Weapons of Mass Destruction

What You Should Know: A Citizen's Guide to Biological, Chemical and Nuclear Agents & Weapons

Gladson I. Nwanna, Ph.D., Editor

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My gratitude and indebtedness also goes to the agencies and departments of the government whose work I have reproduce in this book. These include: the Red Cross, Federal emergency Management Agency (FEMA), the Centers for Disease Control and Prevention (CDC), the Agency for Toxic Substances and Diseases Registry (ATSDR).

Preface

The September 11, 2001, terrorist/catastrophic assault on America sets both the background and motivation for this book. The sad events not only ushered in a new awakening for Americans, it also cast an indelible mark on America's consciousness and history. It was an awakening and reminder of its vulnerabilities, but as well as a challenge to its hegemony. The September 11 event has, for all practical purposes, changed the course of American history and the way of life of Americans. It has also substituted the national rallying point with vigilance as the new mantra.

The September 11 event, the ensuing discussion surrounding it and subsequent national policy shifts and changes have included the learning of words and phrases such as "Weapons of Mass Destruction" (WMD), Smart Bomb, Bioterrorism, a lexicon of words and phrases rarely before used with such frequency to conjure impending and catastrophic danger which citizens must understand and embrace; words and phrases, hitherto, within the domain of use and technical understanding almost exclusively limited to scientists, top policy makers and specialized institutions. The September 11 event appears to have created need for an understanding of these terms with a goal to better appreciate the government's policy, the urgency of action, and the command to rally around the cause and the challenges as enunciated by the President of the United States.

Like many fellow citizens, I felt persuaded and convinced. I felt I understood the case, the call, the subject matter and the urgency. I assumed the majority of the citizen's understood as much. Did the majority of my fellow citizens really understand many of the words, phrases and statements that filled the airwaves? I wondered if they really understood their responsibilities as called for by this sudden awakening in the national consciousness not only with the present threats, but also the potential threats which led to the new Department of Homeland Security emergency alert system.

As I pondered the threats, the warnings, the phrases and on what I believed I was required to do as a citizen in the event of an attack, I thought about the millions of other Americans

who are fully at alert status, but who possess very little knowledge about what this is all about. I pondered in particular, if they knew what to do in the event of another incident similar to the 9-11 event or a chemical or biological agent attack. I pondered even more about these types of attacks, the illnesses and havoc they may cause and I continue to wonder how many friends, relatives and fellow citizens know what they can do to prevent or minimize the effect of such attacks, thereby safeguarding their heath and the life.

It was all of these concerns and my conviction that I may not be far from being correct in my thoughts that motivated me to write this book. It is my belief that personal security and well being is intimately tied to National Security. And if you are apt to agree with me, you will also agree that a book such as this will be invaluable for Americans and non Americans alike, in particular those who are not so imbued with relevant scientific and technical knowledge of the core material. Those who may not have the time to research these matters should personally find the book informative.

In this book, I explore in a rather non-technical fashion the concept of Weapons of mass Destruction as used both narrowly and broadly, historically and contemporarily. I address in particular biological and chemical agents and diseases, as well as nuclear/radiological agents, agents that have had a history of being weaponized and those that have the potential. I also explore basic elements of these agents, how they are transmitted, their potential health effects on humans and ways of minimizing threats posed by these agents including the government's role and our role as citizens.

I must also point out determined, deliberate, and persistent efforts on the part of U.S. State and local governments and media outlets to alert and educate citizens on the issue of terrorism, Weapons of Mass Destruction and related subject matters. Unfortunately, this information is often widely scattered . It is scanty and very technical or in the case of radio/TV broadcast media, very transitory. There are millions of Americans who either do not have timely access to available mass media outlets to benefit, or do not know about the existence of this valuable information. This book is largely intended for that audience. I have made every effort to arrange the information in such a way as to be easily understood and available in a readily usable format.

This book is essentially a collection of relevant information on the subject of Weapons of mass Destruction. The information came primarily from federal government sources and is believed to be reliable and authoritative. I have included in the book the sources of all information.

It is my hope that this book will not by any means be considered the final words or a treaty on Weapons of Mass Destruction or related topics covered, nor should it be considered a comprehensive treatment of the topic. Rather, I would prefer it to be considered simply a non-technical and basic introduction and overview of the subject.

It is, my hope that information contained in this book will not only make the lay reader better informed on the subject matter, as indeed it has made me, but that it will make all of

us better citizens, who collectively will be better capable of identifying managing future threats, and protecting the country

In the Appendix section of this book, I have provided valuable resources (addresses, phone numbers, institutions, agencies and other information) that should be of help to readers.

I believe this book will generate wide appeal. The information should be useful to Americans as well as citizens of other countries that may be facing similar experiences.

We hope that your expectations will be met and when they are, we would appreciate hearing from you. Should the contents of this book fall short in meeting your expectations, we would certainly like to hear from you so that an effort can be made to improve future editions. Suggestions and letters should be mailed to Public Relations Department, Frontline Publishers, P.O. Box 32674, Baltimore, Maryland 21282-2674.

Editor's Note:

[1] In this book, an effort has been made to reproduce materials from several sources, including valuable advice and answers to questions of potential interest to readers. This book provides these sources by incorporating the advice of experts in the field. To these sources, I must say THANKS for facilitating the process of preparing this book.

[2] The editor and publisher has made a determined effort to reproduce several of the borrowed materials verbatim and in their entirety. Only in a few instances was it necessary to make minor alterations in order to facilitate reading and to ensure consistency and uniformity.

[3] We live in changing times, including changing information on some of the topics addressed in this book. Whereas most of the information contained in this book will remain valid through the ages, some is bound to change. Therefore, I have provided you with relevant references, including addresses (mailing & web), phone numbers, and e-mail addresses of government and non-government agencies and organizations that will keep you up-to-date.

For a book of this size, with all the diligence on the part of the publisher, errors, and omissions both typographical and in content are bound to occur. I urge you to inform us whenever you find such errors and omissions so that they may be corrected in the next edition. At the time this book went to press, every effort was made to ensure that all references were accurate. I must, however, make the following explicit disclaimer.

DISCLAIMER

The editor and Frontline Publishers shall have neither liability nor responsibility to any person or entity with respect to any loss or damage caused, or alleged to have been caused, directly or indirectly, by information contained in this book. Nor will they be held responsible for the experiences of readers. The information contained in this book is meant to serve only as a general guide and to assist you as you deal with matters in the area of Weapons of Mass Destruction. It is by no means the only source, or the ultimate source of the information on the subject of WMD. This information is neither all inclusive, exhaustive nor cast in bronze. I certainly recommend additional research and independent verification and assessment from other sources. If you do not wish to be bound by the above, you are advised not to purchase this book.

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Chapter 1

INTRODUCTION

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As Steve Bowman stated in his article "Weapons of Mass Destruction (WMD): The Terrorist Threat," the term weapons of mass destruction is a former Soviet military term which was euphemistically used to denote nuclear, chemical, and biological weapons. It is now widely used despite debate over its appropriateness, and its definition has broadened to include radiological weapons. For some, particularly in the wake of the World Trade Center airliner attacks, the term WMD has come to include any means capable of inflicting mass casualties."

In this book I use the broader definition. I examine the biological, chemical and nuclear (radiological) agents which are employed in the production of WMD including health effects and how to minimize the effects of exposure.

While the term "Weapons of Mass Destruction" connotes destruction and something we all should be afraid of, since September 11, 2001, this is largely the case when viewed within the context of terrorism or warfare. Generally, many of the agents that have been weaponized are still being used in one form or the other for peaceful and useful purposes from the production of energy to the manufacture of pharmaceuticals, food, cosmetics and pesticides. It is within this context that you may have heard the phrase "Dual Use." Suffice it to say, some are integral ingredients in the manufacturing process of day to day products. Similarly, while the term "Weapons of Mass Destruction" appears to be a concept suddenly invented in the 20th or 21st century, the use and exposure to chemical and biological agents have had the same effect for centuries. In other words, it is not an entirely novel phenomenon.

What essentially has changed overtime is the technology and engineering applied to the manufacture and delivery of these agents, and the accompanying interest and advancement in the means of containing and managing their effects. What has also changed is growth in the wealth of knowledge surrounding the manufacture and use of these agents; in particular, their manufacture and use by individuals and some governments as an offensive weapon to inflict fear, pain and suffering.

While new technologies related to biological warfare are emerging rapidly, the implications of genetic engineering of chemical and biological warfare are far reaching.

CHALLENGES/FUTURE

In this book we will examine various biological, chemical and nuclear agents that have been weaponized and used in past wars and conflicts, and those currently in military applications world-wide. We will also examine some that had been used and discontinued, but that could be revived in the future. We will also examine some that have the potential to be constituted and used as a weapon of mass destruction.

As these agents are examined a number of things should be kept in mind particularly of biological and chemical agents: 1) this book does not attempt to examine all agents. Not only are there hundreds of agents that a book of this nature cannot meaningfully address, the great majority have not been weaponized. (2) Many of the agents that have not been weaponized may never be weaponized because of the cost involved, the nature and structure of the agent or the absence of an effective delivery system. (3) With the advent of new technology, many potential new weaponized agents are constantly evolving as a result of biological and genetic engineering processes. Genetic modification of existing agents and mixtures of various chemical agents and their compounds essentially means newer potential weapons with unique and different characteristics. (4) Some agents are easier to produce and deliver than others (5) While the impact on our health of some agents is rather obvious, others are not quite so clear; research on them continues.

THE ROLE OF GOVERNMENT

For many, determining the presence of these WMDs may be difficult. There is no need to be alarmed. Except for the sudden use of nuclear weapons that may be instantly catastrophic, we would most likely have to depend on the government (federal, state, local) for notification and guidance in the event of an attack. What we do following that notification and our ability to withstand the attack and its effects will invariably depend on how much prior knowledge we have about the weapon. Such guidance will be provided throughout this book as each agent is examined and as we examine the role of the government during such events.

Chapter 2

BIOLOGICAL, CHEMICAL AND NUCLEAR WEAPONS: A MILITARY PERSPECTIVE

■ ■ ■ ■

INTRODUCTION

Before the demise of the Soviet Union, the proliferation of nuclear, biological, and chemical weapons was considered in the context of superpower relations. The breakup of the Soviet Union and the subsequent events have had many consequences. Regional conflicts, once constrained, are now increasingly likely to result in the use of weapons of mass destruction. Opportunities to acquire key technologies and components have expanded through the dual stimuli of underutilized technical expertise and difficult economic circumstances. Simultaneously, development and availability of applicable technologies have expanded.

Responsible states have endeavored to stem proliferation of WMD through international agreements and export controls. Such tools, while imperfect, remain the basis for increasingly comprehensive steps to address the broad WMD threat.

Concern about the proliferation of nuclear, biological, and chemical weapons and their means of delivery has reached exceptional levels. On November 14, 1994, the President of the United States found that "...the proliferation of nuclear, biological, and chemical weapons ('weapons of mass destruction') and of the means of delivering such weapons, constitutes an unusual and extraordinary threat to the national security, foreign policy, and economy of the United States...." He declared a national emergency to deal with the threat. This executive order (12938) was extended on November 8, 1995; November 12, 1996; and again on November 12, 1997.

WMD warfare involves a myriad of factors: types of weapons; delivery systems; conflict arena size and WMD launch-to-target distance; attack size, timing, tactics, frequency, and duration; military or political, counterforce or countervalue attack objectives; weapon stockpile sizes; and custody and release policies and procedures. In summary, development, integration, and employment of Weapons of Mass Destruction and their means of delivery is grounded in a huge number of choices which will be driven overwhelmingly by the political aims, culture, and resources of the proliferator. Other drivers include economics, a trained workforce, and available technical knowledge.

BIOLOGICAL WEAPONS TECHNOLOGY

Biological agents are naturally occurring microorganisms (bacteria, viruses, fungi) or

toxins that can cause disease and death in a target population. They can also attack the food supply and/or materiel of a nation. Biological weapons (BW) which project, disperse, or disseminate biological agents have two characteristics that enhance their effectiveness as weapons: (1) biological agents, other than toxins, reproduce and, therefore, a small amount of infectious agent can cause disease; (2) biological agents, other than toxins, usually require an incubation period of hours to days to manifest signs of exposure so the affected soldier (or person) is not certain whether a biological agent attack has occurred until illness sets in.

The United States has forsworn the use of biological weapons and has developed a strategy of offensive strike power by other means, coupled with biological defense capability, as a suitable deterrent to potential adversaries. A nation, subnational group, or organization, or even an individual, determined to construct a biological weapon and release the agent can, with minimal financial resources and infrastructure, produce an effective weapon. Small amounts of biological material are sufficient because of the reproductive nature of microorganisms. The availability of small amounts of biological organisms, including those listed by the Australia Group (AG), in culture collections provides a major resource for such determined entities. All of these stocks are also available from natural sources, such as soil samples and infected rodents. In addition to naturally occurring organisms, genetically modified organisms may be used as biological agents. Some organisms exist primarily in repositories and may be used as biological agents (Variola Virus). It is estimated that between 10 and 10,000 virulent organisms of the AG agents are sufficient to cause illness in one individual. The number of organisms required is a function of the specific agent and the means of delivery.

There are aspects that make biological weapons agents unique and different from all other weapon systems. Whereas a subnational group would be required to have a significant infrastructure to develop nuclear devices, it would be less complicated to make biological agents. Moreover, the biological agent could be a strategic and disorganizing threat because of its ability to reproduce and the delayed manifestation of symptoms. Those delivering BW could be protected by active or passive immunization or by well-designed protective masks to protect the respiratory system from aerosols, the primary delivery mechanism.

An additional characteristics and certainly a concern is the relative low cost required for the production and theease of deployment of biological agents by subnational groups and organizations for biomedical, pharmaceutical, and food production. All of the equipment used to produce biological agents is dual use.

Because biological agents reproduce, only small amounts of a starter organism are needed. Other weapons of mass destruction (WMD) require the purchase of large amounts of precursor or of fissile material to achieve threat capability. The self-generation of the biological agent is a unique element of this WMD.

1. History of Biological Weapons and recent developments

Crude forms of biological warfare have been employed since 300 B.C., when the decaying corpses of animals and humans were placed near water and food supplies of adversaries. Over the years, different diseases, including plague and smallpox, were used as the agent. Catapults were one vehicle for introduction of the infected tissue. Other vehicles, including blankets, have been employed to transmit smallpox to a target population. World War I saw the development of biological warfare strategies. Cholera and plague were thought to be used in Italy and Russia while anthrax was presumably used to infect animals in Romania. A consequence of such events was the 1925 Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous, or Other Gases, and of Bacteriological Methods of Warfare—known as the Geneva Protocol. This protocol banned the use of biological agents in warfare but not research, development, production, or stockpiling of such agents.

With the advent of World War II, rapid developments occurred in biological warfare capability in the United States and other nations.

In 1969, President Nixon stated that the U.S. unilaterally renounced biological warfare. Biological weapon stockpiles and their associated munitions were destroyed following the preparation of an environmental impact statement and review by both federal and state authorities and the public. Low targeting capability, the potential for catastrophic outcome on civilian populations, and public antipathy to biological weaponry were factors in the renunciation of biological warfare. In 1972, there was international agreement to the Convention of the Prohibition of the Development, Production, and Stockpiling of Bacteriological and Toxin Weapons and their Destruction [Biological Weapons Convention (BWC)]. Concern over USSR compliance with the Convention arose with the sudden outbreak of anthrax cases in Sverdlovsk (now Ekaterinenberg) in 1979. The early 1980's saw renewed discussion of the utility of biological weapons as strategic weapons. For example, information became publicly available concerning studies of biological agents in Japan and the studies on the effects of infectious agents on human subjects in Harbin, Manchuria, during World War II. The number of infectious agents used on human populations was about 25 (e.g., plague, typhus, smallpox, tularemia, gas gangrene, tetanus, cholera, anthrax, tick encephalitis). In 1941, the Japanese deployed plague-infected fleas in Hunan Province, resulting in the death of several hundred persons. The difficulty encountered by the Japanese was the development of an effective delivery system.

In recent years, newly emerging infectious diseases have complicated the picture. They include AIDS, prion disorders, and several hemorrhagic fevers such as Ebola. These diseases and the possible reduction in immunocompetence have fostered an increased role of the United States and international agencies in monitoring disease outbreaks.

The introduction of modern biotechnology during the past 25 years has markedly changed the qualitative and quantitative impact that biological warfare, or the threat of

such warfare, can have on military forces and urban communities. This new technology provides the potential capability of (1) developing biological agents that have increased virulence and stability after deployment; (2) targeting the delivery of organisms to populations; (3) protecting personnel against biological agents; (4) producing, by genetic modification, pathogenic organisms from non-pathogenic strains to complicate detection of a biological agent; (5) modifying the immune response system of the target population to increase or decrease susceptibility to pathogens; and (6) producing sensors based on the detection of unique signature molecules on the surface of biological agents or on the interaction of the genetic materials in such organisms with gene probes. The specific technologies used in realizing these capabilities include:

(1) cell culture or fermentation; (2) organism selection; (3) encapsulation and coating with straight or crosslinked biopolymers; (4) genetic engineering; (5) active or passive immunization or treatment with biological response modifiers; (6) monoclonal antibody production; (7) genome data bases, polymerase chain reaction equipment, DNA sequencers, and the rapid production of gene probes; and (8) the capability of linking gene probes and monoclonal antibodies on addressable sites in a reproducible manner.

New technologies related to biological warfare are emerging rapidly. The technology of monoclonal antibody production has existed only since 1975, while the technology of genetic engineering has existed since the 1980's. Technology for sequencing the genomes of organisms has changed so dramatically that the rate of sequencing has increased by several orders of magnitude since 1994. All of these reflect the enormous change in information databases and in technology including biotechnology, computer equipment, processes, and networking of research teams.

The rapid rate of development reflects to some degree the national and international investment in this technology. The level of federal spending in the United States in the entire biotechnology area during 1994 approximated 4 billion dollars. The private sector invested approximately 7 billion dollars during the same year. This investment and the rate of information accrual indicates that biological technology that can be used for peaceful and military purposes is increasing in capability at a rate exceeding most other technologies. The pharmaceutical industry is relying on biotechnology for new therapeutic products to improve prophylaxis and therapy for many different diseases.

The explosive growth of applicable biotechnologies from a broad field of knowledge and applications, in aggregate, are doubling every 18 months. Examples of sustained geometric growth include monoclonal antibodies, combinatorial chemistry, and gene probes.

Biological weapons are unique because the effects from pathogenic organisms, except toxins, are not seen for hours to days after dissemination. If adequate detection devices are not available, the first indication of a biological weapon attack could be symptoms

in target personnel. At this point, treatment propylaxis and therapy is often ineffective.

The biological technology industry is information intensive rather than capital intensive. Data on technologies involved in biological production are widely available in the published literature. These technologies are dual use, with applications in the pharmaceutical, food, cosmetic, and pesticide industries. New technologies, such as genetic engineering, are more likely to affect fabrication, weaponization, or difficulty of detection than to produce a "supergerm" of significantly increased pathogenicity.

(See Appendix D, Table 2 for a list of Australia Group Biological Agents)

While laboratory-scale capability for production of biological agents is sufficient for achieving most terrorist purposes, large-scale production for military purposes can be achieved easily in dual-use facilities. All of the equipment needed for large-scale production of offensive biological agents is dual use and available on the international market. Although a typical vaccine plant costs in excess of $50 million, a less elaborate fermentation plant that could produce biological agents could be built for less than $10 million.

If disseminated properly, only a small amount of biological agent is needed to infect numerous people. Proper dissemination, however, is a non-trivial problem because the agent must be dispersed in 1 to 10 micron particles and be inhaled by the target population. Symptoms normally take hours to days to appear. Detection is key to implementation of protective measures. Since biological organisms are living, they have the potential to reproduce. They can continue to affect people for extended periods of time.

Vaccines can be produced to defend against biological agent use; however, to produce the vaccine, the organism being employed by an adversary must be known. Although some of the proliferation concerns for biological weapons are similar to those for other WMD, some concerns are unique. The unique features include containment of the agent during production, stabilization and dispersion of the agents, detection, identification, and warning. All these aspects are important because biological agents are relatively easy to hide. The diffusion of information, technologies, and raw materials associated with biological and pharmaceutical processing are almost always dual use and, therefore, raise non-proliferation issues.

Because of the low financial costs of acquiring equipment for biological agent production, the implications for the proliferation of production and dispersion are clear: developing nations can attack targets effectively with biological agents. Defensive technologies are of interest because changes in vaccine production or other self-protection measures could presage an offensive attack. Stabilization and dispersion are proliferation concerns because these technologies increase the efficacy of biological

agents. Detection, identification, and warning technologies can be used to support efforts to mask the presence of biological agents even though these technologies do not pose a direct threat.

Most industrialized nations manufacture equipment and materials that can be used for the production, containment, purification, quality control, and stabilization of biological agents and for their dissemination and dispersion. Most developed nations manufacture the equipment for identifying these agents, but the means for detection and warning are less readily available. All these technologies are dual use, with applications in the pharmaceutical, food, cosmetic, and pesticide industries. The AG group of biological agents are readily available in the natural environment and from culture collections in the industrialized and in some developing nations. The recent outbreaks of Ebola in Africa and Hanta (Hantaan) virus infections in Asia and North and South America are evidence of occurrence in the natural environment. In addition, these organisms can be obtained from national collections [e.g., American Type Culture Collection (ATCC) and European collection]. The ATCC and European collections do not necessarily share information.

Many collections of organisms recognized as potential biological agents and included in the AG list exist throughout the world and are made available with minimal monitoring of use or transport. This is particularly the case in the open societies of the United States, Europe, and Japan, as was documented in 1995 by a case occurring in Ohio. The nutrients, growth media, and small-size fermenters are readily available.

BIOLOGICAL MATERIAL PRODUCTION

The design of a production facility provides important information regarding whether the facility is intended to produce pharmaceutical grade products or biological weapon grade materials. Relevant design elements include containment, purification equipment, sterilization equipment, and ventilation and filtration systems.

The design of a biochemical processing plant is an important signal of covert biological agent production. Containment of the biological material during processing is of special interest. There is a clear distinction between processing materials for biological or toxin agent weaponization and processing protective agents to be used for countermeasures or personnel performance enhancement. For the production of biological agents for offensive military activities, the processing containment requirement is to protect the environment from the agent because of its infectious nature. For the production of biomaterials, such as vaccines, biological response modifiers, antibiotics, and anti viral agents, for defensive military activities, the containment requirement is to protect the processed biomaterial from contaminating materials in the environment.

The primary difference between the production requirements for biological weapons and non-military commercial purposes lies in containment and contamination. During

biological agent production, efforts are generally made to avoid contaminating the environment with the organism. Less concern arises about the contamination of the product. Conversely, the pharmaceutical, brewing, and biotechnology industries are most concerned about protecting the purity and quality of the product. (See Table 1 for a list some of the naturally occurring pathogens and toxins potentially used as BW agents. Whereas the majority of the agents have no current dual-use applications, a small number do have biomedical roles other than those in vaccine production.)

The highly toxic botulinal toxin A, produced by Clostridium botulinum, shows medicinal promise in blocking involuntary muscle spasms or weakening a muscle for therapeutic purposes. Five medical uses of toxins that might be used in BW have been approved by the Food and Drug Administration. Immune protection against these agents is important because they occur naturally in some regions of the world. Toxins and pathogens that affect animals, such as anthrax, brucella, plague, and tularemia, are widespread. Vaccines are widely produced and administered. The issue of the need for the same toxic agent for either BW/TW production or countermeasure vaccine production emphasizes the dual-use nature of the technologies. Indeed, initial processing of agents and processing of their associated vaccines only differ by a few steps (e.g., the degree of purification and the type of containment used).

The qualitative and quantitative impact of biological warfare, or the threat of such warfare, on military forces and urban communities has changed markedly in the past 20 years. Production techniques have resulted in more virulent strains of organisms and the genetic modification of non-pathogenic organisms to pathogenic strains with virulent characteristics. The implications of genetic engineering for chemical and biological warfare are far-reaching.

Seed stocks of the AG group of biological agents are readily available in the natural environment and from culture collections in the industrialized and in some developing nations. The recent outbreaks of Ebola in Africa and Hanta virus infections in Asia and North and South America are evidence of this. In addition, these organisms may be obtained from national collections (e.g., American Type Culture Collection [ATCC] and European collections).

Most industrialized nations manufacture equipment and materials necessary for the production, containment, purification, and quality control of these materials. Canada, France, Germany, Israel, Japan, the Netherlands, Russia, Sweden, Switzerland, the Ukraine, the UK, and the United States are the most advanced countries in the techniques of manufacturing large quantities of biological agents and protective vaccines and materials required for prophylaxis and therapy. See Appendix D, Table 5 for a list of Biological Material Production Technology Parameters

STABILIZATION, DISSEMINATION, AND DISPERSION

Biological weapons production can be divided into three distinct phases: biological

agent production (see previous section), stabilization, and dissemination/dispersion. Stabilization is critical to effective dissemination. Stabilization and dissemination/dispersion are important issues because of the susceptibility of the biological agents to environmental degradation, not only in storage but also in application. This is a problem whether the end use is for biological weapons, pharmaceutics, cosmetics, pesticides, or food related purposes and is related to the susceptibility of the organisms to inactivation of the biochemical compound by the environment. This loss of bioactivity can result from exposure to high physical and chemical stress environments, such as high surface area at air-water interfaces (frothing), extreme temperatures or pressures, high salt concentrations, dilution, or exposure to specific inactivating agents. Various techniques of stabilization are used such as freeze drying and ultra freezing, and various techniques of dissemination/dispersion, such as spray devices, cluster bombs, etc. Modes of delivery include such as cruise missiles, airplanes, and artillery shells.

Biological agents have some unique characteristics that make weaponizing them attractive. Most biological weapons consist of living organisms (toxins are the exception) and, thus, can replicate once disseminated. A relatively small group of persons, using single individuals deployed in a military staging area, could bring about the infection of a large percentage of targeted persons. The clinical illness could develop within a day of dispersal and last for as long as 2–3 weeks.

Approximately 10 grams of anthrax spores can kill as many persons as a ton of sarin. Under appropriate meteorological conditions and with an aerosol generator delivering 1–10 micron particle-size droplets, a single aircraft can disperse 100 kg of anthrax over a 300 km^2 area and theoretically cause 3 million deaths in a population density of 10,000 people per km^2. The mean lethal inhalator dosage is 10 nanograms. (See Table 5) On the other hand, some biological agent characteristics can severely limit the effectiveness of BW, which consist of living organisms. A technique to stabilize (protect) the organisms from adverse environments is essential if the weapons are to maintain their effectiveness over some period of time. This requirement of stabilization also extends to the methods of delivery since the organisms are very susceptible to degradation in the environments associated with delivery systems.

Any country having pharmaceutical, cosmetic, or advanced food storage industries will have stabilization facilities similar to those that could be used for biological weapons. The ability to disseminate the biological agent over a wide area would be limited to those countries having cruise missiles or advanced aircraft. Even the smallest country or a terrorist group, however, has the capability to deliver small quantities of BW agent to a specific target. Canada, France, Germany, Israel, Japan, the Netherlands, Russia, the UK, and the United States have the most advanced techniques of manufacturing large quantities of biological agent and are also the most apt to have the capability to disseminate the biological agent over large areas.

DETECTION, WARNING, AND IDENTIFICATION

Detection, warning, and identification involve sensors and transduction of a detected signal to a transponder. Standoff detectors provide early, wide-area spectroscope and warning of biological agent attack.

No single sensor detects all agents of interest. Sensor systems based on physical or chemical properties of biological agents include high-performance liquid and gas chromotography, mass spectrometry, scattering Light Detection and Ranging (LIDAR), and ion mobility spectrometry (IMS).

Biodetection systems providing limited warning and identification functions currently exist. Systems in the inventory or in the advanced stages of development warn that a biological attack has occurred and collect samples for subsequent laboratory analysis. However, no real-time, on-site detection systems are available today. The rapid growth in biotechnology is assisting in the area of improved biological defense technologies, although many of the same advances can also be used to improve biological agents.

Early detection and warning is the first line of defense against biological agents. Detection and identification of biological agents allow commanders, (citizens or targets) to take steps to avoid contamination, to determine the appropriate protection for continued operations, and to initiate proper prophylaxis and therapy to minimize casualties and performance degradation.

Besides the United States, several countries have a significant capability in the sensor technology that underlies detection and identification of biological agents: Canada, France, Germany, Israel, Japan, The Netherlands, Russia, Sweden, and the UK. Several other countries are just a step behind: Austria, China, Czech Republic, Finland, Hungary, Slovak Republic, South Africa, Switzerland, and the Ukraine. The worldwide efforts to develop improved biological agent detectors are extensive.

BIOLOGICAL DEFENSE SYSTEMS

A proliferant would require some type of BW defensive capability for protection during employment and defense against a counterattack. Vaccines are possible but the agent must be known (requires lead time for full protection). Detection and identification are key to determine appropriate defensive measures to take after an attack. A mask is sufficient to prevent a majority of biological agents from infecting personnel. Biotechnology offers potential for enhanced protection in the future.

Vaccines can be produced by any country with a pharmaceutical industry. Equipment can be purchased on the open market since it is all dual use. Protective masks are made in many countries. A simple dust mask could provide significant protection as long as it was worn when being exposed to the biological agent.

CHEMICAL WEAPONS TECHNOLOGY

Chemical weapons are defined as weapons using the toxic properties of chemical substances rather than their explosive properties to produce physical or physiological effects on an enemy. Although instances of what might be styled as chemical weapons date to antiquity, much of the lore of chemical weapons as viewed today has its origins in World War I. During that conflict "gas" (actually an aerosol or vapor) was used effectively on numerous occasions by both sides to alter the outcome of battles. A significant number of battlefield casualties were sustained. The Geneva Protocol, prohibiting use of chemical weapons in warfare, was signed in 1925. Several nations, the United States included, signed with a reservation forswearing only the first use of the weapons and reserved the right to retaliate in kind if chemical weapons were used against them. (Note: the United States did not ratify the Protocol until 1975). Chemical weapons were employed in the intervening period by Italy (in Ethiopia) and Japan (in Manchuria and China). Both nations were signatories to the Geneva Convention. Chemical weapons were never deliberately employed by the Allies or the Axis during World War II, despite the accumulation of enormous stockpiles by both sides.

Development of chemical weapons in World War I was predominantly the adaptation of a chemical "fill" to a standard munition. The chemicals were commercial chemicals or variants. Their properties were, for the most part, well known. The Germans simply opened canisters of chlorine and let the prevailing winds do the dissemination. Shortly thereafter the French put phosgene in a projectile and this method became the principal means of delivery. In July 1917, the Germans employed mustard shells for the first time and simultaneously attempted to use a solid particulate emetic, diphenyl chloroarsine, as a mask breaker. Mustard, an insidious material, penetrates leather and fabrics and inflicts painful burns on the skin. These two themes, along with significant increases in toxicity, represent a large segment of the research and development of chemical weapons that nations have pursued over the years.

There is first the concept of agents that attack the body through the skin, preferably also through clothing, and more preferably through protective clothing. Along with that concept is the idea of penetrating or "breaking" the protective mask so that it no longer offers protection for the respiratory system. Increasing the toxicity of the chemical agent used would theoretically lower the amounts required to produce a battlefield effect.

Unless this increase is significant, however, it can be masked by the inefficiencies of disseminating the agent. Consequently, later development has focused on the methods for delivering the agent efficiently to the target.

The chemicals employed before World War II can be styled as the **"classic" chemical weapons**. They are relatively simple substances, most of which were either common industrial chemicals or their derivatives. An example is phosgene, a *choking agent*

(irritates the eyes and respiratory tract). Phosgene is important in industry as a chlorinating material. A second example is hydrogen cyanide, a so-called *blood agent* (prevents transfer of oxygen to the tissues), now used worldwide in the manufacture of acrylic polymers. The industrial application of many of the classic chemical agents is recognized by the CWC and they are included on a schedule wherein few restrictions apply. They would be only marginally useful in modern warfare and generally only against an unsophisticated opponent. Moreover, large quantities would be required to produce militarily significant effects, thus complicating logistics.

Blister agents or **vesicants** are an exception to the limited utility of classic agents. Although these materials have a relatively low lethality, they are effective casualty agents that inflict painful burns and blisters requiring medical attention even at low doses. The classic mustard is the most popular among proliferant nations since it is relatively easy to make. Mustard is generally referred to as the "king" of agents because of its ease of production, low cost, predictable properties, persistence, and ability to cause resource-devouring casualties rather than fatalities. Its insidious nature is both an advantage and a disadvantage. Mustard on the skin causes no immediate sensation and symptoms normally do not appear until several hours after exposure. At incapacitating levels this may be as long as 12 hours. (Contrary to the normal expectation, horrible fatalities occurred in the Iran-Iraq War because Iranian soldiers, feeling no effects, continued to wear mustard soaked clothing and inhale its fumes.) To produce immediate effects, an arsenical vesicant known as lewisite was developed in the United States. Much of the former Soviet Union vesicant stocks were mixtures of lewisite and sulfur mustard.

Between the world wars the development of chemical weapons included adaptation to aircraft delivery (bombs) and exploitation of lewisite, since the more potent mustard was, from a battlefield perspective, slow in producing casualties. Independent experiments in several countries led them to consider/adopt mixtures of mustard and lewisite as fills for chemical munitions.

Nerve gases, or anticholinesterase agents, were discovered by the Germans in the 1930's and developed during World War II. In 1936 during studies of possible pesticides, the German chemist Gerhard Schrader discovered what he called "tabun" or GA. Two years later Schrader discovered the even more toxic "sarin" or GB. These compounds are orders of magnitude more toxic than those used in World War I and thus represent the significant toxicity increase that changed the concept of employment.

Fortunately for the Allies, the Germans never exploited their technological advantage, although they did produce a large number of tabun-filled munitions. Nerve gases are liquids, not gases, which block an enzyme (acetylcholinesterase) that is necessary for functions of the central nervous system. Similar in action to many pesticides, they are lethal in much lower quantities than classic agents. The nerve gases are effective when inhaled or when absorbed by the skin (percutaneous), or both, although there are

differences in effectiveness. In general, the lower the material's volatility (and hence its inhalation threat) the greater its percutaneous toxicity. Nerve agents are generally divided rather arbitrarily into G- and V-agents, although there are numerous structural variants that are potent cholinesterase inhibitors. Nerve agents known to date to have been produced for chemical warfare purposes are all organophosphorus compounds and are liquids at room temperature.

The Italians, Hungarians, Japanese, French, English, Russians, and Americans, as well as the Germans, all perfected mustard, phosgene, and similar agents during World War II. Although never used in the conflict, these nations amassed such huge quantities of chemical munitions that their disposal presented a practical problem, one that would be virtually insurmountable in today's more environmentally conscious world.

In those more naive times, however, the munitions simply found their way to the bottoms of almost all the world's oceans in the holds of expendable ships. After World War II the victors took an interest in exploiting the potential of the remarkably potent "nerve" agents. The British, in particular, had captured small stocks of sarin (GB) and set about investigating its potential. The Soviets removed the Germans' GB production plant to the Soviet Union. GB turned out to be perhaps the best of the respiratory agents, being volatile as well as exceedingly toxic. The United States designed a cluster bomb to exploit the characteristics of GB and followed this with a litany of adaptations of munitions. Artillery rockets were produced as were bombs, projectiles, and spray tanks. Many of these used the basic design of high-explosive weapons and simply changed the fill to GB.

The 1960's saw continued development in nonlethal agents, or riot control agents, first used in World War I. Most notable is CS. These agents are strong irritants of the mucous membranes. The purpose of CS and similar materials is temporary incapacitation without permanent harm.

Incapacitating agents. These were initially seen by some as a panacea to make warfare safe and humane. Thousands of potential compounds were screened, obtained from government sources in the United States and from commercial pharmaceutical companies around the world. Although there were several promising materials, primarily mental incapacitants, only BZ was ever standardized.

The problem of incapacitants, or incapacitating agents, is complex. The use of incapacitants in warfare is considered to be prohibited by the Chemical Weapons Convention even though only a single agent, BZ (3-Quinuclidinyl benzilate), and its immediate precursors are included as listed compounds (Schedule 2) in that Treaty.

Binary chemical weapons use toxic chemicals produced by mixing two compounds immediately before or during use. Binary weapons do not necessarily employ new toxic chemicals. In U.S. parlance, relatively innocuous precursors were stored separately and

reacted to form the toxic chemical agent en route to the target. In principle, the binary concept could also be used to produce highly lethal but unstable compounds or mixtures of compounds unsuitable for long-term storage. The U.S. type classified and produced a GB (sarin) binary nerve agent weapon, the M687 projectile (a 155-mm artillery shell), and was in the late stages of development of two other binary weapons when its offensive CW program was terminated.

Other possibilities for chemical agents include toxins and allergens which also have been, at times, considered biological agents. Although not living organisms themselves, these materials are usually products of living organisms with complex molecular structures. A wide variety of toxins with an equally broad spectrum of chemical, physical, and physiological properties exists. The CWC attempts to avoid the complexity by listing only two toxins in its list of substances for verification. They are ricin, a byproduct of castor bean extraction, and saxitoxin, a shellfish poison. Given the large number of potential toxins, these would appear to be place holders to permit the inclusion of any toxin if deemed necessary at a future date.

Until the recent attempts at terrorism by the Japanese cult Aum Shinrikyo, virtually all uses of chemical weapons have been as tactical weapons by nations. These have ranged from attempts to break the stalemate in World War I to the recent use by Iraq to blunt Iranian human wave attacks in the Iran-Iraq War (1982–87). Chemical weapons were not employed by the major protagonists in World War II. Between World Wars I and II, two signatories of the Geneva Protocol (Italy and Japan) employed chemical weapons. Typically, nations have employed them against unprotected targets and not against an equally well-armed nation; chemical weapons are therefore arguably an example of mutual deterrence. Although there have been charges of chemical weapon use in virtually every conflict in recent decades, most have not been substantiated by clinical or physical evidence.

There are a number of reasons for a country to pursue the development of chemical weapons. Chemical weapons are relatively inexpensive to produce. Many standard munitions can be modified and filled with toxic chemicals. A chemical attack (or even a credible threat of a chemical offensive) can reduce the efficiency of an opposing force by making it take precautionary steps

Military forces that contemplate CW employment have many things to consider. The use of chemical weapons runs counter to the global norm and is apt to engender strong denunciation by third parties and retaliation by the nation attacked.

A number of technologies are required to develop, integrate, and employ chemical weapons. Although many of these technologies are old and available in the open literature, successful employment entails more than simply producing toxic chemicals.

Starting in World War I, a number of countries have employed chemical weapons.

After false starts by others, the Germans finally employed chlorine successfully at Ypres, Belgium, in 1915. Other WWI use included phosgene and chloropicrin in 1916 by the British, and mustard in 1917 by Germany. Lewisite was developed in 1918, too late to be used in WWI.

Between the world wars, Japan began research on chemical weapons and began production in the late 1920's. The Italians used mustard in Ethiopia in 1935-36. Although Allied and Axis nations produced and stockpiled chemical weapons, they were not used during World War II. Egypt employed mustard and probably G-agent in Yemen in the 1960's. Both sides relied on CW during the Iran-Iraq conflict. The Iraqis used mustard, tabun, and sarin from 1982-87 and were prepared to do so in the Gulf War. Libya dropped chemical agents from a transport aircraft against Chadian Troops in 1987.

Many nations have become States Parties to the CWC and can be expected to adhere to their commitments not to develop chemical weapons. Others will not sign or may abrogate their commitments. Any nation with a sophisticated chemical industry has the potential to produce chemical weapons, although nerve agents require a greater amount of expertise than classical agents and vesicants. Having the potential, however, does not indicate intent. Subnational groups, both independent and state-sponsored, could produce or purchase toxic chemicals or possibly chemical warfare agents to threaten a civilian populace. Since civilians are poorly prepared for attacks by toxic materials, consequences of a successful attack could be severe. Governments are increasingly concerned about the use of toxic chemicals in light of the Aum Shinrikyo attack in Tokyo but thus far have been unable to come to grips with the complexity of the problem. The armed forces of many nations have some type of detection equipment and protection gear, although there are wide variations in their quantity and capability.

