an answer, a part of which is as follows:

"In all my experiments with oxygen, and I often gave it very freely, I never observed any anæsthetic effect. I have no means of referring to Dr. Gray's article, but I suspect that in cases in which anæsthesia has been observed while oxygen was being inhaled, it was due to a number of very deep inspirations, succeeding each other rapidly, which we all know will produce a slight degree of anæsthesia, even when common air is respired. I have often breathed pure oxygen for several minutes at a time, without experiencing anything more than a slight sensation of pressure or weight above the eyes; a few patients have complained of slight giddiness."

As some persons might desire to test for themselves oxygen gas, either with nitrous oxide or alone, as an anæsthetic or therapeutic agent, I am enabled, through the kindness of S. S. White & Co., to show the complete apparatus which they now manufacture for the use of dentists and physicians.

Pure Oxygen and Apparatus for its Therapeutic Administration.

The value of pure oxygen in the treatment of various diseases, has been generally admitted by the medical profession, but the difficulties of proper generation and convenient administration, have heretofore been serious obstacles in the way of its general use. At the solicitation of a number of medical practitioners interested in the therapeutic uses of oxygen, S. S. White & Co. have devised an apparatus for its administration, both by inhalation and by enema, which overcomes all the difficulties formerly encountered, and which will, we believe, meet all the requirements of safe transportation, easy keeping and convenient administration.

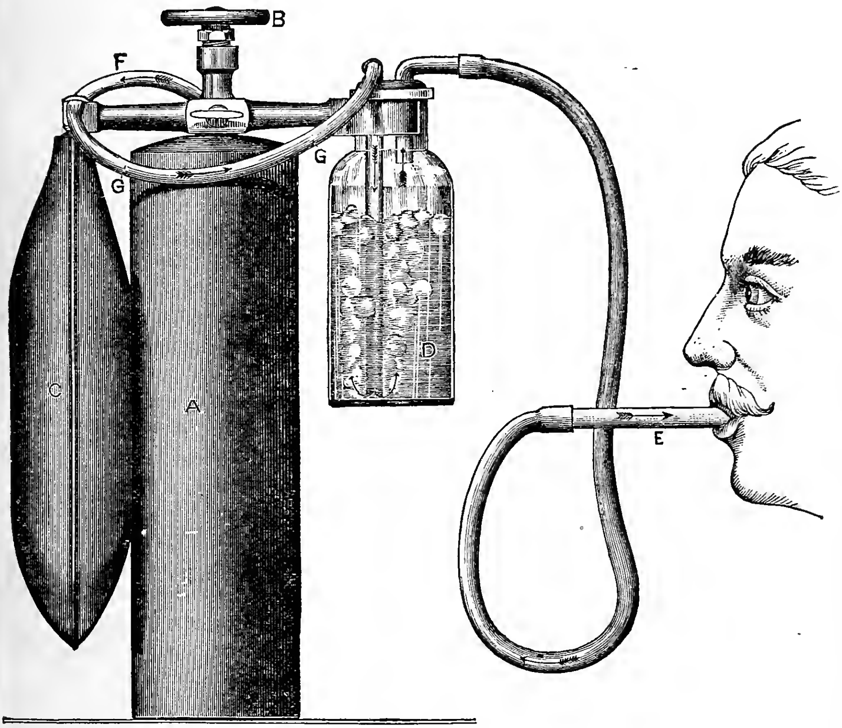
In both of these apparatuses, the administration is absolutely under the control of the operator in charge, and we believe they will be found to be the most convenient and economical on the market.

The Inhalation Apparatus, it will be seen (Plate 18), is a modification of the nitrous oxide apparatus, to adapt it to the needs of oxygen exhibition. A, represents the cylinder filled with compressed oxygen; B, the gas-valve; C, a rubber bag, holding three pints; D, a wash-bottle half-filled with water;* E, a

* The wash-bottle serves several important purposes: indicates how fast the gas is flowing; calls attention if the valve of the cylinder be not closed tightly; arrests any dust that might be carried from the cylinder or from the interior of the tubing or bag; and moistens the gas, thus preventing its absorbing moisture from the throat and air-passages.

mouth-piece attached by a rubber tube to the bottle; F, a rubber tube connecting the rubber bag to B; and G, a rubber tube connecting the bag to the wash-bottle by means of a glass tube which extends nearly to the bottom of the bottle.

Plate 18.



INHALATION APPARATUS.

In using the apparatus, arrange the parts as shown in the cut, being careful to place the leather washer properly at the outlet of the valve B, and half fill the bottle D, with water. Open the valve B, *very slowly and cautiously;* the oxygen will then flow through the tube F, to the gas-bag C. When the bag is filled, the valve B, may be closed and the apparatus is ready for use. If the valve B, is opened too much, a portion of the gas may rush by the bag, and forcing its way through the water, be lost; to correct this it is only necessary to partially close valve B. In administering the oxygen by the lungs, the usual practice is to cause the patient to inhale very slowly from three to four gallons.

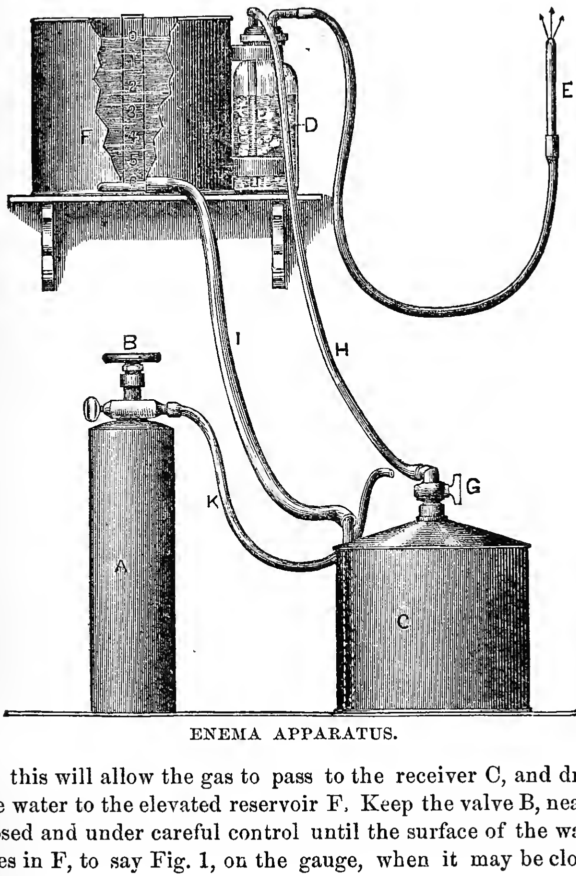
Cylinders are furnished containing forty or one hundred gallons of pure Oxygen Gas, or a mixture of Oxygen and Nitrous Oxide in definite proportions respectively, of 20 per cent. and 40 per cent. of Nitrous Oxide.

Cylinders containing pure Nitrous Oxide Gas are painted *black;* those containing pure Oxygen, are painted *red.* Oxygen cylinders containing twenty per cent. of Nitrous Oxide, are painted *black*, one-fifth of their length, the remainder red; those containing forty per cent. of Nitrous Oxide, are painted *black* two-fifths of their length, the remainder red.

Administration of oxygen by enema is a later suggestion. In some diseases, this method is more effective in results than when the gas is administered by inhalation, and it promises a considerable range of usefulness.

The cut (Plate 19) shows the enema apparatus, as set up for use,—the receiver C, having been previously filled with oxygen, —in which A, represents the cylinder; B, the gas-valve; C, the gas-receiver; D, the wash-bottle used to moisten and warm the gas; E, a syringe-point; F, a water-tank or reservoir, provided with a measuring gauge on its side; G, a stopcock on the gas-receiver; H, a rubber tube, serving a double purpose as below described. To put a new apparatus in use, place it as shown in the cut, the vertical distance between the supports for the two metal cans being about 22 inches. Proceed first to expel the air from the gas-receiver C, then to fill it with oxygen from the gas-cylinder. To accomplish this, disconnect the tube H from the cock G, and having opened G, pour water slowly into F, allowing it to pass through I into C, until it appears at G. Close G, and continue the operation until the surface of the water rises in F, to Fig. 5, on the gauge. Place the yoke connection over the valve B, on the gas-cylinder, as shown in the cut, being careful to put the leather washer in its proper place about the gas-valve opening. Reconnect the rubber tube H, to G, and change its upper end from the wash-bottle D, to the gas-yoke. Open G, full, and then *very slowly* and *cautiously* open

Plate 19.



ENEMA APPARATUS.

B; this will allow the gas to pass to the receiver C, and drive the water to the elevated reservoir F. Keep the valve B, nearly closed and under careful control until the surface of the water rises in F, to say Fig. 1, on the gauge, when it may be closed entirely, as the water will continue to rise after the gas is shut off. As soon as the water in F, ceases to rise, close G, and replace the tube H, in the position shown in the cut. The wash-bottle D should now be half filled with water at a temperature of 110° to 120° Fahrenheit, when the syringe-point E, may be inserted in the rectum of the patient and the stop-cock G slowly opened. The oxygen will now pass through the warm water to the patient, and when the surface of the water in the reservoir has fallen one division on the gauge, one quart will have been administered, which is the quantity usually given.

The flow of gas may be stopped by closing G, and the gas remaining in C, retained; it being necessary to refill it from the cylinder only when the water in F, has fallen to Fig. 5, on the gauge. As the surface of the water in F, falls, it may be advisable to set the reservoir a few inches higher, to obtain the requisite pressure on the gas.

Caution.—Special care is required in beginning the administration of oxygen by enema, to avoid the distress caused by a too rapid flow of the gas. It should be permitted to bubble through the water in the bottle very slowly. This is accomplished by opening the stopcock G, very gradually, so as to permit only a gentle flow. After a few administrations, no pain or discomfort will be experienced.

Oxygen Gas.

The best formula for preparing oxygen gas for practical purposes, is that suggested by Fresenius: *

℞	P. Potass. chlorat., Squibb's or Merk's	lbs. iv.
	P. Manganesii dioxid., best imported cryst. . .	lb. i.
	P. Ferri carb. prec.	℥ ij.
M.		

S.—To be well mixed and triturated, avoiding violent friction, lest an explosion be produced. (With reasonable care, the liability to this accident is very slight.) The prepared material should be thoroughly desiccated, by being exposed to moderate heat in an open oven, or by means of a chemical drying-chamber. Store in any receptacle which will protect it from moisture, until wanted for use.

* Bulletin Practical Results. The American Oxygen Association, New York.

The best retorts are made either of brass or iron. Copper oxidizes more rapidly, besides requiring an increased degree of heat. The conical shape, with broad bottom, is much superior to the old-fashioned flat or pear-shape, the evolution of gas from the latter being tumultuous, and less under control. For making more than thirty or forty gallons at an effort, the cylindrical form of retort is still more preferable. With the latter form, the process is entirely under control.

"In opposing the views of those who believe the inhalation of oxygen to be dangerous on account of its activity in chemical combustion, Demarquay, states, that he, himself, his friends, his pupils, and large numbers of his patients, have inhaled from ten to thirty litres (2½ to 10 gallons) of the gas at a time, without experiencing the slightest injury. . . . Its effect on the various sensations is but slightly marked, except in case of nervous subjects."—*Dr. J. Solis-Cohen.*

"Demarquay refers much of the objectionable results, formerly attributed to oxygen, to certain impurities with which it became contaminated in the methods of preparation, an objection to its use, which no longer exists under the improved methods of obtaining the gas in its pure state."—*Idem.*

"Demarquay, as the result of his extensive clinical experience, recommends inhalations of oxygen in all chronic affections associated with debility, dyspepsia and anæmia, the enumeration of which it is useless to repeat."—*Idem.*

Both in the preparation of debilitated patients to undergo serious operations, and in the treatment of protracted suppuration, and other depressing conditions after operation, inhalations of oxygen were found of great efficacy."—*Idem.*

"Pure oxygen, contrary to the general belief, can be inhaled for several hours without being detrimental to health; its action is antagonistic to that of chloroform; it is a powerful remedy for the disagreeable accidents arising from chloroform and other anæsthetics; and in asphyxia, from poisonous gases—as, for instance, from carbonic acid—it exercises, likewise, a beneficial influence. . . .

"Every patient awakening from a chloroform narcosis should inhale oxygen, in order to rid himself of headache and other inconveniences, following the administration of that anæsthetic." —*Ducroy.*

"A young man attached to the laboratory of the New York Medical College became asphyxiated from the inhalation of the vapor of chloroform; and so far had its effects been carried that he became pulseless, and all hopes of his resuscitation abandoned; and as all the usually recommended remedies had been tried without success, nothing but the death of the young man was looked for, when I proposed, as a *dernier resort*, the application of pure oxygen gas, as the only chance by which resuscitation could be brought about; but at the time, the proposal met with opposition from the medical men present, who were anxiously watching what seemed to be the expiring efforts of the poor boy, expecting each moment to be his last. Having, however, consented, the gas had not been more than a few seconds applied to his nostrils, when he who was apparently beyond the help of human skill, and absolutely *in articulo mortis*, arose and placed himself upon a chair, proving most conclusively how correct I was in proposing the application of oxygen gas as a remedy against the deleterious effects of chloroform as an anæsthetic."—*Dr. Simeon Abrahams.*

"Dr. Const. Paul reports a case of opium poisoning in which the gas was successfully used after atropia had failed, and when the patient appeared to be dying, and another in which it was successfully employed in narcosis from charcoal gas."—*Rankin's Abstract, XLVIII.*

"Sieveking reports two cases of restoration by oxygen, in poisoning by carbon."—*The Lancet,* 1869.

"It is my firm conviction that oxygen will do in croup all that can be done by tracheotomy, although neither the one nor the other is competent to undo the mischief wrought by severe and prostrated dyspnœa."—*Dr. Andrew H. Smith.*

"Biegel believes that in children predisposed to phthisis, the inhalation of oxygen would delay or even prevent the outbreak of the disease; and that even after their development of the affection, inhalations of the same sometimes render astonishing services."—*J. Solis-Cohen.*

"In one case of undoubted incipient phthisis, the inhalation of oxygen certainly warded off the threatened disease, and gave the patient renewed vigor, as evinced by increase in nutrition, renewal of vital buoyancy, and restored powers of physical endurance."—*Idem.*

"It has been used with more or less success in the treatment of many constitutional diseases: diabetes, albuminuria, syphilis, scrofula, scorbutus, gout, boils and carbuncles, torpid and gangrenous ulcers, neuralgias, epilepsy, paralysis, atonic and fatty diseases of the heart, dyspepsia, in valvular cardiac disease, and also in pneumonia, capillary bronchitis and some other acute affections."—*Idem.*

"Dr. Lasukewitch, examining the physiological action of oxygen, insists upon the following points:

"1st. Pure oxygen is absorbed by the blood in far greater proportion than the oxygen of the air.

"2d. Inhalations of pure oxygen produce an augmentation of the daily excretion of urea.

"3d. At the same time they augment the temperature of the body from 0.2° to 0.9° C. (0.36° to 1.6° F.)

"4th. They modify the pulse by increasing its fulness.

"5th. They diminish reflex activities.

"6th. They augment the secretion of urine.

"Passing to the therapeutic applications of oxygen, the author sets forth that he has had eight successes and six failures.

"Oxygen shows itself inefficient in paralysis agitans, in meningeal myelitis, in ataxia, in chorea. It has given excellent results in the following cases:

"1. In a grave case of hystero-epilepsy the inhalations invariably arrested the onset, produced calm sleep, ameliorated the general state, and finally, after two weeks of treatment, brought about a cure, either permanent or at least temporary.

"2. In a case of hysterical hemiplegia, inhalations for a single minute succeeded in dispersing the symptoms.

"3. In a severe case of hysterical convulsions, the hysterical excitement following a severe moral [mental?] shock, inhalations of oxygen lasting one minute, and frequently repeated through the day, have not only arrested the attacks, but have resulted in complete cure.

"4. In a case of severe spasmodic cough at the beginning of pregnancy, the inhalations immediately arrested the cough, and cured the patient in the course of two days.

"5. In a case of hydrophobia, the inhalations very much modified the paroxysms, but did not succeed in averting a fatal termination.

"6. In a case of syphilitic affection of the marrow, with exaggerated muscular excitability, all the symptoms subsided after three days' treatment.

"7. In a case of bronchial asthma recurring with each menstrual epoch, oxygen very happily modified the trouble.

"In locomotor ataxia, Uspensky, obtained diminution of the pains, and improvement in co-ordination.

"In pleuritis, Afanasieff, has experienced two successes with oxygen.

"In the inveterate vomiting of pregnancy, Tschaudnowsky has obtained excellent results.

"In bacillary phthisis, Albrecht, has employed inhalations of oxygen, and has obtained an augmentation of body-weight, and a diminution of dyspnœa.

"In Asiatic cholera, Tronchin, has used oxygen inhalations, and has noted a marked and constant betterment of the general state of the pulse."—*La Therapeutique Med. et Chirurg., Paris,* 1887.

"Dr. Loyssel, has experimented with pure oxygen, and from it has obtained very good results. He concludes:

"1st. That in certain poisonings, such as those by chloroform, ether, opium, sulphuretted hydrogen, carbon dioxide, cyanhydric acid, oxygen constitutes the only means of recalling the patient to life, when all else has failed.

"2d. That its presence in the operating room is certain protection against fatal accidents from the use of anæsthetics.

"3d. That it succeeds equally well in asphyxia, caused by strangulation, by immersion, by toxic gases, etc., as well as with the new-born, in condition of apparent death.

"4th. Life can almost, with certainty, be maintained in all cases where respiration has not entirely ceased, even if there are long intervals between the inspiratory efforts.

"5th. If the respiratory and circulatory functions have been completely arrested for a short time, they may be re-established by means of oxygen, which it is necessary to administer with perseverance, even when it is believed that all efforts will be useless. There are reported many cases of drowned persons, and of children apparently dead, who have been saved, thanks to persistence in administering oxygen.

"6th. Oxygen may be inhaled in notable quantity without the least danger."

"Holstein, affirms, that oxygen diminishes or hinders in marked manner the exaggeration of the reflexes."

"Favr, (Vratch, No. 13, 1885,) has published two cases of puerperal eclampsia, where oxygen has been inhaled with complete success."—*La Therapeutique*, 1887.

"*Oxygenated Water* occupies the third rank in the list of antiseptics, according to Miguel; the binoxide of mercury and the iodide of silver alone being more active. As this (oxygenated water) is neither irritant nor toxic, it can replace in surgery, those agents which present these objectionable properties.

"Dugardin Beaumetz, employed it with success internally in grave cases of anorexia.

"Dayton, who has experimented with peroxide of hydrogen, concludes, that it is an energetic deodorant, a powerful antiseptic; that it is indicated in a vast category of maladies where the mucous membranes are affected. Employed in irrigations, it is superior to all other substances.

"At the present day there is a tendency to attribute to the presence of peroxide of hydrogen in the air, the immunity from pulmonary affections enjoyed by persons dwelling in the vicinity of pine forests."—*The Medical Age.*

PART THIRD.

ALCOHOL, U. S.

CHAPTER XIII.

Alcohol, different Kinds—The Alcohol recognized by U. S. Pharmacopœia—Absolute and Dilute Alcohols—The Alcohol in Whiskey, Wine and Brandy—Amylic Alcohol—The Toxic Action of Alcohol—In Moderate Doses the Action of Alcohol on the Heart—Heat-producing and Waste-preventing Action of Alcohol—Physiological Action of Alcohol—Alcohol as an Anæsthetic—Views of Richardson, Link and Others—Toxicology—Treatment of Acute Alcoholic Poisoning.

THERE are at least a dozen different kinds of alcohol. Nine are liquid, as methyl alcohol, ethyl and amyl, etc.; the other three alcohols are not liquid, being waxy, such as melyssyl, etc.

The U. S. Pharmacopœia, recognizes alcohol containing 94 per cent. of absolute alcohol, and having the specific gravity of 0.820, and alcohol dilutum, (dilute alcohol), containing 53 per cent. of alcohol, and having the specific gravity of 0.928.

There is another alcohol which is termed absolute, and should be free from water, being very volatile, boiling at 172° F., not congealed by a cold of 166° F., and having the specific gravity of 0.796.

This alcohol is a chemical agent, producing cold by its evaporation, and acting powerfully on the peripheral motor nerves and the skin, as a local anæsthetic. In aural surgery it acts upon polypi, removing their watery constituents, and drying them up.

Alcohol is found to be the active agent in the officinal spiritus frumenti, or whiskey, and spiritus vini gallici, or brandy, which are obtained, respectively, by the distillation of fermented grain, and of fermented grapes, and should contain from 48 to 56 per cent. of absolute alcohol.

Another alcohol which is mostly used in this country, and European countries for adulterating, and contains much amylic alcohol, is made from Indian corn, potatoes, beets, wood, etc. It has a burning, acrid taste, an unpleasant odor, and is oily. It is of a dark brown color; but this is removed by filtering through lime, charcoal and alum.

Physiological Action.

It has long been recognized that when persons are under the controlling influence of alcohol, either in the form of wine, gin, whiskey or brandy, they may be cut, bruised, and bones broken, without expressing or experiencing much or any pain. These various agents were employed, as we have before stated, long before any true anæsthetic was discovered. Whiskey is still quite common in the hands of our railroad surgeons, and was and is resorted to alone, or in conjunction with chloroform.

When alcohol is inhaled, its effects are developed in four distinct stages:

First Stage.—There is excitement, flushing of the body and dilatation of the pupils; after a time there follows languor, and the muscular movements become irregular.

Second Stage.—Muscular prostration and labored breathing, attended by deep sighing movements and rolling over of the body.

Third Stage.—Complete insensibility to pain, with unconsciousness to all external objects, with inability to exert any voluntary muscular power. The breathing now becomes embarrassed, and blowing, with bronchial râles, due to the passage of air through fluid that has accumulated in the finer bronchial passages. The heart and lungs, however, even in this stage, retain their functions, and therefore recovery will take place, if the conditions for it be favorable. Also, if the body be touched or irritated in parts, there will be a response of motion, not from any knowledge or consciousness, but from reflex action. During all these stages there is no violent convulsive action, but, step by step, a reduction of temperature; so at last, the loss of heat will become dangerous, for the cool body cannot throw off the water freely, and therefore fluid collects in the lungs, and there is a risk of suffocation, as from drowning. If the administration of the methylic spirit be continued, when the third degree has been reached, there is a fourth stage, which is that of death. The two remaining nervous centres, which feed the heart and respiration, cease simultaneously to act, and all motion is over. If, however, after the third stage of insensibility, the administration of the spirit be stopped, recovery from the insensibility and prostration will invariably take place, *on one condition*,—that the body be kept warm for seven hours.*

Alcohol as an Anæsthetic.†

In our "Manual of Anæsthetic Agents," first edition, published in March, 1878, on p. 18, it is stated that Dr. John Link, had long employed alcohol in the form of whiskey as an anæsthetic, alone, or in conjunction with chloroform, in numerous minor operations; but up to April, 1876, he had not tried it in a capital operation. He further stated that he should depend upon it exclusively in his next amputation of a limb. This, he states, in the pamphlet before us, did not occur in a satisfactory way until 1880. Up to this time he administered whiskey to the amount of from fourteen to eighteen ounces, or two ounces, in proportion to tolerance of the patient, at intervals of from two to five minutes, and chloroform to the extent of a few inspirations.

In his first case, he reported, a great shock was sustained in a railroad accident, by a brakeman, on the Indianapolis & St. Louis Railroad; whiskey alone was given. The amputation was down near the hip; also an operation on the foot,

* Richardson.

† Pamphlet of 8 pages. Prepared for the International Medical Congress. By John E. Link, M.D., Terre Haute, Ind., Chief Surgeon of the Vandalia R. R., etc., etc., etc.

through the metatarsal bones. The patient asked for water, and in other respects seemed rational during the operation, but died soon after from the shock. He then reports four cases, with details of temperature, pulse, etc.,—amputation of right arm, right foot, secondary of two left legs. He states these are given in detail as typical cases. If left to choose between whiskey and chloroform, alcohol would be his preference, administered rapidly, preserving a more normal or physiological condition of the system, than either chloroform or ether.

There is less drunkenness at the same stage of insensibility to pain with the former, than with the latter.

With alcohol we have hyperæmia of the base of the brain, as evidenced by the flushed face, and fulness of the features about the eyes, mouth and the lips, etc. His views are that it has a counteracting influence against shock, anæmia of the brain, from loss of blood, etc.

On page 8, Dr. Link, defends himself against the charge that such administration of alcohol leads to tippling and drunkenness. He knew of no one case where such had been the result, and, on the contrary, he might cite many instances where a repugnance and distaste for whiskey had been the result, even in those where an appetite for it existed previously, the very smell of whiskey, being associated with the operation and suffering.

Desiring to have the opinion of a gentleman who is, and has been for many years, one of the surgeons to one of the most extensive railroad companies in the United States, I submitted Dr. Link's pamphlet for his opinion, which we now publish, as the matter is of great practical importance:

"Huntingdon, Pa., November 21, 1887.

"*My Dear Doctor:*

"When in the city a few weeks ago, I promised to read the report of Dr. Link on 'Alcohol as an Anæsthetic,' and write you my experience with it. The promise I will try to redeem this afternoon, knowing full well that all I may say, will throw no new light on the subject.

"In regard to the report of Dr. Link, I must say that I cannot fully endorse his ideas, for the reason that he gives credit to the

'Alcohol,' which, in my opinion, at least, is partly due to the chloroform.

"Before administering chloroform to a patient I invariably give 2 to 3 oz. whiskey, with from $\frac{1}{3}$ to $\frac{1}{2}$ gr. morphia, place the subject on the table (in case of amputation), and see that *all* clothing is loose and the patient's head low; then on a towel or large napkin, folded in 4 to 6 plies, I pour on about ʒss chloroform, and allow the patient to inhale it slowly at first, adding ʒss from time to time, as required, until completely under its influence. In this way it is seldom that more than ℥ss is required in an ordinary amputation.

"If the patient does not go under the influence rapidly enough, I place my open hand over the towel, and exclude the air for a few inhalations, which always has the desired effect, when the hand should be removed. D. H. MILLER, M.D."

The late Valentine Mott, in his essay on "Pain and Anæsthetics," objects to those agents which are apt to disturb the stomach, and reports the following case:

"I well remember a case of amputation of the thigh which occurred a few years since in my own practice, where the attending physician, notwithstanding repeated cautions, administered brandy to the patient so freely as to induce vomiting, thus interfering with the continuance of the reaction, and inducing a fatal result. It was an extensive cannon shot of the knee-joint, and the operation was performed on the third day from the injury, before the collapse had sufficiently passed off."

These various alcohols have all a toxic action when given in sufficiently large doses. The general effect they produce on the organism is paralysis, affecting the nerve-centres in the inverse order of their development. Their lethal power and the symptoms they produce are modified by the physical characters and the quantity administered.

Yet, it has been found that in moderate doses, alcohol caused great increase in the rate and force of the cardiac beat, and corresponding rise of the arterial pressure, and that these phenomena were not affected by previous division of the pneumo-gastrics, of the accelerators or of the spinal cord. There is also, in these small doses, a sensation of warmth, and an increase of heat, while in very large doses there is a fall of temperature, from an increase of oxygen consumed and of carbonic acid eliminated. The exhibition of alcohol has been found to lessen the excretion of urea or tissue waste, while it increased bodily weight. Alcohol is a most valuable remedy in typhoid fever and diphtheria.

Toxicology.

Cases of acute alcoholic poisoning occur during every few months by persons drinking very large quantities, and more especially young persons. The treatment consists in the evacuation of the stomach, keeping the body warm, and the use of the alternate hot and cold water bag of Chapman, while keeping the person in active motion, by rubbing six or seven hours.

Strychnine in Alcoholism.

From experiments, we feel justified in drawing the following conclusions: 1. Strychnine undoubtedly neutralizes the intoxicating and narcotic effects of alcohol. 2. It enables large quantities of alcohol (when necessary) to be taken for a considerable stretch of time, without causing the usual organic lesions which follow the use of alcohol alone. 3. There are, however, limits beyond which the alkaloid itself becomes injurious to the organism. 4. Therapeutically, strychnine should be used in all forms of alcoholism. 5. It may be regarded as a powerful prophylactic against alcoholism.

CHAPTER XIV.

ETHER.

Manufacture—Chemical Reaction and Composition—Tests of Purity, Inflammability—Ether Fortior—Dr. Squibb's Ether—Tin or Glass in Preserving Ether—Inflammability of Ether—Influence of Ether on the Brain and Pulse—The Ordinary Method in use for the Administration of Ether: Towel, Cone—Precautions to be employed before and after using Ether, and Treatment of Dangerous Symptoms.

Ethyl Oxide, Ethyl Ether, $\left.\begin{matrix} C_2H_5 \\ C_2H_5 \end{matrix}\right\} O$.

THIS body, commonly called "ether," is manufactured on a large scale by heating a mixture of strong alcohol and concentrated sulphuric acid to 140°. The reaction takes place in two stages: in the first, ethyl sulphuric acid and water are formed:—

$$\left.\begin{matrix} C_2H_5 \\ H \end{matrix}\right\} O + \left.\begin{matrix} H \\ H \end{matrix}\right\} SO_4 = \left.\begin{matrix} C_2H_5 \\ H \end{matrix}\right\} SO_4 + \left.\begin{matrix} H \\ H \end{matrix}\right\} O.$$

The ethyl sulphuric acid acts at 140° upon another molecule of alcohol; hydrogen and ethyl change places, and ether and sulphuric acid are formed:—

$$\left.\begin{matrix} C_2H_5 \\ H \end{matrix}\right\} SO_4 + \left.\begin{matrix} C_2H_5 \\ H \end{matrix}\right\} O = \left.\begin{matrix} H \\ H \end{matrix}\right\} SO_4 + \left.\begin{matrix} C_2H_5 \\ C_2H_5 \end{matrix}\right\} O.$$

The ether and the water produced are distilled off, whilst the sulphuric acid remains behind, ready to convert another quantity of alcohol into ether.

The Physical and Physiological Properties of Ether.

Ether is colorless, very volatile, inflammable, both it and its vapor, which latter is twice as heavy as ordinary air, and sinks therefore to the floor, which is important to remember when a light has to be used, or a heated metal. It is soluble in alcohol; its odor is garlic-like, strong and pungent. Its taste is hot, slightly soluble in water. Ether must be kept in the dark and in well and carefully prepared tins (see reasons by Dr. Squibb). When in ordinary use, keep in the bottle of Dr. Roberts (Plate 21, page 228); for if kept in a hot place or in the tropics, it is apt to change by absorption of water, undergoing decomposition and developing acetic acid, making it unfit for inhalation.

The following are some of the methods of determining if the ether is pure: *

1. Ether, if pure, forms a clear mixture with oil of copaiba; but if it contains water or alcohol, an emulsion will result.

2. Water is detected by adding tannin; for when water is present, the mixture becomes syrupy, while, if absent, the powdered tannin remains unchanged.

3. Alcohol, if present, gives a red stain with crystals of fuchsine; it also increases the specific gravity.

4. Acids sulphuric and sulphurous are detected by the precipitates they give with barium chloride; also an acid which produces a deep red color upon the addition of an iron salt.

5. Fusel oil may be detected by leaving a greasy stain on paper.

When inhaled, it produces a burning and choking sensation—in some almost suffocation—from the vapor uniting with the fluids. If inhaled freely, mixed with air, it produces intoxication with roaring and buzzing in the ears, varying in its effects upon different individuals. In some persons it causes depression, with weeping; others, elevation of spirits, indicated by shouting, laughing, singing; others disposed to fight or strut about declaiming, imagining themselves upon the stage. When still semi-conscious, there is a feeling as if one's immediate surroundings were afar off, with visions and illusions. In this first stage the patients will open their eyes, and a slight noise or loud talking will arouse them.

* Buxton.

If now all air is withdrawn, and the patient breathes deeply and long, it brings about sooner or later the second stage of complete unconsciousness or ether narcosis; but still there is muscular rigidity. As soon as this passes off, the complete anæsthetic stage takes place, when the patient lies quiet, with slow and regular, automatic respiration, and the arm, when elevated, will fall as if paralyzed, and the eye, if touched, will not wink. Now and then we have a slight stertor in the breathing. Now is the time for operation and the partial withdrawal of the ether, giving the patient air at intervals, but sufficient ether to keep him fully under its influence by the combined vapor.

Deep, stertorous respiration, due to paresis of the muscles of the palate, should be the signal for allowing air to mix with ether vapor or for the entire withdrawal of the anæsthetic. The usual appearance of the face of the patient during etherization is reddish, lips especially; if marked pallor and lividity should show themselves, indicating failure of heart action, the ether is to be stopped at once, and the feet of the patient elevated and the head depressed until the color returns. Another important sign of danger is what is termed shallow breathing; the respiration, from being slow and regular, becomes very much quickened, and then becomes slower and slower until it gradually ceases or intermits for long intervals. In such case, stop the inhaler and admit cold air, or apply the vapor of aqua ammonia to the nose; or the application of a wet towel, wrung out of cold water, applied to the uncovered chest with some little force, will generally cause the patient to make a sudden gasp, and rouse the respiratory function to action. If these measures fail, then resort must be had to artificial respiration and the prevention of great reduction of heat, as the lungs are the chief eliminators, the kidneys only doing a part, and yet if they are diseased, it is apt to produce great distress and may be the cause of death.

The ordinary method in use of the administration of the second discovered anæsthetic, namely, washed ether, is as follows:

An inhaler is made by folding a towel into a large cone, or bag, and then placing a coarse sponge, wrung out of hot water, in its apex. Ether is then poured upon it from a bottle—about two drachms to half an ounce at a time—and repeated, when necessary, by removing the cone from the patient's mouth to renew the supply of ether.

The lower part of the face, mouth and nose, are covered with the cone, so as to exclude most of the air, and allow the patient to fill his lungs, with more or less diluted ether vapor, giving it slowly, and with great care. After a time, there will be attempts to struggle, on account of the irritating nature of the ether, and the stimulating action of the drug, which are to be gently but firmly restrained, using as little force as possible, and only one or two inspirations of pure air allowed. In from three minutes to three and a half, complete quiescence usually follows, and the patient passes into a profound state of insensibility. One of the best tests of the patient being fully under the influence of the ether is when the conjunctival surface of the eye can be touched with the finger without producing winking. If the face becomes livid or very pale or gray in color, or the breathing much oppressed, the cone is lifted entirely away for a time, until these conditions disappear. In delicate persons, it is well to notice any unusual slowness, or intermittence of the respiration and pulse. The second test is, if the arm be raised, it will generally fall, as if paralyzed. As soon as complete anæsthesia is established, if it is a prolonged operation, the cone is taken off the face at intervals, that he may take a few inspirations of air, keeping up the condition with less ether.

The functions of the cerebrum or brain are first affected, before those of other portions of the nervous system. After a more prolonged inhalation, the anterior or motor centres soon fail to respond to mechanical irritation, yet the functions of the medulla oblongata are performed.

If the inhalation of ether is still further carried on, the sensory and finally the motor functions of the medulla oblongata are involved, and death occurs from a paralysis of the respiratory centres and heart. Louget states, that he found the sensory functions abolished very early, but he has never failed in any stage of the narcosis from ether, to get a response from the anterior part of the cord, by employing powerful galvanic currents.

Pulse Tracings under Ether, by Morgan, of Dublin.

Plate 20—(Figs. 1-8).

Fig. 1.

Fig. 2.

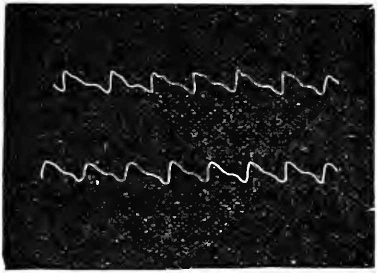
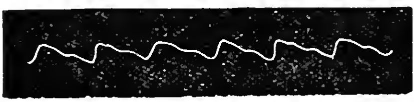


Fig. 1 represents the pulse of a female patient, aged twenty-five, who had been confined to bed for five months; pulse writing taken before etherization.

Fig. 2 represents it during its full influence. It will be seen that the heart power indication was rather stronger during etherization than before.

Fig. 3.



Another instance of a female, aged seventeen, also long confined in bed. The contrast of Fig. 3, taken before ether-

Fig. 4.

ization, and of Fig. 4, during profound etherization, is notable;

the elevation of the pulse line, showing the stimulating property of the ethereal influence.

Fig. 5.

Fig. 5 represents the excited pulse writing of a small and nervous female, previous to etherization and operation.

Fig. 6.

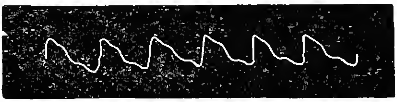


Fig. 6 represents the pulse writing of the same patient when steadied by etherization. The contrast is remarkably favorable.

Fig. 7.

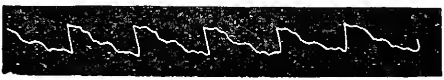


Fig. 7 represents the pulse writing of a healthy young man of twenty-two, previous to operation for artificial pupil—an affection which had not interfered with his general health.

Fig. 8.

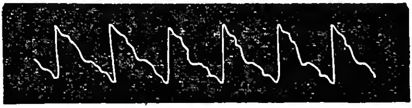


Fig. 8 represents the same when taken under full etherization, and after the completion of the operation. A comparison of this pulse writing with that of the natural soft pulse, will be ample evidence of the safety of etherization in its action on the heart.

Precautions to be Employed before and after using Ether as an Anæsthetic.

Ether should not be inhaled immediately after a full meal; indeed, it is better to take only a biscuit, or cracker, and a glass of wine or a teaspoonful of brandy and water, or a scruple of bromide of potassium in water, half an hour before, always avoiding for several hours previous the risk and annoyance of a full stomach. Nothing like solid food should ever be allowed a feeble patient before inhalation, for twenty-four hours. If nourishment is necessary, let it be of a liquid character, like beef tea, as solid food, not digested, has been the cause of death, in more than one person.

Perfect quiet should be enjoined on all around the patient, as noises, or even loud talking, interfere with the perfect and rapid action of the anæsthetic. Nothing like a tight band or garment should prevent the free action of the throat, chest, or interfere with the muscles of respiration. False teeth should always be laid aside until after the inhalation is over.

An examination of the kidneys should always be made before using ether, as they are the active agents in eliminating ether from the blood, and if they are unable to perform this office, and if the skin is cold, moist and inactive, death will supervene by accumulation of mucus in the lungs, or congestion of the brain, as in true Bright's disease of the kidneys.

Avoid all excitement to the patient, from fear, sight of instruments, too many spectators, etc., all of which tend to induce shock. Have appliances for resuscitation at hand, and plenty of fresh air during the administration of the anæsthetic. In ether the respirations and heart need to be watched, during and after anæsthesia, and also prevent the reduction of temperature by hot bottles of water, etc., in the later stages of narcosis from ether.

Dr. Hobart A. Hare, (*University Medical Magazine*), advises that where there is embarrassed respiration, or temporary suspension of the inspiratory effort during the administration of ether, that in place of resorting to flagellation with towels wet with cold water, a little ether poured upon the belly will cause, by the cold, such a shock as to produce deep inspiration.

The boiling point of pure ether is 95° F.

A test-tube filled with it and held in the warm hand, should boil on the addition of fragments of broken glass. In hot countries, like India and our Southern States, or in the close wards of a hospital, if preserved in imperfectly stoppered bottles, ether will absorb oxygen, and forms acetic acid, becoming impure, and is therefore unsuitable for inhalation. Glass is not a good material for holding ether, because it is so fragile and so liable to accident, and ether, when spilled, is so dangerously inflammable.

Dr. Squibb has seen ether take fire at a measured distance of fifteen feet between the source of the escaping vapor and the source of fire. In his experience of thirty years he could recall five disastrous fires, involving many lives and serious injuries, and over a million dollars' worth of property, which were traced directly to the breaking of bottles of ether. No method of using strong ether or transporting it from far or near distances can be compared to soldering it in tin; it is thus preserved in a perfect condition.

The stud is as easily removed as a cork or stopper, and leaves a smooth neck to be fitted with a cork.

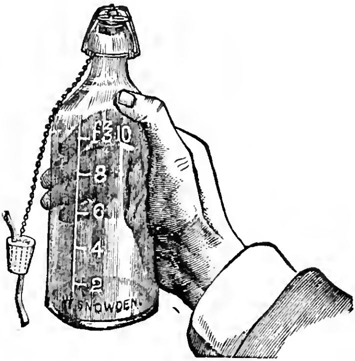
Even well-stoppered glass bottles do not retain the ether fortior, or stronger ether, of the Pharmacopœia of 1882. The shelf or closet in which it is placed, always smells quite distinctly of the ether; and it has been found, by accurately weighing a tray containing 50 one-pound bottles well stoppered, so as not to leak perceptibly, when laid on their sides for any length of time, that they lost at the rate of about 2 ounces per month, during a year. Again, a leaky stopper cannot be detected, unless the liquid escapes at a rate faster than it can evaporate.

Corks do not secure ether any better, nor as well, as glass stoppers, because if the ether be of full strength, the cork shrinks and becomes too small for the bottle, by absorbing all the water from the cork. The cork is very good for temporary use.

The Polyclinic Never-Leaking Ether Bottle.

Dr. John B. Roberts, of this city, after using, with varying degrees of dissatisfaction, tin cans with corks and ground-stoppered bottles in cases, finally had made a graduated white glass bottle, with rubber stopper and wire-spring clamp, like that used for sealing effervescent drinks. These bottles, being made of strong glass, are not broken by rolling in the bottom of the carriage, nor by being carried in a bag with steel instruments; no leakage is possible; the stopper cannot be blown out, nor is it liable to stick and become immovable. The bottle is always quickly and easily opened by pressure with one thumb on the lever-like clamp, while its shape allows the ether to be rapidly and completely poured out. Its transparency and the graduation blown in the glass, enable the surgeon to know at a glance how much ether he has on hand. A cork, perforated by two small tubes, is attached by a chain, and is to be inserted, when the anæsthetic is poured out in small quantities. Dr. Roberts uses it thus, with satisfaction, at the Polyclinic, St. Mary's Hospital, and the Pennsylvania Hospital. If the rubber stopper becomes worn out or softened, it can easily be renewed, without changing the spring clamp. These ether bottles can be obtained from Mr. Snowden.

Plate 21.



Inflammability of Ether.

Four accidents have come to our knowledge, in which the ether was ignited, and, although causing no actual injury, produced much fear and confusion. The first, was where a bottle of ether was accidentally broken and ignited, while Dr. William Hunt was operating, during the night, at the Pennsylvania Hospital. The second occurred, while Dr. William H. Pancoast was applying the actual cautery to a patient at the Jefferson College Hospital clinic, during the day.

In a letter to the author from H. C. Yarrow, A. A. Surgeon, U. S. A., he states that a case of ether taking fire from the galvanic cautery occurred to Dr. Huntington, Surgeon, U. S. A., and himself at the Soldiers' Home, Washington, D. C., during an operation for the removal of a cancerous growth on the temporal region by means of the galvano-cautery. The patient being under the influence of ether, the vapor became ignited by contact with the heated platinum wire. No injury resulted beyond a slight scorching of the patient's hair, but the accident shows the necessity for great care in the use of ether operations with the galvano-cautery.

The practical safety of ether vapor, when near a flame or a heated wire, is doubtless, partly owing to the fact that the air cooled by its evaporation establishes a downward current. This is due to the greater density of ether *vapor*, for whilst the ether itself has a specific gravity of .728, its vapor has 2.568 for its specific gravity; and this fact may be readily noted by observing the downward currents of vapor when pouring from one bottle to another.

The ether which is employed in Philadelphia by its chief surgeons in private practice, and, indeed, throughout the United States, is that manufactured by Dr. E. R. Squibb, of Brooklyn, New York, but the objections to it are, that it is of higher price, and is almost free from water, resembling chloroform, therefore the more dangerous for use in the ordinary quantity; it is also more apt to produce irritation if used too freely, causing cough and spasm. This may be obviated by moistening with warm water the sponge in the paper and towel cone, or inhaling apparatus, or by diluting the vapor before use with air.

The following correspondence between the writer and Dr. Squibb, will give his opinion in regard to the character of the ether, which is so much in demand:

PHILA., Feb. 7, 1881.

DR. E. R. SQUIBB, Brooklyn, New York.

My Dear Doctor,—On Wednesday next, Dr. John B. Roberts will read a paper before the Phila. Co. Medical Society on "Ether Deaths," when I shall be happy to see you—if you feel it of sufficient importance to be present—a personal experience in *four cases* of death from anæsthetics. In one of these deaths, the ether employed was your preparation, and the *first* primary death in Phila. I would like you to inform me if you have made any change in the mode of manufacture, or are you less careful in its purification ; can you give me any hints on the subject? An early answer will oblige

Yours very truly, L. TURNBULL.

BROOKLYN, N. Y.

DR. LAURENCE TURNBULL, Phila.

My Dear Doctor,—Your very kind invitation is at hand, but I am sorry to say I cannot accept it. I have an engagement for to-morrow evening, and on the following morning have to be in Poughkeepsie at a meeting of a Hospital Consulting Board, of which I am a member, *which meeting I have given a promise to attend.* I have made very little change, in either the process, or the character or quality of the ether, made by me in the past 25 years. Of course the longer one does a thing the better he is able to do it, and the ether of to-day is a little better and cleaner than it was 5 or 10 years ago. But that a certain, though very small, proportion of accidents, fatal and not fatal, would occur from chemically pure ether, I have not the slightest doubt. Nor have I a doubt that they would occur as frequently with chemically pure ether as with that which I sell, and precisely the same may be said of both chloroform and nitrous oxide, with only this difference : that the conditions in, or of, anæsthesia most dangerous to life, occur least frequently with nitrous oxide, and most frequently with chloroform. Where most is to be gained, is in the study of the phenomena of the accidents, while accepting the conditions, that is the agents, from which fewest accidents occur.

Very truly yours, E. R. SQUIBB.

The washed ether which is employed as an anæsthetic in the various hospitals and medical institutions of the United States, is manufactured by the reliable firm of Powers & Weightman, of Philadelphia.

With profound anæsthesia from ether, the vaso-motor centres continue to act for a much longer time, than when chloroform is employed. Yet the ether fortior, and even the washed, will sometimes suddenly kill certain individuals by producing paralysis of the vaso-motor centres.

The following experiment was made, allowing an animal fully to recover from the mixed anæsthetic, and placing it under the full effects of Squibb's ether fortior, (in the University of Pennsylvania laboratory, April 27, 1885, in the presence of Dr. John D. Thomas, Prof. Reichert, and the writer).

Ether was crowded on it, until the respiration ceased, and the heart almost stopped beating; then a solution of 100th of a grain of sulphate of atropia was introduced, to see if it had any power to stimulate the heart, or restore respiration in this stage, but it produced no such results, and the animal was dead.

If the same amount of caution is employed in the use of this more powerful agent, as in the use of chloroform, the number of deaths would be less. It must always be borne in mind, that in full anæsthesia, no matter what agent is employed, there is a suspension of life forces, and but a step to death.

The administration of atropine may be resorted to, but morphia subcutaneously injected, will increase the risk with ether, not so much with chloroform. There are many individuals who have idiosyncrasies, and cannot bear even what is known as a small dose of morphia, without great disturbance of the stomach, or faintness.

It has been suggested to add atropine to the morphia, but the experiment just related will demonstrate that it will not relieve the heart, when fully under the influence of the stronger ether. There are no agents which relieve the irritation of the broncho-pulmonary mucous membrane so well, as keeping the skin warm and free from moisture or draughts. Above all, no one should give the ether who had not had some practical experience and is not desirous of witnessing the operation; let his whole attention be given to the patient, and never crowd the ether after the patient has become fully anæsthetized, but keep it off at a distance so that the patient may get a small portion of it. Keep up the influence of the ether by short and slight inhalations, well diluted with warm air.

The writer still holds to the opinion expressed in his earlier edition, that the safest systemic anæsthetic, is ether in prolonged and capital operations, and in this opinion, he is upheld by the majority of surgeons, and by a committee of the British Medical Association, and *British Medical Journal,* also in the chief medical journals of the United States.

In the face of the constantly-recurring notices in medical journals, and even in the public prints, of so many deaths during the administration of chloroform, a small number of which are published, it cannot fail to be patent to every one, that there is greater danger in the administration of chloroform. It will be observed that it does not affect our argument, whether such deaths were unavoidable, or were the result of faulty administration, or of administration of an insufficient quantity, as we believe to be not unfrequently the case. The fact remains that deaths do occur; and, in such circumstances, is it not the duty of the medical profession, to endeavor to use a safer anæsthetic?

Observations made on rabbits and dogs, showed that chloroform had a most disastrous action on the heart, as well as upon the respiratory centre; that, while ether might be administered for an indefinite period without affecting the heart, no sooner was the inhalation of chloroform commenced, than the right ventricle began to distend, and, in course of time, the cardiac contraction ceased. In every respect but one, *ether is superior to chloroform.* It has been stated, that it has one disadvantage, viz.: the length of time which was required to obtain its action. But is not this rather an advantage as regards safety? The difference in the action of chloroform and ether on the blood-pressure is shown by means of more delicate instruments than those obtained by the Committee of the Royal Medical and Chirurgical Society, the report of which was published in 1874. With chloroform, there was, at first, a slight transient rise in the blood-pressure, followed by a gradual but irregular fall. (See Plate 22, Fig. 3, Sphygmographic Tracings). When ether was administered, the primary rise was better marked and more prolonged, and the depression which followed it, very slight. As regards chloroform, the pulse fell to 64, 60, 56, frequently, and in one instance, to 48, in the minute; while the rate of respiration often rose much above normal, and on one occasion reached to a rapidity of 72, per minute. The same relation between these two anæsthetics is observed in regard to respiration: complete arrest of the pulmonary circulation being obtained most rapidly by chloroform, and with the smallest dose; least rapidly by ether.

It is unfortunately true that at the present day, ether deaths occur more frequently while the patient is under the surgeon's hands, than in years gone by.

Such sudden deaths were extremely rare, but are now more frequent, owing, we think, to, first, the use of a purer chemical ether; and, second, to the larger amount employed, as in the case of a recent death, when six ounces were employed for a non-capital operation, which could have been performed under a local anæsthetic. These six ounces are just the quantity required to kill a healthy, large-sized dog in our hands.

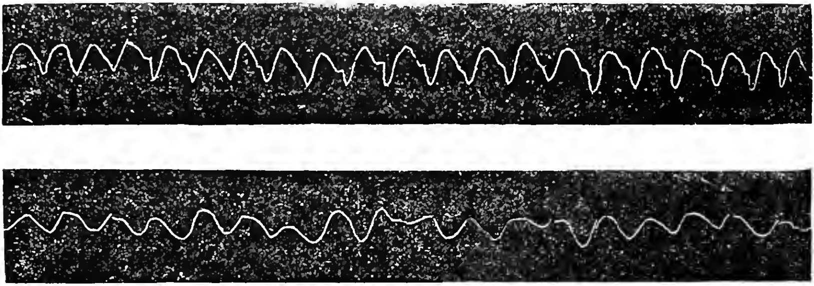
The reason for employing so large a quantity of ether, is the strong desire to etherize the patient as rapidly as possible, and to keep him profoundly still, so as to perform the operation as quickly as possible.

The number of deaths from chloroform in 1887, are some 450, and from ether in the same year, 75; and it is well known that ether is much more extensively employed than chloroform in the United States and England, while in Europe chloroform is the agent chiefly used. Life in Europe, is not of so much importance as in the United States (?).

In ether, it is almost always interruption of the respiration, and not of the heart's action, and there is a chance for the use of artificial respiration. When the heart is the first to fail, invert the body, if the face is pale, for a short time, until the face flushes, so as to restore the action of the heart and blood current.

Sphygmographic Tracings (Plate 22).—The following is another more recent series of sphygmographic tracings. There will be found a decided difference in the pulse and heart in these tracings: Ether in Figs. 1 and 2, Chloroform in Fig. 3, and Bromide of Ethyl in Fig. 4.

Plate 22—(Figs. 1–4).



Figs. 1 and 2.—Ether, first and second stages.

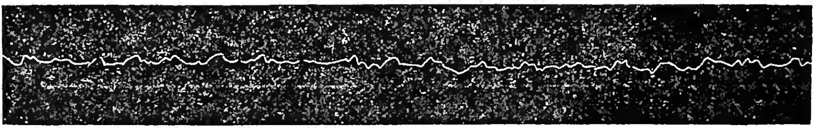


Fig. 3.—Chloroform.

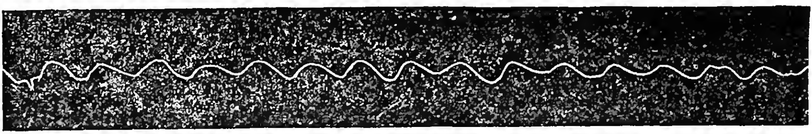


Fig. 4.—Bromide of Ethyl, or Hydrobromic Ether.

It will be noticed how much freer from influence upon the heart ether is, and how distinct and free from dangerous diacrotic impressions compared with chloroform, which depresses the action of the heart. Hydrobromic ether, is not considered quite so dangerous as chloroform.

TREATMENT OF DANGEROUS SYMPTOMS.—(1). Nélaton's plan suggests immediate inversion of the patient ~~in case of~~ heart failure, and artificial respiration, keeping it up for some time. (2). Inhalation of gtt. v.-x. of nitrite of amyl may be given early, the tongue being drawn out to lift the epiglottis, by elevating the jaw (Nancrede). (3). Stimulation, in case respiration is affected, but not entirely suspended, should be employed by means of either atropine, ammonia to the nostril, cold towel, or injection of ammonia into the veins, or ice in the rectum. (4). ~~Galvanism~~ faradic current, if employed, may be administered by the following methods: ~~Horapath's method (*Lancet*, 1852).~~ The positive pole is placed to the ~~nostril~~ phrenics, and the negative pole, over the diaphragm. ~~A reflex action is thus excited between the fifth pair and the pneumogastric.~~ This is used, chiefly, in case of respiratory failure. (5). Tracheotomy, and inflation of the lungs, by a catheter passed down the trachea, as suggested by Langenbeck (Berlin, 1859), may be resorted to in desperate cases.

In a discussion upon anæsthetics, the writer stated that ether produces inebriation like alcohol, and the patient must be kept warm while under its influence, or the temperature will sink below the normal, the skin become cold and clammy, with symptoms of collapse. The pulse-rate falls, the breathing becomes embarrassed, and an increase of secretion takes ~~place~~ in the lungs, and death occurs from pulmonary œdema, and respiratory paralysis, just as in drunkards who are exposed to cold. On account of the similarity of their action, alcoholic stimulants should not be given, where a patient appears to be sinking after ether administration.

Prof. H. C. Wood, endorsed these remarks, about alcohol and ether, and said that the more closely their effects on the lower animals are studied, the more closely are they seen to correspond. Atropia and digitalis, on the other hand, are of value, but their effects have been greatly magnified; they could be given in much larger doses than we are accustomed to, and without harm.

In considering the causes of death after ether, we must not forget that patients sometimes die of heart-failure, collapse, or shock after operations, where no ether has been given. Cases of severe burns, or of surgical operations, frequently rally after the operation, but die afterward with secondary syncope. The danger of shock is very much reduced where the anæsthetic is used, and in cases of albuminuria the danger from shock without the anæsthetic might be greater than from the ether. Moreover, the amount of albumen in the urine is not an index of the increased risk, for in some cases of contracted kidney the proportion is very small. In the treatment of collapse after ether, Prof. Wood recommends the use of ammonia, digitalis, and proper attention to the position, and covering of the patient.

Prof. Bartholow said, that the prevailing impression of the profession, of the comparative safety of ether, over chloroform, makes a careful investigation into fatal cases necessary, in order to ascertain all the causes contributing to the result, so as to avoid them in the future.

" Where there is danger of death from paralysis of respiration, there are two means of stimulation far superior to medicine: they are artificial respiration and faradism, which are far better in these cases than the so-called cardiac stimulant, atropia. If the cardiac ganglia are beginning to fail from exhaustion, the cardiac stimulant may meet with no response, or may prove injurious, for its first effect is that of stimulation; the second, exhaustion. The heart may be sustained by intravenous injection and artificial heat. He most decidedly protested against the subcutaneous injection of the tincture of digitalis. The action of digitalis is slow, and requires several hours to affect the heart. In a case reported by Boehm, death occurred five days after the administration of a poisonous dose of digitalis, from paralysis of the heart. Digitalis acts by stimulating the inhibitory apparatus, and not by giving increased power to the cardiac ganglia."

Cases in which Ether should not be employed as an Anæsthetic, except by an Expert or with the greatest care.—The conditions rendering anæsthetics dangerous are: Fatty degeneration of the heart, a prominent contra-indication where there is pain in heart region, pale face and arcus senilis in eye; persons who have an alcoholic history, brain tumors and degenerations, respiratory obstructions from swollen epiglottis, enlarged tonsils, œdema glottidis, laryngeal paralysis, thoracic tumors or aneurism, emphysema and obstructed pulse, circulation from engorgement of right heart, and deficient heart-power, valvular lesions, provided compensatory hypertrophy is not proportionately developed; incomplete anæsthesia, during painful surgical procedures, causing death from shock, as the result of peripheral irritation. As we have stated before, it is of the greatest importance, that attention should be given to the condition of the kidneys, and an examination made of the urine, when an anæsthetic is to be administered. Deaths, unaccountable otherwise, are due to this cause. In diseases of the kidneys, the blood being loaded with urea, anæsthetics almost invariably produce convulsions, coma and death.

Prof. Norris, has reported two cases of death supervening unexpectedly from ether after operations for cataract. Both recovered consciousness, but died comatose, one in a few hours, the other, after 18 days; no organic lesion was found at post-mortem, except Bright's disease.

Cases have also been reported by Emmet, Hunt, and Montgomery, verified by post-mortem.

CHAPTER XV.

Sudden Deaths under Ether—Internal Administration of Ether—Ether in Mitigation of the Agonies of Death—Ether Intoxication—Vivisection with Ether.

In the first, and second editions, of our Manual, the opinion was held that sudden or primary deaths from ether were very rare when given with care as an anæsthetic. In this, we were supported by the Committee of the Boston Society for Medical Improvement, a high professional authority at that time (1861). Now, at times, fatal cases occur, irrespective of the disease or the operation.

No one has done more to prove this peculiar action of ether, than Dr. J. C. Reeve, of Dayton, Ohio; and we gladly avail ourselves of the experience from his labors in this direction,*

* It is stated that the first case of recorded death from ether, was that of M. Jobert, of the St. Louis Hospital, brought before the Academy of Medicine of Paris, February, 1847; and the second reported in *The Medical Gazette* by Mr. Roger Nunn, at the Colchester Hospital, March 5, 1847.

in collecting the proof by cases. From the reports of cases which follow, every reader can judge for himself. Only such points as seem to be essential are given, for the sake of brevity, but references to the original sources have been carefully made in every instance. We begin with the first reported case of death from ether:

First Case.—Paris, July 10, 1847. Patient, male, forty-five years of age; operation for cancerous affection of left breast; "a man of tolerably robust constitution, which the disease had not yet deteriorated." After an administration of about ten minutes' duration, insensibility was manifest; respiration was loud, slow, but exempt from râles, and the surgeon began the operation. "The incision had scarcely commenced, and only a small quantity of dark blood had escaped, when the countenance changed, and the respiration became slow. The pulse, examined now for the first time, was soft, full, and very slow; all at once it stopped; all was over." The post-mortem revealed an extremely softened spleen, but no affection of a vital organ.*

Snow† says: "This patient appears to have died rather from the want of admission of sufficient air to the lungs, than from the effects of ether. The administration had been slow, and after death all the organs gave a strong odor of ether; but to attribute a death so sudden to suffocation, is a woeful distortion of evidence."

Second Case.—Female, aged fifty-five, in very poor health; operation for tumor of superior maxillary bone, at Lyons, September 11, 1852. The operation had not proceeded far, the ascending ramus had not yet been divided, when all at once respiration ceased, the pulse and beating of the heart could not be felt, and all efforts at resuscitation proved fruitless.

Snow, says: "This patient evidently died of hemorrhage;" yet, in a full report of the case ‡ by the surgeon, all that is said of this is, "I had tied some vessels upon the edges of the incision!" In his efforts to clear ether of this death, Snow

* Traité d'Anæsthésie chirurgicale, p. 250 Lallemand et Perrin, Paris, 1863.

† On Chloroform and Other Anæsthetics, p. 363. London, 1868.

‡ Traité d'Anæsthésie chir., p. 252.

resorts to most astounding logic. He says: "According to the results of my experiments on animals, ether is not capable of causing the kind of death with which this patient died!"* therefore, belladonna could produce no injurious effects upon man, because some animals can eat it with impunity!

The next four cases are taken from Kappeler's table, which contains reports of thirteen cases of death from ether. We have not access to the original reports, even of the cases which occurred in this country. The foot references are those given by Kappeler.

Third Case.—Duming's case, Bellevue Hospital, New York, 1872. Male, sixty-eight years old, etherized for adjustment of fracture of thigh. In ten minutes, patient was fully under the influence. After some manipulation, inhalation was suspended for four or five minutes. Inhalation recommenced on account of muscular rigidity; but in one or two minutes the administrator observed the pupils suddenly dilate, and respiration cease. The heart was still beating. All attempts at resuscitation failed. No report of post-mortem examination.†

Fourth Case.—Male, aged fifty-four, resection of maxilla, for caries. An incision was made along the bone, and four teeth extracted, when it was observed that the patient was very blue in the face. Artificial respiration and galvanism were without result. Kappeler says: "The editor of the *Boston Journal*, believes that the patient was suffocated by blood in the trachea." The report of the autopsy makes no mention of this.‡

Fifth Case.—Dr. Sinclair's case; Boston; operation for incision of the cervix. Soon after the operation was commenced, the administrator observed that the pulse was gone, and respiration had ceased. All efforts at resuscitation proved unavailing. The post-mortem examination showed Bright's disease, chronic pleuritis, and embolism of pulmonary artery. The evil influence of the former as to the effect of ether, was not then recognized as now.§

* Op. cit., p. 364.

† *Lancet*, 1872.

‡ *Brit. Med. Journal*, Dec., 1875; *Boston Medical and Surgical Journal*, Nov., 1875.

§ *Brit. Med. Journal*, October, 1876; *Boston Medical Journal*.

Sixth Case.—Lowe's case; female, aged forty-eight, of healthy appearance and of tolerably strong build. Operation for the removal of a mammary gland. After a few inhalations, the patient's face suddenly became turgid, and the hands white. The inhaler was at once removed, the tongue brought forward, cold water dashed over the face, and the chest rubbed with brandy; but the breathing became stertorous, the face became more and more congested, the pulse failed, there was an effort at vomiting, and death took place within a few seconds.*

Kappeler, places this case in his table, without any question or expression of doubt, as to its being a death from ether.

Seventh Case.—Male, aged sixty-nine, much exhausted; London Hospital; strangulated hernia. There was much struggling; as the lips became blue the inhaler was removed. Respiration improved for a brief period, but remained bad. The pulse became worse and worse, and disappeared—while the breathing continued for thirty seconds. Heart flabby, the left ventricle not contracted, the lungs emphysematous, and the bronchi filled with "purulent mucus." Incarcerated hernia.†

The next is published in Holmes' "Surgery." In a foot-note it is stated that the case was never before published, and no names are given in connection with it. We will now say that it occurred to a prominent practitioner of Rhode Island, and the report was furnished us by our friend, Dr. Charles O'Leary, of Providence.

Eighth Case.—Male, aged sixty-two, addicted to drink. Ether was given for examination of hips injured the day before, patient being in good condition. Two ounces of whiskey given, then ether administered to amount of three or four ounces. Patient never fully anæsthetized; pulse carefully watched. At a period not later than fifteen to twenty minutes from beginning the inhalation, "the patient suddenly, and without any symptomatic warning whatever, stopped breathing, and was dead." "Death was instantaneous," another observer writes. Post-mortem examination showed

* *Brit. Med. Jour.*, Nov 17, 1877. See, also, *New York Med. Record*, Jan. 5, 1878.

† *Brit. Med. Jour.*, May 26, 1877.

pleuritic adhesions, heart full of dark fluid blood, its muscular structure healthy; the valves, especially the aortic, affected with atheromatous deposit; liver and kidneys congested, the latter studded with cysts.

The next case occurred in Philadelphia:

Ninth Case.—Male, aged sixty-seven; Pennsylvania Hospital. A feeble old man, with strangulated hernia; a hard drinker; had suffered much from exposure and want of food. After anæsthesia by ether had been kept up some time, herniotomy was decided upon. Soon after the operation was commenced, a copious bronchial secretion kept filling the patient's mouth; during an effort to expel this a very large portion of the bowel was forced out; at this time the breathing became labored, the pulse faltered, asphyxia developed rapidly, and the patient expired on the table. This was evidently a poor subject for anæsthesia, and a bad subject for operation, yet, in the language of the reporter of the case, "the ether was unquestionably the immediate cause of death."*

Tenth Case.—Male, aged sixty-six, for some weeks had abdominal symptoms, which finally culminated in complete intestinal obstruction, and right lumbar colotomy was undertaken. "There was no complicating disease in heart or lungs, . . . there was nothing to contraindicate the use of an anæsthetic, or to make one more than usually anxious as to its effect." Ether given by Clover's smaller inhaler. After five minutes, the first incision was made by Mr. Pridgin Teale. In ten minutes, just as the reporter "was engaged in counting the carotid pulse, which was beating evenly, and with rather a stronger impulse than before the operation, he showed an inclination to vomit, and ejected a quantity of brownish fluid, smelling strongly of brandy. He then took one deep inspiration, and seemed as if inclined to vomit again: but his head sank back on the pillow, and he quietly died, making no further respiratory effort, except one short gasp during artificial respiration. No post-mortem was allowed, but examination failed to show any mechanical obstruction to breathing.

*Paper by Dr. Thomas G. Morton, *Amer. Journ. of Med. Sci.*, Oct. 1876, p. 415.

The inhaler showed that a little more than an ounce of the ether had been used." *

The following two cases are from a paper on "Deaths from Anæsthetics in 1885," by Ernest H. Jacobs, M.A., M.D. †

Eleventh Case.—Male, aged sixty-two years, at London Hospital. Ether given to reduce a dislocation of shoulder. "In three minutes he began to look pale, his breathing was feeble; a dusky pallor increased in spite of artificial respiration. At the post-mortem the lungs were found emphysematous and congested, and there was bronchitis (?). The heart was flaccid and fatty, with adherent pericardium."

Twelfth Case.—Girl, aged ten years, much emaciated and looking very ill; to be sounded for a calculus. When she had taken but a few inhalations, she was observed to be very pale, "the pulse ceased, the breathing continued." All efforts of resuscitation were in vain. "This," the reporter says, "is the most remarkable case of the kind I have ever known. The patient took not more than a drachm of ether, and died in a precisely similar manner to that which generally obtains in the case of chloroform."

Thirteenth Case.—Male, aged fifty years, suffering from severe inflammation of the bowels, due to obstruction. Ether was carefully administered preparatory to an operation. He inhaled it without the slightest hesitation or discomfort, but had not taken more than three or four inhalations when he fell back, breathed once or twice, and died. At the post-mortem examination, there was found considerable purulent effusion in the peritoneal cavity; at the lower part of the descending colon was a malignant mass of the size of a small cocoa-nut, blocking the canal. In the right ventricle of the heart was a fibrinous clot attached to the tricuspid valve. The medical men did not think the patient died from the ether, because death occurred so very early in the administration. The post-mortem failed to explain so sudden a death, without the ether as a factor.

"This collection of cases, is not presented as complete; I am

* *London Lancet*, Sept. 4, 1880, p. 376.

† *Brit. Med. Journal*, March 13, 1886, p. 489.

very certain that it is not so. To make it so, I have not gone beyond the resources of my own library. I have not given any cases in which death, evidently due to ether, took place at a period, more or less remote from the administration. There are many such on record. Nor will I extend this paper, by presenting cases in which dangerous symptoms occurred under ether; just such symptoms as patients had from the A.-C.-E. mixture. I have kept closely to my text: '*Ether in the human subject may cause death as suddenly, as unexpectedly, and in the identical manner that chloroform does.*' Whether the evidence adduced sustains the proposition or not, must be left to others to determine. If, however, the ground be taken that the cases adduced did not die from ether, then it is incumbent upon the objector to show what they did die from.

"Finally, I wish to disclaim, in the most emphatic manner, any feeling of partisanship in this matter. I have no 'case' to make out against ether. I have no anæsthetic to advocate as perfectly safe, for such a thing does not exist. *I am ready to admit that probably ether is the safest anæsthetic we possess for surgical purposes.* I am ready to assent to the proposition that, *theoretically,* any mixture of anæsthetics increases in danger, in proportion as chloroform is added to it."