(See Table 6 & 7 for a list of Chemical Wafare Agents currently in military applications worldwide)

CHEMICAL MATERIAL PRODUCTION

There are thousands of toxic chemicals that could be used in chemical weapons. Those listed have been stockpiled and/or used by a number of countries. The CWC Depending on the type of agent to be produced, there can be technical hurdles that must be overcome. "Classic" agents can be manufactured using existing chemical infrastructure, and most have legitimate commercial uses. Likewise, vesicants are not technologically complicated. The production of the nerve agents, however, requires significantly more sophisticated chemical processing. Some production processes require strict temperature control. Containment of toxic substances and gases can pose problems. Depending on the immediacy of use, purity of product can add a difficult dimension to production. In some cases, special equipment or handling is required to prevent corrosion of equipment and/or rapid deterioration of the product. These hurdles can be overcome. If sufficient purity cannot be attained, an agent can be manufactured and used

immediately. This presupposes the capability to manufacture a sufficient quantity in the time allotted. If special, corrosive-resistant equipment cannot be obtained, corroded equipment can be replaced when necessary or only a limited amount can be produced. If nerve agent production is technologically infeasible for a proliferant, a simpler agent (vesicant or classic agent) can be produced. Alternatives can entail increased costs, increased munition requirements, or reduced CW capability. Some of the simpler **classic chemical agents** can be manufactured using existing chemical infrastructure. For example, phosgene is manufactured internally within chemical plants throughout the world for use as a chlorinating agent. Chlorination is the most common of chemical intermediate reactions in the chemical process industry. A reasonable size phosgene facility could be purchased with an investment of $10–$14 million. Similarly, hydrogen cyanide is currently manufactured worldwide as an intermediate in the manufacture of acrylic polymers and could be diverted for other uses or separately manufactured with about the same investment. In either instance the technologies are simple, well known, and require no specialized equipment.

Almost all proliferant states since World War I have manufactured **vesicants**, principally sulfur mustard, bis(2-chloroethyl) sulfide. There are several routes to this compound, none of which require sophisticated technology and/or special materials Virtually all those producing mustard have experienced a large number of industrial accidents resulting in casualties from mustard burns. Nitrogen mustards have been synthesized only in pilot plant quantities, but did not require any unusual processes or materials. Lewisite was produced by both the United States and the Soviet Union during World War II. The plants were quite small and unsophisticated by today's standards. Lewisite is an arsenical and as such would require unusually large amounts of arsenates in its production.

Production of the **nerve agents** requires significantly more sophisticated chemical processing. In a majority of these materials, there are corrosive chemicals in the process that require specialized corrosion-resistant construction materials. With the exception of GA (tabun), manufactured by the Germans in World War II and the Iraqis during the Iran-Iraq war, G-agent production involves both chlorination and fluorination steps. Both of these steps require special and expensive construction materials. Reactors, degassers, distillation columns, and ancillary equipment made of high nickel alloys or precious metals are needed to contain the corrosive products and by products. Only the last step of the process involves the highly toxic material, so that special air handling equipment would be needed for only a small portion of the facility.

There are many process routes for producing the G- and V-agents; the majority involve the synthesis of methylphosphonic dichloride (DC) at some stage. The United States designed and built plants for four different processes for producing DC. Two were used in the stockpile production of GB (sarin), a third represented an upgrade of the stockpile production process to minimize waste, and the fourth represented a newer method used in producing material for binary weapons. The Soviet Union used a still

different process to make DC and Iraq one similar to the last U.S. process. DC is a relatively easy material to store and to ship and need not be produced at the same site as the final product. It is very stable and has been stored for over 30 years with little deterioration. The size of the facility required to produce DC in militarily significant quantities ranges from very large down to room sized. A facility to produce DC with ancillary support would cost approximately $25 million not including pollution and environmental controls and waste treatment. Modern waste treatment and pollution abatement to U.S. standards would more than double the cost, although it is doubtful that a proliferant would build to these standards. The various DC production processes require some special corrosion-resistant equipment, generally glass-lined reactors and storage tanks, although not the ultra-expensive equipment required for later stages. DC has limited commercial use. The V-agent formed exclusively in the United States was VX. The former Soviet Union, the only other known producer of significant quantities of V-agent, did not produce VX per se, but rather a structurally different variant with the same molecular weight. The Soviets designed their process to make maximum use of production capability already available.

Incapacitating agent production is similar in many ways to the manufacture of pharmaceuticals, since these compounds are normally variations or derivatives of compounds used or postulated for use as pharmaceuticals. Since most pharmaceuticals are produced in relatively small quantities, production would entail a scale-up to an unusual process size for the type of reactions entailed. Moreover, virtually all candidate incapacitating agents are solids at room temperature and would require drying and grinding to an inhalable particulate. Given the tendency of many compounds to acquire a static charge and agglomerate, the grinding is a nontrivial manufacturing problem. The problems associated with manufacture (and use) of solid lethal agents (such as carbamates) are analogous to those experienced with incapacitants.

As a consequence of the diversity and complexity involved, it is difficult to provide any generic insights to **toxin** production. The only toxin to exist naturally in large quantities is ricin. It is a byproduct of castor oil production. Production of ricin is a physical separation. There are weak parallels with plutonium extraction or uranium isotope enrichment in nuclear processing. Toxin separation is much easier, less expensive, and requires smaller equipment. These advantages might make a toxin attractive to a poor, proliferating country. Most other toxins must be laboriously extracted in small quantities from the organism that secretes them. While synthetic toxins are possible, they are complex molecules, the synthesis of which in any significant amount would be difficult. Biotechnology may enhance the ability to produce toxins that were previously difficult to obtain in significant quantity.

Production of chemical agents in the past has anticipated their long-term storage since (in the instance of United States at least) they were viewed as deterrent weapons and by policy would not have been employed except in response to aggressor use.

This also meant that the agents and/or their weapons of employment might be stored for extensive periods of time. The life span of chemical weapons was first expected to be a decade. The requirement was later increased to 20 years when it became clear that munitions were likely to be stored at least that long. Chemical agents can either be stored in bulk quantities or loaded into munitions. With the nerve agents in particular, the quality of the initial material must be excellent and they must be stored under inert conditions with the absolute exclusion of oxygen and moisture.

Since there are so many toxic chemicals that could be used in chemical weapons, only those agents of major significance and their precursors have been included. These toxic chemicals have been designated of most concern by the world community. The majority of nerve agents, sulfur mustards, lewisites, and some of the nitrogen mustards are listed in the CWC schedules of chemicals (Table 7). Each nerve agent is representative of a family (hundreds to thousands) of chemicals. Those specifically included have been produced and stockpiled by a number of countries. The precursor DC is the fundamental building block for a significant portion of G- and V-agents. The classic chemicals (phosgene, cyanogen chloride, and hydrogen cyanide) have been included since they are so readily available that a proliferant could obtain them easily. Although these chemical agents would require high munitions expenditures and are easily defeated by a gas mask, they could be used effectively against unprotected populations and/or poorly equipped combatants. Toxins have not been included in this subsection.

Biological Weapons Technologies. Although toxins are not living organisms, they are made by living organisms. They are listed in Schedule 1A of the CWC and the biological agent part of the Australia Group list.

Any country with a chemical industry has the capability, if not the intent, to produce toxic chemicals. Most of the technologies are old and described in the open literature.

See Table 8 for a list of countries that have the capability or have used chemical weapons in the past and therefore are technically capable of producing chemical weapons. The assessment is not an indication of current intent. Many of these countries have signed/ratified the CWC.

CHEMICAL WEAPONS DELIVERY

Perhaps the most important factor in the effectiveness of chemical weapons is the efficiency of dissemination. A variety of technologies that can be used to weaponize toxic chemical agents. Munitions include bombs, submunitions, projectiles, warheads, and spray tanks. Techniques of filling and storage of munitions are important. The principal method of disseminating chemical agents has been the use of explosives. These usually have taken the form of central bursters expelling the agent laterally.

DISSEMINATION, DISPERSION, AND WEAPONS TESTING

Aerodynamic dissemination technology allows nonexplosive delivery from a line source. Although this method provides a theoretical capability of controlling the size of the particle, the altitude of dissemination must be controlled and the wind direction and velocity known. Accurate weather observations can enable the attacker to predict wind direction and velocity in the target area.

An important factor in the effectiveness of chemical weapons is the efficiency of dissemination as it is tailored to the types of agent. The majority of the most potent of chemical agents are not very volatile. Indeed, the most volatile of the G-agents is GB(sarin), which has a volatility near that of water. All are nonvolatile liquids or solids at room temperature. VX is an oily liquid.

Casualties due to premature initiation of the warhead are unacceptable in tactical weapons. Accordingly, an additional function such as a simple electrical or mechanical timer may be used to arm the height-of-burst sensor.

A more recent attempt to control aerosol particle size on target has been the use of **aerodynamic dissemination** and sprays as line sources. **Thermal dissemination**, wherein pyrotechnics are used to aerosolize the agent has been used particularly to generate fine, inhalable clouds of incapacitants. **Dispersion** considers the relative placement of the chemical agent munition upon or adjacent to a target immediately before dissemination so that the material is most efficiently used.

Many dissemination technologies have been included because many are available to a proliferant. There is sufficient open literature describing the pros and cons of various types of dissemination to dictate the consideration of all of them by a proliferant. Although most countries and perpetrators could develop the toxic agents and adapt their standard munitions to carry the agents. It is much more difficult, however, to achieve success in effective dispersion and dissemination. Weather observation and forecasting are essential to increase the probability of effective CW dissemination and reduce the risk of injuring friendly forces.

As stated previously, most countries have the capability to develop chemical weapons. Those with a well-developed military infrastructure could readily adapt existing munitions for chemical warfare. During the Iran-Iraq War, Iraq delivered mustard and tabun with artillery shells, aerial bombs, missiles, and rockets. Virtually any country or subnational group with significant resources has sufficient capability to attain the minimum capability that would be needed to meet terrorist aims. Any nation with substantial foreign military sales or indigenous capability in conventional weapons will have (or have ready access to) both the design know-how and components required to implement at least a moderate capability.

DETECTION, WARNING, AND IDENTIFICATION

A number of Western countries (Canada, France, Germany, the UK, and the United States) have significant capability in sensor technology. Russia and Israel also are well advanced in this field. At least 18 countries have some type of chemical detector in their armed forces. Countries among the 18 include China, Finland, Hungary, Iran, Iraq, Libya, the Netherlands, North Korea, the Czech Republic, and South Africa.

In chemical warfare, effective chemical defense measures can greatly limit the damage inflicted by a chemical attack. In World War I the gas mask had a dramatic effect in limiting the significance of chemical weapons. Developments since then (improved masks, protective clothing, detectors, and training) have further widened the margin of protection. Collective protection takes defensive measures one step further by providing a toxic-free environment for group functions such as command centers and medical facilities. Since World War I, chemical warfare has only been used against those entirely lacking or highly deficient in protective equipment. Some suggest that chemical defense acts as a deterrent to the initiation of chemical warfare because there is less incentive to attack a well-protected force. World War II is cited as an example of this theory, since both sides were well equipped for chemical defense and neither side used chemical weapons. Others suggest that equivalent offensive capability is the real deterrent. While protective clothing can reduce the effects of CW, its use poses other problems.

Chemical defense includes individual and collective protection and decontamination. The goal of individual and collective protection is to use clothing ensembles and respirators as well as collective filtration systems and shelters to insulate forces from chemical agents. Decontamination is essential to return personnel and equipment to normal operating conditions.

Collective protection enables groups to work in a toxic-free environment in tents, vehicles, or special shelters. Efforts are aimed at making systems mobile and easy to erect. Air supplied to shelters is purified in much the same way as it is for individual masks.

Shelf life of protective equipment is a concern to all users. Periodic inspections are necessary to ensure readiness. Decontamination removes toxic substances or renders them harmless. Individuals and equipment must be decontaminated. Depending on the particular agent, CW agents can be washed and rinsed away, evaporated, absorbed, or removed by heat treatment.

There is medical treatment available to offset the effects of chemical weapons. Atropine and 2-PAM chloride can be administered upon suspicion of exposure to a nerve agent. Atropine is an anticholinergic agent. It blocks the action of acetylcholine (a nerve transmitter substance), preventing it from stimulating nerves. 2-PAM chloride is anoxime, which increases the effectiveness of drug therapy in poisoning by some—but not all—cholinesterase inhibitors. Atropine and 2-PAM chloride only work to a limited

degree with refractive nerve agents such as GD. Their administration when an exposure has not occurred can be harmful. Diazepam (more commonly known as Valium) is used as an anticonvulsant once an individual exhibits incapacitating

CHEMICAL DEFENSE SYSTEMS

Masks and protective clothing are needed to defend against many toxic chemicals. Reduction in combat efficiency from wearing protective gear is estimated to be up to 50 percent. Proliferators may not provide the same measure of protection that is afforded U.S. troops. Training and protection reduce the effectiveness of chemical weapons.

Numerous countries produce chemical protective gear. Production of masks is the most common, including masks for civilians (as seen in Israel during Operation Desert Storm), although limited shelf life remains a problem. A number of countries have developed collective protection for shelters: Finland, France, Israel, Sweden, Switzerland, and the UK. Since 1990 North Korea has placed a high priority on military and civilian chemical defense readiness.

RADIOLOGICAL & NUCLEAR WEAPONS

Introduction

Radiological weapons use the beta rays, neutrons, and gamma rays emitted by the decay of highly radioactive isotopes to kill or incapacitate. (See Appendix C). In general, the latency period between exposure to high doses of radiation and the onset of symptoms is long (hours to weeks, depending upon dose), but it may be as short as minutes if neutron doses on the order of several thousand rads (whole body dose) can be delivered. However, there is no practical way to transport enough radioactive material to provide doses this high because the amounts of isotopes necessary to inflict reasonably prompt casualties (hours to days) over a large area (square kilometers) on a foe may produce so much heat that it melts even steel bomb cases. Because of the long latency period, radiological weapons are probably of little tactical use on the battlefield except that fear of radiation on the part of the opponent may act to deny areas to him. For area denial to be effective, the opponent's troops must be notified of the presence of the agent, because the radiation does not cause prompt casualties. Radiological weapons may have the potential for use against rear areas. The isotopes of greatest concern are those normally produced as fission products in nuclear reactors or which are copiously produced when "fertile" material is irradiated in a reactor (e.g., $_{137}Cs$, $_{60}Co$). More rapidly decaying, and hence more potent, radioisotopes generally have short half lives (a year or less), complicating the problem of stockpiling them for later use.

Gamma-ray and neutron-emitting isotopes in quantities needed to cause injuries to opposing troops are likely to be very dangerous for the attacker's troops to handle. The mass of the required shielding will greatly exceed that of the agent. On the other hand, public fear of radiation is so great that small quantities of radioactive materials

dispersed about a city may well induce considerable panic in the populace. Such use of radiological agents would most likely be announced by the attacking force, because the material may not otherwise be detected. Alpha radiation ($_4He$ nuclei) is normally not dangerous unless it enters the body and lodges there. This can lead to lung cancer, but with a decades-long latency period.

Although radiological weapons have little or no tactical importance on the battlefield, the fear of radiation has become so widespread and ingrained that if an opponent spreads even small, harmless but detectable amounts of radioactive material in rear echelon areas, the action may force troops to don full protective garb and attempt to operate under that handicap.

It is not possible to dispose of radiological agents by burning; they will merely be transferred to the effluent. Neither can radiological agents be "sterilized" by heat or other chemicals. Decontamination is usually accomplished by a wash-down, with the waste water becoming low-level radioactive waste. Only time—the passing of many half-lives of the isotopes in question and their radioactive daughters—can totally eliminate the hazard posed by radioactive contamination.

Radiological agents can be conveniently and secretly made in any research reactor designed to irradiate material samples. Spent fuel from any reactor can be cut up and the material dispersed without further chemical treatment. Thus, any nation with a research reactor or with civilian power reactors and the capability of discharging spent fuel from those reactors has the potential to produce material suitable for use in radiological weapons. The fundamental tool for producing radioisotopes, a nuclear reactor, can be found in very many countries. (See Appendix C). The 44 nations identified in the 1996 Comprehensive Test Ban Treaty as having safeguarded reactors and other fuel facilities provide a good start at identifying possible sources for radiological warfare agents. Actually turning the radioisotopes into weapons may require special techniques for handling the material safely. Similarly, those crews chosen to disperse the material will require protective gear or, alternatively, must be ready to become human sacrifices. Efficient use of radiological material requires converting it from bulk form into a dust or aerosol which can be inhaled and then finding methods to spray the material. These technologies may not be present in every state which can produce radioactive isotopes. On the other hand, they are not required if the aim is merely to cause panic or to force troops or the target population to work in protective clothing.

NUCLEAR WEAPONS TECHNOLOGY

General

The technologies needed to construct nuclear and radiological weapons and to employ both kinds of weapons either for military purposes or an act of terror are not new. Since their introduction in 1945, nuclear explosives have been the most feared of the weapons of mass destruction, in part because of their ability to cause enormous

instantaneous devastation and of the persistent effects of the radiation they emit, unseen and undetectable by unaided human senses. The Manhattan Project cost the United States $2 billion in 1945 spending power and required the combined efforts of a continent-spanning industrial enterprise and a pool of scientists, many of whom had already been awarded the Nobel Prize and many more who would go on to become Nobel Laureates. This array of talent was needed in 1942 if there were to be any hope of completing a weapon during the Second World War

For many decades the Manhattan Project provided the paradigm against which any potential proliferator's efforts would be measured. Fifty years after the Trinity explosion, it has been recognized that the Manhattan Project is just one of a spectrum of approaches to the acquisition of a nuclear capability. At the low end of the scale, a nation may find a way to obtain a complete working nuclear bomb from a willing or unwilling supplier; at the other end, it may elect to construct a complete nuclear infrastructure including the mining of uranium, the enrichment of uranium metal in the fissile isotope $_{235}U$, the production and extraction of plutonium, the production of tritium, and the separation of deuterium and $_{6}Li$ to build thermonuclear weapons. At an intermediate level, the Republic of South Africa constructed six quite simple nuclear devices for a total project cost of less than $1 billion (1980's purchasing power) using no more than 400 people and indigenous technology.

Acquisition of a militarily significant nuclear capability involves, however, more than simply the purchase or construction of a single nuclear device or weapon. It requires attention to issues of safety and handling of the weapons, reliability and predictability of entire systems, efficient use of scarce and valuable special nuclear material (SNM) (plutonium and enriched uranium), chains of custody and procedures for authorizing the use of the weapons, and the careful training of the military personnel who will deliver weapons to their targets.

In contrast, a nuclear device used for terrorism need not be constructed to survive a complex stockpile-to-target sequence, need not have a predictable and reliable yield, and need not be efficient in its use of nuclear material. Although major acts of terrorism are often rehearsed and the terrorists trained for the operation, the level of training probably is not remotely comparable to that necessary in a military establishment entrusted with the nuclear mission.

To summarize, the following can be said about nuclear weapon
(1) The design and production of nuclear weapons today is a far simpler process than it was during the Manhattan Project.
(2) Indigenous development of nuclear weapons is possible for countries with industrial bases no greater than that of Iraq in 1990. Given a source of fissile material, even terrorist groups could construct their own nuclear explosive devices.
(3) At least two types of nuclear weapons can be built and fielded without any kind of

yield test, and the possessors could have reasonable confidence in the performance of those devices.
(4) The standing up of elite units to take custody of nuclear weapons or to employ them would be a useful indicator that a proliferant is approaching the completion of its first weapon.
(5)The acquisition of fissile material in sufficient quantity is the most formidable obstacle to the production of nuclear weapons.

Although talented people are essential to the success of any nuclear weapons program, the fundamental physics, chemistry, and engineering involved are widely understood; no basic research is required to construct a nuclear weapon. Therefore, a nuclear weapons project begun in 1996 does not require the brilliant scientists who were needed for the Manhattan Project.[1]

Testing of Nuclear Weapons
The first nuclear weapon used in combat used an untested gun-assembled design, but a very simple and inefficient one. The first implosion device was tested on July 16, 1945, near Alamogordo, New Mexico, and an identical "physics package" (the portion of the weapon including fissile and fusion fuels plus high explosives) was swiftly incorporated into the bomb dropped on Nagasaki.Nuclear weaponry has advanced considerably since 1945, as can be seen at an unclassified level by comparing the size and weight of "Fat Man" with the far smaller, lighter, and more powerful weapons carried by modern ballistic missiles.

Most nations of the world, including those of proliferation interest, have subscribed to the 1963 Limited Test Ban Treaty, which requires that nuclear explosions only take place underground. Underground testing can be detected by seismic means and by observing radioactive effluent in the atmosphere. It is probably easier to detect and identify a small nuclear test in the atmosphere than it is to detect and identify a similarly sized underground test. In either case, highly specialized instrumentation is required if a nuclear test explosion is to yield useful data to the nation carrying out the

[1] *When the Manhattan Project began far less than a microgram of plutonium had been made throughout the world, and plutonium chemistry could only be guessed at; the numbers of neutrons released on average in 235U and 239Pu fissions were unknown; the fission cross sections (probabilities that an interaction would occur) were equally unknown, as was the neutron absorption cross section of carbon.*

experiment. A Comprehensive Test Ban Treaty was opened for signature and signed at the United Nations on 24 September 1996 by the five declared nuclear weapon states, Israel, and several other states. By the end of February 1998, more than 140 states had signed the accord. The Treaty bans all further tests which produce nuclear yield. In all probability, most of the nations of greatest proliferation concern will be persuaded to accede to the accord.

International Regimes, Treaties, Protocols and Conventions

There are a number of international treaties, agreements, regimes, and informal arrangements that seek to constrain the spread of nuclear, biological, and chemical weapons and missiles as well as conventional weapons. Some address material/agents and equipment in general terms while others are more specific. Some have led to explicit export control arrangements limiting the transfer of technologies, materials and equipment while others contain broad prohibitions of activities. All have varying degrees of participation and adherence. The agreements, in many cases, establish an international norm of behavior that can be used to highlight aberrant actions. (See Table 10)

NUCLEAR NON-PROLIFERATION TREATY (NPT)

The Treaty on the Non-Proliferation of Nuclear Weapons (NPT) entered into force in 1970 and is adhered to by over 170 nations. A fundamental objective of the NPT is to prevent the further spread of nuclear weapons. To this end, the nuclear weapons states (five had tested and manufactured nuclear weapons by the time the treaty was negotiated and available for signature) agreed not to transfer nuclear weapons or other nuclear explosive devices, and not to assist, encourage, or induce non-nuclear weapons states (NNWS) to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices. Each NNWS pledged not to receive nuclear weapons or other nuclear explosive devices, not to manufacture or otherwise acquire them, and not to seek or receive assistance in their manufacture. The treaty also obliged each NNWS party to the NPT to accept international safeguards through agreements negotiated with the International Atomic Energy Agency (IAEA). The intent of these safeguards is to prevent by deterring, via IAEA inspections, the diversion of nuclear material for nuclear explosive purposes. Nuclear material and specified equipment would be exported to NNWS only under IAEA safeguards.

An offshoot of the NPT, the Zangger Committee, which first met in 1971, maintains a list of nuclear exports that require IAEA safeguards as a condition of supply.

The Committee is made up of 30 NPT members who export nuclear material and equipment.

The **Nuclear Suppliers Group (NSG)** reinforces the work of the Zangger Committee through an expanded set of controls and by potentially including non-NPT states that are nuclear suppliers. In April 1992, the NSG approved a comprehensive arrangement to prohibit exports of some 65 dual-use items of equipment and materials to unsafeguarded nuclear activities and nuclear explosive programs. It also agreed to a common policy not to engage in significant, new nuclear cooperation with any NNWS that has not committed itself to full-scope safeguards on all present and future nuclear activities.

The NSG conditions for transfer apply to all NNWS whether or not they are NSG

members. Nuclear transfers require acceptance of IAEA safeguards; dual-use transfers are prohibited for use in unsafeguarded nuclear fuel-cycle activities and nuclear explosives activities.

Legal authority in the United States for controlling the export of specialized nuclear items is the Atomic Energy Act and the NPT. The licensing agencies are the Nuclear Regulatory Commission and the Department of Energy. The Code of Federal Regulations (CFR) #110 and #810 address federal regulations regarding nuclear equipment and material and assistance to foreign atomic energy activities. On an international basis, CFR #110 controls items on the International Atomic Energy List.

GENEVA PROTOCOL OF 1925 (GP)

At the Geneva Conference for the Supervision of the International Traffic in Arms of 1925, the United States took the initiative of seeking to prohibit the export of gases for use in war. At French suggestion, it was decided to draw up a protocol on non-use of poisonous gases. Poland recommended that bacteriological weapons be covered in the prohibition. The Geneva Protocol was signed on June 17, 1925, and restated the prohibition previously laid down by the Versailles and Washington treaties and added a ban on bacteriological warfare. The Protocol contained a one-paragraph prohibition against the use of chemical (and bacteriological) weapons. However, agents could be legally developed, produced, stockpiled, and transferred. Several countries, as conditions of their ratification or accession, reserved the right to respond in kind to aggressors using these weapons.

BIOLOGICAL WEAPONS CONVENTION (BWC)

The 1972 Convention on the Prohibition of the Development, Production, and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction (BWC) entered into force in 1975 and has been signed and ratified by over 135 parties. The BWC prohibits the development, production, and stockpiling of toxins or of microbial or other biological agents of types and in quantities that have no justification for prophylactic, protective, or other peaceful purposes; also prohibited are development, production, and stockpiling of weapons, equipment, or means of delivery designed to use such agents or toxins for hostile purposes or in armed conflict. It does not provide a mechanism for controlling export of these items.

During the two decades since the BWC entered into force, there have been increasing concerns about biological weapons proliferation and the ability of the Convention to deter it. Efforts at periodic review conferences have centered on strengthening the implementation and effectiveness of the Convention. The treaty as written has no verification measures. Although confidence-building measures have been approved, there is still concern whether verification could be effective. There is no existing BWC committee comparable to the Zangger Committee in the NPT. The Convention does not prohibit exchange of equipment, materials, or scientific and technical information for peaceful purposes. The Second Review Conference, held in 1986 in an effort to reduce

the occurrence of ambiguities, doubts, and suspicions and to improve international cooperation in peaceful biological activities, adopted voluntary measures to strengthen confidence in treaty compliance and to help deter violations. Because of continuing concerns about proliferation, possible noncompliance of some parties, and the rapid and significant advances in biotechnology, the Third Review Conference, held in 1991, reaffirmed and extended the voluntary confidence building measures. As a result of a mandate of the Third Review Conference, an Ad Hoc Group of Government Experts convened to identify, examine, and evaluate potential measures for verifying the provisions of the BWC from a scientific and technical viewpoint.

The Ad Hoc Group (also known as "Verification Experts") assessed 21 potential off-site and on-site measures using six mandated evaluation criteria. They also considered some combination of measures. The group's final report concluded that because of the dual-use nature of nearly all biological-weapons-related facilities, equipment, and materials, and the huge overlap between prohibited and permitted purposes, no single approach could fulfill the mandated criteria for a stand-alone verification measure. Nevertheless, the group found that some measures, either singly or in combination, have the potential to strengthen the BWC by helping to differentiate between prohibited and permitted activities and thus to reduce ambiguities about compliance.

CHEMICAL WEAPONS CONVENTION (CWC)

The Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on Their Destruction [referred to as the Chemical Weapons Convention (CWC)] was opened for signature in January 1993. Over 160 countries have signed the Treaty. It entered into force on April 29, 1997.

The CWC bans the production, acquisition, stockpiling, and use of chemical weapons. It charges each party not to develop, produce, otherwise acquire, stockpile, or retain chemical weapons; transfer, directly or indirectly, chemical agents to anyone; use chemical weapons; engage in any military preparations to use chemical weapons; and assist, encourage, or induce, in any way, anyone to engage in any activity prohibited to a party to the Convention. Each Party undertakes in accordance with the provisions of the Convention to destroy the chemical weapons it possesses or that are located in any place under its jurisdiction or control, destroy all chemical weapons it abandoned on the territory of another Party, and destroy any chemical weapons production facilities it owns or possesses or that are located in any place under its jurisdiction or control. Finally, each Party undertakes not to use riot control agents as a method of warfare.

The CWC provides for routine and challenge inspections to assist in the verification of compliance with the Convention. Routine inspections of declared facilities are mandated by the Convention. In accordance with CWC provisions, challenge inspections may be conducted at a facility where a Party suspects illegal activities. The CWC does not include a specific list of controlled chemicals or equipment. It does contain an Annex on Chemicals in which are listed three "Schedules" of toxic

chemicals and their precursors based on the threat they pose to the purpose and objectives of the CWC and the extent of their commercial use. The Verification Annex describes restrictions on transfers of scheduled chemicals in detail. Transfers of some chemicals to countries who have not ratified the Convention will be prohibited by the CWC.

AUSTRALIA GROUP (AG)

In 1984, several countries, reacting to the use of chemical weapons in the Iran- Iraq War, began informal consultations, the goal of which was to discourage and impede proliferation by harmonizing national export controls on chemical weapon (CW) materials. This informal, international forum was chaired by Australia and became known as the Australia Group. At their December 1992 meeting the AG members, recognizing the need to take steps to address the increasing problem of the spread of biological weapons, agreed on measures to control the export of biological agents and dual-use equipment which could be used in the production of biological weapons. They also agreed on a framework paper for effective licensing arrangements for export controls, thereby further strengthening measures to address the problem of chemical and biological weapon (CBW) proliferation and use.

Today, the AG controls extend to 54 dual-use chemical precursors for CW, microorganisms and toxins that could be used in BW, and dual-use equipment and technologythat could be used in chemical or biological weapons production. Controls agreed to during meetings of the AG are applied on a national basis, although all participants are agreed that controls will be more effective if similar measures are introduced by all potential exporters of relevant chemicals and equipment and by countries of possible transshipment. In the United States, the Commerce Control List (CCL) is the vehicle that implements AG agreements.

There are currently 30 members of the AG. It has no charter or constitution and operates on consensus. The AG's actions are viewed as complementary measures in support of the 1925 Geneva Protocol, the 1972 Biological and Toxins Weapons Convention, and the 1993 Chemical Weapons Convention. In tandem with export controls, the AG has periodically used warning mechanisms to sensitize the public to CBW proliferation. The AG has issued an informal "warning list" of dual-use CW precursors and bulk chemicals and of CW-related equipment. Members develop and share the warning lists with their chemical industry and ask it to report on any suspicious transactions. The AG has also used an approach to warn industry, the scientific community, and other relevant groups of the risks of inadvertently aiding BW proliferation. Meetings of the AG focus on sharing information about national export controls, considering proposals for "harmonization"—the adoption of common export controls by all members—and considering other measures to address CBW proliferation and use.

MISSILE TECHNOLOGY CONTROL REGIME (MTCR)

The Missile Technology Control Regime currently provides the central institutional arrangement as well as the base international norm for dealing with missile proliferation. The aim of the MTCR is to restrict the proliferation of missiles, unmanned air vehicles, and related technology for those systems capable of carrying a 500-kilogram payload at least 300 kilometers as well as systems intended for the delivery of weapons of mass destruction .

The MTCR is neither an international agreement nor a treaty but a voluntary arrangement among countries which share a common interest in limiting the spread of missiles and missile technology. The MTCR considers "missiles" to include ballistic missiles, space launch vehicles (SLV), and sounding rockets. Unmanned air vehicles (UAVs) include cruise missiles, drones, and remotely piloted vehicles (RPVs). The MTCR's members cooperate by applying on a national level common export control guidelines to an agreed list of items (the Equipment and Technology Annex).

When the MTCR was instituted in 1987 by the United States and six other concerned countries, it was intended to limit the risks of nuclear proliferation by controlling technology transfers relevant to nuclear weapon delivery other than by manned aircraft (i.e., by restricting the proliferation of missiles and related technology). In 1993, MTCR member states tightened export controls further, agreeing to also control transfers of rocket systems or UAVs (including cruise missiles) capable of a 300-km range regardless of range or payload. Also, if the seller has any reason to believe these systems would be used to deliver WMD, there is a "strong presumption to deny" the transfer regardless of the inherent range and/or payload of the system. There are now 29 MTCR members; other countries have agreed to abide by the basic tenets of the MTCR.

The annex of controlled equipment and technology is divided into "Category I" and "Category II" items. It includes equipment and technology, both military and dual-use, that are relevant to missile development, production, and operation. Category I consists of complete missile systems (including ballistic missile systems, space launch vehicles, and sounding rockets); unmanned air-vehicle systems such as cruise missiles, and target and reconnaissance drones; specially designed production facilities for these systems; and certain complete subsystems such as rocket engines or stages, reentry vehicles, guidance sets, thrust-vector controls, and warhead safing, arming, fuzing, and firing mechanisms. According to the MTCR Guidelines, export of Category I items is subject to a presumption of denial.

Category II covers a wide range of parts, components, subsystems, propellants, structural materials, test and production equipment, and flight instruments usable for the Category I systems and subsystems. These items are less sensitive components and technologies, most of which have dual-use applications. Category II also covers those systems that have a range of 300 km (but cannot carry a 500-kg payload to that range) and some associated subsystems. Category II items may be exported by MTCR

members on a case-by-case basis, provided that the importing state furnishes sufficient end-use guarantees for the item.

The MTCR Guidelines specifically state that the Regime is "not designed to impede national space programs or international cooperation in such programs as long as such programs could not contribute to delivery systems for weapons of mass destruction."

The United States maintains a strict interpretation of this statement. Despite some differences of opinion with regard to commercial space applications, all members agree that the technology used in an SLV is virtually identical to that used in a ballistic missile.

WASSENAAR ARRANGEMENT (WA)

In December 1995, 28 governments agreed to establish a new international regime to increase transparency and responsibility for the global market in conventional arms and dual-use goods and technologies. The official name of the regime is "The Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies," Wassenaar being the town outside The Hague where five rounds of negotiations took place over a 2-year period. The arrangement will respond to the new security threats of the post Cold War by providing greater openness through information sharing about arms and technology transfers worldwide. The Wassenaar Arrangement is an international framework that will need to be elaborated and defined more fully. It will focus on the threats to international and regional peace and security. A central part of the regime is the commitment by its members to prevent the acquisition of armaments and sensitive dual-use items for military end-users to states whose behavior today is, or becomes, a cause for serious concern, such as Iran, Iraq, Libya, and North Korea. The regime will also undertake to prevent destabilizing accumulations of conventional arms worldwide. The Iraq war taught that indiscriminate exports of conventional weapons and sensitive dual-use technologies can pose serious threats to U.S. interests, to foreign policy goals, and to international security. This regime will seek to apply the lessons of Iraq to prevent similar destabilizing buildups. It will also fill an important gap in the global non-proliferation regimes by covering conventional arms and associated dual-use technologies. The WA, by requiring its members to adhere to current non-proliferation regimes, will encourage non-members to also adhere to these regimes.

The WA seeks to prevent destabilizing buildups of weapons by establishing a formal process of transparency and consultation. Participants have agreed to control through their national policies those items and technologies contained in a list of Dual- Use Goods and Technologies and in a separate Munitions List.

OTHER NUCLEAR-RELATED AGREEMENTS

There are a number of other agreements that restrict nuclear weapons in some way. Many of them ban nuclear weapons from a location or geographic area (i.e., nuclear-

weapon-free zones). The following lists the treaty/agreement, the year it entered into force, the number of signatories, and a brief description of its provisions.
Antarctic Treaty: 1961; 37 countries; internationalized and demilitarized the Antarctic Continent and provided for its cooperative exploration and future use. The treaty prohibits "any measures of a military nature, such as the establishment of military bases and fortifications, the carrying out of military maneuvers, as well as the testing of any type of military weapons."

Limited Test Ban Treaty (LTBT): 1963; 117 countries; prohibits nuclear weapons tests "or any other nuclear explosion" in the atmosphere, in outer space, and under water.

Outer Space Treaty: 1967; 98 countries; parties undertake not to place in orbit around the Earth, install on the moon or any other celestial body, or otherwise station in outer space nuclear or other weapons of mass destruction .

Latin American Nuclear-Free Zone Treaty (Treaty of Tlatelolco): 1968; 29 countries (24 in force); obligates Latin American parties not to acquire or possess nuclear weapons, nor permit the storage or deployment of nuclear weapons on their territories by other countries.

Seabed Treaty: 1972; 94 countries; prohibits emplacing nuclear weapons or weapons of mass destruction on the sea bed and the ocean floor beyond the 12- mile coastal zone. Threshold Test Ban Treaty (TTBT): 1974; United States, USSR; prohibits underground nuclear tests having a yield exceeding 150 kilotons. South Pacific Nuclear Free-Zone Treaty (Treaty of Rarotonga): 1985; 15 countries; prohibits testing, deployment, or acquisition of nuclear weapons in the South Pacific.

Intermediate Range Nuclear Forces (INF) treaty: 1987; United States, USSR; eliminated ground-launched ballistic and cruise missiles with a range between 500 and 5,500 kilometers. All of these missiles, their launchers, and associated support structures and support equipment were destroyed.

START I: 1994; United States, USSR; reduces arsenals by about 30 percent. The original signatory, the USSR, has since dissolved and the states of Russia, Belarus, Kazakhstan, and Ukraine have endorsed the treaty by signing the START I Protocol. African Nuclear Weapons Free-Zone (Treaty of Pelindaba): 1996; 53 signatories, three ratifications; prohibits building, testing, burying, or stockpiling nuclear materials.

Comprehensive Test Ban Treaty (CTBT): 1996; 148 signatories, 7 ratifications (as of 1 October 1997): bans any nuclear weapon test explosion or any other nuclear explosion.

See Table 10 for a list of Regime Participants

Chapter 3

TERRORISM

Terrorism is defined in the Code of Federal Regulations as "the unlawful use of force and violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives."

When terrorism strikes, communities may receive assistance from State and Federal agencies operating within the existing Integrated Emergency Management System. FEMA is the lead Federal agency for supporting State and local response to the consequences of terrorist attacks.

FEMA's role in managing terrorism includes both antiterrorism and counterterrorism activities. Antiterrorism refers to defensive measures used to reduce the vulnerability of people and property to terrorist acts, while counterterrorism includes offensive measures taken to prevent, deter, and respond to terrorism. Within the emergency management arena, antiterrorism is a hazard mitigation activity and counterterrorism falls within the scope of preparedness, response and recovery.

Terrorism is often categorized as "domestic" or "international." This distinction refers not to where the terrorist act takes place but rather to the origin of the individuals or groups responsible for it. For example, the 1995 bombing of the Murrah Federal Building in Oklahoma City was an act of domestic terrorism, but the attacks of September 2001 were international in nature.

For the purposes of consequence management, the origin of the perpetrator(s) is of less importance than the impacts of the attack on life and property; thus, the distinction between domestic and international terrorism is less relevant for the purposes of mitigation, preparedness, response, and recovery than understanding the capabilities of terrorist groups and how to respond to the impacts they can generate.

ABOUT TERRORISM (Prior to September 11, 2001)

On February 29, 1993, a bombing in the parking garage of the World Trade Center in New York City resulted in the deaths of five people and thousands of injuries. The bomb left a crater 200 by 100 feet wide and five stories deep. The World Trade Center was the second largest building in the world and houses 100,000 workers and visitors each day.

The Department of Defense estimates that as many as 26 nations may possess chemical agents and/or weapons and an additional 12 may be seeking to develop them.

The Central Intelligence Agency reports that at least ten countries are believed to possess or be conducting research on biological agents for weaponization.

TERRORISM IN THE UNITED STATES

In the United States, most terrorist incidents have involved small extremist groups who use terrorism to achieve a designated objective. Local, State and Federal law enforcement officials monitor suspected terrorist groups and try to prevent or protect against a suspected attack. Additionally, the U.S. government works with other countries to limit the sources of support for terrorism. Most terrorist incidents in the United States have been bombing attacks, involving detonated and undetonated explosive devices, tear gas and pipe and fire bombs.