This finishes Dr. Reeves' collection of cases and his opinion of ether in comparison with chloroform. (The *Italics* are ours.)

A DEATH DURING THE ADMINISTRATION OF ETHER.*—"On the 3d of August, 1887, I was called to visit, by appointment, Mr. R. D., æt. forty-five, at his hotel in Philadelphia, for the purpose of removing two ulcerating hemorrhoids, which had resisted the ordinary means of treatment for several months, and were causing the patient great discomfort. Dr. White was asked to accompany me and administer the ether. There were no ascertainable reasons why an anæsthetic should not be given, as neither the heart nor kidneys were diseased, and the patient appeared to be in good health. Only one year previous I had divided and stretched the sphincter ani of Mr. D. for fissure, administering the ether myself, and after anæsthesia,

* By D. Hayes Agnew, M.D., *Medical News,* Nov. 19, 1887.

entrusting the agent to a friend of the patient, who was present, for the brief time required for the operation. About six ounces were taken at this time.

"At the time of the last operation nothing occurred during the early stage of the inhalation, other than what is witnessed every day when ether is exhibited. In the course of fifteen minutes the patient, though somewhat rigid, was placed across the bed. One of the tumors was dragged down, transfixed, and ligated with a double ligature. When about to seize the second, the breathing, which had been strong and free, suddenly ceased. The operation was immediately suspended, and the usual methods for resuscitation instituted. These consisted in examining the throat for the probable presence of some obstructing cause, dragging the tongue forward, the use of artificial respiration, flagellating the surface with the end of a wet towel, ammonia to the nose, partial inversion of the patient, and, finally, the passage of the electro-galvanic current through the phrenic nerves. Notwithstanding these measures were persisted in for at least three-quarters of an hour, during twenty-five minutes of which time the pulsations of the heart could be recognized, not a single effort of natural respiration occurred. The man was dead.

"The post-mortem, made by Dr. Formad, revealed complete collapse of the lungs, marked traces of an old meningitis, attributed to a former sunstroke, and what satisfactorily explained the sudden termination of life, the rupture of a calcified vessel in the floor of the fourth ventricle, the recognized physiological centre of respiration; all the vessels comprising the circle of Willis, were in a similar state of atheromatous degeneration. It was evident, therefore, that the increased vascular tension of these cerebral vessels, caused by the ether, determined the lesion, a result which might have followed any unusual excitement, mental or physical. The heart and kidneys were healthy.

"The question naturally occurs, Could this sad disaster have been prevented? Certainly, in view of all the circumstances, it could not. *First.* The ether was that known as Squibb's. The can contained eight ounces; two ounces remained in the vessel; two ounces, it is fair to suppose, had been retained in the folds of the towel, leaving four ounces, or, at most, less than five ounces which had been inhaled. *Second.* There was a sufficient admixture of atmospheric air with the respired vapor, as the anæsthetic was administered from an ordinary towel, folded into a cone, and with an opening at the apex. *Third.* The position of the administrator, Dr. White, that of reclining alongside of the patient, with the face of the latter in full view, would have enabled him to detect at once, any signs of approaching danger, which, from his long experience in giving anæsthetics, would have been quickly recognized; and, *last*, the impossibility of being able to ascertain during life, the state of the blood-vessels of the brain, disclosed by the autopsy, and rendered very improbable in a man of forty-five years of age.

"After forty years of surgical work, often, too, of the gravest character, and sometimes requiring prolonged anæsthesia, without an accident in a single instance, I had come to believe that the exhibition of ether, unless recklessly administered, was entirely free from danger. Several deaths, I am aware, have been reported, from time to time, from its use, even in the hands of the most careful operators, but I never could divest my mind of the idea, that in these cases there was some undetected element involved, more influential in the issue than the ether, as in the present instance.

"The following case, which came directly under my own observation only a few weeks before the death of Mr. D., is in point:

"I was called to one of our suburban towns to see a case of strangulated hernia. The patient was a female about seventy years of age. The intestine had been incarcerated for three days. Her pulse was quite good, and there were no signs of collapse. I noticed the pupils were much contracted, no doubt from the opium which had been administered. I directed her medical attendant to place the patient properly in bed, and prepare a cone for giving the anæsthetic, while I made my preparation for the operation. This was done. In a few minutes I was ready to proceed, and then told the doctor to give the ether. While reaching for the bottle, and before removing the cork, the patient gave a sudden convulsive movement, at the same time ejecting a large amount of stercoraceous matter from the stomach, and expired in a moment. Had the etherization been commenced, or the operation begun, before the death of the woman, the fatal result would have been charged to either the anæsthetic or to the knife."

Deaths from Ether and Chloroform.

There are many fatal accidents from both ether and chloroform which are never reported. Dr. Wickham, of Chicago, a friend of the writer, reported a death from ether in the practice of a friend of his, and Dr. F. H. Akin, in the discussion of Dr. McGuire's paper, stated as follows: "I know of one death from ether occurring in Baltimore several years ago, where an operation was being performed for a uterine fibroid, in a patient very greatly reduced by hemorrhage. This, I believe, was never published. Again some years ago, a friend in one of our towns in West Virginia told me of a fatal case from chloroform happening to him. I asked him if he had published an account of it. 'No, indeed; I felt too badly, and besides, it was published enough, without my reporting it,' was the substance of his reply. I have been told of others occurring in military practice during the late Civil War, which have never been reported."

Reduction of Temperature by the Action of Ether, as a Cause of Death.

The bodily temperature is reduced by the action of ether. Among twenty cases the average diminution of temperature was 0.68° C. The minimum fall was 0.3° C.; the maximum was 1.5° C. Among twelve cases, uncomplicated by any febrile movement, the average fall was 0.52° C. In thirteen of the nineteen cases in which the commencement of heat-depression was noted, the mercury began to descend when inhalation had been continued for ten minutes. In five instances, fifteen minutes, and in one instance, twenty minutes elapsed, before any depression was noticed.

The shortest time in which the greatest fall was reached, was twenty minutes after the commencement of inhalation; the longest time was two hours. It was always remarked that the greatest depression of temperature accompanied the most abundant use of the anæsthetic agent, and the most profound anæsthesia.

The only cases in which elevation of temperature is observed are presented by patients in whom, for a brief period during the stage of excitement, an increased muscular activity liberates a slight increase of heat. This reduction of temperature, is a secondary cause of death from ether, but not a primary one. We have never found the skin or pulse to fail under ether until the inhalation had stopped; then the skin became moist, clammy and cold; and, if exposed, collapse of the lungs. If the system is not able to remove the moisture from the skin, the lungs must suffer, and the patient dies.

In many persons the lungs contain so little residual air that the ether vapor fills them almost entirely, not only depriving the blood of its required oxygen, but also producing its special influence upon the brain and nerves of sensation and motion. It is true that no apparatus now at our disposal entirely prevents air from reaching the lungs; but the great difficulty lies generally in the sponge or towel used becoming so wet with the watery vapor, that a perfectly air-tight covering for the mouth and nose is formed, necessarily producing asphyxia if left too long. Ether, like water, may also fill the trachea, preventing the air from reaching the lungs, as often noticed in drowned persons, the trachea being found full of water—undoubtedly a cause of death; but as a general rule, the real cause of death from chemically pure ether, is direct paralysis of respiration, followed by secondary paralysis of the heart. A death having occurred, to all appearances, from ether in Philadelphia was so reported, but has since been questioned by the editor of the *Medical News*, June 4, 1887, and we give it as it was published, as it contains much that is useful and to the point:

"WAS IT A DEATH DUE TO ETHER?—We reply in the negative. The case in question occurred in Philadelphia last week, and was the subject of comment in the newspapers, and of an extra-judicial opinion by the coroner. The facts with which we are concerned are these:

"A minor surgical operation being necessary, ether was employed as an anæsthetic. No accident happened during the anæsthesia, and no unusual incidents followed the operation until the fifth hour thereafter, when the patient suddenly expired. A jury summoned by the coroner, rendered a verdict which ascribed the death to ether, but implied no censure of the two physicians in charge of the case. The coroner, however, animadverted with no little severity on that lack of skill which failed to detect the 'fatty heart.' The coroner's physician, who conducted the autopsy, testified to the existence of fatty degeneration of the cardiac muscular tissue, and without hesitation referred the fatal ending of the case to the action of ether. An examination of the brain appears not to have been made, nor was the vascular system inspected with the view to detect thrombus or emboli. Such omissions, if made, must cast doubt over the conclusions arrived at from insufficient data, and are the more reprehensible, since the physicians are held up to public reprobation when innocent of offence.

"To ordinary observation, without prejudice, the two facts of the case—the inhalation of ether, the death several hours after—seem too remote to have the relation of cause and effect. The supposed fatty heart bore the strain of the ether inhalation, and the surgical procedure, and yet succumbed when the anæsthetic was no longer in action, and the shock of the operation, if any, had passed away. It is no doubt true, as recently stated in these columns, that a fatal result may occur from ether inhalations several days after, because of pulmonary inflammation induced by prolonged contact of ether vapor. It is not alleged that the case in question was of this character; but, finding a fatty heart, the fatal ending required no further explanation. Did this conclusion turn on the naked-eye appearances, or was it decided by a microscopic examination of the muscular elements?

"The coroner seemed to have been outraged in his innermost moral consciousness, that the fatty degeneration of the heart had eluded *ante-mortem* examination. We opine that his strictures are not justified by our existing knowledge of the rational and physical signs of this morbid condition. We have the conviction that considerable fatty degeneration may exist without any definite symptoms, and all of the usual signs of this affection may co-exist with a normal state of the organ. Assuming that the heart of this patient had undergone, to some extent, degenerative changes, should this condition inevitably preclude the administration of ether? An answer to this question is furnished us by the mode of dying in ether narcosis. It is now conceded on all sides, that failure of the respiration is the mode, the action of the heart being rather stimulated, than depressed by ether.

"To connect the death of this patient with the ether inhalation after several hours had elapsed, is to do violence to every fact; to assume as a cause of the fatal ending, a condition of the heart which had passed through the ordeal of a surgical operation and complete insensibility, is to tax credulity above its power of endurance; and to ignore the results of physiological investigations that have demonstrated the nature and character of the dangers in anæsthesia by ether, is to substitute for exact knowledge the vagaries of uninstructed opinions.

"To permit the coroner to give utterance to extra-judicial opinions, that reflect on the judgment and attainments of physicians who have the misfortune to come within his jurisdiction, is to touch nearly the honor of the medical profession. To permit the coroner's physician to announce hasty opinions after insufficient examination that discredit the knowledge and reflect on the integrity of the physicians concerned, is to place in his hands an opportunity for mischief that can hardly fail of being utilized. If post-mortem investigations that involve mortification or disgrace, or merely annoyance, are conducted without giving an opportunity to the physician implicated to observe for himself, is it not certain that a grievous wrong is being perpetrated, and the good name created by a life of honest endeavor, put at the mercy of caprice, of prejudice, or of ignorance? We learn that in the case now under consideration, the *post mortem* was conducted without acquaint-

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ing the physicians concerned, and thus affording them the opportunity to prepare for their own defence.

"It must be obvious to the least observant physician, that there is an increasing distrust of the medical profession, growing out of those personal discussions in which the integrity and acquirements of each other are called in question. The world is apt to adopt that view of a body of men to which they themselves give expression. In these times of combinations, of syndicates, of organizations, the medical profession is apparently engaged in a process of disintegration rather than solidarity."

A PATIENT SUCCUMBS TO THE ETHER ON THE OPERATING TABLE AT BLOCKLEY.*—Donato Ferro, an Italian journeyman tailor, died on the operating table in the Clinic Hall of Blockley Hospital on Saturday, June 8, 1889, about noon, while undergoing a surgical operation for hip-joint disease. The immediate cause of death was the quantity of ether administered to the patient.

Ferro was 36 years old, and lived at 827 Fitzwater Street, until about three months ago, when he became an inmate of the Philadelphia Hospital, suffering from a disease of the hip-joint which, when the hospital physicians began to treat it, had reached what is called the third stage. There was little superficial evidence of pus formation at the time Ferro came to the hospital. Shortly after this, the joint became greatly swollen. The doctors found that there was an internal and external abscess of the pelvis. An incision was made in the outer sac through which the pus flowed, thus proving that what Ferro was suffering from was a disease of the socket of the joint. Ferro began to suffer intensely then, and about May 1, he could not sleep except when under the influence of narcotics.

Two weeks ago, the doctors made an examination of the limb. Ferro was anæsthetized at the time for the purpose of destroying some adhesions. The physicians noticed that there were no ill effects from the ether at the operation. About

* *Phila. Med. Times*, No. 404, May 19.

Thursday of last week a consultation was held upon the advisability of aspirating the joint, but it was postponed until Saturday. On that day Dr. A. W. Ransley, of 1230 South Tenth Street, who is one of the attending physicians of the Philadelphia Hospital, decided to make the operation; he was assisted in it by resident physicians Samuel M. Hamill, and Charles Walter.

Ferro was taken from the ward about 10 o'clock on Saturday morning, and prepared for the clinic, in which about 100 students from different medical colleges were assembled. The physicians had agreed previously that an operation was necessary to save Ferro's life, as he could not live under the circumstances more than a month. Ferro was confident of his approaching end, it is said, and urged the doctors to proceed with the operation. He was accordingly examined, and it was thought that he was physically able to stand the treatment. When Ferro was brought into the clinic he was under the influence of the drug, and while the operation was in progress for over three-quarters of an hour, it is said that a towel was held over the mouth of the patient, and ether freely applied.

About 11.45 o'clock, one of the doctors noticed that Ferro's face was blanched, his pulse feeble and respiration very slow. Heroic measures were at once resorted to to restore the patient. Aromatic spirits of ammonia, whiskey and ether, were injected hypodermically, and everything known to science tried. In less than ten minutes after Ferro's condition was first noticed, he was dead. To allay any excitement that might occur among the students who witnessed the operation, and the sudden efforts to restore the subject, the body was wheeled from the hall, and only a few of them learned of the death.

The body was at once removed to the Morgue and Dr. Ransley in person, called upon Coroner Ashbridge, and notified him of the death. The latter ordered a post-mortem, which was held the next day in the Morgue, at 2 o'clock. When the coroner's physician made the incision in the abdomen there was at once a perceptible odor of ether throughout the room and every organ as it was opened emitted the odor of the drug. It was a remarkable incident in the examination, and it seemed that Ferro's body was thoroughly impregnated. There is no doubt that the operation was a justifiable one. Life could not be prolonged for more than a month. There were symptoms of blood poisoning from the scrofulous abscess at the hip joint, which extended to the abdominal cavity, where there was also a *psoas* abscess.

Coroner Ashbridge began an inquest in the case, and after Ferro's brother testified to identifying the body the inquest adjourned. It is a certainty that death ensued from the effects of the ether.

DEATH WHILE UNDER THE INFLUENCE OF ETHER.—On Monday, January 30, 1888, a man—Richard McKee—aged fifty-three, of No. 2016 Woodstock Street, Philadelphia, received an injury to his nose from a fall. Drs. A. and B. administered ether, which was soon followed by a comatose state. After efforts without result, and while in this condition, he was taken to the Philadelphia Hospital, over the river—a distance of a mile—in very cold weather, where everything was done to overcome this condition without success. It was found, on examination of the urine, that he had Bright's disease of the kidneys, finding albumen and casts in his urine, and that he was suffering from uræmic convulsions. The removal of the patient during such cold weather was, in itself, a very injudicious procedure, and has been, in almost every instance, the cause of death from congestion of the lungs, etc. There is always an active reduction of temperature in the body on the use of ether. No post-mortem was allowed by the family of the man. The following are the observations of Dr. Osler on the case, with another such case from a friend. We called the attention of the profession as early as March 9th, in American Medical Association, referring to Emmet's experiments, and also to Norris' case. (See pamphlet and cases of our own knowledge of the danger in such cases.)

FATAL COMA AFTER ETHER ANÆSTHESIA.—A deepening and fatal coma after ether may be due to apoplexy or to uræmia.* An illustration of the former occurred in Montreal eight or ten years ago in the practice of Dr. Fuller,

* Editorial *Canada Medical and Surgical Journal*, March, 1888, p. 309.

in an operation for cataract in an old man. Cerebral hemorrhage was present (post-mortem). On the 26th of January, 1888, a man aged fifty-three was admitted to Dr. Wm. Osler's ward in the Philadelphia Hospital, to whom, on the 25th, ether had been given by Dr. Earackson, to stitch a wound on the face due to a fall. The patient, a sober man, had not been well for some time, and was very tottery on the 25th, when he fell and cut his nose. According to the friends, he took the ether very well, and the operation did not last long; but he never regained consciousness. When seen on the morning of the 27th, the temperature was 97.5°, the pulse 104; the limbs relaxed, but moved occasionally; pupils, medium size, immobile; respiration, noisy. The urine obtained from the bladder was highly albuminous, and contained many finely granular and hyaline casts. In the evening the temperature was 98°, and the condition was unchanged. He was thoroughly purged and sweated without benefit. He died on the morning of the 28th, never having roused or shown any sign of consciousness. An autopsy was not allowed, nor did the coroner order one! We have in another place referred to this important matter, and fully agree with the opinion of Dr. Osler on this subject, when he states: "I do not think that the simple presence of albumen and casts should absolutely preclude the administration of ether; but a knowledge of their existence should increase, if possible, the precautions taken, particularly when associated with the *arterial* and cardiac changes so common in chronic Bright's disease."

Dr. David Cheever, of Boston, believes that the following operations may be better done without anæsthesia: Extraction of cataract, tracheotomy for disease and paracentesis thoracis.

"Ether has been accused* (1) of killing patients by asphyxiation from spasm of the glottis; (2) of killing by provoking pulmonary mischief, bronchitis, pneumonia, etc.; (3) of paralyzing the respiratory movements; (4) of inducing syncope. Syncope does certainly occur during ether administration, although very rarely. Gosselin, (*Clin. Chirurgicale de la Charité*), cites a case which occurred where an attempted reduction of a

* Buxton, *British Medical Journal*, September 19, 1885.

dislocated thigh was proceeding. Amidon (*New York Medical Record*), in describing the condition, believes he has succeeded in avoiding this danger, by injecting small doses of atropin. One or two cases have since been recorded (*British Medical Journal*, 1878, vol. ii., p. 602). It is probably doubtful whether these cases are due to ether inhalation, as we shall see, the heart is practically uninfluenced for evil, by ether. Ringer has shown how ether will hardly affect the heart-muscle of frogs; and Wood, after noting the same fact, mentions that, when it is injected into the veins of animals, the heart's action remains uninfluenced; while it is easily demonstrable, that when the mammalian heart is watched, artificial respiration being maintained, it will be found practically unaffected by the most enormous doses of ether. When death does occur, from cessation of respiration, the heart beats for a considerable time. Moreover, the heart-muscle being intact, it readily resumes its functions when artificial respiration is performed. The action of ether upon the vaso-motor system has been carefully worked out. Arterial pressure is always increased in ether narcosis.*

"The death from spasmodic closure of the glottis is so rare, as practically to be unimportant, save as a means of pointing a moral; for such cases are certainly due to the administration of too powerful a blast of ether to a timid patient. He holds his breath as long as nature permits him, and then, with the attempt at a deep-drawn inspiration, inhales a supersaturated ether atmosphere. The delicate mucous membrane rebels, and so arises the spasm. Even in such cases, admission of air and pressure on the chest will set matters right. Such accidents, I think, rarely, if ever, occur when Clover's inhaler is employed, by one accustomed to its use.

"Death from chilling of the pulmonary mucous membrane, giving rise to pneumonia, or, through the direct irritation by the pungent ether vapor, causing tracheitis and bronchitis,

* Chloroform Committee, Royal Medical and Chirurgical Society. Scientific Grants Committee, British Medical Association. Anstie, "Stimulants and Narcotics." Sansom on "Chloroform." Bowditch and Minot (*Boston Medical and Surgical Journal*, 1874; quoted by Wood).

does in a certain number of cases occur. Sédillot (Péau, Clinique Chirurgicale à l'Hôpital St. Louis, 1882, *De l' Anæsthésie Chirurgicale*, 1882) found, experimentally, that dogs get pneumonia when ether is introduced through an opening in the trachea. Mr. Lawson Tait (*Practitioner*, March, 1876), recognizing this danger, invented an apparatus for preventing cold air from entering the lungs. That there is a considerable danger of these occurrences in the case of young and delicate children, I am pretty certain; and I should be glad to learn the experiences of others on this subject.

"We now have to deal with the last and most important danger,—invasion of the medullary centre and stoppage of respiration. Ether, there, falls short of the ideal as an anæsthetic, in so far as it travels beyond merely annulling sensation, and attacks vital centres. However, considering the great volatility of ether, and that the advent of apnœa is heralded by marked signs, while the heart remains in active function even after apnœa, we have, I submit, a far less alarming symptom with which to deal, than in the case of chloroform apnœa."*

Internal Administration of Ether.

Exhibited internally, ether is an excellent diffusible stimulant. It sinks in water, and is best administered mixed with spermaceti and sugar, or in mucilage of gum arabic; its taste is hot, pungent and irritating, and when placed in the mouth, ears, nose or rectum, pain is produced. It dissolves in alcohol, whiskey or brandy; and when required as a powerful stimulant, as in fainting, exhaustion or collapse, this is an excellent method for administering it. In using it for some time, it is best given enclosed in capsules.

Gout.—In sudden attacks of gout in the stomach or intestines, a useful mixture is the following:

℞ Spiritus vini gallici,
Æther. . . . . āā . . . . f℥j. M.

Sig.—Dose, one teaspoonful in sugar and ice-water, repeated until relief is afforded.

* With all the cases of death from ether reported, yet how small they number to the millions of times it has been employed without loss of life!

This same preparation will be found valuable in *spasm of the stomach, or intestines, or heart.* Ether has been proved useful in *tape-worm*, alone, or combined with the oleo-resin of the male fern. The patient must live upon milk and a little bread for one day, and the following morning, fasting, take the full dose:

℞ Oleo resinæ Filicis . . . . ʒ ss.
Æther . . . . f ʒ j.
Mucilag. acaciæ, ad. ft. . . . . f ℥ ss. M.

This is to be repeated in three hours; in the evening food can be taken, to be followed with a full dose of castor oil with twenty drops of spirits of turpentine. Some French authorities prefer to give f ʒ iss. of ether alone, administered at once, and followed in two hours by the purgative.

Ether is also one of our most potent remedies in *hysteria*, especially when associated with valerian, asafœtida, musk or camphor. In the first with the fluid extracts, as follows:—

℞ Æther.
Valerian. ex. fluid. . . . . āā . . . . . f ℥ j. M.
SIG.—A teaspoonful every hour.

In the second it is mixed with the tinctures as follows:

℞ Æther.
Tinct. Asafœtidæ, ... āā . . . . . ℥ j.
Mucilag. acaciæ . . . . ℥ j. M.
SIG.—A teaspoonful every hour until relieved.

With musk:

℞ Moschus . . . . ℈ ij.
Æther.
Mucilag. acaciæ, ... āā . . . . . f ℥ j. M.
SIG.—A teaspoonful every hour.

With camphor, ether is not only useful in hysteria, but all forms of "*nervousness*," in *dysmenorrhœa, diarrhœa, cholera, abnormal sexual excitement, epilepsy, hysterical, puerperal and* *strychnic convulsions.* Camphor with ether is best administered as follows:

℞ Vitelli ovi . . . . ℥ij.
Pulv. camphoræ . . . . ʒij.
Æther . . . . ℥ij. M.

Add the ether to the camphor, and then the emulsion; administer in tablespoonful doses every two hours.

Treatment of Sciatica by Subcutaneous Injection of Ether.

We first gave fifteen drops, which was followed immediately by great relief from the pain, which soon passed off. The injection, in increasing doses up to thirty drops, was repeated morning and evening for three days, when the patient was discharged cured. No local injury resulted; the injections were made in the ordinary superficial method, and not deep.

Asthma.

Inhalation of ether is very valuable in relieving spasmodic asthma, and obtaining sleep for the patient. It can be employed alone, or associated with the tincture of digitalis, conium or opium. The ordinary dose of the ether is from ten to forty minims, and of the tincture of digitalis or opium from ten to thirty minims.

The Ether-Spray in Post-partum Hemorrhage.

The use of ether-spray in post-partum hemorrhage has been sometimes successful in cases in which the usual means of arresting the flow had been resorted to without effect. The spray is directed on the abdominal walls, along the spine and over the genitals.

Coryza and Obstinate Hoarseness.

Drs. Chapman and Physick, recommended the vapor of equal parts of Hoffman's anodyne or compound spirits of sulphuric ether, with equal parts of laudanum, in cases of recent catarrh, in coryza and obstinate hoarseness, by inhalation.*

* We have also employed one-quarter grain of sulphate of morphia in the place of the laudanum, making a more elegant preparation, and with good success.

Ether as an Expectorant.

Ether has been found useful as an expectorant in the subacute, or chronic form of bronchitis. It is a valuable remedy. It is prescribed in five- and ten-minim doses, on a little sugar, every three or four hours, or it can be taken by inhalation as follows: The cork of a bottle, half-filled with ether, is perforated by two glass tubes, neither being immersed in the ether. A few inspirations through the tubes every hour or two is sufficient. As the remedy is also a diuretic and diaphoretic, its utility is thereby increased.

Chorea.

A jet or hand spray of sulphuric ether, free from alcohol, applied to the spine will relieve the most violent spasmodic or convulsive attack of chorea, with the subsequent use of Fowler's solution, five to ten drops three times a day in water, and occasional application of the galvanic current to the spine.

Nervous Aphonia, or Temporary Loss of Voice.

The vapor of ether has been highly recommended, as a most valuable remedy in hysterical or nervous loss of voice. It has been the means of discovering malingerers, who were supposed or stated to be deaf and dumb, and who, as soon as they came under its anæsthetic influence, were able both to hear and speak.

Diphtheritic Angina, or Pseudo-Membranous Croup.

Cases of diphtheritic angina have been treated with success by inhalations of ether and steam, with the internal use of brandy.

Whooping-Cough.

Ether alone by inhalation is extremely useful in the relief of whooping-cough; and a combination of ether sixty parts, chloroform thirty parts, and oil of turpentine one part, has been found a successful remedy. The patient should be confined to his room, making him, at every access of coughing, place before his mouth a small piece of cloth, folded several times, wet with a teaspoonful of the mixture. This remedy we have used with most gratifying results, at the same time employing, between the paroxysms, extract belladonna and quinine sulph. internally, with the diluted carbolic acid on a sponge about the patient's room.

Ether in Cardiac Dyspnœa.

It is stated that ether has been found a remedy for cardiac dyspnœa, the sense of dyspnœa being relieved by the internal administration of it in capsules, containing from twenty to thirty drops, or by small sub-cutaneous injections. Large doses have the same effect as extreme cold, so that the respiration becomes slow and shallow. The same action is produced by chloral, chloroform, alcohol, opium, physostigmine, muscarine, gelsemine, aconite and veratrine.

Ether in Suspended Animation After Delivery.*

The delivery was effected. The child not breathing, it was placed in a bowl of warm water, sprinkled on the chest with cold water, and Sylvester's method of artificial respiration was practiced upon it. At the end of 10 minutes, estimated time, there was no sign of life. With a hypodermic syringe, between 3 and 4 minims of ether were injected deep into the child's arm. Within a minute the child gasped, and in 2 or 3 minutes it was breathing well enough to enable the doctor to cease the artificial respiration.

Ether-Spray on the Vertebral Column in Tetanus and Chorea.

The local application of the ether-spray to the spinal column, so warmly recommended some time ago by Lubelski and Jaccoud, seems actually an effective remedy in the diseases mentioned. Bonteillier reports in *Le Progrès Médicale*, 40, 48, a case of traumatic tetanus, which was perfectly cured by the ether-spray, applied at first every two hours, then

* By N. A. Powell, M.D.

every five hours to the vertebral column. In a case of chorea, where the application was made every morning and night, and lasted from three to five minutes, another perfect cure was obtained within a month. It need not be added, that all other known remedies were previously tried in vain.

Ether in Mitigation of the Agonies of Death.

John C. Warren, M.D.,* says:

"I am fully aware that the agony in the dissolution of the bond between the bodily frame and its spiritual tenant, is not so great as it is believed to be; for, having questioned a great number of persons passing through the last stage of earthly existence, whether they suffered pain, the answer has been almost uniformly in the negative; and on inquiring what sensation was experienced, the reply has been such as to lead me to consider it an undefinable sense of discomfort. The intellectual faculties appear to be so clouded and confused, that they are unable to take cognizance of the agitation which convulses the physical organization.

"There are, however, exceptional cases, in which there is great bodily suffering; and there is in all men an instinctive dread of the pains of death. If we find the means of preventing or relieving these pains, the great change may be viewed without horror, and even with tranquillity. He who would experience a real euthanasia should not, however, trust merely to the virtues of ether, but should also have settled his accounts with this world, and be well prepared to settle those of the future.

"In illustration of the practice alluded to may be mentioned the case of a lady, who died of dysentery in the summer of 1847, at the age of ninety. She had been my patient more than forty years; and during that time, besides heavy domestic calamities, had undergone a number of attacks of pleurisy, one of pericarditis, a severe and protracted bleeding

* Etherization, with Surgical Remarks by John C. Warren, M.D., Emeritus Professor of Anatomy and Surgery, University of Cambridge, Surgeon at Massachusetts General Hospital, Boston. William D. Ticknor & Co., Boston, 1847, pp. 70.

from the stomach, with symptoms of malignant disease of this organ. She was once dangerously poisoned by eating partridge; moreover, by a fall she had a fracture of the neck of the thigh-bone, and soon after her restoration was attacked with senile mortification of the foot, from which, having suffered months of intense pain, she wholly recovered.

"Very temperate in her eating and drinking, and of a religious character, she was cheerful, notwithstanding all these visitations; appeared to enjoy life more as she grew older, went out freely, and made two or three excursions into the country, within a few weeks of her last illness.

"The dysenteric attack, which terminated her career, accompanied with symptoms of unusual severity, was only relieved for a very short time by the use of opium. After more than two weeks of illness, violent pain occurred in one of the feet, with discoloration, ending in gangrene. The pain of mortification suddenly ceasing under the use of opium, that of the abdomen returned, with convulsive twitchings of the limbs; and other remedies failing to mitigate these symptoms, inhalation of ether was employed with perfect relief.

"From the first inhalation to the period of her death, five days elapsed, during which a considerable number of etherizations were used, and with such effect that, as soon as any suffering occurred, she desired ether. In the intervals, her mind was clear; she arranged such worldly matters as remained unsettled, received the consolations of religion, and finally, under ethereal influence, her spirit imperceptibly took its flight."

Ether Intoxication.

"A few years ago there was published in the *Reporter** the 'confessions of an ether inhaler,' a member of our own profession, for whom it subsequently became our sad duty to sign a certificate of insanity.

"We are reminded of this by a paper in the London *Medical Record*, by Dr. Ewald, of Berlin, on a somewhat similar case. It is that of a man aged thirty-two, who was lately admitted

* *Medical and Surgical Reporter.*

into the Charité Hospital, under Professor Frerichs, suffering from general debility and trembling of the muscles. On inquiry, it was found that he was notorious in Berlin for intoxicating himself with ether, his abuse of which had reduced him to his present miserable condition. He was originally temperate, and had been a university student, passing all his examinations with credit; he was, however, of a mystical turn of mind. Unfortunately, a little more than nine years ago, there fell into his hands a medico-popular treatise, in which the use and effects of ether, used medicinally, were described, and a glowing account was given of its effect in quickening the creative power of the mind. He procured about two or two and a half ounces of sulphuric ether, and inhaled it from a handkerchief; the result being to produce insensibility for about a quarter of an hour, during which time he imagined that he lived for an indefinite time, and traveled over whole worlds. This condition, however, he was not again able to induce in so high a degree. Becoming gradually more and more addicted to his habit, he no longer confined himself to indulging himself in his own room, but with his etherized handkerchief before his face, he wandered through the streets, purchasing small quantities of ether at the druggists' shops, until, at last, he became so great a nuisance to them that many of them closed their doors against him. He was also turned out of his lodgings, on account of the annoyance produced by the smell of his breath, and became a houseless wanderer, reduced in means and in health. In the hospital there was no indication that his mind was affected; his memory was not impaired; his style of speaking was fluent. On one occasion an attempt was made to produce complete anæsthesia. For this purpose more than seven ounces were required; the ether being given by an inhaler, and loss being prevented by closing in the apparatus with cotton-wool. No sooner, however, was the inhalation stopped, than the state of insensibility passed off. He was then allowed to take the ether in his own way, by inhaling it from a handkerchief. Given in this way, it produced a stage of excitement, during which he danced about the room, talked nonsense, and appeared much pleased, but there was no true narcotism. It was not thought justifiable to subject him to other experiments with ether, as it was desirable to break through his habit. It is interesting, that his susceptibility to the action of cannabis indica was not impaired. This drug was given as a substitute for ether, and on the first occasion, too large a dose having been given, the result was the production of phantasms, such as are induced by the smoking of hasheesh."

The late Dr. Morgan, of Dublin, states that ether is employed in certain portions of Ireland as a substitute for whiskey.

A case has come under the writer's notice, in which a patient began the use of sulphuric ether in teaspoonful doses, as a nervine ordered by a physician, and ultimately increased the dose to one pint per day. When informed of its injurious character, she had lost her appetite, and suffered gastric disturbance; she gradually diminished the quantity and was able to give it up after a month or two. The only effect it had upon her was to give her apparent strength to go on with her teaching of music. Large quantities of ether have been taken internally, and, so far as we have been able to learn, no death has yet occurred from its use in this way.

Chronic Intoxication from Ether.*—The patient, a woman of forty-eight years, had been in the habit of swallowing after each meal a lump of sugar wetted with sulphuric ether, to relieve a difficulty in digestion. During the space of two months and a half preceding her admission to the hospital *de La Pitié*, she took, in this manner, a total of 180 grammes (nearly six ounces). When she had continued the practice for about seven weeks, trembling of the hands commenced. A week later she began to feel severe pains in the lower, front part of the chest, and between the shoulder-blades. She also suffered from vomiting of a whitish watery fluid, on rising in the morning. In a week more her gait became unsteady, and she suffered from trembling of the toes, cramps in the calves, and prickling sensations in the feet.

Upon admission to the hospital, she presented all the above symptoms. The pain resembled that which would be caused

* Martin. *Gazette des Hôpitaux*, May 10, 1870.

by two blisters, of eight or ten centimetres in diameter, the one placed a little above the epigastrium, the other at the same level on the back. It was intermittent, and was excited by any sort of aliment. There were regular slight twitchings in certain portions of the limbs. The strength of the hands was not diminished. Almost continual buzzing in the ears; muscæ volitantes occasionally, usually followed by a brief attack of frontal headache. Pupils slightly enlarged. Sleep undisturbed. No fever. Soft souffle at base of heart, and in vessels of neck, accompanying the first sound. No other important symptoms.

An emetic at entrance, a daily bath, a little opium at night, and abstinence from ether, constituted the entire treatment. Recovery was complete at the end of two weeks.

Vivisections.

An excellent use of ether may be made in regard to animal vivisections. Ether enables us to lull the sensibilities of the victim, tranquilly pursue the natural workings of the internal organs, and the changes which take place from experimental applications; while the student of surgery can accustom himself to those gushes of the vital fluid, which, in the human body, are viewed with so much terror by the unpracticed. Animals of any size may be etherized in a box, or by covering the head with an India-rubber sack, into which a mixture of ether and atmospheric air is forced.

Vivisections with Ether and Chloroform.

Prof. Schiff, of Geneva, states: "In our experiments, that is, in more than three thousand cases, we have adopted etherization with a view to preserve the life of animals; and that, with few exceptions, indicated elsewhere (Memoir on the Laryngeal Nerve), not a single case of death occurred. On the other hand, chloroform has cost us a considerable number of animals, when I have wished to push anæsthesia to its ultimate stage."

In our experiments we have proven, that even bromide of ethyl is safer in making vivisections, than chloroform.

CHAPTER XVI.

Ethers which have Anæsthetic Properties—Acetic Ether—Experiments by Dr. H. C. Wood on Animals, etc—Formic Ether—Byasson's Conclusions in regard to it—Hydriodic Ether—Properties and objections to its use—Methylic Ether—Dr. Richardson's Experiments with it—Bichloride of Methylene—Observations upon it by Dr. Jones, of Cork, Dr. Taylor and Spencer Wells, of London—Ethyl Iodide—Ethylene Bromide—Iodoform—Carbon Dichloride—Bromoform—Tetrachloride of Carbon—Butyl Chloride—Chloride and Bichloride of Ethylene—Ethyl Nitrate—Iodide of Methyl—Amylene—Chloral Hydrate—Acetic Aldehyde.

Acetic Ether ($C_2H_6C_2H_3O_2$).

Acetic ether is colorless, and has an agreeable odor and burning taste. Specific gravity 0.89; boiling point 165.2° F. If kept in contact with air, and in the presence of water, free acetic acid is formed. According to Dr. H. C. Wood, in pigeons and rabbits it produces perfect unconsciousness without as much previous struggling as when sulphuric ether is used, and has the advantage over that compound of being less inflammable; on the other hand, its volatility is less. No experimenter has employed this ether on man to produce anæsthesia.

Formic Ether ($C_2H_5CHO_2$).

Formic ether is a colorless liquid, recalling the odor of rum, and having an agreeable taste. Specific gravity 0.915; density 62.8; boiling point 127.3° F. It dissolves in nine parts of water, and all proportions in alcohol, ether, fixed and volatile oils. Byasson, made some experiments with it on animals, and found that this ether decomposed into alcohol and alkaline

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formiates through the alkalies of the blood. When inhaled, it lowers the temperature and induces asphyxia.

Hydriodic Ether (C_2H_4I).

Hydriodic ether is a colorless, non-inflammable liquid, having a peculiar ethereal odor and taste, soluble in alcohol, and nearly insoluble in water. It boils at 158.5° F.; specific gravity of liquid at 32°, 1.9755. Exposed to the air and light it liberates iodine and becomes brown, which irritates the nostrils and causes lachrymation, and is sometimes employed by inhalation to bring the system under the influence of iodine in chronic bronchitis and phthisis.

Methylic Ether $(CH_3)O_2$.

Methylic ether is a colorless and very inflammable gas, heavier than air, of an oppressive odor. It is soluble in water, wood-spirit, alcohol and ether. A saturated solution in ether, at 32° F., has been recommended by Dr. B. W. Richardson, who experimented upon himself, and found that there was no preliminary spasm excited in the larynx, or elsewhere. The pulse arose to ninety-six, and the anæsthesia was perfect; yet he objected to it because it rapidly volatilizes from its solution, and on account of its unpleasant odor. Dr. Carter says: "In Dr. Richardson's own hands I have seen the various (new) ethers act perfectly well, producing complete unconsciousness and relaxation of muscle without either struggling or sickness, and without unpleasant symptoms of any kind; but I cannot judge how far such results may have been due to the qualities of the agents employed, how far due to specially skillful or careful administration, or how far to the state of the patients themselves." *

* In specific gravity, boiling-point, etc., we have followed Prof. Wm. Allen Miller's "Elements of Chemistry," Part III., Organic Chemistry (London: Longman, Green, Reader & Dyer, fourth edition, 1869), or Prof. Maisch's National Dispensatory (Philadelphia· H. C. Lea, 1879).

Bichloride of Methylene (CH_2Ol_2).—**An Anæsthetic.**

PREPARATION.*—By acting on chloroform with nascent hydrogen.

$$CHCl_3 \times H_2 = CH_2Cl_2 \times HCl.$$

Boiling point, 40° C. (104° F.).*

CHARACTERS.—A colorless, volatile liquid with smell like chloroform.

This anæsthetic was carefully studied by Dr. Richardson, who gave it a very high character. This was 1867. His views were soon called in question by Nussbaum in Germany, and Tourdes, Hept and Péan in France, while Spencer Wells took up the subject and defended it in England. For years it was fully tested at Moorfields Ophthalmic Hospital; but two deaths occurred without any indication of danger from the state of the pulse or heart. In 1879 we had it prepared by Dr. W. H. Greene, and even with all his care the specimen contained chloroform, and was very costly. It was then tested by the late Dr. Washington Atlee, the article having been obtained through Spencer Wells; but Atlee did not find it as satisfactory in ovariotomy as his mixture of ether and chloroform. Subsequently more deaths occurred from its use.† Spencer Wells stated at the meeting of the British Medical Association, 1877: "Whatever may be its chemical composition, whether it is chloroform mixed with some spirit or ether, or whether it is really bichloride of methylene, I am still content with the effects of the liquid sold under that name." It is, we believe, still employed in the "Samaritan Free Hospital" of London by the officers in charge; but Spencer Wells has retired from the institution where he achieved such wonderful results. The operation of ovariotomy has been improved upon by Mr. Lawson Tait, under the use of ether, namely, one hundred and thirty-nine consecutive operations without a single death.

* ACTION.—Like that of chloroform, but more rapid, though a larger quantity is required. It depresses the action of the heart more than chloroform, and death is even more sudden and without warning symptoms.

† See list of deaths, with details, p. 270.

Four years ago MM. Regnauld et Villejeau (*Journ. de Pharm. et de Chem.*, 1878) undertook a research which has recently been completed, and which led them to the following results: that the commercial methylene, obtained through agents accredited by Sir Spencer Wells, and therefore genuine, was a mechanical mixture composed of four parts of chloroform and one of methylic alcohol. In some comparative experiments they administered the two agents, finding that while the commercial agent behaved precisely like chloroform, the genuine methylene bichloride produced choreiform and epileptiform convulsions.

Bichloride of methylene was discovered in 1840, but was introduced by Dr. B. W. Richardson. For some years it has received the fullest trials at Moorfields Ophthalmic Hospital, London, where they now use, almost exclusively, sulphuric ether. Within the two years' trial of the bichloride of methylene in the hospital above referred to, two deaths occurred without any indication of danger from the state of the pulse or heart; in the last instance of death, it occurred from the exhibition of one drachm and a half of methylene to a healthy sailor, aged twenty-seven years. It has been employed, not only in short operations, but also in such operations as ovariotomy. "With this agent, Dr. Jones,* of Cork, has had considerable experience, having used it constantly for all minor operations in hospital and private practice for over seven years. Hard drinkers or old tipplers bore this form of anæsthetic badly, and on some occasions he has been alarmed and compelled to desist from its administration; he also found it to be dangerous in old cases of chest affection. His mode of administration was in a conical gauze bag lined with flannel, and containing a small sponge."

Mode of Preparation.—Bichloride of methylene is both difficult and expensive to make. It is prepared by heating one part of methylic alcohol, two parts of common salt and three parts of sulphuric acid, and passing the gas through water into a glass globe, into which chlorine gas is conducted at the same

* Medical Responsibility in the Choice of Anæsthetics. By H. M. Jones, M.D., Surgeon to Cork Ophthalmic Hospital. Cork, 1876.

time. The globe is drawn out below so as to form a thin tube, which passes into one tubulure of a Wolfs bottle, the second tubulure being connected by means of a bent glass tube with a second Wolfs bottle, this second bottle being placed in ice; the other tubulure of this second bottle is connected with a flask cooled by means of a freezing mixture. The liquid which is condensed in the Wolfs bottles is chiefly chloroform, while that in the flask is almost pure methylene dichloride, or bichloride of methylene.

Bichloride of methylene is a colorless fluid, having an odor much like that of chloroform. It is pleasant to inhale as a vapor, and produces very little irritation of the fauces and air-passages. Its specific gravity is 1.344, and its boiling point 105° F. From its easier evaporation, it requires freer administration than chloroform; and because of its denser vapor, less quantity than ether.

Bichloride of methylene has no action on test-paper, is soluble in alcohol and ether and is frequently mixed with other agents in England, this being easily accounted for by the difficulty in making it, and its cost. These various mixtures give us a clue to its unequal character in regard to safety, in the hands of different experimenters. Its vapor has a density of 3.012, and burns with a bright flame. Six deaths have occurred from its use. There is no doubt that it has many of the dangerous qualities of chloroform, as it belongs to the same chemical family, and death results from syncope, with dilated pupils.

The bichloride of methylene was employed in the Samaritan Free Hospital, of London; and the officer in charge of the anæsthetic states it to be very satisfactory. Junker's form of apparatus is used for its administration. The mortality from this agent is two in ten thousand, or one to five thousand.

As we have stated above, the strongest advocate for the bichloride of methylene or chloromethyl is Sir Spencer Wells,* who believes that with this agent he has had all the advantages of complete anæsthesia, with fewer drawbacks than any other; this is his experience of five years, and of three hundred and

* Meeting of British Medical Association, 1877.

fifty serious operations. He gives it diluted with air by Junker's apparatus, and, from his doubts of its composition, we suspect what he employs to be a mixture of methylic alcohol and chloroform. These are his own words: "Whatever may be its chemical composition, whether it is chloroform mixed with some spirit or ether, or whether it is really bichloride of methylene, I am still content with the effects of the liquid sold under that name."

Dr. Taylor * also states that "a mixture of chloroform and ether has been sold as bichloride of methylene. On shaking this mixture with water, the chloroform is separated and sinks." He reports three deaths from this agent, and the allegation, therefore, that the vapor possesses any greater degree of safety than chloroform in surgical practice, is not supported by facts.

Death from the Bichloride of Methylene.

Case 1.—A death from bichloride of methylene took place at the Ipswich Hospital, England, which affords a remarkable illustration of the relative safety of that drug and of ether. The patient was fifty-six years of age, and was to have had a necrosed bone removed from his leg. He was first given the methylene, which was changed for ether, for some cause which is not stated, but which may have been some alarming symptom produced by the methylene. Having taken the ether with safety until anæsthesia was obtained, the operation was proceeded with; but, the patient being allowed to wake too soon, the methylene was again resorted to; in fifteen seconds he was dead. No *post-mortem* examination was made, but some ingenious person hazarded a guess that there had been unobserved apoplexy; and the jury, happy at any alternative except condemnation, adopted the hint, and voted the death accidental, and the medical officers free of all blame. A most unsatisfactory case in all its aspects, and one which should please the medical officers inculpated less than any one else; such a fatality may be hidden away by such a verdict, but no

* On Poisons, op. cit. p. 629.

one can be satisfied, without evidence, that the case was not one of anæsthetic manslaughter.—*Medical Press*, London.

CASE 2. *Pharmaceutical Journal*, 1871, p. 875. Male, æt. forty. Given during an operation on the eye; result, death in five minutes. *Post-mortem*, congestion of the lungs.

CASE 3. *Pharmaceutical Journal*, 1871, p. 875. Male. Inhaled ʒ iss; result, death rapid. *Post-mortem*, no special post-mortem appearances.

CASE 4. *Lancet*, October 23d, 1869, p. 582. Mr. Marshall. Male, æt. thirty-nine; ʒ iss. The man was sitting in a chair during the time of administration, and preparing for an operation. Symptoms, pupils slightly dilated; no stertor or lividity of countenance; result, death.

CASE 5. One of the most painful cases of death from the vapor of methylated ether occurred in the Birmingham Hospital, England, under Mr. Tait. A patient was about to undergo the operation of ovariotomy; five drachms of methylated ether in vapor were administered to her on a fold of a towel, by the resident medical officer. The pulse suddenly stopped, the pupils became dilated, and respiration ceased; all efforts at restoration were fruitless. On inspection the heart and all the other organs were healthy, except the ovary.—*Lancet*, July 5th, 1873, p. 23.

" Kappeler, says, that experience shows it to be as dangerous, if not more so, as chloroform, and furnishes a list of nine cases of death from its use. Unfortunately, I have not had a copy of Kappeler's work at my disposal; but in looking over the details of cases published in the journals to which I have had access (*Med. Times and Gaz.*, 1869, ii. p. 524; *Lancet*, 1869, p. 582; *British Medical Journal*, Sept. 1871; *Pharmaceutical Journal*, 1871, p. 875, two cases; *British Medical Journal*, August, 1872; *Lancet*, 1873, i. p. 23; *Ibid.*, 1877, ii. p. 26), I have found that in several of them doses of a drachm and a half caused death, and, judging from the symptoms, it must be undoubted that death ensued in some of them, at least from cardiac paralysis. The experiments made by the British Committee, on frogs, show that the heart becomes slowed and is soon stopped, and that *the heart was affected the same as by chloro-*

form, the first sign of paralysis being the distension of the right ventricle. Even were it not certified by the above Committee that it affects the heart like chloroform, the fact of death occurring after doses but ordinarily sufficient to produce anæsthesia is sufficient to impress every one with the truth that it acts, like chloroform and ethyl bromide, wholly out of proportion to the dose."—(*Reichert.*)

Dr. Dudley Buxton writes: "I believe I am accurate in saying Sir Spencer Wells obtains his methylene from only one source, and I am unaware that it is to be got elsewhere in England. The methylene so obtained was tested clinically, and found to produce the usual anæsthetic trance. It was then submitted to chemical analysis, and a result obtained which showed it to be composed of four parts methylated chloroform diluted by one part of methylic alcohol. Subsequently these investigators prepared some genuine bichloride of methylene ($C_2H_2Cl_2$) which they administered to animals, with the result that no anæsthesia appeared, but in its place wild excitement, convulsions and death."

Methylene was carefully studied by Dr. Richardson, who gave it a very high commendation. His views were early called in question by Nussbaum in Germany, and Tourdes and Hept and Péan in France, while Sir Spencer Wells took up the cudgels in its defence. Subsequently, several deaths occurring, the belief in this agent became shaken. It was further objected by the Anæsthetic Committee of the British Medical Association that the methylene was probably not a simple body. Six years ago, MM. Regnauld et Villejeau (*Journ. de Pharm. et de Chim.*, 1883) undertook a research which has recently been completed, and which led them to the following results: that the commercial methylene obtained through agents accredited by Sir Spencer Wells, and therefore genuine, was a mechanical mixture composed of four parts of chloroform and one of methylic alcohol. Their proofs we cannot detail. They next investigated true methylene dichloride—that is, methylene bichloride —a substance very difficult to prepare pure, and very costly. In some comparative experiments they administered the two agents, finding that, while the commercial agent behaved precisely like chloroform, the genuine methylene bichloride produced choreiform and epileptiform convulsions. Unless any flaw can be shown in the work of these gentlemen, methylene cannot, we take it, be accredited with any virtues greater than belong to the long-known mixtures of chloroform and alcohol. Obviously, no further discussion on our part is needed.

Ethidene and amylene have, unfortunately, been discredited, as deaths have occurred during their use. Those attributed to amylene are, according to M. Péan, attributable to causes other than the agent employed; and the same may well be said of several, notably the one recorded by Mr. Clover (*British Medical Journal*, 1878), with regard to the fatalities of ethidene. The behavior of the group before us reveals, in a striking degree, the working of laws which connect their behavior towards the organism with the molecular weight of the agent. Thus, Dr. Richardson, comparing a number of them, says: "There appears to be reason for the belief that the lethal energy of an anæsthetic is clearly related to the molecular weight of the substance, increasing directly as its weight increases." However, in summing up the case of the various members of the carbon-series in which chlorine occurs, we think we must admit that, as far as the evidence is now before us, they are all dangerous anæsthetics.

"Hydriodic Ether *or* Ethyl Iodide,

also used by Nunnelly (*loc. cit.*, p. 324), was found to be so dangerous as to entirely preclude its use in medicine for anæsthetic purposes; and he states, that whatever anæsthetic property it might possess (and this is not insignificant), it never could be employed in practice, as its action is so very deleterious; for out of the four animals experimented upon, three of which were rendered insensible, all died, and the fourth had not sufficient of the vapor to render it in the least insensible; and yet, for two or three days, it was doubtful whether it would recover. Like the bromide of olefiant gas (ethylene bromide), its immediate effects were not so dangerous, as the consequences of inhalation were in a few hours; even when not enough to produce insensibility had been used, and when the animal to all appearances had been perfectly well, death would supervene. In one case the odor of the ether was distinctly perceptible in the brain twelve hours after death, and Nunnelly thinks that death was caused by *blood-poisoning.** Therapeutically it has been used in recent years, '*by inhalation to bring the system speedily under the influence of iodine.*' (*National Dispensatory*, 1880, p. 114.)

"Bromide of Olefiant Gas or Ethylene Bromide

was also condemned by Nunnelly (*loc. cit.*, p. 327), who stated that, although it produced insensibility, it caused the respiration to become laborious, and although the appearances of distress speedily disappeared when the animals were released, yet in a few hours they all, without exception, died. He further remarks that in this respect it differs from other (?) anæsthetics, because of the animals appearing well immediately following the experiments, but soon dying. He attributes this effect to *blood-poisoning.*

"Iodoform

was not sufficiently volatile to cause anæsthesia (Nunnelly), but, from what we know of its use, when given per stomach or used locally, it possesses powerful anæsthetic (analgesic) properties. Unfortunately it has not been used sufficiently internally, nor have physiological experiments been pursued to such an extent as to give us an accurate knowledge of its action on the economy; yet we do know that it diminishes the pulse-rate, produces muscular and nervous debility, and is decomposed in the body, and that, when applied to mucous, serous or abraded surfaces, it *becomes decomposed by the fat, and the iodine is eliminated from the body in the form of soluble iodides.* If iodine is liberated in the system, no further comment is needed." (See Iodoform under Local Anæsthetics.)

* Quotations on pp. 273–280 chiefly from Professor Reichert.

Carbon Dichloride or Chloric Ether

has been used to a sufficient extent to indicate that it produces distinct cardiac depression.

Bromoform,

which possesses undoubted anæsthetic properties, was found in experiments of Dr. Reichart, to powerfully depress the heart, and in one experiment on a small dog the intravenous injection of thirty minims of the preparation caused immediate cardiac arrest. Consequently, it was considered useless to pursue any further investigation in this line.

"Tetrachloride of Carbon

(CCl_4) was used by Laffont (*American Dispensatory*, 1880, p. 354), who found that it caused great debility of the heart, and lowering of the vascular tension. Simpson (*Medical Gazette*, 1865, ii. p. 651) previously used it under the name of *Bichloride of Carbon*, or *Chlorocarbon*, and more recently the same compound has been used by Smith (*Lancet*, 1867, i. pp. 575, 660). The latter observer found, in the post-mortem examinations of the animals experimented on, that the auricles were much distended with blood, and especially on the right side. He noticed that the heart did not beat after the cessation of respiration, and that the pulse was decidedly lowered. In conclusion, it is stated that 'when pushed to extremes, it seems to destroy life by causing an arrest of the circulation of the blood through the lungs, a distended condition of the right side of the heart, an insufficient supply of blood to the left side of the heart, and consequently diminished systemic circulation.'

"Chloride of Ethydene, or Ethylidene or Ethidene,

was first used by Snow, (*Anæsthetics*), and more recently by Liebreich (*Med. Times and Gazette*, 1870, i. p. 642); the British Medical Association Committee ('Action of Anæsthetics,' *British Medical Journal*, 1879); Bird, (*Medical Times and Gazette*, 1879, i. pp. 62); and Reeve, (*New Remedies*, Nov. 1880, p. 334—quoted from *Chicago Med. and Surg. Examiner*, June, 1880). Liebreich, considers it somewhat safer than chloroform; the British Committee found an enormous diminution in the arterial pressure, and that the heart-beats became so infrequent as to be virtually ineffectual in supplying the respiratory centres with blood. Bird esteems it a powerful cardiac stimulant, and states that all the patients under its influence presented the appearance of a strong cardiac stimulant, but that he would not like to keep a patient long under its influence for fear of a reaction in the opposite direction. His investigations were not carried far enough to justify this conclusion of its cardiac action, and, as his conjecture is contrary to the results of all other investigators, it must be rejected as untenable. Reeve found a diminution of blood pressure, which differed from that caused by chloroform, because it did not advance to complete extinction, nor exhibit such wide variations in its effects at different times in the same animal. A death from its use in Berlin has been reported by Kappeler (*loc. cit.*). Steffer (Binz's 'Evidence of Therapeutics,' p. 69) says that it resembles chloroform in ultimate action, yet is not so dangerous.

"Ethylene or Ethene Bichloride, or Dutch Liquid, was used by Nunnelly (*loc. cit.*), who speaks of it in a decidedly laudable way, stating that just as small a quantity will produce anæsthesia as chloroform, but that a much larger quantity is required to destroy life. Simpson (*Edinburgh Medical Journal*, 1848, vol. viii. p. 740) also made some investigations with it, and found that when its vapor was inhaled, it caused so much irritation in the throat that but few persons could endure inhaling it until anæsthesia was produced, and that the condition of anæsthesia was not attended with any excitement of the pulse. On himself it produced such a degree of irritation in the throat that it did not disappear for many hours. Recently, the British Committee (*loc. cit.*) used it, and report that no anæsthesia was produced up to the commencement of convulsions. The results of a series of experiments (*Phila. Med. Times*, May 7, 1881) made by Reichert with this compound indicate that it is a powerful anæsthetic, and that it fulfils considerable that Nunnelly claimed for it.

It is undoubtedly a direct cardiac depressant. Why the British Committee got such anomalous results is rather curious."

Butyl Chloride

(British Committee) caused the cardiac pulsation to become weaker, and finally extinguished; while *Methyl Chloride* only effected drowsiness. *Isobutyl Chloride* was not noticed as regarding any cardiac action.

Bichloride of Ethylene ($C_2H_4Ch_2$).

(DUTCH LIQUID.)

Bichloride of ethylene is a colorless, oily liquid, having an ethereal odor resembling that of chloroform and a sweetish taste; specific gravity 1.270, boils at 185° F.; sparingly soluble in water, and freely soluble in alcohol and ether; it is inflammable, and burns with a yellow flame with a green border. This agent, when tested by Prof. Simpson, was found so irritating to the throat that it could not be used long enough to induce the anæsthetic state. By the action of chlorine upon Dutch liquid a number of chlorinated compounds may be obtained, which are isomeric with chlorinated compounds. Numerous careful experiments with ethylene bichloride were made by Professor Reichert, of the University of Pennsylvania (see pamphlet "Ethylene Bichloride as an Anæsthetic Agent," *Phila. Med. Times*, May 21 and June 4, 1887).

Early in his experiments he learned that "in order to know whether an animal was completely anæsthetized, it was not necessary to consult the conjunctiva, *but merely to watch the respirations, for just so soon as they became very frequent the animal was either anæsthetized or so near and rapidly approaching that condition that the inhaler could be removed and the operation proceeded with.* If after the second stage is very pronounced the administration of the ethylene be continued, *the animal invariably dies from a failure of the respiration, and never in a single instance could he induce death by a stoppage of the heart by the inhalation of the vapor, no matter how concentrated the vapor was.*

"The dose required to produce anæsthesia was about the same as chloroform, for the difference was so slight as to be unnoticeable.

"The diverse and interesting results of these parallel experiments with chloroform are so valuable as scarcely to be overestimated in a comparison of the relative safety of the two compounds, as the pulse in the ethylene experiment could be detected on the tracing for over twenty-five minutes, notwithstanding that the animal was continuously inhaling the vapor during the whole of this time, while in the chloroform experiment but a single dose was placed on the inhaler, the pulse-curves rapidly diminished in size, and the pressure fell to twelve millimetres in a little over two minutes, and the pulse was extinct.

"It needs no further argument to prove that this article (or, probably, ethydene chloride) should replace chloroform in such cases where ether cannot be used; but, as it is inflammable, care must be exercised in its use at night, and, as it is a cardiac and respiratory depressant (in toxic amounts), the same cautions should be observed in its use, and never should it be employed, if possible, without amyl nitrite at hand."

Ethylene Ethylate and Ethylene Methylethylate were experimented with, and, although each of them possessed some slight anæsthetic powers, they were so feeble in this respect and caused such distress in breathing that they were abandoned as useless.

"Ethyl Nitrate

was used by Simpson, who found it easy and pleasant to inhale, and to possess very rapid and powerful anæsthetic properties, and that small quantities, such as fifty or sixty drops, sprinkled on a handkerchief, produced insensibility after a few inspirations. Shortly after, Nunnelly stated that it possessed not much, if any, anæsthetic power; and my own experiments confirm this, as the following result will show:

"*Rabbit.*—Time, 12.32. Added one drachm to inhaler; .32½, struggles; .33, breathing deeper and slightly faster; .34, no change;

.35, added a second drachm to inhaler; .35½, respirations again temporarily increased; .37½, orbital refluxes slightly diminished (?); .39, added a third drachm to inhaler; .40, respirations increased; .43, animal not anæsthetized, but somewhat drowsy, and, although the inhalation was continued for several minutes, no anæsthesia was produced."

Iodide of Methyl (CH_3I).

This compound was discovered by Dumas and Peligot in 1835, and is made by combining phosphorus, iodine and methylic alcohol. A safer and more agreeable preparation of it is made, according to Wanklyn, by mixing iodide of potassium and anhydrous methylic alcohol in a retort, in equivalent proportions; dry chlorine gas is passed into the mixture, which is then distilled, and the distillate agitated with water and rectified.

Iodide of methyl is a colorless liquid of an ethereal odor. Specific gravity, 2.199, at 32° F.; it boils at 110° F., and burns with difficulty, giving off violet vapors. This agent was proposed in 1868 by Dr. B. W. Richardson as an anæsthetic, but was found by him and by Prof. Simpson as unsafe. It has been recommended as a local anæsthetic in cancerous cases.

Amylene.

The vapor of this liquid was introduced by the late Dr. Snow as a substitute for the vapor of chloroform. It produces a loss of sensibility without causing complete coma or stupor. Its use has already led to at least two deaths, and is, according to Dr. Taylor,* not so safe an agent as chloroform vapor for surgical purposes. The only appearance met with in one fatal case was an emphysematous state of the lungs, or excessive dilatation of the air-cells (*Medical Times and Gazette*, April 4th and 18th, 1857, pp. 332, 381), and in the other a distension of the right cavities of the heart with dark fluid blood. There was no congestion of the brain, and no smell of amylene perceptible in the body.—*Medical Times and Gazette*, August 8th, 1857, p. 133.

* On Poisons, op. cit. p. 627.

"Chloral Hydrate,

Although not an anæsthetic in a therapeutic sense, has, like chloroform and ethyl bromide, given us painful instances of its acting at times altogether out of proportion to the dose. Fuller (*Lancet*, March, 1871), quotes a case, where thirty grains caused death in a young lady. Schwaighofer, (*Irish Hospital Gaz.*, 1873) reports another, of a drunkard, in which a drachm produced death; and three other cases (Reynolds, *Practitioner*, March, 1870; Watam, *Med. and Surgical Reporter*, January, 1871; Fuller, *loc. cit.*), in which forty-five, eighty, and thirty grains, respectively, caused alarming symptoms, and, from the large dose, death nearly ensued. Death has resulted from a dose of ten grains (*American Dispensatory*, 1880, p. 396). Other deaths have been reported (*Medical Times and Gaz.*, 1871, pp. 1831, 672; Norris, *Lancet*, 1871, i. p. 226, and Browne, *ibid.* p. 574); and in some of these cases indisputable evidences of its power of weakening the heart were present. Did chloral hydrate become decomposed in the system into formic acid and chloroform (Personne, *Journ. de Pharm. et Chimie*, 1870; and Pellogio, *Schmidt's Jahrbücher*, bd. cli. p. 89; Liebreich, *Wiener Med. Wochensch.*, Aug., 1860), we could readily account for its acting at times in a manner wholly disproportionate to the dose, and for its being a cardiac depressant; but, as recent investigations disprove this theory (Hammertin, *Schmidt's Jahrbücher*, bd. cli.; Rajursky, *Ibid.*, bd. cli.; Amory, *N. Y. Med. Jour.*, 1870; Djurburg, *Schmidt's Jahr.*, bd. cli.; Leurison, *Archiv. Anat. u. Phys.*, 1870), we must look elsewhere for this toxic principle."

Replies received from Dr. B. W. Richardson, who introduced Methylene.—They deal with points of importance to the general practitioner, working short-handed, as is usually the case.

1. "Methylene can be given from any simple inhaler; but, as it evaporates more quickly than chloroform, it must be confined by some structure that will fold into a funnel, like strong paper, a piece of starched linen, or a fold of leather."

2. "It will keep as long as chloroform in a cool place and

away from the light. I narcotized quite recently from a specimen which had been in keeping many months."

ETHYLENE CHLORIDE ($C_2H_4Ch_2$) has been found to possess the singular and unpleasant property of causing opacity of the cornea. The effect was observed not long since on dogs experimented upon by Drs. Raphael Dubois, and L. Roux, of Lyons. At the same time it was noticed the opacity takes place no matter how the chloride has been administered. Further experiments with a view to determine the cause of the phenomenon have proved that the accident is due to the direct action of the chemical through the aqueous humor, having for effect to dehydrate the cornea, and thus deform and harden it.—*Paris Letter*, *Therapeutic Gazette*, *Oct.* 15, 1888, p. 709.

Methylene Chloride as an Anæsthetic.

In a recent article on this drug by Dr. Eichholz, and Professor Genther (*Deutsche Medizinal Zeitung*, August 22, 1887, and *Therapeutic Gazette*, Dec. 15, 1887), the authors claim, that until now the pure article has never been tested as an anæsthetic on man. This is a mistake, as we had the article chemically pure, prepared by Dr. Greene, of this city, and made numerous tests on animals and man, and our experiments coincided with theirs, that it was in its action like chloroform, the only advantage being that methylene chloride is less dangerous in its action on the heart.

They recommend a mixture of methyl alcohol with chloroform, a mixture which we consider more dangerous than chloroform pure, as it is apt to be all alcohol first and almost pure chloroform at the last.

They conclude their paper with the following sentences: First, that the substance heretofore employed as methylene chloride is a mixture of chloroform and methyl alcohol (this is not new, as we published the same fact in our second edition, also in 1887, in *Med. and Surg. Reporter*, of this city); second, this mixture is to be preferred to chloroform for the production of narcosis (this is not good or safe advice, for the reasons before stated); third, that pure methylene chloride produces narcosis quite as rapidly and as profound as either of the above preparations; fourth, that the action of pure methylene chloride on the circulation and respiration is by far less dangerous than that of either of the other preparations (the disadvantages of this preparation are, first, that it produces salivation; chloroform, pure, does not; narrowing of the pupil, which chloroform does not; rigidity of muscles of the neck, which chloroform does not).

M. Polaillon, recently read a memoir before the French Academy of Medicine (*La Pratique Médicale*, July 2, 1889), in which he communicated the results of his experiments with methylic chloroform (four volumes of chloroform containing one volume of methylic alcohol). He was led to the employment of this anæsthetic through the fatal results which recently followed at his hands the employment of chloroform as an anæsthetic; and he has now employed this methylic chloroform in seventeen different instances in women. In two of these the anæsthesia was incomplete, while in fifteen others the sleep was very satisfactory, and might have been readily prolonged indefinitely without inconvenience. Vomiting occurred three times after wakening, once during the narcosis, and in this case the vomiting produced prolapse of the intestine after a laparotomy. He believes, however, that the sleep produced by methylic chloroform has advantages over that due to ordinary chloroform,—the awakening is much more easy, and the discomfort much less. He contends, therefore, that it might be substituted with advantage for ordinary chloroform. Polaillon has likewise employed this agent in ten operations on the male subject; in four cases it was not possible to narcotize the patient, although the attempt was persisted in for more than half an hour. In one case, at the end of seventeen minutes, there was only reduction of sensibility without anæsthesia. In another case, twenty-three minutes after the commencement of administering the anæsthetic, symptoms of asphyxia were noted, and necessitated the performance of tracheotomy. In four cases the anæsthesia was complete, once in ten minutes, one between ten and fifteen minutes.

ETHIDENE DICHLORIDE ($C_2H_4Cl_2$) is isomeric with the ethylene bichloride. In the journal of the *British Medical Journal* will be found the reports of their committee appointed to investigate the action of anæsthetics. The latest was that of December 18, 1880. In conducting these investigations two lines were followed: first, to discover wherein the special dangers of chloroform consist; and second, to attempt to find some safer anæsthetic.

Of a considerable number of substances which were made trial of in the course of this inquiry, ethidene dichloride appeared to yield the most promising results; and, consequently, the actions of this compound were submitted to more special investigation. So long ago as the year 1848, attention was directed to ethidene dichloride by Drs. Simpson and Snow, who had employed it in several cases; and since then it has been made use of by Nunnelly, Liebreich, Langenbeck and various other observers. The committee were fortunate enough to be able to make trial of anæsthetics in the wards of the Western Infirmary, Glasgow; and they were thus enabled to compare the action of ethidene and chloroform on the human subject. They give details of fifty unselected cases in which each drug was administered to produce anæsthesia during some surgical operation. From the tabular statements so obtained we may extract some important facts. The average dose of ethidene was 1.8 cubic *centimètres* for each minute during which the patient was under the influence of the anæsthetic; while, in the case of chloroform, the dose was somewhat smaller, the corresponding figure being 1.7 cubic *centimètres.* The time required to anæsthetize with chloroform was 1.1 minute greater than that necessary in the case of ethidene; and sickness appears to have been more prominent during the administration of chloroform than during that of the other anæsthetic. The most important difference in the action of the two anæsthetics, as observed at the bedside, consists in their influence on the pulse-respiration ratio. Charts are appended to the report which represent this in graphic form. In only one case did the pulse fall to 64 per minute during the administration of ethidene; and, in a large number of instances, the pulse and respirations were peculiarly regular.

The report before us adds to this the effect of ethidene on the blood-pressure, and shows that this substance stands in an intermediate position between the other two anæsthetics; causing more lowering of pressure than ether, but less than that produced by chloroform.

The results of numerous trials of this agent have not carried out the original favorable opinion of the British Committee. It has been found to cause decided lowering of the respiration, with severe attacks of asphyxia and other alarming symptoms. With several cases death has followed its use.

Aldehyde (C_2H_4O)—Ethaldehyde, Acetic or Ethylic Aldehyde.

Specific gravity, 0.801 (32° F.); boiling point, 22″ C. (71.6° F.); vapor density, 1.532.

Acetic aldehyde is a very volatile liquid, produced by the oxidation and destructive distillation of alcohol and other organic compounds. It is a transparent, colorless liquid, resembling the ethers, having a pungent, suffocating odor. It is very inflammable, and burns with a beautiful blue flame. It is mixed with water, and dissolves in alcohol and ether. It dissolves sulphur and phosphorus, also iodine, forming a brown solution and becomes chemically changed by the contact or addition of an oxidizing agent which will reduce it to acetic acid. Aldehyde possesses anæsthetic power; small quantities of the vapor retard the pulse, large quantities accelerate the pulse and respiratory movements, while larger doses arrest them, causing irritation of the glottis and constriction of the chest, while the action of the heart is disturbed, with a tendency to entire arrest of respiration. It has therefore been classed as a dangerous anæsthetic. Three to five cubic centimetres (thirty-six to sixty grains) injected in watery mixture into the veins of a medium-sized dog, produce almost immediate insensibility and arrest of respiration. Death is preceded by dilatation of the pupils.

Every alcohol can become an aldehyde by oxidation. The one referred to differs only in the following point: first, by the prefix par multiplying the chemical equivalent by four—$C_6H_{12}O_3$.

Again, at the freezing-point it is, like oleic acid, a solid. In its physical properties it is precisely the same as the one referred to. It is also, according to our experiments, an anæsthetic—forty-five minims, being inhaled on a towel, produced a choking, disagreeable sensation with fulness of the head, but slight anæsthetic effect, and instead of accelerating the pulse, it reduces it from 96 to 80. A second experiment was made with sixty minims, when there was considerable irritation of the nose and throat of a peppery character and no full anæsthesia, but the pulse rose to 114. The respiration was but slightly accelerated, and on recovery, which was rapid, there was no severe headache and no sick stomach or vomiting; there was, however, considerable irritation of the conjunctiva and slight dilatation of the pupil. The writer has tried it on himself and other patients, but with one exception it has been unsatisfactory. In a case of neuralgia of the fifth pair, cause exposure, it was given in forty-five minim doses and the patient was relieved and slept all night, and did not find the taste so disagreeable when mixed with a wine-glass of sugar and water. A case of valvular lesion of the heart, the patient not being able to sleep unless under the influence of $\frac{1}{8}$ of a grain of morphia suppos. and $\frac{1}{150}$ of atropia, slept only two hours from 30 minims of paraldehyde. A second larger dose, 45 minims, had no better result in spite of the following mixture:

Paraldehydi	♏xxx.
Aquæ	ad ℥jss.
Syrupi aurantii	ʒii.
Spts. chloroformi	♏xxx.

M. ft. haustus. Hora somni sumeod.

CHAPTER XVII.

Etherization by the Rectum.

LIKE all discoveries in science and in the medical arts, there has to be a beginning and a gradual advance in observation and experiment. It is stated that* the first suggestion of the possibility of anæsthesia by the rectum in the human being was by M. Roux,† of Paris, in 1847; but it was a mere idea that such a condition as insensibility could be produced by the administering of ether per rectum.

This was followed by experiments of Dr. Vincenti y Nedo,‡ who injected ether into the lower bowel of rabbits and produced anæsthesia, followed by inflammation, and in some instances the death of the animal.

The next year (1848) M. Mara Depuy, of Paris, produced the same injurious results, even when the ether was diluted with water.

In 1847, Professor Pirogoff, of Russia,§ to whom the credit is due of first inducing insensibility in the human being by means of the vapor of ether per rectum, began his experiments by injecting the vapor of ether, and ether itself largely diluted with water, for the relief of neuralgia, spasm of the muscles of deglutition, lead colic, inflammatory pains of the joints, and cancer of the intestinal canal, and reported favorably of its anodyne and antispasmodic effects. He subsequently recommended an apparatus for the use of the vapor, which was employed by other surgeons in Europe.

* *Virginia Medical Monthly*, Richmond, October, 1884, p. 361.

† Compt. Rendu. de l'Academie des Sciences, February 1, 1847.

‡ *Gazette Medicale de Paris*, 1847.

§ Recherches pratiques et physiologiques sur l' etherization, St. Petersburg, 1847.

Advantages of Ether by the Rectum.

The advantages of ether by the rectum are as follows: It avoids the first and chief danger to the respiration, the production of stertor, and the falling back of the jaw and tongue. Second danger: It avoids the irritating influence of ether upon the mucous membrane of the throat and air-passages—first shown by croupy respiration and flow of a frothy mucus. Third: It prevents a dangerous complication—tetanic setting of the inspiratory muscles of the chest; no air enters; respiration with the diaphragm fails to fill the lungs, and the patient dies as in true tetanus. Fourth: It prevents simple exhaustion, another source of danger, as the patient can take nourishment before the operation, to sustain the system. Death is not so apt to occur from slowly-failing respiration when the ether is employed by the rectum. Fifth: It avoids the distressing and exhausting vomiting and lasting nausea which is so disastrous in abdominal section, in operations for hernia, and sections of the cornea and iris.

The following is one of the most recent reports of the administration of ether per rectum, which we are able to collect, (*British Med. Jour.*, August, 1888), and the cases were under the care of F. H. Appleby, of Newark, England:

"ADMINISTRATION OF ETHER PER RECTUM.—I have this day, for the fourth time, administered ether *per rectum*, and send you the following short notes of the case, which may possibly be of interest to your readers:

The patient was a woman, aged 29, who has had four children; a total abstainer, and in fair health. She required the extraction of the whole of the teeth in the upper jaw, twelve in number; some were badly decayed, others were stumps. Mr. R. F. H. King, was the operator, and the operation was performed in his operating-room. The ether was administered through a simple apparatus made for me by Messrs. Maw, Son, and Thompson; the ether used was of the specific gravity of 0.717, and its boiling point 74° F. Precisely two minutes after the commencement of administration the characteristic smell was detected in the patient's breath; at the same time she remarked, 'Oh, I can taste it.' In 7 minutes 56 seconds, she was sufficiently under its influence for Mr. King to commence, and the administration was continued until eight of the teeth had been extracted; then, exactly ten minutes from its commencement, it was discontinued, and the remaining four teeth were extracted without any sensation of pain. The whole operation lasted exactly fifteen minutes. The teeth were very awkward to extract, and could not be taken out hurriedly, as they were very brittle, and required great care. The amount of ether used was fourteen drachms; and the sole discomfort complained of by the patient was a sense of heat in the rectum. The pulse was quickened very considerably, going up from 80 to 132, and being full and bounding; after the expiration of eight minutes it slowed down to 108, and became soft; it was always regular. The respiration was not interfered with in the least, and we could not tell that it varied at all. There was no sickness, and twenty-one minutes from the commencement the patient rose and walked with assistance into another room. She was exhilarated, and remarked that she felt rather stupid, but had not felt the extractions. Of course, the anæsthesia was not pushed to a sufficient extent to produce insensibility to the pain of a more severe operation; but in my three previous cases, which were all for cancer of the tongue and floor of the mouth, in two complete anæsthesia was produced in twenty minutes, in the third, a strong burly man, who had been rather a free liver, the result was a failure, and it had to be administered in the usual way."

For prolonged dental operations we feel sure it will be very useful, as it gives the operator more command over his patient; there is no inhaler in his way, and he can take his time, knowing that the patient can be kept under its influence.

The Chief Danger from the Administration of Ether per Rectum.

The chief danger from the administration of ether per rectum has been found, as has been shown in the report of the cases given—first, the over-distension of the bowels with the ether vapor, or the tenesmus with bloody discharges from the rectum caused by fluid ether being forced through the tube and deposited in contact with the mucous membrane, producing freezing of the parts and secondary inflammation and ulceration. Experiments have demonstrated that the cool rubber tubing which has been employed, had a tendency, unless kept warm by wrapping with cotton or felt, to produce a rapid condensation of the vapor driven over into ether, which boils by the simple heat of the hand, or 93° or 96° F. The temperature of the water-bath should not exceed 103° or 105° F. If the temperature is allowed to rise to 120° or 130° F, the boiling becomes so active as to drive over fluid ether.

In a few rare operations, the vapor of ether per rectum may be employed with advantage, as in cases of excision of the superior maxilla (*Medical News*, January 10, 1885). Dr. George A. Peters, of New York, found that the administration of the ether by the rectum in two operations on the superior maxilla, performed upon a single patient, was eminently satisfactory. The patient was profoundly anæsthetized, and the anæsthesia continued for some time; but he came out from under the influence of ether with less subsequent annoyance than usually follows the administration of this anæsthetic. Dr. L. A. Stimson devised an instrument for this operation, consisting of a tube about the size of a No. 40 urethral catheter, surrounded at one end with a large sponge with a rubber coating, which, when passed into the pharynx, prevents the flow of blood in that direction while the patient breathes through the tube.

In an addition or appendix to the second edition of our "Manual of Anæsthetics," we entered more into details, and presented all the cases and facts up to that time on the Use of Ether per Rectum; in this we have summarized the facts in the briefest manner, and yet given all the essential details, with new cases.

Administration of Ether per Rectum.

In the method of etherization per rectum, the most obvious advantages are as follows:

1. Dyspnœa is avoided, and the patient is saved from the anxiety due to a sense of impending suffocation.

2. There is avoided the danger of simultaneous irritation of the superior laryngeal and pneumogastric nerves at the periphery—these irritations neutralizing each other in the respiratory centre, and suspending respiration entirely.

3. The danger of asphyxia is lessened, the patient not being drowned in his own mucus, and the integrity of the pulmonary mucous membrane, as an organ of gas exchange, is preserved. Of course, some vapor finds its way into the lungs, and acts there as a local irritant, elimination being by that channel. But the quantity is not great, and does not constitute a source of danger. In the cases reported, the increase in secretion was too trifling for discovery.

4. The stage of excitation is therefore not prolonged by the struggles for breath. In general, it may be said that the delirium of any alcoholic intoxication is a pleasant and good-natured one, unless the patient is crossed, as he certainly feels himself to be when a wet towel is pressed over his face.

5. Nourishment may be taken before operation to sustain the powers of life and lessen the dangers from shock.

6. Return to consciousness is prompt, this stage not being prolonged by carbonic acid poisoning.

7. The anæsthetic seems as readily suspended as by the ordinary method, the bowel being promptly emptied by gentle massage.

8. Economy in ether is an advantage hardly to be mentioned with more important considerations.

The more obvious disadvantages are:

1. The exposure of person required, the abdomen being necessarily under observation, even if the catheter be inserted under cover.

2. More judgment and experience are required in the administration than by the ordinary method, overboiling in the apparatus and too much distension being both painful and highly dangerous. The warning to cease is sudden, and must be immediately obeyed.

3. Just as the other mode is inconvenient in oral surgery,

so in perineal operations is the apparatus needed for this method in the way.

4. In abdominal surgery, or if there be marked intestinal lesion, this mode is contra-indicated.

5. The inapplicability in cases of accident and emergency, when time cannot be allowed to prepare the bowel, has already been mentioned.

6. Diarrhœa has been noted in seven out of the thirty-seven cases on record, though in none of the writer's.

We believe this sequel is due to pre-existing intestinal lesion, to the lack of preparation, to a too great distension of the bowel, or to the accidental introduction of ether in liquid form. Furthermore, our method has differed from that of other experimenters in this respect—that, instead of allowing the vapor to remain indefinitely, we secured a constant change by using a recurrent catheter, and introducing a certain quantity, or permitting it to escape, as indicated.

Other points of advantage and disadvantage may occur in later experience, and to other observers, and new dangers may be discovered; but we are convinced that this method is worthy of further trial, and will find its place in surgery, fulfilling its own, though not *all*, indications. Like all else in therapeutics, it must pass through the stages of bungling use, condemnation and revival.

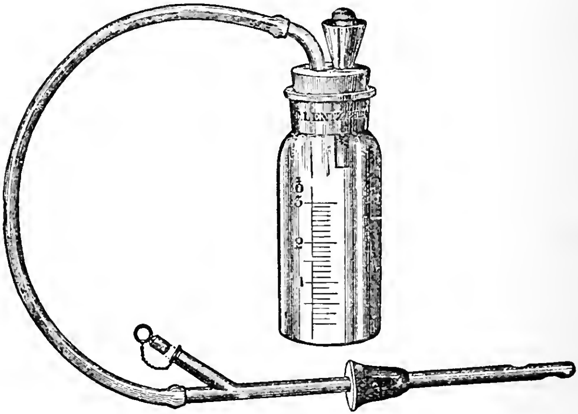
Dr. Miller's form of apparatus, see Plate 23, which he had made by Charles Lentz & Sons, No. 27 South Tenth Street, for this purpose, consists simply of a water-bath, a graduated bottle provided with a funnel and valve for pouring in the ether, and a supply-pipe for conducting vapor to the rectum. This tube terminated in a straight recurrent catheter, the exhaust channel of which is controlled by a valve. The catheter is furthermore provided with a movable collar for pressure against the anus, it having been found that the vapor tends to escape by the tube.

The following are Dr. Miller's conclusions which he kindly sent to me January 7, 1885:

"I am unable to add further data to the subject of rectal etherization. To attempt to strike a balance of the same I deem as yet premature. The mechanical dangers of over-distension, the difficulty of emptying the bowel of vapor, when a suspension of the anæsthetic is desired, and the greater caution needed in the administration—all these points I have already mentioned in my paper. There are only a few points to which I would further allude, viz.:

"First, as to rate of elimination: This taking place by the lungs, no matter how introduced, would be more rapid than when the agent is inhaled, inasmuch as, by the new method, the pulmonary mucous membrane is preserved intact, and is there-

Plate 23.



C. Lentz. Phila.

fore more capable of osmotic function than if bathed in mucus, as by the ordinary way.

"A more serious objection has not yet been referred to—one based upon theoretical considerations. The experiments of Paul Bert—now already classic—have demonstrated:

"1. That the degree of anæsthesia depends, not upon the absolute amount of the agent used, but upon the percentage in the blood, and therefore on the tension of the vapor in the *atmosphere inhaled.*

"2. That the percentage needed to suspend respectively the functions of animal and organic life bear a definite ratio to each other—a ratio constant for each of the known anæsthetic agents, and for species of animals and for each human individual. All between the two percentages mentioned is termed the *manageable zone.*

"3. That most, if not all, the undesirable effects of an anæsthetic, are due to leaving this zone.

"4. That the greatest safety is therefore in mixing the cases beforehand, as has long been done by Mr. Spencer Wells.

"If, now, ether be given by the rectum, it will be readily seen that the gauging can only be by absolute quantity, and not by the percentage actually in the blood. We could never know how near this zone is to being exhausted. To my mind this is the most serious objection that can be offered.

"Dr. Frank Foster * mentions a fatal case—that of a woman in ordinary health, to whom ether was given for a minor operation and in whom the autopsy showed a condition of acute ulceration, not only of the whole large intestine, but also of the lower portion of the small intestine."

CHAPTER XVIII.

Hydrobromic Ether or the Bromide of Ethyl ($C_2H.Br$)—Chemical Nature, Properties, Decompositions, etc.—As an Anæsthetic in Labor, in Dental Operations—Table of the Purity of Various Specimens of Bromide of Ethyl.

Hydrobromic Ether or Bromide of Ethyl ($C_2H.Br$).

PROPERTIES.—Bromide of ethyl ($C_2H.Br$), or "hydrobromic ether," is a colorless liquid, with an agreeable odor; it boils at about 40.7° C. (105.8° F.); has a density of 1.419 at 15° C. (59° F.); the boiling-point and density are, therefore, intermediate between those of chloroform and sulphuric ether.

* *New York Medical Journal,* May 24, 1884.

Transparent and colorless liquid, heavier than water (Serullas); specific gravity 1.40 (Löwig), 1.4733 at 0° (Pierre); vapor density 3.754 (R. Marchand J. per cm. 188); very volatile; boiling-point 40.7° C. when the barometer stands at 757 mm. (Pierre); has a strong ethereal odor and pungent taste (Serullas). According to Löwig, its taste is strongly and agreeably sweetish, with a somewhat burning after-taste. The vapor, when inhaled, exerts an anæsthetic action, like chloroform (Robin, *Compt. Rend.* xxx. 669). It is sparingly soluble in water, but mixes in all proportions with *alcohol* and *ether.*

DECOMPOSITIONS.—1. Vapor of hydrobromic ether passed through a glass tube at a low red heat is resolved into ethylene and hydrobromic acid gas. 2. It burns with difficulty, but with a beautiful green flame, which does not smoke, a strong odor of hydrobromic acid being at the same time evolved. 3. It is not decomposed by nitric acid, oil of vitriol or potassium. 4. With ammonia it yields hydrobromate of ethylamine.

The hydrobromic ether or bromide of ethyl was discovered by Serullas, in 1827, but received no special attention until Dr. Thomas Nunnelly, of Leeds, reported some experiments made with it on animals in 1849. Dr. Nunnelly brought the subject again before the profession by a paper read at the meeting of the British Medical Association in 1865, in which, speaking of it in conjunction with another anæsthetic, he said he had for some time employed the one or the other in all the principal operations at the Leeds General Eye and Ear Infirmary. This was at a time when chloroform held such complete sway in England that no importance was attached to Nunnelly's experience or experiments. He had no one to follow him in using it; and we hear no more of it until 1876, when some experiments were made with it in France, by Rabuteau, on the lower animals; but evidently without a knowledge of the fact that this had been done previously in England by Nunnelly.

The writer then took the agent up without the knowledge of the experiments of Dr. Nunnelly. He had it made in Philadelphia by Professor Remington, and with two friends began experimenting in September, 1877, using it first on himself and then upon his patients. When pure, bromide of ethyl is a volatile, colorless and almost uninflammable liquid, contrasting favorably in this respect with sulphuric ether, the highly inflammable and explosive properties of which are well known. It has a hot, but saccharine, taste; its specific gravity is 1.42, and it boils at 105.8° Fahrenheit. Its boiling-point and density are therefore intermediate between those of chloroform and ether. After satisfying himself as to its efficiency and safety as an anæsthetic, by experiments upon himself and others, the writer laid the subject before the Pennsylvania State Medical Society in 1878, and a record of ten cases, with his conclusions, was published in the volume of their transactions for that year. In August, 1879, he brought it before the British Medical Association at Cork; and in September of the same year presented a report of one hundred cases before the International Medical Congress at Amsterdam, to which he was a delegate from the American Medical Association. Up to March, 1879, when the second edition of his work on anæsthetics went to press, he had published a report of one hundred and twenty-five successful cases in quite a variety of surgical operations, and had not only employed it at his daily ear clinic, but also in the Jefferson Medical College Hospital; and he administered it in April, 1879, to a patient of the late Dr. Samuel W. Gross, at the public clinic, when he (Dr. Gross) removed a hyoid cyst from in front of the neck of a child. Dr. R. J. Levis, who was at this clinic, for the first time saw it employed, and became much interested in its use.

The writer thus compelled chemists to make it by producing a demand for it, and gave them, through Dr. Greene, a good formula for obtaining it free from impurities. He induced surgeons all over the country to try it—and especially the surgeons of this city—by bringing it in every way before their attention. The whole number of cases in which it has been employed by himself and friends was, up to June, 1880, some eight or nine hundred.

Then followed two deaths, but neither of the cases reported by the late Dr. Sims, or Levis, were due to the use of anæsthetics *per se;* in the former instance because of the very depressed condition of the patient, and in the latter because death did not occur until many hours following the administration of the anæsthetic.

But in connection with these cases we know, first, that Emmet (*Gynæcology*, 2d edition, p. 746) called the attention of the profession to the danger of administering anæsthetics where any disease of the kidneys exists, because of the active part taken by these organs in the elimination of them.

In Dr. Sims' case there was a marked scantiness in the secretion of the urine, and on post-mortem examination it was found that she had acute catarrhal nephritis, indicating that the kidneys were disabled from performing their function in eliminating the ether; hence its retention in the economy, with the subsequent toxic symptoms. In Levis' case, it seems plain that a simple explanation of the death of the patient lies in the fact that the heart, which had become so enfeebled from exhausting chronic disease, was unable to bear the strain of the powerful depression of its already diminished powers that ensued upon the administration of the anæsthetic, and as a consequence, broke down under the excessive load.

We cannot but feel disappointed that these deaths, not produced by it, should have been associated with it,* as advantage was taken of the accidents by those having a prejudice against the ether, to condemn it on theoretical grounds.† In several

* "The Bromide of Ethyl as an Anæsthetic," by Marion Sims, M.D., LL.D, *New York Medical Record*, April 3, 1880.

† In the discussion following the report of the fatal case by Dr. Sims to the New York Medical Society, Dr. Squibb undertook to account for the poisonous effects of bromide of ethyl by assuming it to be a loosely molecular article, easily decomposed; that thus its administration is prone to be followed by an impregnation of the system with bromine; and that if it remained as bromide of ethyl in the system it might not be harmful. This theory has been shown to be based on insufficient grounds. In the first place Professor Jungk has shown that bromide is not "a loosely molecular article;" that in fact it is a very stable salt (for a salt it really is), and very difficult of decomposition; much more difficult than chloroform. In the second place, the assumption that anæsthesia is due to a breaking up of the anæsthetic into its elements is nothing more than a hypothesis, and one, too, which has little or nothing to support it. The fact that one of the characteristics of bromide of ethyl is that it is perfectly unirritating to the bronchi, goes to show that it is not decomposed: if it were, the bromine in its composition—one of the most irritant of substances—would certainly manifest itself in its effects on the air passages.

instances recently, the use of this anæsthetic has been attended with persistent vomiting and free secretion of mucus, though in the thousands of cases in which it has been employed, chiefly in Philadelphia, in not one single instance has it caused cerebral trouble, or any of the symptoms produced by the action of free bromine. We have experimented upon frogs, cats, dogs, rabbits and various other animals, by subjecting them to an atmosphere highly charged with the vapor of hydrobromic ether, and in rare instances were there the effects as described above.

In the case of death under the employment of this agent in the hands of Dr. Levis, we do not think he was doing justice to it in subjecting the new anæsthetic to this most severe test. He knew the extreme debility of the patient, and that the most simple nervous shock would render him liable to death. Hundreds of patients have thus died. Again, when ordinary ether, chloroform, or other anæsthetics cause fainting—which was no doubt the result in this case—artificial respiration must be resorted to. We are reliably informed that in this instance, the movement of the chest walls forced *the pus which was in this man's lungs into his bronchial tubes and suffocated him.* We are also very sorry that the valuable agent, nitrite of amyl, which has been found useful in such cases, was not employed.

The following report of the case will be of interest:

"PHILADELPHIA, June 2, 1880.

"Deputy Coroner Beam made an investigation of the circumstances, as reported in *The Times*, of the death of William Linderman, eighteen years old, of Schuylkill County, while upon the operating table at the Jefferson College Hospital under the influence of the new anæsthetic, bromide of ethyl, and about to be treated for stone in the bladder. He had been for about sixteen weeks under the care of Dr. R. J. Levis, one of the strongest advocates of the new anæsthetic, and was taken to the hospital by his direction. Linderman's health was very poor at the time. Dr. Ames, who administered the bromide, said an incision had not yet been made, but Dr. John B. Roberts said that there had. The patient was in such a condition that something had to be done, because he could not tide over the hot weather —96° to 98° in the shade.

"Dr. J. G. Lee, the coroner's physician, testified that he found the brain congested, *the lungs far advanced in consumption, and the kidneys and liver enlarged*, and two large encysted stones in the bladder. His opinion was that they could not have been safely taken out. *Linderman could not have lived over a week or two at any rate.* Dr. Lee said further, that he had experimented with the bromide on animals without bad results. In his opinion death resulted from exhaustion and prostration, the results of phthisis. The jury took the same view in their verdict."

As is well observed by Dr. Henry M. Lyman, "All experience shows that the administration of anæsthetics to certain patients is attended with danger. Even sulphuric ether may prove fatal if the kidneys are seriously damaged, and pulmonary disorganization is a well-known source of danger during the inhalation of anæsthetic vapor. The administration of chloroform to such a patient would be a very hazardous undertaking. The fatal results in these cases cannot be charged against the particular anæsthetic employed, but rather against the exhibition of any anæsthetic agent whatever." *

In some recent experiments on animals, we crowded four ounces (the quantity stated to have been used by Dr. Sims) upon a dog by means of a tin inhaler, until he became apparently dead, with no perceptible action of the heart or lungs; but the expression of his eye was clear and the pupil was dilated, while there was no secretion from the eyes or nostrils. The apparatus was removed in the space of four minutes, and he was exposed to the air, when at once he began to breathe, and by the end of six minutes he had almost entirely recovered consciousness. The dog did not seem much inclined to move for ten or twelve minutes afterwards. While this dog was only partially under the influence of this anæsthetic, having at first caught the inhaling apparatus between his teeth, there was a good deal of rigidity and slight tetanic movements of the extremities, but this was overcome by the free use of the ether.

Now, had we been using chloroform, just before we would

* "Artificial Anæsthesia and Anæsthetics," pages 220, 221.

have been ready to perform any experiments upon the animal, he would have been dead; and neither the removal of the anæsthetic, nor exposure to air, would have been of any avail. Again, if Squibb's rectified and absolute ether had been employed, we must have super-saturated the animal, and been annoyed by the expectoration of large quantities of mucus, which in one recent experiment by us, was followed by death. Then we frequently have seen tetanic convulsions, with great reduction of temperature, requiring several assistants to hold the patient, from the use of ordinary ether. The rapidity of the anæsthetic action of hydrobromic ether, and its rapid elimination from the system by the lungs, are two of its chief merits for all operations that are not prolonged. *We recommend pure hydrobromic ether in operations, not lasting over forty minutes.* For operations lasting one or two hours, we would advise the additional use of sulphuric ether, commencing after thirty or forty minutes' exhibition of the bromide of ethyl.

There is one great advantage in the use of this agent, that the administrator must attend to the anæsthetic all the time; he cannot watch the operation, and forget the patient for a few seconds; his whole attention must be given to keep up its action. We believe that patients have sometimes been stifled by close pressure of the napkin, wet with the water present in ordinary ether, by the carelessness of the person giving it, whose attention has been given to the operation, rather than to the patient.

As an anæsthetic in labor, it has peculiar advantages, in that it is so rapid in its effects: the patient is comforted between the pains, but never passes into such a state of profound anæsthesia, that she is not aroused by the expulsive effort, and has all her consciousness about her; and there are none of the depressing effects of ether or chloroform. It is also most valuable in these cases, when it becomes necessary to change the position of the child; also in bringing forward the neck of the uterus into its proper position.* In none of our cases

* "Bromide of Ethyl as an Anæsthetic in Labor," by E. E. Montgomery, p. 312.

was there disturbance of the bowels, or pain in the back or head.

Müller, of Berne, speaks well of this obstetrical anæsthetic, which he has used in sixteen cases of primiparæ, and six of multiparæ. Reddening of the face and acceleration of the pulse were frequently noted, thus giving the assurance that cerebral anæmia, as in the chloroform-syncope, need not be feared. The peculiar analgesic virtues were gratefully commented upon, especially by multiparæ. Hæckermann, and Parnemann (*Schmidt's Jahrbuecher*, No. 12, 1884), express themselves in equally eulogistic terms of the anæsthetic in confinements.

To the country practitioner, who is obliged to extract teeth, or perform any of the minor operations in surgery, it is a great boon, as it acts like nitrous oxide gas. It is well where a number of teeth are to be extracted, that a prop of hard wood attached to a string should be used; so as to prevent such an accident as once occurred in Philadelphia under the use of nitrous oxide gas—the swallowing of a prop of cork. It frequently happens in the use of hydrobromic ether, that when narcotism is not very profound, that the muscles of the patient become rigidly contracted. This condition occurred in a recent case, when we administered ℥i of this anæsthetic; the operator's finger was caught and pinched, as also his forceps; and yet before operating, he could touch the cornea with impunity. Although the impression passed away very rapidly, twelve teeth were extracted with entire success, the patient not feeling the pain, and promptly recovering consciousness.

In the following case, the patient went under it very kindly. The patient was a man of very nervous temperament. With three drachms of hydrobromic ether, anæsthesia was produced without any struggling; and in four minutes from the time he had commenced to inhale it, the dentist had extracted ten teeth, and he had fully recovered consciousness, and without nausea, although he had just eaten a breakfast of solid food.

In a recent case of cataract extraction, the patient went beautifully under the influence of the anæsthetic, extraction was accomplished, and the patient recovered so as to be able to count fingers, yet owing to some strong coffee which she drank, from dyspeptic symptoms, or the swallowing of water soon after the operation, she became very sick at her stomach, and vomited for almost twenty-four hours; and yet the case did well. In a case of operation for torticollis, for a woman, so much air was swallowed with the ether, that as a consequence she complained of pain of a hysterical character, in lower part of the abdomen; the same which is often the result, when nitrous oxide gas is inhaled, and too much air admitted.

In a letter received from the late Dr. J. Patterson Cassells, of Glasgow, a distinguished aurist, and a surgeon to the celebrated Glasgow Infirmary, he writes that he has used a specimen of the hydrobromic ether, which we gave him at Cork, as vapor, in diseases of the middle ear, and has also employed it as an anæsthetic with success.

As we have before stated,* "*no anæsthetic can be used with absolute safety;*" all will kill. Chloroform kills, in round numbers, about one in every three thousand. Pure ether † is, next to nitrous oxide, the safest anæsthetic; see table of deaths, and many of these doubtful, having been reported from its use. ‡ But it requires boldness and freedom in its administration; if slowly or ineffectually administered it is apt to produce a free secretion of bronchial mucus, which occasions troublesome coughing. If nitrous oxide is administered alone as a prelude to ether, the secretion of mucus is less troublesome, but there is a great amount of venous congestion, and the tissues become gorged with blood, so that every incision tends to bleed. At times, also, wild excitement is produced by the gas. Some surgeons use the mixture which is known as A.-C.-E., which contains one part by measure of

* See "A Presumable Ether-Death from Heart Failure," by John B Roberts, M.D., *Medical News*, September 27, 1884; by the same author, "Ether-Death," *Medical Times*, June 4, 1881. "Case of Death following the Inhalation of Chloroform," reported by P. L. Helsman, M.D , Albany (Ga.) *Medical News*, September 27, 1884.

† Ether fortior, liquid, 94 per cent. of oxide ethyl, 6 per cent. of alcohol, and a little water.

‡ See tables at the end of Chloroform.

absolute alcohol, two of chloroform, and three of Squibb's ether. This is not simply a mixture; the absolute alcohol,* 99.4 per cent., causes a solution of the other two, and they evaporate together. But the mixture should be administered freely from a cone of felt or flannel, with a paper covering, and the desired effect should be produced as rapidly as possible. The best results are by the agents which produce rapid effects, and which are as rapidly recovered from. No other has produced such rapid anæsthesia as the hydrobromic ether, and it is the most rapidly recovered from.

As the result of observations and experiments with the bromide of ethyl, our conclusions have been that one hour is the longest time that a patient can remain under the influence of this anæsthetic with safety. In the case of potent remedies like morphine, atropine, hydrocyanic acid, etc., no one will attempt to ignore, or refuse to use such valuable remedies, because in certain individuals, and under certain conditions of the system, they produce death.

Can we in all cases rely on the experiments on animals, as a true and absolute guide to determine our course in the human being? We think not; for it is a well-known fact, that many animals eat plants which are deadly poisons to man, and certain anæsthetics are fatal to dogs.† Again, certain salts taken with impunity by man, are poisonous to animals. The results of the prolonged experimental use of anæsthetics in the laboratory, even when of two hours'‡ duration, cannot be taken as unquestioned as the results obtained by numerous careful observers, on themselves, and others. Clinical experience has now reached at least ten thousand§ well authenticated cases in which the bromide of ethyl has been employed, with safety, since 1880, when the two deaths were reported.

* Specific gravity, .0716, at 77° F.

† Dr. B. A. Watson, Jersey City. "An Experimental Study of Anæsthetics." *Medical News*, p. 313, May, 1878. Method not given.

‡ "Two New Anæsthetics," by J. C. Reeve, M.D., Dayton, Ohio. *Cincinnati Lancet and Clinic.*

§ Dr. Chisholm, of Baltimore. *Maryland Med. Jour.*, January, 1883. Dr. Prince, of Jacksonville. *St. Louis Med and Surg. Jour.*, October, 1883, and Dr. L. Turnbull, of Philadelphia. *Medical Bulletin*, June, 1880.

The following trials of this anæsthetic were made by Dr. I. C. Reeve, to test its merits and to obtain personal experience of its effects. They were made by a gentleman very familiar with all the other anæsthetics, and his experience should be worthy of confidence. For the record of occurrences after loss of consciousness, and for care and attention during administration, he was indebted to his friends, Drs. Pilate and Conklin.

First Experiment.—March 14th. Four hours after eating a moderate breakfast, he proceeded to inhale the bromide of ethyl in the recumbent position; and from a bottle just opened, labeled "1 oz. bromide ethyl," about one-fourth of the contents was poured into an Allis' ether inhaler. The first and immediate sensations upon inhaling it were a sharp, pungent impression on the air-passages, a sense of warmth rapidly extending, and exhilaration. With the second inspiration he felt a decided influence upon the brain, and began to talk; anxious to continue speaking as long as possible, and to state his sensations. A rapid beating in the ears is a constant symptom with him in taking chloroform, and immediately precedes entire loss of consciousness. He marked its presence now, and also its early appearance. It could not have been later than the third, or possibly the fourth, inspiration when he noted it, and this, as with chloroform, was the last sensation.

Upon opening his eyes after recovery from the anæsthetic, he immediately collected himself, and could remember all; could talk clearly, and had no confusion of thought. He felt a slight sense of nausea and a feeling of languor. Eight minutes afterwards he got up and walked about without dizziness, and was confident he could have done so sooner. He did not attempt it sooner because he felt that sickness would ensue if he arose. The feeling of nausea remained until he commenced eating his next meal, about forty minutes later.

Second Experiment.—Pulse at beginning, 80; he having just ascended a flight of stairs. Two drachms administered. Symptoms began to be manifested after two respirations. Spoke of general warmth, pleasant sensations and beating in the ears. Anæsthesia produced in one minute and a quarter;

in another quarter-minute it was profound, as tested by a knife-point. Pulse during the first minute ran up to nearly 100, then fell during the next minute to about 70, feeble and intermittent. Pupils unchanged; normal; no struggling or excitement, but tetanic clutching of the inhaler so that it could be gotten away only with difficulty. The anæsthesia lasted one minute and a half. He then awakened without mental confusion. Pulse seven to eight minutes later, 64. He was not satisfied with this experiment, particularly in regard to the irregularity and intermittence of the pulse—not a very assuring symptom in anæsthesia, and a result not agreeing with other observations. He had a suspicion from this fact, and from the nausea, that the specimen used was not pure. The bottle bore the name of a house which is always a guarantee of the good quality of medicines; but in the early period of manufacture of a new article, it would not be surprising if perfection was not immediately attained; he therefore obtained another specimen,* and one week after the above trial again inhaled it.

Third Experiment.—Being in the recumbent position, four hours after eating, one drachm, by measure, was poured into Allis' inhaler. He tried to take it slower this time, and count the respirations aloud to mark when conscious action ceased. He immediately felt the same grateful and pervading glow of warmth all over the body; counted to the seventh respiration; beating in the ears was again the last recognized impression. Pulse before, 80; at the end of the first minute, 120; one and a half minutes, at the rate of 100; at the end of two minutes, 78; no irregularity or intermittence; pupils unaffected; totally unconscious in one minute. Consciousness returned in three minutes.

It was his design to push the inhalation farther this time, and to test the muscular relaxation, as well as to decide in regard to the irregularity of the pulse. Feeling that this had not been done, after about fifteen minutes he took it again.

Fourth Experiment.—Two measured drachms were poured

* From the house of John Wyeth & Bro., Philadelphia.

on the inhaler, and he placed it over his mouth and nose. The impression was much stronger on the nose and air-passages, and the first inspiration made him cough. He then counted to the third inspiration, and was gone. Pupils the same as before, unaffected; pulse before taking, 78; at the end of the first minute, 124; one and a half minutes, 100; and of two minutes, 78; no irregularity or intermittence. Anæsthesia in one minute. At the end of three minutes from the beginning, he got up, and walked across the room, and could have remained up. As an effort at prolonged anæsthesia, this was not, therefore, a success. In eighteen minutes, he was on his way driving to see a patient. He had not the slightest nausea after these two inhalations; felt, if anything, better than before.

FIFTH EXPERIMENT.—His next trial of the agent, and first attempt at administration, was not satisfactory. The patient was a man aged about 50, a wiry, muscular fellow, of the type and build likely to give troublesome manifestations with any anæsthetic. He was placed on the table for an operation for hæmorrhoids, by Dr. Conklin, who had brought with him for the operation a large conical sponge, with which he was in the habit of giving the A.-C.-E. mixture. Upon this he poured two drachms of hydrobromic ether and placed it over the patient's mouth and nose. After one long, deep inspiration, his face became deeply flushed, and he soon began to talk and then to shout. More of the liquid was poured on the sponge; but his movements interfered with the inhalation of it with promptness; muscular rigidity then came on, and was marked; respiration was very nearly, if not quite, stopped for a time by tetanic spasm of the chest. These symptoms were almost as bad as are ever seen from ether, chloroform, or the mixed vapors. The doctor had seen worse muscular action and rigidity, but this was as bad as generally met with. During this time the ether was rapidly added until the supply was exhausted (13 drachms), and sufficient relaxation was not produced to make the operation feasible. No observations could be made, of course, of the patient's pulse. He recovered consciousness quite rapidly, as compared with other anæsthetics, and suffered no unpleasant after-effects.

This was not, of course, a fair trial of the remedy. The mode of administration was decidedly faulty. It is an ether, and must be given as an ether; and that this is imperative, is the lesson to be learned by this failure.

Our personal experience with hydrobromic ether fully sustains the observations of others as to its exceeding promptness of action, and the rapidity with which recovery from its effects takes place. It is also more pleasant to inhale than chloroform, which is not very disagreeable, and infinitely pleasanter than ether.

In our own experiments on animals, we found that frogs, placed in a watery solution of ethylic bromide, become as completely anæsthetized, as if they were immersed in an aqueous solution of chloroform. Berger, states, to the Société de Chirurgie (*Le Progrès Médical*), that he had been impressed by the rapidity with which these animals succumbed to its vapor. Terrillon administered the vapor of ethylic bromide to eighteen dogs, without accident to any one of them.

Dr. Ott, of Easton, Pa., who has made thorough and scientific researches with the bromide of ethyl, experimenting upon frogs and rabbits, believes, that the increased frequency of the pulse is due to stimulation of the accelerative nerves, or of the cardio-motor ganglia, and the dangers in administering the drug are less than those of chloroform.

W. H. Hingston, Montreal, Canada, has used no other anæsthetic, since commencing the use of bromide of ethyl. There is less resistance, and struggling, on the part of the patient. Vomiting is less frequent. It is eliminated from the body more rapidly, than any anæsthetic, except laughing gas.

"Bromide of ethyl is one of the, and in some respects, the, most valuable anæsthetic hitherto used."

In Terrillon's experiments, muscular relaxation occurred in human beings in two or three minutes; at times, there was congestion of face, neck and upper part of the chest. The pupils did not contract, but were dilated. The pulse was always quickened, and every fresh dose caused fresh acceleration. Respiration was always hastened, and a hyper-secretion from the buccal and pharyngeal glands took place. Sensibility and consciousness returned with great rapidity; vomiting was not uncommon, both during insensibility, and sometimes for hours after. Verneuil, at the same meeting of the Société de Chirurgie, stated that one patient, a woman, to whom he had given the vapor of ethylic bromide, was asleep in an instant; and Terrillon, stated, that anæsthesia may be produced in less than a minute. In our own experiments, the shortest time necessary for primary anæsthesia was thirty seconds.

Dr. I. S. Stone, of Lincoln, Va.,* remarked that for operations requiring only a few moments, he preferred bromide of ethyl, to ether or chloroform. He thinks it much safer than chloroform, and it does not carry with it the dangers attributed by Dr. Wellford, to ether.

Dr. H. C. Wood found, by experiments upon animals, that if the vapor of ethylic bromide be given with moderation, anæsthesia may be produced without notable reduction of blood-pressure. He further observes (*The Th. Gazette,* June 15, 1885): "After mixing with olive oil, and agitating and distilling the liquid with this precaution, we can obtain a safe and powerful anæsthetic, well adapted to cases of minor surgery, which do not warrant the exhibition of ether, and chloroform, and particularly eligible in obstetrical practice." In the experiments of Dr. C. C. F. Gay,† of Buffalo, the agent employed was evidently, from color and taste, impure, as was also that used by Dr. D. C. Wilkinson,‡ of Galveston, Texas. In Dr. I. C. Moore's cases, the ethyl was abandoned for ordinary ether, even when the insensibility had not passed off, owing to the exhibition of so-called bad symptoms, great excitement, with intense and persistent retching and vomiting, with venous engorgements. The article was stated to be pure, and was from Wyeth & Brother. The bromide of ethyl is costly, from the great care required in its preparation; and the great demand for it, has caused many imitations to be placed on the market. The importance of its purity, was at first so little understood, that the original manufacturers did not take sufficient time to purify it,

* Discussion of Dr. McGuire's paper. See Chloroform.

† *Medical Record,* July 17, 1880.

‡ *Medical Record,* May 15, 1880.

so that for a time the article contained carbon bromide (C_2B_4), and free bromine, phosphorus, and bromoform.* These were found in the specimen employed by Dr. Sims, which was a brown acrid liquid, with a pungent and disagreeable odor. Twenty drops of this given to a rabbit which had previously taken two grammes (thirty grains) of pure ethylic bromide without the slightest ill effect, produced irritation of the gastro-intestinal tract, followed by death in eighteen hours.†

That ethylic bromide may be employed with ease and success, has been abundantly proved by the experience of many observers. M. Bourneville, has administered it to a large number of patients in the Salpêtriére Hospital, for the arrest of paroxysmal hysteria and epilepsy. He has also administered it, daily by inhalation for fifteen or twenty minutes, with the fortunate result of considerably diminishing the frequency of the convulsive paroxysms. In several of these cases, the temperature was depressed about half a degree centigrade, during the act of inhalation. Immediately after the withdrawal of the anæsthetic the normal degree was recovered, and sometimes even surpassed. The pulse in about five hundred administrations, was somewhat accelerated during the period of inhalation. In six instances only, was retardation observed. Respiration, in like manner, was almost always accelerated. A copious overflow of tears was nearly always remarked. The urine never contained, either albumen, or sugar, and the quantity of the liquid, was not affected. Rigidity of the limbs and tremor involving the upper extremities, were sometimes noted. Daily inhalations for a period of two months, exercised no unfavorable influence over the general process of nutrition; five patients found their weight increased during this period.

There are certain preparatory precautions which are necessary to the safe inhalation of the bromide of ethyl:

* (See tables). This can be prevented by mixing bromide of ethyl, with two per cent. of olive oil, agitating and distilling the liquid successively.

† Dr. S. Wolff, *Am. Journal of Pharmacy*, May, 1880. The writer also obtained a portion of the same liquid from Dr. Wolff, and, on comparing it with the specimen from Dr. Sims, found it to be the same.

1. All tight-fitting garments, in, and about the neck and chest, should be loosened.

2. The saturated ethyl vapor must be inhaled almost to the exclusion of atmospheric air. The best form of inhaler is a thick towel, folded in the form of a cone, closed at the apex with a large pin; between the folds of the towel, place a sheet of newspaper. The base of the cone must be wide enough to include both mouth and nose.

3. Instruct the patient, in advance, to make deep and long inspirations. In the cone, place about one drachm, by measure, and at once cover the nose and mouth with it, and do not remove the cone, until anæsthesia is produced, which will be in from twenty to thirty seconds.

The anæsthetic sleep will not last more than from two to three minutes. The patient retains the usual healthy color of lips and skin, and the pulse first becomes rapid, then slower, and stronger, as the narcosis becomes profound. The patient, as a rule, awakens suddenly, and completely; but if there is nausea, or much agitation, it is best for him to remain quiet, and in a horizontal posture for some time.

Perhaps no operations are more painful, than those on the eyes, eyelids, or eyeball, to a sensitive person, and there is no anæsthetic that we have found, so applicable, as bromide of ethyl in such operations. We administered it, for the removal of a deep-seated tumor of the eyelid; the operation being performed by Dr. Hermann Knapp, of New York. The patient took the towel, with about two drachms of the ether, in her hands and applied it to her face, and in thirty seconds she was so completely anæsthetized, that she was not conscious of one particle of pain until the tumor was entirely removed; she had no nausea whatever, or any other disagreeable symptom.

Again, in operations on diseased mastoid cells, we have employed it in some twenty cases, with entire success, and in a very recent case in which the whole bone was diseased, and much of it had to be removed, the operation being of a most painful nature. We administered the bromide of ethyl to this patient, who was very much exhausted by profuse discharge from a large cancerous growth. The patient went under the influence of this anæsthetic, with the most delightful effect, not suffering at all from the operation, and going to sleep after it without a bad symptom.

We have, in times past, heard a great deal of the injurious effects of bromides; and for a time, therefore, we gave the hydrobromic acid, and ether, with great caution, never exceeding thirty drops, three times a day. But not so now; experience has taught us, that we can use it, if well-diluted, up to sixty drops, three times a day, without any injurious results. To obtain its full physiological effects in epilepsy, certain cases of pulsating tinnitus aurium, and in preventing the disagreeable cephalic symptoms, occasioned by quinine, and iron, in these various nervous affections, we have found it at times very satisfactory. The salts of this agent, bromine, can be, and are, used with the greatest freedom, in the form of bromide of potassium, sodium, and lithium, in doses of grs. xl–ʒ vi, given in six days, without the least fear of its injurious effects upon the most delicate stomach; and relieving, as by a charm, convulsions, epilepsy, whooping cough, sleeplessness, headache, cerebral disturbance, tetanus, and all forms of non-organic mental derangement.

As is well observed, by Dr. Chisholm: * "For office use I find the bromide of ethyl, invaluable, on account of its promptness, efficiency, the evanescent nature of the anæsthesia, the absence of nausea, and the perfect comfort with which patients operated upon, can leave my office within a few minutes after the etherization."

Bromide of ethyl, should never take the place of chloroform, or sulphuric ether, where any tedious operations are to be performed; but there is no reason why this useful anæsthetic should not be employed in all operations in minor surgery, and in those on the eye, ear, throat and nose: having everything ready in advance, so that the patient shall be as short a time as possible, exposed to the evil effect of an anæsthetic.

*_Maryland Medical Journal_, January, 1883.

Some Recent Observations on the Use of Bromide of Ethyl.

"Szuman of Thorn" has used the bromide of ethyl since 1883, in one hundred and twenty operations, in dentistry, extraction of teeth, removal of small tumors, opening of abscesses, scraping of the sacs of tender teeth, etc. He applies the ethyl with a mask, or chloroform inhaler, using from ten to twenty drops at a time. Szuman, considers bromide of ethyl, indicated in plastic operations, in nervous, or timid subjects, as it is so agreeable to the smell and taste. In large doses, he considers it as dangerous as chloroform, or ether.

"Eschawzier," an assistant to a dentist of Brooklyn, had the misfortune to lose a patient from this mixture of bromide of ethyl, and oil of roses, so-called soporative, after the extraction of a tooth. He had no assistant, and operated in the ordinary manner. The lady recovered from the anæsthetic, and shortly after was attacked with syncope, and choked. Had he elevated her feet and depressed her head, or drawn out the tongue, all would have been well, but nothing was done, as no medical man was present. The cause of death was stated to the jury as asphyxia, and pulmonary congestion. She was stated to have had a fatty heart, but as there was no *post-mortem*, we do not know how the non-medical man arrived at this conclusion. But this was for the jury, who exonerated the dentist's assistant, but wisely recommended that in all doubtful cases, the patient should be examined by a competent medical man, before the anæsthetic be administered.

This is a lesson to those who employ mixtures, which are never as safe as the agents alone, which should be well studied by the dental or medical man, before being employed. (See our remarks in Part First, on this subject.)

The following are the conclusions arrived at, in 1879. Our favorable opinion remains unchanged at this time, after using the article from 1878 to 1889 in most of our office operations.

	Minutes.	Seconds.
Shortest time taken to place a patient under the primary anæsthetic influence,	0	30
Longest time, ...	5	00
Average time, ...	1	30

We did not then advise that bromide of ethyl should be resorted to in protracted operations, and we never have employed it in any case, longer than forty minutes, and have never used more than four ounces of the pure ether, in one case.

The Bromide of Ethyl as an Anæsthetic in Labor.*

The expression of Galen, "Dolor dolentibus inutilis est," has ever been an actuating principle in the practice of medicine, and surgery, and would undoubtedly have been equally effective in midwifery, had not obstetricians labored for ages, under that incubus to progress, "Meddlesome midwifery is bad."

It is true, there is now no question, as to the value of anæsthetics in irregularities of labor-pains, in eclampsia, and in the various operative obstetric procedures; but their habitual employment for assuaging the pains of natural labor, is still a much mooted subject. We are not confronted, as were the earlier advocates of anæsthesia, with the charge that the arrest of labor-pain, is a violation of divine and physiological laws, retribution for which, entails upon the unfortunate patient paralysis, mania and other bodily ills; but it is apparent, that anæsthesia in natural labor, is not only, not practiced, but opposed, by the teaching, and practice, of the majority of the profession of this country. In the discussion of a paper read before the Philadelphia Obstetrical Society in 1879, the general sentiment was expressed as adverse to the practice.

It may be asserted, that this opposition to anæsthesia in natural labor is sufficient evidence that such practice is undesirable, but we need only quote the following graphic descriptions of the last stage of labor to controvert this:

Dr. Merriman, ("Synopsis of Parturition," p. 15) says: "The pulse gradually increases in quickness, and force; the skin grows hot; the face becomes intensely red; drops of sweat stand upon the forehead, and a perspiration, sometimes profuse, breaks out all over the body; frequently violent trembling

*By E. E. Montgomery, M.D., late Obstetrician Philadelphia Hospital, Professor of Didactic and Clinical Gynæcology, Medico-Chirurgical College.

accompanies the last, and at the moment the head passes into the world, the extremity of suffering seems beyond endurance." Denman ("System of Midwifery," p. 103): "The distress and pain which women often endure, while they are struggling through a difficult labor are beyond all description, and seem to be more than human nature would be able to bear under other circumstances." "Mere pain can destroy life" (Gooch, in Merriman's "Synop. of Parturition," p. 239), as is shown by the report of women delivered in the Dublin Lying-in Hospital under Dr. Collins: "Of women whose sufferings were terminated in 2 hours only, 1 in 320 died; where labor varied in duration from 2 to 6 hours, 1 in 145 died; in those in whom it continued from 7 to 12 hours, 1 in 80 died; where it endured from 12 to 24 hours, 1 in 26 died; where it lasted from 24 to 36 hours, 1 in 17 died; and out of all those whose parturient sufferings were prolonged beyond 36 hours, 1 in every 6 perished." ("Anæsthesia in Surg. and Midwifery," Simpson, p. 98.)

Meigs ("Prac. of Midwif.," p. 153) says: "What do you call the pain of parturition? There is no name for it but agony."

Finding so universal assent, as to the severity of labor-pains, we are induced to seek farther, for the cause of the non-administration of anæsthetics. It is undoubtedly based upon a want of confidence, in the safety of the various alleviating agents. Of these, chloroform has probably been the most frequently used in this country.

Anæsthesia, in obstetrics, was first introduced, and actively championed, by Simpson. The frequent fatality from the use of chloroform in surgical practice, and the influence of public opinion, have led to its more infrequent use in obstetrics.

Theoretical reasons have been given why chloroform should be perfectly safe in labor; but are all dispelled, when cases are reported, as they have been by Fagge (*Schmidt's Jahr.*, No. 5, 1860) and Curtin, (Discuss. Philad. Obs. Soc., Dec. 4th, 1879), in which death occurred, as a result of its administration.

As to the influence of chloroform upon the uterine contractions and the progress of labor, there has been great diversity of opinion. It has, however, been certainly demonstrated, that profound chloroform narcosis does suspend involuntary as well as voluntary muscular contractions. But complete narcosis is unnecessary, except in operative procedures. In natural labor, it is only given during a pain, allowing the patient to recover consciousness in the interval; but, even so administered, there is a general feeling, that the frequency of uterine inertia, post-partum hemorrhage, is thereby greatly enhanced. But this tendency to weakening, and after-hemorrhage, is not so significant, as to outweigh the advantage of relief from pain, were we not under the ban of the relatively so rare evil influences, and fatal results of the drug, in surgical cases.

Although ether has been generally preferred to chloroform, in surgical practice, from its greater safety, it is less desirable in obstetrics, for the reason that the patient must be profoundly etherized, to afford relief. A small quantity of ether, removes the woman's moral control, without alieviating pain. Tait, (*Brit. M. J.*, vol. ii., 1880, p. 845) directed attention to the fact, that ether passes quickly into the fœtal circulation, and increases the peril of the fœtus. He cites a case of extra-uterine pregnancy, operated upon under ether, in which the fœtus was profoundly hypnotized, and says this peril to the child from ether was indicated by Simpson.

Klikowitsch (*St. Petersb. M. Wochenschr.*, 1880, 117 and 249) praises a mixture of nitrous oxide four parts, air one part, as being the ideal obstetric anæsthetic agent. But the difficulty in transporting so large a bulk, and the necessity for a special apparatus, render its general use, in private practice, improbable.

The ideal obstetric anæsthetic, is one which will act rapidly, surely, and safely, one whose effects are of short duration, and that can be carried in small compass. The bromide of ethyl, answers these demands. It is a colorless, not unpleasant smelling fluid, which when breathed, removes the sensation of pain without destroying intelligence. It was quite recently introduced into surgical practice in this country, by Drs. Turnbull and Levis, though its anæsthetic properties had long been known.

Rabuteau, studying to fix its physiological action, arrived at the following conclusion : the bromide of ethyl, in comparison with chloroform, is better borne, is more rapid, but displaced, its action is less continuous, and is eliminated through the lungs much more rapidly.

Lebert, (*Arch. de Tocologie*, June, 1882) first employed it in obstetrics. He published four cases—a forceps operation, a version, and two normal labors—in which he produced complete absence of pain, with but little disturbance of the sensorium. He mentioned that he had tried the agent for a long time, and spoke with such enthusiasm, that others were induced to follow his example.

C. Wiedemann, (*St. Petersb. M. Wochenschr.*, 1883, No. ii.) reports a series of seven well-controlled normal labors, and Hæckermann, (*Centralbl. f. Gynœk.*, 1883, No. 34) has tried the drug in fifty cases. Both concluded that it could be used without danger to mother, or child, without influence upon the course of labor, and without loss of consciousness, essentially diminishing or quite removing the pains of labor. They pronounced it the long-sought-for, and yearned-after means for abrogation of the curse resting upon mankind, "with pain shalt thou bring forth thy children."

Prof. Müller (*Arch. f. Gynœk.*, Berl., 1883, xxii., 99, 102; *Berl. Klin. Wochenschr.*, 83, xx., 673) employed it in twenty-two, exactly observed, obstetrical cases; sixteen were primiparæ, and six multiparæ, all of whom, were quite healthy. In nine cases, a trifling acceleration of the heart and lung activity was observed. In eight cases, dilatation of the pupil swiftly occurred, and very frequently the face became red—a circumstance which speaks for, rather than against the agent, as we ascribe the syncope of chloroform, to anæmia of the brain. The unpleasant after-influences of chloroform, as pain in the head, etc., were entirely wanting. Elimination, appeared to occur almost exclusively by the lungs, and continued over the first two days of childbed, producing a garlicky odor upon the breath. This odor could be distinctly perceived upon the breath of the fœtus, showing that it had quickly passed to its circulation, but without producing the most trifling effect upon it.

Müller did not, like his predecessors, find the drug free from disadvantage. In five of his cases, weakness of labor was induced, but all were terminated naturally. No hemorrhage followed, nor was there any delay in the process of involution. More important still, was disturbance of the respiratory organs, during convalescence. One patient, to whom eighty grams (fl ℥ ij) were given, complained afterward of suffocation and headache, and was annoyed by a dry cough. Temperature and pulse were normal, with regular action of the abdominal organs. Coarse, crepitant râles, were heard over both lungs. The unpleasant symptoms had vanished by the tenth day. The second patient, to whom over 100 grams (fl ℥ iiss) were given, presented more serious symptoms. About the third or fourth day of convalescence the pulse rose to 100, temp. 39° C. (102⅕° F.), and both lungs were filled with large and small crepitant râles, without phenomena of smothering. The symptoms vanished with profuse expectoration, and the patient was discharged at the end of two weeks well. His experience further showed it, not always effective. Thus, in thirteen cases, in which it was administered at the time of expulsion, a complete result was obtained in but five cases, three times, pain was diminished, but in five cases it produced no effect whatever.

We have used the drug in twenty-nine cases, and have become so well pleased with its action, as to regard it a necessity in the practice of obstetrics.

In the use of a new anæsthetic, and one which, from its recent use, must necessarily be regarded with suspicion, we have been extremely careful, in observing and noting its effects.

Of these cases, eight were primiparæ, and twenty-one multiparæ; in the former, delivery was completed five times with forceps, in the latter eleven times.

Analyzing these cases farther, discloses that:

In 5, ethyl was not given, until the forceps were applied;

In 3, labor was completed naturally, where previous labors were instrumental;

In 1, former labor was also instrumental;
In 3, labor-pains were weak before, and after, administration of the drug;
In 2, pains were weak, but strength greatly increased after its administration;
In 2, the fœtus presented with vertex in R. O. P. position;
In 1, delivery followed by uterine inertia, inversion and hemorrhage;
In 1, fœtus still-born;
In 1, child died same day, in convulsions;
In 1, child died second day, of cyanosis.

In the presentation of any anæsthetic for general obstetric use, the profession have the right to demand that it shall be shown to be absolutely safe for mother and child; that it will not cause uterine inertia, thus increasing the danger of post-partum hemorrhage; nor induce acute inflammatory conditions in the organs, by which it is eliminated, complicating the puerperal stage.

Of our cases, three deserve especial consideration; in one, a woman of delicate physique, who had been supposed to have phthisis, in a previous pregnancy, after inhalation of about a drachm of the ethyl during three pains, began to complain of a sense of suffocation, or oppression; respirations were less frequent and sighing; pulse normal, pupils dilated. The anæsthetic was discontinued, and labor completed normally, but the sensation did not wholly disappear until the following day. The second, a nervous and hysterical primipara, with fœtus presenting the R. O. P., took ℥vi between 9.30 P.M. and 2 A.M., when the delivery was completed by the forceps. The uterus contracted firmly. There was no laceration of vaginal mucous membrane, or perineum. The patient seemed in good condition, and did well, until in the afternoon. At 5.30 P.M., temperature 103°, P. 152, respirations frequent, looked badly, abdomen tympanitic, bowels had been frequently evacuated unconsciously. Quinine, morphine and digitalis were promptly given, and vaginal injections employed.

The following morning her temperature was normal, pulse 120. Her subsequent improvement was undisturbed, save by the want of control of the bowel, which continued for nearly ten days.

The third patient, a primipara, having had more or less severe pain for twenty-four hours, without the os dilating, was at 12 M. ordered, ℞ Ext. belladon., morphiæ sulph., āā gr. ij ; Ol. theobromæ, q. s. ft. supposit. no. iv. One suppository to be inserted at once, and another in the evening. At 10 P.M., we found they had inserted three. She was then experiencing the effects of the belladonna, in dryness of the throat, dilated pupils, etc. Pains were infrequent and feeble, os dilated slowly. At 8 A.M., it was fully dilated, the fœtal head was driven down to the inf. strait, but the pains were insufficient to accomplish more. At 9.15 A.M., delivery was completed with forceps. The ethyl was not administered until the application of the forceps, and was continued until delivery. After delivery of the fœtus, the uterus was flabby, did not contract, and bleeding was quite free. The removal of the placenta was hastened by expression and traction, upon the placental mass by two fingers in the vagina. Shortly after its delivery, continued hemorrhage, and the absence of a uterine tumor through the abdominal walls, led to a vaginal examination, which disclosed complete inversion of the uterus. She was quickly given the ethyl, and the uterus restored, by pressing the fingers against the fundus and carrying the hand into the vagina, while the uterus was held by the external hand.

The placenta had been attached to the posterior surface, low down. The uterine cavity was washed out with hot water. She recovered without special difficulty.

The first case mentioned was one unsuitable for the administration of any anæsthetic. The alarming symptoms of the second case, we are inclined to attribute, rather to the shock of a threatened peritonitis than to any deleterious effects of the anæsthetic. In the third case the inertia was too plainly present before its use. Although the ethyl was administered to restore the organ, it became at once quite firm, and there was no subsequent inclination to relaxation.

There was a fœtal mortality of three. The first died of cyanosis, the second day after delivery. It was small and poorly developed. The mother had been under treatment, during the last three months of pregnancy, for albuminuria; the labor had been quite tedious, and was completed by forceps, with some difficulty. The other two, were both cases in which the anæsthetic was only given during the use of instruments; in one it was the eleventh pregnancy. She had a pendulous abdomen, and the fœtus presented the vertex in R. O. P. position. The delivery was accomplished after considerable difficulty. The child did well for several hours, when convulsions occurred, and death followed. The other was a primipara seen in consultation. She had a contracted conjugate, and had been in labor some hours. Her attendant had made three trials with instruments, before my arrival. The head was delivered after hard pulling, the cord encircled the child's neck, but no pulsations were perceptible in it. The greatest difficulty was experienced in delivering the body. Prolonged efforts were made to resuscitate the child without avail.

In this paper, then, we are able to enumerate one hundred and twelve cases in which the drug was used without any fatality for mothers, and with but three deaths in children, none of which could be attributed to its action. Fearing, that the unusually large proportion of operative cases in our series would be attributed to the enervating effect of the drug upon the progress of labor, we have looked over the notes of the same number of cases, immediately preceding those in which the anæsthetic was used, and find that twelve of them were operative.

With but one exception, the anæsthetic was not employed, until the completion of the second stage of labor, and in five, only for the application of instruments. The only case of post-partum inertia was one of these, the third case described above.

The ethyl was administered with the advent of each pain, by holding over the face of the patient, a napkin, on which a few drops had been poured. This was removed as the pain subsided. There was no choking or suffocation, as in chloroform, and entire absence of the stage of excitement. After one inhalation, the patient invariably begged for it with the advent of each recurring pain. With small quantities, the sensation of pain was blunted, while intelligence was uninterrupted; the patient was perfectly subject to control, and ready to render or withhold voluntary efforts, as desired. Under such treatment, the expulsive efforts resembled those made to evacuate obstinately constipated bowels, and were not attended with more pain. In multiparæ, the usual expression was, that they had never known such relief.

No diminished power in the uterine contractions was observed, subsequent to its use; in fact, in many of the cases where before the contractions had been ineffective and irregular, they became strong and regular. In one case we attempted to determine the duration of pause and pain, during a part of the labor, by palpation over the abdomen, with the following result:

BEFORE ADMINISTRATION.		AFTER ADMINISTRATION.	
Time of beginning.	Length.	Time of beginning.	Length.
11′, 13″, 30‴ P.M.	30‴	11′, 40″, 45‴	30‴
11′, 15″, 45‴	30‴	11′, 42″, 30‴	1″
11′, 19″	1″, 30‴	11′, 44″, 30‴	45‴
11′, 21″, 20‴	1″	11′, 46″, 30‴	1″
11′, 22″, 45‴	30‴	11′, 49″, 15‴	1″
11′, 25″, 20‴	1″	11′, 52″	30‴
11′, 27″	30‴	11′, 54″	1″
11′, 28″, 45‴	2″, 30‴	11′, 56″	1.15
Total T. 17″, 45‴	Total L. 8″	T. T. 16″, 30‴	T. L. 7″

It was difficult to determine the exact length, of the first and third pains, after administration of the drug, as a nausea that had existed for some time, then culminated in vomiting. The above kind of observation has not, however, sufficient power of demonstration to decide the important question, whether this agent influences the character of the labor-pains, and consequently, the duration of the labor.

We have noticed, a marked want of uniformity, in the action of different preparations of this drug. Some, procured for use in the Philadelphia Hospital, had an unpleasant irritating odor, and was slow in producing the anæsthetic effect. To this fact, we are inclined to ascribe the want of action, experienced by Müller, in a number of his cases. We have been in the habit of specifying either, Wolff & Co., or Parke, Davis & Co., when procuring it, as we have invariably found their preparations of the drug, with a pleasant odor, and reliable in action.

We feel that the experience derived from our own cases, together with the commendation of other experimenters, justify us, in urging upon the profession, a more extended trial of this agent, in alleviating the sufferings of the most trying period of maternal life.

In a discussion before the Obstetrical Society of Pennsylvania, Dr. W. H. Parish, stated, that he would like to hear more particularly from Dr. Montgomery, in his closing remarks, respecting the safety of bromide of ethyl, as an anæsthetic. A few years ago, it was introduced into surgical practice in this city, and was abandoned in consequence of its dangerous character. If dangerous in surgery, why should it not be in obstetrics also? Chloroform, which was at one time considered perfectly harmless in the latter class of cases, has been found to be no safer there, than in ordinary cases.

Dr. Parish, has established for himself three rules, respecting the use of anæsthetics in obstetric cases: 1st, In easy normal cases, no anæsthetic is required; 2d, If the patient is nervous, excited and uncontrollable, he gives chloroform at the incipiency of each pain, to quiet the excitability of the patient, and take away the sharpness of the pain, without producing unconsciousness. During the intervals, between pains, the chloroform is withheld. 3d, Whenever he considers that unconsciousness (full anæsthesia) is necessary, he employs ether, so as to avoid the depressing effects of chloroform. Bromide of ethyl might be used in place of chloroform, as indicated in his second rule, if shown to be equally safe; but he would not consider it proper to use it to produce complete relaxation, as required for version, or the application of the forceps.

Professor Wood, in his experiments, found bromide of ethyl more dangerous than chloroform. Dr. Parish does not use it; (Dr. P. did use it, and reported such cases to us) and he fears it would go hard with any physician before our courts, if he had a fatal accident to occur during its use.

Dr. Montgomery, in closing, said that as to the danger resulting from the use of bromide of ethyl, he thought there could be none if a pure article was carefully used. The patient is not completely narcotized—consciousness is not lost; the administration of the drug is interrupted. The patient can coöperate, although relieved of suffering. She can answer questions.

Professor Müller, is the only one who has failed in obtaining good effects; and this was probably due to impurity in the drug. Bromide of ethyl does not take the place of chloroform, nor does it produce muscular relaxation, nor relaxation of the uterus, as required in version. It can be pushed to complete unconsciousness; but that is not necessary, as pain will be relieved, while the contraction of the uterus, and respiratory muscles, are fully as effective as without it. Labor is undoubtedly a physiological process, as much so, as respiration or defecation, but it does hurt.

This is the type of the most severe and agonizing suffering; and we, as physicians, are called upon to relieve that suffering, and prevent the waste of vital force, to the extent that we are able, by preventing pain—long-continued pain.

Bromide of ethyl, is apparently entirely safe, when given as we have used it. Experimental physiologists, do not all agree with Prof. Wood, as to the comparative danger of this, and other anæsthetics.