A terrorist attack can take several forms, depending on the technological means available to the terrorist, the nature of the political issue motivating the attack, and the points of weakness of the terrorist's target. Bombings have been the most frequently used terrorist method in the United States. Other possibilities includes an attack at transportation facilities, an attack against utilities or other public services or an incident involving chemical or biological agents.

Terrorist incidents in this country prior to the September 11, 2001 attack have included bombings of the World Trade Center in New York City, the United States Capitol Building in Washington, D.C. and Mobil Oil corporate headquarters in New York City.

The effects of terrorism can vary significantly from loss of life and injuries to property damage and disruptions in services such as electricity, water supply, public transportation and communications.

One way governments attempt to reduce our vulnerability to terrorist incidents is by increasing security at airports and other public facilities. The U.S. government also works with other countries to limit the sources of support for terrorism.

DEALING WITH TERRORISM (BEFORE, DURING, and AFTER)

BEFORE

Learn about the nature of terrorism.

Terrorists look for visible targets where they can avoid detection before or after an attack such as international airports, large cities, major international events, resorts, and high-profile landmarks.

Learn about the different types of terrorist weapons including explosives, kidnappings, hijackings, arson, and shootings.

Prepare to deal with a terrorist incident by adapting many of the same techniques used to prepare for other crises.

Be alert and aware of the surrounding area. The very nature of terrorism suggests that there may be little or no warning.

Take precautions when traveling. Be aware of conspicuous or unusual behavior. Do not accept packages from strangers. Do not leave luggage unattended.

Learn where emergency exits are located. Think ahead about how to evacuate a building, subway or congested public area in a hurry. Learn where staircases are located.
Notice your immediate surroundings. Be aware of heavy or breakable objects that could move, fall or break in an explosion.

Preparing for a Building Explosion
The use of explosives by terrorists can result in collapsed buildings and fires. *People who live or work in a multi-level building can do the following:*

Review emergency evacuation procedures. Know where fire exits are located.

Keep fire extinguishers in working order. Know where they are located, and how to use them.
Learn first aid. Contact the local chapter of the American Red Cross for additional information.

Keep the following items in a designated place on each floor of the building.
Portable, battery-operated radio and extra batteries
Several flashlights and extra batteries
First aid kit and manual
Several hard hats
Fluorescent tape to rope off dangerous areas

Bomb Threats
If you receive a bomb threat, get as much information from the caller as possible. Keep the caller on the line and record everything that is said. Notify the police and the building management.

After you've been notified of a bomb threat, do not touch any suspicious packages. Clear the area around the suspicious package and notify the police immediately. In evacuating a building, avoid standing in front of windows or other potentially hazardous areas. Do not restrict sidewalk or streets to be used by emergency officials.

DURING

In a building explosion, get out of the building as quickly and calmly as possible.

If items are falling off of bookshelves or from the ceiling, get under a sturdy table or desk.If there is a fire.

Stay low to the floor and exit the building as quickly as possible.
Cover nose and mouth with a wet cloth.
When approaching a closed door, use the palm of your hand and forearm to feel the lower, middle and upper parts of the door. If it is not hot, brace yourself against the door and open it slowly. If it is hot to the touch, do not open the door--seek an alternate escape route.

Heavy smoke and poisonous gases collect first along the ceiling. Stay below the smoke at all times.

AFTER

If you are trapped in debris.

Use a flashlight.
Stay in your area so that you don't kick up dust. Cover your mouth with a handkerchief or clothing.
Tap on a pipe or wall so that rescuers can hear where you are. Use a whistle if one is available. Shout only as a last resort--shouting can cause a person to inhale dangerous amounts of dust.

Assisting Victims

Untrained persons should not attempt to rescue people who are inside a collapsed building. Wait for emergency personnel to arrive.

Chemical Agents
Chemical agents are poisonous gases, liquids or solids that have toxic effects on people, animals or plants. Most chemical agents cause serious injuries or death.

Severity of injuries depends on the type and amount of the chemical agent used, and the duration of exposure.

Were a chemical agent attack to occur, authorities would instruct citizens to either seek shelter where they are and seal the premises or evacuate immediately. Exposure to chemical agents can be fatal. Leaving the shelter to rescue or assist victims can be a deadly decision. There is no assistance that the untrained can offer that would likely be of any value to the victims of chemical agents.

Biological Agents
Biological agents are organisms or toxins that have illness-producing effects on people, livestock and crops.

Biological agents can be dispersed as aerosols or airborne particles. Terrorists may use biological agents to contaminate food or water because they are extremely difficult to detect. Chemical agents kill or incapacitate people, destroy livestock or ravage crops. Some chemical agents are odorless and tasteless and are difficult to detect. They can have an immediate effect (a few seconds to a few minutes) or a delayed effect (several hours to several days).

Because biological agents cannot necessarily be detected and may take time to grow and cause a disease, it is almost impossible to know that a biological attack has occurred. If government officials become aware of a biological attack through an informant or warning by terrorists, they would most likely instruct citizens to either seek shelter where they are and seal the premises or evacuate immediately.

A person affected by a biological agent requires the immediate attention of professional medical personnel. Some agents are contagious, and victims may need to be quarantined. Also, some medical facilities may not receive victims for fear of contaminating the hospital population.

Biological and chemical weapons have been used primarily to terrorize an unprotected civilian population and not as a weapon of war. This is because of fear of retaliation and the likelihood that the agent would contaminate the battlefield for a long period of time. The Persian Gulf War in 1991 and 2003 and other confrontations in the Middle East were causes for concern in the

United States regarding the possibility of chemical or biological warfare. While no incidents occurred, there remains a concern that such weapons could be involved in an accident or be used by terrorists.

Chapter 4

RESPONDING TO BIOLOGICAL AND CHEMICAL ATTACKS

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Introduction

This chapter provides a broad over view of the chemical and biological terrorist threat and, drawing on the lessons learned from the few chemical and biological incidents to date, suggests some basic means of detection, defense, and decontamination. The intention is not to alarm people but to enable employees and their family members to recognize and properly react to a chemical or biological situation in the even they encounter one.

In 1995, the Aum Shinrikyo, a Japanese religious cult, launched a large-scale chemical attack on the Tokyo subway system. The attack focused on four stations using Sarin gas, a potent chemical warfare nerve agent. Twelve people were killed but the attack fell far short of the apparent objective to inflict thousands of casualties. Subsequent investigation by authorities revealed that the cult had previously conducted several unsuccessful attacks against a variety of targets using other chemical agents and the biological agents botulism toxin and anthrax.

Since 1997, religious organizations, health clinics, and Government agencies in Indiana, Kentucky, Tennessee, California, Hawaii, and the District of Columbia, among other states, have received threatening letters purporting to contain the biological agent anthrax. While none of the letters were found to contain anthrax, they caused considerable fear and disruption where received. Disturbing as they are, these incidents serve to illustrate a potentially new type of terrorist threat of concern to law enforcement and emergency planning officials throughout the U.S. Government.

The Threat

Aside from their common lethality, there is no "one size fits all" when it comes to describing the types and effects of possible chemical or biological agents. Chemical agents are generally liquids, often aerosolized, and most have immediate effects or are delayed for a few hours. Many chemical agents have a unique odor and color.

Biological agents differ in that the effects are delayed, often for days. The effects of toxins, such as botulinum toxin, occur typically in less than a day. Living biological agents, such as anthrax or plague, generally take 2–5 days for symptoms to appear. Biological agents have no odor or color and chemical and biological agents that a terrorist could use as a weapon, but we can make the following broad generalizations:

• Although food or water contamination or absorption through the skin are possible attack routes, most experts agree that inhalation of chemical or biological agents is the most likely and effective means. Protection of breathing airways is therefore the single most important factor in a situation where chemical or biological agents may be present.

• Many likely agents are heavier than air and would tend to stay close to the ground. This dictates an upward safehaven strategy.

• Basic decontamination procedures are generally the same no matter what the agent. Thorough scrubbing with large amounts of warm soapy water or a mixture of 10 parts water to 1 part bleach (10:1) will greatly reduce the possibility of absorbing an agent through the skin.

• If water is not available, talcum powder or flour are also excellent means of decontamination of liquid agents. Sprinkle the flour or powder liberally over the affected skin area, wait 30 seconds, and brush off with a rag or gauze pad. (Note: The powder absorbs the agent so it must be brushed off thoroughly. If available, rubber gloves should be used when carrying out this procedure.)

• Generally, chemical agents tend to present an immediately noticeable effect, whereas many biological agents will take days before symptoms appear. In either case, medical attention should be sought immediately, even if exposure is thought to be limited.

• Most chemical and biological agents that present an inhalation hazard will break down fairly rapidly when exposed to the sun, diluted with water, or dissipated in high winds.

• No matter what the agent or its concentration, evacuation from the area of attack is always advisable unless you are properly equipped with an appropriate breathing device and protective clothing or have access to collective protection.

Warning Signs of An Attack or Incident

A chemical or biological attack or incident won't always be immediately apparent given the fact that many agents are odorless and colorless and some cause no immediately noticeable effects or symptoms. Be alert to the possible presence of agent. Indicators of such an attack include:

• Droplets of oily film on surfaces

• Unusual dead or dying animals in the area

• Unusual liquid sprays or vapors

• Unexplained odors (smell of bitter almonds, peach kernels, newly mown hay, or green grass)

• Unusual or unauthorized spraying in the area

• Victims displaying symptoms of nausea, difficulty breathing, convulsions, disorientation, or patterns of illness inconsistent with natural disease

• Low-lying clouds or fog unrelated to weather; clouds of dust; or suspended, possibly colored, particles

• People dressed unusually (long-sleeved shirts or overcoats in the summertime) or wearing breathing protection particularly in areas where large numbers of people tend to congregate, such as subways or stadiums

What To Do In Case of Attack

Protection of breathing airways is the single most important thing a person can do in the event of a chemical or biological incident or attack. In most cases, absent a handy gas mask, the only sure way to protect an airway is to put distance between you and the source of the agent. While evacuating the area, cover your mouth and nose with a handkerchief, coat sleeve, or any piece of cloth to provide some moderate means of protection. Other basic steps one can take to avoid or mitigate exposure to chemical or biological agents include:

• Stay alert for attack warning signs. Early detection enhances survival.

• Move upwind from the source of the attack.

• If evacuation from the immediate area is impossible, move indoors (if outside) and upward to an interior room on a higher floor. Remember many agents are heavier than air and will tend to stay close to the ground.

• Once indoors, close all windows and exterior doors and shut down air conditioning or heating systems to prevent circulation of air.

• Cover your mouth and nose. If gas masks are not available, use a surgical mask or a handkerchief. An improvised mask can be made by soaking a clean cloth in a solution of 1 tablespoon of baking soda in a cup of water. While this is not highly effective, it may provide some protection. Cover bare arms and legs and make sure any cuts or abrasions are covered or bandaged.

• If splashed with an agent, immediately wash it off using copious amounts of warm soapy water or a diluted 10:1 bleach solution.

• Letters from unknown sources should first be screened by security personnel. If opened, letters allegedly containing anthrax or another toxin should be handled carefully. Note if there was a puff of dust or particles from the envelope when it was opened and be sure to report that when assistance arrives. Carefully place such a letter and its envelope in a sealed plastic pouch. Thoroughly wash face and hands with warm soapy water before calling for assistance.

• If circumstances dictate, plan and prepare a chemical/biological safehaven in your residence using guidelines listed in this chapter and elsewhere in this book.

• At the office, familiarize yourself in advance with established emergency procedures and equipment at your post. See your regional or post security officer for details.

• If in a car, shut off outside air intake vents and roll up windows if no gas has entered the vehicle. Late model cars may provide some protection from toxic agents.

• In any case of suspected exposure to chemical or biological agents, no matter what the origin, medical assistance should be sought as soon as possible, even if no symptoms are immediately evident.

Preparing a Safehaven

In some remote but possible scenarios (such as the incident in Bhopal, India) an entire city or neighborhood could become endangered by lethal gas. If conditions at your post make this a

possibility, you may want to plan and prepare a sealed chemical/biological safehaven at your residence as follows:

Choosing a Safehaven Room

- Select an inner room on an upstairs floor with the least number of windows and doors.

- Choose a large room with access to a bathroom and preferably with a telephone.

- Avoid choosing rooms with window or wall air conditioners; they are more difficult to seal.

Sealing a Room

- Close all windows, doors, and shutters.

- Seal all cracks around window and door frames with wide tape.

- Cover windows and exterior doors with plastic sheets (6 mil minimum) and seal with pressure-sensitive adhesive tape. (This provides a second barrier should the window break or leak).

- Seal all openings in windows and doors (including keyholes) and any cracks with cotton wool or wet rags and duct tape. A water-soaked cloth should be used to seal gaps under doors.

- Shut down all window and central air and heating units.

Suggested Safehaven Equipment

- Protective equipment—biological/chemical rated gas masks, if available; waterproof clothing including long-sleeved shirts, long pants, raincoats, boots, and rubber gloves.

- Food and water—a 3-day supply.

- Emergency equipment—flashlights, battery operated radio, extra batteries, can or bottle opener, knife and scissors, first aid kit, fire extinguisher, etc.

- Miscellaneous items—prescription medicines and eyeglasses, fan, extra blankets, passports and other important papers, television set, toys, books, and games.

Chapter 5

BIOLOGICAL DISEASES/ BIOLOGICAL WARFARE AGENTS

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ANTHRAX

Anthrax is an acute infectious disease caused by the spore-forming bacterium Bacillus anthracis. Anthrax most commonly occurs in hoofed mammals and can also infect humans.

Symptoms of disease vary depending on how the disease was contracted, but usually occur within 7 days after exposure. The serious forms of human anthrax are inhalation anthrax, cutaneous anthrax, and intestinal anthrax.

Initial symptoms of inhalation anthrax infection may resemble a common cold. After several days, the symptoms may progress to severe breathing problems and shock. Inhalation anthrax is often fatal.

The intestinal disease form of anthrax may follow the consumption of contaminated food and is characterized by an acute inflammation of the intestinal tract. Initial signs of nausea, loss of appetite, vomiting, and fever are followed by abdominal pain, vomiting of blood, and severe diarrhea.

Direct person-to-person spread of anthrax is extremely unlikely, if it occurs at all. Therefore, there is no need to immunize or treat contacts of persons ill with anthrax, such as household contacts, friends, or coworkers, unless they also were also exposed to the same source of infection.

In persons exposed to anthrax, infection can be prevented with antibiotic treatment.
Early antibiotic treatment of anthrax is essential–delay lessens chances for survival. Anthrax usually is susceptible to penicillin, doxycycline, and fluoroquinolones.

An anthrax vaccine also can prevent infection. Vaccination against anthrax is not recommended for the general public to prevent disease and is not available.

Children and Anthrax:

How to Reduce Children's Fears

Help your children feel safe. Let them talk about their fears and worries. Stick to family routines that help children feel comfortable and secure. Reassure them that parents, teachers, doctors, and government officials are doing everything possible to keep them safe and healthy.

Limit children's viewing of television news. Children may be frightened, overwhelmed, or traumatized by news reports about bioterrorism. Supervise what they watch on television, and when they do watch, be sure to allow for family-discussion time during and after viewing to let them air their fears and concerns.

Arm yourself with the facts. Education is your best protection against unnecessary fear. Your children will be less fearful if they see that you are not afraid and if you spend time with them answering all of their questions.

What Every Parent Should Know

Anthrax is an illness caused by bacteria called Bacillus anthracis. These bacteria are found naturally in the soil. They can form a protective coat around themselves called spores, and they can release poisonous substances into the bodies of infected people.

You and your children cannot catch anthrax from each other or from any other person. Even if you were to become sick with anthrax, you could not pass on the illness to your children. Also, even if someone were to put the bacteria that causes anthrax in your workplace on purpose, it is highly unlikely that you would carry the bacteria home to your children on your clothes or hair.

People come into contact with (are "exposed" to) bacteria or become infected with bacteria that cause anthrax in three ways. They can be exposed and infected by breathing in (inhaling) the bacteria, by coming into contact with the bacteria through cuts or abrasions in the skin, or by eating something that contains the bacteria (usually undercooked meat from an infected animal). The chance of coming into contact with the bacteria in any of these ways is very low. Also, our bodies have defenses against bacteria, so not everyone who comes into contact with the bacteria will become ill with anthrax.

There are three kinds of anthrax, all of which are treatable with antibiotics:

Skin (cutaneous) anthrax is the least serious form of anthrax. The first symptom is a small, painless sore that develops into a blister. One or two days later, the blister develops a black scab in the center.

Gastrointestinal anthrax is more serious than skin anthrax. The initial symptoms are nausea, loss of appetite, and fever, followed by severe abdominal pain. This is the least common form of anthrax.

Inhalational anthrax is the most serious form of anthrax. This illness begins with symptoms similar to those for a cold or the flu. If caught early, inhalation anthrax can be treated successfully with antibiotics. If it isn't caught early and more serious symptoms develop, inhalation anthrax usually results in death. Almost all cold and flu symptoms are not anthrax.

The signs and symptoms of anthrax infection in children older than 2 months of age are similar to those in adults. The illness affects children and adults in much the same way, though children may be more likely to suffer side effects from some of the antibiotics used to prevent or treat the disease.

Although you may be tempted to ask your doctor for a supply of antibiotics to keep on hand, neither the Centers for Disease Control and Prevention (CDC) nor the American Academy of Pediatrics recommends doing this. You should not obtain antibiotics for your children unless

public health authorities have confirmed that it is likely that your children have come into contact with the bacteria that cause anthrax. Giving your children antibiotics when the antibiotics are not needed can do more harm than good. Many antibiotics have serious side effects in children, and using antibiotics when they are not needed can lead to the development of drug-resistant forms of bacteria in your children. If this happens, the antibiotics will not be able to kill the resistant bacteria the next time your child needs the same antibiotic to treat ear, sinus, or other infections that children frequently develop.

Currently, there is no anthrax vaccine for children. The anthrax vaccine used for adults has never been studied in children, and it is not recommended for people younger than 18 years old. It is currently available only for people in the military service, although public health officials are now considering its use for people in other high-risk professions.

The chances of your children coming into contact with bacteria that cause anthrax are extremely low. However, if public health officials confirm or suspect that you or your children have come into contact with the bacteria, your doctor or other health official will prescribe antibiotics to keep you and your children from developing anthrax. Early identification and treatment of anthrax in children is critical, so call your health care provider immediately with any questions or concerns. Remember: never give your child an antibiotic unless a doctor has examined your child and prescribed an antibiotic. Also, be sure to use any antibiotic exactly as directed by the doctor or pharmacy.

Where to Get More Information

The American Academy of Pediatrics Web site addresses numerous issues related to anthrax, bioterrorism, and children. You can access these topics at http://www.aap.org/advocacy/releases. Suggestions for helping children after a disaster are available at the Web site of the American Academy of Child and Adolescent Psychiatry at http://www.aacap.org/publications/factsfam/disaster.htm. CDC also offers information on a wide range of bioterrorism topics at http://www.bt.cdc.gov.

Frequently Asked Questions (FAQ)

What is anthrax?

Anthrax is an acute infectious disease caused by the spore-forming bacterium Bacillus anthracis. Anthrax most commonly occurs in wild and domestic lower vertebrates (cattle, sheep, goats, camels, antelopes, and other herbivores), but it can also occur in humans when they are exposed to infected animals or tissue from infected animals.

Why has anthrax become a current issue?

Because anthrax is considered to be a potential agent for use in biological warfare, the Department of Defense (DoD) has begun mandatory vaccination of all active duty military personnel who might be involved in conflict.

How common is anthrax and who can get it?

Anthrax is most common in agricultural regions where it occurs in animals. These include South and Central America, Southern and Eastern Europe, Asia, Africa, the Caribbean, and the Middle East. When anthrax affects humans, it is usually due to an occupational exposure to infected animals or their products. Workers who are exposed to dead animals and animal products from

other countries where anthrax is more common may become infected with B. anthracis (industrial anthrax). Anthrax in wild livestock has occurred in the United States.

How is anthrax transmitted?
Anthrax infection can occur in three forms: cutaneous (skin), inhalation, and gastrointestinal. B. anthracis spores can live in the soil for many years, and humans can become infected with anthrax by handling products from infected animals or by inhaling anthrax spores from contaminated animal products. Anthrax can also be spread by eating undercooked meat from infected animals. It is rare to find infected animals in the United States.

What are the symptoms of anthrax?
Symptoms of disease vary depending on how the disease was contracted, but symptoms usually occur within 7 days.

Cutaneous: Most (about 95%) anthrax infections occur when the bacterium enters a cut or abrasion on the skin, such as when handling contaminated wool, hides, leather or hair products (especially goat hair) of infected animals. Skin infection begins as a raised itchy bump that resembles an insect bite but within 1-2 days develops into a vesicle and then a painless ulcer, usually 1-3 cm in diameter, with a characteristic black necrotic (dying) area in the center. Lymph glands in the adjacent area may swell. About 20% of untreated cases of cutaneous anthrax will result in death. Deaths are rare with appropriate antimicrobial therapy.

Inhalation: Initial symptoms may resemble a common cold. After several days, the symptoms may progress to severe breathing problems and shock. Inhalation anthrax is usually fatal.

Intestinal: The intestinal disease form of anthrax may follow the consumption of contaminated meat and is characterized by an acute inflammation of the intestinal tract. Initial signs of nausea, loss of appetite, vomiting, fever are followed by abdominal pain, vomiting of blood, and severe diarrhea. Intestinal anthrax results in death in 25% to 60% of cases.

Where is anthrax usually found?
Anthrax can be found globally. It is more common in developing countries or countries without veterinary public health programs. Certain regions of the world (South and Central America, Southern and Eastern Europe, Asia, Africa, the Caribbean, and the Middle East) report more anthrax in animals than others.

Can anthrax be spread from person-to-person?
Direct person-to-person spread of anthrax is extremely unlikely to occur. Communicability is not a concern in managing or visiting with patients with inhalational anthrax.

Is there a way to prevent infection?
In countries where anthrax is common and vaccination levels of animal herds are low, humans should avoid contact with livestock and animal products and avoid eating meat that has not been properly slaughtered and cooked. Also, an anthrax vaccine has been licensed for use in humans. The vaccine is reported to be 93% effective in protecting against anthrax.

What is the anthrax vaccine?
The anthrax vaccine is manufactured and distributed by BioPort, Corporation, Lansing, Michigan. The vaccine is a cell-free filtrate vaccine, which means it contains no dead or live

bacteria in the preparation. The final product contains no more than 2.4 mg of aluminum hydroxide as adjuvant. Anthrax vaccines intended for animals should not be used in humans.

Who should get vaccinated against anthrax?
The Advisory Committee on Immunization Practices has recommend anthrax vaccination for the following groups:

Persons who work directly with the organism in the laboratory
Persons who work with imported animal hides or furs in areas where standards are insufficient to prevent exposure to anthrax spores.
Persons who handle potentially infected animal products in high-incidence areas. (Incidence is low in the United States, but veterinarians who travel to work in other countries where incidence is higher should consider being vaccinated.)
Military personnel deployed to areas with high risk for exposure to the organism (as when it is used as a biological warfare weapon).

The anthrax Vaccine Immunization Program in the U.S. Army Surgeon General's Office can be reached at 1-877-GETVACC (1-877-438-8222). http://www.anthrax.osd.mil

Pregnant women should be vaccinated only if absolutely necessary.

What is the protocol for anthrax vaccination?
The immunization consists of three subcutaneous injections given 2 weeks apart followed by three additional subcutaneous injections given at 6, 12, and 18 months. Annual booster injections of the vaccine are recommended thereafter.

Are there adverse reactions to the anthrax vaccine?
Mild local reactions occur in 30% of recipients and consist of slight tenderness and redness at the injection site. Severe local reactions are infrequent and consist of extensive swelling of the forearm in addition to the local reaction. Systemic reactions occur in fewer than 0.2% of recipients.

How is To anthrax diagnosed?
Anthrax is diagnosed by isolating B. anthracis from the blood, skin lesions, or respiratory secretions or by measuring specific antibodies in the blood of persons with suspected cases.

Is there a treatment for anthrax?
Doctors can prescribe effective antibiotics. To be effective, treatment should be initiated early. If left untreated, the disease can be fatal.

Where can I get more information about the recent Department of Defense decision to require men and women in the Armed Services to be vaccinated against anthrax?

The Department of Defense recommends that servicemen and women contact their chain of command on questions about the vaccine and its distribution. The anthrax Vaccine Immunization Program in the U.S. Army Surgeon General's Office can be reached at 1-877-GETVACC (1-877-438-8222). http://www.anthrax.osd.mil

FAQ: Exposure

What is the difference between exposure to anthrax and disease caused by anthrax?
A person can be said to be exposed to anthrax when that person comes in contact with the anthrax bacteria and a culture taken from that person is positive for anthrax. A person can be exposed without having disease. A person who might have come in contact with anthrax, but without a positive culture would be said to be potentially exposed. Disease caused by anthrax occurs when there is some sign of illness, such as the skin lesion that occurs with cutaneous anthrax.

A person who is exposed to anthrax but is given appropriate antibiotics can avoid developing disease.

What kind of mail should be considered suspicious?

Identifying Suspicious Packages and Envelopes

Some characteristics of suspicious packages and envelopes include the following:
- Inappropriate or unusual labeling
- Excessive postage
- Handwritten or poorly typed addresses
- Misspellings of common words
- Strange return address or no return address
- Incorrect titles or title without a name
- Not addressed to a specific person
- Marked with restrictions, such as "Personal," "Confidential," or "Do not x-ray"
- Marked with any threatening language
- Postmarked from a city or state that does not match the return address

Appearance
- Powdery substance felt through or appearing on the package or envelope
- Oily stains, discolorations, or odor
- Lopsided or uneven envelope
- Excessive packaging material such as masking tape, string, etc.

Other suspicious signs
- Excessive weight
- Ticking sound
- Protruding wires or aluminum foil

If a package or envelope appears suspicious, DO NOT OPEN IT.

What should people do who get a letter of package with powder?

Handling of Suspicious Packages or Envelopes*
How to Recognize and Handle a Suspicious Package or Envelope
Letters containing Bacillus anthracis (anthrax) have been received by mail in several areas in the United States. In some instances, anthrax exposures have occurred, with several persons becoming infected. To prevent such exposures and subsequent infection, all persons should learn how to recognize a suspicious package or envelope and take appropriate steps to protect themselves and others

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Handling of Suspicious Packages or Envelopes*
Do not shake or empty the contents of any suspicious package or envelope. Do not carry the package or envelope, show it to others or allow others to examine it. Put the package or envelope down on a stable surface; do not sniff, touch, taste, or look closely at it or at any contents which may have spilled. Alert others in the area about the suspicious package or envelope. Leave the area, close any doors, and take actions to prevent others from entering the area. If possible, shut off the ventilation system. WASH hands with soap and water to prevent spreading potentially infectious material to face or skin. Seek additional instructions for exposed or potentially exposed persons. If at work, notify a supervisor, a security officer, or a law enforcement official. If at home, contact the local law enforcement agency. If possible, create a list of persons who were in the room or area when this suspicious letter or package was recognized and a list of persons who also may have handled this package or letter. Give this list to both the local public health authorities and law enforcement officials

What should I do to protect my family and myself if a dangerous chemical agent were released in my community?
Emergency management teams would lead efforts in the event of a chemical attack and would let you know if you need to evacuate the area or seek some type of shelter.

Should I purchase a gas mask as protection from any chemical agent release such as anthrax?
No, CDC does not recommend purchasing gas masks. The likelihood that you would be involved in a chemical attack is low, and your protection is the responsibility of state and federal law

enforcement officials. They are on high alert to ensure that such an event does not happen. In addition, CDC believes that purchasing a gas mask causes a false sense of security and can do more harm than good. Masks that aren't used properly or that do not fit well will not give you adequate protection.

Are nasal swabs sufficient for diagnosing anthrax?
No. Nasal swabs should not be used to diagnose cases of anthrax or to evaluate whether a person has been exposed to B. anthracis. The results of nasal swabs are not a predictor for disease, and the ability of this method to correctly identify those who have been exposed has not been quantified. At best, a positive result may be interpreted only to indicate exposure; at worst, a negative result is not useful in any way. Nasal swab screening of potentially exposed persons may be used in conjunction with environmental sampling during an epidemiologic investigation in order to determine the extent of exposure in a given area.

When is the collection of nasal swabs useful?
Nasal swabs may be useful as part of an epidemiologic investigation to help define an area exposed to aerosolized B. anthracis. When a possible anthrax exposure occurs at a known time, nasal swabs are quickly performed as one of the environmental tests to determine where airborne spores may have traveled.

A positive nasal swab suggests that you were recently in the vicinity of airborne anthrax spores – it does NOT necessarily mean that you received enough bacteria to make you sick.

A negative nasal swab does not provide ANY information – it does not rule out the possibility that you were exposed to airborne anthrax if there was a release into the environment near you. Therefore, the nasal swab is, at best, a relatively crude test that tells us something in the positive but nothing in the negative.

When is the collection of nasal swabs not useful or recommended?
The collection of nasal swabs for culture should not be done to diagnose anthrax, to determine someone's risk of exposure, or to determine someone's need for prophylactic antibiotics. Nasal swabs should not be used to determine whether someone should stop prophylactic antibiotic treatment. Nasal swabs are not considered useful for diagnostic purposes.

Why are environmental scans done even when nasal swab cultures are no longer considered useful?
Unlike the human body, equipment does not have a "self-cleaning" mechanism. Equipment and surfaces may still be contaminated with anthrax spores for a period of time after an exposure has occurred. For this reason, it still makes sense to swab tables long after it no longer makes sense to swab noses.

FAQ: Signs and Symptoms

What are the signs and symptoms of anthrax?
Symptoms of disease vary depending on how the disease was contracted, but symptoms usually occur within 7 days.

Cutaneous anthrax is the most common naturally occurring type of infection (>95%) and usually occurs after skin contact with contaminated meat, wool, hides, or leather from infected animals.

The incubation period ranges from 1-12 days. The skin infection begins as a small papule, progresses to a vesicle in 1-2 days followed by a necrotic ulcer. The lesion is usually painless, but patients also may have fever, malaise, headache, and regional lymphadenopathy. Most (about 95%) anthrax infections occur when the bacterium enters a cut or abrasion on the skin. Skin infection begins as a raised bump that resembles a spider bite, but (within 1-2 days) it develops into a vesicle and then a painless ulcer, usually 1-3 cm in diameter, with a characteristic black necrotic (dying) area in the center. Lymph glands in the adjacent area may swell. About 20% of untreated cases of cutaneous anthrax will result in death. Deaths are rare if patients are given appropriate antimicrobial therapy.

Inhalational anthrax is the most lethal form of anthrax. Anthrax spores must be aerosolized in order to cause inhalational anthrax. The number of spores that cause human infection is unknown. The incubation period of inhalational anthrax among humans is unclear, but it is reported to range from 1 to 7 days, possibly ranging up to 60 days. It resembles a viral respiratory illness and initial symptoms include sore throat, mild fever, muscle aches and malaise. These symptoms may progress to respiratory failure and shock with meningitis frequently developing.

Gastrointestinal anthrax usually follows the consumption of raw or undercooked contaminated meat and has an incubation period of 1-7 days. It is associated with severe abdominal distress followed by fever and signs of septicemia. The disease can take an oropharyngeal or abdominal form. Involvement of the pharynx is usually characterized by lesions at the base of the tongue, sore throat, dysphagia, fever, and regional lymphadenopathy. Lower bowel inflammation usually causes nausea, loss of appetite, vomiting and fever, followed by abdominal pain, vomiting blood, and bloody diarrhea.

What specific symptoms should I watch for?
People should watch for the following symptoms:
Fever (temperature greater than 100 degrees F). The fever may be accompanied by chills or night sweats.
Flu-like symptoms
Cough, usually a non-productive cough, chest discomfort, shortness of breath, fatigue, muscle aches
Sore throat, followed by difficulty swallowing, enlarged lymph nodes, headache, nausea, loss of appetite, abdominal distress, vomiting, or diarrhea
A sore, especially on your face, arms or hands, that starts as a raised bump and develops into a painless ulcer with a black area in the center.
See also Notice to Readers: Considerations for Distinguishing Influenza-Like Illness from Inhalational Anthrax.

Is anthrax contagious?
No. Anthrax is not contagious; the illness cannot be transmitted from person to person.

What are the case fatality rates for the various forms of anthrax?
Early treatment of cutaneous anthrax is usually curative, and early treatment of all forms is important for recovery. Patients with cutaneous anthrax have reported case fatality rates of 20% without antibiotic treatment and less than 1% with it. Although case-fatality estimates for inhalational anthrax are based on incomplete information, the rate is extremely high, approximately 75%, even with all possible supportive care including appropriate antibiotics.

Estimates of the impact of the delay in postexposure prophylaxis or treatment on survival are not known. For gastrointestinal anthrax, the case-fatality rate is estimated to be 25%-60% and the effect of early antibiotic treatment on that case-fatality rate is not defined.

Can the presence of Bacillus anthracis spores be detected by a characteristic appearance, odor, or taste?
Bacillus anthracis spores do not have a characteristic appearance (e.g., color), smell, or taste. Spores themselves are too small to be seen by the naked eye, but have been mixed with powder to transport them. The U.S. Postal Service advises that individuals be suspicious of letters or packages with any powdery substance on them, regardless of color. (See http://www.usps.gov/news/2001/press/pr01_1010tips.htm.)

What would be the approximate size of enough Bacillus anthracis spores to cause infection?
They could not be seen by the naked eye but could be seen under a microscope.

How can I know my cold or flu this season is not anthrax?
Many human illnesses begin with what are commonly referred to as "flu-like" symptoms, such as fever and muscle aches. However, in most cases anthrax can be distinguished from the flu because the flu has additional symptoms. In previous reports of anthrax cases, early symptoms usually did not include a runny nose, which is typical of the flu and common cold.

If I have the flu, can I still get anthrax?
Yes, a person could theoretically get both the flu and anthrax, either at the same time or at different times.

FAQ: Risk

What is the risk for an individual if he or she is treated with antibiotics and is exposed to Bacillus anthracis again?
Because inhalational anthrax in humans is so rare, we cannot be certain about the risk of reinfection; therefore, CDC recommends that another course of antibiotic treatment be given promptly if a person is reexposed to Bacillus anthracis. In animal studies of inhalational anthrax, animals given anthrax vaccine and antibiotics after exposure did not develop anthrax when reexposed 4 months after the original exposures, while animals treated with antibiotics alone became ill when reexposed.

Can the spores that cause anthrax multiply outside of a human or animal host?
We do not think so, but we are not certain.

What are the odds of my getting anthrax? (What is the average risk of contracting anthrax in the United States?)
In an average year, the chance that any one individual in the United States will contract anthrax is extremely low—about one in about 300 million. This year, even with the intentional release of Bacillus anthracis spores in some environments, the nationwide risk is still extremely low—about 23 cases in about 300 million people.

Can anthrax affect pregnancy? Should pregnant women exposed to anthrax take antibiotics?
Anthrax is a serious illness in all humans, including pregnant women. Inhalational anthrax has a high fatality rate, and cutaneous (skin) anthrax also is serious, but less frequently fatal. Because

these infections are potentially fatal, it has been recommended that ciprofloxacin, or similar antibiotic drugs, be prescribed for pregnant women believed to have been exposed to anthrax. Clinical studies of the use of the ciprofloxacin in pregnant women have not been conducted, so ciprofloxacin and related drugs are not generally recommended for pregnant women with less serious illnesses.

Can anthrax be transmitted by handling money?
The Department of the Treasury sponsored a study to investigate this risk, and it revealed no evidence that anthrax can be spread by handling money.

What is the risk for anthrax in employees of a facility with a positive environmental sample?
The risk would depend on where the environmental sample was, the amount (quantity) of material, and if it was collected in an air sample or on a surface. The risk would also depend on the person's contact with the type of sample in terms of breathing or touching the sample.

Finding a positive surface or air sample does not mean that employees of a facility are at risk for anthrax. Heavily contaminated surfaces may pose a small risk for cutaneous anthrax, which can be minimized by clean-up. Laboratory test results of environmental surface samples should not be the only criterion for starting, continuing, or stopping preventive antibiotic therapy for inhalational disease.

FAQ: Treatment

What is the treatment for patients with inhalational and cutaneous anthrax?
Treatment protocols for cases of inhalational and cutaneous anthrax associated with this bioterrorist attack are found in the MMWR, 10/26/2001; 50(42), 909-919.

What if I develop side effects from the antibiotic?
If you develop side effects from the antibiotic, call your healthcare provider immediately. Depending on the type of side effects, you may be able to continue taking the medicine, or may be switched to an alternative antibiotic. If necessary, your physician may contact your State Department of Health for consultation on possible alternate antibiotics.

Has CDC tested the anthrax isolates for sensitivity to different antibiotics?
Yes. Antibiotic sensitivity testing performed at CDC has determined that the strain of anthrax was sensitive to a wide range of antibiotics, including penicillin and ciprofloxacin, giving public health officials important treatment information.

What are the risks of using tetracyclines and fluoroquinolones in children; are alternatives available?
Risks of using tetracyclines and fluoroquinolones in children must be weighed carefully against the risk for developing a life-threatening disease due to B. anthracis. Both agents can have adverse health reactions in children. If adverse reactions are suspected, therapy may be changed to amoxicillin or penicillin.

Are there special instructions for taking ciprofloxacin or doxycycline?
As with all antibiotics, take the medication according to the schedule you were instructed, and even if you begin to feel better, continue taking it for the full number of days. If you need an extension of the antibiotic at the end of your prescribed number of days, local emergency

healthcare workers or your healthcare provider will inform and tell you how to get more medicine. They may also tell you to discontinue the antibiotic, or will change the type of antibiotic, depending on results of laboratory tests.

After I have started taking ciprofloxacin to protect me from developing anthrax, what side effects could I get from taking this antibiotic?
Side effects which sometimes occur include nausea, mild diarrhea, stomach pain, headache and dizziness. Talk with your doctor if you have any of these problems while you are taking the antibiotic. Certain foods and medications should not be taken with ciprofloxacin; this should be discussed at the time the antibiotic is prescribed, so that side effects will not occur from the combinations. Ciprofloxacin also can cause sun sensitivity which increases the chances of sunburn. More serious side effects include central nervous system side effects such as confusion, tremors, hallucinations, depression, and increased risk of seizures. High blood pressure and blurred vision are also possible. Allergic reactions could cause difficulty breathing; closing of the throat; swelling of the lips, tongue, or face; hives or severe diarrhea. Pain, inflammation, or rupture of a tendon are possible and also severe tissue inflammation of the colon could occur. Call your doctor or seek medical advice right away if you are having any of these side effects. This list is NOT a complete list of side effects reported with ciprofloxacin. Your healthcare provider can discuss with you a more complete list of side effects.

After I have started taking doxycycline to protect me from developing anthrax, what side effects could I get from taking this antibiotic?
Less serious side effects include diarrhea, upset stomach, nausea, sore mouth or throat, sensitivity to sunlight, vaginal yeast infection or itching of the mouth lasting more than 2 days. You should talk with your doctor if you have any of these problems while taking doxycycline. Certain foods and medications should not be taken with doxycycline, and this should be discussed with your healthcare provider at the time the antibiotic is prescribed, so that side effects will not occur from the combinations. Doxycycline also causes sun sensitivity which increases the chances of sunburn. Serious side effects of doxycycline that are possible but uncommon include: life-threatening allergic reaction (symptoms are trouble breathing; closing of the throat; swelling of the lips, tongue, or face; hives), blood problems (symptoms are unusual bleeding or bruising), liver damage (symptoms are yellowing of the skin or eyes, dark urine, nausea ,vomiting, loss of appetite, abdominal pain), irritation of the esophagus. Call your doctor or seek medical attention right away if you are having any of these side effects. This list is NOT a complete list of side effects reported with doxycycline. Your healthcare provider can discuss with you a more complete list of side effects.