Brom-Ethyl, and its Value in Dental Operations.

After a careful discussion of the merits of the various anæsthetics, Dr. Julian Scheps, of Breslau, gives an elaborate account of brom-ethyl, and of its great usefulness as a narcotic in dental surgery. (*Centralblatt für Chirurgie*, Sept. 24, 1887; *Therapeutic Gazette*, Dec. 15, 1887.)

He quotes Dr. H. C. Wood, who states, that brom-ethyl has a direct paralyzing effect on the muscles of the heart, causing a marked decrease of the pressure of blood, and therefore equally as dangerous, as chloroform.

Dr. Scheps agrees with us, that these symptoms only occur, after long-continued inhalation, and he holds, that the drug is perfectly safe in short operations. The drug, says the author, should be administered in the same manner as chloroform, on an Esmarch's mask. Terrillon, advises its being poured on a compress which covers the face, but Dr. Scheps, says, the mask only, should be used under all circumstances.

The patient should be placed as horizontal as possible.

The author then gives a minute description of several remarkable cases, and gives a large number of other cases in tabular form. All these cases relate to the extraction of diseased teeth.

The average dose of brom-ethyl required to produce anæsthesia, was 15 grammes (4 drachms). In most of the cases, the patient was conscious of the extraction, but experienced no pain whatever. The author is of the opinion, that in introducing brom-ethyl into dental surgery, he has brought forward an anæsthetic, which can be rivaled by none.

A great drawback to the extensive use of brom-ethyl, is its peculiar tendency, to cause rigidity of the jaws, and excessive secretions of mucus, which follow its use.

As an anæsthetic, nitrous oxide has this same peculiarity, so that a prop must in all instances be employed, to keep the mouth open during extraction.

Various mixtures have been made with brom-ethyl, and agents employed to disguise its taste and smell.

The following article by the editor of the *Dental Cosmos*, will reveal a fraud practiced by a member of the dental profession:

Proprietary Anæsthetics.—Our attention has again been called to this subject by a correspondent, who inclosed a circular announcing a "new discovery for producing natural sleep at will; safe and efficient for extracting teeth without pain or danger; indorsed by the leading medical journals in Europe, and America."

The proprietor of this wonderful agent, claims that it was discovered after years of labor and research; that since 1864, he has been constantly on the alert, for some agent that would be more efficient, safe, and economical, than nitrous oxide. He appends statistics, showing its relative economy, and testimonials as to its safety and efficiency. He claims that he was led to the investigations which resulted in the discovery of this *new* anæsthetic from the conviction, that "progressive science should devise means for producing natural sleep at will," and he therefore determined to investigate and discover, if possible, some agent, that would not be open to the objections which appertain to chloroform, ether, and nitrous oxide gas, all of which, he considers unsafe, because they produce congestion of the brain, and death is likely to result from such abnormal condition; that the *new* anæsthetic produces natural sleep without congestion, and is therefore absolutely free from danger, and that "heart disease, pregnancy, lactation, menstruation, kidney troubles, and old age, are no drawbacks in its administration." The discoverer of this new anæsthetic has given it the name of "Soporative," the word being derived from the Latin *soporo*, meaning natural sleep, as we are informed in the circular.

Realizing at once the value which an agent of this character would have in the practice of medicine and dentistry, we procured a bottle direct from the proprietor, at a cost of five dollars, at once submitted it for analysis, and have received the following report thereon:

PHILADELPHIA, March 29, 1886.

J. W. WHITE, M.D.:

Dear Sir:—The sample of "Soporative" received from you on the 24th inst. has been examined. It is *Bromide of Ethyl*, flavored with rose, and containing distinct traces of alcohol, as follows:

Bromide of ethyl	99.13 per cent.
Alcohol and oil of rose	.87 " "
	100.00

Yours truly, HENRY TRIMBLE,
Professor of Analytical Chemistry in the
Philadelphia College of Pharmacy.

(See table opposite.)

Analysis of 0.307 grammes bromide of ethyl:

C.	67.601
H.	14.081
Br.	225.322
	307.004

Table Showing Reactions of Commercial Samples of Bromide of Ethyl.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	Pure Chloroform.
1. Color and reaction.	yellowish, slightly acid.	colorless, neutral.	colorless, neutral.	colorless, neutral.	colorless, neutral.	slightly col'rd acid reaction.	yellowish col'r acid reaction.	colorless, slightly acid.	colorless, neutral.	
2. Odor after evaporation from blotting paper.	acid, smells plainly of acetic ether.	odor reminds of allyl sulphide.	no foreign odor	no foreign odor.	slight odor of garlic.	smells sour.	odor reminds of sulphur compounds.	no foreign odor.	no foreign odor.	
3. Specific gravity at 15° C.	1.4216.	1.408	1.437.	1.450	1.4144.	1.408.	1.2314 at 20° C.	1.432.	1.436	
4. Constant boiling point.	37° C.	35° C.	36° C.	36° C.	35° C.	35° C.		36° C.	36½° C.	
5. After ten minutes' contact with sodium	slightly attacked.	strongly attacked.	slightly attacked.	slightly attacked.	slightly attacked.	sodium entirely dissolved.	sodium dissolves with strong effervescence.	affected very slightly.	not attacked.	slightly attacked.
6. Reaction and odor after removal from the sodium.	slightly alkaline, irritating to the eyes.	alkaline, slight foreign odor, irritating.	neutral, faint evanescent smell of herrings.	slightly alkaline, strong persistent smell of herring.	slightly alkaline, odor of herrings.	alkaline, vapor irritating.	strongly alkaline, garlicky odor.	natural, very faint foreign odor.	no foreign odor.	no foreign odor.
7. Reaction with sodium amalgam and water.	yellow.	yellow.	yellow.	yellow.	yellow.	yellow.	strongly affected before addition of water	yellow.	yellowish.	
8. Reaction of liquid from No. 7 with sodium nitroprusside.	slightly red coloration.	brownish yellow.	yellow.	no reaction.	no reaction.	no reaction.	blood red coloration.	no reaction.	no reaction.	
9. Reaction with conc. sulphuric acid.	brown color, vapor irritating to the eyes.	effervesces, lower layer brown, smells of H Br.	brown at plane of contact.	no effervescence, ether colors brown.	no effervescence, lower layer brown	both layers brown, vapors strongly irritating.	colors brown with elevation of temperature	slightly brown at plane of contact.	remains clear.	remains clear.
10. With Fehling's solution.	milky.	clear.	upper layer turbid, odor of coal gas.	slight odor of herrings.	no reaction, slight odor.	no reaction.	slightly decolorized.	no reaction.	clear, no reaction.	reduces the copper.
11. With alcoholic potassa, fifteen minutes' contact.	clear.	clear.	clear.	clear.	clear.	clear.	immediate precipitate.	clear.	clear.	immediate precipitate.
12. Aqueous solution of potassa.	milky.	clear.	clear.	turbid.	clear.	turbid.		clear.	clear.	becomes turbid.
13. Solution of potassa with potassic permanganate.	color weakens in two minutes, colorless in five min., brown at end of 24 hours.	color destroyed in 10 minutes.	decolorized in 20 minutes.	loses color in 10 minutes, destroyed in 24 hours.	no immediate reaction, color destroyed in 24 hours.	color destroyed in 15 minutes.	color destroyed immediately.	no immediate reaction, color destroyed in 24 hours.	color destroyed in 36 hours.	green at once.
14. Solution potassic bichromate and sulphuric acid.	greenish coloration.	lower layer brown, upper layer violet.	yellow.	upper layer brown, lower layer brownish yellow.	slight greenish coloration of other layer.	upper layer violet, lower layer dark brown.	green at first, brown in 5 minutes.	no change of color, ether clear.	no change of color noticeable at end of 4 days.	green at once, later brownish yellow.
15. Acetate of lead solution.	becomes turbid.	slight turbidity, soluble in acetic acid.	clear.	turbid, clears with acetic acid.	clear.	turbid, sol. in acetic acid.	strongly turbid.	hardly noticeable turbidity.	clear.	strong turbidity.
16. Nitrate of silver solution.	supernatant liquid becomes milky.	upper layer turbid.	turbid.	milky.	milky.	milky.	precipitates immediately.	slight turbidity.	clear.	clear.
17. Ammoniacal nitrate of silver.	becomes turbid.	turbid, slight reduction of silver	upper layer milky.	both layers milky.	milky.	turbid.	precipitates at once.	slightly turbid.	clear.	both layers turbid.
18. Liquid from No. 5 after acidulating with sulphuric acid.	slight sulphurous odor.	smell not noticeable.	slight sulphurous odor.	slight foreign odor.	hardly perceptible odor.	hardly noticeable odor.	strong garlicky odor.	no change.	no change.	

Estimated from formula C_2H_2Br.

C.	67.596
H.	14.082
Br.	225.322
	307.000

Note, explanatory to some of the reactions mentioned in this table:

To No. 6. In this set of reactions the quantities of sodium and ether used were as nearly as possible alike.

To No. 6. The liquid after treatment with sodium is dropped on blotting paper and allowed to evaporate; foreign substances betray their presence by the odor. The irritating property of the vapor, when referred to, is meant to apply mainly to its action on the eyes.

To No. 7. The sample is first left in contact with the sodium amalgam alone ; after color reactions are obtained, the water is added. This sample, we may remark, was furnished Dr. William Brodie, of the *Therapeutic Gazette*, by Dr. J. Marion Sims. It is a portion of that employed by this distinguished surgeon in the fatal case with the details of which the profession is so familiar.

To No. 14. The ether being heaviest, constitutes in this case the lower layer.

To Sample No. 7. In this case the specific gravity was taken at 20° C. All the rest were taken at 15° C.

Postscript.—After the above article had already passed into the hands of the printer, Professor Jungk received an additional consignment of various commercial brands of bromide of ethyl. As the time for making further tests was too limited to take in hand more than a single sample, we selected for the purpose one purporting to have been used by Dr. Levis, of Philadelphia, in the fatal case which he has lately reported as having occurred in his practice from the effects of this anæsthetic, which sample consisted of about two fluid ounces, and was contained in a bottle with the name "Jefferson Medical College Hospital" blown in the glass. The reaction obtained with this sample resembles very much that of No. 7 in the accompanying table,*

* This valuable table was received from Park, Davis & Co., of Detroit.

and were as follows: Colorless; reaction neutral. On cooling the ether to 20° C., it became opalescent, and on being allowed to remain at rest for a while after the treatment, a separation of a liquid substance takes place, which refuses to be again incorporated with the main body of the ether by agitation.

Water agitated with the sample, acquires a decidedly acid reaction. The specific gravity is 1.2123 at 15° C. This sample begins to boil at 33° C., but the boiling-point does not remain constant until 35° C. is reached. Sodium was strongly attacked, with the formation of a very considerable quantity of bromide of sodium. The liquid decanted from the sodium and evaporated from blotting-paper, left an odor similar to that of acetic ether. Another portion of this liquid, when supersaturated with concentrated sulphuric acid, evolved vapors of hydrobromic acid.

Sodium amalgam was strongly attacked, with the formation of a white flocculent precipitate. The liquid decanted from the sodium amalgam, gave no reaction with sodium nitroprusside. When the ether is treated alone, with concentrated sulphuric acid, it becomes turbid, and also colors brown at the plane of contact.

Half a fluid drachm, treated with five drops of Fehling's solution, changes the color of the latter to a light green, which cannot again be restored to a blue by the addition of caustic soda.

When treated with an equal volume of alcoholic potassa, the ether remains clear for about fifteen minutes, and then becomes turbid. Agitated with aqueous solution of potassa, the latter acquires a turbidity; the addition of potassium permanganate, is followed by an immediate green coloration of the liquid, and after about half an hour, by the formation of a brown precipitate.

No reaction is obtained by treatment with sulphuric acid, and potassium bichromate. With acetate of lead solution, aqueous as well as alcoholic, it gives a turbidity. With silver nitrate, the supernatant liquid is at once colored yellow, and at surface of contact a reduction of the silver can be observed. The same results are obtained with ammoniacal nitrate of silver, with additional formation of a turbidity, which is not soluble in nitric acid.

The reactions of this sample, as well as those obtained with Nos. 1, 4, 6 and 7, demonstrate conclusively their entire unfitness for the purposes of inhalation.

An Experimental Study of Anæsthetics.*

The author introduced his subject, by stating that it was the aim of his paper to show, by experiments on rabbits and dogs, the physiological action and relative safety of those anæsthetics, which are most frequently used by surgeons. The anæsthetics employed, were chloroform, sulphuric ether, bromide of ethyl, and various mixtures of these drugs.

The observations in these experiments were chiefly limited to the temperature, pulsations, respirations, mortality, and *post-mortem* appearances; but the conclusions reached, through the experimental investigations made by Dr. H. C. Wood, of Philadelphia, for the purpose of determining the physiological action of chloroform, sulphuric ether, and bromide of ethyl, on the heart, are likewise mentioned.

The introduction to this article was followed by a brief explanation of these experiments, which was intended to prepare the reader for a full comprehension of the work performed, and which was connected with the anæsthetizing of eighty-two rabbits, and twenty-five dogs. Following these explanatory notes, there were presented in a tabulated form the general results, which are contained in ten tables, six of which relate to the experiments performed on rabbits, and four to those on dogs.

The tables are followed by a comprehensive *résumé* of the results, and the author remarks that their most casual inspection cannot fail to impress the observer, with the relatively small mortality produced by the sulphuric ether, when it is compared with that which followed the use of the bromide of ethyl, chloroform, or the mixtures which were employed.

The percentage of the mortality produced by the different

*Dr. B. A. Watson, of Jersey City.

anæsthetics employed in the experiments on rabbits, was as follows:

Sulphuric ether,	$16\frac{2}{3}$
Chloroform,	$62\frac{1}{2}$
Bromide of ethyl,	50
Alcohol, chloroform, and ether mixture,	75
Alcohol, chloroform, and ethyl mixture,	$66\frac{2}{3}$

Attention is called to the fact that owing to the evanescent character of the bromide of ethyl, it was found impracticable to keep the rabbits constantly under the influence of this drug, or its mixtures; and consequently, the figures given in the above, do not accurately represent the mortality which may justly be anticipated, when these animals are kept under its full influence, for two hours—the period during which full anæsthesia was intended to be continued, in all of the experiments. The above comments are entirely limited to the administration of the bromide of ethyl, and its mixtures, to the rabbits, the same, not applying in any degree to the dogs, or to any other anæsthetic. The whole number of dogs experimented on was twenty-five, and among these, twelve deaths occurred, in which the percentage of mortality chargeable to the different anæsthetics, was as follows:

Sulphuric ether,	.00
Chloroform,	.00
Alcohol, chloroform and ether mixture,	.80
Alcohol, chloroform and ethyl mixture,	.80
Bromide of ethyl,	100.00

It is shown by the above comments, and others which follow in the author's detailed statements, that the danger arising from the use of the bromide of ethyl and its mixture, is more accurately portrayed in the experiments on dogs, than in those on rabbits. The author finally reaches the conclusion that the *primary effect of the bromide of ethyl, resembles that of chloroform,* and not that of ether; but it is certainly much more dangerous than the former agent, especially when full anæsthesia is continued with it for a period of two hours. The deaths which occurred in the experiments, during the administration of the ethyl, are believed to have been caused by its paralyzing action on the heart, while those occurring at a later period were probably more or less dependent on the same; but in these cases, the *post-mortem* appearances reveal extreme congestion of the principal visceral organs, with other indications of inflammation, in all cases in which death was sufficiently delayed.

We have now reached a point in our study of the various anæsthetics, where we believe we are justified in *firmly asserting*, in the light of the theoretical and practical knowledge, which we now possess of the action of the bromide of ethyl, that neither this drug, nor its mixture, should ever be employed for the production of anæsthesia, especially where it is necessary to prolong this state. It has long since been sufficiently shown, that sulphuric ether is decidedly the safest anæsthetic which has yet been employed in general surgical practice; and our experiments, are merely confirmatory of the correctness of this decision. The use of a mixture of alcohol, chloroform, and ether, for the purpose of producing anæsthesia, is theoretically wrong and practically bad, since it is unquestionably much more dangerous than sulphuric ether.

By a careful analysis of this valuable paper we find the following points for criticism:

1st. Other animals should have been employed as a comparison with dogs, as it is well known from our experiments, and those of others, that there is considerable difference in the action of chloroform on dogs, pigs, rabbits or guinea pigs.

2d. The chloroform, and bromide of ethyl, should have been chemically pure and from a reliable house, and even what was employed should have been tested before use. Forty of the dogs were not suitable cases for the experiments, as they were suffering from complicated traumatic injuries, not stated.

Dr. W. W. Dawson, of Cincinnati, in opening the discussion, said, that he believed the sentiment of Dr. Watson's paper was correct. He had had a rather painful experience with chloroform, and narrated two cases which had terminated fatally. The first was in 1868, before the agent was considered dangerous. He was amputating a foot. The field of operation became bloodless; artificial respiration was practiced without success. At that time, he said, we were unwilling to admit that chloroform could kill, it was so prompt in its action. The second case lost, was that of a little boy. In that case, also, the first symptom was the cessation of hemorrhage, from the field of operation. The anæsthetic was for a moment withdrawn. The patient revived, and the operation was proceeded with. Soon the operation again became bloodless, and the same thing occurred a third time. This time it was permanent. The heart had ceased to beat, and failed to start even after the most energetic artificial respiration.

The speaker further stated, that since this experience, he was very cautious in the use of the alcohol, chloroform, and ether mixture, and preferred ether alone. He further reported the case of a woman who, although she had several times taken chloroform during parturition, and at one time had remained under its influence for an hour, died after a few inhalations in a dentist's chair.

President Moore, called attention to the fact, that the woman just spoken of was in all probability in an erect posture when inhaling the ether, a position which renders the danger much greater.

Dr. Donald Maclean, of Detroit, spoke strongly in favor of chloroform. He did not believe the dangers from its use much, if any, greater than those from ether. He has used it almost exclusively in his practice. A great deal of the danger, he believed, is in the mental impression made by using the anæsthetic. Other cases, too, die from other causes than the action of the anæsthetic. In this connection he reported the case of a woman whom he saw a week ago. She was a robust woman, apparently in perfect health, except a slight asthmatic dyspnœa, a common affection in Michigan. He decided to operate in a few days, for an ovarian tumor. He had been away only an hour when she died. Had the operation been in progress, or had the patient taken a breath or two of chloroform, her death would have been attributed to it. He had never seen death from an anæsthetic, and had had trouble in only very few. The last case, in which there was any cause for alarm, was that of a man, from whom he had just removed the entire tongue. The instrument not working perfectly, there was some hemorrhage. Blood was drawn into the larynx, but after removing the blood, and practicing a little artificial respiration, all came right. In conclusion, he stated, that while he believed in the use of chloroform, he believed it equally important, that the agent be administered by a competent person, able to recognize and handle any complications that may arise.

Dr. William A. Byrd, of Quincy, Ill., took his stand with those who opposed the use of chloroform. He had lost but one case, and that a woman, who had been operated upon several times before coming under his care for a vesico-vaginal fistula; being once nine hours anæsthetized. He had also kept her under chloroform for an hour, without any symptoms of danger, and the fistula was closed. When, however, he went to remove the stitches, the patient demanded an anæsthetic. She took only a few inhalations, when she suddenly died. He further spoke extensively of the action of the bromide of ethyl. He had at first used it with the fullest confidence, but had abandoned its use later, on account of its action being so profound and causing such marked suffusion of the face. He now uses a mixture containing one ounce of ethyl bromide, three ounces of ether, and two ounces of alcohol. The action of this, he said, is prompt, efficient, and, as far as his experience goes, safe.

Dr. L. McLane Tiffany, of Baltimore, said that he must negative absolutely, the statement of the essayist, in regard to the similarity of action, between the bromide of ethyl and chloroform. Clinically, the action is different. He had never had a fatal case due to chloroform, although he had seen patients in great danger. No one, he believed, could use it with perfect confidence; and he referred to the experience of the late Dr. Sims, who, after having most excellent results from its use, lost a case shortly before his death. He referred to the practice of Dr. Chisholm, of Baltimore, who uses the ethyl bromide in ophthalmic operations, with no inconvenience.

Dr. P. S. Connor, of Cincinnati, stated that he had used the bromide of ethyl pretty extensively in the Cincinnati Hospital. He had been both surprised, and astonished, at its action on the heart. He had seen the pulse run up from 100 to 120, during its administration. He had never seen an agent so mild and efficient in its action, and yet so profound, and apparently, not dangerous. He did not believe that any anæsthetic can be called safe. It is impossible, he said, to carry patients to the border-line of life, without now and then some one slipping beyond that line. Such being the case, he believed it the duty of the surgeon to employ the agent of least danger.

Sphygmographic Tracings of Ether, Ethyl Bromide, and Chloroform.

The sphygmographic tracings, (see pp. 215 and 216, Lyman), taken in the Physiological Laboratory at Rush Medical College, Chicago, correspond to, and corroborate those which were taken for us at the Physiological Laboratory, of the University of Pennsylvania. These tracings, prove to us that there is a material difference in the rapidity of death and overpowering effects of chloroform over ether and ethyl bromide. It is true that the pulse-curves given of ethyl bromide exhibit far greater cardiac depression under its influence, than is produced by ether; it more resembles chloroform, but not the same evidences of syncope, and the animal can be restored even on the very brink of the grave, which you cannot always do with chloroform. So that we still hold to the first views expressed in our second edition, that ethyl bromide is a safer anæsthetic than chloroform, if chemically pure. In purchasing ethyl bromide, it should be stated on the label, or a guarantee obtained from the manufacturer, that it is free from carbon bromide (C_2B_4) and free bromine. If there is fear that the article is not pure, have your chemist mix it with two per cent. of olive oil, agitating it from time to time, for twenty-four hours. The flask should then be placed upon a water-bath, and the progress of distillation should be conducted at a heat, which will not permit the temperature of the vapor in the space above the liquid, to rise above 40° (104° F.). The product thus obtained, will be pure ethyl bromide.

CHAPTER XIX.

ETHER INHALERS.

The Cone—Inhalers of Hawksley, Ormsby, Hearn, Cheatham, Lente, Allis, Morgan, Richardson, Angrove—An Improved Ether Inhaler by Parkinson—Rapid Anæsthesia by Ether, Müller, and Corning Device.

SOME of the inhalers in use, are made with the object of heating the anæsthetic used, to furnish a large evaporating surface, or to serve the purpose of allowing an admixture of atmospheric, or warm air with the gas or liquid, to be inhaled.

The Cone.

The cone is the chief form in which ether is administered, as an anæsthetic, in the United States. It is made by folding a starched towel, inside of which is a newspaper, into a cone large enough to go over the mouth and nostrils. The edges are rounded, and the sides pinned together with catch-pins. In the apex of this cone, is placed a carefully-washed sponge dipped in hot water, and squeezed out from time to time, so as to prevent freezing of the watery portions of the ether. Ether is poured on the sponge, half an ounce at a time, and repeated, as found necessary, by removing the cone from the patient's mouth. A very convenient cone has been found in the ordinary straw cuff, in which is fixed a sponge, devised by a dentist of Hartford.

ADVANTAGES OF THE CONE FOR THE INHALATION OF ETHER.—The advantages are: First, the ease with which they are made and removed from the patient's mouth, when there are signs of danger; second, the simple cone is never employed with a second patient, which is a great advantage in the way of cleanliness. All heavy or complicated inhaling apparatus, are objectionable, as they are apt to become unclean, the valves get out of order and the patient interfered with in his movements by the weight of them.

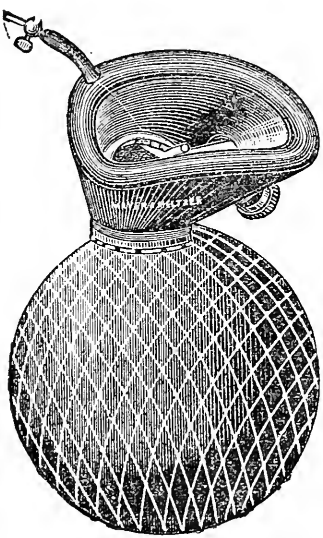
The chief objections to the cone, and its modifications, are, by allowing the undiluted ether vapor to impinge upon the larynx, or the sponge to become frozen, with wastefulness of the ether.

Ether Inhalers—Modifications of the Cone.

In 1866, Dr. Lente, invented a modification of the cone inhaler (see Plate 27). He found the air-cushion a failure, and substituted hair in the cushion, which retains its roundness so as to fit the face almost air-tight.

A piece of sheet lint is stuffed into the cone, a piece of wire or whalebone is slipped in, so as to keep the lint in place and prevent its touching the face. The lint is saturated with ether, and placed over the face. There is an opening, fitted with a cork stopper at the apex, large enough to admit air. This is usually closed, but if it is found necessary, the stopper can be removed. The ether can be poured in at this opening, without removing the apparatus from the patient's face. Its cleanliness is perfect, if a different piece of lint is employed each time.

Plate 24.



ORMSBY'S ETHER INHALER.

One of the same kind as the above is that called after its designer, Dr. Ormsby, of Dublin (Plate 24). It consists of a leather face-piece with cushioned rim, provided with a valve, which can be opened at the pleasure of the administrator; at the top of the face-piece is a cone-shaped wire cage, covered externally with leather, and leading into a soft leather bag, covered by a loose net, which prevents its undue expansion. In the wire cage, a sponge is placed, and upon this, an ounce of ether is poured. The apparatus is applied to the patient's face, and he is desired to take a full breath. Even when the valve is kept widely open, the sense of suffocation is so great (the rush of ether vapor producing more or less spasm), that the patient struggles fiercely to escape what appears like impending asphyxia.

Should it be necessary to add fresh anæsthetic during the operation, it is done by pouring ether down a tube which enters the centre of the sponge.

Ormsby's inhaler, is open to several objections: *e.g.*, it produces great discomfort by allowing undiluted ether vapor to impinge upon the larynx; the sponge is very liable to freeze hard, and so no evaporation of ether takes place; it occasions great struggling; it is wasteful of the ether.

Hawksley Inhaler.

It consists of "a glass vessel, capable of holding ten ounces of ether, with an inlet valve for air, and its sliding tube is graduated in ounces for the purpose of measuring the quantity of ether consumed. A pipe conveys the vapor to the face-piece, the edge of which is surrounded by a water-cushion, to secure exact adaptation. There is also a shutter-valve for regulating the admission of air, either at the beginning of an operation, or during its course. It has also an additional pipe, furnished with a valve, which conveys the expired vapor to the floor." This latter is a useful addition, when employed in a hospital, where a large number of patients are to be etherized in succession, so that the ether is not diffused in the air around the operator. When in use, the vessel in which the ether is contained, is immersed in water, heated to 100°, which promotes a more rapid and equable evaporation of the ether. "Ether boils at about 90°; but before the quantity contained in the vessel has reached that point, the temperature of the surrounding water will have fallen." This is a valuable inhaler; it is too complicated for every-day use by the physician or surgeon, but will be found very useful in large hospitals, and cause a great saving in the amount of ether employed.

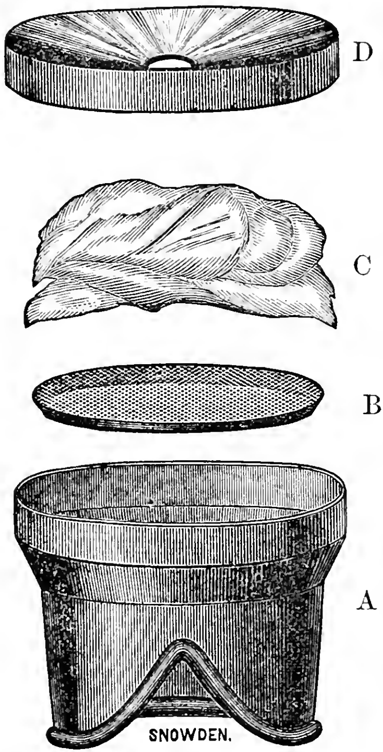
The most recent ether inhaler, invented by a man of great practical experience, it has two most positive advantages:

there is no waste of ether or diffusion in the room; second, the cloth can be removed and the water pressed out of it, and again employed, being free from all moisture and carbonic acid.

Hearn's Ether Inhaler.

It is named after its inventor, Dr. Joseph W. Hearn, of this city, who has had an extended experience in the administration of anæsthetics.

Plate 25.



The inhaler, (Plate 25) has its outer case A, made of thin sheet metal, having the lower edge, which comes in contact with the face, covered with rubber.

Inside of this case, a screen of wire gauze B is fitted, which comes opposite the lower joint, as at A.

The lint or canton flannel upon which the ether is poured is shown at C, and is held in place between the wire gauze screen B, and the funnel-shaped top D.

The object of this inhaler is to furnish an undiluted ether vapor, and prevent, as it should when ether is used, the patient's inhaling the surrounding atmosphere. The time required to produce complete anæsthesia, in ordinary cases, is from five to eight minutes.

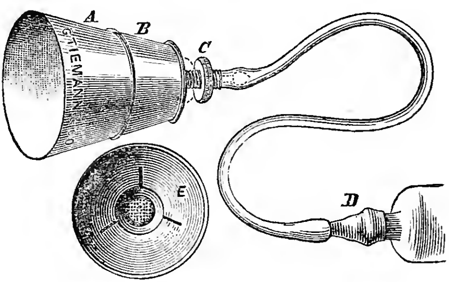
"Another object of the inhaler is economy; it rarely requiring, more than two or three ounces of ether to produce the full effect, for which reason, it is especially adapted to hospital use. The apparatus, by confining the ether vapor, prevents in a great degree the impregnation of the atmosphere in the room." If the patient needs air, the inhaler can be withdrawn between every second or third inspiration.

Cheatham's Ether Inhaler.

This operates by replenishing the evaporating surface, without removing it from the face. A patient cannot be etherized as quickly with it as with the common cone, but with much less ether, and by it, you avoid the disagreeable effects of having the ether permeating every part of the office, or house, in which it is used. Its convenience of application is, also, quite obvious. The ease with which the face-piece (being paper) can be removed immmediately after use, and thrown away, is, we think, a strong recommendation in its favor.

The apparatus consists of a tin cup (Plate 26, A) holding

Plate 26.



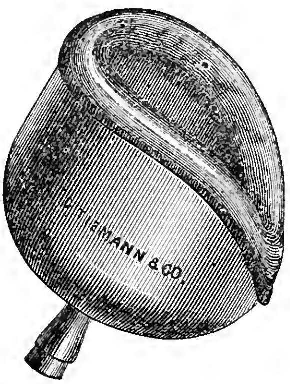
in the inside, a sponge as an evaporating surface, and connected from the top by rubber tubing, with the bottle that contains the anæsthetic. This tube has attached to its distal end, a cap D, that will fit over the neck of almost any bottle, thus doing away with Lente's graduated bottle.

Mode of using the Inhaler.—Make a cone of paper, cut the top off, so when the tin cup, A, is slipped inside the top of the cup it will protrude a line or two from the top of cone. Place tin cup, B, over both cup and cone, screw it down tightly by means of nut, C, and you have the cone held tightly. Attach tube to top of cup, and the apparatus is complete. The smaller the cone, the more quickly you can get the patient under the influence of the anæsthetic. We would suggest after the cone is in position, the bottom should be trimmed, leaving a part of it (we shall call it the back part) that is intended to go over the chin, three inches longer than the cup, and sloping forwards and upwards, leaving the front part, intended to go over the nose, about an inch longer than cup. E gives an inside view of cup, A.*

Dr. Lente's Ether Inhaler.

As early as 1866, Dr. Lente invented a form of inhaler, which has recently been modified. (See Plate 27). The present improved instrument, resembles very much the face-piece of "Waldenburg's apparatus" for the inhalation of condensed and rarefied air. The idea of using sheet brass, and the india-rubber air-cushion, was taken from it. The air-cushion, however, proved a failure, and the inventor substituted hair for stuffing the cushion, which he states, retains sufficient of its rotundity, to fit the face air-tight.

Plate 27.



Mode of Employing this form of Inhaler.—A piece of sheet lint is stuffed into the cone, a piece of wire or whalebone is slipped in, so as to keep the lint in place and prevent its touching the face. The lint is saturated with ether and placed over the face. There is an open-

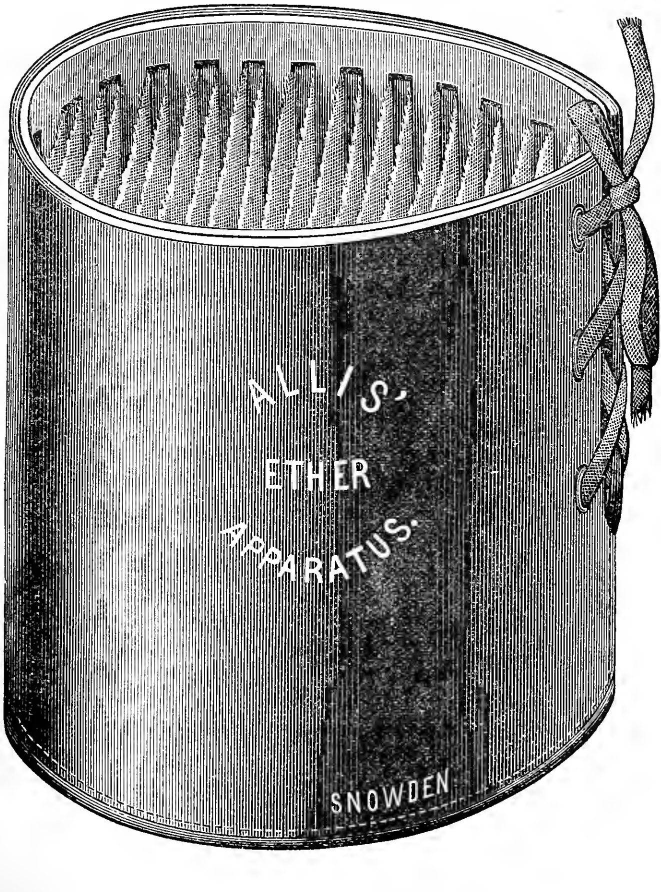
* These various forms of inhalers are made by S. S. White, Snowden, Gemrig, or Kolbe, instrument makers, of this city; also, George Tiemann & Co., of New York, and by Codman & Shurtleff, of Boston.

ing, fitted with a cork stopper at the apex, large enough to admit air. This is usually closed, but if it is found necessary the stopper can be removed. The ether can be poured in at this opening, without removing the apparatus from the patient's face. Its cleanliness is perfect, as a different piece of lint should be employed each time.

Allis' Ether Inhaler.

We present below cuts of the apparatus of Dr. Allis, for the

Plate 28.—Instrument complete.

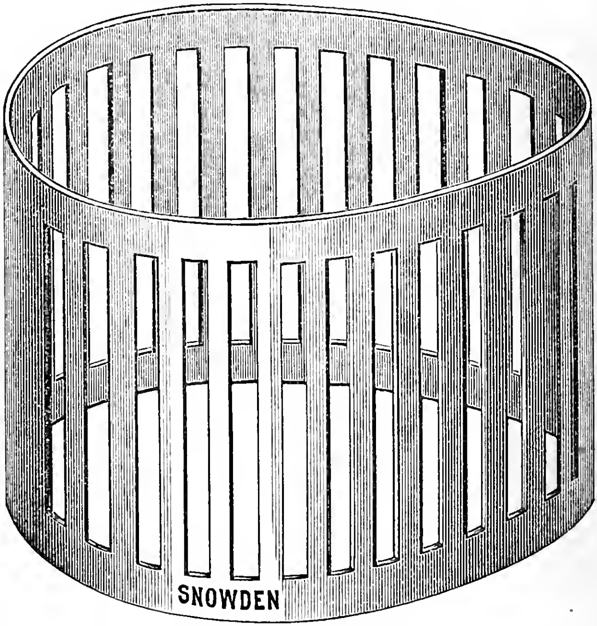


administration of ether. This instrument has been in use in the United States, and Europe, for several years, and may be said to have won a place among the standard instruments.

This, and the following cuts, are two-thirds the size of the manufactured instrument.

It is now made simpler and stronger than the first that were offered to the profession.

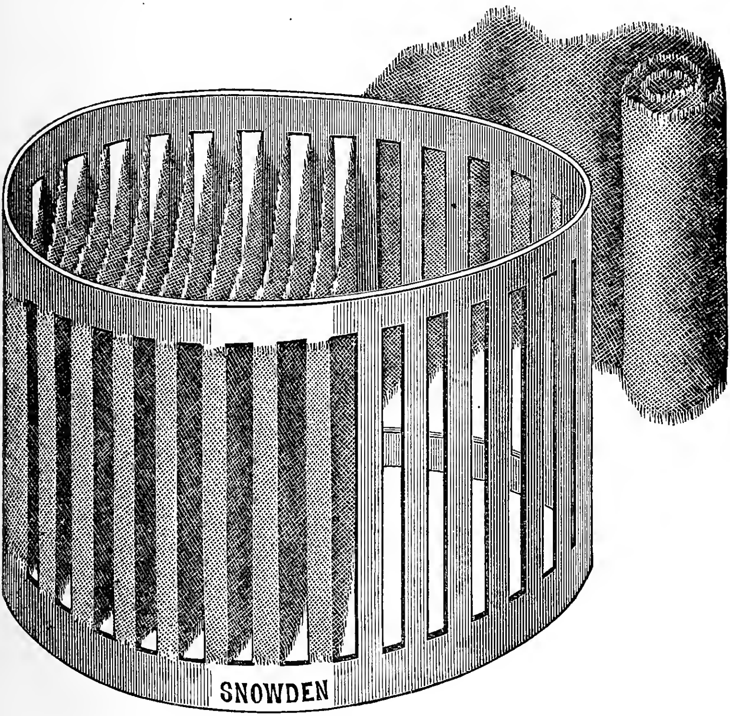
Plate 29.



Description of the Inhaler.—It consists of a metallic frame, sufficiently large to cover the lower part of the face. The bars are nearly a quarter of an inch broad, leaving a quarter of an inch between each and its fellow. The spaces are made by a punch, which removes a section from a solid sheet of metal. It will thus be seen that there can be no danger of the bars giving way, as they would were they soldered upon a band.

In Plate 30, we produce Plate 29, with a bandage partly laced between the bars. It has been passed from side to side, di-

Plate 30.



viding the instrument into parallel sections. On the right, a part of the bandage may be seen rolled up. When the bandage has been passed between all the bars, and the hood or cover put on (Plates 28 and 31), one can look through the instrument from end to end, as there is a space of nearly a quarter of an inch between the several sections of the bandage.

The advantages of this mode of construction are stated by Dr. Allis to be:—

1st. It gives the patient (Plate 31), the freest access of the air. It is necessary that *the air should be saturated with the vapor of ether.*

Plate 31.

2d. It affords a series of thin surfaces, upon which the ether can be poured, and from which it will almost instantly evaporate. In this respect it differs from the sponge, which retains the ether in a fluid state much longer. Should the bandage become soiled a new one can be inserted in a few minutes.

3d. By leaving the instrument open at the top, the supply can be kept up constantly if desired; and as *ether vapor is heavier* than air, there is no loss by not covering it. *The top should never be covered.*

Mode of using the inhaler:—

1st. Place a towel beneath the chin of the patient, as experience has taught that a towel should always be within reach in administering anæsthetics.

2d. Place the instrument over the face, covering the nose and chin, and let the patient breathe through it before any ether is applied. This will convince him that he is not to be deprived of air.

3d. Begin with, literally, a few drops of ether; this will not irritate the larynx. Add, in a few seconds, a few drops more, and as soon as the patient is tolerant of the vapor, increase it gradually to its fullest effect.*

4th. When the patient is fully influenced, it is well to add a few drops at short intervals, and thus keep up a gradual anæsthetic effect.

The advantages of the inhaler:—

1st. It presents a large surface for the liberation of ether vapor. The partitions are made of thin bandage, and the air coming to both sides of each layer, sets the ether vapor free, more rapidly, than is possible in the use of a towel or sponge.

2d. It is open at the top, and ether can be added constantly if desired, and in small quantities, without removing from the face. The sponge and towel both require removal, and the ether is usually poured on them in quantities.

3d. The ether vapor falls by its weight, as it is heavier than the air; and as the instrument fits the face, the patient gets the full advantage of it.

4th. It does not cover the patient's eyes, does not terrify him, and he often passes under its influence without a struggle.

5th. By its proper use, the laryngeal irritation may be wholly avoided, the anæsthetic effect as easily gained as is possible, with the use of ether, a great economy of ether, and great comfort to the patient.

Dr. G. H. Coburn, a resident physician of Howard Hospital, carefully recorded all the cases, at our request, occurring

*When the effect of the anæsthetic is apparent, a single layer of a coarse towel may be laid over the nose and mouth, and the instrument replaced. This is a wise precaution against vomiting, or spitting.

during the years 1875–76, in which this form of Allis' inhaler was employed in the various surgical operations, performed in the institution. It was found by him that the shortest time required to produce complete anæsthesia in a young female patient, was three minutes, and the amount of ether employed, was only one fluid ounce The longest period required in an adult female was seven minutes, and the amount of ether used, two ounces and a half. The doctor did not notice, in any of the cases, but slight redness of the eyes. In a few instances, there was a hysterical tendency, among the females. If solid food had been taken, vomiting would follow, but after liquid, or light forms of nourishment, vomiting was very rare, not more than one in fifty cases. In temperate males the time for full anæsthesia was from five and a half to eight minutes. Ether consumed: minimum quantity, two ounces; maximum, three ounces.

The objections to this form of apparatus are:—

1st. That the exhaled vapor is not conveyed to the floor, but is diffused in the air, to be breathed by the operator, and his assistants. For a single operation, this is not of much importance, but where there are a number of cases, the arrangement is not conducive to the comfort of the operator.

2d. The bandage of muslin across the bottom becomes clogged with moisture and saliva, and at times by discharges from the stomach, and cannot be so readily removed.

3d. Owing to the peculiar arrangement of the muslin strips, it is tedious, when it is required for a number of patients, to remove or replace them.

In a conversation with Dr. Allis, he stated, that he considered the chief merit of his instrument was, that it thoroughly and instantaneously liberated the ether, and that while there was not the least impediment to respiration, yet all the air was impregnated with the anæsthetic.

Neither ether, nor chloroform, can be inhaled in the pure state.

It is always atmospheric air, impregnated with the anæsthetic, that sustains life and produces anæsthesia.

The expression "give him nothing but ether, exclude the air," are only relative terms; they simply mean *saturate the air, as much as possible with the ether. Permit* the patient to have *no fresh air*, but *compel* him to breathe *air, charged with ether.*

Now, in Allis' apparatus, there is no chance for the ether to remain in its fluid state; but exposed as it is on a thin stratum of muslin, it yields its anæsthetic principle promptly.

When he first employed his instrument, bystanders would suggest that it be closed at the top, so as to permit no escape of ether.

This will show that the true laws of ether were overlooked; ether vapor, while it will diffuse itself throughout an entire room, is of greater specific gravity than atmospheric air, and tends to the floor.

To close this apparatus at the top, would necessitate ingress of air at the part surrounding the mouth, for air *must* be admitted.

If it be excluded at the bottom and left open at the top, the advantage of having a constant supply of ether dropping upon the folds, is very great.

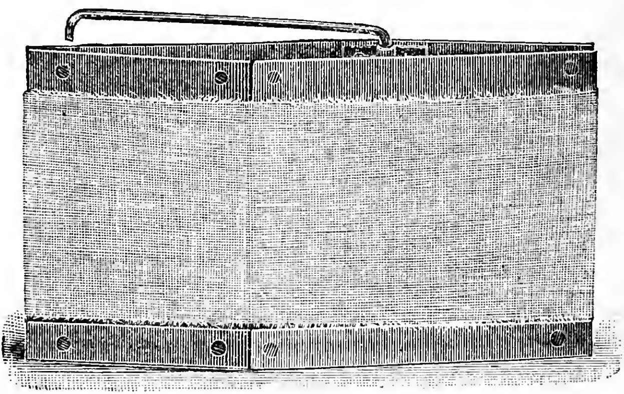
As germane to this subject, we would direct attention to the following experience, recorded by Dr. Wm. Goodell, of Philadelphia, in the course of a recent paper, giving a year's experience in ovariotomy:

"One of the chief lessons I have learned from my experience during the past year, is to administer ether. Hitherto I have, in common with most American surgeons, given this anæsthetic by a closed cone, in such a manner that the patient breathed her own air over and over again. I am now disposed to think that this is a very unsafe mode, and that to it is due, in a large measure, the alarming prostration of the patient while undergoing the operation. For instance, among the twenty-five cases of last year, cases 70, 71, and 82, presented such profound symptoms of shock, that the operation had to be suspended, until hypodermic injections of brandy, and of ether, were made, and some degree of reaction had set in. In cases 70, and 71, it was indeed with great difficulty that the women were kept from dying on the table; while case 85, clearly died from œdema of the lungs. Now, I do not find such alarming symptoms referred to, in any reports of cases, by British operators. I am therefore forced to the conclusion, that either under the strain of rivalry, they do not operate in very desperate cases, or their mode of administering anæsthetics, is a safer one than ours. Fully impressed with this idea, I have lately been using Dr. Allis' improved inhaler, and have thus far found it to act promptly, safely and economically."

A Folding Allis' Ether Inhaler.

"Although many surgeons still prefer the ordinary folded napkin, or improvised cone method of administering ether, yet there can be no doubt as to the advantages to be derived from the use of a specially devised apparatus, like the Allis' Inhaler. In it, are combined simplicity of construction, ease of manipulation, rapidity of etherization, economy of ether and a free ingress of atmospheric air charged with ether, and egress of expired air. It is open to the objection, though to a less extent than other instruments of its class, of being somewhat cumbersome when carried about, and of occupying, therefore, consid-

Plate 32.



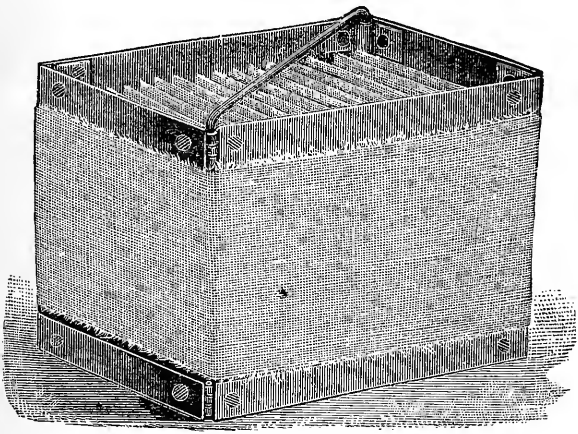
SNOWDEN

erable space in the operating satchel. My attention was forcibly directed to this point,* when devising an emergency operating

* By George R. Fowler, M.D., Boooklyn, N. Y.

bag, recently. I have, therefore, endeavored to overcome this objectionable feature by slightly altering the shape of the inhaler, in such a manner, as to allow of its being folded flatwise. The accompanying cuts, will show how this is accomplished. Plate 32, represents the inhaler folded, ready for placing in the pocket or satchel, in which shape it occupies about as much room in the pocket or satchel as an ordinary visiting list. By a very simple movement, provided for by bringing together the

Plate 33.



corners of the metal sides, the two long sides are made to separate from each other, until the shape shown by Plate 33 is formed, in which position it is securely held, by a little bar, which swings over from one corner, to the one diagonally opposite, and fastened, by its bent extremity, into a socket provided for the purpose. The only covering needed for an Allis' Inhaler, is a simple towel folded lengthwise, in which the instrument is inclosed, just prior to its use. This can be procured at the patient's house, and, after the operation, unpinned and thrown aside."

Mr. Morgan, Surgical Registrar at St. George's Hospital, London, has suggested a modification of the felt cone ordinarily in use in this, and other hospitals, in England.

"The instrument consists of a cone of felt, in the apex of which a piece of sponge is fixed, on which the ether is poured. This is fitted into a case of metal, surrounded by an outer one of similar shape, but sufficiently large to leave a space between them, through which the expired air can freely circulate before it escapes. There are two valves, acting in opposite directions—one admitting the air, which passes through the sponge moistened with ether; the other, through which it escapes into the chamber between the two metal cones. The close application of the instrument to the face, is secured by means of the India-rubber cushion, which is filled with air by the tap, so that all the air inspired, must pass through the valve. The warmth produced by the air which circulates between the two cones prevents the ether on the sponge from freezing, and the vapor which escapes is carried off by a tube to any distance which may be desired. The quantity of ether required in this apparatus is much smaller than in the ordinary cone; and the advantage it thus possesses, as well as the safety and freedom from ether vapor obtained by the administrator, render it superior to other similar apparatus. Several American surgeons, whose knowledge and experience of ether are generally recognized, have expressed considerable approbation of this invention. It is manufactured and sold by Messrs. Blaise & Co., 67 St. James Street."

The following results* were obtained by the use of Morgan's inhaler:

REPORT OF EXPERIMENTS WITH ETHER IN TWENTY-SIX CASES.†

Shortest time taken to place a patient under the anæsthetic influence, ...	3 min.	30	seconds.
Longest time, ...	24 "	0	"
Average time, ...	8 "	10	"
Average time under influence, ...	19 "	6	"

*Those who have used both the English and American ethers, state, that the former gives less favorable results than our washed ether, æther fortior, U. S. P.

†By Surgeon-Major Porter, Assistant Professor of Military Surgery. London; 1875.

Smallest quantity of ether used in one case, .	2 ounces	4 drachms.
Largest, ...	9 "	
Average, ...	5 "	1 "

Vomiting, occurred in eleven cases, during or after the administration of the drug. Excitement occurred in seven cases to a marked degree, during, or after administration, of the drug. (Does our experimenter mean resistance as excitement, or, if in a female, as hysterical excitement?) The anæsthetic was invariably given on an empty stomach. The ether was given by Morgan's inhaler. Ether was analyzed and found to be perfectly pure, s. g. 720.2 at 64° F.

Ether Inhaler of Dr. Richardson.

In 1873 Dr. B. Willis Richardson,* of Dublin, designed and employed a simple form of ether inhaler, for use in hospital practice. The ether-box, of metal, has a capacity of three ounces, with an oval air-opening half an inch long, and about an eighth of an inch, from its upper margin. By rotating the lid, which has a similar-shaped opening in its side, the admission of air can be easily regulated. At the beginning of the inhalation, the inner opening may be fully exposed, and gradually covered. The ether-box communicates with the face-piece by means of a tube an inch in length, and one inch and a half in diameter, the ether-box opening of the tube being two-thirds closed by a fixed diaphragm. This prevents the fluid ether from passing into the tube, when the patient is in the horizontal position. The face-piece opening of the tube, has a diameter of one inch. The tube itself, in order to increase the evaporating surface, should be nearly filled with soft cotton candlewick, having, when used, one end submerged in the fluid ether. The inhaler may be made of silvered copper, or of block tin, but the margin of face-piece, should be formed of flexible metal, and covered with morocco leather.

"This inhaler, the inventor states, to be simple in form, and moderate in price, and designed as a substitute for the towel

* Description and illustration of an ether inhaler, etc. By B. W. Richardson, F.R.C.S.I. John Falconer, Dublin, 1873.

and sponge, in the use of which, there is much waste of ether, a matter in hospital economy, that may be of some importance."

Dr. Richardson has employed, and prefers, anhydrous sulphuric ether, because it was fouud to produce the most rapid anæsthesia.

Dr. Angrove's Handy Ether Inhaler.*

This gentleman states, that in England, there is a great want felt, just at present, for an effective, handy, and cheap, inhaler. He has endeavored to supply this want. His inhaler "consists of a cylinder, on which fits, by a bayonet joint, a cap, around the rim of which, are attached several stout wires. The top of the cap is perforated with holes, and through the middle is inserted a long metal tube reaching nearly to the bottom of the cylinder. One end of an air-tight silk reservoir is fastened to the cap, and the other to the flexible tube, which is also attached to the mouth-piece. The flexible tube runs through the reservoir, and is directly connected with the metal tube. The inside of the cylinder, is lined with felt, and a couple of turns of the same material, are wound around the wires, thus presenting three surfaces for the evaporation of the ether. Having filled the reservoir with air, an ounce of ether is poured into the cylinder through the nozzle; this diffuses itself all over the felt. The mouth-piece is then applied to the patient; he is told to 'draw in his breath;' the vapor he inspires comes from the reservoir, passes through the holes in the cap, over the evaporating surfaces of felt, and up through the whole length of tube; he expires the same vapor, which passes back to the reservoir, and becomes re-charged with ether during the next inspiration. The inventor further states, he has completely anæsthetized several individual patients, in a little over one minute, one in forty seconds. An ounce of ether, is sufficient to keep a patient about ten minutes."

The cylinder is five inches high and three in diameter. The reservoir holds about a pint and a half. The length of the

*The description of a handy ether inhaler. By W. T. Angrove, House Surgeon to the Yarmouth Hospital *London Lancet*, March, 1877, p. 123.

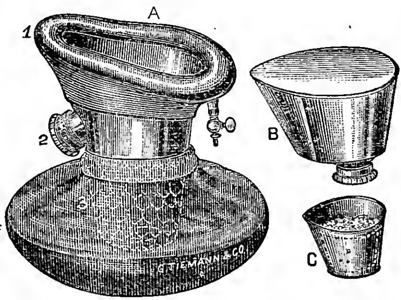
tube can be made according to taste. To show that they are still at sea in England, in regard to ether inhalers, we will conclude this part of our subject by giving a description of one of the latest invented, from the *British Medical Journal.*

An Improved Ether Inhaler.*

"In presenting this apparatus to the notice of the profession, I wished at the outset to disclaim any idea of misappropriation. The instrument is in principle, identical with Ormsby's inhaler, the best points of which have been utilized. A practical experience of some nine years, with the original apparatus, has induced me to modify it, so that a compact, efficient and inexpensive inhaler could be obtained by any practitioner. The improvements are the substitution of rigid, instead of flexible metal in the face-piece, the omission of the ether supply tubes, and the modification of minor details throughout.

"The apparatus consists of a metallic face-piece, the base of which corresponds to the usual facial lines. To the upper part

Plate 34.



A. Inhaler ready for use. *B.* Ether reservoir. *C.* Ether measure, showing sponge inside. 1. Air cushion, inflated. 2. Air cap. 3. Wire net basket to contain sponge. 4. Rubber bag collapsed.

of this is fastened a wire net basket, around the mouth of which, and projecting into the face-piece, is a small gutter, which prevents ether, or moisture, from dropping on the patient. On one

*By James H. Parkinson, L.R.C.S.I.

side of the face-piece is an air cap, which exposes or covers a slot, on rotation. A collapsible rubber bag, shaped somewhat like a cranial ice cap, is attached to the face-piece, its elastic neck grasping the apex of the latter, where a groove has been made for its reception. A rubber air cushion fits over the base of the face-piece, maintaining its position by a lip which forms part of the cushion.

"To prepare the inhaler for use, when the temperature of the room is below 65°, place a small napkin or towel, wrung out of very hot water, in the face-piece for a few minutes. The sponge, which should have an absorption capacity of two ounces, is soaked, squeezed dry, and placed in the wire net cone, so that every part is above the gutter. The air cushion is then fitted, and *partially* inflated. Pour one ounce, by measure, of Squibb's ether on the sponge, and place the inhaler on the face, with the air slot wide open. This should be closed after three or four inspirations. During the progress of an operation, fresh ether is added, as required, in quantities of four drachms. If used for half an hour, it is advisable to remove the sponge and squeeze out the moisture which has formed by condensation.

"The points of superiority claimed for this inhaler are, that it is compact, portable and inexpensive. It is simple in construction, and the rubber portions, when worn out, are easily duplicated. It is most economical in the use of ether, and the unpleasant odor of the drug by diffusion, is absent. With it, the production of anæsthesia, is a certainty. The rapidity of its action will equal any apparatus, and there is no method of ether administration, which surpasses it, in safety.

"Amongst the objections raised, are those common to all permanent apparati: that it is dirty, and that infective matter will adhere to it, or may lodge in the sponge. The simplicity of its construction admits of a ready and perfect cleansing; and no part will be injured by hot water or antiseptic solutions which are familiar to most practitioners. Against the inhaler *per se* it is urged that the anæsthesia partakes largely of carbonic di-oxide poisoning—that this is a source of danger, and an inseparable defect.

"The re-breathing of the ether-charged air with a small atmospheric mixture is the main point on which the superiority of the inhaler rests. That it is not in any sense a defect or danger, practical experience of several years has proved; and, in support of the position, I will quote three opinions.

"Pridgen Teale, writing in the *British Medical Journal*, says: 'The patient breathes the same air over and over again, * * * thereby economizing the heat of the air passages, economizing ether, and enhancing the effect of the ether by partial asphyxia.'

"Mr. Woodhouse Braine, Lecturer on Anæsthetics at Charing Cross Hospital, states that, in using the inhaler, he frequently removes the sponge, and maintains anæsthesia by allowing the patient to breathe into and from the rubber bag. He says: 'It may be urged against this method that the patient re-breathes the carbonic acid of his own expired air, and this is true; but from the length of time I have employed this plan, and from never having seen any deleterious results from it, I do not attach any importance to the objection.'

"Mr. Ormsby, in reply to an inquiry, has kindly written: 'I believe that carbonic di-oxide in a diluted form assists the ether as an anæsthetic, while the rebreathing of the vapor warms it, so that it is more readily tolerated by the patient.'

"In my own experience, which has been extended and considerable, I have found no disadvantage arising from the alleged asphyxiation. I would add a few hints as to the method of administration, omitting the usual preliminaries and precautions, which should be observed during the progress of anæsthesia. Always measure the ether used, for economy, and in order to *know* how much is being consumed. A given quantity will yield a certain result. This precision, which obtains in the majority of cases, contributes largely to the saving in the drug. Having poured the ether on the sponge, invert the inhaler before placing it on the patient's face, to be certain that no fluid will escape and startle him.

"As a preliminary I usually apply the inhaler with the air slot open, and direct the patient to keep the mouth closed and breathe slowly and quietly. This may seem a triviality, but I am satisfied from personal experiment and frequent experience that, when closely followed, it completely abolishes the troublesome cough which usually accompanies the first inspirations. In slowly passing through the nasal cavities, the vapor is warmed and fails to irritate the laryngeal mucous membrane. In the lungs the presence of the reserve air at first assists to dilute the vapor, and as insensibility sets in, the respiration deepens. The inhaler should be pressed firmly in the face to diminish leakage. When anæsthesia is complete, the instrument should be removed and re-applied, as occasiou demands.

"In consequence of a letter which appeared in the *Journal of the American Medical Association*, for October 16th, 1886, I have received many inquiries as to an inhaler which would give the results there stated. Ormsby's figures for the old apparatus were:

"Average time required to produce insensibility, 2 minutes.

"Average quantity of ether employed, 1 oz.

"This is a fair statement when calculated from a large number of cases, and the improved inhaler will give as good results."

Inhaler of Nitrous Oxide Gas or Ether of Codman & Shurtleff, of Boston.

The points for which they claim superiority, are:—

"1st. Durability; being made of metal, they are not liable to be easily broken, as so frequently happens to the hard-rubber inhalers, and as they are nickel-plated they retain their brilliant polish without change.

"2d. For convenience both to the patient and operator. With one hand, the latter can apply the inhaler, and open or close the two-way stopcock, leaving the other hand at liberty to control the patient, or for such exigencies as may occur. As the elastic hood covers both nose and mouth, the patient is saved the necessity of having the nostrils closed either by clamps, or the fingers—a part of the operation always very disagreeable, and to very sensitive patients positively frightful, as it produces a feeling of suffocation.

"3d. Cleanliness. The rubber hood, which alone comes in contact with the face, is easily removed and replaced, and as all the other parts are either metal or hard rubber, the whole instrument can be kept perfectly pure by washing, which is a point of great importance to the comfort of the patient.

"4th. Durability, and accurate working of the valves."

Upon this, perhaps, more than anything else, depends the successful administration of anæsthetics. If the exhaling valve does not quickly, and perfectly, close while the gas is being inhaled, air is taken with it, and the gas is so much diluted, that it very much delays, or wholly prevents, the desired effect.

If, on the other hand, the inhaling valve does not work properly, the patient breathes back into the reservoir a mixture of nitrous oxide and air.

Plate 35 is the inhaler with a hard rubber mouth-piece, A; the metal hood, B, is used for nitrous oxide gas.

Plate 35.

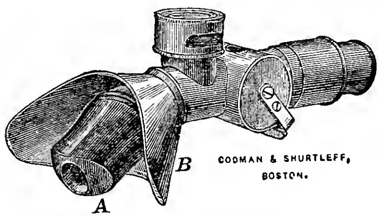
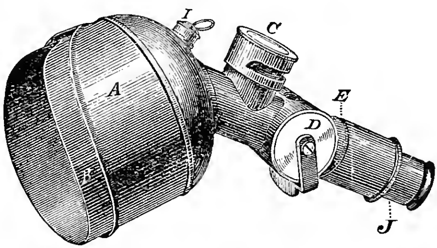


Plate 36, is the inhaler for nitrous oxide gas. A, metallic hood, containing B, flexible rubber hood, covering both nose

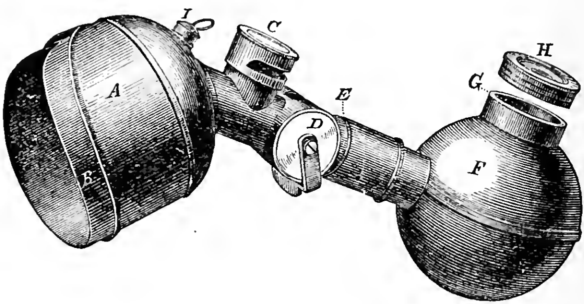
Plate 36.



and mouth; C, exhaling valve; D, two-way stopcock; I, packing, through which a silk cord passes; E, sliding-joint, where J, is detached to connect the ether reservoir; J, contains the inhaling valve.

Plate 37, the inhaler arranged for using ether. This differs from Plate 36 only in the addition of the hollow sphere, F, which contains a coarse sponge, on which the ether is poured through the opening G; H, cover closing the reservoir when not in use. This part is attached at the sliding-joint E, and will fit most inhalers made by Codman & Shurtleff, during the last three years. By this arrangement, waste of ether by evaporating, is

Plate 37.



prevented, and it is stated that less than half the quantity is required to produce, or keep up anæsthesia.

The operator also escapes breathing so much of the ether, as he is compelled to do, when using it from a sponge or napkin.

Experiments made with the Inhaler of Codman & Shurtleff, Boston.—First experiment with new inhaler, November, with three patients, two males, and one female.

In each was tested the ether attachment: two, were unable to make the valve act quickly; in the third, the operation of inhalation was a success, the exhaling valve acting with each respiration, by a click.

Nov. 2d. Second experiment, two females, and one male. With the females the soft rubber covering for the mouth, nose and face fitted admirably. With the male, the rubber cover could not be made to fit air-tight, owing to his having a beard, but it worked more satisfactorily. If the distance from the ether supply, and the mouth-piece, is shortened, the ether passes much more rapidly in the case of a patient who is feeble.

The exhaling valve should be screwed tightly, else it is apt in handling to become loose and will drop out.

Rapid Anæsthesia by Ether.*

The following method of rapid anæsthesia by ether, was suggested to A. F. Müller, M.D., attending physician, Germantown Hospital, seven or eight years ago, by a thought that the great length of time often consumed in etherizing patients was due to the fact, of the frequent interruptions necessary to replenish the cone or towel used for the purpose, and the consequent partial recovery of the patient. To obviate the difficulty and obtain a continuous flow of pure ether vapor, he had made, an apparatus, consisting of the two halves of a rubber foot-ball, sewed together at the edges, and connected by a tube with a bottle containing ether, which is plunged into a bucket of hot water. Ether boils at 90°, and vapor passes over steadily and rapidly, and is inhaled by the patient, whose face is covered by the inhaler, protected by a clean towel.

The result has been surprising to himself, as will be seen by the following cases, all etherized by this method, within three months, at the Germantown Hospital. In none of the cases was there nausea previous to anæsthesia; one at least came to the house the morning of the operation, having eaten a hearty breakfast. In most cases, no struggling, and if so, only slight; no stage of excitement. In cases that require only a few moments for operation, the patient wakes up nearly as quickly as after nitrous oxide. After the patient is etherized, the amount passing over can be regulated by a stopcock at the bottle end of the tube.

The apparatus he had used, was very crude, made only for the purpose of experiment, and he is having an improved one made, which he hopes will be more satisfactory in some of its details.

The quantity of ether used to produce complete insensibility

* *Medical Times*, April 4th, 1885.

in no case exceeded three ounces; in some, it was less than an ounce and a half.

First Case.—D. E., epithelioma of eyelid; plastic operation; unconscious in thirty seconds.

Second Case.—K. McF., periotomy; unconscious in one minute twenty seconds.

Third Case.—K. McF., periotomy; unconscious in one minute eleven seconds.

Fourth Case.—M. P., paronychia and palmar abscess; forty-five seconds.

Fifth Case.—Mrs. B., lacerated cervix; one minute twenty seconds.

Sixth Case.—Mrs. B., lacerated cervix; one minute fifteen seconds.

Seventh Case.—Bilateral lithotomy; one minute fourteen seconds.

Eighth Case.—Miss M., dilatation of cervix; one minute forty seconds.

Ninth Case.—Mrs. T., laceration of cervix; one minute twenty-four seconds.

Tenth Case.—Mrs. S., fracture of anatomical neck of humerus; one minute seventeen seconds.

Eleventh Case.—Mrs. M., fracture of tibia, and fibula; forty seconds.

Twelfth Case.—Mrs. M., fracture of tibia, and fibula; one minute forty-five seconds.

Thirteenth Case.—Mrs. B., fracture of tibia, and fibula; two minutes.

Fourteenth Case.—Cataract; one minute, fifteen seconds. This man, when operated upon in the Germantown Hospital for cataract in the other eye, about a year ago, took a large quantity of ether, and required an hour to put him under its influence.

Fifteenth Case.—Mrs. D., amputation of forearm; one minute thirty seconds.

Sixteenth Case.—McLane, hypopyon; one minute twenty seconds.

Seventeenth Case.—Mrs. S., lacerated cervix operation; one minute thirty seconds.

Eighteenth Case.—Cleaver, sarcoma of iris; one minute, twenty seconds.

Dr. Corning, of New York, has used the following device to produce rapid anæsthesia: "A strong, flat, elastic tourniquet was secured around each of the patient's thighs, so as to arrest both arterial, and venous blood-flow in the same. By this procedure each limb was converted into a species of receptaculum for a considerable proportion of the total blood-mass. The ligatures being in place, the ether-cone was applied over the mouth, and face of the patient, and in about three minutes by the watch, the patient was anæsthetized. On the completion of the operation, the ligatures were removed, and the patient recovered from the effects of the ether instantly. The rapid recovery, is somewhat remarkable."

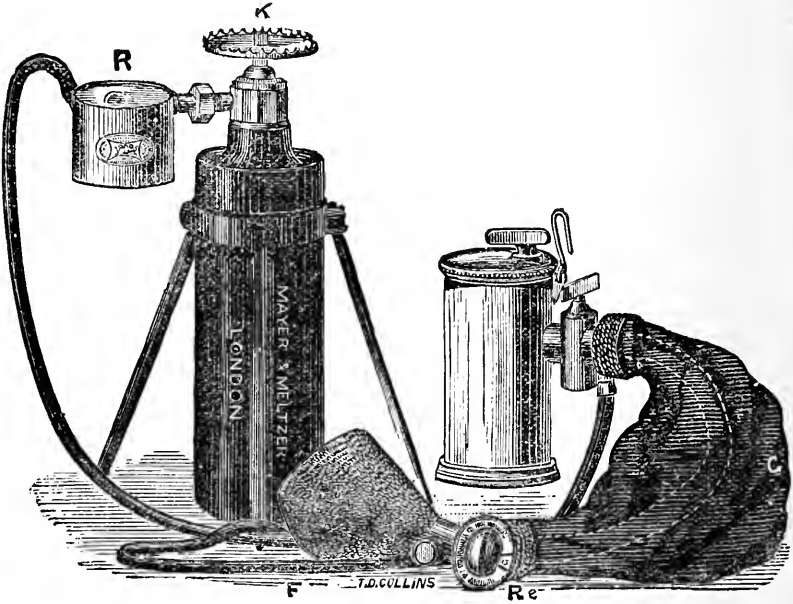
Anæsthesia was produced by draining the blood from the head into other parts of the body. In some of the hospitals in Paris, according to Brunton, a plan was sometimes employed to render a patient insensible, before an operation by laying him flat on the ground, and then lifting him very suddenly to a standing posture by the united efforts of six or eight men. Local arrests of the circulation to the brain have a similar effect. "Walter" has recommended diminution of the cerebral circulation, by the combined effects of simultaneous pressure on the carotid arteries, and vagi-nerves as an easy means of producing anæsthesia for short operations.

Clover's Inhaler for Nitrous Oxide and Ether.

This apparatus is considered by our English brethren as one of "most convenient and portable" "Buxton" for the inhalation of ether, and nitrous oxide. This form of inhaler was invented by "Clover" and has stood the test of a number of years' constant use. It consists of a tripod supporting a cast-iron bottle, containing fifty gallons of nitrous oxide, the bottle being gripped firmly by a screw. The supply is regulated by the administrator's foot, which is placed upon the foot-piece K. This is provided with teeth, which bite into the foot and enable the administrator, by turning his foot to the left, to open the outlet to the gas. R, is the connection between the bottle and the bag G. The small metallic receiver can be filled with warm water in cold weather, or a purifying solution.

The rubber tube will be seen to fix on to a stop-cock in front of the ether receiver, which latter is suspended by a hook from the administrator's coat. When only gas is to be given, the stop-

Plate 38.

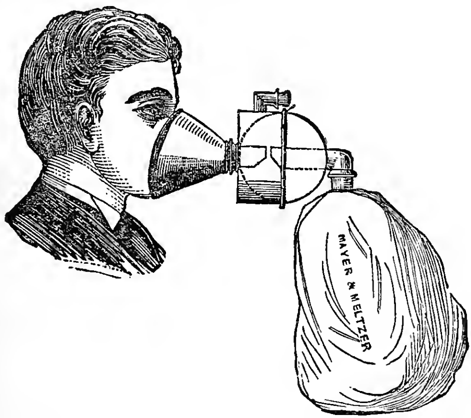


cock on the ether vessel is put at right angles to the long axis of the bag; when ether is to be used, this stop-cock is turned into the long axis of the bag. The stop-cock in front of the ether receiver is more conveniently placed, just above where the tube is seen to end.

The bag is so arranged as to allow of pure nitrous oxide, pure ether, or a mixture of these two substances to be administered. The supply is regulated firstly by the stop-cocks above mentioned, but more immediately by an arrangement represented at Ke. It consists of a semicircle of plated metal, upon which are engraved at opposite ends the letters G and E. An indicating rod plays upon this, and by simply shifting the indicator so that it revolves free of the semi-disc, air is inspired. When the indicator points to G, nitrous oxide passes into the face-piece, and as the indicator travels towards E, ether vapor is permitted to mix with the gas, until arriving fully at E, when pure ether is inhaled. The cushioned foot-piece is supplied with a single expiratory valve.

Clover's Small Portable Ether Apparatus.

Plate 39.



Methods of Administering Ether.

The face-piece is edged with an air cushion. The ether vessel and water chamber which surrounds it and maintains it at the desired temperature for evaporation, rotate upon the mouth of the face-piece. When the instrument is first applied, the stopper should be opposite the patient's forehead, and the indicator which travels round the lower end of the water chamber pointing to the figure 0. The bag should not be placed in position until the patient has taken two or three inspirations; it must then be inflated by blowing air into it and be fitted to the upper end of the water chamber as shown in the figure. As the ether vessel is turned round the indicator traveling from 0 to 1, 2, 3, and F successively, the air has to traverse the ether vessel before reaching the bag, and so the patient gets gradually a more and more highly saturated ether atmosphere. Two ounces of ether are poured into the projecting arm before the operation, and these usually suffice for the case. The opening is so arranged as to prevent an excessive quantity being used and to guard against the possibility of a few drops escaping through the inner openings.

The ether vessel and surrounding water chamber are so arranged that, although the vapor freely escapes, no fluid overflows in whatever position the inhaler may be held. The water chamber is centred by a shaft which communicates with the interior of the ether receptacle, and the vapor escapes into this shaft. From below a hollow metal cylinder fitting to the face-piece, and above shaped like a clarionet mouth-piece, enters the shaft and closes it, being able at the same time to rotate with the face-piece. To this is fixed the long metal indicator turned at right angles at its extremity. From above a similar-shaped piece of metal is fixed, so that the two "clarionet" pieces are adjacent, the lower one capable of rotation the upper one fixed. Finally the shaft is completely closed above by the air bag, which is attached to a metal cylinder, closing but freely movable in the shaft. Ether can only reach the patient when the two "clarionet" pieces wholly or partially coincide. When the lower piece moves, the indicator travels with it, and should it point to 0, the ether way is blocked, and then the patient breathes simply air through the shaft in and out of the bag. As soon as the indicator is moved from 0, the "clarionet" pieces cease to shut off ether, and the air enters the chamber and becomes impregnated with its vapor. When F is reached, the patient is inhaling ether vapor diluted only by the amount of air exhaled from his lungs. The following is the method of using this inhaler :—The appropriate sized face-piece being selected and two ounces of ether placed in the receiver, the air-bag is removed and the indicator turned to 0. The patient is then directed to inspire deeply, and the face-piece applied firmly but gently. Uniform pressure is well borne, while hard pressure, if unequally distributed, will not be tolerated. When the patient has taken two or three deep breaths, the air-bag is filled by the administrator blowing in air, and is placed into an aperture at the top of the dome, so that the patient now breathes in and out of this bag. The indicator is now moved to 1 so that the patient is breathing one-fourth ether and three-fourths air. A few breaths of such a dilution of ether will accustom the larynx to the irritating vapor, and so obviate coughing, spasm, and the wretched feeling of suffocation which ensues upon presenting a strong ether atmosphere to the patient at the commencement of an inhalation. This tolerance achieved, the indicator is pushed to 2, and the patient then inhales half ether and half air. If this strength of vapor do not distress him, the indicator can be, after a few seconds, carried to 3 (one-fourth part air, three parts ether) and then to F (all ether). The patient will, in from ninety seconds to two minutes and a half, be completely unconscious and ready for operation. Some persons require more ether to put them off, and those who persistently resist taking the anæsthetic by holding their breath or by taking the shallowest breaths consistent with life, will delay the onset of unconsciousness much longer. These persons also, since they voluntarily semi-asphyxiate themselves by repressing respiratory movements, suffer great additional discomfort from the feeling of suffocation they induce.

As soon as complete anæsthesia is thoroughly established, the indicator may be brought back to 2, and there kept until the operation is over. It may be necessary in warm weather, and in the case of prolonged operations, to renew ether in the receiver. This is easily done by removing the inhaler from the patient's face, loosening the cork, and pouring in a further supply.

The patient will, during a prolonged operation, require the inhaler taken off his face every sixth breath or so, in order that he may take a few inspirations of air. The necessity for this will be readily recognized by the degree of cyanosis apparent in the face, and by the character of the respirations and the pulse. It should be carefully borne in mind, that the amount of an anæsthetic required to produce narcosis is much greater than is needed to maintain that condition. Also the degree of narcosis must be varied in correspondence with the region of the body upon which operative measures are being pursued.

Clover's larger ether inhaler is figured on p. 360. It is used mainly, if not exclusively, for giving nitrous oxide and ether in combination. The method of using it without nitrous oxide is simple. The air-bag is fully inflated by the administrator, who then moves the indicator off the dial plate and turns the ether tap. The indicator is next turned to G, when air only will be taken. As soon as the indicator passes towards E, ether begins to be received; the same principles and cautions guide the further proceedings with this as were employed for the other inhaler.

PART FOURTH.

CHAPTER XX.

CHLOROFORM.

Chloroform—Dichlorinated Chloride of Methyl—Terchloride of Formyl ($CHCl_3$).

Chloroform was discovered in 1831, almost simultaneously by Soubeiran, of France, Liebig, of Germany, and Guthrie, of Sackett's Harbor, New York.

Its true constitution was discovered by Damas, in 1834.

The ordinary method of preparing chloroform, is by the distillation of alcohol, and chloride of lime; but owing to the heavy duty upon alcohol, the following methods will show how it may be otherwise manufactured, at less cost. One of the new processes consists, in the substitution of wood alcohol (being ⅓ less in price than grain alcohol).

Wood is subjected to distillation, and the result is *pyroligneous acid*, and *pyroxylic spirit*, commonly called *wood alcohol.* The latter is separated in a very impure state, redistilled with lime, and then manufactured into chloroform, in the ordinary way, with chloride of lime, and sulphuric acid. The manufacture of chloroform from pure wood alcohol, is not entirely new, but the value of the patent, consists in the fact of being able to use the alcohol in a crude or intermediate state, before it is separated from the pyroligneous acid, and the other liquid constituents of wood, thus reducing the cost to a minimum.

Chloroform prepared from wood-spirit is specifically lighter, and has at times an empyreumatic odor from acids or chlorinated oils, and gives rise, when inhaled, to unpleasant sensations, with prostration, and headache. Many chloroform accidents are doubtless due to impurities in the drug. Sleep is obtained with difficulty, and is disturbed in character. In some cases, the attempt had to be given up, after trying successively, producing disorder of the stomach, vomiting, etc.

Impure and Dangerous Chloroform.

Some chloroform obtained from a highly respectable German firm, having aroused the suspicions of operators by the frequency with which patients anæsthetized with it presented grave symptoms, Professor Menthin, of Warsaw, undertook to examine it, with a number of chloroforms obtained from other firms. The results were, that not a single sample entirely answered the tests of the Russian Pharmacopœia, which are somewhat stringent, though less so, than those of the French Codex. Professor Menthin—whose article is published in the *Vrach*, giving details and names of the firms, from which the different samples were obtained—found that all the specimens left a residue on evaporation, some of these residues being evidently of a very prejudicial character, causing headache, and giddiness on prolonged smelling. One of them smelt at first like nitro-benzol, with an admixture of tobacco, the odor changing in two days, to one like benzoic acid. When heated, this residue gave off an odor resembling burnt india-rubber. One of these samples came from a British firm, and appears to have been by far the best of them all, thirty-nine cubic centimetres, leaving only a residue weighing .0001 gramme, and having a transitory smell of malic ether; whereas forty-nine cubic centimetres of one of the German specimens, left a residue weighing .0022 gramme, and of a peculiarly offensive character. Professor Menthin's investigations, would seem to offer some explanation of the extreme care taken by some of our continental brethren, in regard to the use of chloroform. If much of what is used is as impure as some of the specimens referred to, it is scarcely to be wondered at, that the results are sometimes disastrous. The specimen, which was the immediate cause of the investigation, is stated to have produced in no less than half of the patients, such dangerous symptoms, that its administration had to be discontinued. To all appearances, however, it was perfectly good, having a specific gravity of 1.487, neutral reaction, containing no free chlorine, and not undergoing any change of color, when mixed with hot sulphuric acid, and left to stand for twenty-four hours. The sequel, of course, shows that these preliminary tests are very insufficient.—*Lancet*, July 6, 1889.

A still more recent patented process of making chloroform is termed the "Albany." By burning acetate of lime, acetone is produced, the distillate being collected, and redistilled with chloride of lime, and is then purified. A specimen of this chloroform has been sent to us, and was found to be clear, free from any empyreumatic odor, with the sweetish burning taste. It did not redden blue litmus paper, but bleached it with a faint reddish tinge, no precipitate with nitrate of silver, no change on the addition of a solution of iodide, or permanganate of potash; nor was it blackened by strong sulphuric acid.

It acted promptly by inhalation, producing narcosis, but with a tendency to irritate the stomach, causing an inclination to vomit. The anæsthetic effect did not last long.

Commercial chloroform, when obtained, is a transparent, heavy liquid, containing 98 per cent. of chloroform, frequently containing hydrochloric acid, chlorine, and foreign chlorine compounds, with traces of arsenic as impurities. It is therefore unfitted for use as a medicine, or as an anæsthetic agent, until purified.

Chloroform Purificatum—Purified Chloroform.

($CHCl_3$; 119. 2—C_2HCl_3; 119. 2.)

After careful purification, by means of distillation, in contact with sulphuric acid, carbonate of sodium, lime, potash, alcohol, and water, it is then ready for use. Chloroform in its pure state is a heavy, clear liquid, having a specific gravity of 1.49°. It has a characteristic, pleasant and ethereal odor, a burning, sweet taste, and a neutral reaction. It dissolves in alcohol, and ether, in all proportions, but only mixes with water in small proportions, and will, after a time, sink to the bottom of such mixtures in clear globules, owing to its being so much heavier. It communicates its sweetish taste to water. Dose, 3 to 10 min. given in capsules, or mixed with alcohol as the spiritus chloroform, 1 volume in 20. Dose, 20 to 60 min. or in the mistura chloroformi—chloroform 8, camphor 2, fresh yolk of egg 10, water 80. Dose, tablespoonful. If a few drops be permitted to evaporate from blotting paper, no stain, or no foreign odor should be perceptible after the odor of chloroform ceases to be recognized. When applied to the skin, chloroform evaporates rapidly, and produces a feeling of cold. When the evaporation is prevented, it passes through the epidermis, and acts as an irritant to the inner skin, producing rubefaction, and local anæsthesia. (See article on Local Anæsthetics.)

No chloroform should be used for anæsthetic purposes, which does not comply with the following requirements:

1st test. When dropped in distilled water, there should be transparent globules with no milky appearance.

2d. Chloroform should have an agreeable odor.

3d. It should not redden blue litmus paper.

4th. When added to a solution of nitrate of silver, it should not form a precipitate, nor even cause cloudiness.

5th. Test with a solution of iodide of potassium (for free chlorine).

6th. When brought to the boiling-point with a concentrated solution of caustic potash, it should not become colored. (Absence of aldehyde and arsenic.)

7th. Sulphuric acid should not blacken it when brought in contact with chloroform.

8th. Mixed with concentrated sulphuric acid and shaken, it should separate in half an hour, into two colorless layers.

Chloroform, is liable to sudden changes, and exposure to light, an imperfect stopper or partially filled bottle, frequently affect its purity; hence it should be tested before using. The combined action of permanganate of potash, and a caustic alkali, have been recommended as exceedingly delicate tests, and, as such a re-agent, the following formula is given:

Permanganate of potash	15 grains
Caustic potash	2½ drachms
Distilled water	7½ ounces

Purified Chloroform—Anæsthetic and Physiological Action.

When one per cent. of chloroform, is mixed with three to five per cent. of atmospheric air, it becomes charged with it, and in this form it is usually employed as an anæsthetic.

"The amount of vapor which can be taken up (held in solution) by the air of the atmosphere, varies with the elastic tension of the chloroform vapor at different temperatures. Thus at 40° F., a small quantity of chloroform would evaporate into air ; at 130° F., so much would volatilize, as to give rise to an almost pure chloroform vapor. In the following table, taken from Snow's 'Anæsthetics,' the amount of chloroform in vapor, is shown in 100 cubic inches of saturated mixture of air, and chloroform, at different temperatures :

Degrees F.	Air per cent.	Vapor per cent.
40	94	6
45	93	7
50	92	8
55	90	10
60	88	12
65	85	15
70	81	19
75	78	22
80	74	26
85	70	30
90	65	35

"One grain of chloroform, in one hundred cubic inches of air, produces the second degree of narcosis, but never carries chloroformization further. This corresponds to a proportion of 1 part, by measure, of chloroform in 16,285 parts blood, or 0.0000614, the proportion, by weight. Two grains in each hundred cubic inches of air, or $\frac{1}{28}$ saturation (unity being saturation), produces the fourth stage of narcosis, or 0.0001228 the proportion by weight.

"Any proportion above two grains in the hundred, causes interference with respiration; three grains in the hundred seems about the ratio which renders respiration impossible. Three grains represent 2.3 cubic inches vapor, and as air at 100° F. can take up 43.3 per cent. of its volume, the blood must contain from $\frac{1}{18}$ to $\frac{1}{19}$ of the proportion it is capable of absorbing when the respiratory centres are poisoned.

"Snow found further, that calculating the weight of the blood as thirty pounds, twelve minims of chloroform, in the circulation produce narcosis of the second degree; eighteen minims, the third degree (surgical anæsthesia); twenty-four deep narcosis (fourth stage), and thirty-six, should paralyze the medullary centres. In practice, more is needed, because a certain proportion evaporates from the tracheal, and bronchial surfaces, and is carried out in expiration. If twelve minims be evaporated into a bladder, and inhaled to, and fro, no more air being allowed than can be blown from the lungs, narcosis of the second degree actually results. Now, taking thirty-six minims, as a lethal dose, the following considerations, upon which Snow, strongly insisted, explain how easily this quantity may enter the circulation, if the administrator be not perpetually upon his guard against over dosage; 18 minims represent the amount absorbed to produce surgical narcosis; this amount might be absorbed by the use of 36 minims, the remaining 18 mimims being exhaled as above mentioned. These 36 minims represent 37.5 cubic inches of vapor, which, at 60° F., would require 257 cubic inches of air. The 300 cubic inches thus formed would be inspired in twelve respiratory acts (25 cubic inches being the amount of tidal air). Now, if a vapor of this strength were continuously inhaled, the residual and complemental air would become saturated, and as about 250 cubic inches represent the air in the lungs, this amount would at 60° F. contain the vapor of 30 minims. Assuming only half this quantity to be absorbed, that is 15 minims, we should then have 18 + 15 or 33 minims in the blood, an amount almost, if not quite, enough to paralyze the respiratory centre. These points being held in remembrance, will explain many cases of chloroform death, ascribed to 'idiosyncrasy,' or the 'fatty heart,' which stand inexpert chloroformists, in such good stead. Death from chloroform, does not, however, always result from respiratory paralysis.

"Working in the same line as Snow, Paul Bert, examined the action upon animals, of small percentages of chloroform vapor in air. He asserted that atmospheres containing chloroform below a certain per cent. failed to induce anæsthesia; below a higher percentage, (*zone maniable*) produced anæsthesia, without danger to life, even when a vapor of this strength were persisted in for an indefinite period, while above this higher percentage death always occurred. The lethal percentage he found to be double the smallest quantity necessary to induce anæsthesia. Lister, who repeated Bert's experiments, found no true *zone maniable* ('workable zone') to exist. Indeed, the French observer appears to have overlooked the important fact, that chloroform not only kills by paralysis of the heart, but by failure of respiration. Richardson, whose views seem to differ from those who adhere to the percentage theory, suggests that death from chloroform is, when it occurs in the latter stage, due to the cumulative action of the drug." —*Buxton.*

"Among the multitude of inhalers which have been devised, we may notice Clover's chloroform apparatus, which consists of a large bag, capable of containing a given volume of air; into this the vapor of a given quantity of chloroform is allowed to enter, and the mixture is so arranged, that the tension of chloroform vapor in the air is maintained below 4.5 per cent. The bag is constructed large enough to hold sufficient for several patients. It is connected at one end by a flexible tube with a face-piece, and at the other, with a bellows worked by the foot. To the bellows, is attached a small metal receiver, into which a known quantity of chloroform is pumped by a graduated syringe, inserted into the lid. Forty minims of the narcotic are supplied with every thousand cubic inches of air pumped in, and as these represent forty-five cubic inches of vapor the percentage of chloroform never exceeds about 4½ per cent."

Air will carry more than double the amount of chloroform vapor on a hot day, than it does at the ordinary temperature of an apartment, in winter. The vapor of all anæsthetics is considerably heavier than air, that of chloroform, more than four times heavier. Therefore, raising the apparatus, a few inches directly upward from the patient's mouth and nose, does not suspend the administration. There is constantly in the lungs, and bronchial tubes, a volume of air, from five to seven times as large as the tide of each respiration; time should now and then be given for the vapor of this residual air to pass into the blood. This is especially necessary as complete anæsthesia is approaching, and only applies to chloroform. It should be dropped on a fine cup-shaped sponge, Esmarch's or Skinner's wire mask, held not too close over the nostrils and mouth, during inspiration, and in a reclining position. Both these inhalers are made of a light metal frame-work or wire, over which a thin cloth is stretched, on the convex surface of which chloroform is added, drop by drop; this allows a complete admixture of atmospheric air. Its effects are divided into three stages. The first effect observed, is a peculiar sensation of fulness, similar to the action of alcoholic stimulants, with a feeling of weight in the cerebrum; acceleration of the pulse, but no great increase in the heart's action; blunted sensibility, and more or less tinnitus aurium. This first stage varies as a rule; it is generally short, but in intemperate persons it may be long, and violent. In the second stage, which is that of complete anæsthesia, consciousness, and sensibility, are abolished, pulse slow, and breathing regular; the entire muscular system is relaxed. These two stages sometimes run together. The third stage, is one usually ushered in by stertorous, noisy, and "catchy" breathing, with weak, irregular pulse, shallow, and less frequent respiration, and dilated pupil, which may be followed by paralysis of the heart and sudden death.

Death may also occur from heart-failure, cardiac syncope, or asphyxia, from too large a quantity of chloroform being employed; also, owing to the closure of the glottis, or paralysis of laryngeal muscles; also, respiratory failure, or absorption into the blood and nerve structures, producing entire alteration of them.

What has experimentation determined definitely in regard to the action of chloroform? The action of chloroform on the brain is, first, congestion; but when there is complete anæsthesia, it produces decided anæmia in man, and animals. The muscular excitement of the second stage is, according to experiments, purely physical; and there is, during the production of anæsthesia, a steady lowering of reflex action.

Chloroform at first induces contraction, and afterwards much the same pupillary phenomena are seen during the action of drugs, which affect the cerebro-spinal system, even in those, which, in the first instance, produce myosis. In such, if the action of the drug be pushed, a stage is arrived at when the function of the respiratory and cardiac centres is so seriously compromised, that the pupils become widely dilated, and fixed. This may be illustrated, by the action of three drugs—opium, chloroform, and alcohol. In opium coma, the pupil is always firmly contracted, while in alcohol coma, we can distinguish it from opium, if we pull the beard, or hair, as this act will cause temporary dilatation.

*In choloroform narcosis, the same pupillary phenomena are observed during the extreme stages. From personal observations, extending over several hundred carefully recorded cases, it is seen that the pupils are in a very variable state during the preliminary periods, much too variable to permit any rule being formulated regarding them. When, however, reflex action is abolished, except in the cardiac and respiratory centres, the pupils become contracted and fixed. (Dr. MacEwen, of Glasgow, stated to us, that young operators frequently make the serious mistake of judging that the patient is ready for an operation merely from the test of touching the cornea with impunity, when an examination of the opposite eye will convince him that he has produced by the close application of the chloroform of the cloth, nothing more than a local anæsthesia, confined to one eye.)

* "The Pupil in its Symptomological Aspects." *Amer. Journ. Med. Sci.*, July, 1887.

Dr. Buxton divides anæsthesia from chloroform into five stages, as follows:

"*In the first stage*—from commencement of inhalation to impairment of consciousness—fulness of the head, ringing, buzzing in the ear, palpitation of the heart are sometimes felt; there is also some diminution of common sensation.

"*In the second stage*, the mental powers are impaired, although not suspended. The patient remains passive, as if sleeping, or occasionally makes a voluntary movement. Sometimes laughing, singing, talking are indulged in, during this stage. Snow, believed that dreaming occurs at this time, and then only. Towards the close, the patient becomes restive; he attempts to remove the face-piece or towel, for he is conscious of being inconvenienced by the vapor, but not of the necessity for remaining passive. Common sensation is much blunted, so that patients submit without expostulation to painful manipulation. This degree of narcotism is sufficient for obstetric practice, and the after-stage of prolonged operations. As a rule, struggles or expressions of pain which show themselves at the time, are not subsequently remembered.

"*In the third stage* all voluntary movements are lost. The conjunctival vessels become full, the muscles rigid, and struggles, even epileptiform convulsions, may supervene. As the stage advances, the muscles relax. Inarticulate jabbering, and mouthing occur. Although really insensitive to pain, the patient may flinch, or even cry out. Later in this stage, all reflex acts are abolished, the conjunctival, and nasal receding, last. The patella jerk also persists late, while under deep anæsthesia, the ankle-joint phenomenon appears. Safety ceases he

"*In the fourth stage*, breathing is stertorous, the pupils dilated, and the muscles completely relaxed and flaccid. In this stage, the patient is profoundly unconscious, and is drifting into danger. Such deep narcosis is seldom needed, save for the reduction of old-standing dislocations, etc.

"*The fifth stage* is the interval which, following the fourth degree of narcosis, intervenes between the respiratory embarrassment, and total cessation of breathing. Even after dyspnœa has passed into apnœa, the heart continues to beat for a brief while. This stage marks the period, when chloroform tension in the blood, is great enough to paralyze the respiratory centres in the medulla oblongata."

The third stage, may be regarded as the safety zone of complete chloroform narcosis. But if anæsthesia be pushed beyond this stage, wide dilatation of the pupils ensues, indicating a suspension of function in the cardiac and respiratory centres. This is a most critical condition, though one by no means necessarily fatal, as by lowering the head and raising the floor of the table, and by promptly carrying out artificial respiration, even while feeble respiratory efforts are being made by the patient, the danger may be, and frequently has been, averted. Given a person free from organic lesion of the nerve centres, heart or lungs, in whom, during chloroform narcosis, stable mydriasis suddenly occurs, as a result of the action of chloroform on the respiratory centres, the patient ought to recover, if artificial respiration, coupled with the lowering of the head, be promptly resorted to, and the former efficiently carried out. It is interesting to note, in such cases, the marked effect produced by elevating the foot of the table, so as suddenly to place the patient's head and thorax at a very low level, the pupils becoming quickly contracted. In this connection, however, it ought to be borne in mind, that one of the earliest indications of a return of reflex action, is vomiting, which, as a rule, is accompanied by dilated pupils, the result of cerebral anæmia.

In cases, where the functions of the cerebro-spinal system, especially of the cardiac and respiratory centres, have already been enfeebled (by organic lesion or otherwise), chloroform acts more powerfully; a few whiffs sufficing to induce complete insensibility, and the administration of an ordinary dose giving rise to an alarming state, which only prompt measures can prevent from becoming fatal. In such cases the pupils very readily pass into wide dilatation, with a very small amount of chloroform.

When the function of the brain is suspended, by want of oxygenated blood, the pupils are widely dilated and fixed.

This may be seen in cases of asphyxia, either by poisonous gases or arising from mechanical causes. It was once observed by Dr. MacEwen, in two men, who had all but succumbed by inhaling coal-gas, emanating from a broken gas-pipe in their bed-room, and it is also seen in cases of hanging.

The Pupil as a Guide in Giving Chloroform.

Neilson, considers the condition of the pupil, a reliable indication of a patient's condition, under chloroform anæsthesia, and concludes from his experiments, as follows:

1. The effect produced by chloroform on the pupil, is, at first, dilatation, varying in degree and duration, then contraction as the narcosis becomes profound, and dilatation again when the sensibility is returning. If the administration be still continued, with the pupil strongly contracted and motionless, the pupil will also dilate, but in this case more suddenly and completely, and will be coincident with a state from which it will be difficult or impossible to resuscitate the patient. This latter, is the dilatation of asphyxia.

2. So long as the pupil dilates, in response to excitation by pinching, etc., the patient is not sufficiently narcotized for the operation to be proceeded with, unless the latter is slight, and does not require complete anæsthesia.

3. When the pupil becomes strongly contracted, and immobile, no more chloroform should be given, until it begins to dilate again. If, then, further anæsthesia be required, a little more chloroform should be given until the pupil again contracts.

4. The occurrence of sickness, causes dilatation similar to, but more sudden than, that which happens when sensibility is returning, and the efforts of vomiting have the effect of arousing the patient.—*British Medical Journal*, July 30, 1887.

During the first half-minute of the inhalation of chloroform, there is a progressive lowering of the arterial pressure. Chloroform, if injected into the jugular vein, instantly arrests the heart's action.

Chloroform produces contraction of the red blood disks; if, however, air be admitted to blood containing chloroform, the red corpuscles rapidly disappear, dissolving in the serum, out of which, after a time, hæmatin crystallizes. One authority states, that after anæsthesia, bile-acids appear in the blood; and it has been found that the oxygen of the blood undergoes an increase during anæsthesia. During the action of chloroform, the temperature falls, the circulation is retarded, and the skin gives off less insensible perspiration.

According to the recent experiments of Ranke, which we have before referred to, and repeated, on several small animals (and this is also the view of the late Claude Bernard), the nature of the action of chloroform upon the nerve cells, is slight coagulation; but if the animal was killed, with the chloroform, there was hardening of the nerve trunks and entire change, in which evident coagulation of the albuminoid tissues took place. If chloroform was mixed with blood not exposed to the air, there is no change except contraction, either shown under the microscope or by spectrum analysis; this we have repeatedly determined in the frog, rabbit, pigeon, etc.

Toxicological Effects.

Chloroform is the most potent and agreeable anæsthetic, but the most dangerous, and is the one in which death may occur at any, and every stage by inhalation. Chloroform kills so suddenly, that neither skill nor care, can always guard against a fatal result. Another disadvantage of chloroform is its high boiling-point, requiring a great amount of heat and vital force to exterminate it from the body, so that it is probably never eliminated entirely by the lungs, but only with the aid of all excreting organs. Any deficiency or derangement of the body, which may consequently lead to such suppression or elimination, causes the nervous system to be overwhelmed, with consequent inactivity. Almost all anæsthetics may kill during the first stage by asphyxia; the air may be very highly charged—even saturated—with the agents; so much so that, owing to its pungency, it cannot be breathed, and if forced upon the patient, stifles and suffocates him in exactly the same manner as would sulphur burned under his nostrils; death would thus occur, without much having entered the body.

Owing to the danger which accompanies its use, chloroform should not be administered when other anæsthetics are available; or under the especial circumstance that, without it, the shock of the operation might kill the patient. In railroad accidents, and military surgery, it becomes at times absolutely necessary; and in the holds of ships, especially those of iron, where the temperature is very high, it is resorted to on account of its rapidity of action, smallness of quantity required, cheapness, small bulk in transportation, and the less risk of explosion and ignition. In obstetrics, chloroform is used with comparative safety to the mother, although a few deaths have been reported; but from our observations taken, in carefully-watched cases, it is apt to be fatal to the infant. Conclusions have been drawn, that in long and instrumental labors, ether, or bromide of ethyl, although not so pleasant, are much safer to the child.

The symptoms which usually occur, as precursors of death from chloroform, are a sudden paleness, or lividity of the countenance, shallow breathing, stertor, loss of, or a quick and weak pulse, tossing about of the patient, delirium, convulsions or coma.

Schiff, (*l'Imparziale*) arrived at the following conclusions, after more than five thousand experiments, as to *the difference of anæsthesia, by ether or chloroform:* "Ether paralyzes first the respiration, and after that the blood-vessels, and the heart; while chloroform can paralyze the heart, and blood-vessels at once, without previously paralyzing the respiration. Artificial respiration with the latter agent is then useless, as oxygenation has ceased; compression of the abdominal vessels, and lowering of the head, may be of advantage. Chloroform can cause death, at the first inspiration. Ether is safer and less dangerous." *

Chloroform should never be administered in a sitting posture, nor should a patient rise suddenly when under its influence.

What is the chief danger to be apprehended, when chloroform has been used, and how do we prevent fatal symptoms, as closure of the glottis, fainting, failure of the pulse, or respiratory syncope?

Stop the administration of the chloroform, lower the head at

*Dr. Lawrie and the Nizam Commission of India, after numerous experiments, have decided that death from chloroform is not from paralysis of the heart, but kills by stopping the respiration. According to the *London Lancet*, Dr. Lauder Brunton will pay a visit to India to test the results of the Hyderabad Chloroform Commission.

an angle of forty degrees, and elevate the feet above the level of the body, and remove what mucus or blood that may collect in the mouth during the operation. Draw out the tongue, and retain it out by a ligature, Ketch forceps, or dry towel, and elevate the jaw, and above all use artificial respiration. Administer from ten to twenty drops of nitrite of amyl, if the face is pale, but not, if flushed; drop from a bottle on a piece of cloth and hold it to the nose and mouth. If the patient makes no effort to breathe, force it up the nostrils by means of a small hand-spray compressing apparatus, and expand the chest by manipulation with the elbows to the side, and compress the chest. This should be continued until the heart acts. Flagellation with towel wrung out of ice water is very useful, but do not chill the patient. If there is still increased narcosis, employ hypodermic injections of water of ammonia (containing five per cent. of ammonia gas) to the quantity of a drachm, or two, or solution of sulphate of atropia. But depend chiefly on lowering the head, and artificial respiration long continued. Give the patient plenty of fresh air by opening the windows; if cold cover with blankets. Apply a galvanic or Faradaic current during the artificial respiration, one electrode to the base of the neck, and the other to the epigastric region, on a line with the diaphragm, but not in the region of the heart or solar plexus. Let the assistants, or nurses rub each extremity briskly, and use even slight blows, on the neck, and side of the chest, but not on the stomach.

It is not safe to continue an operation immediately on a patient's recovery from the excessive action of anæsthetics, but to wait until respiration has been energetically restored; otherwise, a new and generally fatal asphyxia may be produced. It is well to remember that anemia of the brain is secondary to the cessation of the heart's action, and that to restore vitality to the brain, requires that the heart's action be restored. For this purpose, as we have stated before, there is nothing better than lowering the head and artificial respiration, and the use of it is to be continued, not only for a few moments, but for hours; indeed, recoveries have occurred after the use of the Faradaic current and artificial respiration for one hour.

Chloroform Accidents.

Apropos of a recent discussion in the Paris Acadêmie de Medecine, Prof. Dastre classifies the causes of fatal accidents resulting from the administration of chloroform as follows: Primary syncope, respiratory or cardiac; secondary syncope; toxic apnœa. In the first class death results from the first inhalations (initial shock); this occurs from reflex cardiac syncope in nervous, impressionable individuals weakened by suppuration or hemorrhages, or in individuals otherwise healthy who suffer from irregularity of the heart's action (in animals with those which exhibit habitual cardiac irregularity, as the dog), or they arise from reflex apnœa under analagous conditions. In the second class (secondary or bulbar syncope) narcotism is more advanced; the heart's action may be arrested suddenly or gradually; the arrest of respiration may be slow and progressive, or sudden from tetanic spasm of the glottis. The third class of cases comprises those of fatal intoxication in which the agent has been administered too freely or for too long a time, and the anatomical elements, particularly the nerve elements, have lost their vitality. In this form of chloroform poisoning there is a destruction of mechanism which seems to involve derangement of the entire respiratory apparatus.

The real danger in the administration of chloroform is from the effects produced upon the heart and not from those upon the respiratory organs. In the case of heart failure we are practically without resource, while in the case of respiratory insufficiency we have a remedy in artificial respiration. In opposition to the generally accepted opinion, the arrest of the heart's action is a phenomenon of excitation and not of paralysis or paresis. This is true of at least four out of five cases.

As a remedy for chloroform intoxication Prof. Dastre proposes a mixed form of chloroform administration. Inasmuch as in the majority of cases it is the stimulation of the inhibitory cardiac apparatus that is concerned, section of the two vagi nerves would constitute the theoretical remedy. This being inadmissible, we have still a practical and delicate means of arriving at the same result, *i. e.*, the administration of atropin. This is really equivalent to section of the vagus, which destroys the excitability of the cardiac filaments as well as their bulbar nucleus. Atropin, however, should not be employed alone on account of its excitative tendencies, which may be obviated by the concomitant administration of its antidote, morphine. The action of the combination of atropin, morphine and chloroform has been experimentally tested in the case of dogs. The dog is infinitely more subject to chloroform accidents than is man. In the laboratory of Sorbonne one dog in three was lost by accident. During the last ten years all the dogs have been anæsthetized by the mixed method, and in hundreds of cases of narcosis there has not been a single death. The mode of procedure is as follows: Ten minutes before the operation a subcutaneous injection is made of a solution containing 2 centigrams of muriate of morphia and 2 milligrams of sulphate of atropia per cubic centimetre. Of this half a cubic centimetre per kilogram of the animal's weight is used. The administration of chloroform is then begun, 2 or 3 grams being sufficient to produce a perfect anæsthesia lasting two hours—a much less quantity than would otherwise be required, while the economy in its use greatly diminishes the danger of fatal results. This mixed method has also been used in human surgery, particularly by M. Aubert and his surgical colleagues of Lyons, who employ the following formula: An injection is made from fifteen to thirty minutes before the operation of 1½ cubic centimetres of the following solution:

Muriate of morphia	10 centigr.
Sulphate of atropia	5 milligr.
Distilled water	10 grams.

M. Aubert gave an account of his experience with the method (Soc. Biol., April 21, 1883) in these terms: "I know of nothing more desirable or practicable. The advantages are the following: 1, safety; 2, the great rapidity with which sleep is produced; 3, the absolute repose of the patient; 4, the quick return of consciousness; 5, the absence of unpleasant sequelæ such as vomiting. Some of my colleagues have at my suggestion employed the method, and M. Gayet particularly recommends it in ophthalmological surgery." The number of instances of its employment now amounts up (1887) into the thousands, and without the occurrence of a single accident.—*La Semaine Médicale*, August 28, 1889.

Sims, on Resuscitation from Chloroform.

It was noticed by the late Dr. M. Sims, the celebrated surgeon, that when chloroform was too freely employed, it produced deadly symptoms, so that the parts assumed a peculiar bluish-livid appearance, and the blood became stagnant. He also noticed and always depended upon, first, failure of the heart by the pulse, then the breathing. He considered the first and best thing to be done, was to invert the body, the head hanging down, while the heels should be raised high in the air. Then with the handle of a spoon, the jaws are to be held open with a tenaculum hooked in the tongue, and given in charge of an assistant, whilst to another is delegated the duty of making efforts at artificial respiration by pressure, alternating from the thorax to the abdomen. Sometimes the patient has to be held in this inverted position from fifteen to twenty minutes, until respiration is restored. As well expressed by Dr. Sims, when caught with such a patient, he confesses that never before, or since, has he felt such a grave responsibility. Sometimes there is danger in raising the patient's head and beginning the operation too soon, when a second time this whole process has to be repeated with more or less success.

While practicing in the North, Dr. Sims expressed, and published, the following opinion: "Many years ago, I imbibed the convictions of my countrymen against chloroform in general surgery, and have always used ether in preference, never feeling the least danger from it under any circumstances. It is otherwise with chloroform."

One of the last means to be resorted to, is

SURGICAL PUNCTURE OF THE HEART FOR THE RELIEF OF CHLOROFORM NARCOSIS.—Attention has been recently called to the importance of puncturing the heart in chloroform narcosis. We have, therefore, collected all the recent important information on the subject. One of the articles* to be discussed will be that of experiments of Dr. Watson, of Brooklyn, New York.

PUNCTURE OF THE HEART, AND VENA CAVA IN MAN.—Puncture of the vena cava, was followed by death in one case, and in our reports of deaths from chloroform, puncture of the heart was performed, but with no benefit to the patient. Dr. Wm. H. Pancoast, tapped the jugular vein in one case; also used other means to resuscitate the patient, but was unsuccessful.

A case in England, which has been reported under the head of deaths from chloroform, where the heart was punctured, proved to be a failure also.

Dr. Watson's experiments show, that he had repeatedly excited the action of the heart in dogs, after that member had ceased to beat. In one instance he punctured four minutes after, and received no response. He gives the following reasons for preferring the ventricle. The propelling power resides in the strong muscular ventricles: There is another reason for not puncturing the right auricle: it is, that since the walls are thin, the puncture endangers the life of the patient, from the consequent leakage. When left in the walls of the ventricle, the needle does not produce laceration, but will, if left in the thin walls of the auricle. Dr. Watson found the same pathological conditions when chloroform is used upon dogs, as when it is used upon men. It was found that the heart was in diastole, and that the veins of the lung were engorged, unless previous hemorrhage had taken place.

In regard to atropia, greater confidence was placed in a needle-thrust into the heart, than in atropia.†

That a heart that has recently ceased to beat can often be restarted by needle puncture, etc., has been known for physiological ages, and it needed no further lengthened series of experiments to demonstrate it. In 1884, Professor Kronecker, then of Berlin, ascertained, at first accidentally, that a needle thrust into the heart of a dog may arrest the ventricular beat and substitute for it a

Medical News, June 4, 1887.

†See Wesley Mills' reply to Watson, showing danger of puncture.

fibrillar action, a sort of incoördinated movement of the muscular fibre, quite ineffective in expelling any blood from the organ. The auricles continue to beat as usual, and while they remain amenable to the action of the vagus nerve, the ventricles pass wholly beyond its control.*

Watson, it will be seen, by our account, advocates puncture of the heart in chloroform narcosis, to stimulate the fibres mechanically, but in this procedure there is not only the danger of hemorrhage, but it is quite possible that Kronecker's co-ordination centre—which, in the dog, occupies the lower part of the upper third of the ventricular septum—might be touched, in which case immediate death would follow. "In puncturing the right auricle, it is well to bear in mind, that this cavity is also always reached by a needle-thrust, close to the sternal margin at the right interspace. In five bodies, recently, (*Amer. Jour. Med. Sci.*, March, 1888, p. 290) a needle so inserted, entered the appendix in two cases,—in one, close to the fringed edge ; in one case, the auriculo-ventricular groove was punctured, and in two, the needle entered the base of the right ventricle. With a greatly-distended right auricle, it might be safer to puncture outside the line of the internal mammary artery—say an inch and a quarter from the sternal margin—and carry the needle downwards and toward the left."

Watson, concludes, that it is better to give chloroform cautiously and with an abundance of atmospheric air.

Dr. R. A. Kinlock, states, before the American Surgical Association (*Medical News*, June 4, 1888) that he had punctured the heart in a case of chloroform narcosis. It was seen that the patient was about to die. All the usual expedients were resorted to; but the patient appeared to be dead. The ventricle was twice punctured. No effect was observed. A long hypodermic needle was used.

STAB WOUND OF THE LEFT VENTRICLE: RECOVERY.—Kiawkoff, in *Russkaja Medizina*, No. 42, reports the case of a Cossack, who, in a quarrel with a fellow-soldier, received a stab wound in the fourth intercostal space of the left side, in

* "Surgical Puncture of the Heart," by T. Wesley Mills, M.A., M.D., *Montreal Medical News*, Vol. LI., p. 39, Philadelphia, July 9, 1887.

the mammillary line and parallel to the ribs, which bled profusely. The wound was cleansed, a compress applied, and restoratives were given. The area of dullness was greatly extended over the cardic region, but the patient gradually recovered, and was discharged from the hospital in four weeks' time. Five days afterward, in attempting to lift a heavy weight, the patient expired, suddenly. Post-mortem examination, showed the integument, wound closed; the pericardium was adherent to the wound. The cavity of the pericardium was filled with dark blood; a small punctured wound of the left ventricle was present, whose edges showed beginning fatty degeneration of the heart muscle; subacate endocarditis was diagnosticated. The wound in the ventricle had probably closed, but the sudden strain had ruptured the cicatrix; the endocarditis resulting from the wound had not yet been recovered from. The reporter writes, that seven per cent. of heart wounds are stated to have been healed. (*Centralblatt für Chirurgie*, March 24, 1888.)*

In conclusion, the operation is not recommended by us, but as a last resource, after all other measures have failed. The insertion of a needle into the heart might excite the quiescent organ to action, while again, it might cause a feebly beating heart, that would perhaps recover if given a chance, to become hopelessly incoördinated.

Abstract, as to the Dangers and Treatment of Fatal Symptoms, from the Use of Chloroform as an Anæsthetic.

First. Failure of the heart, which may occur at all stages; 2d. From reflex inhibition by terror; 3d. By the irritation of the vapor; 4th. From chloroform idiosyncrasy.

SYMPTOMS.—Feeble, fluttering pulse, pallor, grayness or blueness of the face, ears and fingers, or a sudden interruption, or complete stoppage of the heart action.

TREATMENT.—Careful examination of the heart, lungs and

* See a valuable paper on "The Fatality of Cardiac Injuries," by H. A. Hare, M.D., Demonstrator of Therapeutics, etc., in the University of Pennsylvania. *Medical and Surgical Reporter*, June 22, and August 10, 1881.

kidneys, and forbidding chloroform in cases of atheromatous disease of the vessels, which can be felt, fatty degeneration of the heart, with great pallor of skin and feebleness of action, aortic or advanced mitral disease, which must be determined by the history, and stethoscope. If the symptoms given in the first part are present, the chloroform must at once be removed, the head and body inverted, first removing all foreign bodies from the mouth; let limbs be elevated in women, and blankets well wrapped around them, or the body inverted over the knee of an assistant. When, as occasionally happens, the anæsthetizer is single-handed, the raising of a patient by the feet is practically out of the question, except to one of unusual strength. Any one of good physique is able, however, to accomplish the same thing, quite readily, by placing his hands beneath the patient's hips, and raising them until the leg can be slipped beneath, and the patient then rests upon his knee, the foot being upon the bed. The head and shoulders can now be swung off the bed, and at need the patient, from the head to knees, brought into a vertical position. If the tongue has fallen back, draw it forward, and keep it held firmly out of the mouth. If the breathing is not relieved, an assistant employs Sylvester's method of artificial respiration,* as follows: The operator stands behind the patient and grasps the arms near the axillæ; he first presses the arms into the sides, so as to compress the thorax and expel air, whilst an assistant makes gentle pressure upon the abdomen. Next, he firmly draws the arms away from the sides, everting them, and lifting the patient as the arms become about 45° beyond the head. Finally, he carries the arms back to a line with the head. He pauses to allow air to rush freely into the lungs, and then brings the arms down to the sides as before. This process is repeated, twelve or sixteen times in a minute.

*Forced respiration is stated to be an advance upon artificial respiration, and will save human life where the latter will fail. According to Dr. Geo. E. Fell, of Buffalo, N. Y. (*Journal American Medical Association*, October, 1889), the apparatus consists of a bellows to supply a steady stream of air, which passes through an air-heating apparatus; an air-valve which controls the ingress of air to the lungs, and is connected by an elastic tube and tracheotomy tube in the neck and trachea of the patient.

It has been clearly proven that in cardiac and respiratory failure, the pneumogastric nerve retains its excitability in chloroform poisoning, and it is, therefore, extremely dangerous to apply electricity to the neck in this condition. (See the experiments and observations of Doctors Hare and Martin on the phrenic nerve.)

A New and Only Way of Raising the Epiglottis.

Dr. Howard, of London, has endeavored to prove that traction of the tongue cannot, as is supposed, raise the glottis, but that the only way by which it can be certainly raised, is by extension of the head and neck, whereby its elevation is instant and complete. The patient is brought to the edge of the bed, or the chest is elevated, so that the head may swing free, and with one hand under the chin, and the other on the vertex, steadily, but firmly, carry the head backward, and downward, until the most possible extension of the head and neck is obtained.

We had intended inserting in our work, the above paragraph, but before doing so, we addressed a letter to Dr. H. A. Hare, knowing that he, in conjunction with Dr. Martin, had made experiments on the subject. He sent us the following article, which is of so much importance, that we have published it entire for the benefit of those who may have "an urgent respiratory crisis in anæsthetization."

The Treatment of Arrested Respiration in Anæsthesia.*

"In a paper read before the Medical Society, of London, Dr. Benjamin Howard, maintains the following propositions:

"1. The epiglottis falls backward in apnœa, and closes the glottis; the first thing in order and importance, is the elevation of the epiglottis.

*By Edward Martin, M D., Instructor in Surgery, University of Pennsylvania; Surgeon to the Philadelphia Hospital and to the Howard Hospital; and H. A. Hare, M.D., Demonstrator of Therapeutics, and Instructor in Physical Diagnosis, in the Medical Department, and in Physiology, in the Biological Department, University of Pennsylvania.

"2. Traction upon the tongue, however, and whatever the force employed, does not, and cannot raise the epiglottis, as supposed.

"3. The epiglottis can only be raised by extension of the head, and neck.

"4. The full effect of extension can only be secured with certainty, by making the extension complete, as directed.

"5. The method of making extension is as follows: 'Having, by bringing the patient to the edge of the table, or bed, or by elevation of the chest, provided that the head may swing quite free, with one hand under the chin, and the other on the vertex, steadily but firmly carry the head backward, and downward; the neck will share the motion, which must be continued till the utmost possible extension of both head, and neck are obtained. Sometimes a slight elevation and extension of the chin will at once check stertor, or irregularity of breathing; but understand, the extension, which can in no case do harm, should always be rather more than appears necessary. It should never be forgotten, however, that the full effects of extension, as above described, can be secured with certainty, only by making the extension complete, as directed.'

"These propositions are, in some respects, so contrary to the daily experience of surgeons and anæsthetizers, and, if well founded, are of such supreme importance in cases of suspended animation, that we have conducted a series of experiments designed to test, in so far as this is possible, by working upon the dead body, the validity of Howard's conclusions.

"Limiting our inquiry to those cases of threatened death which occur from respiratory obstruction, during the administration of an anæsthetic, we must first endeavor to discover the mechanical cause, which is principally operative in producing such obstruction. We presume that by apnœa, Howard means, not a condition of suspended respiratory efforts through hyperoxidation of the blood, which is the true significance of the term, but cessation of respiratory movement. We cannot believe the epiglottis is chiefly at fault as an obstructive agent, because, in the vast majority of cases, the air-passage is at once made free by drawing the tongue forward; since tip-traction has no effect upon the epiglottis, as stated by Howard, and confirmed by our own observations, this manipulation could not relieve the breathing, were the epiglottis the cause of the difficulty. The effect of traction upon the tip of the tongue, is to draw this organ free from the soft palate and the post-pharyngeal wall; it is the tongue, then, fallen back upon the posterior wall of the pharynx, which is the most common obstructing cause; consequently, the tongue should receive the most immediate consideration. We do not for a moment deny the possibility of respiratory difficulty being caused by the epiglottis alone, though experimentally, the inward passage of air was very little influenced by any position of the epiglottis, provided the tongue was carried well forward; we would insist, however, upon the position of the tongue as a matter of prime importance. Considering next the effect of tongue-traction upon the epiglottis, we are not prepared fully, to endorse Howard's statement. Tip-traction, moves the epiglottis, not at all; this we have confirmed by many trials, both in the living, and in the dead subject; but if a tenaculum is fixed in the dorsum of the tongue, two and a half inches back from the tip, traction at once draws the base of the tongue, and the epiglottis with it, far forward, so that the air-passage is absolutely free from the larynx to the mouth. Traction can then, be so applied to the tongue that the epiglottis is raised, and the air-way made absolutely free, and we have devised an instrument by which this may be accomplished, without the laceration attendant on the use of hooks or forceps.

"Is extension of the head and neck, the only method of raising the epiglottis? Again we are compelled to take exception to Howard's statement. As detailed in our experiments, the epiglottis can be raised by traction upon the dorsum of the tongue, by pressing the greater cornua of the hyoid bone forward, by the action of gravity in the abdominal decubitus, and most thoroughly, by flexing the neck, and extending the head upon the neck. That Howard's position accomplishes mechanically all that he claims for it, we freely grant. The way in which the soft, collapsed structures straighten under his manipulation, the tongue riding forward, and the epiglottis springing erect, is most striking; and we are convinced that the admirable mechanical explanation he gives for this effect, is correct. Howard states:

"' . . . by extension of the head and neck, carried to the utmost completeness, the backward-fallen tongue, the velum palati, and uvula, are all simultaneously shifted from the air-way, and the entire pharynx is enlarged throughout, as follows: *a.* The tongue, the dorsum of which before fell by gravitation upon the then horizontal posterior wall of the pharynx, falls upon the now horizontal arch of the palate. *b.* The velum palati, by means of the great tension of the palato-pharyngei muscles, is pulled away from the posterior wall of the pharynx, the entire membrane being stretched tightly forward, and downward, behind part of the dorsum of the tongue, forming a partition which helps to shut the tongue out of the pharynx and into the mouth, where it belongs, and with part of the dorsum, forms the anterior wall of a new post-oral air-way, thus created and maintained. *c.* The pharynx, anteriorly, is stretched far forward, by the extremely tense sterno-thyroidei muscles acting through the thyroid cartilage, by the genio-hyoidei and mylo-hyoidei muscles, acting through the os hyoidei. The base of the tongue, and the velum palati, are shifted forward in the manner already described, the posterior nares being shifted, by the extension of the head, by its occipito-vertebral articulation, about sixty degrees. Posteriorly, the wall of the pharynx is shifted back its whole length by the extension of the cervical vertebræ, upon each other, in all about thirty degrees, extension being particularly great, just opposite the glottis. Thus the upper air-way, which before was a tortuous, angular, flaccid canal,—barely, and, if at all uncertainly permeable,—is made an enlarged, firm, but slightly curved tube, free throughout, from the glottis to the nares.'

"With all this, except the backward shifting of the posterior wall of the pharynx by extension, we are fully in accord. We cannot, however, concede that his practical deduction from these facts, is a step in the right direction. With the head and neck in extreme extension, the soft palate is strapped over the dorsum of the tongue, the mouth is closed from the pharynx, and the entrance of air to the lungs depends absolutely upon the condition of the nostrils. Can it be considered an additional safeguard—an improved method—to substitute for the roomy mouth an air-way, but just sufficient at the best, subject to an infinite variety of obstructions, varying in size from hour to hour, in many persons absolutely, and permanently occluded? Certainly no American rhinologist would answer in the affirmative. Hypertrophies, polypoid growths and vegetations are not the rare exception. The slightest congestion, is frequently sufficient to block patulous nares. A nostril which will admit the little finger of the surgeon when the patient is standing, may become completely closed, when the head is placed on a level with the body. The recumbent or dependent position, the irritating effect of ether upon the mucous membranes, cephalic congestion due to insufficient oxidation, all combine to render the nostrils unsafe—in fact, absolutely impracticable—as the sole passage of communication between the lungs, and the external air. We cannot believe, that recourse to this method, in cases of suspended animation under anæsthetics, could be followed by favorable results; if the tongue were drawn forward, it would certainly provide ample air-way, the passage from the pharynx to the mouth being opened by this manipulation. One of the great advantages of this method, however, as claimed by Howard, is that the necessity for traction upon the tongue, is entirely done away with. If the necessity for drawing forward the tongue is not done away with, we cannot see that Howard's method offers any material advantage, over that ordinarily practiced in this city.

"Our experiments show that extension of the head carried so far, that the base-line, (Reid's) makes an angle of somewhat more than fifty degrees, to the plane of the bed, or table, raises the tongue and epiglottis so entirely clear of the posterior pharynx, that there is ample air-way; the soft palate, too, lies free of the post-pharyngeal wall, but is not drawn closely across the dorsum of the tongue, thus allowing respiration to take place through the mouth. If, in the course of an anæsthetization, there is respiratory difficulty, the method which obtains here is as follows: The chin is immediately pressed forward by the fingers placed behind the rami of the lower jaw; at the same time, and by the same manipulation, the head is extended, the pillow, if any has been used, being removed; if there is still apparent obstruction, the tongue is now drawn forward. With this manipulation, except in case of foreign body, or abnormality of structure, the air-passage from the mouth to the larynx, is absolutely free. Hereafter, we may modify this method, so placing the pillow, that the neck is flexed as far forward as possible, then extending the head upon the neck, as we find that this gives us wide dilatation, the posterior pharyngeal wall, representing the arc of a circle, from the concavity of which extension of the head draws forward the tongue, epiglottis and larynx. In the method as detailed above, it rarely occurs that the tongue has to be drawn forward.

"Finally, we cannot grant that Howard is justified in believing, of the hundred cases of death, due to the administration of an anæsthetic, that in each case, the epiglottis was in all probability unraised, and continued unraised until death was complete. The appearance of the parts after death, cannot be taken as indicative of their relative position during life—when inspiratory efforts are still taking place, when the rigor mortis has not made the surrounding muscles more rigid, than the epiglottis. Again, the very traction upon the tongue, as usually exerted, extends the head, sufficiently, to carry the epiglottis free of the post-pharyngeal wall. Finally, where inspiratory efforts are being made, there is no difficulty in determining, whether, or not, air is entering the chest; the noise of its passage through the mouth, and throat, the respiratory sounds, are sufficiently characteristic of its free entrance; while sinking in of the intercostal spaces, epigastrium, and suprasternal region, during an inspiratory effort, are absolutely diagnostic of obstruction. These signs, though not so patent, are still sufficiently clear in artificial respiration, and if the cause of death were even in the majority of cases simply obstructive, this condition of obstruction, would unquestionably have been recognized, and remedied, if not by position, certainly by tracheotomy, or intubation.

"The results of our examinations, made upon several cadavers, are as follows:

"By chipping away the basilar process of the occipital bone, the naso-pharynx is exposed.

"Subject in the dorsal decubitus, head midway between flexion and extension, eyes looking directly upward, Reid's base-line (from the lower border of the orbit through the bony meatus) at right angles to the plane of the table.

"The tongue lies in close contact with the posterior wall of the pharynx, only the tip of the epiglottis being visible. The soft palate, and the dorsum of the tongue, shut the mouth from the pharynx. The air-passage is completely obstructed, by the tongue, and epiglottis.

"By means of a tenaculum, passed through its tip, the tongue is seized, and drawn forward, as far as possible. The body of the tongue, is drawn clear of the post-pharyngeal wall, and the soft palate; the hyoid bone, the base of the tongue and the epiglottis, are not at all influenced.

"The tenaculum is now fixed two and a half inches from the tip; traction, draws both the base of the tongue, and the epiglottis, well forward.

"The fingers are passed behind the angles of the lower jaw, and the latter is pressed forward; this elevates the epiglottis, and the base of the tongue, about a quarter of an inch from the post-pharyngeal wall. Extending the head, so that the base-line makes an angle of forty-five degrees with the plane of the table, draws the base of the tongue, and the hyoid bone far forward, this motion being at the same time imparted to the epiglottis, so that the latter stands upright, and is separated from the posterior wall of the pharynx by an interval of about an inch. By tightly closing the jaw, the antero-posterior space, is still further increased.

"The body is drawn to the end of the table, so that the head hangs free; the latter is now extended until the base-line is parallel to the plane of the table; the antero-posterior space between epiglottis and pharynx is slightly greater than that which obtains from moderate extension. At the same time, the tongue drops toward the roof of the mouth, the soft palate is put upon the stretch, and the mouth cavity is shut out from that of the pharynx.

"Placing the head, so that the base-line is perpendicular to the plane of the table, again produces complete closure of the pharynx, owing to the tongue and epiglottis falling directly backward.

"Placing the fingers upon the posterior cornua of the hyoid bone, and pressing the latter directly forward, carries the epiglottis, and tongue, about one-half inch forward, and entirely free of the post-pharyngeal wall.

"With the head moderately extended, and the jaw pushed forward, an effort is made to crowd the tongue, and epiglottis against the post-pharyngeal wall; this is found to be impossible.

"Flexing the neck by lifting the head forward, (keeping the base-line perpendicular to the plane of the table) separates the post-pharynx, from the epiglottis and the base of the tongue, by about one-half an inch. Extending the head upon the neck, the neck being still flexed, produces a yet wider separation, the antero-posterior diameter of the breathing space, being somewhat more than one inch.

"Placing the body in the position of abdominal decubitus, the base-line being perpendicular to the plane of the table, the hyoid bone, base of the tongue, and epiglottis all fall forward, leaving an interval of about a half-inch between the epiglottis, and post-pharyngeal wall.

"On elevating the shoulders, by seizing them, and lifting them directly upward, this space is increased to fully an inch; at the same time the arytenoid cartilages are drawn backward, exposing the glottis throughout its whole extent.

"Bringing the body to the end of the table and letting the head droop forward (still in abdominal decubitus), thus flexing the neck to its full capacity, then extending the head at the occipito-atloid articulation, exposes the larynx more completely, than any of the previous postures or manipulations.

"CONCLUSIONS.—The epiglottis may prevent free entrance of air to the lungs, even though the tongue is pulled forward. Any means which accomplishes the anterior projection of the hyoid bone, immediately, and infallibly raises the epiglottis, and the base of the tongue.

"The hyoid bone may be made to project anteriorly, by direct pressure upon its cornua, by direct pressure or traction applied to the dorsum of the tongue, behind the anterior half-arches of the palate, by the action of gravity in the abdominal decubitus, or by extension of the head upon the neck.

"Extension of the head upon the neck, carried as far as forty-five degrees, produces practically as patulous a condition of the air-way as forced and extreme extension. At the same time this moderate extension usually leaves sufficient room between the palate and the dorsum of the tongue, for breathing to continue through the mouth.

"In forced extension of the head and neck, the entrance of air into the lungs, depends upon the sufficiency of the nasal passages.

"Flexion of the neck, with extension of the head upon the neck, does away with the epiglottis as an obstructing factor as completely, as any other posture. This is best accomplished by supporting the head upon a high pillow, then pulling it directly backward by the hand placed under the chin, so that the weight of the head falls upon the occiput, rather than upon the back of the neck.

"Therefore, in case of an urgent respiratory crisis in anæsthetization, we would direct that, the index-fingers placed behind the greater cornua of the hyoid bone, and the middle fingers resting upon the angles of the lower jaw, both these structures be pressed directly forward, the same force also serving to extend the head upon the neck. If obstruction to breathing still persists, the tongue should be at once drawn or pushed forward by force, exerted upon its dorsum posterior, to the anterior half-arches.

"No force, unless directly applied to the tongue itself, is sufficient to infallibly prevent this organ from acting as an obstructing factor. No manipulation yet devised, can, in every case, take the place of direct action.

"The tongue may act either in conjunction with the pharyngeal walls, or with the palate in preventing free entrance of air.

If the position of moderate extension, and direct traction or pressure upon the tongue, fail to remove the obstruction to breathing, intubation, or bronchotomy, remains as the last resort."

Apparatus of Martin and Hare for the Treatment of Cases of Arrested Respiration and their Conclusions in Injury or Destruction of the Phrenic Nerve.

"The apparatus which we devised for use, in a case where the body is too large to permit of the operator swinging it, as in the man and dog, under similar circumstances to those named, was constructed, as follows, and consisted of a board supported on an upright of equal width and rounded edge, the horizontal plank, resting by means of a groove, on its under surface, upon the convexity of the vertical support. To this horizontal board, is then bound the subject, and by a see-sawing movement, the body is rapidly changed, so that at one moment the head is down at an angle of forty-five degrees and at the next moment is correspondingly raised, while the feet fall. In this way, the weight of the abdominal contents is thrown against the diaphragm, as the head is lowered, and the air in the thorax is thereby driven out. On the other hand, if the head is rapidly raised and the feet fall, the abdominal contents drop into the pelvic space, dragging the diaphragm after them and thereby producing inspiration.

"In order at the same time to extend the chest, as the abdominal contents sagged downwards, we were forced to invent a simple apparatus which, by means of cords, raised the arms above the head, at the moment that the feet approached the floor."

Conclusions.

"1st. Injury, or destruction of the phrenic nerves, is not followed by death, as has heretofore been taught.

"2d. That in injuries involving the diaphragmatic movements it is important that the patient shall not be anæsthetized, as under those circumstances the absence of voluntary aid in respiration may be attended by fatal results.

"3d. The seriousness of phrenic injury, is in direct ratio to the dependence of the respirations of the normal animal on the diaphragm, and to the ability of the chest walls to make compensatory movement.

"4th. The symptoms resulting from interference with the functions of the phrenic nerves are as definite and characteristic, as those following interference with any other motor nerve. There will always be well-marked increase in the scope of the thoracic excursions, and distinct reversal of the movements of the belly, *i.e.*, the belly will retract on inspiration.

"5th. Fear of injury, to one, or both phrenic nerves, need not prevent operations about the neck and upper portion of the chest, provided, that due caution be exercised, that the patient is but slightly under the influence of the anæsthetic at the time, that danger of injury to these nerves is most imminent. Infancy, however, constitutes an exception to this rule; only absolute, and pressing necessity, for operation would afford justification for such a procedure, in early life.

"6th. The real effects of section of the phrenic nerves being known, it follows that the nerve is subject to the same operation in case of injury, as are other nerves of the body, such as suture.

"7th. The presence of the abdominal viscera, are necessary for the normal movements of the diaphragm.

"8th. The abdominal contents may alone be used for the production of artificial respiration, but while they are always to be employed to this end, their use should never be allowed to displace those movements, which are directed to the chest. Both should be used together if possible.

"9th. In cases of injury to the phrenic nerves, support should be given to the belly walls, to prevent movement of the same, and to brace and steady the paralyzed diaphragm, care being taken that the floating ribs are free.

"10th. The method of Sylvester drives more air through the lungs, than any other single method, but its best results are not gained, unless the feet be drawn down as the arms are extended.

"11th. The volume of respired air after section of the phrenic nerves is temporarily decreased, until the thorax compensates for the loss of the diaphragm.

"12th. Oxygen gas, is a valuable agent in the treatment of persons suffering from coal-gas poisoning.

"13th. Oxygen gas aids very materially in bridging over the respiratory crisis occurring after injury to the phrenic nerves.

"14th. In life-saving stations, mines, police stations, or other points to which asphyxiated persons may be brought for resuscitation; in hospital clinics, or in private houses where ether or chloroform is given, oxygen in appropriate form for immediate administration should be provided. The accoucheur also, will find in this gas a valuable adjunct in the treatment of cases of suspended animation in the newly born. Very small cylinders, containing 40 gallons of the compressed gas, are easily carried and require a small amount of space.

"15th. The electrical methods now employed for the resuscitation of persons who have ceased breathing, are dangerous, and unjustifiable."

On the Influence of Climate and Heat on the Use of Chloroform.—The following extracts from letters of distinguished surgeons in the South, will show the influence of climate, on the use of chloroform:

Dr. Langdon B. Edwards, editor of the *Virginia Medical Monthly*, October 21, 1878, states, that it is one of the most peculiar facts he has ever known in medical practice—the difference of experience in Europe, and the North, with chloroform and ether as compared with that of the South—the high rate of mortality in the North, and the low rate in the South. Anæsthetics are used for more trivial affections and surgical operations in the South, than in the North, and of course, for obstetrical cases, etc. Even during the war, when Southerners were not using Squibb's ether, or a chloroform having the reputation of such purity, their preference was for chloroform, although of home manufacture. Had a case that was fatal occurred from its use, in any of the small cities or towns, it would have become wide-spread news.

The Use of Chloroform in Regard to Nationality and Race.—Dr. M. T. Coomes, of Louisville, Kentucky, says that the Irish, as a class, will take more chloroform, and be longer in yielding to its influence, than any other nationality. The behavior of Americans is similar to that of the Irish; they possess great power of resistance, but yield to the influence of the anæsthetic with more ease and take less of it. Germans require still less; and it is not an uncommon occurrence to see them become anæsthetized, without a struggle. If any demonstration is made, it is usually in the form of rapid conversation, or a song. The negro is more easily influenced than any of the before-mentioned races, and in many instances sing, and pray, while inhaling the anæsthetic.

Dr. A. W. Calhoun, Atlanta, Ga., writes, that recent experience has taught him, that it is perfectly safe and oftentimes very desirable to give chloroform, at least to the extent of enabling you to begin the operation without resistance on the part of the patient. There may be something in the difference in the boiling-point of chloroform in the South, and in the fact of the air being more stimulating and heated.

Is Chloroform a Perfectly Safe Anæsthetic for Children?

It has been found that no anæsthetic is perfectly safe, under all circumstances, and in all conditions of health, or the peculiar environment of individuals. Children are no exception to this general rule. Healthy and well-nourished children, in well-ventilated, and sanitary homes, and hospitals, can inhale chloroform as an anæsthetic, with comparative safety. Those of delicate organizations, or subject to constitutional diseases, in which the lungs, brain, or abdominal organs are impaired, in their action or functions, are not fit subjects for any general anæsthetic, but should be treated by a local one, or when this cannot be possible, then it is safer, and better, to exhibit nitrous oxide, hydrobromic ether, or an alcoholic mixture of chloroform. What are the objections to the ethers, or their mixtures, in such operations as laryngotomy, thyrothotomy, or on any part of the throat? It is the great and uniform tendency to the elimination of large quantities of mucus, which is apt to interfere with the operation, and in some instances with the action of the lungs, and the depressing effects, after two cases of death from chloroform were reported after such operations in the section of otology of the B. Medical Association in Glasgow, 1888.

The following, is an interesting case of the depressing effects of chloroform, which has been reported in the *London Lancet,* of April 4th, 1888: "A recent inquest was held by A. Braxton Hicks, the coroner of London, upon the body of an infant who died from chloroform in one of the large London hospitals. The child, aged five months, was operated upon for the removal of a nævus, and died from the effects of the chloroform, after the operation had been completed." In this case there was no good reason why so powerful a general anæsthetic need have been employed, when we have now so valuable, and safe a local anæsthetic, as cocaine, or even ether, rhigolene, or cold, in form of an ice mixture. When a general anæsthetic is imperatively required, nitrous oxide alone, or combined subsequently with ether, can better be employed.

The following letters give an account of an interesting case of chloroform narcosis, which was successfully treated by Dr. F. C. Hotz, of Chicago, Ill.

CHICAGO, ILL., March 15, 1879.