Why is CDC recommending doxycycline instead of ciprofloxacin for the treatment and prevention of anthrax?
Both doxycycline and ciprofloxacin are effective in treating Bacillus anthracis that we are dealing with in these investigations. Although CDC first recommended the use of either drug for postexposure prophylaxis for the prevention of inhalational anthrax, we are now recommending doxycycline in order to prevent other bacteria from developing resistance to ciprofloxacin. Ciprofloxacin is part of the fluoroquinolone family of drugs, a relatively new class of antibiotics used to treat infections caused by organisms for which doctors do not have information about antimicrobial susceptibility. This kind of treatment is known as empiric therapy. Ciprofloxacin and other fluoroquinolones are used for empiric treatment for a variety of serious and common infections in the United States, including pneumonia, gastrointestinal infections, and urinary tract infections. The number of people who have been exposed to B. anthracis and need antibiotics has

increased dramatically since CDC first issued guidelines for treatment. If all those people take ciprofloxacin, other bacteria they carry in their bodies may develop resistance to fluoroquinolones, potentially limiting the usefulness of these drugs as empiric therapy. Doxycycline is less frequently used for empiric treatment than ciprofloxacin; therefore, we have fewer concerns regarding this drug and the emergence of new resistant bacteria.

Why are people who have been exposed to B. anthracis being given antibiotics for different amounts of time?

The initial number of people placed on prophylaxis may reflect conservative estimates with wide safety margins based on limited preliminary information. As the investigation progresses, and a clearer picture of exposure develops, the number of people advised to continue prophylaxis may be reduced. As of the last week of October 2001, when preliminary tests show that people have been exposed to Bacillus anthracis, those exposed may be provided with a starter packet of antibiotics; the number of days for which antibiotics are prescribed can vary according to the specific situation and person. Additional tests are then conducted of the area where exposure occurred and to determine the extent of exposure. Based on the results of these additional tests, those exposed may be instructed to return to a centralized location for additional care or to seek additional care from their primary care providers; additional antibiotics may be prescribed based on the particular situation and person. Lastly, it is recommended that people found to be at risk of inhalation anthrax be prescribed 60 days of antibiotics. These general procedures may change at any time as new information is gathered.

Are there different strains of B. anthracis? Do they all respond to antibiotics?

Yes, there are different strains of Bacillus anthracis. Some strains of B. anthracis may be naturally resistant to certain antibiotics and not others. In addition, there may be biologically mutant strains that are engineered to be resistant to various antibiotics. A laboratory analysis can help to define which strain of B. anthracis is present and which antibiotic would be the most effective in treating the resulting anthrax.

What is the FDA telling physicians and other health professionals about prescriptions for ciprofloxacin?

Although FDA does not regulate the practice of medicine, the agency is strongly recommending that physicians not prescribe ciprofloxacin for individual patients to have on hand for possible use against inhaled anthrax. Indiscriminate and widespread use of ciprofloxacin could hasten the development of drug-resistant organisms and lessen the effects of these agents against many infections.

Can other fluoroquinolones be used instead of ciprofloxacin for postexposure prophylaxis (PEP)/treatment?

Other fluoroquinolones, such as ofloxacin and levofloxacin, are not specifically recommended as alternatives to ciprofloxacin because of a lack of sufficient data on their efficacy. However, if first-line drugs were not available, these other fluoroquinolones may be effective.

Why do I need 60 days of antibiotics?

Anthrax spores grow like plant seeds. If you plant seeds and give them sun and water, they will grow into plants. If you give anthrax spores the right environment, such as the human body, they can grow into the harmful form of the bacteria that can cause anthrax disease. It takes anthrax spores an average of 7 days to grow into the harmful form of the bacteria, but it can take longer. For this reason, you must continue taking preventive antibiotics for the full 60 days.

What happens if I take ciprofloxacin, doxycycline, or amoxicillin for a few days, stop, and then restart the antibiotics?
You should complete the 60-day course of antibiotics that you were given. It is best to take antibiotics as prescribed and not to skip any doses.

The ciprofloxacin I am taking gives me headaches. Is there anything I can do to help this?
If you don't have a history of headaches, then your headache may be related to the medicine. Changing the time of day that you take the ciprofloxacin or eating after you take the medicine may help. Pain relievers such as acetaminophen may help your headache. If your headache does not go away, you should consult your doctor.

The ciprofloxacin, doxycycline, or amoxicillin I am taking makes me feel sick to my stomach. Is there anything I can do to help this?
Taking your antibiotic with food may help reduce this sick feeling. Ciprofloxacin and doxycycline should not be taken within 2 hours of taking antacids. Ciprofloxacin and doxycycline should not be taken with dairy or calcium-fortified products (such as ice cream or calcium-fortified orange juice).

The ciprofloxacin, doxycycline, or amoxicillin I am taking gives me diarrhea. Is there anything I can do to help this?
Antibiotics may disrupt bacteria in the gastrointestinal tract, causing diarrhea. Food may help relieve the diarrhea. If the diarrhea does not go away, your doctor may recommend another antibiotic. If you develop severe, long-lasting diarrhea, you may have a serious condition and should consult your doctor.

If taking one of the recommended antibiotics makes me feel terrible, can I switch to another of these antibiotics?
If you have tried taking the medicine with food or changing the time of your dose but still feel terrible, you should ask your doctor about switching antibiotics.

I am having terrible yeast infections while taking ciprofloxacin, doxycycline, or amoxicillin. Is there anything I can take for this?

Occasionally, women develop yeast infections while taking amoxicillin. You may treat the infection with over-the-counter medicines such as clotrimazole. If the symptoms do not go away, you should consult your doctor.

I feel much better if I take only one pill of ciprofloxacin, doxycycline, or amoxicillin each day. Is that okay?
No. The drug must be taken twice a day to kill the bacteria. If your body contains anthrax bacteria and you do not take the full dose, the bacteria may start to grow again and become harder to kill.

My prescription says to take one pill every 12 hours. If 15 hours have passed since my last dose, is it still okay to take the pill?
Yes. It is okay to take the next pill even if 15 hours have elapsed. However, you should not make a habit of this. The medicine works best when taken every 12 hours.

What side effects are serious enough that I should go to a doctor?

Any side effect that forces you not to take your medicine is serious enough that you should consult or see your doctor. Serious side effects of ciprofloxacin include seizures, mental confusion, rash that does not go away, or excessive diarrhea. If you have any of these effects, call your doctor. Serious side effects of doxycycline include jaundice (yellow eyes or skin), rash that does not go away, or excessive diarrhea. If you have any of these effects, call your doctor. Any reaction that causes a rapid swelling of the lips and face, shortness of breath, or hives is a medical emergency. You should call 911. These types of reactions are extremely rare.

Can I drink alcohol if I am taking ciprofloxacin, doxycycline, or amoxicillin?
Social drinking of alcohol (fewer than 2 drinks a day) should not cause any side effects unless you already have a liver problem. However, drinking too much alcohol can cause the medicine to leave your body faster, which will decrease the effectiveness of the medicine. If you drink more than two drinks a day, you should tell your doctor so that different medicines can be prescribed.

The **ciprofloxacin, doxycycline, or amoxicillin I am taking makes me feel itchy all over. Is there anything I can do to help this?**
Rashes that appear suddenly or do not go away after a few days may be signs of an allergic reaction. You should see your doctor immediately.

The ciprofloxacin, doxycycline, or amoxicillin gave me an allergic reaction and I stopped taking it. What should I do?
If the allergic reaction was severe or rapid, you should notify your doctor before taking another antibiotic. Your doctor will prescribe a different antibiotic that will kill the bacteria without causing an allergic reaction. Remember: you should complete the entire 60 days of treatment even if you change antibiotics.

Why can't I take a shot, wear a patch, or take one large dose of the medicine instead of taking it for 60 days?
Spores can stay in your body for some time before they start growing and causing you to become ill. When the spores are not growing, antibiotics are not effective. Only after the spores start to grow can the antibiotics work. Therefore, you need a constant level of antibiotic in your body for 60 days to make sure that when the spores start to grow, the antibiotic is there to kill them.

Ciprofloxacin and doxycycline look different and come in different doses. Is one better than the other?
Ciprofloxacin 500 mg and doxycycline 100 mg both have the same killing power in your bloodstream and are equally effective against anthrax bacteria. Doxycycline is available in both tablet and capsule form. Both will give you the same amount of medicine in your bloodstream to kill the bacteria.

Should all patients who have flu-like symptoms be treated with antibiotics?
No. CDC does not recommend treating all patients who have flu-like illness with antibiotics. Antibiotics do not kill viruses, which cause the flu. If the patient is not at risk for developing anthrax, antibiotics are not recommended because the person may experience serious side effects. Also, taking antibiotics can increase the chance that the medicine will not be as effective against other bacterial infections.

Does a patient have immunity after recovering from anthrax infection?
We do not have enough data at this time to make this determination. However, it is theoretically possible to gain post-infection immunity.

How do doctors treat inhalational anthrax to reduce the risk of death in patients?
When inhalational anthrax is suspected, physicians prescribe antibiotics to treat the disease. To be effective, antibiotic therapy should be initiated as soon as possible after exposure. Other treatment includes supportive care in hospital. B. anthracis usually responds effectively to several antibiotics including penicillin, doxycycline, and fluoroquinolones (such as ciprofloxacin).

I was told that I had been exposed to Bacillus anthracis and prescribed antibiotics. I took the medicine for a couple weeks. Wouldn't that weaken any anthrax that's in my body?
You should take the full 60 days of antibiotics even if you feel better. Inhaled anthrax spores become lodged in the body and may activate after initial exposure. Antibiotics have little or no effect when the spores are inactive. To be effective in preventing inhalational anthrax, the antibiotics must be in your system when the spores activate. It is necessary to take the medicine for at least 60 days to ensure the best protection against inhalational anthrax.

Why was ciprofloxacin ever publicized as the best drug for anthrax? How can we know which antibiotic is best?
At the beginning of the recent anthrax outbreak, investigators did not know which drugs would kill the strains of Bacillus anthracis responsible for the outbreak. They used ciprofloxacin because very few bacteria are resistant to it. Recent laboratory tests using all of the B. anthracis strains from the recent outbreak have indicated that all the strains are susceptible to ciprofloxacin, doxycycline, and other antibiotics.

Besides anthrax, what else is ciprofloxacin prescribed for? Has there been resistance to ciprofloxacin when used in other instances (historically)?
Ciprofloxacin is a broad-spectrum, highly effective antibiotic that has been part of the "international traveler's" kit at CDC for at least a year. It can be used against most bacterial infections. However, ciprofloxacin is frequently overused for many diseases that can be treated with less powerful, narrower-spectrum drugs. Right now, most bacteria are susceptible to ciprofloxacin, which is why we want to be cautious about its use. Overuse of ciprofloxacin could lead to the development of resistance.

Is there a generic form of ciprofloxacin?
No, there is currently no generic form of ciprofloxacin in the United States.

FAQ: Pregnancy

I'm taking medication to prevent anthrax, and I just found out that I'm pregnant. What should I do?
It is very important that you continue to take as directed the medication you have been prescribed. You should also contact your doctor or local public health officials right away to let them know that you are pregnant. They will want to discuss which medicine would be the best choice for you—to prevent anthrax and to be safe for both you and the fetus.

I'm pregnant. What medicine should I take to prevent anthrax?

You should take medication to prevent anthrax only if a public health official confirms that you have had a potential exposure to anthrax. You and your doctor will want to discuss the risks and benefits of the various antibiotics that can be used to prevent anthrax. Which medicine is most appropriate for you will depend on the specific place and situation of your exposure and on your general medical history (including other medicines you may be taking and any medication allergies you may have). Currently, there are three main antibiotics used to prevent anthrax: ciprofloxacin, amoxicillin, and doxycycline. Ciprofloxacin is effective against anthrax and is unlikely to cause major problems for the fetus, but there is not enough experience or data involving ciprofloxacin during pregnancy to say for certain that there is no risk to the fetus. Doctors are more confident about the safety of amoxicillin for the fetus, but amoxicillin may not always be effective against anthrax. Before prescribing amoxicillin for you, your doctor would want to make sure that the anthrax you were exposed to is not resistant to amoxicillin. Doxycycline can sometimes cause tooth and bone problems in the fetus. Therefore, you should not take doxycycline unless there is a specific reason why you cannot take either ciprofloxacin or amoxicillin.

I've heard that doctors don't generally prescribe ciprofloxacin to pregnant women. Why is that? Why are they recommending it for anthrax prevention?
Ciprofloxacin is not likely to cause major problems for a fetus, but there is not enough experience and data involving ciprofloxacin during pregnancy to say for certain that there is no risk to the fetus.

Ciprofloxacin is not commonly used during pregnancy because most infections that pregnant women get can be treated with other drugs whose safety for pregnant women and their fetuses is better documented. However, because anthrax is a life-threatening disease, the benefits of using ciprofloxacin may outweigh potential risks to the fetus.

I was started on ciprofloxacin to prevent anthrax. I've heard that amoxicillin may be a safer drug for me to take during my pregnancy. How do I know if I can be switched to amoxicillin?
Doctors are often more confident about using amoxicillin than ciprofloxacin in pregnancy because they have more information on the safety of amoxicillin for the mother and the fetus. But in some situations, amoxicillin may not be effective against anthrax; this is because the bacteria that cause anthrax can sometimes develop resistance to penicillins such as amoxicillin. Before prescribing amoxicillin for you, your doctor will want to learn more about the specific place and situation of your exposure to anthrax and also about your general medical history. (For instance, some women cannot take amoxicillin because they are allergic to it.)

Doxycycline is being recommended for my coworkers who aren't pregnant. Is doxycycline a better medicine against anthrax than ciprofloxacin?
No. There are no data to suggest that doxycycline is better than ciprofloxacin for preventing anthrax.

I'm having a lot of heartburn during my pregnancy. Can I take ciprofloxacin at the same time as I take antacids?
No. Antacids should not be taken at the same time as ciprofloxacin because they may make ciprofloxacin less effective. (They can interfere with the absorption of ciprofloxacin.) You should not take antacids in the 6 hours before you take a ciprofloxacin pill or for 2 hours after you take ciprofloxacin.

I've been trying to get pregnant and have just started taking medication to prevent anthrax. Can I continue to try to get pregnant while taking this medication?
Whether to try to become pregnant while taking medication to prevent anthrax is your personal decision. When making this decision, you should discuss the possible risks and benefits with your family and your doctor. Some women may prefer to wait until after completing the full course of antibiotics before becoming pregnant. If you decide not to wait, it may be best not to take doxycycline unless there is a specific reason why you cannot take either ciprofloxacin or amoxicillin.

I just recently found out I'm pregnant, and I was exposed to anthrax at work. I want to take the best medication for my fetus and me, but I don't yet want my employer to know that I'm pregnant. What should I do?
It is very important that you tell your doctor or local public health officials that you are pregnant. They will not be required to tell your employer.

FAQ: Anthrax and Influenza

Influenza (flu) and inhalation anthrax can have similar symptoms. Does CDC recommend that I get a flu shot to help diagnose anthrax?
You should get a flu shot only to prevent the flu. CDC does not recommend you get the flu shot so doctors can tell whether you have the flu or anthrax. Many illnesses (including anthrax) begin with flu-like symptoms, which include fever, body aches, tiredness, and headaches. In fact, most illnesses with flu-like symptoms are not either the flu or anthrax.

The flu vaccine is the best protection you can get to prevent the flu and its severe complications, especially among those who are at the highest risk (e.g., people older than 65 years old or younger people with chronic disease such as diabetes or heart disease). The flu shot can prevent 70%-90% of flu infections, but it will not prevent illnesses with flu-like symptoms caused by anything other than influenza.

Is there a way to distinguish between early inhalational anthrax and flu?
Early inhalational anthrax symptoms can be similar to those of much more common infections. However, a runny nose is a rare feature of anthrax. This means that a person who has a runny nose along with other common influenza-like symptoms is by far more likely to have the common cold than to have anthrax.

In addition, most people with inhalational anthrax have high white blood cell counts and no increase in the number of lymphocytes. On the other hand, people with infections such as flu usually have low white blood cell counts and an increase in the number of lymphocytes.

Chest X-rays are also critical diagnostic tools. Chest X-rays showed that all patients with inhalational anthrax have some abnormality, although for some patients, the abnormality was subtle. CT scans can confirm these abnormalities.

Is there a quick test that doctors can do to tell whether I have anthrax or an illness like the flu?
Some influenza detection tests give results fairly quickly. However, these tests are not perfect and are not appropriate for every patient. Rapid influenza tests can provide results within 24 hours;

viral culture provides results in 3-10 days. However, as many as 30% of samples that test positive for influenza by viral culture may give a negative rapid test result. And, some rapid test results may indicate influenza when a person is not infected with influenza.

How many cases of flu, and how many cases of anthrax occur each year?
Each year, several tens of millions of people get "influenza-like illness" from many different infections during the fall and winter months. This happens every year and is expected. These illnesses are due to many different viruses and agents, including influenza viruses and common cold viruses.

By contrast, few people ever get anthrax. Since October 2001, when the first cases of inhalational anthrax related to bioterrorism were diagnosed, only 10 cases have occurred in a few communities, and most of those cases occurred within particular groups of people (e.g., postal workers). Inhalational anthrax has not been diagnosed in most communities in the country.

BOTULISM

Facts about Botulism

Botulism is a muscle-paralyzing disease caused by a toxin made by a bacterium called Clostridium botulinum.

There are three main kinds of botulism:

- Foodborne botulism occurs when a person ingests pre-formed toxin that leads to illness within a few hours to days. Foodborne botulism is a public health emergency because the contaminated food may still be available to other persons besides the patient.

- Infant botulism occurs in a small number of susceptible infants each year who harbor C. botulinum in their intestinal tract.

- Wound botulism occurs when wounds are infected with C. botulinum that secretes the toxin.

With foodborne botulism, symptoms begin within 6 hours to 2 weeks (most commonly between 12 and 36 hours) after eating toxin-containing food. Symptoms of botulism include double vision, blurred vision, drooping eyelids, slurred speech, difficulty swallowing, dry mouth, muscle weakness that always descends through the body: first shoulders are affected, then upper arms, lower arms, thighs, calves, etc. Paralysis of breathing muscles can cause a person to stop breathing and die, unless assistance with breathing (mechanical ventilation) is provided.

Botulism is not spread from one person to another. Foodborne botulism can occur in all age groups.

A supply of antitoxin against botulism is maintained by CDC. The antitoxin is effective in reducing the severity of symptoms if administered early in the course of the disease. Most patients eventually recover after weeks to months of supportive care.

Frequently Asked Questions

What is botulism?

Botulism is a rare but serious paralytic illness caused by a nerve toxin that is produced by the bacterium Clostridium botulinum. There are three main kinds of botulism. Foodborne botulism is caused by eating foods that contain the botulism toxin. Wound botulism is caused by toxin produced from a wound infected with Clostridium botulinum. Infant botulism is caused by consuming the spores of the botulinum bacteria, which then grow in the intestines and release toxin. All forms of botulism can be fatal and are considered medical emergencies. Foodborne botulism can be especially dangerous because many people can be poisoned by eating a contaminated food.

What kind of germ is Clostridium botulinum?

Clostridium botulinum is the name of a group of bacteria commonly found in soil. These rod-shaped organisms grow best in low oxygen conditions. The bacteria form spores which allow them to survive in a dormant state until exposed to conditions that can support their growth. There are seven types of botulism toxin designated by the letters A through G; only types A, B, E and F cause illness in humans.

How common is botulism?

In the United States an average of 110 cases of botulism are reported each year. Of these, approximately 25% are foodborne, 72% are infant botulism, and the rest are wound botulism. Outbreaks of foodborne botulism involving two or more persons occur most years and usually caused by eating contaminated home-canned foods. The number of cases of foodborne and infant botulism has changed little in recent years, but wound botulism has increased because of the use of black-tar heroin, especially in California.

What are the symptoms of botulism?

The classic symptoms of botulism include double vision, blurred vision, drooping eyelids, slurred speech, difficulty swallowing, dry mouth, and muscle weakness. Infants with botulism appear lethargic, feed poorly, are constipated, and have a weak cry and poor muscle tone. These are all symptoms of the muscle paralysis caused by the bacterial toxin. If untreated, these symptoms may progress to cause paralysis of the arms, legs, trunk and respiratory muscles. In foodborne botulism, symptoms generally begin 18 to 36 hours after eating a contaminated food, but they can occur as early as 6 hours or as late as 10 days.

How is botulism diagnosed?

Physicians may consider the diagnosis if the patient's history and physical examination suggest botulism. However, these clues are usually not enough to allow a diagnosis of botulism. Other diseases such as Guillain-Barré syndrome, stroke, and myasthenia gravis can appear similar to botulism, and special tests may be needed to exclude these other conditions. These tests may include a brain scan, spinal fluid examination, nerve conduction test (electromyography, or EMG), and a tensilon test for myasthenia gravis. The most direct way to confirm the diagnosis is to demonstrate the botulinum toxin in the patient's serum or stool by injecting serum or stool into mice and looking for signs of botulism. The bacteria can also be isolated from the stool of persons with foodborne and infant botulism. These tests can be performed at some state health department laboratories and at CDC.

How can botulism be treated?
The respiratory failure and paralysis that occur with severe botulism may require a patient to be on a breathing machine (ventilator) for weeks, plus intensive medical and nursing care. After several weeks, the paralysis slowly improves. If diagnosed early, foodborne and wound botulism can be treated with an antitoxin which blocks the action of toxin circulating in the blood. This can prevent patients from worsening, but recovery still takes many weeks. Physicians may try to remove contaminated food still in the gut by inducing vomiting or by using enemas. Wounds should be treated, usually surgically, to remove the source of the toxin-producing bacteria. Good supportive care in a hospital is the mainstay of therapy for all forms of botulism. Currently, antitoxin is not routinely given for treatment of infant botulism.

Are there complications from botulism?
Botulism can result in death due to respiratory failure. However, in the past 50 years the proportion of patients with botulism who die has fallen from about 50% to 8%. A patient with severe botulism may require a breathing machine as well as intensive medical and nursing care for several months. Patients who survive an episode of botulism poisoning may have fatigue and shortness of breath for years and long-term therapy may be needed to aid recovery.

How can botulism be prevented?
Botulism can be prevented. Foodborne botulism has often been from home-canned foods with low acid content, such as asparagus, green beans, beets and corn. However, outbreaks of botulism from more unusual sources such as chopped garlic in oil, chile peppers, tomatoes, improperly handled baked potatoes wrapped in aluminum foil, and home-canned or fermented fish. Persons who do home canning should follow strict hygienic procedures to reduce contamination of foods. Oils infused with garlic or herbs should be refrigerated. Potatoes which have been baked while wrapped in aluminum foil should be kept hot until served or refrigerated. Because the botulism toxin is destroyed by high temperatures, persons who eat home-canned foods should consider boiling the food for 10 minutes before eating it to ensure safety. Instructions on safe home canning can be obtained from county extension services or from the US Department of Agriculture. Because honey can contain spores of Clostridium botulinum and this has been a source of infection for infants, children less than 12 months old should not be fed honey. Honey is safe for persons 1 year of age and older. Wound botulism can be prevented by promptly seeking medical care for infected wounds and by not using injectable street drugs.

What are public health agencies doing to prevent or control botulism?
Public education about botulism prevention is an ongoing activity. Information about safe canning is widely available for consumers. State health departments and CDC have persons knowledgeable about botulism available to consult with physicians 24 hours a day. If antitoxin is needed to treat a patient, it can be quickly delivered to a physician anywhere in the country. Suspected outbreaks of botulism are quickly investigated, and if they involve a commercial product, the appropriate control measures are coordinated among public health and regulatory agencies. Physicians should report suspected cases of botulism to a state health department.

PLAGUE

General
Plague, caused by a bacterium called Yersinia pestis, is transmitted from rodent to rodent by infected fleas.

Plague is characterized by periodic disease outbreaks in rodent populations, some of which have a high death rate. During these outbreaks, hungry infected fleas that have lost their normal hosts seek other sources of blood, thus increasing the increased risk to humans and other animals frequenting the area.

Epidemics of plague in humans usually involve house rats and their fleas. Rat-borne epidemics continue to occur in some developing countries, particularly in rural areas. The last rat-borne epidemic in the United States occurred in Los Angeles in 1924-25. Since then, all human plague cases in the U.S. have been sporadic cases acquired from wild rodents or their fleas or from direct contact with plague-infected animals.

Rock squirrels and their fleas are the most frequent sources of human infection in the southwestern states. For the Pacific states, the California ground squirrel and its fleas are the most common source. Many other rodent species, for instance, prairie dogs, wood rats, chipmunks, and other ground squirrels and their fleas, suffer plague outbreaks and some of these occasionally serve as sources of human infection. Deer mice and voles are thought to maintain the disease in animal populations but are less important as sources of human infection. Other less frequent sources of infection include wild rabbits, and wild carnivores that pick up their infections from wild rodent outbreaks. Domestic cats (and sometimes dogs) are readily infected by fleas or from eating infected wild rodents. Cats may serve as a source of infection to persons exposed to them. Pets may also bring plague-infected fleas into the home.

Between outbreaks, the plague bacterium is believed to circulate within populations of certain species of rodents without causing excessive mortality. Such groups of infected animals serve as silent, long-term reservoirs of infection.

Geographic Distribution of Plague

In the United States during the 1980s plague cases averaged about 18 per year. Most of the cases occurred in persons under 20 years of age. About 1 in 7 persons with plague died.

Worldwide, there are 1,000 to 2,000 cases each year. During the 1980s epidemic plague occurred each year in Africa, Asia, or South America. Epidemic plague is generally associated with domestic rats. Almost all of the cases reported during the decade were rural and occurred among people living in small towns and villages or agricultural areas rather than in larger, more developed, towns and cities.

The following information provides a worldwide distribution pattern:
There is no plague in Australia.

There is no plague in Europe; the last reported cases occurred after World War II.

In Asia and extreme southeastern Europe, plague is distributed from the Caucasus Mountains in Russia, through much of the Middle East, eastward through China, and then southward to Southwest and Southeast Asia, where it occurs in scattered, localized foci. Within these plague foci, there are isolated human cases and occasional outbreaks. Plague regularly occurs in Madagascar, off the southeastern coast of Africa.

In Africa, plague foci are distributed from Uganda south on the eastern side of the continent, and in southern Africa. Severe outbreaks have occurred in recent years in Kenya, Tanzania,

Zaire, Mozambique, and Botswana, with smaller outbreaks in other East African countries. Plague also has been reported in scattered foci in western and northern Africa.

In North America, plague is found from the Pacific Coast eastward to the western Great Plains and from British Columbia and Alberta, Canada southward to Mexico. Most of the human cases occur in two regions; one in northern New Mexico, northern Arizona, and southern Colorado, another in California, southern Oregon, and far western Nevada.

In South America, active plague foci exist in two regions; the Andean mountain region (including parts of Bolivia, Peru, and Ecuador) and in Brazil.

How Is Plague Transmitted?

Plague is transmitted from animal to animal and from animal to human by the bites of infective fleas. Less frequently, the organism enters through a break in the skin by direct contact with tissue or body fluids of a plague-infected animal, for instance, in the process of skinning a rabbit or other animal. Plague is also transmitted by inhaling infected droplets expelled by coughing, by a person or animal, especially domestic cats, with pneumonic plague. Transmission of plague from person to person is uncommon and has not been observed in the United States since 1924 but does occur as an important factor in plague epidemics in some developing countries.

Diagnosis

The pathognomic sign of plague is a very painful, usually swollen, and often hot-to-the touch lymph node, called a bubo. This finding, accompanied with fever, extreme exhaustion, and a history of possible exposure to rodents, rodent fleas, wild rabbits, or sick or dead carnivores should lead to suspicion of plague.

Onset of bubonic plague is usually 2 to 6 days after a person is exposed. Initial manifestations include fever, headache, and general illness, followed by the development of painful, swollen regional lymph nodes. Occasionally, buboes cannot be detected for a day or so after the onset of other symptoms. The disease progresses rapidly and the bacteria can invade the bloodstream, producing severe illness, called plague septicemia.

Once a human is infected, a progressive and potentially fatal illness generally results unless specific antibiotic therapy is given. Progression leads to blood infection and, finally, to lung infection. The infection of the lung is termed plague pneumonia, and it can be transmitted to others through the expulsion of infective respiratory droplets by coughing.

The incubation period of primary pneumonic plague is 1 to 3 days and is characterized by development of an overwhelming pneumonia with high fever, cough, bloody sputum, and chills. For plague pneumonia patients, the death rate is over 50%.

Treatment Information

As soon as a diagnosis of suspected plague is made, the patient should be isolated, and local and state health departments should be notified. Confirmatory laboratory work should be initiated, including blood cultures and examination of lymph node specimens if possible. Drug therapy should begin as soon as possible after the laboratory specimens are taken. The drugs of choice are streptomycin or gentamycin, but a number of other antibiotics are also effective.

Those individuals closely associated with the patient, particularly in cases with pneumonia, should be traced, identified, and evaluated. Contacts of pneumonic plague patients should be placed under observation or given preventive antibiotic therapy, depending on the degree and timing of contact.

It is a U.S. Public Health Service requirement that all suspected plague cases be reported to local and state health departments and the diagnosis confirmed by the CDC. As required by the International Health Regulations, CDC reports all U.S. plague cases to the World Health Organization.

Prevention
Plague will probably continue to exist in its many localized geographic areas around the world, and plague outbreaks in wild rodent hosts will continue to occur. Attempts to eliminate wild rodent plague are costly and futile. Therefore, primary preventive measures are directed toward reducing the threat of infection in humans in high risk areas through three techniques -- environmental management, public health education, and preventive drug therapy.

Environmental Management
Epidemic plague is best prevented by controlling rat populations in both urban and rural areas. This goal has been reached in the cities, towns, and villages of most developed countries. It has not been achieved in either the rural or urban areas of many developing countries where the threat of epidemic plague continues to exist. Control of plague in such situations requires two things: 1) close surveillance for human plague cases, and for plague in rodents, and 2) the use of an effective insecticide to control rodent fleas when human plague cases and rodent outbreaks occur.

Public Health Education
In regions such as the American West where plague is widespread in wild rodents, the greatest threat is to people living, working, or playing in areas where the infection is active. Public health education of citizens and the medical community should include information on the following plague prevention measures:

Eliminating food and shelter for rodents in and around homes, work places, and recreation areas by making buildings rodent-proof, and by removing brush, rock piles, junk, and food sources (such as pet food), from properties.

Surveillance for plague activity in rodent populations by public health workers or by citizens reporting rodents found sick or dead to local health departments.

Use of appropriate and licensed insecticides to kill fleas during wild animal plague outbreaks to reduce the risk to humans.

Treatment of pets (dogs and cats) for flea control once each week.

Preventive Drug Therapy
Antibiotics may be taken in the event of exposure to the bites of wild rodent fleas during an outbreak or to the tissues or fluids of a plague-infected animal. Preventive therapy is also

recommended in the event of close exposure to another person or to a pet animal with suspected plague pneumonia. For preventive drug therapy, the preferred antibiotics are the tetracyclines, chloramphenicol, or one of the effective sulfonamides.

Vaccines
The plague vaccine is no longer commercially available in the United States

Facts about Pneumonic Plague
Plague is an infectious disease that affects animals and humans. It is caused by the bacterium Yersinia pestis. This bacterium is found in rodents and their fleas and occurs in many areas of the world, including the United States.

Y. pestis is easily destroyed by sunlight and drying. Even so, when released into air, the bacterium will survive for up to one hour, although this could vary depending on conditions.

Pneumonic plague is one of several forms of plague. Depending on circumstances, these forms may occur separately or in combination:

Pneumonic plague occurs when Y. pestis infects the lungs. This type of plague can spread from person to person through the air. Transmission can take place if someone breathes in aerosolized bacteria, which could happen in a bioterrorist attack. Pneumonic plague is also spread by breathing in Y. pestis suspended in respiratory droplets from a person (or animal) with pneumonic plague. Becoming infected in this way usually requires direct and close contact with the ill person or animal. Pneumonic plague may also occur if a person with bubonic or septicemic plague is untreated and the bacteria spread to the lungs.

Bubonic plague is the most common form of plague. This occurs when an infected flea bites a person or when materials contaminated with Y. pestis enter through a break in a person's skin. Patients develop swollen, tender lymph glands (called buboes) and fever, headache, chills, and weakness. Bubonic plague does not spread from person to person.

Septicemic plague occurs when plague bacteria multiply in the blood. It can be a complication of pneumonic or bubonic plague or it can occur by itself. When it occurs alone, it is caused in the same ways as bubonic plague; however, buboes do not develop. Patients have fever, chills, prostration, abdominal pain, shock, and bleeding into skin and other organs. Septicemic plague does not spread from person to person.

Symptoms and Treatment
With pneumonic plague, the first signs of illness are fever, headache, weakness, and rapidly developing pneumonia with shortness of breath, chest pain, cough, and sometimes bloody or watery sputum. The pneumonia progresses for 2 to 4 days and may cause respiratory failure and shock. Without early treatment, patients may die.

Early treatment of pneumonic plague is essential. To reduce the chance of death, antibiotics must be given within 24 hours of first symptoms. Streptomycin, gentamicin, the tetracyclines, and chloramphenicol are all effective against pneumonic plague.
Antibiotic treatment for 7 days will protect people who have had direct, close contact with infected patients. Wearing a close-fitting surgical mask also protects against infection.

Frequently Asked Questions (FAQ) About Plague

What is plague?

Plague is a disease caused by Yersinia pestis (Y. pestis), a bacterium found in rodents and their fleas in many areas around the world.

Why are we concerned about pneumonic plague as a bioweapon?

Yersinia pestis used in an aerosol attack could cause cases of the pneumonic form of plague. One to six days after becoming infected with the bacteria, people would develop pneumonic plague. Once people have the disease, the bacteria can spread to others who have close contact with them. Because of the delay between being exposed to the bacteria and becoming sick, people could travel over a large area before becoming contagious and possibly infecting others. Controlling the disease would then be more difficult. A bioweapon carrying Y. pestis is possible because the bacterium occurs in nature and could be isolated and grown in quantity in a laboratory. Even so, manufacturing an effective weapon using Y. pestis would require advanced knowledge and technology.

Is pneumonic plague different from bubonic plague?

Yes. Both are caused by Yersinia pestis, but they are transmitted differently and their symptoms differ. Pneumonic plague can be transmitted from person to person; bubonic plague cannot. Pneumonic plague affects the lungs and is transmitted when a person breathes in Y. pestis particles in the air. Bubonic plague is transmitted through the bite of an infected flea or exposure to infected material through a break in the skin. Symptoms include swollen, tender lymph glands called buboes. Buboes are not present in pneumonic plague. If bubonic plague is not treated, however, the bacteria can spread through the bloodstream and infect the lungs, causing a secondary case of pneumonic plague.

What are the signs and symptoms of pneumonic plague?

Patients usually have fever, weakness, and rapidly developing pneumonia with shortness of breath, chest pain, cough, and sometimes bloody or watery sputum. Nausea, vomiting, and abdominal pain may also occur. Without early treatment, pneumonic plague usually leads to respiratory failure, shock, and rapid death.

How do people become infected with pneumonic plague?

Pneumonic plague occurs when Yersinia pestis infects the lungs. Transmission can take place if someone breathes in Y. pestis particles, which could happen in an aerosol release during a bioterrorism attack. Pneumonic plague is also transmitted by breathing in Y. pestis suspended in respiratory droplets from a person (or animal) with pneumonic plague. Respiratory droplets are spread most readily by coughing or sneezing. Becoming infected in this way usually requires direct and close (within 6 feet) contact with the ill person or animal. Pneumonic plague may also occur if a person with bubonic or septicemic plague is untreated and the bacteria spread to the lungs.

Does plague occur naturally?

Yes. The World Health Organization reports 1,000 to 3,000 cases of plague worldwide every year. An average of 5 to 15 cases occur each year in the western United States. These cases are usually scattered and occur in rural to semi-rural areas. Most cases are of the bubonic form of the

disease. Naturally occurring pneumonic plague is uncommon, although small outbreaks do occur. Both types of plague are readily controlled by standard public health response measures.

Can a person exposed to pneumonic plague avoid becoming sick?
Yes. People who have had close contact with an infected person can greatly reduce the chance of becoming sick if they begin treatment within 7 days of their exposure. Treatment consists of taking antibiotics for at least 7 days.

How quickly would someone get sick if exposed to plague bacteria through the air?
Someone exposed to Yersinia pestis through the air—either from an intentional aerosol release or from close and direct exposure to someone with plague pneumonia—would become ill within 1 to 6 days.

Can pneumonic plague be treated?
Yes. To prevent a high risk of death, antibiotics should be given within 24 hours of the first symptoms. Several types of antibiotics are effective for curing the disease and for preventing it. Available oral medications are a tetracycline (such as doxycycline) or a fluoroquinolone (such as ciprofloxacin). For injection or intravenous use, streptomycin or gentamicin antibiotics are used. Early in the response to a bioterrorism attack, these drugs would be tested to determine which is most effective against the particular weapon that was used.

Would enough medication be available in the event of a bioterrorism attack involving pneumonic plague?
National and state public health officials have large supplies of drugs needed in the event of a bioterrorism attack. These supplies can be sent anywhere in the United States within 12 hours.

What should someone do if they suspect they or others have been exposed to plague?
Get immediate medical attention: To prevent illness, a person who has been exposed to pneumonic plague must receive antibiotic treatment without delay. If an exposed person becomes ill, antibiotics must be administered within 24 hours of their first symptoms to reduce the risk of death. Notify authorities: Immediately notify local or state health departments so they can begin to investigate and control the problem right away. If bioterrorism is suspected, the health departments will notify the CDC, FBI, and other appropriate authorities.

How can someone reduce the risk of getting pneumonic plague from another person or giving it to someone else?
People having direct and close contact with someone with pneumonic plague should wear tightly fitting disposable surgical masks. Patients with the disease should be isolated and medically supervised for at least the first 48 hours of antibiotic treatment. People who have been exposed to a contagious person can be protected from developing plague by receiving prompt antibiotic treatment.

How is plague diagnosed?
The first step is evaluation by a health worker. If the health worker suspects pneumonic plague, samples of the patient's blood, sputum, or lymph node aspirate are sent to a laboratory for testing. Once the laboratory receives the sample, preliminary results can be ready in less than two hours. Confirmation will take longer, usually 24 to 48 hours.

How long can plague bacteria exist in the environment?
Yersinia pestis is easily destroyed by sunlight and drying. Even so, when released into air, the bacterium will survive for up to one hour, depending on conditions.

Is a vaccine available to prevent pneumonic plague?
Currently, no plague vaccine is available in the United States. Research is in progress, but we are not likely to have vaccines for several years or more.

Additional Questions and Answers About Plague

Q. How is plague transmitted?
A. By fleas that become infected with bacteria Yersinia pestis that cause plague.

Q. How do people get plague?
A. By the bite of fleas infected with the plague bacteria.

Q. What is the basic transmission cycle?
A. Fleas become infected by feeding on rodents, such as the chipmunks, prairie dogs, ground squirrels, mice, and other mammals that are infected with the bacteria Yersinia pestis. Fleas transmit the plague bacteria to humans and other mammals during the feeding process. The plague bacteria are maintained in the blood systems of rodents.

Q. Could you get plague from another person?
A. Yes, when the other person has plague pneumonia and coughs droplets containing the plague bacteria into air that is breathed by a non-infected person.

Q. What are the signs and symptoms of plague?
A. The typical sign of the most common form of human plague is a swollen and very tender lymph gland, accompanied by pain. The swollen gland is called a "bubo" (hence the term "bubonic plague"). Bubonic plague should be suspected when a person develops a swollen gland, fever, chills, headache, and extreme exhaustion, and has a history of possible exposure to infected rodents, rabbits, or fleas.

Q. What is the incubation period for plague?
A. A person usually becomes ill with bubonic plague 2 to 6 days after being infected. When bubonic plague is left untreated, plague bacteria invade the bloodstream. When plague bacteria multiply in the bloodstream, they spread rapidly throughout the body and cause a severe and often fatal condition. Infection of the lungs with the plague bacterium causes the pneumonic form of plague, a severe respiratory illness. The infected person may experience high fever, chills, cough, and breathing difficulty, and expel bloody sputum. If plague patients are not given specific antibiotic therapy, the disease can progress rapidly to death.

Q. What is the mortality rate of plague?
A. About 14% (1 in 7) of all plague cases in the United States are fatal.

Q. How many cases of plague occur in the U.S.?
A. Human plague in the United States has occurred as mostly scattered cases in rural areas (an average of 10 to 20 persons each year). Globally, the World Health Organization reports 1,000 to 3,000 cases of plague every year.

Q. How is plague treated?
A. According to treatment experts, a patient diagnosed with suspected plague should be hospitalized and medically isolated. Laboratory tests should be done, including blood cultures for plague bacteria and microscopic examination of lymph gland, blood, and sputum samples. Antibiotic treatment should begin as soon as possible after laboratory specimens are taken. Streptomycin is the antibiotic of choice. Gentamicin is used when streptomycin is not available. Tetracyclines and chloramphenicol are also effective.

Persons who have been in close contact with a plague patient, particularly a patient with plague pneumonia, should be identified and evaluated. The U.S. Public Health Service requires that all cases of suspected plague be reported immediately to local and state health departments and that the diagnosis be confirmed by CDC. As required by the International Health Regulations, CDC reports all U.S. plague cases to the World Health Organization.

Q. Is the disease seasonal in its occurrence?
A. No, plague can be acquired at anytime during the year.

Q. Where is plague most common?
Generally, plague is most common in the southwestern states, particularly New Mexico and Arizona.

Q. Who is at risk for getting plague?
A. Outbreaks in people occur in areas where housing and sanitation conditions are poor. These outbreaks can occur in rural communities or in cities. They are usually associated with infected rats and rat fleas that live in the home.

SMALLPOX

The Disease

Smallpox is a serious, contagious, and sometimes fatal infectious disease. There is no specific treatment for smallpox disease, and the only prevention is vaccination. The name smallpox is derived from the Latin word for "spotted" and refers to the raised bumps that appear on the face and body of an infected person.

There are two clinical forms of smallpox. Variola major is the severe and most common form of smallpox, with a more extensive rash and higher fever. There are four types of variola major smallpox: ordinary (the most frequent type, accounting for 90% or more of cases); modified (mild and occurring in previously vaccinated persons); flat; and hemorrhagic (both rare and very severe). Historically, variola major has an overall fatality rate of about 30%; however, flat and hemorrhagic smallpox usually are fatal. Variola minor is a less common presentation of smallpox, and a much less severe disease, with death rates historically of 1% or less.

Smallpox outbreaks have occurred from time to time for thousands of years, but the disease is now eradicated after a successful worldwide vaccination program. The last case of smallpox in the United States was in 1949. The last naturally occurring case in the world was in Somalia in 1977. After the disease was eliminated from the world, routine vaccination against smallpox among the general public was stopped because it was no longer necessary for prevention.

Where Smallpox Comes From

Smallpox is caused by the variola virus that emerged in human populations thousands of years ago. Except for laboratory stockpiles, the variola virus has been eliminated. However, in the aftermath of the events of September and October, 2001, there is heightened concern that the variola virus might be used as an agent of bioterrorism. For this reason, the U.S. government is taking precautions for dealing with a smallpox outbreak.

Transmission

Generally, direct and fairly prolonged face-to-face contact is required to spread smallpox from one person to another. Smallpox also can be spread through direct contact with infected bodily fluids or contaminated objects such as bedding or clothing. Rarely, smallpox has been spread by virus carried in the air in enclosed settings such as buildings, buses, and trains. Humans are the only natural hosts of variola. Smallpox is not known to be transmitted by insects or animals.

A person with smallpox is sometimes contagious with onset of fever (prodrome phase), but the person becomes most contagious with the onset of rash. At this stage the infected person is usually very sick and not able to move around in the community. The infected person is contagious until the last smallpox scab falls off.

Smallpox Disease
Incubation Period
(Duration: 7 to 17 days)
Not contagious

Exposure to the virus is followed by an incubation period during which people do not have any symptoms and may feel fine. This incubation period averages about 12 to 14 days but can range from 7 to 17 days. During this time, people are not contagious.

Initial Symptoms (Prodrome)
(Duration: 2 to 4 days)
Sometimes contagious*

The first symptoms of smallpox include fever, malaise, head and body aches, and sometimes vomiting. The fever is usually high, in the range of 101 to 104 degrees Fahrenheit. At this time, people are usually too sick to carry on their normal activities. This is called the prodrome phase and may last for 2 to 4 days.

Early Rash
(Duration: about 4 days)
Most contagious

Rash distribution:

A rash emerges first as small red spots on the tongue and in the mouth.

These spots develop into sores that break open and spread large amounts of the virus into the mouth and throat. At this time, the person becomes most contagious.

Around the time the sores in the mouth break down, a rash appears on the skin, starting on the face and spreading to the arms and legs and then to the hands and feet. Usually the rash spreads to all parts of the body within 24 hours. As the rash appears, the fever usually falls and the person may start to feel better.

By the third day of the rash, the rash becomes raised bumps.

By the fourth day, the bumps fill with a thick, opaque fluid and often have a depression in the center that looks like a bellybutton. (This is a major distinguishing characteristic of smallpox.)

Fever often will rise again at this time and remain high until scabs form over the bumps.

Pustular Rash
(Duration: about 5 days)
Contagious

The bumps become pustules—sharply raised, usually round and firm to the touch as if there's a small round object under the skin. People often say the bumps feel like BB pellets embedded in the skin.

Pustules and Scabs
(Duration: about 5 days)
Contagious

The pustules begin to form a crust and then scab.

By the end of the second week after the rash appears, most of the sores have scabbed over.

Resolving Scabs
(Duration: about 6 days)

Contagious The scabs begin to fall off, leaving marks on the skin that eventually become pitted scars. Most scabs will have fallen off three weeks after the rash appears.

The person is contagious to others until all of the scabs have fallen off.

Scabs resolved
Not contagious

Scabs have fallen off. Person is no longer contagious.

* Smallpox may be contagious during the prodrome phase, but is most infectious during the first 7 to 10 days following rash onset.

Vaccine Overview

The Smallpox Vaccine

The smallpox vaccine helps the body develop immunity to smallpox. The vaccine is made from a virus called vaccinia which is a "pox"-type virus related to smallpox. The smallpox vaccine contains the "live" vaccinia virus—not dead virus like many other vaccines. For that reason, the vaccination site must be cared for carefully to prevent the virus from spreading. Also, the vaccine can have side effects (see the section "Smallpox Vaccine Safety" in this fact sheet). The vaccine does not contain the smallpox virus and cannot give you smallpox.

Currently, the United States has a big enough stockpile of smallpox vaccine to vaccinate everyone in the country who might need it in the event of an emergency. Production of new vaccine is underway.

Length of Protection

Smallpox vaccination provides high level immunity for 3 to 5 years and decreasing immunity thereafter. If a person is vaccinated again later, immunity lasts even longer. Historically, the vaccine has been effective in preventing smallpox infection in 95% of those vaccinated. In addition, the vaccine was proven to prevent or substantially lessen infection when given within a few days of exposure. It is important to note, however, that at the time when the smallpox vaccine was used to eradicate the disease, testing was not as advanced or precise as it is today, so there may still be things to learn about the vaccine and its effectiveness and length of protection.

Receiving the Vaccine

The smallpox vaccine is not given with a hypodermic needle. It is not a shot as most people have experienced. The vaccine is given using a bifurcated (two-pronged) needle that is dipped into the vaccine solution. When removed, the needle retains a droplet of the vaccine. The needle is used to prick the skin a number of times in a few seconds. The pricking is not deep, but it will cause a sore spot and one or two droplets of blood to form. The vaccine usually is given in the upper arm.

If the vaccination is successful, a red and itchy bump develops at the vaccine site in three or four days. In the first week, the bump becomes a large blister, fills with pus, and begins to drain. During the second week, the blister begins to dry up and a scab forms. The scab falls off in the third week, leaving a small scar. People who are being vaccinated for the first time have a stronger reaction than those who are being revaccinated. The following pictures show the progression of the site where the vaccine is given.

Post-Vaccination Care

After vaccination, it is important to follow care instructions for the site of the vaccine. Because the virus is live, it can spread to other parts of the body, or to other people. The vaccinia virus (the live virus in the smallpox vaccine) may cause rash, fever, and head and body aches. In certain groups of people (see the section "Smallpox Vaccine Safety" in this fact sheet), complications from the vaccinia virus can be severe.

Benefit of Vaccine Following Exposure

Vaccination within 3 days of exposure will prevent or significantly lessen the severity of smallpox symptoms in the vast majority of people. Vaccination 4 to 7 days after exposure likely offers some protection from disease or may modify the severity of disease.

Smallpox Vaccine Safety

The smallpox vaccine is the best protection you can get if you are exposed to the smallpox virus. Anyone directly exposed to smallpox, regardless of health status, would be offered the smallpox vaccine because the risks associated with smallpox disease are far greater than those posed by the vaccine.

There are side effects and risks associated with the smallpox vaccine. Most people experience normal, usually mild reactions that include a sore arm, fever, and body aches. However, other people experience reactions ranging from serious to life-threatening. People most likely to have serious side effects are: people who have had, even once, skin conditions (especially eczema or atopic dermatitis) and people with weakened immune systems, such as those who have received a transplant, are HIV positive, are receiving treatment for cancer, or are currently taking medications (like steroids) that suppress the immune system. In addition, pregnant women should not get the vaccine because of the risk it poses to the fetus. Women who are breastfeeding should not get the vaccine. Children younger than 12 months of age should not get the vaccine. Also, the Advisory Committee on Immunization Practices (ACIP) advises against non-emergency use of smallpox vaccine in children younger than 18 years of age. In addition, those allergic to the vaccine or any of its components should not receive the vaccine.

In the past, about 1,000 people for every 1 million people vaccinated for the first time experienced reactions that, while not life-threatening, were serious. These reactions included a toxic or allergic reaction at the site of the vaccination (erythema multiforme), spread of the vaccinia virus to other parts of the body and to other individuals (inadvertent inoculation), and spread of the vaccinia virus to other parts of the body through the blood (generalized vaccinia). These types of reactions may require medical attention. In the past, between 14 and 52 people out of every 1 million people vaccinated for the first time experienced potentially life-threatening reactions to the vaccine. Based on past experience, it is estimated that 1 or 2 people in 1 million who receive the vaccine may die as a result. Careful screening of potential vaccine recipients is essential to ensure that those at increased risk do not receive the vaccine.

Smallpox Vaccine Availability

Routine smallpox vaccination among the American public stopped in 1972 after the disease was eradicated in the United States. Until recently, the U.S. government provided the vaccine only to a few hundred scientists and medical professionals working with smallpox and similar viruses in a research setting.

After the events of September and October, 2001, however, the U.S. government took further actions to improve its level of preparedness against terrorism. One of many such measures—designed specifically to prepare for an intentional release of the smallpox virus—included updating and releasing a smallpox response plan. In addition, the U.S. government ordered production of enough smallpox vaccine to immunize the American public in the event of a smallpox outbreak. Right now, the U.S. government has access to enough smallpox vaccine to effectively respond to a smallpox outbreak in the United States.

People Who Should NOT Get the Smallpox Vaccine (Unless they are exposed to smallpox)

Some people are at greater risk for serious side effects from the smallpox vaccine. Individuals who have any of the following conditions, or live with someone who does, should NOT get the smallpox vaccine unless they have been exposed to the smallpox virus:

Eczema or atopic dermatitis. (This is true even if the condition is not currently active, mild or experienced as a child.)

Skin conditions such as burns, chickenpox, shingles, impetigo, herpes, severe acne, or psoriasis. (People with any of these conditions should not get the vaccine until they have completely healed.)

Weakened immune system. (Cancer treatment, an organ transplant, HIV, Primary Immune Deficiency disorders, some severe autoimmune disorders and medications to treat autoimmune disorders, and other illnesses can weaken the immune system.)

Pregnancy or plans to become pregnant within one month of vaccination.

In addition, individuals should not get the smallpox vaccine if they:
Are allergic to the vaccine or any of its ingredients (polymyxin B, streptomycin, chlortetracycline, neomycin).

Are younger than 12 months of age. However, the Advisory Committee on Immunization Practices (ACIP) advises against non-emergency use of smallpox vaccine in children younger than 18 years of age. In addition, the vaccine manufacturer's package insert states that the vaccine is not recommended for use in geriatric populations in non-emergency situations. The term geriatric generally applies to people age 65 and above.

Have a moderate or severe short-term illness. (These people should wait until they are completely recovered to get the vaccine.)

Are currently breastfeeding?
Are using steroid drops in their eyes. (These people should wait until they are no longer using the medication to get the vaccine.)

Again, people who have been directly exposed to the smallpox virus should get the vaccine, regardless of their health status.

Don't Hesitate!
If offered the smallpox vaccine, individuals should tell their immunization provider if they have any of the above conditions, or even if they suspect they might.

Reactions after Smallpox Vaccination

The smallpox vaccine prevents smallpox. For most people, it is safe and effective. Most people experience normal, typically mild reactions to the vaccine, which indicate that it is beginning to work. Some people may experience reactions that may require medical attention.

Normal, Typically Mild Reactions

These reactions usually go away without treatment:
The arm receiving the vaccination may be sore and red where the vaccine was given.
The glands in the armpits may become large and sore.

The vaccinated person may run a low fever.
One out of 3 people may feel bad enough to miss work, school, or recreational activity or have trouble sleeping.

Serious Reactions
In the past, about 1,000 people for every 1 million people vaccinated for the first time experienced reactions that, while not life-threatening, were serious. These reactions may require medical attention:

A vaccinia rash or outbreak of sores limited to one area. This is an accidental spreading of the vaccinia virus caused by touching the vaccination site and then touching another part of the body or another person. It usually occurs on the genitals or face, including the eyes, where it can damage sight or lead to blindness. Washing hands with soap and water after touching the vaccine site will help prevent this (inadvertent inoculation).

A widespread vaccinia rash. The virus spreads from the vaccination site through the blood. Sores break out on parts of the body away from the vaccination site (generalized vaccinia).

A toxic or allergic rash in response to the vaccine that can take various forms (erythema multiforme).

Life-Threatening Reactions
Rarely, people have had very bad reactions to the vaccine. In the past, between 14 and 52 people per 1 million people vaccinated for the first time experienced potentially life-threatening reactions. These reactions require immediate medical attention:

Eczema vaccinatum. Serious skin rashes caused by widespread infection of the skin in people with skin conditions such as eczema or atopic dermatitis.
Progressive vaccinia (or vaccinia necrosum). Ongoing infection of skin with tissue destruction frequently leading to death.
Postvaccinal encephalitis. Inflammation of the brain.
People with certain medical conditions—including people with weakened immune systems or certain skin conditions—are more likely to have these reactions and should not get the smallpox vaccine unless they have been exposed to smallpox.

Based on past experience, it is estimated that between 1 and 2 people out of every 1 million people vaccinated may die as a result of life-threatening reactions to the vaccine.

Important Note: Statistical information about smallpox vaccine adverse reactions is based on data from two studies conducted in 1968. Adverse event rates in the United States today may be higher because there may be more people at risk from immune suppression (from cancer, cancer therapy, organ transplants, and illnesses such as HIV/AIDS) and eczema or atopic dermatitis. The outcome associated with adverse events may be less severe than previously reported because of advances in medical care. Rates may be lower for persons previously vaccinated.

CLOSE CONTACTS OF PEOPLE CONSIDERING VACCINATION

Someone You Are Close to May Get the Smallpox Vaccine: What You Should Know and Do

If someone you have close, physical contact with (your spouse, partner or other member of your household) is considering getting the smallpox vaccine, there are some things you should know.

Before Vaccination: What You Should Know

The smallpox vaccine contains a live virus called vaccinia, which is related to smallpox, though milder. The vaccine helps the body develop immunity to smallpox. And while the smallpox vaccine is safe and effective for most who receive it, people with certain health conditions are more likely to have serious reactions to the smallpox vaccine. These people should not be vaccinated and they should not be in close contact (household or similar intimate physical contact) with someone who has been vaccinated.

Careful screening measures are in place to help ensure that people who are more susceptible to serious reactions, or who live with others who are more susceptible to serious reactions, are not vaccinated. As your close contact considers vaccination, it's important that you actively participate in this screening process. Inform your close contact if you have any of the conditions listed below, or even if you have any concerns about any of the conditions listed below.

Health conditions that would mean you should not be in close contact with someone who has been vaccinated are:

A diagnosis of eczema or atopic dermatitis, past or present
A weakened immune system, for whatever reason (HIV, cancer and cancer treatment, some autoimmune diseases and some treatments for autoimmune conditions can weaken the immune system)
A skin condition with breaks in the skin (chickenpox, shingles, burns, severe acne, etc ...) or Pregnancy
If any of these conditions apply to you, you should not be in close contact with someone who has gotten smallpox vaccine because of the risk it poses to you (or your fetus if you are pregnant).

After Vaccination: What You Should Know

If neither you nor your close contact has any condition that might place you at increased risk from a serious reaction, and that close contact decides to get vaccinated, there are still some things you should keep in mind.

The main concern for people who have close, physical contact with someone who has gotten the vaccine is that the vaccinia virus can be spread from the vaccination site, causing rash (mild to severe), fever, and head and body aches. Vaccinia is spread by touching a vaccination site before it has healed or by touching bandages, clothing, or other material contaminated with live virus from the vaccination site and then touching another part of the body or touching someone else. The vaccination site often becomes itchy, which may lead to scratching, rubbing, or touching the site.

In the past, when vaccinated persons spread vaccinia to other parts of their body, it often was to their eyes or their genitals. Vaccinated persons also can spread vaccinia to other individuals. In the past, this was reported to occur between 20 and 60 times out of 1 million people vaccinated for the first time and often involved children. Most of the time, this took place in situations of

close contact, such as happens in a household, or in similar situations involving close physical contact where careful hand hygiene and site care may not be followed.

After Vaccination: Taking Care

People getting the vaccine will receive instructions for special care to minimize the risk of spreading vaccinia by touch, but you also can take precautions to protect yourself. These measures should be followed until the scab that forms at the vaccination site after vaccination falls off on its own (in 2 to 3 weeks).

Do not touch the vaccine site or any materials that might be contaminated with live virus from the site (such as bandages, towels, clothing, or washcloths used by the person who got the vaccine).

If you accidentally come in contact with the vaccine site, or something that may be contaminated with live virus, immediately wash with soap and warm water.

If you share a bed with the vaccinated person, be sure that they are wearing a gauze bandage held in place with first aid adhesive tape over the vaccination site. As an extra precaution, the person who got the vaccine can wear a shirt or pajamas that cover the bandaged vaccine site. If they do not, you may choose to sleep in a separate bed. (When involved in direct patient care, healthcare workers should cover the gauze with a semipermeable dressing as an additional barrier.)

Keep a separate laundry hamper for items like clothing, towels, or bedding that have come in direct contact with the vaccine site or drainage from the site. Launder these items, using hot water with detergent and/or bleach and wash hands carefully afterwards.

Remind the person who got the vaccine to follow site care and hand washing instructions. If their hand is contaminated and they touch you, you can contract vaccinia.

TULAREMIA

Frequently Asked Questions

What is tularemia?

Tularemia is an infectious disease caused by a hardy bacterium, Francisella tularensis, found in animals (especially rodents, rabbits, and hares).

How do people become infected with the tularemia bacteria?

Typically, persons become infected through the bites of arthropods (most commonly, ticks and deerflies) that have fed on an infected animal, by handling infected animal carcasses, by eating or drinking contaminated food or water, or by inhaling infected aerosols.

Does tularemia occur naturally in the United States?

Yes. It is a widespread disease of animals. Approximately 200 cases of tularemia in humans are reported annually in the United States, mostly in persons living in the south-central and western states. Nearly all cases occur in rural areas and are associated with the bites of infective ticks and biting flies or with the handling of infected rodents, rabbits, or hares. Occasional cases result from inhaling infectious aerosols and from laboratory accidents.

Why are we concerned about tularemia as a bioweapon?
Francisella tularensis is highly infectious: a small number of bacteria (10-50 organisms) can cause disease. If F. tularensis were used as a bioweapon, the bacteria would likely be made airborne for exposure by inhalation. Persons who inhale an infectious aerosol would generally experience severe respiratory illness, including life-threatening pneumonia and systemic infection, if they were not treated. The bacteria that cause tularemia occur widely in nature and could be isolated and grown in quantity in a laboratory, although manufacturing an effective aerosol weapon would require considerable sophistication.

Can someone become infected with the tularemia bacteria from another person?
No. People have not been known to transmit the infection to others, so infected persons do not need to be isolated. People who have been exposed to F. tularensis should be treated as soon as possible. The disease can be fatal if it is not treated with the appropriate antibiotics.

How quickly would someone become sick if they were exposed to the tularemia bacteria?
The incubation period for tularemia is typically 3 to 5 days, with a range of 1 to 14 days.

What are the signs and symptoms of tularemia?
Depending on the route of exposure, the tularemia bacteria may cause skin ulcers, swollen and painful lymph glands, inflamed eyes, sore throat, oral ulcers, or pneumonia. If the bacteria were inhaled, symptoms would include the abrupt onset of fever, chills, headache, muscle aches, joint pain, dry cough, and progressive weakness. Persons with pneumonia can develop chest pain, difficulty breathing, bloody sputum, and respiratory failure. 40% or more of persons with the lung and systemic forms of the disease may die if they are not treated with appropriate antibiotics.

What should someone do if they suspect they or others have been exposed to the tularemia bacteria?
Seek prompt medical attention. If a person has been exposed to Francisella tularensis, treatment with tetracycline antibiotics for 14 days after exposure may be recommended.

Local and state health departments should be immediately notified so an investigation and control activities can begin quickly. If the exposure is thought to be due to criminal activity (bioterrorism), local and state health departments will notify CDC, the FBI, and other appropriate authorities.

How is tularemia diagnosed?
When tularemia is clinically suspected, the healthcare worker will collect specimens, such as blood or sputum, from the patient for testing in a diagnostic or reference laboratory. Laboratory test results for tularemia may be presumptive or confirmatory.

Presumptive (preliminary) identification may take less than 2 hours, but confirmatory testing will take longer, usually 24 to 48 hours.

Can tularemia be effectively treated with antibiotics?
Yes. After potential exposure or diagnosis, early treatment is recommended with an antibiotic from the tetracycline (such as doxycycline) or fluoroquinolone (such as ciprofloxacin) class, which are taken orally, or the antibiotics streptomycin or gentamicin, which are given

intramuscularly or intravenously. Sensitivity testing of the tularemia bacterium can be done in the early stages of a response to determine which antibiotics would be most effective.

How long can Francisella tularensis exist in the environment?
Francisella tularensis can remain alive for weeks in water and soil.

Is there a vaccine available for tularemia?
In the past, a vaccine for tularemia has been used to protect laboratory workers, but it is currently under review by the Food and Drug Administration.

RIFT VALLEY FEVER

What is Rift Valley fever?
Rift Valley fever (RVF) is an acute, fever-causing viral disease that affects domestic animals (such as cattle, buffalo, sheep, goats, and camels) and humans. RVF is most commonly associated with mosquito-borne epidemics during years of unusually heavy rainfall.

The disease is caused by the RVF virus, a member of the genus Phlebovirus in the family Bunyaviridae. The disease was first reported among livestock by veterinary officers in Kenya in the early 1900s.

Where is the disease found?
RVF is generally found in regions of eastern and southern Africa where sheep and cattle are raised, but the virus also exists in most countries of sub-Saharan Africa and in Madagascar. In September 2000, a RVF outbreak was reported in Saudi Arabia and subsequently Yemen. These cases represent the first Rift Valley fever cases identified outside Africa.

RVF virus primarily affects livestock and can cause disease in a large number of domestic animals (this situation is referred to as an "epizootic"). The presence of an RVF epizootic can lead to an epidemic among humans who are exposed to diseased animals. The most notable epizootic of RVF, which occurred in Kenya in 1950-1951, resulted in the death of an estimated 100,000 sheep. In 1977, the virus was detected in Egypt (probably exported there in infected domestic animals from Sudan) and caused a large outbreak of RVF among animals and humans. The first epidemic of RVF in West Africa was reported in 1987 and was linked to construction of the Senegal River Project. The project caused flooding in the lower Senegal River area and altered interactions between animals and humans resulting in transmission of the RVF virus to humans.

How is RVF virus spread among animals? An epizootic of RVF is generally observed during years in which unusually heavy rainfall and localized flooding occur. The excessive rainfall allows mosquito eggs, usually of the genus Aedes, to hatch. The mosquito eggs are naturally infected with the RVF virus, and the resulting mosquitoes transfer the virus to the livestock on which they feed. Once the livestock is infected, other species of mosquitoes can become infected from the animals and can spread the disease. In addition, it is possible that the virus can be transmitted by other biting insects.

How do humans get RVF?
Humans can get RVF as a result of bites from mosquitoes and possibly other bloodsucking insects that serve as vectors. Humans can also get the disease if they are exposed to either the blood or

other body fluids of infected animals. This exposure can result from the slaughtering or handling of infected animals or by touching contaminated meat during the preparation of food. Infection through aerosol transmission of RVF virus has resulted from contact with laboratory specimens containing the virus.

What are the symptoms of RVF?

RVF virus can cause several different disease syndromes. People with RVF typically have either no symptoms or a mild illness associated with fever and liver abnormalities. However, in some patients the illness can progress to hemorrhagic fever (which can lead to shock or hemorrhage), encephalitis (inflammation of the brain, which can lead to headaches, coma, or seizures), or ocular disease (diseases affecting the eye). Patients who become ill usually experience fever, generalized weakness, back pain, dizziness, and extreme weight loss at the onset of the illness. Typically, patients recover within two days to one week after onset of illness.

Are there complications after recovery?
The most common complication associated with RVF is inflammation of the retina (a structure connecting the nerves of the eye to the brain). As a result, approximately 1% - 10% of affected patients may have some permanent vision loss.

Is the disease ever fatal?
Approximately 1% of humans that become infected with RVF die of the disease. Case-fatality proportions are significantly higher for infected animals. The most severe impact is observed in pregnant livestock infected with RVF, which results in abortion of virtually 100% of fetuses.

How is RVF treated?
There is no established course of treatment for patients infected with RVF virus. However, studies in monkeys and other animals have shown promise for ribavirin, an antiviral drug, for future use in humans. Additional studies suggest that interferon, immune modulators, and convalescent-phase plasma may also help in the treatment of patients with RVF.

Who is at risk for the illness?
Studies have shown that sleeping outdoors at night in geographical regions where outbreaks occur could be a risk factor for exposure to mosquito and other insect vectors. Animal herdsmen, abattoir workers, and other individuals who work with animals in RVF-endemic areas (areas where the virus is present) have an increased risk for infection. Persons in high-risk professions, such as veterinarians and slaughterhouse workers, have an increased chance of contracting the virus from an infected animal. International travelers increase their chances of getting the disease when they visit RVF-endemic locations during periods when sporadic cases or epidemics are

How is RVF prevented?
A person's chances of becoming infected can be reduced by taking measures to decrease contact with mosquitoes and other bloodsucking insects through the use of mosquito repellents and bednets. Avoiding exposure to blood or tissues of animals that may potentially be infected is an important protective measure for persons working with animals in RVF-endemic areas.

What needs to be done to address the threat of RVF?
A number of challenges remain for the control and prevention of RVF. Knowledge regarding how the virus is transmitted among mosquitoes and the role of vertebrates in propagating the

virus must be answered to predict and control future outbreaks of RVF. Vaccines for veterinary use are available, but they can cause birth defects and abortions in sheep and induce only low-level protection in cattle. The human live attenuated vaccine, MP-12, has demonstrated promising results in laboratory trials in domestic animals, but more research will be needed before the vaccine can be used in the field. In addition, surveillance (close monitoring for RVF infection in animal and human populations) is essential to learning more about how RVF virus infection is transmitted and to formulate effective measures for reducing the number of infections.

Q - FEVER

Overview of the disease

Q fever is a zoonotic disease caused by Coxiella burnetii, a species of bacteria that is distributed globally. In 1999, Q fever became a notifiable disease in the United States but reporting is not required in many other countries. Because the disease is underreported, scientists cannot reliably assess how many cases of Q fever have actually occurred worldwide. Many human infections are inapparent.

Cattle, sheep, and goats are the primary reservoirs of C. burnetii. Infection has been noted in a wide variety of other animals, including other breeds of livestock and in domesticated pets. Coxiella burnetii does not usually cause clinical disease in these animals, although abortion in goats and sheep has been linked to C. burnetii infection. Organisms are excreted in milk, urine, and feces of infected animals. Most importantly, during birthing the organisms are shed in high numbers within the amniotic fluids and the placenta. The organisms are resistant to heat, drying, and many common disinfectants. These features enable the bacteria to survive for long periods in the environment. Infection of humans usually occurs by inhalation of these organisms from air that contains airborne barnyard dust contaminated by dried placental material, birth fluids, and excreta of infected herd animals. Humans are often very susceptible to the disease, and very few organisms may be required to cause infection.

Ingestion of contaminated milk, followed by regurgitation and inspiration of the contaminated food, is a less common mode of transmission. Other modes of transmission to humans, including tick bites and human to human transmission, are rare.

Signs and Symptoms in Humans

Only about one-half of all people infected with C. burnetii show signs of clinical illness. Most acute cases of Q fever begin with sudden onset of one or more of the following: high fevers (up to 104-105° F), severe headache, general malaise, myalgia, confusion, sore throat, chills, sweats, non-productive cough, nausea, vomiting, diarrhea, abdominal pain, and chest pain. Fever usually lasts for 1 to 2 weeks. Weight loss can occur and persist for some time. Thirty to fifty percent of patients with a symptomatic infection will develop pneumonia. Additionally, a majority of patients have abnormal results on liver function tests and some will develop hepatitis. In general, most patients will recover to good health within several months without any treatment. Only 1%-2% of people with acute Q fever die of the disease.

Chronic Q fever, characterized by infection that persists for more than 6 months is uncommon but is a much more serious disease. Patients who have had acute Q fever may develop the chronic form as soon as 1 year or as long as 20 years after initial infection. A serious complication of chronic Q fever is endocarditis, generally involving the aortic heart valves, less commonly the

mitral valve. Most patients who develop chronic Q fever have pre-existing valvular heart disease or have a history of vascular graft. Transplant recipients, patients with cancer, and those with chronic kidney disease are also at risk of developing chronic Q fever. As many as 65% of persons with chronic Q fever may die of the disease.

The incubation period for Q fever varies depending on the number of organisms that initially infect the patient. Infection with greater numbers of organisms will result in shorter incubation periods. Most patients become ill within 2-3 weeks after exposure. Those who recover fully from infection may possess lifelong immunity against re-infection.

Diagnosis

Because the signs and symptoms of Q fever are not specific to this disease, it is difficult to make an accurate diagnosis without appropriate laboratory testing. Results from some types of routine laboratory tests in the appropriate clinical and epidemiologic settings may suggest a diagnosis of Q fever. For example, a platelet count may be suggestive because persons with Q fever may show a transient thrombocytopenia. Confirming a diagnosis of Q fever requires serologic testing to detect the presence of antibodies to Coxiella burnetii antigens. In most laboratories, the indirect immunofluorescence assay (IFA) is the most dependable and widely used method. Coxiella burnetii may also be identified in infected tissues by using immunohistochemical staining and DNA detection methods.

Coxiella burnetii exists in two antigenic phases called phase I and phase II. This antigenic difference is important in diagnosis. In acute cases of Q fever, the antibody level to phase II is usually higher than that to phase I, often by several orders of magnitude, and generally is first detected during the second week of illness. In chronic Q fever, the reverse situation is true. Antibodies to phase I antigens of C. burnetii generally require longer to appear and indicate continued exposure to the bacteria. Thus, high levels of antibody to phase I in later specimens in combination with constant or falling levels of phase II antibodies and other signs of inflammatory disease suggest chronic Q fever. Antibodies to phase I and II antigens have been known to persist for months or years after initial infection.

Recent studies have shown that greater accuracy in the diagnosis of Q fever can be achieved by looking at specific levels of classes of antibodies other than IgG, namely IgA and IgM. Combined detection of IgM and IgA in addition to IgG improves the specificity of the assays and provides better accuracy in diagnosis. IgM levels are helpful in the determination of a recent infection. In acute Q fever, patients will have IgG antibodies to phase II and IgM antibodies to phases I and II. Increased IgG and IgA antibodies to phase I are often indicative of Q fever endocarditis.

Treatment

Doxycycline is the treatment of choice for acute Q fever. Antibiotic treatment is most effective when initiated within the first 3 days of illness. A dose of 100 mg of doxycycline taken orally twice daily for 15-21 days is a frequently prescribed therapy. Quinolone antibiotics have demonstrated good in vitro activity against C. burnetii and may be considered by the physician. Therapy should be started again if the disease relapses.

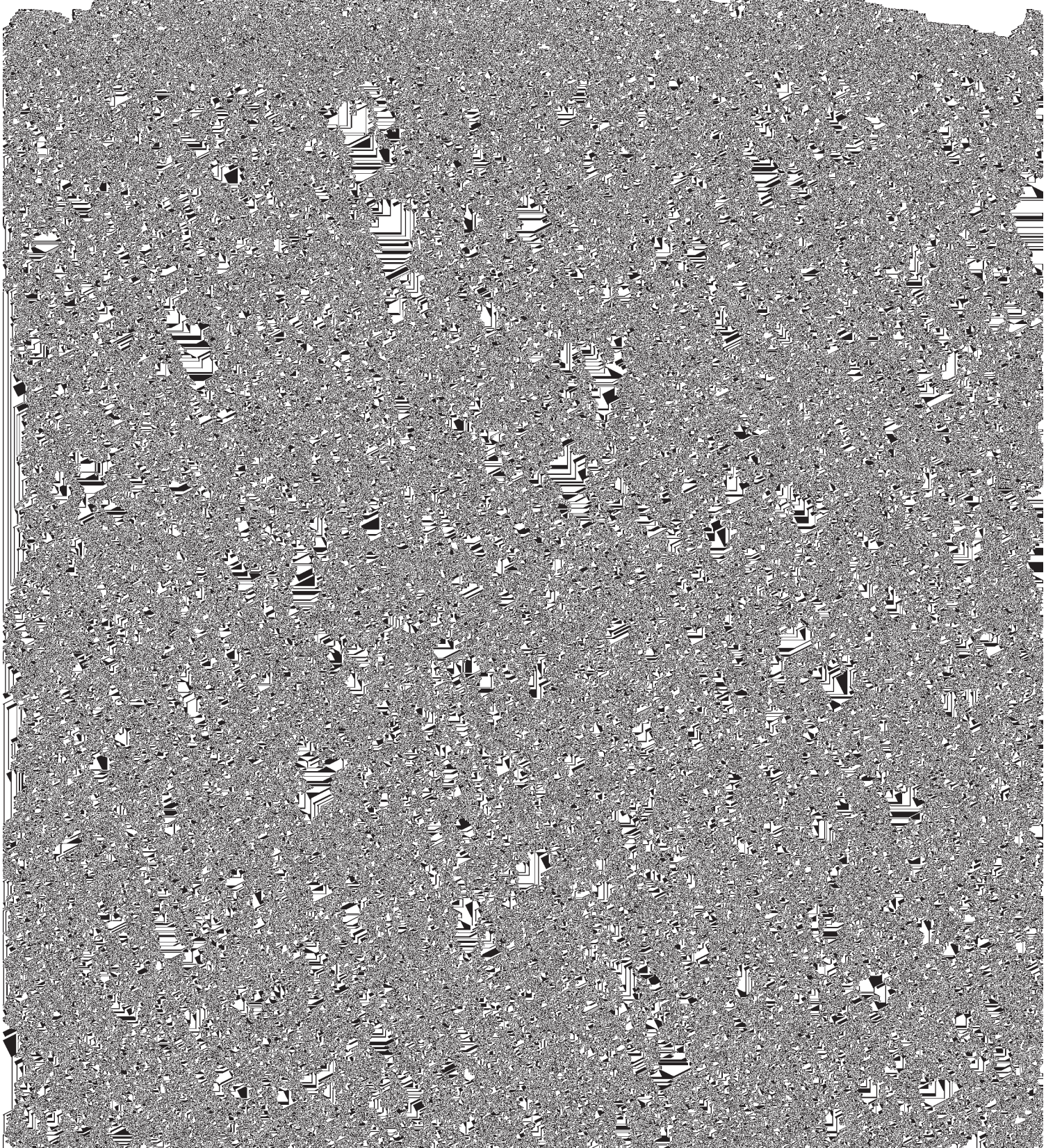
Chronic Q fever endocarditis is much more difficult to treat effectively and often requires the use of multiple drugs. Two different treatment protocols have been evaluated: 1) doxycycline in combination with quinolones for at least 4 years and 2) doxycycline in combination with hydroxychloroquine for 1.5 to 3 years. The second therapy leads to fewer relapses, but requires

routine eye exams to detect accumulation of chloroquine. Surgery to remove damaged valves may be required for some cases of C. burnetii endocarditis.

Prevention

In the United States, Q fever outbreaks have resulted mainly from occupational exposure involving veterinarians, meat processing plant workers, sheep and dairy workers, livestock farmers, and researchers at facilities housing sheep. Prevention and control efforts should be directed primarily toward these groups and environments.

The following measures should be used in the prevention and control of Q fever:



Sever infections of the central nervous systems or lining of the heart may occur. Brucellosis cab also cause long-lasting or chronic symptoms that include recurrent fevers, joint pain, and fatigue.

How common is brucellosis?
Brucellosis is not very common in the United States, where100 to 200 cases occur each year. But brucellosis can be very common in countries where animal disease control programs have not reduced the amount of disease among animals.

Where is brucellosis usually found?
Although brucellosis can be found worldwide, it is more common in countries that do not have good standardized and effective public health and domestic animal health programs. Areas currently listed as high risk are the Mediterranean Basin (Portugal, Spain, Southern France, Italy, Greece, Turkey, North Africa), South and Central America, Eastern Europe, Asia, Africa, the Caribbean, and the Middle East. Unpasteurized cheeses, sometimes called "village cheeses," from these areas may represent a particular risk for tourists.

How is brucellosis transmitted to humans, and who is likely to become infected?
Humans are generally infected in one of three ways: eating or drinking something that is contaminated with Brucella, breathing in the organism (inhalation), or having the bacteria enter the body through skin wounds. The most common way to be infected is by eating or drinking contaminated milk products. When sheep, goats, cows, or camels are infected, their milk is contaminated with the bacteria. If the milk is not pasteurized, these bacteria can be transmitted to persons who drink the milk or eat cheeses made it. Inhalation of Brucella organisms is not a common route of infection, but it can be a significant hazard for people in certain occupations, such as those working in laboratories where the organism is cultured. Inhalation is often responsible for a significant percentage of cases in abattoir employees. Contamination of skin wounds may be a problem for persons working in slaughterhouses or meat packing plants or for veterinarians. Hunters may be infected through skin wounds or by accidentally ingesting the bacteria after cleaning deer, elk, moose, or wild pigs that they have killed.

Can brucellosis be spread from person to person?
Direct person-to-person spread of brucellosis is extremely rare. Mothers who are breast-feeding may transmit the infection to their infants. Sexual transmission has also been reported. For both sexual and breast-feeding transmission, if the infant or person at risk is treated for brucellosis, their risk of becoming infected will probably be eliminated within 3 days. Although uncommon, transmission may also occur via contaminated tissue transplantation.

Is there a way to prevent infection?
Yes. Do not consume unpasteurized milk, cheese, or ice cream while traveling. If you are not sure that the dairy product is pasteurized, don't eat it. Hunters and animal herdsman should use rubber gloves when handling viscera of animals. There is no vaccine available for humans.

My dog has been diagnosed with brucellosis. Is that a risk for me?
B. canis is the species of Brucella species that can infect dogs. This species has occasionally been transmitted to humans, but the vast majority of dog infections do not result in human illness. Although veterinarians exposed to blood of infected animals are at risk, pet owners are not considered to be at risk for infection. This is partly because it is unlikely that they will come in contact with blood, semen, or placenta of the dog. The bacteria may be cleared from the animal within a few days of treatment; however re-infection is common and some animal body fluids

may be infectious for weeks. Immunocompromised persons (cancer patients, HIV-infected individuals, or transplantation patients) should not handle dogs known to be infected with B. canis.