Dear Doctor:—Knowing that any accident occurring during anæsthesia is of great interest for you, I will communicate to you the following observation which I must say was something new to me, and for which I have no explanation. If you have any suggestion to offer, I shall be greatly obliged to you.

On February 24th, 3 o'clock P.M., Thomas Jones, aged 8 years, came to the Illinois Charitable Eye and Ear Infirmary, to have the operation for convergent strabismus performed on his eyes. His mother was with him, and informed me that he had taken no food since breakfast (for at a previous visit I had told her not to give the boy any dinner on the day of the operation). The boy was so glad to get rid of his disfigurement that he did not struggle the least when he was put on the operating table and chloroform was administered. It was sprinkled on the strips of an Allis' inhaler.

As soon as the boy was anæsthetized—and it did not take more than two to three minutes—the apparatus was removed and never applied again. The right eye was first operated on; all this time pulse, and respiration, and color of the face, were good. I put the spring speculum in the left eye, pinched up a conjunctival fold and was just going to cut into it, when I noticed that hiccoughing respiration, which generally precedes vomiting. Thinking the boy was going to vomit, I laid down my instruments. But just then the boy's face became (fairly black) very livid; respiration ceased, although the tongue was held out, and *the pupil suddenly became fully dilated and immovable.* The foot end of the table was raised at once, while I executed artificial respiration by methodical compression of chest or abdomen.

I am glad to say that after a few minutes the boy recovered, but when he began breathing it had, for a few seconds, the same hiccoughing character. He did not vomit afterwards.

I can assure you, Doctor, that I cannot describe the anxiety with which I watched the pupils, and how happy I was when I saw them contract again.

Now, what was it? Yours very truly,

F. C. Hotz.

Chicago, Ill., March 27, 1879.

Dear Doctor:—Thanks for your letter, which I read with great interest. You are right in supposing that I considered chloroform as safe as ether in children. This has always been my opinion. My chloroform was pure; I tested it as you suggested; and we keep it protected against the sunlight.

But pardon me, Doctor, if I return once more to my case. What I wished to find out, was the probable cause of the asphyxia occurring *so late.* Remember the patient had not received any chloroform after he was once anæsthetized. It was removed out of his neighborhood; his anæsthesia was not too profound; and yet at a time when you expect the patient will come out of the narcosis, the asphyxia, with dilatation and immobility of the pupil, occurred. That's what puzzles me.

I have not tried the hydrobromic ether; but I shall employ it to see how I like it compared with sulphuric. Again thanking you for your kindness, I am yours very truly,

F. C. Hotz.

Deaths from Chloroform.

A friend, on reading this letter, wrote me a brief account of the following case:

"A young girl, perhaps 13 years, was operated upon by Prof. Jaeger, of Vienna, for some trifling eye defect. The operation lasted but a few minutes, and was done under chloroform. A bandage was applied and the patient put to bed, already partly conscious, when a few minutes later defective breathing, and blueness of skin was noticed. Artificial respiration and various agents for restoring consciousness were in vain employed, and finally a tracheotomy was done by Dr. Gussenbauer, and artificial respiration carried on by means of a bellows through the canula, but with no effect. The child was probably dead at the time the operation on the trachea was performed. Post-mortem revealed nothing satisfactory."

Chloroformed to Death.—In Cincinnati, September 4th, 1889, George Dilhof died while under the influence of chloroform administered for the purpose of making a surgical operation. Dilhof had injured his thumb so that amputation was necessary. Doctors Mussey and Evans gave him a teaspoonful of chloroform, and were proceeding with the operation when they found him in convulsions. They immediately tried remedies, but were unsuccessful. Mr. Dilhof was a young married man.

This is the class of cases in which a four per cent. solution of cocaine should be employed. This should be injected into the sound tissue near to the place selected for the amputation. Not more than from fifty to sixty drops should be introduced, after the tourniquet has been applied. To prevent the cocaine from entering the system too rapidly after the operation, the tourniquet is relaxed gradually. If there is an open wound or sinus the solution can be thus introduced. By these means, such sudden deaths by chloroform from trifling operations can be avoided. We have been informed that occasionally, after surgical operations, union by first intention will not always follow the use of the cocaine, and that in two cases—one reported, the other verbal—limited gangrene occurred in the removal of the toe nail.

Chloroform.

While attending the meeting of the British Medical Association at Glasgow, in August, 1888, we listened to an historical address "On the Progress of Surgery during the last Half-Century," by Sir George H. B. Macleod, M.D., Regius Professor of Surgery in the University of Glasgow, in which address, he made the following remarks in his review of the period (1837 to 1887), in regard to anæsthetics:

"CHLOROFORM*—LOCAL ANÆSTHESIA.—I, myself, after fairly trying most of the agents in use, now exclusively employ chloroform, and having for years kept an accurate record of its administration, and given it freely and without stint in all sorts of surgical proceedings, never refusing its benefits to a single patient, no matter what his condition or the operation to be performed, I have never had an accident except once, when an epileptic took a fit while being put under its influence, and died with a full and fixed chest.

"For speed and energy, for ease of application and agreeableness, for rapid recovery, with little subsequent trouble, and for safety *when properly administered*, chloroform is, in my opinion, unrivaled.

"That it needs no apparatus, but a towel, is a great point in its favor.

"I never measure the quantity used, but exhibit it freely, and take the color of the lips and the respiration as my chief guides.

"Making the patient count, at the beginning of the administration, is a most valuable aid; and Nélaton's inversion of the body, with artificial respiration, is, I think, the surest mode of resuscitation in danger from failure of the heart.

"A minute, is about the average period for inducing insensibility, and it is very rare, if proper precautions are taken in the way of preparation, and after-management, to have any sickness.

"There is little doubt that 'nervous' persons and those who

*Abstract of Address on Surgery, British Medical Association, August, 1888.

are intemperate in the use of alcohol, tobacco and narcotics, and also epileptics, require special care.

"Over-saturation from the too frequent renewal of chloroform, induces, in my opinion, the chief after-trouble."

This is the record of one, who has administered it constantly almost from the time of its introduction into practice, and the statement in this sense, may not be without its value.

"*Local Anæsthesia.*—Local anæsthesia, in its present form, is also a conquest of the last half-century, and though many agents possess this power, and some of them, like cocaine, are specially valuable for particular purposes, the finely-divided ether spray introduced by Dr. Richardson, (a distinguished student of the Glasgow School) in 1866, is more efficient, and easy of application, than any other, for practical purposes.

"Finally, as regards this point, I may note that Braid, of Manchester, who published in 1843, an article on hypnotism, caused much interest in a system which had been largely tried in India, but which has now fallen entirely out of use.

"I need hardly say that anæsthesia has changed the whole face of surgery. The 'lion-heart' is no longer the requisite of a surgeon.

"Finesse, and manipulative skill, now take the place of force. Innumerable operations are rendered possible, which could not before be attempted, and the surgeon has benefited almost as much as his patient."

Our only remark upon this paper, is to state that this surgeon has been unusually fortunate. No one reading the number of deaths from this agent in the hands of the most careful operator in England, Ireland, Scotland and the United States, should, we think, advise this agent in all kinds of operations, without giving a word of caution to the young and inexperienced surgeon. It was somewhat remarkable that, a few days after this lecture, we met a lady in Dumbarton who stated that on undergoing an operation by the same surgeon, he had great difficulty in saving her life, owing to the chloroform employed.

Have we any Means of Preventing Excessive Vomiting, After the Use of Anæsthetics like Ether, or Chloroform, in Abdominal, or Other Prolonged Operations?

MEANS EMPLOYED BEFORE THE OPERATION.—A very light meal of toast, and tea, at least three hours before; no coffee, chocolate, or any malt beverages; no meats of any kind, or vegetables, such as potatoes, which are so apt to be heavy.

MEANS TO BE EMPLOYED AFTER THE OPERATION.—No liquids, or food, to be given immediately after. If a cooling agent be required, small portions of ice given, not too frequently; no coffee, or tea, for several hours after. A small quantity of lime water, with or without carbolic acid, four drops to two ounce mixtures of champagne, or apollinaris water should then be given if there is a disposition to nausea or retching, or the one-sixth of a grain of the hydrochlorate of cocaine, in powder, placed on the tongue. After the act of vomiting, if all these means fail, and the patient is still disposed to vomit, and very restless, a hypodermic injection of morphia sulphas $\frac{1}{4}$ grain with $\frac{1}{150}$ of a grain of atropine, will cause sleep, after which, all the disagreeable symptoms usually disappear.

In the use of anæsthetics in abdominal operations, Dr. I. Taber Johnston, of Washington, D. C., prefers the early part of the day—before 9 A.M. where possible—and upon nearly an empty stomach. He never allows any solid food, within at least four hours after operation.

After an abdominal operation, if there is "ether vomiting," he gives nothing in the way of medicine, or food, for at least two days; if food is then required, he gives it by enema.

This is simply his own experience, after many trials and much experience, of which method is best; communicated to the author, in conversation.

The Choice of General Anæsthetics in Surgery and Obstetrics.*

"Beginning with a denial of the common statement, that the use of any anæsthetic, lessens the success of operative surgery, Dr. McGuire, mentioned that chloroform is the popular anæsthetic used in France, (except in Lyons), Germany (except in Vienna), and in Italy. In Great Britain, mixtures of ether, and chloroform are principally used. In China, chloroform is chiefly used. In the United States, ether is the popular agent, throughout the Northern, and Northwestern States, while chloroform is the generally adopted anæsthetic of the Southern, and Southwestern States. Thus it will be seen, that throughout the civilized world, chloroform is much more generally used than ether. Combining the obstetrical cases, in which anæsthetics are used with the surgical, it may be safely estimated, that chloroform is used twenty times as often as ether, as the anæsthetic—the two agents to which he restricted his paper. He predicted that when a full analysis of all the facts is finally made, in certain cases it will be determined that ether should be given, and chloroform in certain other cases—thus, establishing the special value of both. In general terms, in the feeble, or anæmic, or in those prostrated by shock, or loss of blood, he prefers ether; but when there is cardiac, renal, or pulmonary trouble, chloroform is preferable. Up to the present time, between 400, and 500 deaths from chloroform have been reported, and about 100 deaths from ether; but he was unable to say what the ratio of deaths by either agent is to the total number of administrations. Sphygmographic tracings during chloroform anæsthesia show depression of the circulation; this is only occasional, and then not so marked when ether is given. Hence, cardiac paralysis is more likely to follow the use of chloroform. But experience proves, that when chloroform is withdrawn, and consciousness returns, the

* Abstract of a paper read before the Medical Society of Virginia, October 19, 1887, by Hunter McGuire, M.D., of Richmond, Va., taken from the journal American Medical Association, November 12, 1887.

patient is safe. But this is not the case after ether is withdrawn. Even acute nephritis or pneumonia occurs sometimes as the result of the use of ether. In short, in diseases of the kidneys, or lungs, ether is more dangerous. But both may kill —especially chloroform, by using a too concentrated vapor during the period of muscular excitement, by paralysis of the respiratory nervous centres.

"In selecting an anæsthetic, Dr. McGuire is somewhat governed by the character of the assistant who is to administer it. In inexperienced hands, ether is the safer. To give chloroform, requires one who knows, and will attend, to his business alone. One accustomed to give ether is not usually the one to select to give chloroform. To ask a patient to take long, deep or rapid inhalations of chloroform vapor, is dangerous. The greatest danger from this agent is in the early stage of its administration, when, by a too concentrated vapor, or its too rapid use, the heart centres may be surprised, and overwhelmed. When using chloroform, it is safer to let the patient's head be turned to one side, so as not to let the concentrated vapor—being four times heavier than air—exclude the atmospheric air. Begin with a small quantity, allow plenty of fresh air, and gradually accustom the patient to the vapor. Never give chloroform in a hurry.

"The giving of alcohol as a heart stimulant, just before giving chloroform, is open to serious objections. In the first place, who knows what the stimulant dose is, in individual cases? In the next place, alcohol increases the duration and stage of excitement, and makes nausea, etc., more likely to occur. We all agree, that those addicted to the free use of liquor, are bad subjects for anæsthetics.

"The speaker mentioned a recent publication, by an eminent New York surgeon, advocating the giving of a very small dose of chloroform in concentrated vapor, on the ground that if alarming symptoms set in, this amount could be speedily pumped out of the lungs by artificial respiration. This is dangerous doctrine to teach. In the only fatal case by chloroform coming under his observation, the heart stopped *suddenly*. The heart did not previously flutter, grow weak or intermit, but abruptly ceased. It was like the syncope of concussion of the brain; the contractile power of the heart was annihilated. We may remove by artificial respiration, in such a case, all of the vapor; but we cannot in this way remove the impression made on the nerve centres which stopped that heart's action.

"Although frequently taught, we are apt to forget, that we should never operate during partial anæsthesia. Many deaths from chloroform are due to not heeding this advice, that comes of experience. Fatal syncope may come on from the consciousness that the painful operation is yet to follow; or if intellectual consciousness is just lost, there seems to be left, so to speak, a consciousness in the nerve centres of the heart and lungs, and the impression of pain on them is fatal. Ether is safe, when an operation is to be performed under partial unconsciousness. In operations in which blood or other fluids may escape into the windpipe, chloroform is the safer. Dr. McGuire does not think he ever saw the irritability of the larynx, or trachea, entirely lost in chloroform anæsthesia, but he has seen it in ether anæsthesia. Possibly the cold vapor of the ether may in a measure account for this loss of reflex excitability in the throat.

"In organic heart diseases, he has never had occasion to regret the choice of chloroform; but ether is preferable in a nervously weak heart, as also in cases of weakness from fatty degeneration, or loss of blood, or great anæmia from other causes, etc. In such cases any anæsthetic is hazardous, but ether is safer.

"Of all the elements of danger from chloroform, fear on the part of the patient, he believes to be the most important, and the most frequent. The heart becomes nervously weak. If a calm, confident manner on the part of the administrator does not allay this fear, give hypodermically a quarter of a grain of morphia sulphate, with a one-hundredth of a grain of atropia sulphate, and wait fifteen minutes or so for the physiological results, before giving the anæsthetic. Emotional excitement, greatly increases the chances of paralysis of the nerve centres presiding over the circulation. Morphia obtunds this sensibility and also acts as a cardiac stimulant, and atropia is probably a more powerful stimulant. That emotional excitement is an important element of danger, he believes all administrators will admit.

"Children take chloroform well and safely. They are not afraid of being killed by it. Nussbaum has seen 40,000 administrations of chloroform in military life, without an accident. Dr. McGuire, has seen, as medical director of Stonewall Jackson's Confederate Army Corps, 28,000 chloroform administrations without causing a death. Neither the age, sex-health, etc., of the soldiers could account for this. The wounded soldiers dread the hazard of chloroform very little. It is also significant that chloroform has been given to hundreds of thousands of women in labor, with but one fatal case, so far as he has learned; and in this instance it is by no means certain that death was due to the anæsthetic. Even when surgical operations have been required in obstetrical cases, no death has followed the use of chloroform. The recumbent position does not explain all this exemption, nor do the pains of labor, for we have pain from the surgeon's knife, etc. The element of success in all such cases, Dr. McGuire believes to be the want of dread of chloroform.

"Dr. McGuire deplores the partisan debates which have occurred on this subject of the choice of anæsthetics. In the last text-book on surgery issued this year, is the following: 'In general, there is no comparison between these agents; ether is so much safer than chloroform, that the latter is fast disappearing in practice. The estimated death-rate after ether is 1 in 20,000; in chloroform, 1 in 3000.' Such statements are the outcome of prejudiced brains, and are absolutely unwarranted by any facts or figures known to the profession.

"Dr. Thomas R. Evans, of Mt. Carbon, West Va., arose, principally to say a word for the country doctor. He is usually unable to carry around with him more than an ounce or so. He has several times derived the desired anæsthesia by giving *chloroform internally* in teaspoonful doses. This dose will sometimes anæsthetize for several hours at a time, and by common consent, this practice seems to be less risky to the

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patient's life. He does not know why it is not more generally adopted.

"Dr. Wm. W. Parker, of Richmond, Va., thinks he was the first doctor in this State to use chloroform, after its announcement as an anæsthetic. One of his patients, years ago, had got in the habit of using it to such an extent as to use $3,000 worth in three years' time, and finally died from it. Properly given, he thinks chloroform the safer of the two anæsthetics. It should not be given from a cone, or buttoned shirt cuff, or anything else of the kind. The safe way of administering it is for the patient to lie down, with clothing perfectly loose, using an open napkin or a suitably shaped sponge. This is to be moistened with a few drops of chloroform, as often as it evaporates, and held three or four inches above the nose and mouth. In this way, all danger of not having enough fresh air is avoided, and the patient is not overwhelmed, so to speak. Exercise a little patience, and all will go well. In this way, on one occasion, he gave chloroform almost continually, night and day, for three weeks, without an alarming or a threatening symptom."

Deaths from Chloroform.

In the discussion which followed the reading of the paper of Dr. McGuire, of Richmond, the following cases of death from chloroform were reported:

"On invitation by the President, Dr. William A. Hammond, of New York, he said that while listening to the paper of Dr. McGuire, he felt that he was sitting at the feet of a master. And yet, as he had had experience with both ether, and chloroform, especially while a surgeon in the U. S. army years ago, he felt, that he had a right to an opinion on the subject under discussion, which he would take the liberty of expressing.

"He had been one of the unfortunates who had witnessed *two* deaths from the surgical use of chloroform. His first fatal case, occurred about thirty-five years ago, while he was serving as an assistant surgeon in the U. S. army, out on the frontiers. A dragoon had been drunk, and had very seriously hurt his arm. He did not see the dragoon, until about two weeks afterwards. He then undertook to examine the injury, by first placing the patient under chloroform. Just as he was getting under the influence of the anæsthetic, the dragoon died *suddenly.*

"Previous to the administration, there was nothing to indicate that he could not take chloroform. But upon post-mortem examination, when his heart was taken out, and cut up into minute sections, and placed under the microscope, that organ was found to be undergoing fatty degeneration. This condition could not have been recognized by the naked eye—it required the microscope to detect it. Nor was the morbid condition sufficiently far advanced to allow of its diagnosis by physical signs, or any of the usual symptoms of advanced fatty degeneration. There is no way known to him by which such cases can be foretold; and yet he could not resist the conclusion, that the fatty heart was the cause of that dragoon's death. There was nothing else to possibly account for it. The case was reported at the time, in the *American Journal of Medical Sciences.* The chloroform was carefully examined, and found to be good.

"The second case of death, by chloroform, under his observation, occurred in Virginia. Just after the memorable battle near Fredericksburg, during the late war, a soldier was brought in, who needed exsection of the elbow. The circumstances of the battle made it desirable that he 'should be a little in a hurry.' Just as he was picking up his knife to begin the operation, the soldier died *suddenly*—without a moment's warning, exactly as Dr. McGuire had described his case as dying. Since then he has not used chloroform much, but has adopted ether in preference. Whether he had had remote deaths, or not, from the use of ether, he does not pretend to say—especially after what Dr. McGuire has said about the more than possible after-effects of its administration. But this, he has to say, that he has never been horrified by a sudden death while using it. In fact, he does not think that he has ever had any bad effects from the use of ether. He wishes he thought chloroform as safe to use as ether, for undoubtedly chloroform is much more agreeable, both to the patient and administrator. He wishes he could make more emphatic than Dr. McGuire has already done, the great importance of not being in a hurry, when about to give chloroform. For army uses, ether he thinks, is unquestionably to be preferred.

"As to how these anæsthetics kill, he is unable to satisfactorily explain. Chloroform undoubtedly kills by stopping the heart's action in the majority of cases; but why, he does not know. As to ether, its immediate dangers are so much less than chloroform, that he prefers it. As to the after-effects of this agent, Dr. McGuire is most probably correct in saying, that deaths are due to it, that are not attributed to it in the mortuary tables.

"As to the prevalent opinion, about the immunity of children from the dangers of chloroform, as remarked upon by Dr. McGuire, Dr. Rohé, of Baltimore, quoted from authorities, to show that about one in ten, of all deaths from chloroform, occur in children under 12 years of age. He thought, also, that Dr. McGuire's statistics could stand correction, as to the stage of the administration, when the greatest danger presented. He referred to authorities, to show that about one-half of all fatal cases from chloroform, occurred either during the surgical operation, or else immediately afterwards. He believed it to be good doctrine to always advise the administration before-hand of a suitable dose of atropia with morphia. This combination maintains anæsthesia, while, at the same time, it keeps up the activity of the vaso-motor centres. He agrees with Nussbaum, in objecting to the use of ether, before beginning with chloroform. There have been *two deaths from chloroform* in Baltimore during the last two years. He has given ether, in the manner that Dr. McGuire opposes. But he has never seen the depressing effects upon the heart, but upon the respiratory organs. To sum up, he believes ether safer than chloroform, in the large majority of cases.

"Dr. J. S. Wellford, of Richmond, Va., said, that during his service as surgeon in the Confederate army, he could not get ether as freely as he wanted it, and hence had to use chloroform, and one death came under his observation. That death was probably due to methylated chloroform, received from

England. Methylated chloroform is cheaper, than ethylated. The purity of the chloroform is, therefore, a very important matter. Anxiety on the part of the operator, especially if he be in haste, may cause him to overdo the matter and 'crowd' the chloroform so as to cause suffocation. Ether is safer under such circumstances, because it contains a very large percentage of oxygen. Anstie, has shown, that air containing over 5 per cent. of chloroform, is dangerous. Death has frequently occurred before commencing the operation, after the administration of chloroform. Given internally, it is a valuable anæsthetic, the full virtues of which use have not been sufficiently dwelt upon by authors.

"Dr. Chancellor, said, he had seen one death under the use of chloroform, but he is unwilling to testify, whether the anæsthetic, or the shock of injury, killed the patient.

"Dr. W. T. Oppenheimer, of Richmond, Va., remarked, that all cases of ether-deaths are by no means recorded. He had witnessed two deaths by this agent in New York City. One of the cases, was in the practice of Dr. Keith. The ether was being given for the operation of excision of the knee. The other case, occurred in the practice of Dr. Bryant. He has since adopted chloroform, and prefers it. Chloroform is specially preferable, if there is hemorrhagic diathesis. In fact, in a case of hemorrhage from the lungs, bleeding was several times arrested for three or four hours, by the repeated administration of chloroform.

"Dr. McGuire, in closing the discussion, said, that as to the dangerous symptoms that have been observed during the administration of anæsthetics, the profession agrees, that ether is not so safe, in diseases of the kidneys. He had not undertaken the task of writing an exhaustive paper on the subject, but had tried to confine himself chiefly to some mooted points, in the hope of getting light on them. He fully agrees with Dr. Wellford, that the purity of the agent, whether it be ether or chloroform, is a very important matter. In dentistry, there are two causes of danger. One, is the upright, or only half-reclining position in the chair, and the other, is the inclination of the dentist to pull the tooth before there is complete anæsthesia. Mr. Keith, of Edinburgh, has used the Clover bag for ether administration for two hours, or more, at a time. But such a bag for chloroform, would be dangerous. Dr. D. Hayes Agnew, of Philadelphia, has been unfortunate enough to recently add another to the death-list from ether; and no one who knows his skill, and caution, can doubt for a moment, but that the ether was properly given by him. It simply illustrates that anæsthetics are dangerous, and should not be resorted to without sufficient justification for the use of such powerful agents. As a conclusion from his study of the subject, he believes that one anæsthetic is about as dangerous as the other, and that each should be selected on the principle of the special fitness of the subject for one or the other."

"A VERY VALUABLE LESSON FOR THOSE WHO USE ANÆSTHETICS IN CHILDREN.*—R. A., a robust, healthy child, three years of age, was recently brought to me with a cancerous left eye. The attention of the parents was first called to the yellow appearance of the pupil eighteen months before. The gliomatous mass, filled the vitreous cavity, distending the pupil, and obliterating the anterior chamber. The eye was injected, and painful. The prompt removal of the eyeball was urged as the only means of protecting the child from a painful death. The operation was accepted by the parents, and the enucleation, under chloroform, accomplished after much difficulty, as the sequel will show.

"The child was suffering from a bronchial trouble, but that was not deemed an obstacle to the administration of an anæsthetic. The patient was placed on the operating table, his clothing loosened about the neck and chest, and chloroform was inhaled from a towel, folded in conical form, with open top. Deep sleep soon was induced.

"When the anæsthesia was complete, the operation for the removal of the diseased eye was commenced. The conjunctiva was divided around the cornea, and the tendon of the external rectus muscle was being sought for, when respiration suddenly

* Paper read before the Baltimore Academy of Medicine, December 6th, 1887, by Julian J. Chisholm, M.D., Baltimore, Md.

ceased. The face assumed a death-like pallor, and the pulse disappeared at the same time from the wrist. Immediately the child was suspended by the feet, with body and head hanging down at an inclination of seventy degrees, while an assistant volunteered chest-compression for artificial respiration. After a few minutes, signs of a feeble respiratory movement were noticed, a slight throbbing of the neck-vessels was detected, and, in time, the child evinced its return to consciousness by crying.

"He was laid on the table, but would not permit the eye to be touched without a twist of the head, evincing great irritability, or sensitiveness of the conjunctiva. As the operation had to be completed, I ordered chloroform to be again administered. Chloroform narcosis was very soon re-established, but before I had time to resume the operation, the child again stopped breathing and the pulse disappeared. The body, apparently of a dead child, was once more hung up by the feet, so as to allow blood to gravitate toward the anæmic head, and brain, but with no further attempts at artificial respiration. Myself and four assistants watched anxiously the pale face, to catch the first evidence of returning vitality. After some minutes, I noticed that the large vessels at the root of the neck showed some fulness; then a slight thrill, and after this the first attempt at a thoracic movement appeared. In ten minutes, breathing was sufficiently strong to allow the child to cry again, much to the relief of all of us.

"Still the operation, which was so imperatively called for, for the future safety of the child—even the saving of its life, from the ravages of cancer—was uncompleted. While the father and mother, both present in the operating-room, were pleading for their child, they were made aware by the restlessness of the patient when the eye was touched, that nothing could be done without the child going again to sleep; so I once more ordered the inhalation of chloroform. For the third time chloroform narcosis was promptly established, and was followed very soon afterward by suspended respiration and the disappearance of the pulse. Death now seemed to be complete. Immediately the child was hung up by the feet. The absolute quiet of the operating-room was broken only by the lamentations of the parents. All eyes watched the face of the child. Five minutes seemed an hour, and the ashy lips showed, so far, no response. Soon after this a faint effort at respiration was observed, which became stronger with each return of the thoracic movements, and the pulse was again felt feebly at the wrist. When respiration seemed established, complete insensibility continuing, I had the child laid upon the operating table. As soon as the body assumed the horizontal position, the pulse, not yet strong, disappeared from the wrist, and the respiration ceased, necessitating at once a renewal of the suspension. This curious phenomenon of breathing when suspended, and becoming inanimate when the prone position was too early assumed, was repeated two, or three times, respectively. For safety (for I was afraid to lay the child down), I was forced to enucleate the eye while the child was suspended with the head downward—an awkward position for operating. It was some time, fully a quarter of an hour, after the operation was completed and the eye bandaged, before I could trust the child in the recumbent posture.

"One of my assistants was very anxious to have whiskey injected, and had filled his hypodermic syringe for that purpose; but I declined its use, trusting to inversion alone for resuscitation. The final successful issue of this case confirmed my faith in this invaluable method, which I had used successfully on former occasions, and hence confided in it for the protection of the patient, through the trying ordeal. In all, the child must have been suspended in the inverted position for fully three-quarters of an hour. After the last suspension, no further trouble ensued. The next day the child was so thoroughly himself, that he left the hospital with his parents. He was brought back to the dispensary for inspection, two days afterward, a picture of health.

"This case cannot be too carefully studied by surgeons, who must continue to use general anæsthetics. It is one of a series occurring to me, now and then, (I am glad to say at long intervals), as the consequence of chloroform inhalation.

"A gentleman brought to me his two boys, one eight, the other six years of age, both subjects for squint-operation. Such operations, I frequently perform at my office with the aid of one professional assistant. The elder boy was put to sleep under chloroform, the tenotomy of the rectus completed, without trouble, and he was laid upon a lounge, vacating my reclining operating-chair, for the younger boy. He also bore chloroform apparently, as well as his elder brother, and under its narcotic influence the squint-operation was speedily completed. After I had removed the eye-speculum, and cleansed the conjunctival sac of blood, respiration suddenly stopped, the pulse disappearing from the wrist, and accompanied by the death-like appearances which belong to this startling condition. Fortunately, I was sitting at the head of the patient, and I immediately tilted down my end of the operating-chair, getting my assistant to elevate the foot-end, so as to secure an inclination of forty-five degrees, with the head of patient downward. After a few minutes blood gravitated into the head. By stimulating the nerve-centres, it started into action those organs so essential to life. Breathing was finally re-established, and with it the circulation.

"In four cases of sudden arrest of the respiratory functions, with failure of heart's action, during chloroform narcosis, occurring in my own individual practice, I feel assured that most of these patients would have died, had they been left in the recumbent posture, regardless of what may have been done otherwise, for their restoration. Fanning, fresh air, water-splashing, spanking, whiskey, or ether injections, electricity, artificial respiration—all of them, the remedies which physicians rely upon—go for very little, provided the patient be left supine. General experience, unfortunately, has too often shown this. In my experience with chloroform, in cases of suspended animation, all of these means for resuscitation are useless, unless the patient be hung up by the feet without any loss of time, so that blood may flow to the anæmic head, and heart, and stimulate the nerve-centres before the vital spark goes altogether out. A fire cannot be rekindled by adding fuel, if there be no live coals in the grate. Fortunately, suspension of the body needs no preparation, nor apparatus, for its immediate application. It only needs vigilance on the part of the operator. Should fright make him forget his duty, then precious minutes are lost in trying useless remedies, and these precious minutes can never be recalled."

"RECENT DEATHS UNDER CHLOROFORM.—A death while under the influence of chloroform, occurred in the Croydon Infirmary (England) on October 18, 1887. The patient was a man named James Portsmouth, aged 28, who came under treatment on June 22d, for pleurisy with effusion. The chest was aspirated on September 15th, and about four pints of serum withdrawn; aspiration was repeated September 20th, when three pints of serum were obtained. On October 17th, the chest, having again filled, aspiration was performed for the third time, and five and a half pints of pus were evacuated. Following the method of treatment which is now thoroughly established as a rule of surgical practice, Dr. Francis W. Clark, the medical officer in charge of the infirmary, after consulting with Dr. Strong, and Dr. Matthey, determined to open the chest-wall, in order to have free drainage. On October 18th, chloroform was administered, and the operation was performed in the ordinary manner. (*British Medical Journal*, Nov. 5, '87.) During the last steps of the operation, symptoms of syncope suddenly developed, and all efforts to restore the patient were unavailing. An inquest was held, and the jury returned a verdict, in accordance with the medical evidence, which recited the above facts.

"Comments by the editor of *British Medical Journal:* We understand that the Board of Guardians have instituted an inquiry into the circumstances. This is not likely to have any useful result. The operation was absolutely necessary, and every precaution was taken in administering the anæsthetic, but it is impossible, with the greatest care, to avoid all danger. Deaths have occurred with both the anæsthetics in general use, and under the hands of the most experienced operators.

"Remarks on the above subject by I. Frederick W. Silk, M.D., Anæsthetist to the Great Northern Hospital, and to the National Dental Hospital, London:

"*Sir*—Your issue of October 29th, contains an account of another death under the influence of chloroform, and the frequent repetition of these announcements, cannot but strike the most superficial observer, and has led me to address a few remarks to you upon the subject, while the matter is still fresh in the minds of your readers.

"Apart from the actual number of deaths, one cannot but feel surprised at the equanimity with which the profession at large, and surgeons in particular, view these constantly recurring accidents, and at the slight efforts which appear to be made to improve matters, even in directions where improvement is obviously possible. Such considerations not unnaturally suggest two questions, namely:

"1. Why is it that chloroform is still so extensively employed as an anæsthetic for general use? I quite admit that in special cases it is invaluable—even absolutely necessary—but, as far as I can judge, the only claim for general use it has upon our consideration, is, that it need not be given in any special form of apparatus, proficiency in the use of which might require a longer or shorter course of special training. Ether has long been proved to be infinitely safer, and, judiciously administered, fulfils all possible requirements; while properly combined with nitrous oxide gas, the violent struggling may be reduced to a minimum, the patient rendered insensible to the unpleasant odor, and the subsequent sickness, etc., much reduced. It is true, that to produce anæsthesia by the combined method, a certain amount of training in the use of more or less complicated inhalers, etc., is necessary; but will any one seriously put an argument forward, in favor of the use of a method which has been proved over and over again, to be fraught with danger, and risk to life? I am aware, that I have advanced none but the most trite arguments in favor of the combined method, and against the free use of chloroform; but, in the present apathetic state of opinion upon the subject, the most veritable truisms will, I am sure, be as valuable as the most precise reasoning.

"2. When will it be recognized, both in theory and practice, that the responsibility which devolves upon the anæsthetist is quite as great, as, or in some cases even greater than, that of the operator; and that his training should be proportionately careful, and systematic? Considering that, but for the discovery of ether, chloroform or some similar agent, the practice or surgery would hardly, in such a comparatively short time, have reached its present very scientific state, it is curious to note how completely the subject of anæsthesia has dropped into the background in general estimation.

"In making these remarks, I have endeavored most carefully to refrain from alluding even remotely to individual cases. I have simply seized the opportunity, which recent accidents afford, of bringing the subject in its entirety before the notice of such as may be interested, or able to influence others, and for whose benefit, I would sum up the points I have endeavored to make, namely:

"1. Chloroform, though of great service in special cases, should not be employed for general use.

"2. For general purposes, the combined gas and other methods will be found to more than fulfill every possible requirement.

"3. That more systematic instruction should be given on the subject."

At how many medical schools (we know of but one in Philadelphia—the Philadelphia Dental College) are any, but slight attempts made, to give instruction in a systematic manner, on a subject which we venture to think is not the least important in the curriculum?

The following is the death under chloroform, referred to, by the writer, above cited:

"A death is reported from Westminster Hospital, under chloroform (*British Medical Journal*, Oct. 29, '87). A patient, a young man aged 30, was about to undergo the operation of stretching the sciatic nerve, for sciatica of long standing. Ether was given in the first instance, under the influence of which he struggled violently. On being brought into the operating theatre, chloroform was administered in order to bring him well under, but almost immediately he was observed to turn pale, and both pulse and respiration ceased."

"DIED WHILE UNDER CHLOROFORM.—Stanley Carl, 30 years of age, who for some years has been a lion-tamer, and trainer in Forepaugh's Circus, died at the Medico-Chirurgical Hospital, while under the influence of chloroform, preparatory to undergoing a minor operation on a knuckle of his right hand. Every effort known to science, was made to resuscitate him, as soon as it was discovered that he was sinking. Dr. Formad, the coroner's physician, in his post-mortem, found that Carl had been suffering from liver and kidney troubles, and also from fatty degeneration of the heart. His death under the anæsthetic, is attributed to the latter cause. So far as known, he leaves no family." (*Press*, Feb. 7, 1887.)

"Professor Pancoast, was visibly affected as he related to the coroner's jury, yesterday, the circumstances attending the sad death of Stanley Carl, the lion-tamer and trainer, aged 30 years, of 927 Race Street, at the Medico-Chirurgical Hospital on Wednesday.

"The man had received an injury to one of his hands, during a scuffle with a colored man at the Dime Museum, where he was employed, several weeks ago, and went to the hospital to have the wounded member operated upon. Professor Pancoast, said, that he had taken a strong personal interest in the man. He was a sturdy, brave, frank-spoken fellow. He had previously been under treatment, and had told the witness, that he had been informed he must sacrifice one of the knuckles of the right hand. A few days ago he visited Professor Pancoast, and said, 'Doctor, I would rather die, than lose my right hand.'

"'My heart was touched,' continued the witness, 'and I offered to do what I could for him, without charge. I found that the hand was without motion, and, knowing what a brave fellow he was, and how he could endure pain, I endeavored to break the adhesions of the tendons, so as to restore motion. Strong as he was, he could not bear the pain, and I had to desist, and resort to an anæsthetic.'

"The witness explained, that his method of using anæsthetics was one, which was endorsed by two distinguished bodies of medical experts, in Paris. The death of Carl, was the most remarkable experience that the witness had had, in a practice extending over thirty-four yaers. 'My early training,' continued the professor, 'was in the direction of learning fully, the uses, effects, and application, of anæsthetics. The death of Carl, is a very painful occurrence—doubly painful to me.'

"Professor Pancoast then described the operation. He said that every precaution had been taken to insure the safety of the operation. Carl was placed on his back, and made to extend his hands upwards, at full length. Half a teaspoonful of chloroform was applied to a towel, and the witness took hold of the injured hand. The patient cried out in agony, and asked for more of the anæsthetic. Not more than two teaspoonfuls in all were given him, and then the witness began the operation. The hands remained extended, the legs moved and there was every evidence of vitality. At the conclusion of the operation, the witness looked at the patient and found that his face was livid, and there was a great difficulty in breathing. Observing that there was something wrong, remedies for resuscitation were tried. When the legs were raised, the face became more congested.' The symptoms were not those of a man dying from the effects of chloroform. In conclusion, the professor said: 'The case is wonderful, and I have never seen anything like it.'

"Dr. Stubbs, one of the professors of the college, testified that in twenty-four years' practice he had never seen a death like that of Carl, from either chloroform, or ether. Efforts to resuscitate the patient were utterly ineffectual, even to the tapping of the jugular, which was done to allow the discharge of blood, which was surcharged with carbonic acid, resulting from the use of chloroform. During the operation, the patient showed every indication of vitality.

"Dr. Formad, coroner's physician, testified that death was due to paralysis of the heart, hastened by the action of chloroform. There was evidence of latent heart disease, and a chronic affection of the kidneys. The jury rendered a verdict in accordance with the facts, and exonerated the surgeons from all blame. To this, Professor Pancoast remarked: 'A very just verdict, gentlemen, and I thank you. No one can feel this more than I do.'"

The experiments of Dr. Lauder Brunton, on the sedative effect of chloroform upon the heart's action, and the reflex phenomena, on irritation of the sensory filaments of the fifth nerve, show, that a small dose of chloroform is a most dangerous thing. Too much caution cannot be written and taught, that the heart-power is most seriously reduced by its action, and that it is incapable of supplying the brain properly, unless the patient is in a recumbent posture.

"Another Death from Chloroform in a Dentist's Chair.—Chicago, April 28, 1888. Dr. W. E. Day, in whose dental office Mrs. J. J. Shay died, while under the influence of chloroform, yesterday, was arraigned to-day on the charge of manslaughter. The coroner's jury not having returned a verdict, the case was postponed until Thursday. The doctor was unable to procure security for the $5000 bonds in which he was held, and remains in jail. When Mrs. Shay visited Dr. Day's office, she was accompanied by her sister, Mrs. Madden, of Pullman. She wanted all her teeth extracted, and the doctor insisted that she must take chloroform. Mrs. Shay objected, and told the doctor that she was subject to heart disease, and that she feared that the administering of an anæsthetic might result fatally. The dentist then felt her pulse, and assured her that there was no danger, as he did not think she had heart disease. The patient was finally persuaded to follow his advice. She took the seat and the drug was applied. When three of her teeth had been drawn, she showed signs of revival, and was drugged once more, and three more teeth were taken out, and again there were signs of returning consciousness.

"For the third time the drug was administered, when the collapse came. The patient was removed from the chair to a lounge, where she died within a few minutes in spite of the efforts of a doctor, who had been hastily called in. This is the story, as told by Mrs. Madden. Dr. Day, denies that he administered chloroform more than once, and insists that the patient died from a nervous shock. Dr. Day has practiced dental surgery in Chicago, since 1876. Officers of the State Dental Association, say, that he holds no diploma from any worthy institution, and that he is ostracized from associations, because he violates professional ethics, by promiscuous advertising. It is claimed by them, that no dentist has the right to administer chloroform, without skillful professional aid from some physician. The drug is very little in use, it is said, among reputable dentists."

"DEATH UNDER CHLOROFORM.—On Wednesday, Dr. Hardwicke held an inquiry on the body of Harry Knowlton, aged seven years, son of a smith, living at 1 Remerton Street, Barnsbury, who expired in the University College Hospital, while under chloroform, administered for the purpose of an operation. The evidence showed, that for the last two years, deceased had been under treatment in four hospitals for contraction of the sinews of the legs and arms; and, at last, he was taken to the University College Hospital. On Thursday, he was placed under bichloride of methylene, and was operated on by Mr. Marshall, the senior surgeon, who ordered that next day he should be again placed under the vapor, and splints put on to his limbs. He was removed into the ward, and the following day, Mr. Sayer, one of the resident medical officers, administered chloroform, with a view to carrying out Mr. Marshall's instructions. At first deceased became excited, but getting quieter, the house-surgeon began the operation, when it was found that he was not sufficiently under the influence of the chloroform, and more was about to be administered, when it was found that respiration had ceased. Artificial respiration was resorted to, but without success. Jury returned a verdict, of death through misadventure." (*British Medical Journal.*)

"DIED IN THE DENTIST'S CHAIR.—Cincinnati, Ohio, Feb. 22, 1889. A despatch from Norwalk, Ohio, says that Miss Minnie Marsaeles, a young lady of that city, died in the dentist's chair yesterday. She had taken chloroform preparatory to having teeth drawn, and it caused her heart to cease beating. It is thought she was affected with heart disease."

It is stated in the editorial notes (*Am. Med. Ass. Journal,* March 2d,) that she "partly recovered from the drug" when she started to rise from the chair, but suddenly sank back and died. From the meagre information conveyed in the press dispatches, one cannot know whether the chloroform was administered by the dentist himself, whether the administrator was a physician, or a person sufficiently skilled to administer chloroform; but one can scarcely conceive of a skillful anæsthetizer, giving chloroform to any one in a dentist's chair under any circumstances. A person that would give chloroform to a patient in a chair would probably not take the other necessary precautions when about to give chloroform, such as removing all sources of constriction of the body.

Is it not time that dentists, and physicians, also, learn that chloroform is a very dangerous drug when given improperly? With the other means of anæsthesia that we have, is the use of chloroform for tooth extracting justifiable? The fact that teeth have been extracted under chloroform, and without injury to the patient, does not justify its use for this purpose. The surgeon that would seat a patient fully clothed in a chair, and give chloroform to amputate a finger, or even open an abscess, would be guilty of negligence, if any, short of criminality. We are too much inclined to excuse blunders, hoping that the blunderers have been taught a salutary lesson, which, however, is of no benefit to the person that has come to an untimely death. There should be more care in dealing with the ills, to which the flesh is heir, that the patient survive the treatment. "It is a well-recognized rule, that a patient should never immediately assume the upright posture, especially after the use of chloroform, whose chief depressing influence is upon the heart, for it has been found that they at once faint, and by placing their head low, the blood returns to the brain, and heart, and the patient is safe. This well-known method of Nélaton has had to be employed in several instances in the same case, and thus saved the life of the patient. The heart of every patient, should be examined before a systemic anæsthetic is employed, and to a patient with a fatty heart, chloroform should never be given."

It was published in the *Louisville Medical News*, May 26, 1883, that during the last year, two deaths from chloroform had occurred in the practice of two prominent Southern surgeons, Dr. Kinlock, of Charleston, and Dr. Hunter McGuire, of

Richmond, which have, "doubtless, detracted from the favor in which chloroform is held in the South, and advanced the popularity of ether as a safer agent, though not so prompt in its effects. In the North, and East, ether has long held undisputed sway, and, with a few exceptions, has enjoyed a higher degree of confidence.

"It is now beginning to be observed by the profession generally, that there is something of very material importance in the *manner* in which anæsthetics are administered—that there is an anæsthetic art, deserving careful study, and application in practice. It is not an uncommon observation to see the administration of the anæsthetic, intrusted without discrimination to an assistant, who holds the paper cone carelessly over the patient's face, and watches, in the meantime, the various steps of the operation. Can it be wondered, that, in a process involving such essential physiological functions, dangerous and alarming symptoms arise under these circumstances? Unquestionably, the administration of the anæsthetic should receive the undivided attention, during an operation, of one who has by study, and training, acquired a knowledge of the proper method of administering the agent, and who, in circumstances of danger, will be prepared to act promptly and intelligently in his efforts at restoration."

DEATH FROM CHLOROFORM NARCOSIS.—FAILURE OF NÉLATON'S METHOD, AND OF THE AMYL NITRITE TREATMENT.—The following, is a death from chloroform in the practice of Professor McGuire. Dr. Hugh M. Taylor, of Richmond, Virginia, reports the following case in the *Virginia Medical Monthly*, of May, 1878:

"Professor McGuire, has requested me to report the following death from chloroform, which occurred a few days ago in his practice. As far as I can learn, it is the second death from this agent which has occurred in our city, and is one of the very few, recorded by our Southern surgeons:

"The patient was a gentleman from North Carolina, æt. 41 years. Twelve or fourteen months ago he received a violent blow upon his perineum, by being thrown upon the pommel of a saddle. His urethra was ruptured; this was followed by urinary infiltration, abscesses, resulting in the loss of the entire penis, and part of the scrotum. Since that time, he has been a very great sufferer, and has become entirely dependent upon anodynes, frequently taking as much as two grains of the sulphate of morphia a day. During the last six months of his sickness, he has spent most of his time in bed, or in the recumbent position.

"On the day of operation, April 20th, 1878, (Doctors Cunningham, Ross, Leech, Maclin, and Carroll co-operating), Squibb's purified chloroform was administered, for the purpose of making a direct outlet for the urine by external perineal urethrotomy. The administration of the anæsthetic was begun while the patient was in his bed. He was then put upon a table in the lithotomy position, and the table was drawn near an open window, occupying a position directly between the open window, and an open door. I noticed, when giving him chloroform in his bed, that he was not easily brought under its influence. Some delay occurred in the first part of the operation in consequence of the extensive undermining of the tissues, and burrowing of the urine, and pus, leaving a great number of false passages, and rendering it tedious to get a guide of any sort into the bladder. During this stage of the operation, he was not kept fully under the chloroform. After some effort, the continuation of the urethra was found, and an instrument passed into the bladder. The administrator then carried the anæsthesia far enough, to allow the operation to be finished. He had done this, and had taken the chloroform away for a few seconds, when we were all startled by one or two stertorous respirations, and then followed an entire cessation of respiratory effort.

"In less time than I can tell, his tongue was drawn forward with a tenaculum; his feet were raised, and his head was lowered; water was dashed in his face; his cheeks smacked; nitrite of amyl held to his nose. As none of these aroused him, he was quickly placed on the table and artificial respiration resorted to. Dr. Ross, and I, raised and depressed his arms, while Doctors McGuire, and Cunningham, compressed his thorax. Let me here remark, that I am sure in this case the death was not from asphyxia, or the impregnation of his blood, with carbonic acid. The efforts at artificial respiration were eminently successful. As the arms were raised, the air rushed into the lungs, producing a stertor as natural as life—and then when the thorax was compressed, the blowing sound of exit was plainly heard. Indeed, these artificial inspirations and expiration were so strikingly normal, as to deceive me for some time into believing them vital. During this time, whiskey was injected into his rectum, amyl occasionally held to his nose, and the foot of the table elevated. Only once, during our prolonged efforts to resuscitate him, was there the least token of returning animation, and that was when the first dash of cold water struck his face. Then he gasped feebly—but once. His features from the first were blanched, and bloodless; he carried to his grave the finger marks produced by slapping him; his pupils were both widely dilated; his lips blue. He had been under the influence of chloroform for about three-quarters of an hour—at no time very profoundly. During this time, he took about ℥j of Squibb's purified chloroform. The large quantity of anodynes which he had accustomed himself to, and the extreme sensitiveness of the parts manipulated, rendered it difficult to anæsthetize him. He had taken chloroform twice, before he came to the city, and this latter trouble, viz., inability to completely affect him, was noticed upon both occasions.

"In reviewing the case, the doctor concludes, that death was brought about, through syncope; that amyl, had no effect in replenishing the anæmic blood vessels of the brain; and that at least one case has happened, when its antidotal virtues were not at all noticeable; that the result was of sudden occurrence, and of speedy termination; that his pulse was good a very few seconds before, and that the artificial respiration would have oxygenated any quantity of carbonized blood, with which his lungs might have been surcharged; that the administrator was in no manner to blame, as he fulfilled his part with the utmost care and skill. The verdict of all present was 'that death was caused by chloroform; but that the same was carefully, and judiciously administered.'"

Being desirous of knowing some obscure points, in regard to the way in which the nitrite had been used, we wrote to Doctor Taylor, addressing the following questions :—Did the nitrite of amyl produce a flushing of the face, action of the heart, and difficult breathing when you employed it yourself? Did you use a tube to force it up the nostrils when the breathing had ceased? How many drops were employed? Was it in capsules or dropped from a bottle?

The doctor kindly replied, as follows:

RICHMOND, May 31st, 1878.

DOCTOR TURNBULL,

Dear Sir:—Your letter, dated May 20th, found me out of the city for a few days. I am very glad to answer your inquiries. You say that "Professor Nélaton's method will sometimes fail, especially when morphia has been used with the chloroform." No morphia was given at the time, with the chloroform. It was during his sickness that large quantities had been administered. In regard to the amyl used, it was made by Squibb, and was, I think, pure. I am sorry I cannot find a sample of it to send you for examination. It was dropped from a bottle upon a handkerchief. The number of drops were not ascertained. No tube was introduced into the nose.

Very respectfully, etc.,

HUGH M. TAYLOR.*

"DEATH FROM CHLOROFORM IN WHICH THE NITRITE OF AMYL WAS EMPLOYED WITHOUT SUCCESS.—Another death in the hands of a Southern surgeon: Death from chloroform April 29th, 1879, by W. P. Mills, M.D.,† of Brownsville, Mobile. I was requested to operate on a boy aged 16 years, for congenital phimosis. He was chloroformed by Dr. A. J. Parsons, who has often administered chloroform by inhalation, and, by the way, he is very cautious in the adminis-

*We do not think the doctor was justified in the use of so powerful an anæsthetic, to risk his patient's life in so trifling an operation. Evidently the nitrite of amyl was not employed until the patient had become unable to inhale it. The conclusions are not the most recent, as a careful reading of our table of deaths from it, will show. It gives but little warning before it kills the patient.

† *St. Louis Medical and Surgical Journal*, June, 1878, p. 492.

tration of this potent drug. Notwithstanding the great prudence, caution, and the general manner in which it was administered, just as the operation was completed, and without any indication of danger whatever, instantaneously—almost as quick as the explosion of gunpowder—respiration ceased, and a livid color overspread his face, and in spite of all the usual restoratives, he was soon dead; in fact, it seemed as if he was struck dead in an instant. Immediately, upon the supervention of these alarming symptoms, his head was lowered, cold water thrown into his face, and artificial respiration induced. Under the influence of this treatment some improvement was manifested, and for a few seconds it seemed that the danger was over, but suddenly all the alarming symptoms before described were again exhibited, and death was the inevitable result. Not more than three drachms of chloroform were used, and of this not more than one and a half or two drachms were actually inhaled, and the patient was not deeply under its influence at any time during the operation, which, as a matter of course, was very brief. Nitrite of amyl, electricity, and hypodermic injections of whiskey were all brought into requisition, but, as the sequel proved, were of no avail. The most noteworthy feature of the case was the very sudden supervention of the alarming symptoms, for, according to my information in regard to chloroform poisoning, there is generally some warning given of its deleterious influence."

"DEATH FROM CHLOROFORM.—On the unfortunate death of the Lady Flora Wilmot, whilst under the influence of chloroform for the extraction of a tooth, Mr. J. Farrant Fry, the medical practitioner who administered the anæsthetic, communicates to *The Lancet* the following observations:

"I beg to forward you particulars of the recent death here from chloroform. The Lady Flora Wilmot, aged twenty-five years, had been under my care for various minor ailments during the last eighteen months. With the exception of a gouty tendency, her constitution was, I believe, sound. On Wednesday, February 24th, I was asked to meet her at Mr. Scott's residence, at Swansea, (her dentist) for the purpose of administering an anæsthetic for the extraction of the right molar tooth. Nitrous oxide gas not being available, I gave chloroform, in preference to bichloride of methylene or ether (both of which I had by me), because for the purpose I considered it the best anæsthetic, and also because her ladyship, having taken it two or three times before, expressed a preference for it. Everything about the chest being perfectly loose, and the patient sitting in the dentist's chair, less than a drachm was sprinkled on lint in an open inhaler, which the gag kept from closely fitting round the mouth and nose. A similar quantity of chloroform was added a second and third time before perfect anæsthesia occurred. The tooth was then removed, and recovery followed without a bad symptom. The patient had taken it capitally, and in all two drachms had been given. Five days afterwards (March 1st,) I again administered chloroform for Mr. Scott, (this time at the patient's residence), to remove the adjoining bicuspid tooth. The patient was seated in a low, deep-backed, well-pillowed easy chair, and was therefore more reclining than on the former occasion. The result of the chloroform before having been so satisfactory, I again administered it in the same way, and, as before, two drachms were given in all, with a similarly good result. The inhaler having been removed, Mr. Scott took out the tooth, cleaned his forceps, and stood by the patient's side. I remarked: 'I hate giving chloroform for you dentists, because you will have your patients sitting up.' This led to a reply from Mr. Scott, who then poured out a tumblerful of water, and asked the patient to rinse her mouth, as the gums were bleeding. No water was taken, and I observed she was not sufficiently conscious yet, and we still stood by the patient. I had during this time one finger on the temporal artery, whilst with the other hand I was raising the eyelid and watching the pupil, which, having been dilated during unconsciousness, had become normal, and the conjunctiva sensitive. Suddenly the pupil became again widely dilated; I could no longer feel the pulse, and the face became blanched. The chair was immediately turned back, the head lowered to the ground, and the body and limbs raised. Nitrite of amyl, sprinkled on a handkerchief, was applied to the nose, and, although the heart could not be felt beating, the breathing still continued for, I should say, at least two minutes. Artificial respiration, drawing out the tongue, and lifting the jaw forward, were of no avail; not the slightest sign of recovery followed. A *post-mortem* examination was refused." (*London Dental Record*, April, 1887.)

Perils of Chloroform Administration in Dental Operations.

Dr. Brunton states, that if a patient were not thoroughly under the influence of chloroform, any irritation of the fifth nerve would produce slowing of the heart's action, and finally stoppage through the pneumogastric nerve. He clearly showed this by an experiment on a rabbit. This may account for the deaths in the dental chair from operations on the teeth. Chloroform is the most powerful of the anæsthetics; too much caution cannot be written and taught, that the heart power is most seriously reduced by its action, and that it is incapable of supplying the brain properly unless the patient is in the recumbent posture.

The researches of Richardson, Rabeteau, and others, have shown that the physiological action increases in intensity and danger, as the number of carbon atoms increase, so that while wood-spirit (methyl alcohol), with but a single atom of carbon, is transient and slight in its effects, those of fusel oil (pentyl alcohol), which has five atoms of carbon, are prolonged and severe.

The number of deaths from chloroform which have occurred up to date, will be seen in tables. It will be seen by a glance how and why deaths from chloroform have occurred, and how unsatisfactorily, in most of the cases, the facts connected with the circumstances have been reported.

Comments upon the Deaths from Chloroform.*

Date when Death occurred from Chloroform.—The number of deaths in the cold months were forty-seven, and

* Abstract of table in author's "Anæsthetic Manual," second edition.

against this we have forty-seven deaths during April, May, June, July and August, showing but little difference in regard to temperature.

Sex.—We find there are seventy deaths in males, and twenty-nine in females. Our results agree with those of Sansom.

Age.—Number of cases over twenty-one, fifty-six; under it, nine, the youngest of which was three (No. 157); then follows one at six, eight, eleven, twelve, fourteen, fifteen, sixteen and eighteen years.

Character of the Operation for which the Chloroform was Administered.—In many instances the chloroform was employed for trifling ailments, which could have been relieved by less hazardous means, or in surgical operations of minor importance, as follows: facial neuralgia, asthma, headache, toothache, sleeplessness, uterine trouble, etc. Of the operations, there were fourteen cases of extraction of teeth; then follows introduction of catheter, extraction of thorn, amputations of fingers and toes, hydrocele, removal of dead bone, dressing of fractures, tumors of small size, fissure of anus, cataract, iridectomy and strabismus; many of which could have been performed without an anæsthetic, or, if this was insisted upon, sulphuric ether, or nitrous oxide could have been employed.

The Time at which the Patient Died.—In twenty-four instances before the operation, sixty-one during, and only ten after the operation.

The Quantity of Chloroform Employed.—The smallest quantity employed was a few drops in case No. 142; then in case No. 21, fifteen to twenty drops; in case No. 156, forty drops; case No. 28, six minims, and in eight cases one drachm only was employed; in twelve cases, two drachms; from half an ounce to one ounce in most of the other cases, with one exception, in which it was stated a large amount in case No. 20 was employed.

Form of Apparatus.—In nine cases a towel or napkin was used; in two, upon lint and sponge; one in the sitting posture; in one, large amount carelessly administered; one lying on abdomen.

CONDITION OF PATIENT.—The first most prominent condition of the patients was the result of habitual employment of chloroform (three), either to induce sleep, relieve pain or in most instances as an intoxicant, at first in moderate quantity, and then increasing it, forgetting its fatal nature. The second condition was its fatal effects upon persons of an intemperate habit (three), anæmic (two), or disease of heart, or broken down in general health. On the other hand, however, many are cut down in a perfectly healthy condition, after the heart has been examined and considered all right (five).

SYMPTOMS.—The most prominent symptoms of chloroform poisoning will be found to be the fainting of the patient, failure of the pulse, heart's action and ceasing of the respiration, stertorous breathing, face livid, convulsive movements and dilatation of the pupil.

THE CAUSE OF DEATH.—Out of twenty-seven cases, the majority of deaths is stated to be from collapse (in fourteen cases), from shock (two), syncope (one), asphyxia (three), from disease or paralysis of the heart (five), chloroform poisoning (two).

POST-MORTEM APPEARANCES.—Heart affections seem to have been the chief causes for death reported. Fatty degeneration of the heart was found in seventeen cases; other cardiac lesions, nine cases. An examination of our table will prove the sad, but positive fact, that a large number of patients who die from chloroform were healthy prior to taking the fatal dose to relieve them of some trifling ailment, or for a minor surgical operation. (The results confirm the experiments of Schiff, who stated, that in more than five thousand cases chloroform paralyzes the heart and blood-vessels at once without previously paralyzing the respiration.) Thirty cases were either healthy, or *post-mortem* results were negative; in one case the patient had been carefully examined, and no disease of heart or lungs was found to exist; one had inhaled chloroform the day before. In two cases, from vomiting, followed by deep inspiration, the food was found drawn into the trachea; in one, tracheotomy of no avail; in the other case, patient died alone (self-administered). In many of the cases the *post-mortem* conditions are given in detail, as though they were pathological changes.

CHLOROFORM GIVES BUT LITTLE WARNING!—The rapidity with which patients die from it, is as follows:

1	patient, instantly, struggling stage .	died in	1 second.
1	" suddenly	"	$1\frac{1}{2}$ minutes.
1	"	"	2 "
1	"	"	3 "
4	"	"	5 "
1	"	"	6 "
4	"	"	10 "
2	"	"	15 "
2	"	"	a few "

"Let us," observes Professor Reichert, of the University of Pennsylvania, "but glance at the chloroform death-list, and, as horrible and incredible as it may seem, there have been *reported* an average of about *a death for every month since the time of its introduction.* With this array of fully authenticated cases before us, what, indeed, must be the actual number?—for it must be conceded that probably double, triple, or quadruple as many more were not reported, and will never come to light. Even Kappeler alone says, that he knows of four cases never reported, and personally, I know of two. However, it needs no words of mine to remind the profession of the dangers of chloroform."

Table of Ratio of Deaths from Anæsthetics.

Chloroform (Lyman)	1 in 5860
Chloroform (Richardson)	1 in 2500 to 3000*
Ether (Andrews)	1 in 23,204
Ether (Lyman)	1 in 16,542 †

* The mortality in chloroform is about one in three thousand, and it should not be employed except under special circumstances.

† In ether one in about sixteen hundred, and it is the safest anæsthetic in prolonged operations, and, as a rule gives warning of death, yet in a few cases has caused sudden death.

Nitrous oxide (Rottensten)	1 in 100,000 *
Mixtures of chloroform and ether	1 in 5,558 †
Hydrobromic ether	1 in 12,500 ‡
Bichloride of methylene (pure)	1 in 10,000
Methylene mixture	1 in 5,000
Amylene	1 in 2380

Table of Deaths from the Various Anæsthetics.

Chloroform (Turnbull, 1888–9)	375
Chloroform (Lyman, 1881)	242
Ether (Lyman)	27
Ether (Turnbull, 1889)	52
Nitrous oxide	3
Amylin (Buxton)	2
Hydrobromic ether	2
Hydrobromic ether mixture	1
Mixture of ether and chloroform	4
Mixture of ether, alcohol and chloroform	2
Bichloride of methylene	5
Methylene mixture	2
Amylene	2

In a recent paper by Dr. Gaspar Griswold on "Electricity as a Stimulant in Cardiac and Respiratory Failure,"§ he clearly proves that "The pneumogastric nerve retains its excitability in chloroform poisoning, and it is, therefore, extremely dangerous to apply electricity to the neck in this condition. In asphyxiation by ether, he found that the heart could stand stimulation of the pneumogastric as well as in health, and he concluded, therefore, that it was safe to stimulate the phrenic nerve to a certain extent in this condition." (See more recent conclusions from experiments by Drs. Hare and Martin, p. 396.)

* Nitrous Oxide.—This is the safest anæsthetic in short operations, but, like all anæsthetics, death may occur from syncope. It may also be combined with ether for prolonged anæsthesia in dentistry.

† Mixtures containing chloroform and ether have the objection of the different volatility of the two agents, and toward the last the patient is apt to receive only chloroform.

‡ Hydrobromic ether is suitable for short operations, and has the tendency to produce rigidity of the muscles, acting like nitrous oxide, but not so safe.

§ *Medical News*, February 28, 1885, p. 241.

In what Class of Cases can Chloroform be Employed with safety?

Chloroform, in certain conditions, is a direct cardiac depressant, while, as expressed by Dr. Fordyce Barker, "In obstetrics, he had found that chloroform had a very different effect from that which it had when given as an anæsthetic in surgical practice. The reason that he assigned for this was, that in surgical practice the anæsthetic was given to anticipate suffering, while in the case of the parturient woman, it was used for the relief of pain already existing. Under the latter circumstances he believed the system would tolerate the depressing influence of the drug, which it might not in ordinary conditions.

"It had long been an accepted point in the opinion of the profession that it was unsafe to administer an anæsthetic when there was organic disease of the heart, but it was at least twenty-five years since he had ceased to believe that the existence of such was a contraindication against the use of chloroform in pregnant women. On the contrary, the presence of cardiac trouble was, to him, an indication which induced him to resort to this anæsthetic at an earlier period than usual. Ether, however, was not safe, and its use in such cases was to be condemned. He then goes on to report a case in which he considered that chloroform was a protection rather than a dangerous or injurious agent. The woman, when received into the lying-in ward, was in the advanced stages of valvular disease of the heart, with marked dropsy, dyspnœa, etc., and was successfully delivered, and rapidly improved after her labor." The author of the paper stated in conclusion, that in chloroform poisoning particularly, he believed it was best to rely on artificial respiration, which was safe and efficient, while stimulation of the phrenic nerve was not safe. The hypodermic injection of ammonia, alcoholic stimulus, etc., might also be employed. In regard to chloroform, Simpson was the first to show that it was much more of a local anæsthetic than other drugs of its class. The local effect of ether was simply one of freezing, on account of its rapid evaporation. There is one very important agency which should never be omitted in arresting respiration from chloroform—that is, flagellation with a towel dipped in ice water applied to the chest and back, and artificial respiration.

In our own experience, and after our experiments, we would limit the use of this most potent of all the anæsthetics to *very young children*, or to those who are weak, strumous or overgrown; to puerperal eclampsia, in very violent convulsions, in male adults, or in females during delivery, where rapidity of dilatation of the *os uteri* is absolutely necessary to save the mother's life.

In some rare cases of painful operation, where, after continued efforts, no complete insensibility can be produced by ether, we would feel justified in the use of chloroform, on a clean sponge or inhaler. By a reference to the recent cases of deaths from this agent, we are fully satisfied that no amount of care or precaution, or mode of administration, or amount inhaled, will prevent, in certain cases, the fatal result; and yet physicians and others will resort to the use of chloroform, on account of its pleasant taste and odor, rapidity of action, cost and comparative bulk.

In the recent admirable work on surgery by Erichsen, he discussed the question, "Do anæsthetics influence the rate of mortality after operation?" and concludes by stating: "I am inclined to believe that the rate of mortality has increased since the use of anæsthetics in operative surgery." Again, "I cannot but think that chloroform does exercise a noxious influence on the constitution, and does lessen the prospect of recovery in certain states of the system, more especially when the blood is in an unhealthy state." He states the most dangerous condition in which chloroform should be administered, is that in consequence of renal disease, the blood is loaded with urea; in such cases, epileptiform convulsions are readily induced.

In the recent work of Professor Billroth, of Vienna, he states: "Recently, ether has come more into use, on account of the number of deaths from chloroform. I now use a composition of three parts chloroform, one sulphuric ether, and one absolute alcohol, which seems less dangerous than chloroform."

Mode of Administering Chloroform by Inhalers, Etc.

When chloroform was first discovered, the apparatus employed was like that designed for etherization, but of a more reduced size. The less volatile nature of chloroform, permits even the abandonment of all apparatus, and most physicians prefer to use a handkerchief or a compress, folded in several thicknesses. After having arranged the folds in cup-shape, you pour on the linen several drops of chloroform, and apply it over the mouth and nostrils of the patient, allowing, however, enough free space for the atmospheric air to enter freely with the chloroform.

If the subject be nervous, irritable, and manifests a feeling of suffocation, remove the handkerchief or compress, still farther from the nostrils, accustoming the patient, little by little, to the odor of chloroform. If the quantity of chloroform does not suffice, renew it as often as is necessary, always observing the same precautions.

This method is certainly simple, although it has its disadvantages. In the first place, it conceals the face of the patient, and prevents the surgeon from observing in the physiognomy, the effect of the anæsthetic. In the second place, it necessitates the use of a greater quantity of chloroform, of which a great deal, after having soaked through the entire compress, is lost by evaporation from its external surface.

An effort has been made to overcome, or diminish, these disadvantages, by the use of, very simple apparatus.

It was necessary to fulfill two requirements—to have an absorbent surface, on which to pour the chloroform, and to permit the access of the air, which must be mingled with the anæsthetic vapors. The apparatus of Raynaud, (of Talon) and Charriere, fulfilled these requirements pretty well. It was composed of a conical horn of pasteboard, pierced by a large opening at the top, and terminating in a sort of mouth-piece, which fitted over the mouth, and nose, of the patient. The apparatus is lined on the inside with wool, and at a certain distance from the top of the cone is a diaphragm, formed by several folds of wool, presenting in the centre a large hole for the entrance of atmospheric air. It is upon this diaphragm, that the chloroform is poured.

The anæsthetic horn of Raynaud, has the disadvantage of leaving much to be desired in the way of cleanliness. Patients very often expectorate into the interior of the apparatus, in that stage which the French call sputation "Le Fort Malgaignes." * A chloroform inhaler much used in England is exempt from this objection. It consists of a kind of metallic box, with the margin hollowed out in the parts, which correspond to the nose and chin of the patient, and of which the bottom and lower wall are pierced by a hole, permitting the entrance of air. An attachment in the shape of a horse-shoe, fastened to the upper wall in the interior of the apparatus, permits the firm adjustment of several rolls of linen, or two bundles of lint, on which the chloroform is poured. The linen, or lint, is renewed each time the box is used, and you can see, that nothing is easier, than to keep the apparatus always in a state of perfect cleanliness.

Moreover, the least change in the physiognomy of the patient cannot escape the eye of the surgeon. For some years past, an endeavor has been made to substitute for the compress, some rather simple apparatus, consisting principally of a piece of woolen stuff held on a frame, which is placed at some distance in front of the mouth (see Skinner's apparatus), as a sort of mask, and on the exterior face of which a certain quantity of chloroform is poured, drop by drop. The necessity of allowing the patient to breathe only vapors of chloroform, mingled with atmospheric air, has led to the construction of several appliances. Clover, had the idea, of preparing beforehand a mixture of a definite quantity of air, and chloroform. His apparatus, of which a description is given at p. 140, is composed of a rubber sack, filled by means of a special kind of a bellows, with a known quantity of atmospheric air, with

* Translated by E. M. Hiestand, *Medical Register*, 1888.

which is mingled, in a definite proportion, a certain amount of chloroform, in such a way, that the propoition of the anæsthetic vapor be 4.5 per 100 volumes of the air imprisoned in the sack. For several years this mode of administering chloroform seemed to give complete security, but from 1867 to 1874, five cases of death were discovered where Clover's apparatus was used, the last occurring at the hands of Clover himself.