How is brucellosis diagnosed?
Brucellosis is diagnosed in a laboratory by finding Brucella organisms in samples of blood or bone marrow. Also, blood tests can be done to detect antibodies against the bacteria. If this method is used, two blood samples should be collected 2 weeks apart.

Is there a treatment for brucellosis?
Yes, but treatment can be difficult. Doctors can prescribe effective antibiotics. Usually, doxycycline and rifampin are used in combination for 6 weeks to prevent reoccuring infection. Depending on the timing of treatment and severity of illness, recovery may take a few weeks to several months. Mortality is low (<2%), and is usually associated with endocarditis.

I am a veterinarian, and I recently accidentally jabbed myself with the animal vaccine (RB-51 or B-19, or REV-1) while I was vaccinating cows (or sheep, goats). What do I need to do?
These are live vaccines, and B-19 is known to cause disease in humans. Although we know less about the other vaccines, the recommendations are the same. You should see a health care provider. A baseline blood sample should be collected for testing for antibodies. We recommend that you take antibiotics (doxycycline and rifampin for B-19 and REV-1, or doxycycline alone for RB-51) for 3 weeks. At the end of that time you should be rechecked and a second blood sample should be collected. (The sample can also be collected at 2 weeks.) The same recommendations hold true for spraying vaccine in the eyes (6 weeks of treatment in this case) or spraying onto open wounds on the skin.

VIRAL HEMORRHAGIC FEVERS

What are viral hemorrhagic fevers?
Viral hemorrhagic fevers (VHFs) refer to a group of illnesses that are caused by several distinct families of viruses. In general, the term "viral hemorrhagic fever" is used to describe a severe multisystem syndrome (multisystem in that multiple organ systems in the body are affected). Characteristically, the overall vascular system is damaged, and the body's ability to regulate itself is impaired. These symptoms are often accompanied by hemorrhage (bleeding); however, the bleeding is itself rarely life-threatening. While some types of hemorrhagic fever viruses can cause relatively mild illnesses, many of these viruses cause severe, life-threatening disease.

The Special Pathogens Branch (SPB) primarily works with hemorrhagic fever viruses that are classified as biosafety level four (BSL-4) pathogens. A list of these viruses appears in the SPB disease information index. The Division of Vector-Borne Infectious Diseases, also in the National Center for Infectious Diseases, works with the non-BSL-4 viruses that cause two other hemorrhagic fevers, dengue hemorrhagic fever and yellow fever.

How are hemorrhagic fever viruses grouped?
VHFs are caused by viruses of four distinct families: arenaviruses, filoviruses, bunyaviruses, and flaviviruses. Each of these families share a number of features:
They are all RNA viruses, and all are covered, or enveloped, in a fatty (lipid) coating.
Their survival is dependent on an animal or insect host, called the natural reservoir.

The viruses are geographically restricted to the areas where their host species live.

Humans are not the natural reservoir for any of these viruses. Humans are infected when they come into contact with infected hosts. However, with some viruses, after the accidental transmission from the host, humans can transmit the virus to one another.

Human cases or outbreaks of hemorrhagic fevers caused by these viruses occur sporadically and irregularly. The occurrence of outbreaks cannot be easily predicted.

With a few noteworthy exceptions, there is no cure or established drug treatment for VHFs.

In rare cases, other viral and bacterial infections can cause a hemorrhagic fever; scrub typhus is a good example.

What carries viruses that cause viral hemorrhagic fevers?

Viruses associated with most VHFs are zoonotic. This means that these viruses naturally reside in an animal reservoir host or arthropod vector. They are totally dependent on their hosts for replication and overall survival. For the most part, rodents and arthropods are the main reservoirs for viruses causing VHFs. House mouse, and other field rodents are examples of reservoir hosts. Arthropod ticks and mosquitoes serve as vectors for some of the illnesses. However, the hosts of some viruses remain unknown -- Ebola and Marburg viruses are well-known examples.

Where are cases of viral hemorrhagic fever found?

Taken together, the viruses that cause VHFs are distributed over much of the globe. However, because each virus is associated with one or more particular host species, the virus and the disease it causes are usually seen only where the host species live(s). Some hosts, such as the rodent species carrying several of the New World arenaviruses, live in geographically restricted areas. Therefore, the risk of getting VHFs caused by these viruses is restricted to those areas. Other hosts range over continents, such as the rodents that carry viruses which cause various forms of hantavirus pulmonary syndrome (HPS) in North and South America, or the different set of rodents that carry viruses which cause hemorrhagic fever with renal syndrome (HFRS) in Europe and Asia. A few hosts are distributed nearly worldwide, such as the common rat. It can carry Seoul virus, a cause of HFRS; therefore, humans can get HFRS anywhere where the common rat is found.

While people usually become infected only in areas where the host lives, occasionally people become infected by a host that has been exported from its native habitat. For example, the first outbreaks of Marburg hemorrhagic fever, in Marburg and Frankfurt, Germany, and in Yugoslavia, occurred when laboratory workers handled imported monkeys infected with Marburg virus. Occasionally, a person becomes infected in an area where the virus occurs naturally and then travels elsewhere. If the virus is a type that can be transmitted further by person-to-person contact, the traveler could infect other people. For instance, in 1996, a medical professional treating patients with Ebola hemorrhagic fever (Ebola HF) in Gabon unknowingly became infected. When he later traveled to South Africa and was treated for Ebola HF in a hospital, the virus was transmitted to a nurse. She became ill and died. Because more and more people travel each year, outbreaks of these diseases are becoming an increasing threat in places where they rarely, if ever, have been seen before.

How are hemorrhagic fever viruses transmitted?

Viruses causing hemorrhagic fever are initially transmitted to humans when the activities of infected reservoir hosts or vectors and humans overlap. The viruses carried in rodent reservoirs are transmitted when humans have contact with urine, fecal matter, saliva, or other body

excretions from infected rodents. The viruses associated with arthropod vectors are spread most often when the vector mosquito or tick bites a human, or when a human crushes a tick. However, some of these vectors may spread virus to animals, livestock, for example. Humans then become infected when they care for or slaughter the animals.

Some viruses that cause hemorrhagic fever can spread from one person to another, once an initial person has become infected. Ebola, Marburg, Lassa and Crimean-Congo hemorrhagic fever viruses are examples. This type of secondary transmission of the virus can occur directly, through close contact with infected people or their body fluids. It can also occur indirectly, through contact with objects contaminated with infected body fluids. For example, contaminated syringes and needles have played an important role in spreading infection in outbreaks of Ebola hemorrhagic fever and Lassa fever.

What are the symptoms of viral hemorrhagic fever illnesses?
Specific signs and symptoms vary by the type of VHF, but initial signs and symptoms often include marked fever, fatigue, dizziness, muscle aches, loss of strength, and exhaustion. Patients with severe cases of VHF often show signs of bleeding under the skin, in internal organs, or from body orifices like the mouth, eyes, or ears. However, although they may bleed from many sites around the body, patients rarely die because of blood loss. Severely ill patient cases may also show shock, nervous system malfunction, coma, delirium, and seizures. Some types of VHF are associated with renal (kidney) failure.

How are patients with viral hemorrhagic fever treated?
Patients receive supportive therapy, but generally speaking, there is no other treatment or established cure for VHFs. Ribavirin, an anti-viral drug, has been effective in treating some individuals with Lassa fever or HFRS. Treatment with convalescent-phase plasma has been used with success in some patients with Argentine hemorrhagic fever.

How can cases of viral hemorrhagic fever be prevented and controlled?
With the exception of yellow fever and Argentine hemorrhagic fever, for which vaccines have been developed, no vaccines exist that can protect against these diseases. Therefore, prevention efforts must concentrate on avoiding contact with host species. If prevention methods fail and a case of VHF does occur, efforts should focus on preventing further transmission from person to person, if the virus can be transmitted in this way.Because many of the hosts that carry hemorrhagic fever viruses are rodents, disease prevention efforts include

controlling rodent populations;

discouraging rodents from entering or living in homes or workplaces;

encouraging safe cleanup of rodent nests and droppings.

For hemorrhagic fever viruses spread by arthropod vectors, prevention efforts often focus on community-wide insect and arthropod control. In addition, people are encouraged to use insect repellant, proper clothing, bednets, window screens, and other insect barriers to avoid being bitten.

For those hemorrhagic fever viruses that can be transmitted from one person to another, avoiding close physical contact with infected people and their body fluids is the most important way of controlling the spread of disease. Barrier nursing or infection control techniques include isolating

infected individuals and wearing protective clothing. Other infection control recommendations include proper use, disinfection, and disposal of instruments and equipment used in treating or caring for patients with VHF, such as needles and thermometers.

In conjunction with the World Health Organization, CDC has developed practical, hospital-based guidelines, titled Infection Control for Viral Haemorrhagic Fevers In the African Health Care Setting. The manual can help health-care facilities recognize cases and prevent further hospital-based disease transmission using locally available materials and few financial resources.

What needs to be done to address the threat of viral hemorrhagic fevers?
Scientists and researchers are challenged with developing containment, treatment, and vaccine strategies for these diseases. Another goal is to develop immunologic and molecular tools for more rapid disease diagnosis, and to study how the viruses are transmitted and exactly how the disease affects the body (pathogenesis). A third goal is to understand the ecology of these viruses and their hosts in order to offer preventive public health advice for avoiding infection.

ARENAVIRUSES

What are the Arenaviridae?
The Arenaviridae are a family of viruses whose members are generally associated with rodent-transmitted disease in humans. Each virus usually is associated with a particular rodent host species in which it is maintained. Arenavirus infections are relatively common in humans in some areas of the world and can cause severe illnesses.

The virus particles are spherical and have an average diameter of 110-130 nanometers. All are enveloped in a lipid (fat) membrane. Viewed in cross-section, they show grainy particles that are ribosomes acquired from their host cells. It is this characteristic that gave them their name, derived from the Latin "arena," which means "sandy." Their genome, or genetic material, is composed of RNA only, and while their replication strategy is not completely understood, we know that new viral particles, called virions, are created by budding from the surface of their hosts' cells.

When were the members of this virus family recognized?
The first arenavirus, lymphocytic choriomeningitis virus (LCMV), was isolated in 1933 during a study of an epidemic of St. Louis encephalitis. Although not the cause of the outbreak, LCMV was found to be a cause of aseptic (nonbacterial) meningitis. By the 1960s, several similar viruses had been discovered and they were classified into the new family Arenaviridae. Since Tacaribe virus was found in 1956, new arenaviruses have been discovered on the average of every one to three years. A number of arenaviruses cause hemorrhagic disease. Junin virus, isolated in 1958, was the first of these to be recognized. This virus causes Argentine hemorrhagic fever in a limited agricultural area of the pampas in Argentina. Several years later, in 1963, in the remote savannas of the Beni province of Bolivia, Machupo virus was isolated. The next member of the virus family to be associated with an outbreak of human illness was Lassa virus in Africa in 1969. Most recently, Guanarito and Sabia viruses were added to this family.

What viruses are included in the virus family? The arenaviruses are divided into two groups: the New World or Tacaribe complex and the Old World or LCM/Lassa complex. Viruses in these groups that cause illness in humans are listed below:

Virus	Disease
Lassa virus	Lassa fever
Junin virus	Argentine hemorrhagic fever
Machupo virus	Bolivian hemorrhagic fever
Guanarito virus	Venezuelan hemorrhagic fever
Sabia	Brazilian hemorrhagic fever

What kinds of animal hosts do these viruses have?
These viruses are zoonotic, meaning that, in nature, they are found in animals. Each virus is associated with either one species or a few closely related rodents, which constitute the virus' natural reservoir. Tacaribe complex viruses are generally associated with the New World rats and mice (family Muridae, subfamily Sigmodontinae). The LCM/Lassa complex viruses are associated with the Old World rats and mice (family Muridae, subfamily Murinae). Taken together, these types of rodents are located across the greater proportion of the earth's land mass, including Europe, Asia, Africa, and the Americas. One notable exception is Tacaribe virus, found in Trinidad, which was isolated from a bat.

How are arenaviruses spread?
The rodent hosts of arenaviruses are chronically infected with the viruses; however, the viruses do not appear to cause obvious illness in them. Some Old World arenaviruses appear to be passed from mother rodents to their offspring during pregnancy, and thus remain in the rodent population generation after generation. Some New World arenaviruses are transmitted among adult rodents, likely via fighting and inflicting bites. Only a portion of the rodents in each host species is infected at any one time, and in many cases only in a limited portion of the host's geographical range. The viruses are shed into the environment in the urine or droppings of their infected hosts.

Human infection with arenaviruses is incidental to the natural cycle of the viruses and occurs when an individual comes into contact with the excretions or materials contaminated with the excretions of an infected rodent, such as ingestion of contaminated food, or by direct contact of abraded or broken skin with rodent excrement. Infection can also occur by inhalation of tiny particles soiled with rodent urine or saliva (aerosol transmission). The types of incidental contact depend on the habits of both humans and rodents. For example, where the infected rodent species prefers a field habitat, human infection is associated with agricultural work. In areas where the rodent species' habitat includes human homes or other buildings, infection occurs in domestic settings.

Some arenaviruses, such as Lassa and Machupo viruses, are associated with secondary person-to-person and nosocomial (health-care setting) transmission. This occurs when a person infected by exposure to the virus from the rodent host spreads the virus to other humans. This may occur in a variety of ways. Person-to-person transmission is associated with direct contact with the blood or other excretions, containing virus particles, of infected individuals. Airborne transmission has also been reported in connection with certain viruses. Contact with objects contaminated with these materials, such as medical equipment, is also associated with transmission. In these situations, use of protective clothing and disinfection procedures (together called barrier nursing) help prevent further spread of illness.

FILOVIRUSES

What are filoviruses?
Filoviruses belong to a virus family called Filoviridae and can cause severe hemorrhagic fever in humans and nonhuman primates. So far, only two members of this virus family have been identified: Marburg virus and Ebola virus. Four species of Ebola virus have been identified: Ivory Coast, Sudan, Zaire, and Reston. Ebola-Reston is the only known filovirus that does not cause severe disease in humans; however, it can be fatal in monkeys.

Structurally, filovirus virions (complete viral particles) may appear in several shapes, a biological feature called pleomorphism. These shapes include long, sometimes branched filaments, as well as shorter filaments shaped like a "6", a "U", or a circle. Viral filaments may measure up to 14,000 nanometers in length, have a uniform diameter of 80 nanometers, and are enveloped in a lipid (fatty) membrane. Each virion contains one molecule of single-stranded, negative-sense RNA. New viral particles are created by budding from the surface of their hosts' cells; however, filovirus replication strategies are not completely understood.

When were the members of the filovirus family first recognized?
The first filovirus was recognized in 1967 when a number of laboratory workers in Germany and Yugoslavia, who were handling tissues from green monkeys, developed hemorrhagic fever. A total of 31 cases and seven deaths were associated with these outbreaks. The virus was named after Marburg, Germany, the site of one of the outbreaks.

After the initial outbreaks, the virus disappeared. It did not reemerge until 1975, when a traveler, most likely exposed in Zimbabwe, became ill in Johannesburg, South Africa. The virus was transmitted there to his traveling companion and a nurse. A few sporadic cases of Marburg hemorrhagic fever have been identified since that time.

Ebola virus was first identified in 1976 when two outbreaks of Ebola hemorrhagic fever (Ebola HF) occurred in northern Zaire (now the Democratic Republic of Congo) and southern Sudan. The outbreaks involved what eventually proved to be two different species of Ebola virus; both were named after the nations in which they were discovered. Both viruses showed themselves to be highly lethal, as 90% of the Zairian cases and 50% of the Sudanese cases resulted in death.

Since 1976, Ebola virus appeared sporadically in Africa, with small to midsize outbreaks confirmed between 1976 and 1979. Large epidemics of Ebola HF occurred in Kikwit, Zaire in 1995 and in Gulu, Uganda in 2000. Smaller outbreaks were identified in Gabon between 1994 and 1996. For information on known Ebola HF cases and outbreaks, please refer to the chronological list .

What are the natural hosts of filoviruses?
It appears that filoviruses are zoonotic, that is, transmitted to humans from ongoing life cycles in animals other than humans. Despite numerous attempts to locate the natural reservoir or reservoirs of Ebola and Marburg viruses, their origins remain undetermined. However, because the virus can be replicated in some species of bats, some types of bats native to the areas where the virus is found may prove to be the viruses' carriers.

How are filoviruses spread?
In an outbreak or isolated case among humans, just how the virus is transmitted from the natural reservoir to a human is unknown. Once a human is infected, however, person-to-person transmission is the means by which further infections occur.

Specifically, transmission involves close personal contact between an infected individual or their body fluids, and another person. During recorded outbreaks of hemorrhagic fever caused by filovirus infection, persons who cared for (fed, washed, medicated) or worked very closely with infected individuals were especially at risk of becoming infected themselves. Nosocomial (hospital) transmission through contact with infected body fluids - via reuse of unsterilized syringes, needles, or other medical equipment contaminated with these fluids - has also been an important factor in the spread of disease. When close contact between uninfected and infected persons is minimized, the number of new filovirus infections in humans usually declines. Although in the laboratory the viruses display some capability of infection through small-particle aerosols, airborne spread among humans has not been clearly demonstrated.

During outbreaks, isolation of patients and use of protective clothing and disinfection procedures (together called viral hemorrhagic fever isolation precautions or barrier nursing) has been sufficient to interrupt further transmission of Marburg or Ebola viruses, and thus to control and end the outbreak. Because there is no known effective treatment for the hemorrhagic fevers caused by filoviruses, transmission prevention through application of VHF isolation precautions is currently the centerpiece of filovirus control.

LASSA FEVER

What is Lassa fever?
Lassa fever is an acute viral illness that occurs in West Africa. The illness was discovered in 1969 when two missionary nurses died in Nigeria, West Africa. The cause of the illness was found to be Lassa virus, named after the town in Nigeria where the first cases originated. The virus, a member of the virus family Arenaviridae, is a single-stranded RNA virus and is zoonotic, or animal-borne.

In areas of Africa where the disease is endemic (that is, constantly present), Lassa fever is a significant cause of morbidity and mortality. While Lassa fever is mild or has no observable symptoms in about 80% of people infected with the virus, the remaining 20% have a severe multisystem disease. Lassa fever is also associated with occasional epidemics, during which the case-fatality rate can reach 50%.

Where is Lassa fever found?
Lassa fever is an endemic disease in portions of West Africa. It is recognized in Guinea, Liberia, Sierra Leone, as well as Nigeria. However, because the rodent species which carry the virus are found throughout West Africa, the actual geographic range of the disease may extend to other countries in the region.

How many people become infected?
The number of Lassa virus infections per year in West Africa is estimated at 100,000 to 300,000, with approximately 5,000 deaths. Unfortunately, such estimates are crude, because surveillance for cases of the disease is not uniformly performed. In some areas of Sierra Leone and Liberia, it

is known that 10%-16% of people admitted to hospitals have Lassa fever, which indicates the serious impact of the disease on the population of this region.

In what animal host is Lassa virus maintained?

The reservoir, or host, of Lassa virus is a rodent known as the "multimammate rat" of the genus Mastomys. It is not certain which species of Mastomys are associated with Lassa; however, at least two species carry the virus in Sierra Leone. Mastomys rodents breed very frequently, produce large numbers of offspring, and are numerous in the savannas and forests of West, Central, and East Africa. In addition, Mastomys generally readily colonize human homes. All these factors together contribute to the relatively efficient spread of Lassa virus from infected rodents to humans.

How do humans get Lassa fever?

There are a number of ways in which the virus may be transmitted, or spread, to humans. The Mastomys rodents shed the virus in urine and droppings. Therefore, the virus can be transmitted through direct contact with these materials, through touching objects or eating food contaminated with these materials, or through cuts or sores. Because Mastomys rodents often live in and around homes and scavenge on human food remains or poorly stored food, transmission of this sort is common. Contact with the virus also may occur when a person inhales tiny particles in the air contaminated with rodent excretions. This is called aerosol or airborne transmission. Finally, because Mastomys rodents are sometimes consumed as a food source, infection may occur via direct contact when they are caught and prepared for food.

Lassa fever may also spread through person-to-person contact. This type of transmission occurs when a person comes into contact with virus in the blood, tissue, secretions, or excretions of an individual infected with the Lassa virus. The virus cannot be spread through casual contact (including skin-to-skin contact without exchange of body fluids). Person-to-person transmission is common in both village and health care settings, where, along with the above-mentioned modes of transmission, the virus also may be spread in contaminated medical equipment, such as reused needles (this is called nosocomial transmission).

What are the symptoms of Lassa fever?

Signs and symptoms of Lassa fever typically occur 1-3 weeks after the patient comes into contact with the virus. These include fever, retrosternal pain (pain behind the chest wall), sore throat, back pain, cough, abdominal pain, vomiting, diarrhea, conjunctivitis, facial swelling, proteinuria (protein in the urine), and mucosal bleeding. Neurological problems have also been described, including hearing loss, tremors, and encephalitis. Because the symptoms of Lassa fever are so varied and nonspecific, clinical diagnosis is often difficult.

How is the disease diagnosed in the laboratory?

Lassa fever is most often diagnosed by using enzyme-linked immunosorbent serologic assays (ELISA), which detect IgM and IgG antibodies as well as Lassa antigen. The virus itself may be cultured in 7 to 10 days. Immunohistochemistry performed on tissue specimens can be used to make a post-mortem diagnosis. The virus can also be detected by reverse transcription-polymerase chain reaction (RT-PCR); however, this method is primarily a research tool.

Are there complications after recovery?

The most common complication of Lassa fever is deafness. Various degrees of deafness occur in approximately one-third of cases, and in many cases hearing loss is permanent. As far as is

known, severity of the disease does not affect this complication: deafness may develop in mild as well as in severe cases. Spontaneous abortion is another serious complication.

What proportion of people die from the illness?
Approximately 15%-20% of patients hospitalized for Lassa fever die from the illness. However, overall only about 1% of infections with Lassa virus result in death. The death rates are particularly high for women in the third trimester of pregnancy, and for fetuses, about 95% of which die in the uterus of infected pregnant mothers.

How is Lassa fever treated?
Ribavirin, an antiviral drug, has been used with success in Lassa fever patients. It has been shown to be most effective when given early in the course of the illness. Patients should also receive supportive care consisting of maintenance of appropriate fluid and electrolyte balance, oxygenation and blood pressure, as well as treatment of any other complicating infections.

What groups are at risk for getting the illness?
Individuals at risk are those who live or visit areas with a high population of Mastomys rodents infected with Lassa virus or are exposed to infected humans. Hospital staff are not at great risk for infection as long as protective measures are taken.

How is Lassa fever prevented?
Primary transmission of the Lassa virus from its host to humans can be prevented by avoiding contact with Mastomys rodents, especially in the geographic regions where outbreaks occur. Putting food away in rodent-proof containers and keeping the home clean help to discourage rodents from entering homes. Using these rodents as a food source is not recommended. Trapping in and around homes can help reduce rodent populations. However, the wide distribution of Mastomys in Africa makes complete control of this rodent reservoir impractical.

When caring for patients with Lassa fever, further transmission of the disease through person-to-person contact or nosocomial routes can be avoided by taking preventive precautions against contact with patient secretions (together called VHF isolation precautions or barrier nursing methods). Such precautions include wearing protective clothing, such as masks, gloves, gowns, and goggles; using infection control measures, such as complete equipment sterilization; and isolating infected patients from contact with unprotected persons until the disease has run its course.

What needs to be done to address the threat of Lassa fever?
Further educating people in high-risk areas about ways to decrease rodent populations in their homes will aid in the control and prevention of Lassa fever. Other challenges include developing more rapid diagnostic tests and increasing the availability of the only known drug treatment, ribavirin. Research is presently under way to develop a vaccine for Lassa fever.

EBOLA (Ebola Hemorrhagic Fever)

What is Ebola hemorrhagic fever?
Ebola hemorrhagic fever (Ebola HF) is a severe, often-fatal disease in humans and nonhuman primates (monkeys, gorillas, and chimpanzees) that has appeared sporadically since its initial recognition in 1976.

The disease is caused by infection with Ebola virus, named after a river in the Democratic Republic of the Congo (formerly Zaire) in Africa, where it was first recognized. The virus is one of two members of a family of RNA viruses called the Filoviridae. There are four identified subtypes of Ebola virus. Three of the four have caused disease in humans: Ebola-Zaire, Ebola-Sudan, and Ebola-Ivory Coast. The fourth, Ebola-Reston, has caused disease in nonhuman primates, but not in humans.

Where is Ebola virus found in nature?
The exact origin, locations, and natural habitat (known as the "natural reservoir") of Ebola virus remain unknown. However, on the basis of available evidence and the nature of similar viruses, researchers believe that the virus is zoonotic (animal-borne) and is normally maintained in an animal host that is native to the African continent. A similar host is probably associated with Ebola-Reston which was isolated from infected cynomolgous monkeys that were imported to the United States and Italy from the Philippines. The virus is not known to be native to other continents, such as North America.

Where do cases of Ebola hemorrhagic fever occur?
Confirmed cases of Ebola HF have been reported in the Democratic Republic of the Congo, Gabon, Sudan, the Ivory Coast, Uganda, and the Republic of the Congo. An individual with serologic evidence of infection but showing no apparent illness has been reported in Liberia, and a laboratory worker in England became ill as a result of an accidental needle-stick. No case of the disease in humans has ever been reported in the United States. Ebola-Reston virus caused severe illness and death in monkeys imported to research facilities in the United States and Italy from the Philippines; during these outbreaks, several research workers became infected with the virus, but did not become ill.

Ebola HF typically appears in sporadic outbreaks, usually spread within a health-care setting (a situation known as amplification). It is likely that sporadic, isolated cases occur as well, but go unrecognized. A table showing a chronological list of known cases and outbreaks is available.

How is Ebola virus spread?
Infections with Ebola virus are acute. There is no carrier state. Because the natural reservoir of the virus is unknown, the manner in which the virus first appears in a human at the start of an outbreak has not been determined. However, researchers have hypothesized that the first patient becomes infected through contact with an infected animal.

After the first case-patient in an outbreak setting is infected, the virus can be transmitted in several ways. People can be exposed to Ebola virus from direct contact with the blood and/or secretions of an infected person. Thus, the virus is often spread through families and friends because they come in close contact with such secretions when caring for infected persons. People can also be exposed to Ebola virus through contact with objects, such as needles, that have been contaminated with infected secretions.

Nosocomial transmission refers to the spread of a disease within a health-care setting, such as a clinic or hospital. It occurs frequently during Ebola HF outbreaks. It includes both types of transmission described above. In African health-care facilities, patients are often cared for without the use of a mask, gown, or gloves. Exposure to the virus has occurred when health care workers treated individuals with Ebola HF without wearing these types of protective clothing. In addition, when needles or syringes are used, they may not be of the disposable type, or may not

have been sterilized, but only rinsed before reinsertion into multi-use vials of medicine. If needles or syringes become contaminated with virus and are then reused, numerous people can become infected.

Ebola-Reston appeared in a primate research facility in Virginia, where it may have been transmitted from monkey to monkey through the air. While all Ebola virus species have displayed the ability to be spread through airborne particles (aerosols) under research conditions, this type of spread has not been documented among humans in a real-world setting, such as a hospital or household.

What are the symptoms of Ebola hemorrhagic fever?
The incubation period for Ebola HF ranges from 2 to 21 days. The onset of illness is abrupt and is characterized by fever, headache, joint and muscle aches, sore throat, and weakness, followed by diarrhea, vomiting, and stomach pain. A rash, red eyes, hiccups and internal and external bleeding may be seen in some patients.

Researchers do not understand why some people are able to recover from Ebola HF and others are not. However, it is known that patients who die usually have not developed a significant immune response to the virus at the time of death.

How is Ebola hemorrhagic fever clinically diagnosed?
Diagnosing Ebola HF in an individual who has been infected only a few days is difficult because early symptoms, such as red eyes and a skin rash, are nonspecific to the virus and are seen in other patients with diseases that occur much more frequently. However, if a person has the constellation of symptoms described above, and infection with Ebola virus is suspected, isolate the patient and notify local and state health departments and the CDC.

What laboratory tests are used to diagnose Ebola hemorrhagic fever?
Antigen-capture enzyme-linked immunosorbent assay (ELISA) testing, IgM ELISA, polymerase chain reaction (PCR), and virus isolation can be used to diagnose a case of Ebola HF within a few days of the onset of symptoms. Persons tested later in the course of the disease or after recovery can be tested for IgM and IgG antibodies; the disease can also be diagnosed retrospectively in deceased patients by using immunohistochemistry testing, virus isolation, or PCR.

How is Ebola hemorrhagic fever treated?
There is no standard treatment for Ebola HF. Patients receive supportive therapy. This consists of balancing the patient's fluids and electrolytes, maintaining their oxygen status and blood pressure, and treating them for any complicating infections.

How is Ebola hemorrhagic fever prevented?
The prevention of Ebola HF in Africa presents many challenges. Because the identity and location of the natural reservoir of Ebola virus are unknown, there are few established primary prevention measures.

If cases of the disease do appear, current social and economic conditions often favor the spread of an epidemic within health-care facilities. Therefore, health-care providers must be able to recognize a case of Ebola HF should one appear. They must also have the capability to perform diagnostic tests and be ready to employ practical viral hemorrhagic fever isolation precautions, or

barrier nursing techniques. These techniques include the wearing of protective clothing, such as masks, gloves, gowns, and goggles; the use of infection-control measures, including complete equipment sterilization; and the isolation of Ebola HF patients from contact with unprotected persons. The aim of all of these techniques is to avoid any person's contact with the blood or secretions of any patient. If a patient with Ebola HF dies, it is equally important that direct contact with the body of the deceased patient be prevented.

CDC has developed a set of tools to meet health-care facilities' needs. In conjunction with the World Health Organization, CDC has developed practical, hospital-based guidelines, entitled Infection Control for Viral Haemorrhagic Fevers In the African Health Care Setting. The manual describes how to recognize cases of viral hemorrhagic fever, such as Ebola HF, and prevent further nosocomial transmission by using locally available materials and few financial resources. Similarly, a practical diagnostic test that uses tiny samples from patients' skin has been developed to retrospectively diagnose Ebola HF in suspected case-patients who have died.

What challenges remain for the control and prevention of Ebola hemorrhagic fever?
Scientists and researchers are faced with the challenges of developing additional diagnostic tools to assist in early diagnosis of Ebola HF and conducting ecological investigations of Ebola virus and its possible reservoir. In addition, one of the research goals is to monitor suspected areas to determine the incidence of the disease. More extensive knowledge of the natural reservoir of Ebola virus and how the virus is spread must be acquired to prevent future outbreaks effectively.

MARBURG HEMORRHAGIC FEVER

What is Marburg hemorrhagic fever?
Marburg hemorrhagic fever is a rare, severe type of hemorrhagic fever which affects both humans and non-human primates. Caused by a genetically unique zoonotic (that is, animal-borne) RNA virus of the filovirus family, its recognition led to the creation of this virus family. The four species of Ebola virus are the only other known members of the filovirus family.

Marburg virus was first recognized in 1967, when outbreaks of hemorrhagic fever occurred simultaneously in laboratories in Marburg and Frankfurt, Germany and in Belgrade, Yugoslavia (now Serbia). A total of 37 people became ill; they included laboratory workers as well as several medical personnel and family members who had cared for them. The first people infected had been exposed to African green monkeys or their tissues. In Marburg, the monkeys had been imported for research and to prepare polio vaccine.

Where do cases of Marburg hemorrhagic fever occur?
Recorded cases of the disease are rare, and have appeared in only a few locations. While the 1967 outbreak occurred in Europe, the disease agent had arrived with imported monkeys from Uganda. No other case was recorded until 1975, when a traveler most likely exposed in Zimbabwe became ill in Johannesburg, South Africa - and passed the virus to his traveling companion and a nurse. 1980 saw two other cases, one in Western Kenya not far from the Ugandan source of the monkeys implicated in the 1967 outbreak. This patient's attending physician in Nairobi became the second case. Another human Marburg infection was recognized in 1987 when a young man who had traveled extensively in Kenya, including western Kenya, became ill and later died. In 1998, an outbreak occurred in Durba, Democratic Republic of the Congo. Cases were linked to individuals working in a gold mine. After the outbreak subsided, there were still some sporadic cases that occurred in the region.

Where is Marburg virus found?
Marburg virus is indigenous to Africa. While the geographic area to which it is native is unknown, this area appears to include at least parts of Uganda and Western Kenya, and perhaps Zimbabwe. As with Ebola virus, the actual animal host for Marburg virus also remains a mystery. Both of the men infected in 1980 in western Kenya had traveled extensively, including making a visit to a cave, in that region. The cave was investigated by placing sentinels animals inside to see if they would become infected, and by taking samples from numerous animals and arthropods trapped during the investigation. The investigation yielded no virus: The sentinel animals remained healthy and no virus isolations from the samples obtained have been reported.

How do humans get Marburg hemorrhagic fever?
Just how the animal host first transmits Marburg virus to humans is unknown. However, as with some other viruses which cause viral hemorrhagic fever, humans who become ill with Marburg hemorrhagic fever may spread the virus to other people. This may happen in several ways. Persons who have handled infected monkeys and have come in direct contact with their fluids or cell cultures, have become infected. Spread of the virus between humans has occurred in a setting of close contact, often in a hospital. Droplets of body fluids, or direct contact with persons, equipment, or other objects contaminated with infectious blood or tissues are all highly suspect as sources of disease.

What are the symptoms of the disease?
After an incubation period of 5-10 days, the onset of the disease is sudden and is marked by fever, chills, headache, and myalgia. Around the fifth day after the onset of symptoms, a maculopapular rash, most prominent on the trunk (chest, back, stomach), may occur. Nausea, vomiting, chest pain, a sore throat, abdominal pain, and diarrhea then may appear. Symptoms become increasingly severe and may include jaundice, inflammation of the pancreas, severe weight loss, delirium, shock, liver failure, massive hemorrhaging, and multi-organ dysfunction.

Because many of the signs and symptoms of Marburg hemorrhagic fever are similar to those of other infectious diseases, such as malaria or typhoid fever, diagnosis of the disease can be difficult, especially if only a single case is involved.

Antigen-capture enzyme-linked immunosorbent assay (ELISA) testing, IgM-capture ELISA, polymerase chain reaction (PCR), and virus isolation can be used to confirm a case of Marburg hemorrhagic fever within a few days of the onset of symptoms. The IgG-capture ELISA is appropriate for testing persons later in the course of disease or after recovery. The disease is readily diagnosed by immunohistochemistry, virus isolation, or PCR of blood or tissue specimens from deceased patients.

Are there complications after recovery?
Recovery from Marburg hemorrhagic fever may be prolonged and accompanied by orchititis, recurrent hepatitis, transverse myelitis or uvetis. Other possible complications include inflammation of the testis, spinal cord, eye, parotid gland, or by prolonged hepatitis.

Is the disease ever fatal?
Yes. The case-fatality rate for Marburg hemorrhagic fever is between 23-25%.

How is Marburg hemorrhagic fever treated?
A specific treatment for this disease is unknown. However, supportive hospital therapy should be utilized. This includes balancing the patient's fluids and electrolytes, maintaining their oxygen status and blood pressure, replacing lost blood and clotting factors and treating them for any complicating infections.

Sometimes treatment also has used transfusion of fresh-frozen plasma and other preparations to replace the blood proteins important in clotting. One controversial treatment is the use of heparin (which blocks clotting) to prevent the consumption of clotting factors. Some researchers believe the consumption of clotting factors is part of the disease process.

Who is at risk for the illness?
People who have close contact with a human or non-human primate infected with the virus are at risk. Such persons include laboratory or quarantine facility workers who handle non-human primates that have been associated with the disease. In addition, hospital staff and family members who care for patients with the disease are at risk if they do not use proper barrier nursing techniques.

How is Marburg hemorrhagic fever prevented?
Due to our limited knowledge of the disease, preventive measures against transmission from the original animal host have not yet been established. Measures for prevention of secondary transmission are similar to those used for other hemorrhagic fevers. If a patient is either suspected or confirmed to have Marburg hemorrhagic fever, barrier nursing techniques should be used to prevent direct physical contact with the patient. These precautions include wearing of protective gowns, gloves, and masks; placing the infected individual in strict isolation; and sterilization or proper disposal of needles, equipment, and patient excretions.

What needs to be done to address the threat of Marburg hemorrhagic fever?
Marburg hemorrhagic fever is a very rare human disease. However, when it does occur, it has the potential to spread to other people, especially health care staff and family members who care for the patient. Therefore, increasing awareness among health-care providers of clinical symptoms in patients that suggest Marburg hemorrhagic fever is critical. Better awareness can help lead to taking precautions against the spread of virus infection to family members or health-care providers. Improving the use of diagnostic tools is another priority. With modern means of transportation that give access even to remote areas, it is possible to obtain rapid testing of samples in disease control centers equipped with Biosafety Level 4 laboratories in order to confirm or rule out Marburg virus infection.

A fuller understanding of Marburg hemorrhagic fever will not be possible until the ecology and identity of the virus reservoir are established. In addition, the impact of the disease will remain unknown until the actual incidence of the disease and its endemic areas are determined.

HANTAVIRUS PULMONARY SYNDROME

Tracking a Mystery Disease:
Highlights of the Discovery of Hantavirus Pulmonary Syndrome
An outbreak of unexplained illness occurred in May 1993 in the "Four Corners," an area of the Southwest shared by New Mexico, Arizona, Colorado, and Utah. A number of previously healthy young adults suddenly developed acute respiratory symptoms; about half soon died.

The New Mexico Department of Health, the Arizona Department of Health Services, the Colorado Department of Health, the Utah Department of Health, the Indian Health Service and CDC, with the assistance of the Navajo Nation Division of Health, rapidly mounted an intensive investigation.

Researchers soon suspected that they were dealing with a form of hantavirus, which is transmitted by rodents. Researchers then investigated the possible rodent connection, trapping rodents in the affected area, doing tissue studies both of rodents and hantavirus victims, until the virus and its principal carrier—the deer mouse—were positively identified.

Why the Four Corners area? Simply because there was a "bumper crop" of rodents there, due to heavy rains during the spring of 1993, which produced an extra-plentiful supply of the foods that rodents eat.

Early on, it was also established that person-to-person spread was unlikely. It was also determined that this "new" hantavirus had actually been present, but unrecognized, at least as early as 1959. Since the 1993 outbreak, hantavirus pulmonary syndrome (HPS) has been identified in over half of the states of the U.S.

How Is Hantavirus Transmitted?

The Rodent Connection

So just how do people get hantavirus pulmonary syndrome (HPS)? It all starts with rodents, like the deer mouse and cotton rat, which carry hantaviruses.

The Basic Transmission Cycle

The short story is that some rodents are infected with a type of hantavirus that causes HPS. In the United States, deer mice (plus cotton rats and rice rats in the southeastern states and the white-footed mouse in the Northeast) are the rodents carrying hantaviruses that cause hantavirus pulmonary syndrome.

These rodents shed the virus in their urine, droppings and saliva. The virus is mainly transmitted to people when they breathe in air contaminated with the virus.

This happens when fresh rodent urine, droppings or nesting materials are stirred up. When tiny droplets containing the virus get into the air, this process is known as "aerosolization."

There are several other ways rodents may spread hantavirus to people:

If a rodent with the virus bites someone, the virus may be spread to that person—but this is very rare.

Researchers believe that you may be able to get the virus if you touch something that has been contaminated with rodent urine, droppings or saliva, and then touch your nose or mouth.

Researchers also suspect that if virus-infected rodent urine, droppings or saliva contaminates food that you eat, you could also become sick.

These possibilities demonstrate why disinfecting rodent-infested areas is so important in preventing transmission of the virus.

Transmission can happen any place that infected rodents have infested. (Remember, by "carrier rodent" we mean deer mice plus cotton rats and rice rats in the Southeast, and the white-footed mouse in the Northeast. Common house mice do not carry hantavirus.) This could be barns or

sheds or other outbuildings, warehouses or summer cottages closed up for the season. But carrier rodents infest homes as well!

Therefore, the most sensible way to avoid contact with rodents is to prevent rodents from infesting the places where you live and work, and to follow safety precautions if you do stumble into a rodent-infested area. The prevention section of this web site details all of this for you!

Can You Get Hantavirus from Another Person?
The types of hantavirus that cause HPS in the United States cannot be transmitted from one person to another. For example, you cannot get the virus from touching or kissing a person who has HPS, or from a health care worker who has treated someone with the disease. Finally, you cannot get the virus from a blood transfusion in which the blood came from a person who became ill with HPS and survived.

Can You Get Hantavirus from Animals Other Than Rodents, or from Insects? What About Pets?
No—the hantaviruses that cause HPS in the United States are not known to be transmitted by any types of animals other than certain species of rodents. You cannot get hantavirus from farm animals, such as cows, chickens or sheep, or from insects, such as mosquitoes. Dogs and cats are not known to carry hantavirus. However, they may bring infected rodents into contact with people if they catch such animals and carry them home. Guinea pigs, hamsters, gerbils and other such pets are not known to carry hantavirus.

Who Is at Risk of Getting HPS, and Why?
HPS Was Discovered in the Southwest, but It's NOT an "Indian Disease."
You can be old or young, male or female, of any race, living anywhere in almost any part of the Americas. Healthy, active people are more likely to become infected because their activities often put them in contact with the virus. By the way, in the United States, you cannot get HPS from another person.

What Kind of Activities Are Risky?
Anything that puts you in contact with rodent droppings, urine or nesting materials can place you at risk for infection. These include such activities as opening up cabins and sheds or cleaning outbuildings that have been closed during the winter—such as barns, garages or storage facilities for farm and construction equipment. Both activities mean you may directly touch rodents or their droppings and/or "stir up the dust," and when you touch or inhale them, you're at risk for infection.

Hikers and campers can also be exposed when they use infested trail shelters or camp in other rodent habitats.

Construction and utility workers can be exposed when they work in crawl spaces under houses or in vacant buildings that may have a rodent population.

Cleaning in and around your own home can put you at risk if rodents have made it their home, too. And many homes can expect to shelter a few rodents, especially when the weather turns cold.

Overall, the chance of being exposed to hantavirus is greatest when people work, play or live in closed spaces where rodents are actively living. However, recent research results show that many people who have become ill with HPS got the disease after having been in frequent contact with rodents and/or their droppings for some time. In addition, many people who have become ill reported that they had not seen rodents or their droppings—at all. Therefore, if you live in an area where the carrier rodents such as the deer mouse are known to live, take sensible precautions before you do activities like those described above—even if you don't see any rodents or their droppings.

What Are The Symptoms of HPS?

The Early Symptoms
Early symptoms include fatigue, fever and muscle aches, especially the large muscle groups—thighs, hips, back, sometimes shoulders. These symptoms are universal.

There may also be headaches, dizziness, chills and/or abdominal problems, such as nausea, vomiting, diarrhea and abdominal pain. About half of all HPS patients experience these symptoms.

How long could it be between the time you get the virus, and the time you start showing these symptoms? Because there have been so few cases of HPS, it isn't quite clear what this "incubation time" is. However, on the basis of limited information, it appears that symptoms may develop between 1 and 5 weeks after exposure to potentially infected rodents and their droppings.

Another important point to remember from the data that the CDC Special Pathogens Branch keeps on all reported cases of HPS, it appears that many people who have become ill were in a situation where they didn't see rodents or rodent droppings. Other people have had frequent contact with rodents and their droppings before becoming ill. This apparent inconsistency makes it very difficult to pin down the precise time when the virus was transmitted.

To learn how a person gets hantavirus, see "How Is Hantavirus Transmitted? The Rodent Connection".

Late Symptoms
Four to 10 days after the initial phase of illness, the late symptoms of HPS appear. These include coughing and shortness of breath, with the sensation of, as one survivor put it, a "..tight band around my chest and a pillow over my face" as the lungs fill with fluid.

What Symptoms Aren't Common?
Earache, sore throat and rash are very uncommon.

How Do I Prevent HPS?

Eliminate or Minimize Contact with Rodents
Make your home, workplace, vacation home or campsite unattractive to them!
Why is this so important? If rodents don't find that where you are is a good place for them to be, too—that means lots of easy-to-get food and nesting material—then you're less likely to come into contact with them.

Recent research results show that many people who became ill with HPS got the disease after having been in frequent contact with rodents and/or their droppings around a home or a workplace. On the other hand, many people who became ill reported that they had not seen rodents or rodent droppings at all. Therefore, if you live in an area where the carrier rodents are known to live, it makes sense to try to keep your home, vacation place, workplace—and as far possible, campsite—clean.

What Is the Treatment for HPS?
At the present time, there is no specific treatment or "cure" for hantavirus infection. However, we do know that if the infected individuals are recognized early and are taken to an intensive care unit, some patients may do better. In intensive care, patients are intubated and given oxygen therapy to help them through the period of severe respiratory distress.

The earlier the patient is brought in to intensive care, the better. If a patient is experiencing full distress, it is less likely the treatment will be effective.

Therefore, if you have been around rodents and have symptoms of fever, deep muscle aches and severe shortness of breath, see your doctor immediately. Be sure to tell your doctor that you have been around rodents—this will alert your physician to look closely for any rodent-carried disease such as HPS.

LYMPHOCYTIC CHORIOMENIGITIS

What is lymphocytic choriomeningitis?
Lymphocytic choriomeningitis, or LCM, is a rodent-borne viral infectious disease that presents as aseptic meningitis (inflammation of the membrane, or meninges, that surrounds the brain and spinal cord), encephalitis (inflammation of the brain), or meningoencephalitis (inflammation of both the brain and meninges). Its causative agent is the lymphocytic choriomeningitis virus (LCMV), a member of the family Arenaviridae, that was initially isolated in 1933. Although LCMV is most commonly recognized as causing neurological disease, as its name implies, asymptomatic infection or mild febrile illnesses are common clinical manifestations. Additionally, pregnancy-related infection has been associated with abortion, congenital hydrocephalus and chorioretinitis, and mental retardation.

Where is the disease found?
LCM and milder LCMV infections have been reported in Europe, the Americas, Australia, and Japan, and may occur wherever infected rodent hosts of the virus are found. However, the disease has historically been underreported, often making it difficult to determine incidence rates or estimates of prevalence by geographic region. Several serologic studies conducted in urban areas have shown that the prevalence of LCMV infection among humans ranges from 2% to 10%.

How is LCMV spread, and how do humans become infected?
LCMV is naturally spread by the common house mouse, Mus musculus. Once infected, these mice can become chronically infected by maintaining virus in their blood and/or persistently shedding virus in their urine, a common characteristic of other arenavirus infections in rodents. Chronically infected female mice usually transmit infection to their offspring, which in turn become chronically infected.

Humans become infected by inhaling infectious aerosolized particles of rodent urine, feces, or saliva, by ingesting food contaminated with virus, by contamination of mucus membranes with infected body fluids, or by directly exposing cuts or other open wounds to virus-infected blood. LCMV infection has also been documented among staff handling infected hamsters. Person-to-person transmission has not been reported, with the exception of vertical transmission from an infected mother to fetus.

What are the symptoms of LCM?
The incubation period of LCMV infection is usually between 8 and 13 days. A characteristic biphasic febrile illness then follows. The initial phase, which may last as long as a week, typically begins with any or all of the following symptoms: fever, malaise, anorexia, muscle aches, headache, nausea, and vomiting. Other symptoms that appear less frequently include sore throat, cough, joint pain, chest pain, testicular pain, and parotid (salivary gland) pain. Following a few days of remission, the second phase of the disease occurs, consisting of symptoms of meningitis (for example, fever, headache, and a stiff neck) or characteristics of encephalitis (for example, drowsiness, confusion, sensory disturbances, and/or motor abnormalities, such as paralysis). LCMV has also been known to cause acute hydrocephalus, which often requires surgical shunting to relieve increased intracranial pressure. In rare instances, infection results in myelitis (inflammation of the spinal cord) and presents with symptoms such as muscle weakness, paralysis, or changes in body sensation. An association between LCMV infection and myocarditis (inflammation of the heart muscles) has been suggested.

During the first phase of the disease, the most common laboratory abnormalities are a low white blood cell count (leukopenia) and a low platelet count (thrombocytopenia). Liver enzymes in the serum may also be mildly elevated. After the onset of neurological disease during the second phase, an increase in protein levels, an increase in the number of white blood cells or a decrease in the glucose levels in the cerebrospinal fluid (CSF) is usually found.

Are there any complications after recovery?
Previous observations have shown that most patients who develop aseptic meningitis or encephalitis due to LCMV recover completely. No chronic infection has been described in humans, and after the acute phase the virus is cleared. However, as in all infections of the central nervous system, particularly encephalitis, temporary or permanent neurological damage is possible. Nerve deafness and arthritis have been reported. Infection of the human fetus during the early states of pregnancy may lead to developmental deficits that are permanent.

Is the disease ever fatal?
LCM is usually not fatal. In general, mortality is less than 1%.

How is LCM treated?
Aseptic meningitis, encephalitis, or meningoencephalitis requires hospitalization and supportive treatment based on severity. There is no specific drug therapy for LCM. Anti-inflammatory drugs, such as corticosteroids, may be considered under specific circumstances. Although studies have shown that ribavirin, a drug used to treat several other viral diseases, is effective against LCMV in vitro, there is no established evidence to support its use for treatment of LCM in humans.

Who is at risk for LCMV infection?
Individuals of all ages who come into contact with urine, feces, saliva, or blood of the house mouse are potentially at risk for infection. Laboratory workers who themselves handle infected animals are also at risk. However, this risk can be minimized by utilizing animals from sources that regularly test for the virus, wearing proper protective laboratory gear, and following appropriate safety precautions. Owners of pet mice or hamsters may be at risk for infection if these animals originate from colonies with circulating LCMV, or if the animals become infected from other wild mice. Human fetuses are at risk of acquiring infection vertically from infected maternal blood.

How can LCMV infections be prevented?
Like many other rodent-borne infectious diseases, LCMV infection can be prevented by avoiding or minimizing direct physical contact with rodents or exposure to their excreta. Adequate ventilation should be provided to any heavily infested, previously unventilated enclosed room or dwelling prior to cleanup. A liquid disinfectant, such as a diluted household bleach solution, should be applied to visible rodent droppings and their immediate surroundings. Gloves should be worn when disinfecting and cleaning up rodent excreta. Rodent spring traps may be set up in households or dwellings where rodent infestations are a concern.

What needs to be done to address the threat of LCMV?
The geographic distributions of the rodent hosts are widespread both domestically and abroad. However, infrequent recognition and diagnosis, and therefore underreporting, of LCM, have limited scientists' ability to estimate incidence rates and prevalence of disease among humans. Understanding the epidemiology of LCM and LCMV infections will help to further delineate risk factors for infection and develop effective preventive strategies. Increasing physician awareness will improve disease recognition and reporting, which may lead to better characterization of the natural history and the underlying immunopathological mechanisms of disease, and stimulate future therapeutic research and development.

GLANDERS (Burkholderia mallei)

Frequently Asked Questions

What is glanders?
Glanders is an infectious disease that is caused by the bacterium Burkholderia mallei. Glanders is primarily a disease affecting horses, but it also affects donkeys and mules and can be naturally contracted by goats, dogs, and cats. Human infection, although not seen in the United States since 1945, has occurred rarely and sporadically among laboratory workers and those in direct and prolonged contact with infected, domestic animals.

Why has glanders become a current issue?
Burkholderia mallei is an organism that is associated with infections in laboratory workers because so very few organisms are required to cause disease. The organism has been considered as a potential agent for biological warfare and of biological terrorism.

How common is glanders?
The United States has not seen any naturally occurring cases since the 1940s. However, it is still commonly seen among domestic animals in Africa, Asia, the Middle East, and Central and South America.

How is glanders transmitted and who can get it?
Glanders is transmitted to humans by direct contact with infected animals. The bacteria enter the body through the skin and through mucosal surfaces of the eyes and nose. The sporadic cases have been documented in veterinarians, horse caretakers, and laboratorians.

What are the symptoms of glanders?
The symptoms of glanders depend upon the route of infection with the organism. The types of infection include localized, pus-forming cutaneous infections, pulmonary infections, bloodstream infections, and chronic suppurative infections of the skin. Generalized symptoms of glanders include fever, muscle aches, chest pain, muscle tightness, and headache. Additional symptoms have included excessive tearing of the eyes, light sensitivity, and diarrhea.

Localized infections: If there is a cut or scratch in the skin, a localized infection with ulceration will develop within 1 to 5 days at the site where the bacteria entered the body. Swollen lymph nodes may also be apparent. Infections involving the mucous membranes in the eyes, nose, and respiratory tract will cause increased mucus production from the affected sites.

Pulmonary infections: In pulmonary infections, pneumonia, pulmonary abscesses, and pleural effusion can occur. Chest X-rays will show localized infection in the lobes of the lungs.

Bloodstream infections: Glanders bloodstream infections are usually fatal within 7 to 10 days.

Chronic infections: The chronic form of glanders involves multiple abscesses within the muscles of the arms and legs or in the spleen or liver.

Where is glanders usually found?
Geographically, the disease is endemic in Africa, Asia, the Middle East, and Central and South America.

How is glanders diagnosed?
The disease is diagnosed in the laboratory by isolating Burkholderia mallei from blood, sputum, urine, or skin lesions. Serologic assays are not available.

Can glanders spread from person to person?
In addition to animal exposure, cases of human-to-human transmission have been reported. These cases included two suggested cases of sexual transmission and several cases in family members who cared for the patients.

Is there a way to prevent infection?
There is no vaccine available for glanders. In countries where glanders is endemic in animals, prevention of the disease in humans involves identification and elimination of the infection in the animal population. Within the health care setting, transmission can be prevented by using common blood and body fluid precautions.

Is there a treatment for glanders?
Because human cases of glanders are rare, there is limited information about antibiotic treatment of the organism in humans. Sulfadiazine has been found to be an effective in experimental animals and in humans. Burkholderia mallei is usually sensitive to tetracyclines, ciprofloxacin, streptomycin, novobiocin, gentamicin, imipenem, ceftrazidime, and the sulfonamides. Resistance to chloramphenicol has been reported.

MELIOIDOSIS (Burkholderia pseudomallei)

Frequently Asked Questions

What is melioidosis?
Melioidosis, also called Whitmore's disease, is an infectious disease caused by the bacterium Burkholderia pseudomallei. Melioidosis is clinically and pathologically similar to glanders disease, but the ecology and epidemiology of melioidosis are different from glanders. Melioidosis is predominately a disease of tropical climates, especially in Southeast Asia where it is endemic. The bacteria causing melioidosis are found in contaminated water and soil and are spread to humans and animals through direct contact with the contaminated source. Glanders is contracted by humans from infected domestic animals.

Why has melioidosis become a current issue?
Burkholderia pseudomallei is an organism that has been considered as a potential agent for biological warfare and biological terrorism.

How common is melioidosis and where is it found?
Melioidosis is endemic in Southeast Asia, with the greatest concentration of cases reported in Vietnam, Cambodia, Laos, Thailand, Malaysia, Myanmar (Burma), and northern Australia. Additionally, it is seen in the South Pacific, Africa, India, and the Middle East. In many of these countries, Burkholderia pseudomallei is so prevalent that it is a common contaminate found on laboratory cultures. Moreover, it has been a common pathogen isolated from troops of all nationalities that have served in areas with endemic disease. A few isolated cases of melioidosis have occurred in the Western Hemisphere in Mexico, Panama, Ecuador, Haiti, Brazil, Peru, Guyana, and in the states of Hawaii and Georgia. In the United States, confirmed cases range from none to five each year and occur among travelers and immigrants.

How is melioidosis transmitted and who can get it?
Besides humans, many animal species are susceptible to melioidosis. These include sheep, goats, horses, swine, cattle, dogs, and cats. Transmission occurs by direct contact with contaminated soil and surface waters. In Southeast Asia, the organism has been repeatedly isolated from agriculture fields, with infection occurring primarily during the rainy season. Humans and animals are believed to acquire the infection by inhalation of dust, ingestion of contaminated water, and contact with contaminated soil especially through skin abrasions, and for military troops, by contamination of war wounds. Person-to-person transmission can occur. There is one report of transmission to a sister with diabetes who was the caretaker for her brother who had chronic melioidosis. Two cases of sexual transmission have been reported. Transmission in both cases was preceded by a clinical history of chronic prostatitis in the source patient.

What are the symptoms of melioidosis?
Illness from melioidosis can be categorized as acute or localized infection, acute pulmonary infection, acute bloodstream infection, and chronic suppurative infection. Inapparent infections are also possible. The incubation period (time between exposure and appearance of clinical symptoms) is not clearly defined, but may range from 2 days to many years.

Acute, localized infection: This form of infection is generally localized as a nodule and results from inoculation through a break in the skin. The acute form of melioidosis can produce fever and general muscle aches, and may progress rapidly to infect the bloodstream.

Pulmonary infection: This form of the disease can produce a clinical picture of mild bronchitis to severe pneumonia. The onset of pulmonary melioidosis is typically accompanied by a high fever, headache, anorexia, and general muscle soreness. Chest pain is common, but a nonproductive or productive cough with normal sputum is the hallmark of this form of melioidosis.

Acute bloodstream infection: Patients with underlying illness such as HIV, renal failure, and diabetes are affected by this type of the disease, which usually results in septic shock. The symptoms of the bloodstream infection vary depending on the site of original infection, but they generally include respiratory distress, severe headache, fever, diarrhea, development of pus-filled lesions on the skin, muscle tenderness, and disorientation. This is typically an infection of short duration, and abscesses will be found throughout the body.

Chronic suppurative infection: Chronic melioidosis is an infection that involves the organs of the body. These typically include the joints, viscera, lymph nodes, skin, brain, liver, lung, bones, and spleen.

How is melioidosis diagnosed?
Melioidosis is diagnosed by isolating Burkholderia pseudomallei from the blood, urine, sputum, or skin lesions. Detecting and measuring antibodies to the bacteria in the blood is another means of diagnosis..

Can melioidosis be spread from person to person?
Melioidosis can spread from person to person by contact with the blood and body fluids of an infected person. Two documented cases of male-to-female sexual transmission involved males with chronic prostatic infection due to melioidosis.

Is there a way to prevent infection?
There is no vaccine for melioidosis. Prevention of the infection in endemic-disease areas can be difficult since contact with contaminated soil is so common. Persons with diabetes and skin lesions should avoid contact with soil and standing water in these areas. Wearing boots during agricultural work can prevent infection through the feet and lower legs. In health care settings, using common blood and body fluid precautions can prevent transmission.

Is there a treatment for melioidosis?
ost cases of melioidosis can be treated with appropriate antibiotics. Burkholderia psuedomallei, the organism that causes melioidosis, is usually sensitive to imipenem, penicillin, doxycycline, amoxycillin-clavulanic acid, azlocillin, ceftazidime, ticarcillin-vulanic acid, ceftriaxone, and aztreonam. Treatment should be initiated early in the course of the disease. Although bloodstream

infection with melioidosis can be fatal, the other types of the disease are nonfatal. The type of infection and the course of treatment can predict any long-term sequelae.

PSITTACOSIS

Clinical Features In humans, fever, chills, headache, muscle aches, and a dry cough. Pneumonia is often evident on chest x-ray.
Etiologic Agent Chlamydia psittaci, a bacterium
Incidence Since 1996, fewer than 50 confirmed cases were reported in the United States each year. Many more cases may occur that are not correctly diagnosed or reported.
Sequelae Endocarditis, hepatitis, and neurologic complications may occasionally occur. Severe pneumonia requiring intensive-care support may also occur. Fatal cases have been reported.
Transmission Infection is acquired by inhaling dried secretions from infected birds. The incubation period is 6 to 19 days. Although all birds are susceptible, pet birds (parrots, parakeets, macaws, and cockatiels) and poultry (turkeys and ducks) are most frequently involved in transmission to humans.
Risk Groups Bird owners, pet shop employees, and veterinarians. Outbreaks of psittacosis in poultry processing plants have been reported.
Surveillance Psittacosis is a reportable condition in most states.
Trends Annual incidence varies considerably because of periodic outbreaks. A decline in reported cases since 1988 may be the result of improved diagnostic tests that distinguish C.psittaci from more common C. pneumoniae infections.
Challenges Diagnosis of psittacosis can be difficult. Antibiotic treatment may prevent an antibody response, thus limiting diagnosis by serologic methods. Infected birds are often asymptomatic. Tracebacks of infected birds to distributors and breeders often is not possible because of limited regulation of the pet bird industry.

TYPHUS FEVERS

Several distinct Rickettsiae species cause typhus fevers in humans. Each agent produces disease with a distinct epidemiology, but all cause illness, usually with fever, headache, or rash, or a combination of these. Treatment of all forms of typhus is similar and includes administration of appropriate antibiotics (for example, the tetracycline class) and supportive care; relapses are infrequent. Epidemic typhus is passed from person to person by the body louse. Endemic, or murine, typhus occurs worldwide and is transmitted by rat fleas. Different tickborne typhus fevers occur in Europe, Africa, the Americas, Australia, and Asia. Scrub typhus, transmitted by rodent mites, occurs in a large area from the Indian subcontinent to Australia and in much of Asia, including Japan, China, Korea, and parts of Russia.

Occurrence

Endemic typhus is common year round in the tropics. In temperate areas, it occurs during the summer months when rats and their fleas are most active and abundant. Outbreaks of epidemic typhus are rare except during periods when normal hygiene is disrupted, as in refugee camps arising from wars or natural disasters. It also occurs in some populations living in higher elevations during the colder months when louse-infested clothing is not laundered and person-to-person spread of lice is common. Scrub typhus can occur throughout the year, but is dependent on temperature and rainfall (which affect the prevalence of the mites that transmit the disease).

Risk for Travelers

Endemic typhus occurs often in people frequenting rat-infested buildings and houses in harbor or riverine areas. Foci of epidemic typhus exist in impoverished and dislocated populations in the highlands of some parts of Africa and South America, but travelers are rarely at risk of acquiring lice and disease. Scrub typhus and tick typhus occur in people who engage in occupational or recreational behaviors that bring them inadvertently in contact with mite- or tick-infested habitats that harbor the rodent hosts of these arthropods. Tick typhus infections, often called spotted fevers, occur occasionally in travelers who spend time in nature trekking or camping, or on safari.

Preventive Measures

Vaccine

Vaccination against any of the typhus fevers is not required by any country as a condition for entry. Although experimental vaccines have been developed for the typhus fevers, no commercially licensed vaccines are produced presently in the United States.

Other

Travelers should be advised that prevention is based on avoidance of vector-infested habitats, use of repellents and protective clothing when exposed, prompt detection and removal of arthropods on clothing and skin, and attention to hygiene. Disease management should focus on early detection and proper treatment to prevent severe complications of these illnesses.

VIRAL ENCEPHALITIS

EASTERN EQUINE ENCEPHALITIS

CLINICAL FEATURES: Symptoms range from mild flu-like illness to frank encephalitis, coma and death
ETIOLOGIC AGENT: Eastern equine encephalitis virus, member of the family Togaviridae, genus Alphavirus: Closely related to western and Venezuelan equine encephalitis viruses
INCIDENCE : 153 confirmed cases in the U.S. since 1964
SEQUELAE : Mild to severe neurologic deficits in survivors
COSTS Total case costs range from $21,000 for transiently infected individuals to $3 million for severely infected individuals Insecticide applications can cost as much as $1.4 million depending on the size of area treated
TRANSMISSION : Mosquito-borne
RISK GROUPS: Residents of endemic areas and visitors; Persons with outdoor work and recreational activities
SURVEILLANCE : National Notifiable Diseases Surveillance System
TRENDS Risk exposure increases as population expands into endemic areas
CHALLENGES : No licensed vaccine for human use; No effective therapeutic drug ;Unknown overwintering cycle; Control measures expensive.

WESTERN EQUINE ENCEPHALITIS

CLINICAL FEATURES: Symptoms range from mild flu-like illness to frank encephalitis, coma and death
ETIOLOGIC AGENT: Western equine encephalitis virus, member of the family Togaviridae, genus Alphavirus. Closely related to eastern and Venezuelan equine encephalitis viruses
INCIDENCE: 639 confirmed cases in the U.S. since 1964
SEQUELAE ; Mild to severe neurologic deficits in survivors
COSTS : Total case costs range from $21,000 for transiently infected individuals to $3 million for severely infected individuals: Insecticide applications can cost as much as $1.4 million depending on the size of area treated
TRANSMISSION; Mosquito-borne
RISK GROUPS: Residents of endemic areas and visitors: Persons with outdoor work and recreational activities
SURVEILLANCE: National Notifiable Diseases Surveillance System
TRENDS: Epidemic disease that is difficult to predict: Risk exposure increases as population expands into endemic areas
CHALLENGES : No licensed vaccine for human use; No effective therapeutic drug; Unknown overwintering cycle; Control measures expensive.

HENDRA VIRUS DISEASE and NIPAH VIRUS ENCEPHALITIS

What are Hendra and Nipah viruses?

Hendra virus (formerly called equine morbillivirus) is a member of the family Paramyxoviridae. The virus was first isolated in 1994 from specimens obtained during an outbreak of respiratory and neurologic disease in horses and humans in Hendra, a suburb of Brisbane, Australia.

Nipah virus, also a member of the family Paramyxoviridae, is related but not identical to Hendra virus. Nipah virus was initially isolated in 1999 upon examining samples from an outbreak of encephalitis and respiratory illness among adult men in Malaysia and Singapore.

Where are Hendra and Nipah viruses found?

The natural reservoir for Hendra virus is thought to be flying foxes (bats of the genus Pteropus) found in Australia. The natural reservoir for Nipah virus is still under investigation, but preliminary data suggest that bats of the genus Pteropus are also the reservoirs for Nipah virus in Malaysia.

Where are the diseases found?

Hendra virus caused disease in horses in Australia, and the human infections there were due to direct exposure to tissues and secretions from infected horses. Nipah virus caused a relatively mild disease in pigs in Malaysia and Singapore. Nipah virus was transmitted to humans, cats, and dogs through close contact with infected pigs.

How are Hendra and Nipah viruses transmitted to humans?

In Australia, humans became ill after exposure to body fluids and excretions of horses infected with Hendra virus. In Malaysia and Singapore, humans were infected with Nipah virus through close contact with infected pigs.
What are the signs and symptoms of Hendra virus disease and Nipah virus encephalitis?

Only three human cases of Hendra virus disease have been recognized. Two of the three individuals known to be infected had a respiratory illness with severe flu-like signs and symptoms. Infection with Nipah virus was associated with an encephalitis (inflammation of the brain) characterized by fever and drowsiness and more serious central nervous system disease, such as coma, seizures, and inability to maintain breathing.

Illness with Nipah virus begins with 3-14 days of fever and headache. This is followed by drowsiness and disorientation characterized by mental confusion. These signs and symptoms can progress to coma within 24-48 hours. Some patients have had a respiratory illness during the early part of their infections.

Are there any complications after recovery?
One of the three Hendra virus infections was marked by a delayed onset of progressive encephalitis. Serious nervous disease with Nipah virus encephalitis has been marked by some sequelae, such as persistent convulsions and personality changes.

Are the diseases ever fatal?
Two of the three human patients infected with Hendra virus died. During the Nipah virus disease outbreak in 1998-99, about 40% of the patients with serious nervous disease who entered hospitals died from the illness.

How are Hendra virus disease and Nipah virus encephalitis treated?
The drug ribavirin has been shown to be effective against the viruses in vitro. However, controlled drug investigations have not been performed and the clinical usefulness of these drugs is uncertain.

Who is at risk for disease from Hendra and Nipah viruses?
People who have contact with body fluids or excretions of horses infected with Hendra virus are at risk for Hendra virus disease. Nipah virus infection is associated with close contact with Nipah virus-infected pigs. Neither disease has spread from human to human.

How are infections with Hendra and Nipah virus prevented?
These diseases can be prevented by avoiding animals that are known to be infected and using appropriate personal protective equipment devices when it is necessary to come into contact with potentially infected animals.

What needs to be done to address the threat of Hendra and Nipah viruses?
The distribution of these agents in their natural reservoirs will eventually define the geographic range of the threat the viruses pose. However, these viruses are recent discoveries, and much work remains to be done on their geographic distribution and the reservoir species. The occurrence of the disease in humans has been associated only with infection of an intermediate species such as horses with Hendra and swine with Nipah virus. Early recognition of the disease in the intermediate animal host is probably the most crucial means of limiting future human cases.

TICK-BORNE ENCEPHALITIS

What is tick-borne encephalitis?
Tick-borne encephalitis, or TBE, is a human viral infectious disease involving the central nervous system. The disease is most often manifest as meningitis (inflammation of the membrane that surrounds the brain and spinal cord), encephalitis (inflammation of the brain), or meningoencephalitis (inflammation of both the brain and meninges). Although TBE is most commonly recognized as a neurologic disease, mild febrile illnesses can also occur. Long-lasting or permanent neuropsychiatric sequelae are observed in 10-20% of infected patient

What causes tick-borne encephalitis?
TBE is caused by tick-borne encephalitis virus (TBEV), a member of the family Flaviviridae, that was initially isolated in 1937. A closely related virus in Far Eastern Eurasia, Russian spring-summer encephalitis virus (RSSEV), is responsible for a similar disease with a more severe clinical course.

How is TBEV spread, and how do humans become infected?
Ticks act as both the vector and reservoir for TBEV. The main hosts are small rodents, with humans being accidental hosts. Large animals are feeding hosts for the ticks, but do not play a role in maintenance of the virus. The virus can chronically infect ticks and is transmitted both transtadially (from larva to nymph to adult ticks) and transovarially (from adult female tick through eggs). TBE cases occur during the highest period of tick activity (between April and November), when humans are infected in rural areas through tick bites. Infection also may follow consumption of raw milk from goats, sheep, or cows. Laboratory infections were common before the use of vaccines and availability of biosafety precautions to prevent exposure to infectious aerosols. Person-to-person transmission has not been reported. Vertical transmission from an infected mother to fetus has occurred.

Where is the disease found?
TBE is an important infectious disease of in many parts of Europe, the former Soviet Union, and Asia, corresponding to the distribution of the ixodid tick reservoir. The annual number of cases (incidence) varies from year to year, but several thousand are reported annually, despite historical under-reporting of this disease.

What are the symptoms of TBE?
The incubation period of TBE is usually between 7 and 14 days and is asymptomatic. Shorter incubation times have been reported after milk-borne exposure. A characteristic biphasic febrile illness follows, with an initial phase that lasts 2 to 4 days and corresponds to the viremic phase. It is non-specific with symptoms that may include fever, malaise, anorexia, muscle aches, headache, nausea, and/or vomiting. After about 8 days of remission, the second phase of the disease occurs in 20 to 30% of patients and involves the central nervous system with symptoms of meningitis (e.g., fever, headache, and a stiff neck) or encephalitis (e.g., drowsiness, confusion, sensory disturbances, and/or motor abnormalities such as paralysis) or meningoencephalitis. In contrast to RSSE, TBE is more severe in adults than in children.

During the first phase of the disease, the most common laboratory abnormalities are a low white blood cell count (leukopenia) and a low platelet count (thrombocytopenia). Liver enzymes in the serum may also be mildly elevated. After the onset of neurologic disease during the second phase, an increase in the number of white blood cells in the blood and the cerebrospinal fluid

(CSF) is usually found. Virus can be isolated from the blood during the first phase of the disease. Specific diagnosis usually depends on detection of specific IgM in either blood or CSF, usually appearing later, during the second phase of the disease.

Are there any complications after recovery?

In approximately two-thirds of patients infected with the TBE virus, only the early (viremic) phase is seen. In the remaining third, patients experience either the typical biphasic course of the disease or a clinical illness that begins with the second (neurologic) phase. The convalescent period can be long and the incidence of sequelae may vary between 30 and 60%, with long-term or even permanent neurologic symptoms. Neuropsychiatric sequelae have been report in 10- 20% of patients.

Is the disease ever fatal?

Yes, but only rarely. In general, mortality is 1% to 2%, with deaths occurring 5 to 7 days after the onset of neurologic signs

How is TBE treated?

There is no specific drug therapy for TBE. Meningitis, encephalitis, or meningoencephalitis require hospitalization and supportive care based on syndrome severity. Anti-inflammatory drugs, such as corticosteroids, may be considered under specific circumstances for symptomatic relief. Intubation and ventilatory support may be necessary.

Who is at risk for TBEV infection?

In disease endemic areas, people with recreational or occupational exposure to rural or outdoor settings (e.g., hunters, campers, forest workers, farmers) are potentially at risk for infection by contact with the infected ticks. Furthermore, as tourism expands, travel to areas of endemicity broadens the definition of who is at risk for TBE infection.

How can TBEV infections be prevented?

Like other tick-borne infectious diseases, TBEV infection can be prevented by using insect repellents and protective clothing to prevent tick bites. A vaccine is available in some disease endemic areas (though not currently in the United States); however, adverse vaccine-reactions in children limit the utility of the product.

Other related viruses.

The family Flaviviridae includes other tick-borne viruses affecting humans and these viruses are closely related to TBEV and RSSEV, such as Omsk hemorrhagic fever virus in Siberia and Kyasanur Forest disease virus in India. Louping ill virus (United Kingdom) is a member of this family; it cases disease primarily in sheep, and has been reported as a cause of a TBE-like illness in laboratory workers and persons at risk for contact with sick sheep (e.g., veterinarians, butchers).

TYPHOID FEVER

Frequently Asked Questions

Typhoid fever is a life-threatening illness caused by the bacterium Salmonella Typhi. In the United States about 400 cases occur each year, and 70% of these are acquired while traveling internationally. Typhoid fever is still common in the developing world, where it affects about 12.5 million persons each year.

Typhoid fever can be prevented and can usually be treated with antibiotics. If you are planning to travel outside the United States, you should know about typhoid fever and what steps you can take to protect yourself.

How is typhoid fever spread?
Salmonella Typhi lives only in humans. Persons with typhoid fever carry the bacteria in their bloodstream and intestinal tract. In addition, a small number of persons, called carriers , recover from typhoid fever but continue to carry the bacteria. Both ill persons and carriers shed S. Typhi in their feces (stool).

You can get typhoid fever if you eat food or drink beverages that have been handled by a person who is shedding S. Typhi or if sewage contaminated with S. Typhi bacteria gets into the water you use for drinking or washing food. Therefore, typhoid fever is more common in areas of the world where handwashing is less frequent and water is likely to be contaminated with sewage.

Once S. Typhi bacteria are eaten or drunk, they multiply and spread into the bloodstream. The body reacts with fever and other signs and symptoms.

Where in the world do you get typhoid fever?
Typhoid fever is common in most parts of the world except in industrialized regions such as the United States, Canada, western Europe, Australia, and Japan. Therefore, if you are traveling to the developing world, you should consider taking precautions. Over the past 10 years, travelers from the United States to Asia, Africa, and Latin America have been especially at risk.

How can you avoid typhoid fever?
Two basic actions can protect you from typhoid fever:
1. Avoid risky foods and drinks.
2. Get vaccinated against typhoid fever.

It may surprise you, but watching what you eat and drink when you travel is as important as being vaccinated. This is because the vaccines are not completely effective. Avoiding risky foods will also help protect you from other illnesses, including travelers' diarrhea, cholera, dysentery, and hepatitis A.

"Boil it, cook it, peel it, or forget it"
If you drink water, buy it bottled or bring it to a rolling boil for 1 minute before you drink it. Bottled carbonated water is safer than uncarbonated water.
Ask for drinks without ice unless the ice is made from bottled or boiled water. Avoid popsicles and flavored ices that may have been made with contaminated water.
Eat foods that have been thoroughly cooked and that are still hot and steaming.
Avoid raw vegetables and fruits that cannot be peeled. Vegetables like lettuce are easily contaminated and are very hard to wash well.
When you eat raw fruit or vegetables that can be peeled, peel them yourself. (Wash your hands with soap first.) Do not eat the peelings.
Avoid foods and beverages from street vendors. It is difficult for food to be kept clean on the street, and many travelers get sick from food bought from street vendors.

Getting vaccinated

If you are traveling to a country where typhoid is common, you should consider being vaccinated against typhoid. Visit a doctor or travel clinic to discuss your vaccination options.

Remember that you will need to complete your vaccination at least 1 week before you travel so that the vaccine has time to take effect. Typhoid vaccines lose effectiveness after several years; if you were vaccinated in the past, check with your doctor to see if it is time for a booster vaccination. Taking antibiotics will not prevent typhoid fever; they only help treat it.

What are the signs and symptoms of typhoid fever?

Persons with typhoid fever usually have a sustained fever as high as 103° to 104° F (39° to 40° C). They may also feel weak, or have stomach pains, headache, or loss of appetite. In some cases, patients have a rash of flat, rose-colored spots. The only way to know for sure if an illness is typhoid fever is to have samples of stool or blood tested for the presence of S. Typhi.

What do you do if you think you have typhoid fever?

If you suspect you have typhoid fever, see a doctor immediately. If you are traveling in a foreign country, you can usually call the U.S. consulate for a list of recommended doctors.

You will probably be given an antibiotic to treat the disease. Three commonly prescribed antibiotics are ampicillin, trimethoprim-sulfamethoxazole, and ciprofloxacin. Persons given antibiotics usually begin to feel better within 2 to 3 days, and deaths rarely occur. However, persons who do not get treatment may continue to have fever for weeks or months, and as many as 20% may die from complications of the infection.

Typhoid fever's danger doesn't end when symptoms disappear
Even if your symptoms seem to go away, you may still be carrying S. Typhi. If so, the illness could return, or you could pass the disease to other people. In fact, if you work at a job where you handle food or care for small children, you may be barred legally from going back to work until a doctor has determined that you no longer carry any typhoid bacteria.

If you are being treated for typhoid fever, it is important to do the following:

Keep taking the prescribed antibiotics for as long as the doctor has asked you to take them.

Wash your hands carefully with soap and water after using the bathroom, and do not prepare or serve food for other people. This will lower the chance that you will pass the infection on to someone else.

Have your doctor perform a series of stool cultures to ensure that no S. typhi bacteria remain in your body.

SHIGELLOSIS

What is shigellosis?

Shigellosis is an infectious disease caused by a group of bacteria called Shigella. Most who are infected with Shigella develop diarrhea, fever, and stomach cramps starting a day or two after

they are exposed to the bacterium. The diarrhea is often bloody. Shigellosis usually resolves in 5 to 7 days. In some persons, especially young children and the elderly, the diarrhea can be so severe that the patient needs to be hospitalized. A severe infection with high fever may also be associated with seizures in children less than 2 years old. Some persons who are infected may have no symptoms at all, but may still pass the Shigella bacteria to others.

What sort of germ is Shigella?
The Shigella germ is actually a family of bacteria that can cause diarrhea in humans. They are microscopic living creatures that pass from person to person. Shigella were discovered over 100 years ago by a Japanese scientist named Shiga, for whom they are named. There are several different kinds of Shigella bacteria: Shigella sonnei, also known as "Group D" Shigella, accounts for over two-thirds of the shigellosis in the United States. A second type, Shigella flexneri, or "group B" Shigella, accounts for almost all of the rest. Other types of Shigella are rare in this country, though they continue to be important causes of disease in the developing world. One type found in the developing world, Shigella dysenteriae type 1, causes deadly epidemics there.

How can Shigella infections be diagnosed?
Many different kinds of diseases can cause diarrhea and bloody diarrhea, and the treatment depends on which germ is causing the diarrhea. Determining that Shigella is the cause of the illness depends on laboratory tests that identify Shigella in the stools of an infected person. These tests are sometimes not performed unless the laboratory is instructed specifically to look for the organism. The laboratory can also do special tests to tell which type of Shigella the person has and which antibiotics, if any, would be best to treat it.

How can Shigella infections be treated?
Shigellosis can usually be treated with antibiotics. The antibiotics commonly used for treatment are ampicillin, trimethoprim/sulfamethoxazole (also known as Bactrim* or Septra*), nalidixic acid, or ciprofloxacin. Appropriate treatment kills the Shigella bacteria that might be present in the patient's stools, and shortens the illness. Unfortunately, some Shigella bacteria have become resistant to antibiotics and using antibiotics to treat shigellosis can actually make the germs more resistant in the future. Persons with mild infections will usually recover quickly without antibiotic treatment. Therefore, when many persons in a community are affected by shigellosis, antibiotics are sometimes used selectively to treat only the more severe cases. Antidiarrheal agents such as loperamide (Imodium*) or diphenoxylate with atropine (Lomotil*) are likely to make the illness worse and should be avoided.