Snow's apparatus, and that of Sansom, have disadvantages which have prevented their adoption. Junker's apparatus, merits more attention.

It is composed of a bottle with two tubes enveloped in steel, but this envelope is pierced by a longitudinal crack, showing what is going on inside the bottle; and has a graduated scale, which keeps count of the quantity of the anæsthetic employed.

A hook allows the operator to suspend the apparatus from his button-hole. The tube conveys to the bottom of the bottle, the air which is forced there by a Richardson bellows. This air, after having mingled with the chloroform, passes out by an attachment and through the tube to the mouth-piece, which is placed before the mouth and nose of the patient.

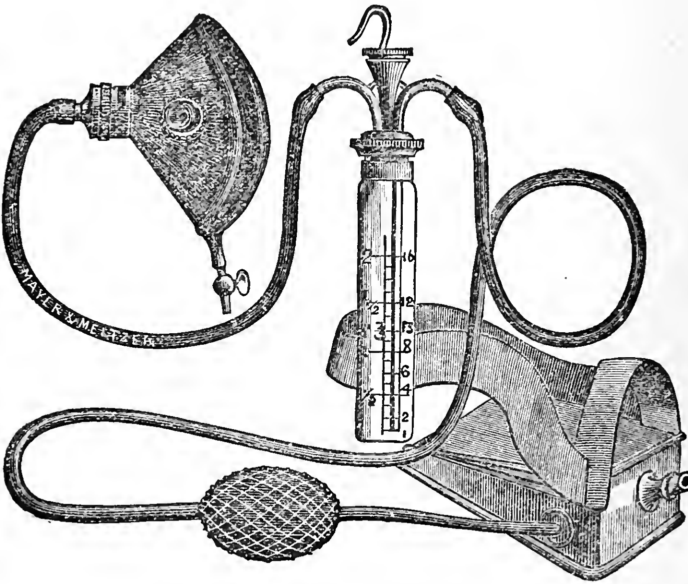
This mouth-piece of hard rubber, has a valve of soft rubber, which opens with expiration, and closes with inspiration.

A movable ring placed at the point where the vapors arrive, and pierced by two slits, corresponding to two openings of the same calibre in the attachment which prolongs the mouth-piece on this side, allows a greater or less quantity of pure air to reach the patient, this being mingled with the anæsthetic vapors propelled through the tube into the mouth-piece. (Junker's inhaler for chloroform, modified by Dudley Buxton see p. 442.)

Junker's Inhaler.

This inhaler, which practical acquaintance with its imperfection has led us to modify, is of value, though it must not be supposed that by its use the patient is placed outside the range of possible danger. In this apparatus, half an ounce of chloroform is poured into a bottle, through a funnel-shaped opening fixed in a screw top; air is then pumped *through* the chloroform, and in its passage, takes up the vapor. The foot bellows are fixed by straps, one of which slips over the toes, while the other receives the heel in the long loop. When the foot presses lightly, the air in the bellows is forced through the tube into the bottle, thence through another tube to a face-piece. The net-enclosed ball, is for equalizing the stream of air and the

Plate 40.



JUNKER'S INHALER FOR CHLOROFORM.
Improved by Dudley Buxton.

avoidance of splashing. It is important not to put more than half an ounce in the bottle at once, and not to pump in air, spasmodically, or too forcibly, otherwise chloroform may be driven through the system of tubes into the face-piece. Even if this should not happen, a strong blast of chloroform-impregnated air is very unpleasant, and deleterious, if allowed to impinge upon the face. When the bottle has become nearly empty the mill-headed stopper which closes the funnel is removed, and more chloroform added; thus the apparatus need never be unhooked from the administrator's coat, and the top never unscrewed until the administration is over, when the bottle should be emptied and cleaned.

CHAPTER XXI.

The Legal Responsibility of Physicians in the Administration of Anæsthetics—Medico-legal Relations of Anæsthetics—Case in Philadelphia of a Surgeon Dentist—The Important Question whether Chloroform can be Administered for Criminal Purposes?—Cases in France, England and the United States—Dr. N. L. Folsom, R. M. Denig—Chloroform as a Poison—The Chloroform Habit.

On the Legal Responsibility of Physicians in the Administration of Anæsthetics.

It is a noted fact, that when anæsthetics are trusted in the hands of an educated and careful surgeon, the mortality from their use, is reduced to the minimum. The individual who administers the anæsthetic, should have nothing else to do; his hands, eyes and mind should be on *this alone.* In our hospitals, clinical assistants should be instructed in the chemical, physiological, and toxicological nature of anæsthetic agents, and after being thoroughly trained in their use, and in the means of resuscitation, receive a certificate of competency.* It is too often the case that valuable lives are placed, as it were, in the hands of young men, who have no proper knowledge of their use, and who do not appreciate the great responsibility under which they are laboring. Such powerful agents as chloroform and ether, or their compounds, should be handled with skill, judgment and discretion, fully realizing that on the exercise of these, depends the life of the patient. There is no doubt, that many deaths have been caused through the want of this proper knowledge and experience. Who is at fault in this? It is, as a rule, the fault

* This is done in the Philadelphia Dental College.

of the operating surgeon, who, in a general way, considers this as a secondary matter, and trusts the anæsthetic to any person who may be with him. To the experienced eye, signs of danger are almost always evident—the disturbed, stertorous, or shallow respiration, the pulse, the pallid or leaden hue of the skin, the fluttering heart.

We repeat it, that a physician or a surgeon, in administering ether and chloroform, or their compounds, is responsible for the life of the patient, and it would be well for some of them if a law were enacted, compelling them to employ the least fatal anæsthetic, unless some idiosyncrasy on the part of the patient did not allow of the use of such an agent, or one less dangerous. Again, in our navy, especially on board steamers, and in countries where the average temperature is 80° F. or over, chloroform might be allowed, but in the army in the field, as well as in the navy, only in capital, or very painful, or extensive operations, this exception being enforced by a rule.

Daniel S. Riddle, Esq., New York, said, as regards the enactment of further laws on this subject, it was not necessary. There are sufficient laws already. The difficulty is in enforcing them. If there is carelessness on the part of the doctor, he should be held responsible. It is the same with lawyers. It belongs to the profession of medicine, to say whether these agents have been carelessly used; and if they have been carelessly used, it is their duty to produce, as well as indicate, the person who uses these great powers carelessly. "If we lawyers," he remarked facetiously, "find out that you are carelessly using these things, it is our duty to pitch in."

Mr. Coroner Ellinger, thought it would be a hard matter to hold doctors responsible, because it is difficult to state scientifically where the responsibility can rest. It ought at least to be shown that there was conscious negligence in the performance of duty. The condition of the patient should be taken into account, and that must be left to the discretion and knowledge of the attending surgeon. He thought that the medical student ought to be taught the danger of the agent he employs, how, and when to use it judiciously, and should be required to secure a certificate to the effect that he has been so instructed before being let loose upon the public. The public would then know that he possesses a knowledge of the agent which he employs. Besides, the physician would be conscious of a certain moral responsibility, for he held that the moral responsibility which every medical gentleman must feel, is greater than the responsibilities placed upon him by the laws of the land.

Jacob F. Miller, Esq., agreed with those who advocated care in the use of these agents. Man is living in the midst of dangerous forces, and will continue to use them, though of necessity many deaths occur. But in order to rest a case against the user, it is necessary to show negligence. Negligence, is the gist of the action. The physician, surgeon or lawyer contracts for the ordinary skill, and care of his profession. He does not contract for any extraordinary skill. The law does not hold him any more responsible than that. It would be unreasonable to do so, because few persons could safely practice their profession; and if any person should use anæsthetics, and the patient should die, that is not sufficient to charge him with the responsibility. He thought, that all would admit, that if a man not having the ordinary skill of his profession, should, by unskillful administration of anæsthetics, cause the death of the patient, he should be prevented from doing further damage by a suit for malpractice. Would it not be better to stop him by such procedure? Shall a man be allowed to use such dangerous forces just as he pleases—let the consequences be what they may? People consult physicians, because they say they have the requisite skill to use these things. They hold themselves out to the community as having this skill, and they ought to possess it; if they do not, and harm results from it, they ought to be held responsible. The coroner says, that physicians are actuated by moral responsibility, which is no responsibility at all. The quack will go on with his practices, until he is stopped by the law. Where is his moral responsibility? What does he care? His practice, only goes to show that he has no moral responsibility. *That lawyers should check such practices, is due to the profession, to the public, and to God. But before they take a case of malpractice, they ought to be convinced that there is malpractice.* It may be all very well to say that negligence is the gist of an action. If it cannot be shown that there is negligence, the case should not be taken, for when the case arrives at the courts, you must show that the defendant is guilty of neglect, and that is done by calling upon a physician who is able to say where negligence has been committed, and that he is guilty of it. This evidence is necessary; lawyers cannot get along without it.

Mr. Max F. Eller spoke of the *fact* that, for any action, as many "experts" could be obtained by one side as the other, provided enough money is paid for such expert testimony. Some will say, the patient should have been notified of the danger; others, that he ought not. Some will say, the chloroform killed him; others, not. For that reason, he thought that before making any more laws regarding the proper administration of anæsthetics, those which already exist should be administered in a better manner, and physicians should be a little more careful how they administer anæsthetics.

Mr. Eller, referred to the popular fallacy that chloroform could be used successfully for the purpose of effecting robbery. He thought, that that delusion ought to be dispelled, for the time between the actual administration of chloroform, and the period of annihilation of sensation, is sufficiently long to render the accomplishment of the object impossible. Such a plea is used by criminals, to shield themselves from the consequences of their own crimes.

A correspondent of the *Societe d'Hygiene et de Medicine Legal*, having been interrogated as a judicial expert, as to "whether the employment of narcotics, in the liquid, or gaseous state, can produce an anæsthesia so profound that violation of the persons to whom it has been given, may be perpetrated, without awakening them," gave an affirmative answer.

M. Dolbeau, apropos to his judgment, made a series of researches, the results of which were laid before the society. He limits the question to the employment of chloroform, and starts with the following proposition:

"*Can chloroform in vapor be administered to a person who is sleeping naturally, to the production of anæsthesia, without awakening him?*"

In M. Dolbeau's experiments, the chloroform was given in the usual manner, on a cone held an inch or so above the nostrils, so as to enable a constant view of the countenance.

In the first series of experiments, three patients out of four were awakened by the chloroform inhalations; in the second series, four out of six; in the third, only three out of nine.

It is not without interest to observe the increasing proportion of subjects anæsthetized; the manual dexterity acquired by the experiments is not without influence upon the results obtained. Accordingly, as a result of his experiments, M. Dolbeau believes himself authorized to formulate the following conclusions:

"Scientifically, it is difficult, but often possible, to cause insensibility by means of chloroform, in persons who are sleeping a natural sleep. Certain precautions—the employment of a perfectly pure agent, and experience—are also conditions which favor the attempt at anæsthesia.

"It is probable that certain subjects are absolutely refractory —that is to say, that it is impossssible to anæsthetize them, without taking every precaution. Others, on the contrary, particularly young children, submit easily to anæsthesia without having been awakened by the irritation produced by the anæsthetic agent in the air-passages.

"From a criminal point of view, it is certain that chloroform, administered to sleeping individuals, may facilitate the perpetration of certain crimes. It is, however, probable, that the conditions favorable to anæsthesia are rarely found on the occasion of criminal attempts. In justice, the expert should declare, that it is possible, but not easy, to render a person who sleeps so insensible by chloroform, that the said person might become the victim of any violence.

"The responsibility attending the use of anæsthetics is of great importance to medical men, as frequently their personal, and professional, reputation is at stake; it is therefore always better, in the administration of an anæsthetic *to a female*, to have some reliable person present. This is especially necessary, when ether, or chloroform, is employed."

During the early period of our medical career, soon after graduating, we had in our Quiz class a young, ambitious dental surgeon, one of the most gentle and amiable of men, who was desirous of obtaining the medical degree, which he ultimately attained. Soon after this the man was married, settled in this city, and acquired a large business. At that time it was common for the dentist to administer anæsthetics in their office, in the extracting of teeth, etc. He had a young female patient to whom he administered chloroform alone, and who afterwards stated that he had taken improper liberties with her person, during this state. This case caused great excitement in our city, and the public sympathy was with the young female, and a suit was instituted in which damages were claimed. The case was argued by distinguished lawyers on both sides, and voluminous testimony taken. The judge charged the jury, and the sentence was ten years' imprisonment. Subsequently the sentiment of the community changed, and it believed it was all the result of her vivid imagination, and that she was laboring under a delusion. The majority of physicians and dentists signed a petition, and the sentence was remitted.

It is stated by Taylor "That the vapors of ether and chloroform have been criminally used in attempt at rape. In a case which occurred in France, a dentist was convicted of this crime upon a woman to whom he had administered the vapor of ether." Now this may be just such a case as the one in our own city. Ether, from its disagreeable taste and irritating vapor, would be much more difficult to administer forcibly and against the will of a patient. The numerous stories of anæsthesia by simply placing a few drops on a handkerchief under a patient's nose or mouth, are in the majority of cases, perfectly absurd, as the shortest time required to bring a patient fully under the influence of either of these drugs—even when forcibly held in contact—is, from two, to ten minutes, and if subsequent rough handling takes place, the patient is at once roused to make resistance by struggling. We were once called to a woman who had been in the habit of employing chloroform by inhalation from a small bottle to cause sleep; she accidentally, when in a drowsy state, let the open bottle, drop on the pillow, and its contents saturated the covering, and she lay with her face in it. But instead of making her sleep soundly, it produced most distressing nausea, and her family were awakened by her efforts at vomiting, and so her life was saved, she not being able to arouse sufficiently, to get rid of the offending matter, which would have lodged in her trachea, or the contents of the stomach might have been brought into the bronchial tubes by deep inspiration, and thus have caused suffocation.

The former case in Philadelphia, settled the important point in the minds of medical men of this city, that this incomplete unconsciousness, does not, coexist with complete motor and sensory anæsthesia, and therefore anæsthetics are employed without any fear in all important operations. These observations, are in part corroborated, by two learned authors, in a recent and most admirable work, on medical jurisprudence, in which they state:—

"A question of some importance to the medical jurist naturally occurs here, namely: '*Whether chloroform can be administered for improper purposes?*' We know, however, that insensibility from chloroform, (and more slowly from ether) vapor, is only slowly induced. It would be difficult, therefore, to administer chloroform forcibly, and against the will, while, of course, the stories of immediate anæsthesia produced by it, are but idle fables. Still, it might be administered to persons asleep, without much difficulty, and this seems the only possible condition under which it could be conveniently used for improper purposes, unless considerable force was employed to prevent the person struggling, which, under ordinary circumstances, would be an almost insurmountable difficulty to its use."

The following case (reported in the *Philadelphia Medical Times*, December 22d, 1877), which occurred in England, more completely confirms our own observations and experiments on this important subject:—

"A case of the utmost importance to the whole profession, not in Great Britain only, but everywhere, was tried before Mr. Justice Hawkins, at the assizes, at Northampton, on the 9th of November. It was a charge against a surgeon's assistant of criminal assault—of rape upon a patient, when under the influence of chloroform. If there is a dastardly crime, it is to take advantage of a woman's helpless unconsciousness to violate her person. And so the magistrate thought, who sent the accused to jail on the 14th of September, declining to hear anything in his favor, and resolutely refusing to accept bail. The charge was, that a married woman, named Child, went to the surgery of her family medical attendant, to have her teeth operated upon. She had been there a day or two before, but the attempt to put her under chloroform then failed. A second attempt was rather more successful. She evidently had some peculiarities, or idiosyncrasies, in relation to chloroform, for he gave it for an hour, and yet she was never sufficiently under its influence to admit of the operation being performed. She was accompanied by a friend—a Miss Fellows. At the end of the hour, Miss Fellows went out of the room. In a quarter of an hour Miss Fellows returned. The prosecutor maintained, that on Miss Fellows' return, she was quite conscious, but unable to speak. Finding it impossible to perform the operation, the accused accompanied the prosecutrix, and her friend home. So far Mrs. Child had been unable to speak, but shortly after the accused left the house she complained to her husband that he had taken advantage of the absence of Miss Fellows, to assault her criminally. Next day, when the accused called, he was told about what she had said, and he replied that she was laboring under a delusion. Under cross-examination, Mrs. Child said, that she told the accused that if he would admit the offence and quit the town (Birmingham) she would forgive him. This the accused declined to do, denying that he had committed any offence. He was then given in custody. The prosecutrix stated that the offence was perpetrated immediately after Miss Fellows left the room; that the prisoner went upon his knees, and then assaulted her. Miss Fellows stated that on her return, she found Mrs. Child in precisely the same position in the chair which she occupied when she went out of the room. Such were the facts of the case. It was quite clear that there had been either an assault committed, or that the woman was under the influence of a very pronounced delusion. The whole of the accused's conduct was in favor of the latter hypothesis. But in such a matter, where no third person was present, the statement of one of the two parties concerned must be taken. When a woman whose character was apparently without blemish, (for in cross-examination no attempt was made to call her reputation in question) makes a definite charge against a man, of assaulting her under circumstances which permitted of such an assault, the law could only send the case to a jury. In the meantime the unfortunate surgeon's assistant, was sent to prison.

"When the case came to be tried a large number of medical men of repute came forward voluntarily, to aid the accused's defence, and did this quite gratuitously. The chief witness for the defence was Dr. B. W. Richardson, F.R.S., whose celebrity is world-wide. As is well known, Dr. Richardson has studied anæsthetics very carefully, and for many years. He stated that there were four stages, or degrees, in which chloroform operated. The first stage was that in which consciousness was not lost; there was resistance and a desire for air. In the second, consciousness is lost, but the operation is impossible, the patient screaming, often without provocation. The third stage, is that of complete unconsciousness, and where all rigidity is lost. This is the stage which permits of operation. In his opinion, the patient was in the second stage; the third, never having been reached. He stated, that in his own experience, he had known persons in this second stage, to have delusions as to what had taken place during that time. He related a number of cases, and stated, that the fact of such delusions being induced by chloroform, was one of the earliest objections raised to its adoption. He related one case, where the patient, a female, was being operated upon by a dentist, and alleged that the dentist criminally assaulted her. And this she persisted in, though her father, her mother, Dr. Richardson, and the dentist's assistant were all present, throughout the whole time. She persisted in her conviction long after the effects of the chloroform had passed away; and Dr. Richardson said she was probably of that belief still. This evidence of Dr. Richardson's, was corroborated by the experience of Dr. Hawksby, of

London, and by Dr. Saundby, and Mr. J. F. West, of Birmingham. The judge asked the jury if it was necessary to sum up, and they replied it was unnecessary—they were already agreed upon a verdict of acquittal. Mr. Justice Hawkins pointed out that such a verdict would not be the slightest imputation upon the absolute sincerity of the prosecutrix, who, no doubt, firmly believed every word of what she had said. He then congratulated the accused, upon having had an opportunity of fully vindicating himself from the charge preferred, and said that the verdict of acquittal did not mean that there was insufficient evidence, but that the accused was entirely cleared of any imputation in respect to the charge preferred against him. There could be no doubt the prosecutrix labored under a delusion. The accused was then discharged from custody, having been in prison two months for no offence. It is not merely that this unfortunate man was imprisoned for two months for an imaginary offence, but that any man who is present when a woman is being put under chloroform, is liable to have the same charge brought against him, that gives this case its gravity and importance.

"Such being the case, it becomes necessary that a little more should be known amidst the profession, as well as the laity, as to the occurrence of erotic sensations in woman. The subject is not a pleasant one, but that is no reason why it should not be investigated. If it is a fact, and there is no doubt about this, that women, when being put under chloroform, are liable to those erotic sensations which they experience from sexual intercourse, the sooner the fact is generally known, the better. It is just the mystery which surrounds such facts, that permits such a monstrous hardship as that mentioned above, to be a possibility at all. Of course it is obvious enough to any one, that it is a delicate matter to inquire into the subjective sensations of women. But, if these subjective sensations take the practical form of a charge of rape, two months in jail, and a trial by jury, they pass from the domain of sentiment, and enter that of stern reality. Few, comparatively few, of the profession seem to be aware that women are subject to conditions and sensations, identical with those associated with the sexual act, which arise quite subjectively and without any extrinsic stimulus. The delusion of St. Catharine, that the devil visited her every night, and enjoyed her person when she was asleep, and could offer no resistance, is no unique experience, but one common enough to women. Every one familiar with asylum work, knows that a certain percentage of women patients have this delusion, among others, that the medical superintendent comes nightly to their bed, and violates their person during sleep. Of course there is no foundation of any kind for such delusions, except the subjective sensations of the woman herself. How strongly such a delusion, however, may be fixed in a woman's mind, is evidenced by the case related by Dr. Richardson, where the woman persisted in her belief, though her own father and mother, as well as others, were present, and where such assault was physically impossible. Such being the case, it behooves every man who is to be present with a woman when she is to be placed under chloroform to see that there is at least one other person present, and that, too, the whole time, without intermission, during which the woman is under the influence of chloroform, and that such other precautions be taken as will preclude the possibility of such a charge being raised. That Mrs. Child charged this unlucky man in good faith, need not be questioned for a moment. She was far from being hostile to him, for she offered if he would avow his guilt and leave the town, she would forgive him. The charge was not pressed from any rancorous spite; that is abundantly clear. But it is equally clear that something had occurred to that woman which she interpreted into the sexual act, and that this was so firmly fixed in her consciousness, that it could not be dislodged. It becomes necessary, then, that the subjective sensations of women should be investigated, and made the subject of scientific observations; and seeing that they exist, they must have a scientific value; and that no prudishness should prevent attempts being made to ascertain what the actual facts are, and what is their interpretation."

The following is the experience of Dr. N. L. Folsom, of Portsmouth, New Hampshire, in the same line :—

"In 1854, a clergyman's sister came to my office for the purpose of taking ether and having a tooth extracted, and brought her brother's wife with her. I began to administer the ether to the patient, and whilst renewing it she got away from me, and seemed alarmed and offended. I did not attempt to compel her to breathe any more ether, but urged her to take it, and so also did her brother's wife, but she would take no more. She had the impression, so her brother told me, that I attempted to violate her, and that his wife assisted me. It was a long time afterward before she would fully give up that she was mistaken in the matter."

We are almost certain, after a number of careful experiments, that chloroform and ether can be administered in sleep, so as to produce the first stage of anæsthesia, and can be carried to full completion or total unconsciousness. Still, this is rare without disturbing the patient's stomach, causing nausea, or irritation of the lungs, with risk of sudden death, by its dense vapor, and thus rousing him or her to consciousness, or a condition in which the patient can resist its influence if the party is willing to make the effort. Another important point is, that loud talking or handling, even in some cases the slightest touch or pain in any way, will cause the patient to start and rouse him to resist. In the case of ether the patient can almost always see indistinctly, and in some instances is able to talk during the anæsthetic state.

Attention has been directed by Dr. J. M. Quimby, of Jersey City, N. J., to certain facts, connected with the use and abuse of chloroform, and from these facts inferences have been derived which may be interesting and instructive to the profession.

He states, "that in consequence of the recent murder of policeman Smith, in Jersey City, while he and his wife were supposed to be asleep in bed, his wife was arrested as a *particeps criminis*. She denied the charge, and asserted that she had been chloroformed during sleep, and therefore was innocent of the crime.

"The State denied this, and contended that it was *impossible* for her to have been chloroformed in that way; that the fumes of the chloroform would have certainly awakened her from her *natural sleep*, and *therefore she must have known who the murderer or murderers were.*

"Here, then, as will be seen, arose a very *nice* and *important* medico-legal question, viz.: whether a person could be chloroformed whilst in natural slumber without first being awakened, or, in other words, whether the application of chloroform, properly given, would awaken the person to whom it was applied; or, could such person pass from the natural to an artificial sleep (or chloroform sleep), without being aroused by its application?

"Mrs. Smith asserted, most positively, that she was chloroformed while she was asleep in bed with her husband, and knew nothing about the murder, until she awoke in a bewildered condition, feeling the cold elbow of her husband pressing against her side. It may be stated here, that there was found in the room of the murdered man a bottle partly filled with chloroform, and a folded towel with bloody finger-prints, which Mrs. Smith asserted was upon her face when she awoke. She also described, quite accurately, the taste, smell and pungency of chloroform.

"Without going into further details, the counsel for Mrs. Smith applied to me to know if it were possible to transfer a person from a natural to an artificial sleep by the use of chloroform without first arousing the sleeper from his natural slumber? I replied, that I had never attempted the application of chloroform to a person while in a natural sleep, and that books, as far as I knew, were silent on that point; although I thought there would be no difficulty, if proper care were taken in administering the chloroform, in transferring a person from the natural to an artificial sleep.

"I was strongly urged on the part of Mrs. Smith's counsel, and in behalf of humanity and justice, to settle by experiment this disputed question. To accomplish this result I made the following experiments: I made arrangements with Mr. A., to enter his room in an hour or two after he had retired, and when he was asleep apply the chloroform; which I did with entire success—transferring him from the natural, to the chloroform sleep without arousing him from his natural slumber. I used about three drachms of Squibb's chloroform, and occupied about seven minutes in putting him to sleep. The second case was a boy, æt. 13, who was suffering from an ingrowing toe-nail. He refused to allow me to touch him with knife or forceps without etherizing him; and when I attempted to apply the ether, he screamed and struggled so desperately that his mother became frightened, and asked me to desist from giving him ether. In this dilemma, I advised the mother to take the boy home and put him to bed with a light supper, and I would call at the house between nine and ten o'clock that evening, give him a little chloroform, and remove the nail without the boy knowing anything about it.

"I called at the time agreed upon, with my friend, Dr. Cahill, and found the boy quietly sleeping. I applied the chloroform, divided the nail in the centre, and removed the two segments by the application of forceps, without awakening the patient, or his having any knowledge of the operation until next morning when he awoke, and, discovering the condition of his foot, remarked, that had he known 'it would not hurt any more than that, he would have had it taken out at the office, and was ashamed that he had made such a fuss about it.'

"Case No. 3, was a boy, æt. 10, who was brought to my office suffering from a swelling over the lower jaw, which proved to be an abscess due to decayed teeth ; but the boy would not let me come near him with either lancet or forceps; so, as in previous cases, I advised his mother to take him home and send him to bed with a light supper, and that I would call at the house after he got asleep, administer the chloroform, open the abscess, extract the teeth, and he would know nothing about it; all of which I did, without arousing the boy.

"I remained with the patient about one hour after the operation, to attend to any hemorrhage that might occur, and to observe if any change would take place when he would pass from his artificial to his natural slumber again.

"Finding there was no change in that time, I left, requesting the parents to watch him, and let me know exactly at what hour he awoke.

"When I called next morning, they reported that he awoke at six o'clock, exclaiming, 'I must have swallowed my teeth, for they are both gone!'"

"BEWARE OF CHLOROFORMING WOMEN WITHOUT AN ATTENDANT!—At Oakland, Cal., during July, 1880, a bank-teller, named E. F. Schrœder, killed Dr. Albert Lefevre, a prominent dentist of that place. It appears that Mrs. Schrœder went to the train on the day of the shooting, to meet her husband. Mrs. Schroeder told him, that on the Saturday previous, while under the influence of chloroform in Dr. Lefevre's office, the dentist made a felonious assault upon her. Schrœder at once proceeded to Dr. Lefevre's office, and committed the tragedy. It is believed that Mrs. Schrœder's charge against the dentist is purely illusory. Such hallucinations are not uncommon after chloroform administrations. Some remarkable cases exist, where hallucinations of this nature have taken the form of absolute conviction in the minds of persons laboring under them, although there exists abundant evidence to prove that this conviction was utterly unfounded. The coroner's jury rendered a verdict charging Schrœder with murder. We know of an instance, in which the presence of a third party, saved a like imputation against the character of an innocent practitioner. The lady herself beyond reproach, still had such an illusion, after recovering from the administration of the chloroform."

"PROSECUTION OF A DENTIST.—At the Manchester Assizes, before Mr. Justice Day, an action was brought against Mr. James Jackson, a dentist, of Burnley, in which the plaintiff, Mr. Robert Jackson, farmer, sought to recover damages for the alleged seduction of his daughter, while under the influence of nitrous oxide. There was also a cross-action for slander brought against the plaintiff. The trial occupied nearly three days.

"His Lordship, in summing up, said the one substantial issue for the jury was, did James Jackson, the dentist, or did he not, administer gas or some narcotic to the young woman, Margaret Ann Jackson, and did he, while she was under the influence of some anæsthetic, criminally assault her? That was the question they had to determine, and it was a question of the very gravest moment. The consequences to the one side, or the other, must necessarily be of the most serious character. The charge which was made against the dentist, was one of assault, under circumstances of the most aggravated and nefarious nature. The charge, on the other hand, of which the woman would be guilty, if she had made a false accusation, was one of the most wicked, odious and vile, that could be brought by one human being against another. The case was one of a most extraordinary character, and one which, he was happy to think, was very rarely raised in a court of justice. It was one which demanded at the hands of the jury, as he knew it would most assuredly receive, their deepest and most anxious attention, so that to the utmost of their ability they might do justice between the parties. He did not hesitate to say that the question was of an extremely difficult character, but it was one which he was confident the jury would, using their own good sense, solve to their thorough satisfaction; and if they did solve it to their satisfaction, it should be satisfactory to all well-minded people. He would say nothing about damages, because it was unnecessary. The parties probably were none of them in a position to pay damages. That, however, was utterly unimportant, and should not affect the amount of damages. It was unnecessary for him to say a word about damages, because he should not venture to put any limit upon the damages which they might award, to either one side, or the other.

"The jury retired to consult on the case, and after deliberating for three hours, returned to court, and stated that there was no possibility of their coming to an agreement. The judge thereupon discharged them."

Chloroform—Its Action as a Poison.

Chloroform is an irritating poison. In a case quoted by Taylor, an individual swallowed four ounces. He was able to walk a considerable distance after taking this large dose, but subsequently fell into a state of coma. The pupils were dilated, the breathing was stertorous, the skin cold, pulse imperceptible, and there were general convulsions. He recovered in five days. (*Medical Gazette*, vol. 47, page 675.) A second case reported, swallowed nearly two ounces and recovered; and a third swallowed two ounces, but he died in six hours afterwards. In this case, the pupils were fully dilated, the breathing was stertorous, and the skin covered with a cold perspiration. On inspection, the lungs were found much engorged with blood, and there were some apoplectic effusions in these organs. The stomach was slightly inflamed in patches, and the mucous membrane was softened. (*American Journal Medical Sciences*, October, 1866, page 571.)

A physician æt. 57, swallowed three ounces of chloroform. He immediately began to stagger, as if intoxicated. He vomited, and sank into a deep stupor, and was in a state of complete anæsthesia. His skin was pale and tolerably warm; the muscles were relaxed, the breathing short, and the action of the heart weak and intermittent. In about fourteen hours sensibility returned. Acute gastritis ensued, with rapid collapse, and proved fatal in twenty-nine hours from the time the chloroform was taken. (*American Journal Medical Sciences*, January, 1870, page 276.)

Treatment.—In poisoning from liquid chloroform, the stomach pump, and emetic should be resorted to. If evidence of suspension of the action of the heart (syncope) exists, there should be a free exposure of the face to a current of air, compression of the chest and artificial respiration, warm applications to the chest, with an inversion of the body, active friction, and stimuli externally, and by the rectum. The poles of a galvanic battery applied to the chest and side of the neck, with sponges dipped in hot water, should be used. Solution of ammonia in water, has been found useful, when injected hypodermically, and strychnia in the same way, to act upon the respiration. Aromatic spirits of ammonia must be given, and great care taken of the gastritis, and disturbance of the liver, which are apt to follow in the convalescence of the patient.

CASE OF POISONING FROM CHLOROFORM TAKEN INTERNALLY.*—"In December I was attending Louise R., six years of age, for measles. The characteristic symptoms were wanting, and the child was rapidly returning to health. As she seemed more feverish than usual on the afternoon of the sixth, the mother determined to give the patient a dessertspoonful of the fever mixture I had ordered some days before. By mistake, she gave the child a dessertspoonful of Squibb's chloroform. No sooner had she done so than the odor made her aware of the substitution. Messengers were immediately dispatched for any physician that could be found, and the husband started for my office. Unfortunately I was not at home. Arriving soon after, however, I drove quickly towards the house. On the way I met my friend Dr. H. H. Barker, who had been to see the patient, and was returning to his office for his galvanic battery. Having procured it, we drove hurriedly to the house of my patient. We found there Drs. Wolhaupter, and Adams, who were endeavoring to promote respiration. An emetic dose of sulphate of zinc had been given, and the child had vomited freely. She had been placed in a hot mustard bath, and they had endeavored to make her swallow several teaspoonfuls of whiskey.

"Despite all this, however, she seemed to be sinking rapidly. Her respiratory efforts were very feeble, her heart-beats scarcely perceptible, the conjunctiva was not responsive, her teeth were clenched, her limbs fell listlessly where placed, she made no movement, uttered no sound, the loudest cry failed to elicit a response, she was cold and nearly pulseless—in a word, death seemed imminent.

"Dr. Barker having prepared the battery, Gaiffé's, one pole was applied in the cervical region at the anterior surface of the sterno-cleido-mastoideus, the other was drawn along the course of the phrenic nerve. Every muscle of the chest and abdomen was made in turn to feel the electric current.

"For five minutes, this was done, without any perceptible

* By T. E. McArdle, A.M., M.D., Assistant Surgeon, Children's Hospital, Washington, D. C.

change in the child's condition. But soon her pulse began to be distinguishable at the wrist, her respiratory muscles began to act emphatically, her breathing could be discerned, her eyelids closed on touching the conjunctiva, she sat up and threw away the electrodes, when we forced them into both her palms.

"Again, though, she immediately dropped off into a heavy slumber, and once more more the battery had to be applied. After half an hour of constant application, she was sufficiently conscious to reply to her mother's questions. We then desisted from our efforts, prescribed some stimulant, gave cracked ice, and kept the patient awake. I ordered a mustard plaster to be placed over the epigastrium, which was done during the night, whilst she was asleep. She slept well, and experienced no untoward symptoms afterwards."

The Chloroform Habit.

Apropos of this habit, which seems to be on the increase in this country, we note the conclusion of an article on the subject, by Dr. A. G. Browning in the *Med. Record*, April 25th. He says: "The man maudlin drunk, on the meanest whiskey, however revolting, is a prince compared with such! For he *was* jolly once; the chloroform drunkard never!

"But it goes further: the process is one of thorough emasculation—death, with geometrical precision, to every function; somatic death, with no incidental solemnities, and but a shadow for final sepulture. Every physiological process, without exception, goes down in the wreck. So surely is this so, that were I commissioned to destroy my kind—to sap their morals, dwarf their intellects, wither their physique, and stop reproduction, the habitual use of chloroform, as I have known it practiced, would leave nothing to be desired.

"I know whereof I speak; do not overdraw, nor can I think my experience, wholly exceptional upon a more general comparison of notes.

"In this rambling communication, I have aimed at nothing but a narration of facts--no attempt at theory, or speculation. I will add here, that in nearly every instance, the chloroform habit has seemed to replace the appetite for drink. I mean that the craze for chloroform has developed, in nearly every case, in individuals who, though strictly temperate themselves, come of a line of drinkers, more or less remote. Is this a matter of hereditary descent?—another evidence that the 'sins of the fathers are visited upon the children, even to the third and fourth generation?' Temperance reformers may make a note."

Ungar (5 *Cent. für Chir.*) reports, as a result of his investigation, pursued since 1883, that the inhalation of chloroform produces fatty degeneration of the heart, of the diaphragm, and other striated muscles, and also of the parenchyma of the liver, and kidneys. He is of the opinion, that protracted inhalation of chloroform vapor, during tedious operations, may thus produce a state of weakness, in which a second inhalation may prove fatal, though the patient apparently tolerates the first inhalation, without dangerous symptoms.* For this reason, he opposes the use of chloroform in normal child-birth. The Philadelphia County Medical Society, has recently recorded its opinion that "the administration of ether is not only necessary and proper when pain is to be implicated upon patients with cardiac lesions, but lessens the dangers incident to operations, provided that due care be taken during the administration of the anæsthetic, and proper regard be paid to its after-effects."

Use of Morphine with Chloroform.

He quotes the statement of Filchne, that when chloroform or ether is inhaled by dogs, to whom morphine has been previously given, Cheyne-Stokes breathing results.

Hewitt believes, that the effect of morphine may frequently serve to enfeeble respiration, and thus to bring on a fatal result, which might have been averted if morphine had not been used.

Mixed Anæsthetics.

The various mixtures of chloroform with ether and alcohol, were used as means of escaping the danger of chloroform.

* Snowder Hewitt's Anæsthetizer (*British Med. Journal*).

They first received their impulse, from the report of the Chloroform Committee, of the Medical Chirurgical Society, of London, who declared their superiority in point of safety. M. Perrin, gives an account of the first death, known at that time to have taken place under a given mixture of ether and chloroform, and gives the credit to the chloroform, as being improperly administered, and Snow says, the patient died of hemorrhage; but our reading of the case, carefully reported by Dr. R. Crockett,* leaves the decided impression that chloroform arrested the heart's action, inducing vomiting, and caused a stoppage of respiration. The following is an abstract of the important facts in the case, and is interesting as the first death from the mixture :—" A sprightly little boy, five years of age, was brought to the doctor to have a fatty tumor removed from his back. The tumor, commencing at a point at its inferior termination, opposite the last rib, about two and a half inches to the right of the spinous processes, and extending obliquely upwards, crossing the spine seven inches, required two elliptical incisions, nine inches long, for its removal." The operation was commenced at 9.30 A.M., April 4th, and the dissection was rapidly executed, stopping to ligate a large artery, that was early divided; the remaining arteries were compressed as they were divided. The tumor was quickly removed, and a ligature applied to the last artery, being the sixth in number. While sponging the wound, the boy begau to vomit, and on examining the wrist, he was found to be pulseless. Dr. K., who had charge of the anæsthetic and pulse, replied that " the pulse had never given way until he began to vomit." He ejected a small portion of the contents of the stomach. He was immediately placed in the " prone position," as recommended by Dr. Marshall Hall; the finger was introduced into the mouth to be certain that the tongue had not fallen back so as to obstruct the glottis, or the entrance of air into the wind-pipe, and the extremities were rubbed with aqua ammonia. The patient died, three or four minutes from the commencement of the vomiting. " He lost probably four ounces of blood, certainly not exceeding six." There was no *post-mortem* examination.

* *Am. Jour. Med. Sci.*, July, 1857, pp. 284–5.

The anæsthetic used was a mixture of washed ether, four parts, and one of chloroform, obtained from the late Frederick Brown, of Philadelphia, whose character is a sufficient guarantee, that they were pure. Every preparation for the operation having been made, the administration of the anæsthetic was commenced by Dr. Crockett, observing all the precautions so fully recommended by Erichsen, p. 78, of his "Operative Surgery." As soon as anæsthesia was induced, the sponge was confided to Dr. Kincannon, who held his finger all the while on the patient's pulse. The doctor concludes, "I have lately employed this anæsthetic freely, formerly having used ether alone. *As yet I have not seen a case of death reported from ether*, or this mixture of it with chloroform, that I can now recollect. Are there any such reported? I fear all the deaths from anæsthesia are not reported." Five deaths from the use of this mixture have been published, two having occurred very recently.

The chief object of these anæsthetic mixtures, is, the avoidance of the danger from *shock*, or from the depressing influence upon the heart-action, which chloroform most certainly exerts, and which ether and alcohol prevent. The committee before referred to proposed the following mixtures:—

A.	Alcohol	1 Part
	Chloroform	2 "
	Ether	3 "
B.	Chloroform	1 "
	Ether	4 "
C.	Chloroform	1 "
	Ether	2 "

Dr. Sansom's mixture* is equal parts by measure of chloroform, and absolute alcohol. The introduction of alcohol, which plays an important part in the mixture, was, according to the doctor, due to Dr. Harley. The committee says, it is by "the uniform blending of the ether and chloroform, when combined with alcohol, and probably the more equable escape of

* Chloroform: Its Action and Administration. By Arthur Sansom, M.B., London.

the constituents in vapor." The chloroform is the potent agent, and the others chiefly coadjutors, vehicles and diluents of the chloroform.

Dr. Sansom gives the following testimony, as to the stimulating effects of alcohol, in counteracting the depressing influence of chloroform: "In my own experiments, I have found that alcohol has had the greatest effect, in sustaining the heart-action during the influence of the chloroform. I can particularly recollect one instance, in which alcohol was administered in vapor to a frog, after it was impossible to cause death by any strength of chloroform vapor." In recommending this mixture before the Obstetrical Society of London, Dr. Sansom went one step farther, and stated that this mixture gives off a proportion of chloroform vapor in a given time almost exactly half of that which is given off by chloroform pure and simple. The result is not confirmed by any experiment of his published.

What are the objections to anæsthetic mixtures?

1. The length of time required for the production of complete anæsthesia. 2. The probability of entire sensibility not being abolished. 3. The unequal rate of evaporation or vaporization of the fluids.

There is not any doubt, but that the process is slower and attended with more excitement by the mixed fluids, than by chloroform alone. The second objection cannot be sustained. The third is the "element of danger." It was first advanced by Snow. He says: "When ether is combined with chloroform, the result is a combination of the undesirable qualities of both agents, without any compensating advantage," and the danger is because the operator, toward the end of the peocess, may be giving a pure chloroform, when he thinks he is giving the weaker mixture of vapors. Dr. Ellis, endeavored to prove this, and states: "Out of the six or seven minutes occupied by the evaporation of the half drachm of fluid, the first was occupied chiefly by the ether, the next three by the chloroform, with a little alcohol, and the last by the alcohol alone. In an inhaler, the patient would have breathed, for one-fifth of the time, chiefly the vapor of ether, for the next three-fifths, that of chloroform, with a little alcohol, and at last, only the vapor of a minute quantity of alcohol." These results, are not stated as obtained by actual experiments, and they depend, first, upon the purity of the agents employed; second, upon the boiling-point, which has a great influence upon the results, for the more volatile the fluid, the greater will be the variation. We here give the boiling-point of the most important anæsthetics.

The temperature which is constant for the same substance, under the same atmospheric pressure, is called the *boiling-point.*

The following are the agents employed as anæsthetics in the form of vapor, the boiling points being given for the mean pressure of 760 millimetres:

Protoxide of nitrogen	—88°
Carbonic acid	—78°
Chloride of Ethyl v. pure ether	+11°
Ether	35°
Chloroform	63°
Alcohol	78°
Oil of turpentine	157°

A difference of pressure of 0.25 centimeter, will cause a difference in the boiling of water one-tenth of a degree. The boiling-point is also influenced by dissolving in a fluid a substance more volatile than itself, (as ether and chloroform); it increases the boiling-point, in proportion to the amount dissolved. The temperature of the atmosphere has a powerful influence on these volatile agents, as it is a well-known chemical fact, that the saturability of the air, increases vastly with the increase of temperature, and the capacity of the air for aqueous vapor, is doubled with each 27° of temperature Fahrenheit. Sulphuric ether at 60° F., and thirty inches of the barometer expands two parts of the air into three, and forms, therefore, at that temperature, and pressure, one-third of the air inhaled into the lungs of a patient. Under the same circumstances, chloroform expands fourteen parts of air into fifteen, and consequently the vapor of chloroform constitutes one-fifteenth part of the air inhaled.

The following experiments were made October 30th, 1878, so as to determine the time required for each of the agents to evaporate on a given surface of tissue-paper, suspended in the air at a temperature of 70° F., one drop of each being carefully measured by the same dropping machine. The time was accurately kept by Dr. C. S. Turnbull, son of the writer, and the results served to confirm the rough experiments made before the Dental Convention at Washington, D. C., on October 10th, 1878, and proved the facts stated in the author's first edition of this work. We have always found that when such a mixture was poured upon the inhaler, the most volatile spirit would rise first, then the next, and so on, leaving the least easily evaporated upon the inhaler. Another important fact was proven, and which was before referred to, that the alcohol employed in the mixtures with chloroform in England, also the ethers made from such alcohols, are much inferior to those made in this country from grain, not from wood, potatoes or other agents. These latter are slow in evaporation, and are mixtures themselves containing a large amount of carbonaceous products.

The following are the results obtained after numerous experiments with as many of the agents employed in the various mixtures, and obtained from the reliable establishments of Powers & Weightman, Bullock & Crenshaw, Wyeth & Bro., and J. P. Remington:

Alcohol, absolute 95° (W. & Bro.)	1	min.	24	seconds.
Alcohol, common (W. & Bro.)	10	"	00	"
Chloroform (P. & W.)	00	"	24	"
Ether (Squibb's)	00	"	12	"
Ether, common, 0.750 (P. & W.)	00	"	24	"
Ether, Hydrobromic (R.)	00	"	12	"
Methylic alcohol (B. & C.)	1	"	00	"
Potato spirit* (B. & C.)	12	"	00	"

Temperature, 70° F.

Barometer, 30.08. Time, 2 P.M.

Besides the danger from inhaling the ether pure and simple, there is another to be prevented—that is, to get rid of the watery vapor, from the mixture and also from the lungs of

* Passed through charcoal by W. & Bro.

the patient, which collects on the sponge. If the napkin or inhaler gets close to the patient's mouth, and nose, it will most effectually prevent air from reaching the lungs. How is this to be prevented? By squeezing out the sponge, napkin, lint, or if an inhaler is employed that cannot thus be treated, casting it aside, and taking a clean napkin, with as much starch in it as possible, so as to keep it in shape. It may again be inquired, which is the best mixture to employ in ordinary surgical operations when it is absolutely necessary to employ such mixtures. The mixture C, in midwifery. Mixture A, or, as it is familiarly known, A.-C.-E. or "ace-of-spades mixture," the most agreeable of all. In the operation for ovariotomy, we prefer the C mixture, as also advised by the late Dr. Washington Atlee; the volumes of the two agents are so different that they ought to be mixed by weight, not by measure, else chloroform will be much in excess, as it is a little over twice the weight of ether. In employing alcohol, it should be as near to absolute, as possible, and free from color, smell, or taste. The ether should be almost anhydrous, pure, full strength, and well washed.

Dr. Atlee, was of the opinion that there is a chemical union of the ether, and chloroform; and Professor Maisch, of this city, found that, if this mixture was exposed to the light, a change took place which rendered the mixture not fit for the purposes of inhalation; it therefore should be kept from the light, and mixed just before being employed.

Perfectly dry chloroform decomposes but slowly, even in direct sunlight; but the presence of water, which always exists in alcohol, and ether, and the action of light at the same time, causes chloroform to decompose into formic and hydrochloric acids. $CHCl_3+2H_2O=CH_2O_2+3\ HCL$.

We have had charge of the anæsthetic mixture (one part by measure of chloroform, and two of washed sulphuric ether), in an operation by Dr. Washington L. Atlee, during the successful removal of an ovarian tumor, weighing forty pounds, and have also assisted him in three cases, in which others gave this same mixture, with good results, and with no apparent risk to the safety of the patients.

Dr. Atlee always administers the anæsthetic, after the patient is upon the operating table, and one individual has charge of, and is responsible for, it. In his three hundred ovariotomies, he informed me, he had never lost a patient by the anæsthetic.

The mixture is given, in almost every instance, by means of the starched towel.

The following experiments were made, to determine the action of ether and chloroform when mixed: When ether and chloroform are mixed, there is an elevation of temperature, and the greatest heat is produced when the mixture is made in equivalent proportions; that is, by weight, about nine and one-quarter parts of ether, to thirteen and one-quarter parts of chloroform. As the chloroform is more than twice as heavy as ether, the volumes would be about one and four-tenths chloroform, to two of ether. But little contraction in volume takes place, and it may be considered that molecular combination takes place, between the chloroform and ether. The mixture begins to boil at fifty to fifty-one degrees C., and may be separated into its constituents by fractional distillation; but when allowed to evaporate spontaneously, as when used as an anæsthetic, both liquids pass into vapor simultaneously.

Whatever mixture is employed, nothing will obviate the necessity of care in the administration, and above all, do not give more of the agent than is absolutely necessary to keep the patient free from pain; not one drop more, for, like all potent medicines which we employ, an excessive dose is sure to kill, and unless we have before gauged the patient's powers, let caution be our guide in the administration of so powerful an anæsthetic. In our anxiety to see the various steps of an operation, we must not saturate the sponge or lean over the patient, and by accident suffocate him. It is, unfortunately, too much the practice to intrust the inhaling apparatus to some inexperienced hand, who, perhaps, never before administered an anæsthetic, and even in some hospitals, to the youngest assistant surgeon, or dresser. It has been well observed by Perrin: "We believe we shall render a veritable service, if we popularize the idea, that anæsthesia should be observed, and studied at the hospital, with as much care, as every other subject of practical medicine." Sansom also says, "The administrator should be experienced; several hospital committees have acted wisely in appointing a chloroformist, a measure which is not of less value to the operating surgeon, than it is to the benefit of the patient. One who administers chloroform in any case, should confine himself exclusively to the task he has undertaken, and should constantly mark the symptoms." What are the symptoms of danger? The failure of the pulse, irregularity of the respiration, and the blanched countenance, and, as beautifully expressed by an old writer in reference to successful administration of anæsthetics: "Proceed steadily but cautiously to the end in view. He who makes haste slowly, and with a boldness tempered by wisdom, carries his patient down into the dark valley which borders on death, drowns human agonies in the water of Lethe, and triumphs in the crowning glory of his art."

Mixed Anæsthesia in Ophthalmic Surgery.

This method of producing anæsthesia, by the combined administration of narcotics, and anæsthetics, was originally recommended by "Bernard of Paris," who founded it upon experiments on animals, and his results were confirmed to a certain extent on man; but it has never been successfully employed or recommended either in England, or this country, as morphia will frequently produce vomiting or depressing symptoms in certain individuals. Mr. Ernest Hart, in some recent notes on "Medical Paris," states, that for the last ten years, the method has been used at the Sorbonne, in anæsthetizing animals for experimentation, and without a single accident, whereas with the ordinary method, the mortality from chloroform, was one animal in three, and sometimes even greater.

The mixed method, as generally used in the human being, consists in injecting hypodermatically from $\frac{1}{6}$ to $\frac{2}{5}$ gr. of morphia and $\frac{1}{192}$ to $\frac{1}{80}$ gr. of atropia, from fifteen to twenty-five minutes, before the inhalation of the anæsthetic, just long enough for the effect of the narcotic to be fully feit by the nervous centres.

"The selection of the *anæsthetic agent* in ophthalmic surgery, is a matter of considerable importance.* But for its liability to occasional death, there is nothing which combines so many advantages as pure chloroform; but this liability is enough to neutralize them all. Chloroform kills, in round numbers, about one in every three thousand, of those to whom it is administered, and there ought to be no deaths in ophthalmic surgery. If experience has made anything certain, I think it is, that the fatal accidents from chloroform have occurred, in the very cases in which there was no reason to anticipate them. I sometimes use it when I am short-handed, and when the administrator is comparatively unskilled in the use of anæsthetics, because I think it is then as safe as any other, and is more easy of administration, and more likely to be effectual than any other. Excepting in such conditions, and in the case of young children, in whom the danger to life from its effects seems to be almost infinitesimally small, I think it ought to be banished from surgery. Pure ether is an admirable and very safe anæsthetic; but it requires a boldness and freedom of administration which are only attained by practice, and, if imperfectly given, it is utterly inefficient for the purposes of the ophthalmic surgeon. Moreover, it is apt, especially if tardily and ineffectually administered, to produce a free secretion of bronchial mucus, which occasions troublesome, and unrestrained coughing, and sometimes leads to sickness. When nitrous oxide gas is administered as a prelude to ether, the secretion of mucus is less likely to be troublesome; but a great amount of venous congestion is always produced, and the tissues become so gorged that every incision bleeds freely. In the performance of iridectomy, under gas and ether, we not only have an unusual amount of bleeding from the conjunctiva, or from the vessels of Schlemm's canal, if these should be divided, but we also have a large effusion of dark, and unoxygenized blood into the anterior chamber, from the cut edges of the iris, and this blood, as already incidentally mentioned, is prone to act as a

* Dr. Carter, London.

foreign body, and to excite troublesome, and possibly very injurious iritis.

"Judging from Dr. Carter's opportunities of observation, he is inclined to believe that the best anæsthetic, for general use in ophthalmic surgery, is the mixture which is commonly known as A.-C.-E., and which contains one part by measure of absolute alcohol, two of chloroform, and three of ether. A mixture of ether and chloroform was long ago suggested by very obvious considerations; but it was not found to succeed well in practice. It was merely a mixture; and, as its ingredients were of different degrees of volatility, they evaporated unequally, and left the administrator in a state of uncertainty, with regard to the proportion of each, which might be left in his inhaler at any given time. The addition of alcohol, provides a solvent for the other two, and they evaporate together. The mixture should be administered freely, from a flannel or felt cone, and the desired effect should be produced as rapidly as possible. To prolong the administration of an anæsthetic, of whatever nature, to give small doses timidly, with frequent admissions of air between them, is, I believe, the most certain method of producing disaster from its imperfect operation. By disaster, I do not mean death, but incomplete anæsthesia, prolonged struggling, muscular spasm, and probably eventual sickness. The cases which do best are those in which the effect is rapidly produced, and in which it is as rapidly recovered from. It would be foreign to my subject, and beyond the limits of my time, to attempt to describe the precautions with which the use of every anæsthetic should be surrounded; but I may add that one advantage of the A.-C.-E., is the ease with which the mixture can be replaced by pure ether, in cases which seem to call for such a substitution. When this substitution is made, moreover, the patient being already narcotized by the A.-C.-E., the pure ether has little tendency to produce the excessive bronchial secretion, which constitutes one of the difficulties of its employment, from the first. I need only add that, more especially in cataract operations, the ophthalmic surgeon who cares for the welfare of his patients, or for his own reputation, will not lightly commit the anæsthetic to strange or unskilled hands, but will insist upon obtaining the aid of an administrator of skill and experience, who knows the special requirements of eye work, and who is capable of relieving the operator from the duty of thinking at all about the anæsthetic or its effects. The administrator should then assume entire responsibility for his share of the proceedings, and the surgeon should await his permission to commence."* The fortunate discovery of the local anæsthetic properties of the hydrochlorate of cocaine, has done away with the use of such powerful and dangerous anæsthetics as chloroform and ether in operations on the eye.

The Inhalation of Chloroform and Ether, a Cause of Aural Disease.

Several cases of deafness are reported by Dr. Charles E. Hackly, of New York, as having followed the inhalation of chloroform for complete narcosis, for surgical operations.

Dr. D. B. St. John Roosa, of New York, has also published that several cases of tinnitus aurium, and loss of hearing, have come under his observation, which were said to have been caused by the inhalation of ether for the purposes of anæsthesia. No such results have followed in our use of anæsthetics.

Brief Extract of Experiments with a Mixture of Ether and Bromide of Ethyl and Chloroform, Performed by Drs. Reichert, Turnbull and Thomas, May 6, 1885.

Experiments were performed first upon a rabbit, then upon a dog. In the first instance a mixture of ether and bromide of ethyl, (℥ij to Oj) was applied, and the animal prepared by inserting a tube, to which a pulse indicator was attached, into the carotid artery, thereby showing the regular action of the heart. The trachea was opened, and a tube applied.

The nasal branch of the fifth pair of nerves was irritated, and inhibition of the heart's action was immediately shown, and when repeated, cessation was almost produced. The ani-

* "Modern Operations for Cataract," R. B. Carter, *Medical Times and Gazette*, London, Feb. 9, 1884.

mal was allowed to recover, after which, it was proposed to apply chloroform, and repeat the test; but almost simultaneously with the application of the chloroform, the heart's action ceased entirely, showing the dangerous character of that agent as an anæsthetic.

The post-mortem showed the lungs to be in a normal condition, as were also all the organs, except the liver, which was badly tuberculous, a condition frequently found in the rabbit. A perceptible heart-motion continued for some time after death, but with insufficient force to propel the blood, the indicator remaining perfectly quiet.

In the second instance, ether was applied to the dog with similar preparation as the rabbit, and with like result, after which he was injected with chloral, and a current of electricity was applied to the laryngeal branch of the pneumogastric nerve. The effect upon the heart was instantaneous, to such an extent, as to cause complete suspension of the pulsation. The result was the same, when the current was applied directly to the pneumogastric, the continuance of which must have produced death.

Anæsthesia by Chloroform and Oxygen.

Dr. Kreutzmann, of San Francisco, employed not the pure chloroform, but Billroth's mixture (three parts of ether to one of chloroform) in conjunction with oxygen. The discoverer of this method was Dr. Neudorfer, of Vienna, who claims, on theoretical grounds, that its employment is entirely without danger. This cannot be so, for no mixture containing chloroform is absolutely safe.—*Pacific Med. and Surg. Jour.*, August, 1887.

Employment of Chloroform in Labor.

It should never be pushed to complete insensibility, but the patient should be held in a state of semi-anæsthesia, so as to produce a diminution of the suffering.

The general rule is, never to administer chloroform except during the period of expulsion.

Experience has shown, that anæsthetics do not arrest the contractions of the uterus or abdominal muscles, but that they weaken the natural resistance of the perineal muscles.

In lessening the suffering, anæsthetics render a great service to those women who dread the pain; they diminish the chances of the nervous crises, which are caused during labor, by the excess of suffering; they make the recovery more rapid.

They are especially useful, to calm the great agitation and cerebral excitement, which labor often produces in every nervous woman.

Their employment is indicated in natural cases, until the pains are suspended, or retarded, by the suffering caused by maladies, occurring previous to, or during labor, and in those cases, where irregular, and partial contractions, occasion internal and sometimes continuous pain, without causing progress of the labor. In a natural labor, chloroform should never be used without the consent of the woman, and her family.

The experience of British practitioners, is generally understood to have disposed them to regard the use of chloroform in labor, as a proceeding of the highest utility and moment; and, according to the mode and limits of the inhalation practiced in the circumstances, practically free from danger. Yet in Ireland, they differ very much in this matter, as may be seen from Dr. Johns' observations. Dr. William T. Lusk, of New York, dwells on the necessity of "Caution in the Use of Chloroform during Labor." He expresses his belief that "not a small number of persons have quietly abandoned chloroform as a pain-stilling agent, because some incident in their practice has led them to suspect, that in spite of statistics, it possesses dangerous properties." The author divides his subject according to the following heads:

1. *Deep anæsthesia, carried to the point of complete abolition of consciousness, in some cases, weakens uterine action, and sometimes suspends it altogether.*

2. *Chloroform, even given in the usual obstetrical fashion, namely, in small doses, during the pains only, and after the commencement of the second stage, may, in exceptional cases, so far weaken uterine action, as to create the necessity for resorting to ergot, or forceps.*

3. *Patients in labor, do not enjoy any absolute immunity from the pernicious effects of chloroform.*

4. *Chloroform should not be given in the third stage of labor. The relative safety of chloroform ceases with the birth of the child.*

5. *The more remote influence of large doses of chloroform, during labor, upon the puerperal state, is a subject that calls for further investigation and inquiry.*

Dr. Playfair thinks, that chloroform inhalation is too indiscriminately used, and says, that he has observed the pains alter, and become less effectual. After chloroformization, and when it is prolonged, he thinks it favors post-partum hemorrhage.

In a recent case which came under the writer's notice, where three pints of chloroform had been employed in tedious labor, there was great retardation; and ultimately, when the forceps were applied, the infant was so narcotized from the effects of the chloroform, that every means employed to restore it failed.

Dr. Colling reported in the *Boston Medical and Surgical Journal* of January 11th, 1876, a case of death by chloroform in parturition. The patient was a primipara, aged twenty-two. The labor was proceeding well, and the head was apparently on the point of emerging, when the patient had a slight convulsion. Chloroform was administered, and the pains returned; and, still later, the administration was repeated. The head was gotten away, and the uterus was contracting well, when a tremor occurred, the pulse ceased, and the patient was dead.

Practical Observations on the Injurious Effects of Chloroform Inhalation during Labor.*

"As, at the present time, the subject of chloroform inhalation is again *sub judice*, I feel it incumbent upon me to raise my voice against its employment in midwifery, and to lay before my professional brethren, my reasons for the adoption of such a course, which I sincerely trust shall have some weight with

*By Robert Johns, A.B., M.D., T.C.D., Chairman of the Midwifery Court, and Examiner in Diseases of Women and Children, Royal College of Surgeons in Ireland, etc.

the unprejudiced, and which may, perchance, call the more serious attention of some, if not of all, of those now too deeply wedded to its use, to the dangerous, and too often fatal results, consequent thereon, in which, if I but even partially succeed, I shall consider myself, well repaid.

"From experience, repeated observation, and the published, as also the otherwise expressed opinions of those who agree, as well as those who disagree with me upon the subject, I am firmly convinced that chloroform, when inhaled during labor, very fruitfully disposes to hemorrhage, puerperal inflammation, chest affections, and to other diseases detrimental to health and life, which it aggravates if given during their presence. It also lays the foundation of diseases to arise at a more distant period, and thus increases the mortality in childbed, and subsequent thereto. I have known puerperal inflammation frequently to have followed its inhalation, and too often with a fatal result; in fact, some years since, when it was more fashionable, and was given with a more lavish hand, a great mortality was obtained amongst the patients of some few men who administered it—so much so that a popular outcry was raised against its employment. In the majority of those cases, puerperal fever was the cause of death, which, when thus raised, being, as I firmly believe, always infectious, or otherwise communicable, became epidemicized, after which, even those who wisely refused the drug, 'charmed it never so sweetly,' were thus inadvertently, and, in some instances, hopelessly poisoned.

"In support of these positions, I shall first refer to the several published Reports of the Dublin Lying-in Hospital. We find, on reference thereto, during the masterships of Drs. Collins, and Johnson,* when chloroform was not inhaled, that the mortality was much less than during that of Dr. Shekleton,† when this 'pernicious drug was used'—as thus:—In the first report are recorded 16,414 deliveries and 164 deaths, or 1 in 100; in the second, 6,634 deliveries and 65 deaths, or 1 in 102;

* By Drs. Hardy and M'Clintock.
† By Drs. Sinclair and Johnston.

whereas in the third, 13,748 deliveries are given, and 163 deaths or 1 in 84!! But of these last 13,406 cases were not chloroformed, of which only 133 died, or 1 in 100, and of the remaining 342 who took the drug, 30 died, or 1 in 11!!! If, again, we examine the reported cases of chloroform administration by Simpson, and Denham, we will find that of 245 cases mentioned by the former, 5, died, or 1 in 49; and of 56 by the latter, 5 died, or 1 in 11!! And, by adding all these recorded cases together, we have a mortality on the whole of 1 in 16!!! By again consulting those reports, we perceive that in Dr. Collins' mastership, there occurred 97 cases of post-partum inflammation, or 1 in 169; in Dr. Johnson's, 62 cases or 1 in 107; but in Dr. Shekleton's, 150 cases, or 1 in 91. Of those 150 cases 20, followed upon chloroform inhalation, or 1 in 17!! and in the remaining 130 cases, in which it was not employed, the average mortality was only 1 in 103. In Denham's report, we find 4 cases, or 1 in 14; which, with all the recorded cases, strikes an average of 1 in 16½!!!

"We also find that, during Dr. Collins' mastership, puerperal convulsions proved fatal in the proportion of 1 in 6; whereas in that of Dr. Shekleton, when under chloroform it amounted to 1 in 3!! and in Denham's cases to 2 in 3!!! or, on the whole, to 1 in 2½!!!

"It appears, that during Dr. Shekleton's tenure of office, post-partum hemorrhage occurred, but once in every 257 cases when chloroform was not used; yet after its inhalation this complication was present in 1 of every 49 cases. In Dr. Denham's report, it was present in 1 of every 19 cases; making, on the whole, an average occurrence of 1 in every 39¾ cases.

"With respect to the mortality after perforation, the report of Drs. Hardy, and M'Clintock, shows 1 fatal case in every 6, and that of Drs. Sinclair, and Johnston, 1 in every 5; but if we go a little below the surface in the latter report, and examine into 99 cases of perforation, all of equal severity and danger, we shall discover that of the 29 cases in which chloroform was inhaled 9 died, or 1 in 3¼; puerperal inflammation occurred 10 times, or 1 in every 3 cases; and hemorrhage followed in 3 cases, or 1 in every 10; whereas, of the 70 cases in which this drug was not employed, only 6 women died, or 1 in every 12; puerperal inflammation, arose only in 3 cases, or 1 in every 23; and in no case did hemorrhage occur.

"Many have testified to the fact, that uterine action has been lessened, and even caused to cease, by anæsthetics; as also that their effect on some is not commensurate with the quantity of the drug employed—as thus: a very large amount not having any effect on some, whereas the inhalation of a very small dose, even of a few drops, has produced almost deep coma in others. Dr. Denham says:—'In some, if left to nature, the labor would probably have been completed in a somewhat shorter space of time. The advantages to be gained by chloroform, in some cases, will not be found an adequate compensation for the loss of power sustained in the muscles of animal, or organic life; and, were we to continue its use, I do believe that the patients would remain undelivered for hours, or even days. The cases that apparently require it most—tedious, and difficult, labors—are those, where it often appears to be injurious, by weakening the pains or relaxing the muscles of animal life.' Rigby says:—'We meet with cases, every now and then, where chloroform undoubtedly retards labor, and in some cases likely to call for the use of the forceps.'

"Dr. Robert Lee, mentions cases in which 'uterine contractions were arrested, requiring the use of the forceps and perforator.'

"Tyler Smith, 'has seen chloroform, stop labor midway.'

"In some of the cases recorded by Sinclair, and Johnston, uterine action was impaired.

"My friend, Dr. Young, of Monaghan, says, in a letter to me: 'I believe chloroform in many instances to delay the labor by causing the pains to come at longer intervals, and rendering the expulsive efforts of the patient less efficient, owing to her insensibility to suffering.'

"Merriman, has mentioned a case in which 'the uterus was so paralyzed, that it failed to act afterwards.'

"Snow, says:—'It is true, that a full dose would at any time suspend uterine action for a few minutes, or as long as it might be kept up.'

"Ferguson, says:—'Chloroform does not destroy muscular action because, when under its influence, some expel urine and fæces.' Now, from this, his doctrine must be, that it increases muscular action; whereas, I take it, that it paralyzes the sphincters.

"On looking into Drs. Sinclair and Johnston's report, we find, 'two cases, in which version was very difficult; and two others, in which that operation was impossible, where chloroform had been inhaled.'

"Murphy thus, speaks:—'In a case of version, I never experienced so much difficulty, in consequence of the strong contractions of the uterine fibres about the child.'

"Barnes' remarks:—'In many cases it does not facilitate the operation of version, the uterus resisting the introduction of the hand.'

"Puerperal, hysterical and epileptic convulsions—mania, paralysis, and insanity, have followed on its use. Cases are recorded by Montgomery, Sinclair, and Denham, in which puerperal convulsions occurred after its employment. Sinclair gives two cases of hysterical convulsions, in one of which, 'violent muscular action was induced; restlessness continued for a considerable time after the inhaler was removed.'

"Murphy states, that in 'dentistry, hysterical women have been seized with fits, when under its influence.'

"Snow, asserts, that 'hysterical patients, as soon as they lose their consciousness from the effects of the vapor, are sometimes attacked with a paroxysm of hysteria.'

"Dr. R. Lee, says:—'Epilepsy has been so induced.'

"Sinclair, records one case of epilepsy.

"Snow, and M. Fix, have stated 'that persons subject to epilepsy, are likely to have a fit brought on by inhaling chloroform.'

"Ramsbotham, 'saw three cases of puerperal mania so caused. A friend of his also saw one similar case.'

"Sutherland, 'met three other cases similarly produced.'

"Tyler Smith, stated 'that he had seen mania from its use.'

"Parks, relates the case of a lady who had chloroform in her third labor. 'She, after delivery, complained of violent pain in the head, became delirious, tore the nurse's gown and the bed-clothes into pieces, and was perfectly maniacal.'

"Mr. Banner, thus speaks:—'A patient became delirious, and continued, so during the day and greater part of the night, after its use.'

"Hartman, 'saw a case of headache terminating in paralysis, caused by this drug.'

"In one of Dubois' published cases, numbness of the fingers, and in another the same condition of the legs, supervened, and had not subsided at the end of twenty-four hours.

"In Denham's report, I find one case of coma after chloroformic inhalation.

"Dr. R. Lee, says, 'that insanity has followed on its employment; that dangerous and fatal peritonitis and phlebitis have been caused by its inhalation.'

"Two or three of Denham's cases were seized with rigors; and Lee, mentions 'others with dangerous fits of syncope;' and in this he is borne out by the following, which I find recorded among Denham's cases:—'While inhaling, the pulse became very weak, and she gave no signs of consciousness; and, immediately on the birth of the child, the respiration of the patient ceased, and the pulse became imperceptible; the application of cold water to the face soon revived her, and she went on favorably for several days; but diarrhœa, with extensive inflammation of the mucous membrane of the ilium, set in, and she died on the fourteenth day.'

"Sinclair, and Johnson, record nearly a similar case, as thus: 'The pulse suddenly became imperceptible, and respiration appeared to have ceased. She subsequently died of phlebitis.' And they give another, in which collapse occurred, and she died with symptoms of phlebitis.

"Tyler Smith, says 'that he knew two ladies in whom a few drops of chloroform, at any time, would produce repeated fainting.'

"I am acquainted with a lady, who, some time since, had a very severe attack of syncope, from taking only five drops of chloroform in a draught.

"Dr. Barnes stated—'That he had himself given chloroform to facilitate the extraction of an adherent placenta, and had witnessed such exceeding prostration for eight hours afterwards, as to make him, and another practitioner who assisted him, apprehensive of the instant death of the patient.'

"Many are of opinion that the inhalation of chloroform predisposes to laceration of the perinæum; indeed, some of the published cases would tend to favor this idea. In Sinclair and Johnston's report, we find that, in the recorded cases, it occurred once in 27 cases; and when not employed, the accident happened only once in 93 cases. In the same work, we find 3 cases of chest affection, aggravated by this means, two of which succumbed. Dr. Ringland, one of the Masters of the Coombe Lying-in Hospital, in reply to a letter from me, thus writes:—

"'I have seen chloroform frequently used in puerperal convulsions, and have used it myself in connection with the practice of the Coombe Lying-in Hospital; and the conclusion I have come to is, that I will never again use it, or sanction its use, in puerperal convulsions. I have observed that, however satisfactory its employment may appear at the time, it has been almost invariably followed by bronchitis, within 48 hours, and that the patients have sunk rapidly under the latter affection. I have seen this so frequently, that I cannot but look on chloroform, and bronchitis, under the circumstances I have named, as cause and effect; and the mortality from the subsequent bronchitis, as the actual result of the employment of chloroform.'

"Ramsbotham, relates the case of 'a lady who was seized with dyspnœa, with excessive lividity of the face, and all the signs of engorgement of the lungs and heart, and died in convulsions six hours after.'

"Murphy has published a case nearly similar; he also admits 'that vomiting, nausea and headache sometimes follow on its use.' Nausea and vomiting were also present in some of Denham's cases.

"Rigby states, 'that intense headache, and even vomiting are consequences of its use.'

"I occasionally use a blistering fluid which contains chloroform, and if I am not very cautious during the *minute* I am employing it, I am certain to suffer from sick headache for the remainder of the day. Not long since, severe vomiting followed upon the inhalation of chloroform, during the operation for vesico-vaginal fistula, in one of our city hospitals; and, in spite of all remedies, lasted for six days. It is needless to say that the operation, in consequence thereof, failed. I have so often seen this effect of the drug that I always object to its use in operations requiring the employment of sutures upon the female genitals. Thus, it is evident, that such a complication existing after labor, would, like severe cough, predispose our patient to inflammation in parts, for whose restoration to health, absolute rest is required.

"Parks, gives the case of a 'lady, in whom, after chloroform inhalation, flooding came on to a fearful extent, and incessant sickness. He managed to extract the placenta; and, owing to the feeble contractions of the uterus (and this latter condition, he is confident, it often produces), he was kept grasping it, for four or five hours; the vomiting continued for eight hours, without intermission; the headache remained for weeks.'

"Tyler Smith, 'believed that post-partum hemorrhage, and retention of the placenta, occurred more frequently after its use than without it.'

"Montgomery, was of the opinion 'that it predisposes to retained placenta and hemorrhage.'

"My friend, Dr. Young, before alluded to, says:—'I have blamed it for causing a longer detention of the placenta, and for occasional after-hemorrhage, owing to the lazy, and inefficient contraction of the uterus. After its use, opiates have very little effect; even very decided doses, in any form, have not been followed by that tranquillity I had hoped for, in that violent pain which I have so often found to follow operation when chloroform had been used.'

"Murphy, speaks of making pressure on the uterus to expel the placenta, in two cases, after chloroform.

"Denham, had one case of retained placenta after its employment. He says:—'We had no reason to think that chloroform predisposed to hemorrhage; on the contrary, we were impressed with the idea that the number of hemorrhagic cases where it had been given, were rather below, than above the average, in ordinary practice.' This statement does not accord with my experience, and I should be sorry to think that hemorrhage so frequently complicated labor, 'in ordinary practice,' as once in every *nineteen cases,* as shown by his report. Some of the loudest advocates for chloroform inhalation in labor, have, in order to counteract its deleterious effects upon uterine action, recommended the co-administration of ergot of rye; which practice, reminds me of the astute physician who, to be sure to hit his patient's disease, prescribed for him the combination of a stimulant with a sedative, and a purgative with a tonic. But I hold that there is a more serious objection than this, to the wholesale use of ergot; for we cannot conceal from ourselves the fact, that its administration, even in appropriate cases, is not always innocuous. Some years since, the following case came under my knowledge:—Ergot was given to an unmarried woman to facilitate the birth of her first child, before her father, who was ignorant of her condition, had returned home to his dinner. The child was rapidly expelled, but sloughing, to a frightful amount, followed, and placed her life in jeopardy for days. And who has not seen the child sacrificed by it? For this reason, it has now become almost an axiom, not to leave a female undelivered for a longer period than two hours, after its employment. I believe that ergot of rye, in some cases, causes incarceration of the placenta and hemorrhage, and in others, sinks the patient; the uterus, after its use, often remains large and uncontracted for days, which state not unfrequently terminates in imperfect involution of the uterus, and its consequences; which last effect chloroform also produces. Many believe that ergot, besides destroying the child at the time of its birth, acts sometimes otherwise deleteriously upon it, by inducing disease—to do so at a shorter or longer, subsequent period—or to reduce it to a state to which death would be preferable.

"Dr. Catlet, in the 57th volume of the *Edinburgh Medical Journal,* page 83, states that ergot of rye, when given during labor, causes puerperal convulsions, hour-glass contraction of the uterus, and infantile hydrocephalus. Amongst the cases of the last, I find one in which 'symptoms of meningeal inflammation were developed on the 19th day, and the child died in convulsions, with coma, on the second day following.' And in another, 'the symptoms of cerebral derangement set in, suddenly, on the 21st day, and the child died on the third day of the attack, in convulsions.'

"Dr. Beatty, in a paper 'On the Influence of Ergot of Rye, on the Fœtus in Utero,' published in the 25th volume of the *Dublin Medical Journal*, page 201, amongst other cases after its use in labor, gives the following:—Case 7. The child had convulsions for three days after its birth. Case 9. The child had convulsions for 48 hours after birth. They then subsided, but left the child in a state resembling paralysis, with occasionally a convulsive motion of the muscles of the face and limbs, and fixed strabismus. No treatment seemed to have any effect upon this condition. Twenty days after its birth, the following report was taken:—'This child has remained in a state of insensibility up to the present time; the strabismus has lately disappeared, but it seldom opens its eyes. The limbs are apparently powerless. It makes no effort to suck, but it swallows breast-milk with difficulty when put into its mouth. The difficulty is increasing; the bowels act naturally.' In this state, the child lingered on, until the 25th day, when it died. Case 12. This child, he first saw when three years old; 'it then had an idiotic countenance, and was never free from spasms and palsy, commencing from its birth.'

"Cusack, and others, have also testified to the deleterious effects of this drug, upon the cerebro-spinal system of the infant.

"Dr. Snow, says, that 'chloroform is a volatile spirit, and that half an hour after its application no traces of it could be found in the system.'

"Now, in refutation of this assertion, Dr. Ramsbotham mentions the case of 'a lady who, for four or five days after its use, could not get rid of the smell.'

"Dr. Aveling, speaks of 'a lady who had chloroform in three labors, all of whose children, when unwell, had for years afterwards the smell distinctly on their breaths. This lady would never take it again.'

"In a monograph by the writer, on 'Blistering the Os and Cervix Uteri,' published in the May number of the *Dublin Quarterly Journal*, of the year 1857, cases are mentioned of females having had the smell of chloroform on their breaths, evident to their friends as well as to themselves, and of others having experienced its taste, lasting, in both instances, for days after the blistering fluid, containing that drug, had been employed.

"When sulphuric ether was first employed as an anæsthetic in this country, a medical student inhaled it as an experiment in this city, and the smell of it was evident on his breath, to any one who spoke with him, for nearly a week after its employment.

"Dr. Jackson, (an American) thus writes upon the subject:—'When chloroform is inhaled into the lungs, the oxygen is abstracted from the blood, and, combining with the formyl, makes formic acid, while the chlorine combines with the blood as a substitute for oxygen. Thus a portion of the blood becomes chemically changed, disorganized, and rendered unfit for its vital functions. I have now a phial of blood, taken from a young lady killed by the inhalation of pure chloroform, before me, it having been kept in my office, exposed to temperatures from the freezing point to above 80°, for more than six years, and yet it has not decomposed, nor has a single blood-globule settled to the bottom of the phial, nor has the color changed in the least.' It has been denied, that females, when under the influence of chloroform, make use of improper and indecent language. Now, I never shall forget the case of a lady I saw, in consultation, a couple of years ago, with a hospital surgeon, who, when chloroformed, threw her arms around him in the most endearing manner, and made use of language which would make her blush if in her senses, of which, I hope sincerely, she was never made cognizant.

"Denham, says:—'There are cases in which chloroform appeared to be not only useless, but when persevered in, positively injurious.' And again:—'In giving chloroform we incur a certain amount of present danger, and perchance of remote ill effects.'

"Dr. Robert Lee, in reply to a letter from me, says:—'I could give you a great number of cases, in which chloroform was not only injurious, but fatal.'

"Dr. Gream, said:—'He agreed with Dr. Lee, in saying that we were quite unacquainted with *one-tenth* of the evil effects which had resulted from the use of chloroform, particularly in Scotland.'

"Dr. Duncan, in a letter to Dr. Lee, thus writes:—'Your case of chloroform death in midwifery is, to the best of my belief, not the only one in Scotland. I was called, too late, to a case which died suddenly while taking it in *small quantity.*'

"Dr. Campbell, of Ayrshire, records another case of death in labor from its use. Mr. Carter, says 'that in two cases its effects would appear to have been pernicious.'

"Prof. Faye, of Christiana, has also recorded a fatal case of labor after its use.

"Dr. Barnes, says:—'In ordinary forceps cases, chloroform certainly is not required, either to facilitate the operation, or to allay pain.' Indeed, by its use in such cases, we lose one very valuable indication by our patient's want of sensibility. Dr. Chas. Kidd, evidently does not consider its use devoid of danger, as he advises the physician who administers it '*always* to carry in his pocket a portable galvanic chain or battery.' Drs. Kidd, and Richardson, are reported as having seen many deaths after its employment; and the former gentleman 'to have seen about 300 cases restored to life, or rescued after they had been pronounced dead.' I would ask, in the name of common sense, is it within the bounds of reason to believe that a medicine can be employed innocuously with the pregnant female, when confessedly its use has often been followed, not only by dangerous, but even fatal results under other circumstances, as testified to by Drs. Kidd and Richardson, amongst many others, as also by almost every periodical we take up? Dr. Snow, in speaking of his imagined advantage of chloroform over opium in version cases, thus writes:—'If 50 or 60 drops of laudanum were given, the patient remained under its influence, more or less, for forty-eight hours.' Now, in this I must join issue with the doctor; for I am, and have been for years, in the habit of giving such, and even much larger doses in those cases, as also in hemorrhage, and I never yet saw such a result, or one at all approaching to it. We have been told, that across the Tweed, death has not, in any instance, followed upon the inhalation of chloroform in labor, whereas some have been since recorded; and not very long ago I was informed, by more than one physician practicing in Scotland, that many have so occurred there, but not made public, yet well known to the profession. It is also a fact that some who have written favorably on its use, have since changed their opinions, but have not said so publicly; and some give it only in name, or as has been styled *à la Reine*. The following is so appropriate here, that I cannot avoid quoting it from Denham: 'That chloroform may be, and sometimes is, given for the purpose of amusing patients, and making them believe that they are saved from a vast amount of pain, when in reality they have scarcely inhaled a single breath of it, I doubt not.'

"We very frequently see safer and better recoveries after tedious, and painful, than after rapid and painless labors, and the latter are not the less likely to be seriously complicated; indeed, in former days, when, happily for the parturient female, chloroform was unknown, and when meddlesome midwifery was strongly reprobated, such an opinion was entertained. *Apropros*, I have two patients—one the mother of five, the other of four children—who always have rapid and, I may say, painless labors, but which are invariably followed by alarming hemorrhage, by no means an unusual occurrence, as already shown, after chloroform inhalation, besides being admittedly a fruitful predisposing cause of puerperal inflammation. In the employment of anæsthetic agents, during instrumental delivery, we deprive ourselves of a very valuable indication in the loss of our patient's sense of feeling, which the following cases forcibly illustrate; for had such means been resorted to in either, it must be evident to all, even to the most skeptical, that the consequences should have been most disastrous: Mrs. D. had a very tedious labor with her first child. When about thirty-six hours in labor, the os uteri was found thinned and spread tightly over the head of the child, dilated to about the size of a shilling, but directed obliquely backwards and upwards, so located as only to be found by the well-educated and practiced finger. Her medical attendant, having failed to discover the real state of matters, took it for granted that he only felt the head, which had passed through the fully dilated os; and proceeded, without further delay, to deliver her with the forceps; but from the great pain which she experienced from the application of its blades on the head so clothed, he was obliged to desist; and, being much alarmed, he sought for further assistance, after which the nature of the case was discovered, when, of course, all interference was given over for the time; but eventually had recourse to destructive instruments. The other was the case of Mrs. M., very similar to the former; but the perforator was the instrument employed, which the medical gentleman pushed into the cervix expanded over the head, when her piercing cries and some slight bleeding caused him to look more narrowly into the state of the parts. She was, however, afterwards naturally delivered, and had a good recovery.

"At page 333, of the *Dublin Quarterly Journal of Medical Science*, for May, 1849, in the late Dr. Montgomery's essay upon 'The Indiscriminate Administration of Anæsthetic Agents in Midwifery,' we find a somewhat similar case recorded, in which the medical man mistook the attenuated anterior section of the cervix uteri for the membranes, which he was endeavoring to perforate with his nail, when the lady's cries arrested him.

"Even though it were possible to divest chloroform of its dangers, it does not, as has been already shown, always produce the advantages expected from its use, as in version; for, indeed, not a few instances have been recorded of its having been an impediment to this operation, which in some cases could not be overcome. I cannot see any advantage derivable from the inhalation of this poisonous drug, in cases of retained placenta, as generally such a complication is caused by inaction of the uterus; and our object, therefore, ought to be to induce uterine action, surely not further to paralyze it. Such treatment reminds me of a case which I was called to see twenty years ago. The placenta had been retained for six hours, and some draining was going on. The lady's medical adviser was looking on very complacently, and dosing her with tartar emetic. Of course, there was not any difficulty in the extraction; but puerperal inflammation set in on the second day, from which she eventually, but slowly recovered. Every practical man hails after-pains as salutary, especially after quick and painless labors, and would not dream of interfering with their wholesome action, unless very severe, for some hours after delivery; yet those misguided chloroformists, think nothing of interfering with that safe action at times, when the advent of hemorrhage would complicate matters more seriously. The other objections to its use at other times, under certain circumstances, are equally admissible here. I think I have now demonstrated that chloroform inhalation is far from being a safe remedy in child bed, and should not then be employed." (*Dublin Quarterly Journal of Medical Science*, May, 1863.)

Effects of Prolonged Chloroform Anæsthesia on Dogs.

Further experiments on the effects of prolonged chloroform anæsthesia on dogs have recently been made by Dr. Strassman, which appear to confirm the views of Dr. Ungar.* Dr. Strassman found that the first organ to be affected was the liver, then the heart, and after that other viscera. The nature of the morbid change was not a fatty degeneration, but fatty infiltration. The actual cause of death in fatal cases appeared to be the cardiac affection, as in all such a very marked degree of change was found in the heart. In non-fatal cases, the morbid change was found to have disappeared in a few weeks' time. When morphine was given previously to the chloroform, less of the latter was required, and consequently the changes produced, were not so considerable as when the ordinary amount was given. Animals suffering from hunger, loss of blood, etc., were especially pre-

* See Ungar, Experiments Under Chloroform.

disposed to the morbid changes due to chloroform.—*Lancet*, July 20, 1889.

An Abstract of the Reports of Recent Deaths from a Mixture of Ether and Chloroform.

A death of a lady had occurred in the practice of Dr. Eastham, a dentist of Boston, causing much excitement in professional circles. The death had taken place about noon, but very few, except those particularly interested, were aware of it till the next day. The coroner, Dr. Ainsworth, who was called in directly after the accident, formed a jury of physicians and apothecaries, and ordered an autopsy. This was made the next morning by Dr. R. H. Fitz, pathologist to the Massachusetts General Hospital; and on the same day the jury met, and, having viewed the body, adjourned until the 14th. The anæsthetic was either chloroform or a mixture of chloroform and ether. The latter proved to be the one used. The jury met again on the 14th, and, having heard a part of the evidence, readjourned till the evening of Wednesday the 19th. Instead of death resulting from ether, it was, as proved by analysis, due to *chloroform*, and the coroner's jury presented the following verdict:—"Death was caused by the inhalation of chloroform, administered in a mixture of chloroform and ether."

Dr. Henry Buren, of Chicago,* gives the following version of a death which took place in that city from the inhalation of a mixture of ether and chloroform:—

"Mrs. B., aged 32, American, had suffered from fistulæ in ano for six months. On the 22d of November last, I operated on her, finding at this time two artificial openings into the rectum, one on either side of the anus. Dr. A. Groesbeck administered the anæsthetic, which consisted of equal parts of sulphuric ether and chloroform. The operation was performed in a few seconds. The patient exhibited no alarming symptoms while under the influence of the anæsthetic, and revived in the usual time.

"On the morning of the 30th of November, eight days after

* *Chicago Medical Journal*, February, 1878.

the operation, I desired to make a thorough examination of the wounds and renew the dressing, and in this, as in some of the previous dressings, the patient insisted upon partial immunity from pain. To this end I commenced to administer upon a napkin two parts of sulphuric ether and one of chloroform. After a few inhalations the patient became violently intoxicated, and resisted, with great force, all efforts to quiet her, demanding in the language of one in delirium, to be let alone. I immediately ceased to administer the anæsthetic, and with great effort prevented her from jumping from the bed. The face became at first turgid, the whole body convulsive, and in a few seconds the patient was dead.

"All of the means usually resorted to were employed to restore action of the vital functions; artificial respiration, elevating the lower extremities, dashing cold water in the face, drawing forward the tongue, spirits of ammonia applied to the nostrils, and, finally a galvanic battery, which was conveniently at hand, but to no avail.

"I have to say in justice to the record of this case, that the patient had for many years habitually partaken of opium. At the time of her unfortunate death she could take at each dose from two to three grains of morphia. During the time she was under my care, one half grain doses of morphia were prescribed at proper intervals, but she asserted that this quantity did not sufficiently support her, and through her nurse, and by stealth, she secured additional quantities from the neighboring drug-stores, and took the same daily without my knowledge or consent.

"I am now of the opinion that the patient had taken an unusually large dose of morphia on the morning of her death, and that the combined influence of this overdose and the additional paralyzing effects of the anæsthetic caused cardiac syncope, and that this was the cause of death.

"A woman aged forty-six, extremely fat, and of slow intelligence, although having complained of shortness of breath, was not known to be the subject of organic heart-disease. She was to be operated upon for senile cataract. A mixture of chloroform and ether, in a modified Clover's apparatus, was being administered by the house surgeon. From the commencement of the administration, respiration was noticed to be shallow, but there was struggling. The pulse was feeble, but not intermittent. There was some slight lividity of cheeks and forehead. Chloroform was at once removed and a few whiffs of pure ether administered as a stimulant. Other means for circulation were tried, but in vain; the patient died. At the *post-mortem* examination the heart was found flaccid and empty; the mitral valve was contracted; the aortic valves were incompetent; kidneys fatty and granular."—(*Med. Times and Gazette*, August 18th, 1876.)

Accidents Accompanying the Use of the A.-C.-E. Mixture.*

"In the spring of 1865, while stationed at the U. S. A. 'Summit' House General Hospital, Philadelphia, the staff were performing an amputation of the leg. At the suggestion of Surgeon Joseph Taylor, in charge, the A.-C.-E. mixture was used. The anæsthetic was administered by Surgeon A. A. Leavitt, Executive Officer of the Hospital. During the operation, the patient's respiration failed. The condition became so alarming that the operation was temporarily discontinued, and all present turned their attention to restoring the patient. Artificial respiration, cutaneous excitation, and inhalation of fumes of ammonia, fortunately, were successful. The operation was then finished, with the patient only partially unconscious. For many years I had not used this mixture, using either ether alone, or the mixture of ether two parts, chloroform one part, by weight; or, rarely, chloroform alone.

"During the past two years I have, on several occasions, used the A.-C.-E. mixture with gratifying results, being led to use it again by the favorable reports given by various authorities. During the summer of 1886, I was removing cancerous mammary and axillary glands—assisted by Drs. Martin and Chesney, of Cairo, West Virginia. To Dr. Chesney was intrusted the administration of the anæsthetic, which was the A.-C.-E.

* W. H. Sharpe, M.D., *Medical News*, March 5, 1887, p. 257.

mixture. During the operation I had requested him to discontinue the anæsthetic, as the patient was sufficiently under the influence. This he did; he had his finger on the pulse, and devoted his entire attention to the patient's condition. The mammary gland had been removed—care being taken by Dr. Martin to prevent entrance of air into the veins. I noticed the extreme pallor of the patient's face, and simultaneously Dr. Chesney said the pulse had failed, so as to be inappreciable. I immediately placed a bottle of nitrite of amyl to her nostrils—respiration was good. Asking Dr. Martin to hold it there, I prepared a hypodermatic syringe with 20 m. of tr. digitalis, and injected it in the precordial region. Dr. Martin meantime announced a slight recovery of pulse. I next administered several syringefuls (hypodermatically) of whiskey, and we had the pleasure of seeing the patient rally from this heart-failure—due, I think, to the depressing influence of the chloroform. It was carefully administered—with a sponge in a cone—*i.e.*, a towel stiffened with a sheet of paper in its folds; the sponge was held in its place in the apex by transfixing with long pins to prevent it falling down on the patient's face. The chloroform and ether were of reliable manufacture. It afterward developed that at this time the liver was involved in secondary cancerous inflammation, from which the patient succumbed a few weeks after recovery from the operation.

"A more recent case of *death* from a *mixture* of *ether* and *chloroform* is reported in the *Philadelphia Medical Times*, March 15, 1879, by I. A. Cleary, Assistant Surgeon U.S.A. Private H. D. B., Co. 19, U. S. Infantry, aged 33, large, robust, addicted to liquor. Injury of middle finger, right hand, resulting in gangrene; decided to amputate. A mixture of equal parts of ether and chloroform (*weight or measure not stated*). Two ounces whiskey were given ten minutes prior to inhalation. The anæsthetic was administered on a piece of lint covered with a small towel held square. He personally administered the mixture, while the steward observed the pulse; air was freely admitted; he inhaled freely. About two drachms were first poured on the cloth, but with no apparent effect (*he, evidently, receiving nothing but ether*). Shortly after about the same quantity was poured on; he observed that 'he did not feel it.' After a time about the same quantity was again poured on. A further quantity was poured on the cloth (say in all ℥viii) when he began to laugh, followed by attempts to articulate, and made strong gesticulations with his arms. He now passed to a state of unconsciousness, when the pulse was not perceived. This was followed by relaxation and death. At once the anæsthetic was removed, cold water dashed in the face. He adds, 'everything I ever heard of, saw or read, appropriate for such a case, was done, but to no effect.' He states as the cause of death, paralysis of the heart. (I think it was syncope from the chloroform.)"

Chloroform and Morphia.

At a very early period this mixed narcosis of morphia, and chloroform, was proposed by Nusbaum, as being especially useful for operations on the mouth and jaws, in which blood is apt to flow into the trachea or down the œsophagus into the stomach, and subsequently to cause vomiting.

A subcutaneous injection of morphia, from a quarter to half a grain, is given as soon as the patient is placed upon the operating table, and immediately afterward the administration of chloroform is commenced. After inhalation for about five minutes, the operation may usually be begun, but the chloroform must be renewed at intervals. The patients lose all sensibility to pain, but evidently retain a considerable degree of consciousness, and control of voluntary movements. This mixed narcosis has been employed successfully, as far as the annihilation of pain is concerned. Paralysis of the heart, too, is less apt to happen, the risk of the occurrence of this accident, and of asphyxia as well, being lessened in proportion to the smallness of the dose of the anæsthetic required to cause and reproduce the anæsthesia. It is pointed out that this method makes chloroform as safe to use, as ether, and that in tropical countries, especially India, where operations have to be performed at a temperature very little below the boiling-point of ether, there is practically no choice of anæsthetics.

The above dose of morphia is too large for safety, as there are many persons on whom even one-quarter of a grain of morphia, hypodermically, will act as a powerful poison, while half a grain even produces death. The injection of morphia should be small, say from one-eighth to one-quarter, and this should be given, according to Claude Bernard, from forty minutes to one hour before the chloroform is employed. The question should always be put to the patient, Have you ever employed morphia, and if so, what effect has it upon you? The great advantage claimed for this method, is that the stage of excitement is rendered always *nil*, and less chloroform is needed to induce sleep than under ordinary circumstances. It must always be borne in mind, that nausea and vomiting are not uncommon at the commencement, if the morphia is quickly absorbed. This, with the vomiting which accompanies chloroform, will, we fear, be apt to complicate a delicate operation, and then you have the double risk of two such poisonous agents.

Ether and Morphia.

Reliable authorities recommend the combination of these two agents, but in our experience, and that of several friends —especially the late Dr. Albert Smith, of this city—the combination of opium or morphia with ether, although prolonging the anæsthesia, has a great tendency to produce respiratory failure, and has, in more than one instance, been followed by death. In a recent, severe, and prolonged operation upon the brain, by a colleague of ours, in the Jefferson Medical College Hospital, he had administered to his patient ether, as the anæsthetic, with one-quarter of a grain of morphia hypodermically, one and a half hours previously.—*Medical News*, December 24, '88. Just before recovering, consciousness vomiting took place. The combined effect of the operation, the opium, and ether, produced an alarming amount of shock and depression of the vital forces, with arrest of respiration, and only by the vigorous use of artificial respiration, and the battery, atropia, digitalis and whiskey, hypodermically, hot water enema, etc., was a fatal termination averted.

In criticising his procedures, Dr. Nancrede, makes the following statement: "I believe that morphia was injurious, and, conjoined with the ether, tended to produce the marked respiratory failure. Anæsthesia, especially when induced by ether, and preceded by morphia, should never be prolonged a moment more than necessary, and should not be pushed to its extreme limits."

This combining anæsthetics with opium preparations, meets a critic in Dr. E. H. Jacob, who writes to the *British Medical Journal*, the following warning: "May I utter a word of warning on the combined effects of ether, and opium? Several cases have recently come to my knowledge—the details of which, I hope, will soon be published—in which death followed a short time after the administration of ether to patients under the influence of opium. In the table of deaths from ether, which you have published, out of six cases in which death could be directly attributed to the anæsthetic, two were cases of hernia, and, therefore, most probably under the influence of opium. Whether it be a case of this kind, or morphia be given subcutaneously, in order to obtain the benefits of 'mixed anæsthetics,' ether is not without danger; and the patient should be carefully watched, after the operation, till complete awakening has taken place. In the recent volume of Billroth's 'Deutsche Chirurgie,' which is devoted entirely to anæsthetics, Dr. Kappeler, from an experience of twenty-five cases, speaks strongly against the practice of mixed anæsthesia by morphia and ether, but allows that by morphia and chloroform, to be open to less objection. Whether death occurs by the ether deepening the morphia narcosis, or by the morphism preventing the patient from clearing his bronchi from the secretion provoked by the ether, I will not undertake to say. It appears to me, to be a very proper question for physiological experiment. Similar warnings have been uttered, against this form of 'mixed anæsthesia;' but I do not think public attention has before been called to this explanation of deaths in hernia operation under the use of ether."

Mixed Narcosis.

"A mode of producing anæsthesia, called mixed narcosis (*gemischte narkose*), has been employed by Thiersch, of Leipzig, whereby insensibility to pain, may be procured without the total abolition of consciousness. The credit of the discovery is ascribed to Prof. Nussbaum, of Munich. Although suitable for all kinds of operations, it is especially serviceable for operations about the mouth and jaws, in which blood is apt to flow into the trachea, or down the œsophagus into the stomach, and subsequently to cause vomiting. In some cases, of the removal of the upper jaw, lately performed by Thiersch, the patient allowed the blood to accumulate for a while at the back of the pharynx, and then spat it completely out when asked to do so; and we are informed that in one instance, the patient watched with evident interest the motion of the saw that was dividing his upper jaw-bone.

"A subcutaneous injection of morphia, from a quarter to half a grain, is given as soon as the patient is placed upon the operating-table, and immediately afterward, the administration of chloroform is commenced. After inhalation for about five minutes, the operation may usually be begun, but the chloroform must be renewed at intervals. The patients lose all sensibility to pain, but evidently retain a considerable degree of consciousness, and control of voluntary movements. Within the last month, mixed narcosis has been employed five times successfully, as far as the annihilation of pain is concerned, and without any bad effects."—*London Lancet.*

The dose of morphia, which is given in the communication in the *Lancet*, is too large for safety, as there are many persons on whom even one-quarter of a grain of morphia, hypodermically, will act as a powerful poison, while half a grain might cause death. The dose of morphia by injection under the skin—not in the vein—should not be more than gr. ⅛ to ¼ given hypodermically half an hour before employing the chloroform. The objections to it are, that it may produce great excitement, and vomiting. "*Pouncet,*" *from a wide experience during the Franco-Prussian War, abandoned the method, owing to the frequency of prolonged stupor, which followed its use.*

Presence of Albumen in the Urine, after the Administration of Chloroform.

MM. Ferrier, and Patin, have experimented upon the production of albumen in the urine, by the administration of chloroform. Ten experiments in all were performed, and the urine in each, was tested before, and after, the operation.

In six cases out of nine, albumen was found after, though not before, chloroformization. In the tenth, the quantity of albumen was increased from nine grains per quart—before anæsthesia—to sixty grains afterward. This patient died.

In résumé, anæsthesia by chloroform, is frequently, but not fatally, followed by albuminuria, thus confirming the experiments of Bouchard, who has observed albumen in the urine of hares, after peripheral nervous lesion, and after the inhalation of chloroform—even without production of anæsthesia. Under the last condition, hæmaturia has also been observed. M. Ferrier, is inclined to attribute the albuminuria to a certain tendency to asphyxia produced by chloroform.—*Revue de Chirurgie*, Jan., 1885; *Medical News*, April 11, '85.

According to Dr. Baillee, there is no more energetic means of overcoming the narcosis produced by chloroform, than the introduction of a small piece of ice, into the rectum. It can be pushed through the sphincter, without the employment of much force. It immediately melts, producing a deep inspiration, which is the precursor of natural respiration, and the re-establishment of cardiac functions.

The Influence of Nitrite of Amyl, in Counteracting the Depressing Effects of Ether, Chloroform, and Cocaine, During Anæsthesia.

In nitrite of amyl, we have an agent which produces a marked dilatation of the superficial vessels, and must, therefore, to a corresponding, degree, relieve the congestion of the visceral circulation by lessening the tension of the blood; but it must never be used, when there is a flushed face, and congested vessels. If the patient is able to inhale, hold a bottle of it under the nostrils, and direct him to sniff it up freely, and repeat this frequently. If not strong enough to inhale, let a small elastic bag be filled with the vapor; force the vapor into the nostrils at intervals, using artificial respiration. To such an extent will this agent relax muscular spasm, that it has at times overcome the tetanic spasm caused by strychnine, and relieves the most agonizing of known maladies, *angina pectoris*. Even tetanus has been alleviated by its prompt use. In certain forms of asthma, it will relieve the spasm and arrest the paroxysm, but when associated with or dependent upon chronic bronchitis, and emphysema, it is not advisable to use it, nor in aortic disease.

An exceedingly convenient mode of carrying the drug, is by means of thin glass globules, containing respectively ♏iiss and ♏v. When required, one of the bulbs is broken in a handkerchief or towel, and its contents immediately inhaled. It is found valuable as inhalation, at the commencement of the aura of epilepsy, to be followed by the use of the bromides of potassium, sodium, lithium and iron; subsequently, by the use of arsenic. Sometimes inhalation of the drug causes in certain individuals disagreeable dizziness; also sudden collapse has followed its too free use.

"Schuller's" experiments, showed a marked contraction of the vessels of the pia mater, followed by the usual dilatation. It has also been observed, that certain patients state, that objects appeared of a yellow color, subsequent to the use of the nitrite.

IMPURITIES.—If exposed to the air it decomposes, leaving amyl alcohol. It is apt to contain free acid, nitrate of amyl, and nitropentone. It should be re-distilled and purified before use.

There is a very great difference in the effects which nitrite of amyl, chemically pure, produces in different persons. We know of two persons, who cannot approach it without immediately experiencing a feeling of distress in the region of the heart, accompanied by a sense of faintness. Another, after one whiff, swung around, and would have fallen to the ground, if support had not been at hand. In our own case, we can inhale it with impunity, and it requires five to ten seconds before flushing of the face, disturbance of the heart, or giddiness are induced.

When first employed, it was with the greatest amount of care; it was supposed to be very dangerous, but we have not found it to be so, nor have we as yet known, of a single death from it, when used as a therapeutic agent.

In a case of spasm of the glottis, following pneumonia, we employed inhalations of the nitrite of amyl, in the form of the glass globules, "pearls of nitrite of amyl," with success, much to the relief of the patient.

While traveling during the summer of 1877, we met a well-known gentleman of Philadelphia, the late Mr. E. Bonsell,* who was affected with angina pectoris. A vial of nitrite of amyl was his constant companion, for several years. Every little while, he would inhale its vapor with decided benefit and relief. He had done so for many months, without the least deleterious effect.

In another case this remedy completely failed, and hypodermic injections of morphia had to be resorted to during the attacks.

In most cases it is best administered lying down. Women are more susceptible to its effects, than men. Given internally, with mucilage and an aromatic, it will at times produce nausea; generally an irritation of the throat. This is increased by the impurity of the drug.

Taking into consideration the different idiosyncrasies and susceptibilities, it is better in all cases to begin with the minimum dose, say one drop, and gradually increase, if well tolerated. It should never be trusted to the patient, until its effects upon his system are well known.

In "flushings of heat," or "heats," which so frequently trouble women at the change of life, or caused occasionally by the sudden arrest of menstruation, the action of nitrite of amyl, followed by tincture of aconite, one drop in water, every half-hour until the pulse has begun to be affected, and then every hour or two hours, according to the necessities of the case, according

* He died at the advanced age of eighty-two, during 1879.

to Ringer, is very marked, preventing or greatly diminishing the profuse perspiration and consequent prostration. It is said to be useful in sick headache and in preventing sea-sickness. It is stated to have arrested a paroxysm of intermittent fever, when inhaled during the cold stage in the dose of four drops. We have made a series of experiments with this remedy, in tinnitus aurium, and came to the conclusion that it was especially suggested only in affections of the labyrinth. We were led to employ this remedy from its well-known sedative action upon the sympathetic system, especially the vaso-motor nerves, and the fact that many forms of tinnitus are caused not only by an increased intra-labyrinthine pressure, but occur as the result of nervous irritation, not only of the auditory nerve, but in branches of the fifth, of a neuralgic character or trophic type of changes. The remedy was employed by Dr. Michel in twenty-five cases by himself, and in six cases by Dr. Urbantchitsch. More or less improvement occurred in nineteen cases; among these were three in which the tinnitus disappeared entirely from one ear, and in another case was somewhat diminished. From one to five drops of the remedy were inhaled at a sitting. The inhalation was continued during the appearance of the usual symptoms—flushing of the face, injection of the blood-vessels of the eye, etc., and suspended on the occurrence of vertigo. In all, the cases improved; the tinnitus was increased *during* the period of inhalation.

At times, we have been much disappointed in the effects of nitrite of amyl, owing to its being impure, having found it to be nothing more than amylic ether, and requiring redistillation. The amyl, is an agent which should always be in the armamentarium of the medical man, who is prepared to meet any emergency that might arise, while producing anæsthesia with chloroform, ether, or cocaine.

Hypnotism as an Anæsthetic.

Hypnotism (from *hypnos*) is the production of sleep, by what was generally known as animal magnetism. Only certain individuals are susceptible to its influence. The person who operates has, in our opinion, great will power over the individual operated upon. The patient hypnotized, is not absolutely insensible, but operations of a trifling nature can be performed without apparent pain.

Therapeutic Hypnotism.

"It is quite well known that a course of action suggested to a hypnotized person is followed irresistibly and unconsciously by that person after, as well as during, the hypnotic state. Upon this is based the medical application of hypnotism. If a subject can be made to carry out useless, eccentric, or, in some cases that have become known, even criminal suggestions, without his own knowledge of the character or the cause of his action, why, ask the scientific experimenters, may not the same cerebral mechanism be brought into play to influence the physical state of persons suffering from certain kinds of disorders? The influence of the mind and the imaginative faculties on the body in such cases has long been known; and it is maintained that this kind of suggestion does not differ, in reality from that of the hypnotic state. Whatever may be the cause which incites the nervous centres of the brain to intervene in order usefully to modify the organic functions of the body, the process, say these investigators, is the same.

"According to the reports submitted at the late Congress, the treatment of invalids in this manner already shows some remarkable results. Two physicians of Amsterdam told of 414 cases they had treated by hypnotism. Of these 100 were fully cured, in 98 there was a noticeable improvement, in 92 a slight one, and in only 71 were there no results; 58 cases were not followed. These cases included organic maladies of the nervous system, mental diseases, and neuralgia, besides others not directly connected with the nervous system. The treatment of the insane was especially discussed by others, and here, too, success has been obtained in some cases, though the difficulties are far greater than in physical maladies. A curious and interesting report was presented by one of the physicians in regard to his experiments with children, whom he found easier to influence by suggestion than their elders. In this he submitted as a proved conclusion the value of hypnotic suggestion as 'an excellent auxiliary in the education of vicious or degenerate children,' it being 'especially efficient in reacting against vicious instincts, habitual lying, cruelty, theft, and inveterate idleness.' This is, perhaps, one of the most startling assurances we are given of the powers of hypnotism in the hands of competent men; and such results, already attained, seem to point to possibilities of great importance in the further development of this study.

"There is another side to all this, however, which the Congress in Paris did not fail to consider. That is the danger of the abuse and the irresponsible use of the hypnotic phenomena. Trick performances of travelling quacks are common, even in this country; and they are to be considered not only as a vulgarization of the science, but a danger to health and morals. Equal danger rests in the experiments of the well-meaning but unskilled; while the opportunities that hypnotism affords the criminally inclined, it can easily be seen, are numerous. A hypnotized subject is readily made the instrument of vengeance or cupidity, quite unconsciously to himself, after emerging from the hypnotic state; and not only that, but may be made to take upon himself the sole blame. All these perils, it may be, will some time have to be guarded against, though knowledge of the subject is yet too restricted to make them alarming. But if this be so, it will be only one more instance, so many of which modern times can show, in which things of value to humanity are perverted to damaging uses. Of course this unfortunate fact will not put an end to the investigations which promise so much of value; the advances made in this curious and, in its scientific application, so recent branch of scientific study will be watched with great interest." *

Hypnotics or Soporifics.

Most of the soporifics, or hypnotics, stimulate the mental functions, when given in very small doses; in increased doses they diminish or abolish the mental faculties. The same drug —as, for example, opium, or alcohol, in different doses may act as a stimulant, narcotic and anæsthetic.

* *Providence Journal*, September, 1889.

The chief hypnotics are:

Opium	Bromide of potassium
Morphine	Bromide of sodium
Chloral hydrate	Bromide of calcium
Butyl-chloral-hydrate	Bromide of zinc
Croton chloral	Monobromo-camphor
Hyoscyamus	Hop
Cannabis	Lettuce
Paraldehyde	Lactic acid

These general anæsthetics, which are chiefly employed at the present day in the practice of medicine, may be reduced in number to four: alcohols, ethers, chloroform, and nitrous oxide gas. These are employed alone, or mixed in various proportions. They can be reduced to a still smaller number, viz.: nitrous oxide gas, and alcohol, as each of the eleven alcohols, will, by the chemical action of an acid, produce its ether or chloroform.

General anæsthetics are:

Nitrous oxide	Terchlorhydrin
Ether	Bi-chloride of methylene
Chloroform	Paraldehyde
Bromoform	Bi-chloride of ethidene
Tetrachloride of carbon	Bromide of ethyl

Nitrous oxide was the first anæsthetic discovered, and is still the safest for all short operations, but the most difficult to administer really well. To get its full effect, it should be administered pure, all air being rigidly excluded; deep snoring and an insensitive conjunctiva are the best signs of insensibility. Pregnant and nursing women take gas without any deleterious consequences; children, even those who suffered from chorea or epilepsy, do not take it well; great age is no disadvantage. From experiments by the writer made on himself he had learned that just before the loss and return of consciousness, the hearing power was greatly intensified, and he warned surgeons to be careful in their remarks, and advised the room to be kept as quiet as possible.

We have described it as the first systemic anæsthetic on our list.

A New Method for Producing Anæsthesia.

About three years since, M. Brown-Séquard announced that he had discovered a new method of producing anæsthesia, and that under the influence of an irritation of the mucous membrance of the larynx, sensibility to pain disappeared more or less completely, in all parts of the body. This result he attributed, to an inhibitory influence exercised by the superior laryngeal nerves upon the nerve-centres. He has since continued his experiments upon monkeys, and upon himself, and has recently reported his results to the Academy of Sciences. He states that he has found carbonic acid, and the vapor of chloroform, to be the most powerful agents for producing the necessary irritation of the larynx, but this is dependent upon these substances, not entering the lungs, since they thence pass into the blood, and prevent the laryngeal nerves from producing analgesia, without sleep. Considerable difficulty, however, was experienced in applying either of these agents to human beings, and only a partial success was obtained, by effecting the inhalation of pure air during two-thirds, or three-fourths, of each respiration, and then finishing the inhalation with carbonic acid, which had to be expelled immediately. Although an analgesic effect was sometimes manifested rapidly, it was occasionally necessary to continue the inhalation of carbonic acid gas in this way, during twenty minutes or more. It was found, however, thus possible, without causing sleep, or interfering in any degree, with the mental powers or voluntary movements, to produce a nearly-complete analgesia of the skin, continuing nearly forty hours, a cessation during two days of pains from various causes, and the complete disappearance of any excessive feeling of fatigue, under which the patient might be suffering before the administration of the gas. In the case of monkeys, where the irritation could be more effectually applied, it was evident that analgesia could be produced, securing without sleep, insensibility, in respect to wounds, lasting ten days or even longer.

Insanity Following the Use of Anæsthetics in Operations.

Dr. George H. Savage, one of the most distinguished and capable physicians who has the opportunity, as Superintendent and Resident Physician, of the Bethlehem Royal Hospital, of London, of seeing a large number of acute cases of insanity, has called the attention of the profession in a paper on this subject read before the British Medical Association, held in Dublin, August, 1887 (*British Medical Association Journal*, Dec. 3, '87). He had met with a series of cases in which the use of anæsthetics, in predisposed subjects, has been followed by insanity. To make the matter more clear, he has also collected similar cases which have followed similar causes, such as the use of alcohol, belladonna, etc. He thinks, by this means, to be able to show, that the relationship is truly causal. He also places before us several propositions which he endeavors to prove.

Any cause which gives rise to delirium, may set up a more chronic form of mental disorder, quite apart from any febrile disturbance. (*a*) The most common form of mental disorder, which comes on in such cases is of the type of acute delirious mania; (*b*) though such mental disorder is generally of a temporary character, it may pass into chronic weak-mindedness, or into (*c*) progressive dementia, which cannot be distinguished from general paralysis of the insane. Beside alcoholic delirium he calls attention to the fact, that delirium accompanying fevers, may start a similar set of symptoms, as also pneumonia in nervous patients.

We must not, however, forget that shock after an operation of any kind, may produce similar mental disorder. We would refer our readers to the report of the cases in detail, and conclude with the practical deduction of the writer, as follows: In this paper he has combined the experience of many years. One or two practical questions arise for the surgeon, the most important being whether neurotic inheritance or neurosis in the individual, as proved by a previous attack of insanity, should in any way affect the prognosis in operations, and to what degree should it interfere with operations of convenience, not essential for the prolonging or saving of life.

Ether or Chloroform—Which ?*

"The important question as to the choice of an anæsthetic, is by no means the simple affair which the partisans of one, or the other claim it to be. Recent discussions on this subject, in the British Medical Association, in the Academy of Medicine, in New York, and in the County Medical Society, in Brooklyn, together with many editorial, and other contributions, in various medical journals, have served to call attention to the various phases of this subject. Perhaps the most important of all the lessons to be derived from the facts which have been elicited, is the entire unreliability of the statistical comparisons which have heretofore been relied upon, to demonstrate the relative safety of the two great anæsthetics—ether and chloroform. It seems to have been quite clearly brought out, that while, as regards the immediate results from its administration, chloroform has rolled up a death rate far in excess of that produced by ether, still the latter is chargeable with many deaths, from later complications, determined by it, which are as yet an unknown quantity, though they are now, becoming more appreciated.

"Shock, defective and delayed reaction, heart-failure, pneumonia, pulmonary œdema, uræmia, nephritis, are terms which in many instances have explained deaths which were properly attributable to ether. The appreciation of these facts, must lead to a more careful study of the whole subject of anæsthesia, and to greater attention to its technique by practitioners in general. As a contribution to this subject, Dr. A. B. Miles, of New Orleans, presented a memoir to the Orleans Parish Medical Society, June 27, 1887, which has been published in the August issue, of the *New Orleans Medical and Surgical Journal*. In this memoir, the relative merits and demerits of ether and chloroform, together with the conditions of the body

* "Annals of Surgery," Oct., 1887, p. 327.

which may influence their effects when administered for anæsthesia, are presented, and discussed, with great discrimination and clearness. With this preface, we reproduce the greater part of it, which will be found to be worthy of careful study:

"Ether is the weaker anæsthetic, possessing the peculiar toxical quality in less degree than chloroform. In small quantity it is decidedly stimulating to the cerebrum and to the vital functions over which the medulla presides; and, in this action, it is more uniform than chloroform. Indeed, the vital reflexes are so uniformly stimulated by ether, that the danger of its primary effects in healthy subjects, is as small as possible under general anæsthesia. In those who take ether well, the stimulating effect on the heart's action and respiration may be observed throughout the anæsthesia. Ordinarily, even anæsthetic doses of ether do not depress these functions, but leave them to themselves, uninfluenced by the general anæsthetic action. Under etherization, the heart's action and respiration are certainly less liable to the irregularities, which are not unfrequently observed in chloroform anæsthesia. In the latter stages of etherization, however, the vital reflexes may be depressed, and powerfully, but gradually, so as to give warning of the approach of danger. Ether danger, usually approaches by way of the lungs, and usually forewarns by the labored, stertorous, irregular breathing, and cyanosis, so as to allow the use of means to avert. Ether danger may, however, approach by the heart. In ten of forty, well authenticated ether deaths, the heart failed first. These deaths resemble chloroform deaths, but comparatively occur much less frequently. So the comparative safety of ether, and its timely admonition of danger, are its chief advantages. They are certainly points of great practical value, in its favor.

"Against the merits of ether, stand in stronger relief to-day than ever before its disadvantages and its dangers. The advocates of ether, who use it excessively, especially those who yet believe in its absolute safety, are doing much to-day to demonstrate its dangers. Its inflammability in the presence of artificial light, and the actual cauteries, is one objection. The danger of igniting is modified by several conditions: the proximity of the light, its position, and whether exposed or not, the saturation of the surrounding air and the direction of the air currents. Ether may ignite at long distances (fifteen feet, it is said) if the currents set in the direction of an exposed light. But the dangers of inflammability may be modified, as above indicated, and much diminished. The exceedingly disagreeable odor, and the irritating property of ether, when brought in contact with mucous surfaces, are serious disadvantages. It was this irritating property, which refuted the claims of rectal etherization as a warrantable procedure in surgery, but not until it had brought sorrow on its advocates, and a worse fate on some of its victims—diarrhœa, dysentery, hemorrhage, collapse, death. The irritation of the respiratory mucous membrane, usually causes coughing, strangling and violent resistance. It may cause catarrhal bronchitis, and pneumonia. It may very seriously aggravate a pre-existing bronchial or parenchymatous inflammation.

"The excessive secretion which ether causes to flow into the breathing passages, is also a disadvantage not to be lightly regarded. This may endanger life by suffocation, especially in cases of pulmonary disease, already attended with free secretion, as in the catarrhal affections of children, and old people. It not unfrequently prolongs the asphyxia caused by the usual method of administering ether.

"Patients are usually asphyxiated, while being anæsthetized with ether. True, the asphyxia favors the anæsthetic effect of ether, and therefore obviates the necessity of too greatly saturating the blood. But the asphyxia complicates and increases the danger of anæsthesia. The dangers of such a state are beyond question. They are not so immediate as those of chloroform, and, therefore, have been less apparent, and less appreciated.

"Asphyxia, as well as etherization, may be carried too far, and at times result disastrously. The respiratory nervous apparatus is exhausted, and the heart fails secondarily. The tone of its own texture is destroyed, by the supply of venous blood, and by impediment to the pulmonary circulation, its right ventricle becomes overdistended, and powerless. So, etherization, as much from asphyxia, due to the manner of administration, as from its anæsthetic effect, may depress the heart's action, as well as respiration. But the sequelæ of etherization, are matters of more serious importance, to which attention is specially directed.

"Aside from the danger of inflammatory diseases, caused by the irritating ether vapor, is the liability to pneumonia, as the result of obstructed pulmonary circulation.

"Again, the asphyxia which goes along with etherization may increase the patient's depression, and retard reaction. The deleterious blood changes in a patient who has undergone prolonged etherization, cannot be well suited to the healing of important wounds. In the suffocating plan of administering ether the blood suffers not alone of the interruption to the interchange of gases, but as much of the rebreathing of excrementitious albuminoid products, which physiologists tell us are so harmful.

"The danger of nephritis, by the action of blood saturated with ether, first pointed out by Dr. Emmet, of New York, has been authentically confirmed by many observers. Healthy organs may be acutely inflamed, and those previously diseased, may be greatly aggravated by the passage of such an irritant over their secretory surfaces. The danger to the kidneys, led to the general adoption of the method by forced etherization, by which the asphyxia lessens the quantity of the ether required.

"Ether, more frequently than chloroform, causes nausea and vomiting. This is an important consideration, in the selection of an anæsthetic to be administered in cases in which persistent retching may interfere with the healing of important wounds.

"While the immediate dangers of ether are comparatively slight, those which occur subsequently, to which we have just alluded, are matters of very serious consequence. These dangers weigh heavily against the merits of this anæsthetic.

"Now, let us pass in running review the advantages and dangers of chloroform.

"Its non-inflammability in the presence of artificial light, or the actual cauteries, is an advantage which increases greatly the range of its usefulness. It is certainly the more agreeable to patients, less irritating to the sensory nerves of the respiratory passages and the more enduring in its anæsthetic effect. It causes comparatively little increase of mucous secretion. It is easier of administration, and the mode of administration does not entail any other effect, than that of a pure and simple anæsthetic. Chloroform is the more energetic agent, possessing the inherent toxical quality, in higher degree than ether. This quality, however, does not differ in character from that which ether possesses.

"The primary effect of chloroform, as of ether, is stimulating to the cerebrum and the vital functions; but the excitement is less intense and of shorter duration than in etherization. Being the more energetic agent, it requires less saturation of the system, for the exercise of its anæsthetic power. This is an important consideration. The practical advantages of chloroform in surgery, are very striking. These and its comparative freedom from disastrous sequelæ, take away much of the terror of its immediate dangers.

"The dangers of chloroform are soon told. They are immediate. If patients do not die during the administration, they are comparatively safe. *Nearly fifty per cent. of deaths by chloroform occur at the outset of the administration.* The chief danger of chloroform is paralysis of the nervous apparatus, governing circulation, and respiration mentioned in the order of frequency. The centres are taken by surprise by the direct, and energetic action of chloroform, and overwhelmed quickly. This sudden action has given to chloroform, the name of being treacherous. It teaches unmistakably the necessity of gradually accustoming the centres to the influence of anæsthetics. We dwell on this point with special emphasis.

"A large proportion of deaths by chloroform are reported as occurring suddenly, and without warning. These cases are usually reported in a way to lay all the blame on chloroform. While we do not doubt the extreme susceptibility of some patients, which makes them liable to such fatal accidents, we are constrained to believe that in more instances than recorded, there are timely admonitions of danger. These admonitions are irregularities of the heart's action, and respiration. Experiments on animals, have shown how, under chloroform anæsthesia, the heart is liable to sudden irregularities. Clinical experience confirms the observation. Irregularity of the heart's action, as regards the strength of its beats, is especially ominous. The hesitating, irregular respiration of chloroform anæsthesia is but little less valuable as a warning of danger, and certainly demands more attention than usually given. The statistics before mentioned, show, that in one-fourth of forty cases of chloroform death, respiration failed before the heart's action. Patients who breathe irregularly, should be anæsthetized with the utmost caution. These irregularities of the heart's action, and respiration, indicate a condition of the centres which bears anæsthetics badly. This condition is more frequently observed in the anæmic and weakly, and in those under the influence of depressing emotions.

"The dangers of ether, and of chloroform, are modified by methods of administration. Indeed, we feel safe in venturing the assertion, that the dangers of anæsthesia lie not more in the inherent property of the agent employed, than in the manner of its administration.

"The risks are very much greater in the unskillful administration of chloroform, than in reckless etherization. In view of the danger of its primary effect, we insist here on the advisability of preparing the way for chloroform. Agents should be given in advance to stimulate the vital reflexes and prepare the nerve centres for the coming anæsthetic effect.

"The old-fashioned whiskey toddy, taken just before the anæsthetic, still has its votaries. The use of alcohol in this way is objectionable. We cannot rely on absorption from the stomach, at the very time its stimulating action is most desirable. If given immediately before the anæsthetic, it is not absorbed in time to sustain the centres as they undergo primary anæsthesia. If given in time for absorption, the alcohol antagonizes the action of the anæsthetic. Alcoholic patients are difficult to anæsthetize, and while under anæsthesia, they often show alarming symptoms.*

* See article on "Alcohol in Operations."

"Again, alcohol is uncertain in the physiological action for which it is given. In many subjects, by abuse, perhaps it may have long since lost its medicinal virtue, while in others its effect may be variable because of nervous susceptibility. Alcohol taken into the stomach before anæsthesia, has the effect of exciting many patients after a surgical operation, at the time when it is most desirable that they should be calm. This excitement may increase the liability to inflammation. The maximum good, with the least harm, follows the use of alcohol when administered hypodermatically, or by inhalation at the outset of anæsthesia. The first whiffs of chloroform may well be mixed with the vapor of alcohol.

"A few breaths of the vapor of ammonia, in advance of chloroform, act like alcohol, but more potently and without its disagreeable effects.

"The method of mixed anæsthesia, by the hypodermatic administration of the sulphate of morphia alone, or in combination with a respiratory stimulant, as the sulphate of atropia, is as sound in physiological principle as useful in practice.* The doses of the sulphate of morphia in adults, should not exceed one-twelfth to one-sixth of a grain; of the sulphate of atropia, one two-hundredth, to one one-hundred and fiftieth of a grain. The atropine acts particularly well in states of bronchial catarrh, in pulmonary diseases and in all cases indicating the action of a respiratory stimulant. The hypodermatic use of morphine, in the doses recommended, secures the primary stimulant effect promptly when desired, aids the anæsthetic in its action, and subsequently promotes the relief necessary after surgical procedures.

"A safe way of preparing the centres for chloroform, and one which we strongly recommend, is by stimulating them primarily with the inhalation of ether. The centres more easily adjust themselves to the action of ether. Statistics show, that the danger of the first effect of ether is almost infinitesimal. Thus, the anæsthesia is begun with the agent, safer at the beginning, and continued with the agent less harmful in its subsequent effects.

* But not always in practice, on account of idiosyncrasy of patient.

"There are causes of danger in the administration of chloroform, which occur so commonly as to warrant special mention here. Chief among these common causes of fatal accidents is overdosage—an excessive amount in a given time. Patients being anæsthetized with chloroform, should never experience the sense of suffocation of which we too frequently hear them complain. Coughing early in the anæsthesia, is usually an evidence of over-action. Chloroform anæsthesia, should be begun with minimum doses—a few drops only—and continued to the degree desired in quantities gradually increasing. To overdosage, more than to idiosyncrasy of patients, should be attributed most of the accidents by chloroform. Witness the manner in which so many physicians give chloroform, by saturating the inhaler at the outset, and forcing the anæsthesia, and there will be less difficulty in explaining many of those deaths, that occur with such electric suddenness.

"Haste in the administration of chloroform, deserves most emphatic condemnation. The anæsthesia should be produced gradually, and maintained uniformly. We believe it unsafe to advise patients at the beginning to 'take long breaths,' with the view of quickly inflating the lungs with saturated air, in order to produce a rapid effect.

"In the calm, which follows the preliminary excitement, chloroform acts with increased energy. The centres are at this moment in a state of exhaustion, and not prepared to have the anæsthesia forced. The depression which follows the primary excitement, is a period in which much harm may be done, by overdoses of chloroform.

"Instead of forcing chloroform anæsthesia, at any time, during its administration, it is better now and then, to give the patient a rest spell, in order to refresh the residual air of the lungs. Some of the singularly sudden deaths, of which we read, may be accounted for by the cumulative effect on the centres caused by the sudden absorption of vapor which saturates the residual air.

"Statistics are yet wanting by which we can accurately estimate the relative death-rate, caused by ether and chloroform. At a meeting of the New York Academy of Medicine, elsewhere mentioned, Dr. Weir reported five deaths by ether, in 10,789 surgical operations. One surgeon reported two deaths by ether, occurring in his own practice, in the course of as many months. These figures do not, most probably, include deaths caused by etherization, yet occurring subsequently, which in years past were not so well understood as now. However, the proceedings of the Academy, prove very convincingly the dangers of an agent, which enjoys an undeserved reputation for its safety.

"At the same meeting of the Academy, Dr. Knapp, of New York, reported that from 1860, to 1876, he had used chloroform in three thousand cases, without a death; that since 1870, he had used ether exclusively, also without a death. The last death of chloroform in our Charity Hospital, occurred on the 12th of November, 1881; the subject a tertiary syphilitic with albuminuria, undergoing operation for removal of necrosis of the tibia. This was one of those appalling, sudden, deaths, most of which occur in patients who are anæmic and wasted by chronic illness. The hospital records do not show the number of cases in which general anæsthetics have been used since 1881, but give the quantity of ether and chloroform consumed, all of which, save the small quantity used for other purposes, was given as a general anæsthetic. In 1881, eighty-eight pounds of chloroform were used, six of ether; in 1882, one hundred and five of chloroform, two of ether; in 1883, one hundred and two, and eighteen; in 1884, ninety-four, and fourteen; in 1885, one hundred and sixteen, and twenty-three; in 1886, eighty-eight, and fifty-six; from January 1 to June 1, 1887, fifty-three pounds of chloroform and eighteen of ether. During the five years, 1882 to 1886, inclusive, five hundred and fifteen pounds, or nearly fifty gallons of chloroform, and one hundred and thirteen pounds, or a little more than seventeen gallons of ether, were used in the hospital. During these years 85,680 patients of all diseases have been treated, and, as will appear in the figures showing the relative quantity of ether and chloroform used, the vast majority of the patients requiring general anæsthesia, including seven hundred cases of important surgical operations reported, have been treated with chloroform. The above statements are made simply to convey an approximate idea of the extent to which chloroform has been used in this house, since 1881, without fatal accident.*

"It is our conviction, with the lights before us, that chloroform, carefully administered, with the precautions herein indicated, is as safe as ether administered by the plan generally practiced in America at the present day. However, the unskillful administration of chloroform, and inattention to its warnings, are fraught with so much more danger than attends or follows etherization by the usual method, that we recommend *ether in the surgery of adults whenever its use is not contra-indicated.*

"Let us now apply practically, what we have written, and in conclusion, sum up those conditions indicating, and contra-indicating, the use of ether, and of chloroform.

"As a rule, in the surgery of adults, anæsthesia should be begun with ether, and continued with ether, unless contra-indicated. The chief contraindications, are pre-existing inflammation of the respiratory passages, of the lungs or the kidneys; insusceptibility to the effect of ether, unless given in overdoses; violent excitement, which may endanger the cerebral vessels in the infirm; and local evidences of excessive irritation of the respiratory surfaces.

"In all quick operations which can be performed during primary anæsthesia, ether is especially preferable. The danger of its primary effect is insignificant.

"Ether is the more applicable in all states of anæmia, acute, and chronic; and in states of extreme nervous depression, whether caused by shock, fright or the neurasthenia of chronic disease. These are the conditions, in which chloroform deaths have occurred most frequently.

"Ether is especially preferable in cardiac diseases and degeneration, where the organ is weak in its action, particularly

* During the Civil War Dr. Hunter McGuire collected the reports of 28,000 admin istrations of chloroform without a death. Nussbaum has recorded 40,000 cases of chloroform anæsthesia without a death. These records are very remarkable. See Discussion on McGuire's paper.

in those cases in which the heart's feebleness is manifested in irregularity as to the strength of its beats. Such are the hearts that are exhausted by overwork; the dilated hearts of mitral and aortic regurgitation; the hearts which sympathize in states of general ill-health, poorly nourished, relaxed in tissue, unsteady in action; the hearts of those convalescing of chronic diseases, of patients depleted by exhausting discharges or hemorrhages, of chronic alcoholics, of old syphilitics; and the hearts which have undergone degenerative changes, resulting from disease, or the decay which comes with age.

"Chloroform is permissible in cardiac diseases, attended with overaction of the organ, as in states of compensatory hypertrophy. It is indicated in this condition of the organ, when associated with nephritis. In all diseases and deformities of the heart, whatever murmurs may be heard, if the organ functions well, chloroform may be given if indicated. As there are a great many crippled limbs doing good service, so there are many hearts, altered by past diseases, which yet act so well as to give no trouble. Such hearts are apt to beat more steadily under an anæsthetic, than when submitted to the tortures of a painful surgical procedure, without it.

"Chloroform is preferable, whenever a general anæsthetic is required in cases suffering from pulmonary diseases. It is less irritating to the respiratory surfaces, causes but little increase of the mucous secretion, and interferes less with the pulmonary circulation. The contraindication to ether in these cases is very positive.

"In nephritis, chloroform is the preferable anæsthetic. In the chronic stage, ether is only permissible at the beginning of anæsthesia, to sustain the heart, now usually very weak, and prepare the nerve centres for chloroform. Of all the conditions said to contraindicate both of these general anæsthetics, Bright's diseases are entitled to the most serious consideration. Aside from the asthenic state of heart muscle, respiration is very often impaired, either by pulmonary œdema, or the renal asthma, which results from anæmia of the nerve centres. These conditions in the aggregate, make the use of any anæsthetic of maximum danger. The observation of the harmful effect on the kidneys, by blood charged with ether, has been authentically confirmed by a number of writers, and has contributed greatly to a better appreciation of the dangers of ether.

"Cases are occasionally met, in which ether fails to produce surgical anæsthesia, unless given in an amount to saturate the system to a dangerous degree. Such patients in our observation, after the preparation of the nervous system by ether, take chloroform very happily and go quickly under its influence.

"Chloroform is preferable, then, in all cases that take ether badly, and those in which the anæsthetic power of ether is insufficient, unless administered in overdoses.

"Chloroform is the preferable anæsthetic in childhood. Statistics show that children, compared with adults, enjoy exceptional immunity from accidents by chloroform. Children bear chloroform so well, that many can be anæsthetized during sleep; while, under ether, they struggle and strangle, and pass through an agony of indescribable terror.*

"Shall we use ether or chloroform, in the aged and infirm? Here we are dealing with organs as delicate, as fragile glassware. The heart is tottering in its action, and the brain is fed by vessels too brittle for any overstrain. Shall we select the milder anæsthetic, the safer for the heart, but which usually excites such violent struggling, and such tumult in the circulation, as to endanger the cerebral vessels by rupture, and which causes subsequent dangers so serious in infirm people? Or shall we select chloroform, which obviates all the objections to ether, but which unquestionably, in these subjects, acts on the cardiac and respiratory nervous apparatus with increased energy? The condition of the organs endangered in individual cases, should decide the choice. In infirm subjects, more especially, anæsthesia should be begun with ether, when not contraindicated, and so continued in those who take it well. If there be much struggling and resistance, or much increased bronchial secretion, or other evidences of the injurious action of ether, then chloroform should be substituted. In our experience, after the first effect of ether, chloroform has proved the

* See our article on "Chloroform as an Anæsthetic in Children"

preferable agent in most cases of aged and infirm subjects, save those whose hearts are very weak and irregular.

"Shall we use ether or chloroform in cases which may be seriously complicated by nausea and vomiting, as in abdominal, and gynecological surgery, and the surgery of the cerebrum? The danger of suffocation by vomited matter, especially in etherization, should never be lightly regarded, nor the ill-effects of persistent nausea, and retching on the healing of important wounds. Chloroform, less frequently than ether, causes vomiting, and in emergencies requiring general anæsthesia before the digestion of a meal, is the preferable agent. Indeed, in all cases where obstinate retching after surgical operation might endanger life, chloroform is preferable.

"As a measure to prevent nausea and vomiting under anæsthesia, we wish to lay stress on the importance of administering the anæsthetic gradually, and maintaining the anæsthesia in a uniform degree. Any surprise to the centres, or sudden alteration of their molecular or nutritive changes, may cause nausea. An hypodermatic injection of the sulphate of morphia occasionally, has this effect. So, anæsthetics, or other agents acting similarly, when administered interruptedly, act unevenly on the centres, and by such repeated surprises cause nausea. They act like a rough sea.

"Chloroform and ether, therefore, have their respective fields of usefulness, in which they are equally serviceable. They are equally dangerous when given in the face of their contraindications. Not until medical men learn to discriminate properly in their choice of these anæsthetics, and recognize the fact that the dangers of general anæsthesia, depend as much on the method of administration, as on the toxical property of the agent employed, will the risk of fatal accidents ever be reduced to the minimum."

Our only observation on this valuable paper, is not "which," but both in the proper cases.

CONCLUSION.

On the Choice of Anæsthetics, and the Importance of Great Caution, in Producing Anæsthesia.

For all minor operations in surgery, at the house of the patient or in private office (when the cost of the anæsthetic is of no consequence, and where disagreeable odor is to be avoided), nothing has yielded us such satisfactory results, as *cocaine or bromide of ether.* For all dental operations (except tedious and protracted dissections on the mouth), the safest anæsthetic is *nitrous oxide gas, and ether* where many teeth are to be extracted, which, in its results, is exhilarating and most satisfactory, and with but little effort produces complete insensibility to pain, and is most rapidly eliminated from the system. For dangerous and protracted operations, the agent which has been employed in this city, and in the United States, is the pure *ether;* the proofs of its *comparative safety are full and complete.* Chloroform, as an anæsthetic, has a long and painful record of valuable lives lost from the time of its introduction to the present day, so that no one is justified in using it, unless the ordinary agents specified above fail him, or unless he has to employ the actual cautery; even with little children, it is not absolutely safe, and a reference to the body of this work, and tables, will show that numerous deaths, follow its use.

Every combination of chloroform, its various modes of administration in both large and small quantities, and mixed with other agents, have been experimented with, but those who have employed it most, have, when its positive fatal action is seen, has had at last to resort to ether, or nitrous oxide and ether.

Great care is to be exercised in the quantity employed of chloroform, bromide of ethyl, and cocaine, and it is prudent to refuse them to aged, anæmic, feeble, or highly nervous persons.

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