Are there long term consequences to a Shigella infection?
Persons with diarrhea usually recover completely, although it may be several months before their bowel habits are entirely normal. About 3% of persons who are infected with one type of Shigella, Shigella flexneri, will later develop pains in their joints, irritation of the eyes, and painful urination. This is called Reiter's syndrome. It can last for months or years, and can lead to chronic arthritis which is difficult to treat. Reiter's syndrome is caused by a reaction to Shigella infection that happens only in people who are genetically predisposed to it.

Once someone has had shigellosis, they are not likely to get infected with that specific type again for at least several years. However, they can still get infected with other types of Shigella.

How do people catch Shigella?
The Shigella bacteria pass from one infected person to the next. Shigella are present in the diarrheal stools of infected persons while they are sick and for a week or two afterwards. Most Shigella infections are the result of the bacterium passing from stools or soiled fingers of one person to the mouth of another person. This happens when basic hygiene and handwashing habits are inadequate. It is particularly likely to occur among toddlers who are not fully toilet-trained. Family members and playmates of such children are at high risk of becoming infected.

Shigella infections may be acquired from eating contaminated food. Contaminated food may look and smell normal. Food may become contaminated by infected food handlers who forget to wash their hands with soap after using the bathroom. Vegetables can become contaminated if they are harvested from a field with sewage in it. Flies can breed in infected feces and then contaminate food. Shigella infections can also be acquired by drinking or swimming in contaminated water. Water may become contaminated if sewage runs into it, or if someone with shigellosis swims in it.

What can a person do to prevent this illness?
There is no vaccine to prevent shigellosis. However, the spread of Shigella from an infected person to other persons can be stopped by frequent and careful handwashing with soap. Frequent and careful handwashing is important among all age groups. Frequent, supervised handwashing of all children should be followed in day care centers and in homes with children who are not completely toilet-trained (including children in diapers). When possible, young children with a Shigella infection who are still in diapers should not be in contact with uninfected children.

People who have shigellosis should not prepare food or pour water for others until they have been shown to no longer be carrying the Shigella bacterium.

If a child in diapers has shigellosis, everyone who changes the child's diapers should be sure the diapers are disposed of properly in a closed-lid garbage can, and should wash his or her hands carefully with soap and warm water immediately after changing the diapers. After use, the diaper changing area should be wiped down with a disinfectant such as household bleach, Lysol* or bactericidal wipes.

Basic food safety precautions and regular drinking water treatment prevents shigellosis. At swimming beaches, having enough bathrooms near the swimming area helps keep the water from becoming contaminated.

Simple precautions taken while traveling to the developing world can prevent getting shigellosis. Drink only treated or boiled water, and eat only cooked hot foods or fruits you peel yourself. The same precautions prevent traveler's diarrhea in general.

How common is shigellosis?
Every year, about 18,000 cases of shigellosis are reported in the United States. Because many milder cases are not diagnosed or reported, the actual number of infections may be twenty times greater. Shigellosis is particularly common and causes recurrent problems in settings where hygiene is poor and can sometimes sweep through entire communities. Shigellosis is more common in summer than winter. Children, especially toddlers aged 2 to 4, are the most likely to get shigellosis. Many cases are related to the spread of illness in child-care settings, and many

more are the result of the spread of the illness in families with small children. In the developing world, shigellosis is far more common and is present in most communities most of the time.

What else can be done to prevent shigellosis?
It is important for the public health department to know about cases of shigellosis. It is important for clinical laboratories to send isolates of Shigella to the City, County or State Public Health Laboratory so the specific type can be determined and compared to other Shigella. If many cases occur at the same time, it may mean that a restaurant, food or water supply has a problem which needs correction by the public health department. If a number of cases occur in a day-care center, the public health department may need to coordinate efforts to improve handwashing among the staff, children, and their families. When a community-wide outbreak occurs, a community-wide approach to promote handwashing and basic hygiene among children can stop the outbreak. Improvements in hygiene for vegetables and fruit picking and packing may prevent shigellosis caused by contaminated produce.

Some prevention steps occur everyday, without you thinking about it. Making municipal water supplies safe and treating sewage are highly effective prevention measures that have been in place for many years.

What is the government doing about shigellosis?
The Centers for Disease Control and Prevention (CDC) monitors the frequency of Shigella infections in the country, and assists local and State health departments to investigate outbreaks, determine means of transmission and devise control measures. CDC also conducts research to better understand how to identify and treat shigellosis. The Food and Drug Administration inspects imported foods, and promotes better food preparation techniques in restaurants and food processing plants. The Environmental Protection Agency regulates and monitors the safety of our drinking water supplies. The government has also maintained active research into the development of a Shigella vaccine.

How can I learn more about this and other public health problems?
You can discuss any medical concerns you may have with your doctor or other heath care provider. Your local city or county health department can provide more information about this and other public health problems that are occurring in your area. General information about the public health of the nation is published every week in the "Morbidity and Mortality Weekly Report", by the CDC in Atlanta, GA. Epidemiologists in your local and State Health Departments are tracking a number of important public health problems, investigating special problems that arise, and helping to prevent them form occurring in the first place, or from spreading if they do occur.

Some tips for preventing the spread of shigellosis:
wash hands with soap carefully and frequently, especially after going to the bathroom, after changing diapers, and before preparing foods or beverages
dispose of soiled diapers properly
disinfect diaper changing areas after using them
keep children with diarrhea out of child care settings
supervise handwashing of toddlers and small children after they use the toilet
persons with diarrheal illness should not prepare food for others
if you are traveling to the developing world, "boil it, cook it, peel it, or forget it"
avoid drinking pool water

FOODBORNE ILLNESS

What is foodborne disease?
Foodborne disease is caused by consuming contaminated foods or beverages. Many different disease-causing microbes, or pathogens, can contaminate foods, so there are many different foodborne infections. In addition, poisonous chemicals, or other harmful substances can cause foodborne diseases if they are present in food.

More than 250 different foodborne diseases have been described. Most of these diseases are infections, caused by a variety of bacteria, viruses, and parasites that can be foodborne. Other diseases are poisonings, caused by harmful toxins or chemicals that have contaminated the food, for example, poisonous mushrooms. These different diseases have many different symptoms, so there is no one "syndrome" that is foodborne illness. However, the microbe or toxin enters the body through the gastrointestinal tract, and often causes the first symptoms there, so nausea, vomiting, abdominal cramps and diarrhea are common symptoms in many foodborne diseases.

Many microbes can spread in more than one way, so we cannot always know that a disease is foodborne. The distinction matters, because public health authorities need to know how a particular disease is spreading to take the appropriate steps to stop it. For example, Escherichia coli O157:H7 infections can spread through contaminated food, contaminated drinking water, contaminated swimming water, and from toddler to toddler at a day care center. Depending on which means of spread caused a case, the measures to stop other cases from occurring could range from removing contaminated food from stores, chlorinating a swimming pool, or closing a child day care center.

What are the most common foodborne diseases?
The most commonly recognized foodborne infections are those caused by the bacteria Campylobacter, Salmonella, and E. coli O157:H7, and by a group of viruses called calicivirus, also known as the Norwalk and Norwalk-like viruses.

Campylobacter is a bacterial pathogen that causes fever, diarrhea, and abdominal cramps. It is the most commonly identified bacterial cause of diarrheal illness in the world. These bacteria live in the intestines of healthy birds, and most raw poultry meat has Campylobacter on it. Eating undercooked chicken, or other food that has been contaminated with juices dripping from raw chicken is the most frequent source of this infection.

Salmonella is also a bacterium that is widespread in the intestines of birds, reptiles and mammals. It can spread to humans via a variety of different foods of animal origin. The illness it causes, salmonellosis, typically includes fever, diarrhea and abdominal cramps. In persons with poor underlying health or weakened immune systems, it can invade the bloodstream and cause life-threatening infections.

E. coli O157:H7 is a bacterial pathogen that has a reservoir in cattle and other similar animals. Human illness typically follows consumption of food or water that has been contaminated with microscopic amounts of cow feces. The illness it causes is often a severe and bloody diarrhea and painful abdominal cramps, without much fever. In 3% to 5% of cases, a complication called hemolytic uremic syndrome (HUS) can occur several weeks after the initial symptoms. This severe complication includes temporary anemia, profuse bleeding, and kidney failure.

Calicivirus, or Norwalk-like virus is an extremely common cause of foodborne illness, though it is rarely diagnosed, because the laboratory test is not widely available. It causes an acute gastrointestinal illness, usually with more vomiting than diarrhea, that resolves within two days. Unlike many foodborne pathogens that have animal reservoirs, it is believed that Norwalk-like viruses spread primarily from one infected person to another. Infected kitchen workers can contaminate a salad or sandwich as they prepare it, if they have the virus on their hands. Infected fishermen have contaminated oysters as they harvested them.

Some common diseases are occasionally foodborne, even though they are usually transmitted by other routes. These include infections caused by Shigella, hepatitis A, and the parasites Giardia lamblia and Cryptosporidia. Even strep throats have been transmitted occasionally through food.

In addition to disease caused by direct infection, some foodborne diseases are caused by the presence of a toxin in the food that was produced by a microbe in the food. For example, the bacterium Staphylococcus aureus can grow in some foods and produce a toxin that causes intense vomiting. The rare but deadly disease botulism occurs when the bacterium Clostridium botulinum grows and produces a powerful paralytic toxin in foods. These toxins can produce illness even if the microbes that produced them are no longer there.

Other toxins and poisonous chemicals can cause foodborne illness. People can become ill if a pesticide is inadvertently added to a food, or if naturally poisonous substances are used to prepare a meal. Every year, people become ill after mistaking poisonous mushrooms for safe species, or after eating poisonous reef fishes.

Are the types of foodborne diseases changing?

The spectrum of foodborne diseases is constantly changing. A century ago, typhoid fever, tuberculosis and cholera were common foodborne diseases. Improvements in food safety, such as pasteurization of milk, safe canning, and disinfection of water supplies have conquered those diseases. Today other foodborne infections have taken their place, including some that have only recently been discovered. For example, in 1996, the parasite Cyclospora suddenly appeared as a cause of diarrheal illness related to Guatemalan raspberries. These berries had just started to be grown commercially in Guatemala, and somehow became contaminated in the field there with this unusual parasite. In 1998, a new strain of the bacterium Vibrio parahemolyticus contaminated oyster beds in Galveston Bay and caused an epidemic of diarrheal illness in persons eating the oysters raw. The affected oyster beds were near the shipping lanes, which suggested that the bacterium arrived in the ballast water of freighters and tankers coming into the harbor from distant ports. Newly recognized microbes emerge as public health problems for several reasons: microbes can easily spread around the world, new microbes can evolve, the environment and ecology are changing, food production practices and consumption habits change, and because better laboratory tests can now identify microbes that were previously unrecognized.

In the last 15 years, several important diseases of unknown cause have turned out to be complications of foodborne infections. For example, we now know that the Guillain-Barre syndrome can be caused by Campylobacter infection, and that the most common cause of acute kidney failure in children, hemolytic uremic syndrome, is caused by infection with E. coli O157:H7 and related bacteria. In the future, other diseases whose origins are currently unknown may turn out be related to foodborne infections.

What happens in the body after the microbes that produce illness are swallowed?
After they are swallowed, there is a delay, called the incubation period, before the symptoms of illness begin. This delay may range from hours to days, depending on the organism, and on how many of them were swallowed. During the incubation period, the microbes pass through the stomach into the intestine, attach to the cells lining the intestinal walls, and begin to multiply there. Some types of microbes stay in the intestine, some produce a toxin that is absorbed into the bloodstream, and some can directly invade the deeper body tissues. The symptoms produced depend greatly on the type of microbe. Numerous organisms cause similar symptoms, especially diarrhea, abdominal cramps, and nausea. There is so much overlap that it is rarely possible to say which microbe is likely to be causing a given illness unless laboratory tests are done to identify the microbe, or unless the illness is part of a recognized outbreak.

How are foodborne diseases diagnosed?
The infection is usually diagnosed by specific laboratory tests that identify the causative organism. Bacteria such as Campylobacter, Salmonella, E. coli O157 are found by culturing stool samples in the laboratory and identifying the bacteria that grow on the agar or other culture medium. Parasites can be identified by examining stools under the microscope. Viruses are more difficult to identify, as they are too small to see under a light microscope and are difficult to culture. Viruses are usually identified by testing stool samples for genetic markers that indicate a specific virus is present.

Many foodborne infections are not identified by routine laboratory procedures and require specialized, experimental, and/or expensive tests that are not generally available. If the diagnosis is to be made, the patient has to seek medical attention, the physician must decide to order diagnostic tests, and the laboratory must use the appropriate procedures. Because many ill persons to not seek attention, and of those that do, many are not tested, many cases of foodborne illness go undiagnosed. For example, CDC estimates that 38 cases of salmonellosis actually occur for every case that is actually diagnosed and reported to public health authorities.

How are foodborne diseases treated?
There are many different kinds of foodborne diseases and they may require different treatments, depending on the symptoms they cause. Illnesses that are primarily diarrhea or vomiting can lead to dehydration if the person loses more body fluids and salts (electrolytes) than they take in. Replacing the lost fluids and electrolytes and keeping up with fluid intake are important. If diarrhea is severe, oral rehydration solution such as Ceralyte*, Pedialyte* or Oralyte*, should be drunk to replace the fluid losses and prevent dehydration. Sports drinks such as Gatorade* do not replace the losses correctly and should not be used for the treatment of diarrheal illness. Preparations of bismuth subsalicylate (e.g., Pepto-Bismol)* can reduce the duration and severity of simple diarrhea. If diarrhea and cramps occur, without bloody stools or fever, taking an antidiarrheal medication may provide symptomatic relief, but these medications should be avoided if there is high fever or blood in the stools because they may make the illness worse.
Note: *CDC does not endorse commercial products or services and so is this publisher.

When should I consult my doctor about a diarrheal illness?
A health care provider should be consulted for a diarrheal illness is accompanied by
high fever (temperature over 101.5 F, measured orally)
blood in the stools
prolonged vomiting that prevents keeping liquids down (which can lead to dehydration)

signs of dehydration, including a decrease in urination, a dry mouth and throat, and feeling dizzy when standing up.
diarrheal illness that lasts more than 3 days

Do not be surprised if your doctor does not prescribe an antibiotic. Many diarrheal illnesses are caused by viruses and will improve in 2 or 3 days without antibiotic therapy. In fact, antibiotics have no effect on viruses, and using an antibiotic to treat a viral infection could cause more harm than good It is often not necessary to take an antibiotic even in the case of a mild bacterial infection. Other treatments can help the symptoms, and careful handwashing can prevent the spread of infection to other people. Overuse of antibiotics is the principal reason many bacteria are becoming resistant. Resistant bacteria are no longer killed by the antibiotic. This means that it is important to use antibiotics only when they are really needed. Partial treatment can also cause bacteria to become resistant. If an antibiotic is prescribed, it is important to take all of the medication as prescribed, and not stop early just because the symptoms seem to be improving.

How many cases of foodborne disease are there in the United States?
An estimated 76 million cases of foodborne disease occur each year in the United States. The great majority of these cases are mild and cause symptoms for only a day or two. Some cases are more serious, and CDC estimates that there are 325,000 hospitalizations and 5,000 deaths related to foodborne diseases each year. The most severe cases tend to occur in the very old, the very young, those who have an illness already that reduces their immune system function, and in healthy people exposed to a very high dose of an organism.

How do public health departments track foodborne diseases?
Routine monitoring of important diseases by public health departments is called disease surveillance. Each state decides which diseases are to be under surveillance in that state. In most states, diagnosed cases of salmonellosis, E. coli O157:H7 and other serious infections are routinely reported to the health department. The county reports them to the state health department, which reports them to CDC. Tens of thousands of cases of these "notifiable conditions" are reported every year. For example, nearly 35,000 cases of Salmonella infection were reported to CDC in 1998. However, most foodborne infections go undiagnosed and unreported, either because the ill person does not see a doctor, or the doctor does not make a specific diagnosis. Also, infections with some microbes are not reportable in the first place.

To get more information about infections that might be diagnosed but not reported, CDC developed a special surveillance system called FoodNet. FoodNet provides the best available information about specific foodborne infections in the United States, and summarizes them in an annual report.

In addition to tracking the number of reported cases of individual infections, states also collect information about foodborne outbreaks, and report a summary of that information to CDC. About 400-500 foodborne outbreaks investigated by local and state health departments are reported each year. This includes information about many diseases that are not notifiable and thus are not under individual surveillance, so it provides some useful general information about foodborne diseases.

What are foodborne disease outbreaks and why do they occur?
An outbreak of foodborne illness occurs when a group of people consume the same contaminated food and two or more of them come down with the same illness. It may be a group that ate a meal together somewhere, or it may be a group of people who do not know each other at all, but

who all happened to buy and eat the same contaminated item from a grocery store or restaurant. For an outbreak to occur, something must have happened to contaminate a batch of food that was eaten by a the group of people. Often, a combination of events contributes to the outbreak. A contaminated food may be left out a room temperature for many hours, allowing the bacteria to multiply to high numbers, and then be insufficiently cooked to kill the bacteria.

Many outbreaks are local in nature. They are recognized when a group of people realize that they all became ill after a common meal, and someone calls the local health department. This classic local outbreak might follow a catered meal at a reception, a pot-luck supper, or eating a meal at an understaffed restaurant on a particularly busy day. However, outbreaks are increasingly being recognized that are more widespread, that affect persons in many different places, and that are spread out over several weeks. For example, a recent outbreak of salmonellosis was traced to persons eating a breakfast cereal produced at a factory in Minnesota, and marketed under several different brand names in many different states. No one county or state had very many cases and the cases did not know each other. The outbreaks was recognized because it was caused by an unusual strain of Salmonella, and because state public health laboratories that type Salmonella strains noticed a sudden increase in this one rare strain. In another recent outbreak, a particular peanut snack food caused the same illness in Israel, Europe and North America. Again, this was recognized as an increase in infections caused by a rare strain of Salmonella.

The vast majority of reported cases of foodborne illness are not part of recognized outbreaks, but occurs as individual or "sporadic" cases. It may be that many of these cases are actually part of unrecognized widespread or diffuse outbreaks. Detecting and investigating such widespread outbreaks is a major challenge to our public health system. This is the reason that new and more sophisticated laboratory methods are being used at CDC and in state public health department laboratories.

Why do public health officials investigate outbreaks?

A foodborne outbreak is an indication that something needs to be improved in our food safety system. Public health scientists investigate outbreaks to control them, and also to learn how similar outbreaks can be prevented in the future. Just as when a fire breaks out in a large building or when an airliner crashes, two activities are critical when an outbreak occurs. First, emergency action is needed to keep the immediate danger from spreading, and second, a detailed objective scientific investigation is needed to learn what went wrong, so that future similar events can be prevented. Much of what we know about foodborne disease and its prevention comes from detailed investigation of outbreaks. This is often how a new pathogen is identified, and this is how the critical information linking a pathogen to a specific food and animal reservoir is first gathered. The full investigation can require a team with multiple talents, including the epidemiologist, microbiologist, food sanitarian, food scientist, veterinarian, and factory process engineer.

How are outbreaks of foodborne disease detected?

The initial clue that an outbreak is occurring can come in various ways. It may be when a person realizes that several other people who were all together at an event have become ill and he or she calls the local health department. It may be when a physician realizes she has seen more than the usual number of patients with the same illness. It may be when a county health department gets an unusually large number of reports of illness. The hardest outbreaks to detect are those that are spread over a large geographic area, with only a few cases in each state. These outbreaks can be detected by combining surveillance reports at the regional or national level and looking for

increases in infections of a specific type. This is why state public health laboratories determine the serotype of Salmonella bacteria isolated from people. New "DNA fingerprinting" technologies can make detecting outbreaks easier too. For example, the new molecular subtyping network, PulseNet, allows state laboratories and CDC to compare strains of E. coli O157:H7 and an increasing number of other pathogens from all across the United States to detect widespread outbreaks.

After an apparent cluster of cases is detected, it is important to determine whether these cases represent a real increase above the expected number of cases and whether they really might be related. Sometimes a cluster of reported cases is caused by something other than an actual outbreak of illness. For example, if the person responsible for reporting has just returned from a vacation and is clearing up a backlog of cases by reporting them all at once, the sudden surge of reports is just a false cluster.

How is a foodborne disease outbreak investigated?
Once an outbreak is strongly suspected, an investigation begins. A search is made for more cases among persons who may have been exposed. The symptoms and time of onset, and location of possible cases is determined, and a "case definition" is developed that describes these typical cases. The outbreak is systematically described by time, place, and person. A graph is drawn of the number of people who fell ill on each successive day to show pictorially when it occurred. A map of where the ill people live, work, or eat may be helpful to show where it occurred. Calculating the distribution of cases by age and sex shows who is affected. If the causative microbe is not known, samples of stool or blood are collected from ill people and sent to the public health laboratory to make the diagnosis.

To identify the food or other source of the outbreak, the investigators first interview a few persons with the most typical cases about exposures they may have had in the few days before they got sick. In this way, certain potential exposures may be excluded while others that are mentioned repeatedly emerge as possibilities. Combined with other information, such as the likely sources for the specific microbe involved, these hypotheses are then tested in a formal epidemiologic investigation. The investigators conduct systematic interviews about a list of possible exposures with the ill persons, and with a comparable group people who are not ill. By comparing how often an exposure is reported by ill people and by well people, investigators can measure the association of the exposure with illness. Using probability statistics, similar to those used to describe coin flips, the probability of no association is directly calculated.

For example, imagine that an outbreak has occurred after a catered event. Initial investigation suggested that Hollandaise sauce was eaten by at least some of the attendees, so it is on the list of possible hypotheses. Now, we interview 20 persons who attended the affair, 10 of whom became ill and 10 who remained well. Each ill or well person is interviewed about whether or not they ate the Hollandaise sauce, as well as various other food items. If half the people ate the sauce, but the sauce was not associated with the illness, then we would expect each person to have a 50/50 chance of reporting that they ate it, regardless of whether they were ill or not. Suppose, however, that we find that all 10 ill people but none of the well persons reported eating Hollandaise sauce at the event? This would be very unlikely to occur by chance alone if eating the Hollandaise sauce were not somehow related to the risk of illness. In fact, it would be about as unlikely as getting heads ten times in a row by flipping a coin (That is 50% multiplied by itself 10 times over, or a chance of just under 1 in 1000). So the epidemiologist concludes that eating the Hollandaise sauce was very likely to be associated with the risk of illness. Note that the

investigator can draw this conclusion even though there is no Hollandaise sauce left to test in a laboratory. The association is even stronger if she can show that those who ate second helpings of Hollandaise were even more likely to become ill, or that persons who ate leftover Hollandaise sauce that went home in doggie bags also became ill.

Once a food item is statistically implicated in this manner, further investigation into its ingredients and preparation, and microbiologic culture of leftover ingredients or the food itself (if available) may provide additional information about the nature of contamination. Perhaps the Hollandaise sauce was made using raw eggs. The source of the raw eggs can be determined, and it may even be possible to trace them back to the farm and show that chickens on the farm are carrying the same strain of Salmonella in their ovaries. If so, the eggs from that farm can be pasteurized to prevent them from causing other outbreaks.

Some might think that the best investigation method would be just to culture all the leftover foods in the kitchen, and conclude that the one that is positive is the one that caused the outbreak. The trouble is that this can be misleading, because it happens after the fact. What if the Hollandaise sauce is all gone, but the spoon that was in the sauce got placed in potato salad that was not served at the function? Now, cultures of the potato salad yield a pathogen, and the unwary tester might call that the source of the outbreak, even though the potato salad had nothing to do with it. This means that laboratory testing without epidemiologic investigation can lead to the wrong conclusion.

Even without isolating microbes from food, a well-conducted epidemiologic investigation can guide immediate efforts to control the outbreak. A strong and consistent statistical association between illness and a particular food item that explains the distribution of the outbreak in time, place and person should be acted upon immediately to stop further illness from occurring.

An outbreak ends when the critical exposure stops. This may happen because all the contaminated food is eaten or recalled, because a restaurant is closed or a food processor shuts down or changes its procedures, or an infected food handler is no longer infectious or is no longer working with food. An investigation that clarifies the nature and mechanism of contamination can provide critical information even if the outbreak is over. Understanding the contamination event well enough to prevent it can guide the decision to resume usual operations, and lead to more general prevention measures that reduce the risk of similar outbreaks happening elsewhere.

How does food become contaminated?

We live in a microbial world, and there are many opportunities for food to become contaminated as it is produced and prepared. Many foodborne microbes are present in healthy animals (usually in their intestines) raised for food. Meat and poultry carcasses can become contaminated during slaughter by contact with small amounts of intestinal contents. Similarly, fresh fruits and vegetables can be contaminated if they are washed or irrigated with water that is contaminated with animal manure or human sewage. Some types of Salmonella can infect a hen's ovary so that the internal contents of a normal looking egg can be contaminated with Salmonella even before the shell in formed. Oysters and other filter feeding shellfish can concentrate Vibrio bacteria that are naturally present in sea water, or other microbes that are present in human sewage dumped into the sea.

Later in food processing, other foodborne microbes can be introduced from infected humans who handle the food, or by cross contamination from some other raw agricultural product. For

example, Shigella bacteria, hepatitis A virus and Norwalk virus can be introduced by the unwashed hands of food handlers who are themselves infected. In the kitchen, microbes can be transferred from one food to another food by using the same knife, cutting board or other utensil to prepare both without washing the surface or utensil in between. A food that is fully cooked can become recontaminated if it touches other raw foods or drippings from raw foods that contain pathogens.

The way that food is handled after it is contaminated can also make a difference in whether or not an outbreak occurs. Many bacterial microbes need to multiply to a larger number before enough are present in food to cause disease. Given warm moist conditions and an ample supply of nutrients, one bacterium that reproduces by dividing itself every half hour can produce 17 million progeny in 12 hours. As a result, lightly contaminated food left out overnight can be highly infectious by the next day. If the food were refrigerated promptly, the bacteria would not multiply at all. In general, refrigeration or freezing prevents virtually all bacteria from growing but generally preserves them in a state of suspended animation. This general rule has a few surprising exceptions. Two foodborne bacteria, Listeria monocytogenes and Yersinia enterocolitica can actually grow at refrigerator temperatures. High salt, high sugar or high acid levels keep bacteria from growing, which is why salted meats, jam, and pickled vegetables are traditional preserved foods.

Microbes are killed by heat. If food is heated to an internal temperature above 160oF, or 78oC, for even a few seconds this sufficient to kill parasites, viruses or bacteria, except for the Clostridium bacteria, which produce a heat-resistant form called a spore. Clostridium spores are killed only at temperatures above boiling. This is why canned foods must be cooked to a high temperature under pressure as part of the canning process.

The toxins produced by bacteria vary in their sensitivity to heat. The staphylococcal toxin which causes vomiting is not inactivated even if it is boiled. Fortunately, the potent toxin that causes botulism is completely inactivated by boiling.

What foods are most associated with foodborne illness?
Raw foods of animal origin are the most likely to be contaminated; that is, raw meat and poultry, raw eggs, unpasteurized milk, and raw shellfish. Because filter-feeding shellfish strain microbes from the sea over many months, they are particularly likely to be contaminated if there are any pathogens in the seawater. Foods that mingle the products of many individual animals, such as bulk raw milk, pooled raw eggs, or ground beef, are particularly hazardous because a pathogen present in any one of the animals may contaminate the whole batch. A single hamburger may contain meat from hundreds of animals. A single restaurant omelet may contain eggs from hundreds of chickens. A glass of raw milk may contain milk from hundreds of cows. A broiler chicken carcass can be exposed to the drippings and juices of many thousands of other birds that went through the same cold water tank after slaughter.

Fruits and vegetables consumed raw are a particular concern. Washing can decrease but not eliminate contamination, so the consumers can do little to protect themselves. Recently, a number of outbreak have been traced to fresh fruits and vegetables that were processed under less than sanitary conditions. These outbreaks show that the quality of the water used for washing and chilling the produce after it is harvested is critical. Using water that is not clean can contaminate many boxes of produce. Fresh manure used to fertilize vegetables can also contaminate them. Alfalfa sprouts and other raw sprouts pose a particular challenge, as the conditions under which

they are sprouted are ideal for growing microbes as well as sprouts, and because they are eaten without further cooking. That means that a few bacteria present on the seeds can grow to high numbers of pathogens on the sprouts. Unpasteurized fruit juice can also be contaminated if there are pathogens in or on the fruit that is used to make it.

What can consumers do to protect themselves from foodborne illness?
A few simple precautions can reduce the risk of foodborne diseases:

COOK meat, poultry and eggs thoroughly. Using a thermometer to measure the internal temperature of meat is a good way to be sure that it is cooked sufficiently to kill bacteria. For example, ground beef should be cooked to an internal temperature of 160o F. Eggs should be cooked until the yolk is firm.

SEPARATE: Don't cross-contaminate one food with another. Avoid cross-contaminating foods by washing hands, utensils, and cutting boards after they have been in contact with raw meat or poultry and before they touch another food. Put cooked meat on a clean platter, rather back on one that held the raw meat.

CHILL: Refrigerate leftovers promptly. Bacteria can grow quickly at room temperature, so refrigerate leftover foods if they are not going to be eaten within 4 hours. Large volumes of food will cool more quickly if they are divided into several shallow containers for refrigeration.

CLEAN: Wash produce. Rinse fresh fruits and vegetables in running tap water to remove visible dirt and grime. Remove and discard the outermost leaves of a head of lettuce or cabbage. Because bacteria can grow well on the cut surface of fruit or vegetable, be careful not to contaminate these foods while slicing them up on the cutting board, and avoid leaving cut produce at room temperature for many hours. Don't be a source of foodborne illness yourself. Wash your hands with soap and water before preparing food. Avoid preparing food for others if you yourself have a diarrheal illness. Changing a baby's diaper while preparing food is a bad idea that can easily spread illness.

REPORT: Report suspected foodborne illnesses to your local health department. The local public health department is an important part of the food safety system. Often calls from concerned citizens are how outbreaks are first detected. If a public health official contacts you to find our more about an illness you had, your cooperation is important. In public health investigations, it can be as important to talk to healthy people as to ill people. Your cooperation may be needed even if you are not ill.

Are some people more likely to contract a foodborne illness? If so, are there special precautions they should take?
Some persons at particularly high risk should take more precautions.

Pregnant women, the elderly, and those weakened immune systems are at higher risk for severe infections such as Listeria and should be particularly careful not to consume undercooked animal products. They should avoid soft French style cheeses, pates, uncooked hot dogs and sliced deli meats, which have been sources of Listeria infections. Persons at high risk should also avoid alfalfa sprouts and unpasteurized juices.

A bottle-fed infant is at higher risk for severe infections with Salmonella or other bacteria that can grow in a bottle of warm formula if it is left at room temperature for many hours. Particular

care is needed to be sure the baby's bottle is cleaned and disinfected and that leftover milk formula or juice is not held in the bottle for many hours.

Persons with liver disease are susceptible to infections with a rare but dangerous microbe called Vibrio vulnificus, found in oysters. They should avoid eating raw oysters.

What can consumers do when they eat in restaurants?
You can protect yourself first by choosing which restaurant to patronize. Restaurants are inspected by the local health department to make sure they are clean and have adequate kitchen facilities. Find out how restaurants did on their most recent inspections, and use that score to help guide your choice. In many jurisdictions, the latest inspection score is posted in the restaurant. Some restaurants have specifically trained their staff in principles of food safety. This is also good to know in deciding which restaurant to patronize.

You can also protect yourself from foodborne disease when ordering specific foods, just as you would at home. When ordering a hamburger, ask for it to be cooked to a temperature of 160oF and send it back if it is still pink in the middle. Before you order something that is made with many eggs pooled together, such as scrambled eggs, omelets or French toast, ask the waiter whether it was made with pasteurized egg, and choose something else if it was not.

There is only so much the consumer can do. How can food be made safer in the first place?
Making food safe in the first place is a major effort, involving the farm and fishery, the production plant or factory, and many other points from the farm to the table. Many different groups in public health, industry, regulatory agencies, and academia have roles to play in making the food supply less contaminated. Consumers can promote general food safety with their dollars, by purchasing foods that have been processed for safety. For example, milk pasteurization was a major advance in food safety that was developed 100 years ago. Buying pasteurized milk rather than raw unpasteurized milk still prevents an enormous number of foodborne diseases every day. Now juice pasteurization is a recent important step forward that prevents E. coli O157:H7 infections and many other diseases. Consumers can look for and buy pasteurized fruit juices and ciders. In the future, meat and other foods will be available that has been treated for safety with irradiation.

These new technologies are likely to be as important a step forward as the pasteurization of milk.
Foodborne diseases are largely preventable, though there is no simple one-step prevention measure like a vaccine. Instead, measures are needed to prevent or limit contamination all the way from farm to table. A variety of good agricultural and manufacturing practices can reduce the spread of microbes among animals and prevent the contamination of foods. Careful review of the whole food production process can identify the principal hazards, and the control points where contamination can be prevented, limited, or eliminated. A formal method for evaluating the control of risk in foods exists is called the Hazard Analysis Critical Control Point, or HACCP system. This was first developed by NASA to make sure that the food eaten by astronauts was safe. HACCP safety principles are now being applied to an increasing spectrum of foods, including meat, poultry, and seafood.

For some particularly risky foods, even the most careful hygiene and sanitation are insufficient to prevent contamination, and a definitive microbe-killing step must be included in the process. For example, early in the century, large botulism outbreaks occurred when canned foods were cooked

insufficiently to kill the botulism spores. After research was done to find out exactly how much heat was needed to kill the spores, the canning industry and the government regulators went to great lengths to be sure every can was sufficiently cooked. As a result, botulism related to commercial canned foods has disappeared in this country. Similarly the introduction of careful pasteurization of milk eliminated a large number of milk-borne diseases.

This occurred after sanitation in dairies had already reached a high level. In the future, other foods can be made much safer by new pasteurizing technologies, such as in-shell pasteurization of eggs, and irradiation of ground beef. Just as with milk, these new technologies should be implemented in addition to good sanitation, not as a replacement for it.

In the end, it is up to the consumer to demand a safe food supply; up to industry to produce it; up to researchers to develop better ways of doing so; and up to government to see that it happens, to make sure it works and to identify problems still in need of solutions.

What is CDC doing to control and prevent foodborne disease?
CDC is part of the U. S. Public Health Service, with a mission to use the best scientific information to monitor, investigate, control and prevent public health problems. Using the tools of epidemiology and laboratory science, CDC provides scientific assessment of public health threats. CDC works closely with state health departments to monitor the frequency of specific diseases and conducts national surveillance for them. CDC provides expert epidemiologic and microbiologic consultation to health departments and other federal agencies on a variety of public health issues, including foodborne disease, and it stations epidemiologists in state health departments to help with the surveillance and investigation of many problems. CDC can also send a team into the field to conduct emergency field investigations of large or unusual outbreaks, in collaboration with state public health officials. CDC researchers develop new methods for identifying, characterizing and fingerprinting the microbes that cause disease. We translate laboratory research into practical field methods that can be used by public health authorities in States and counties.

CDC is not a regulatory agency. Government regulation of food safety is carried out by the Food and Drug Administration (FDA), the U.S. Department of Agriculture (USDA), the National Marine Fisheries Service, and other regulatory agencies. CDC maintains regular contact with the regulatory agencies.

When new public health threats appear, CDC learns what they are and how they can be controlled through rapid scientific field and laboratory investigation. CDC shares the results of these investigations with the states, with the regulatory federal agencies and with the industries themselves. Although we do not regulate the safety of food, CDC assesses the effectiveness of current prevention efforts. We provide independent scientific assessment of what the problems are, how they can be controlled, and of where there are gaps in our knowledge.

SALMONELLOSIS

What is salmonellosis?
Salmonellosis is an infection with a bacteria called Salmonella. Most persons infected with Salmonella develop diarrhea, fever, and abdominal cramps 12 to 72 hours after infection. The illness usually lasts 4 to 7 days, and most persons recover without treatment. However, in some

persons the diarrhea may be so severe that the patient needs to be hospitalized. In these patients, the Salmonella infection may spread from the intestines to the blood stream, and then to other body sites and can cause death unless the person is treated promptly with antibiotics. The elderly, infants, and those with impaired immune systems are more likely to have a severe illness.

What sort of germ is Salmonella?
The Salmonella germ is actually a group of bacteria that can cause diarrheal illness in humans. They are microscopic living creatures that pass from the feces of people or animals, to other people or other animals. There are many different kinds of Salmonella bacteria. Salmonella serotype Typhimurium and Salmonella serotype Enteritidis are the most common in the United States. Salmonella has been known to cause illness for over 100 years. They were discovered by a American scientist named Salmon, for whom they are named.

How can Salmonella infections be diagnosed?
Many different kinds of illnesses can cause diarrhea, fever, or abdominal cramps. Determining that Salmonella is the cause of the illness depends on laboratory tests that identify Salmonella in the stools of an infected person. These tests are sometimes not performed unless the laboratory is instructed specifically to look for the organism. Once Salmonella has been identified, further testing can determine its specific type, and which antibiotics could be used to treat it.

How can Salmonella infections be treated?
Salmonella infections usually resolve in 5-7 days and often do not require treatment unless the patient becomes severely dehydrated or the infection spreads from the intestines. Persons with severe diarrhea may require rehydration, often with intravenous fluids. Antibiotics are not usually necessary unless the infection spreads from the intestines, then it can be treated with ampicillin, gentamicin, trimethoprim/sulfamethoxazole, or ciprofloxacin. Unfortunately, some Salmonella bacteria have become resistant to antibiotics, largely as a result of the use of antibiotics to promote the growth of feed animals.

Are there long term consequences to a Salmonella infection?
Persons with diarrhea usually recover completely, although it may be several months before their bowel habits are entirely normal. A small number of persons who are infected with Salmonella, will go on to develop pains in their joints, irritation of the eyes, and painful urination. This is called Reiter's syndrome. It can last for months or years, and can lead to chronic arthritis which is difficult to treat. Antibiotic treatment does not make a difference in whether or not the person later develops arthritis.

How do people catch Salmonella?
Salmonella live in the intestinal tracts of humans and other animals, including birds. Salmonella are usually transmitted to humans by eating foods contaminated with animal feces. Contaminated foods usually look and smell normal. Contaminated foods are often of animal origin, such as beef, poultry, milk, or eggs, but all foods, including vegetables may become contaminated. Many raw foods of animal origin are frequently contaminated, but fortunately, thorough cooking kills Salmonella. Food may also become contaminated by the unwashed hands of an infected food handler, who forgot to wash his or her hands with soap after using the bathroom.

Salmonella may also be found in the feces of some pets, especially those with diarrhea, and people can become infected if they do not wash their hands after contact with these feces. Reptiles are particularly likely to harbor Salmonella and people should always wash their hands

immediately after handling a reptile, even if the reptile is healthy. Adults should also be careful that children wash their hands after handling a reptile.

What can a person do to prevent this illness?
There is no vaccine to prevent salmonellosis. Since foods of animal origin may be contaminated with Salmonella, people should not eat raw or undercooked eggs, poultry, or meat. Raw eggs may be unrecognized in some foods such as homemade hollandaise sauce, caesar and other salad dressings, tiramisu, homemade ice cream, homemade mayonnaise, cookie dough, and frostings. Poultry and meat, including hamburgers, should be well-cooked, not pink in the middle. Persons also should not consume raw or unpasteurized milk or other dairy products. Produce should be thoroughly washed before consuming.

Cross-contamination of foods should be avoided. Uncooked meats should be keep separate from produce, cooked foods, and ready-to-eat foods. Hands, cutting boards, counters, knives, and other utensils should be washed thoroughly after handling uncooked foods. Hand should be washed before handling any food, and between handling different food items.

People who have salmonellosis should not prepare food or pour water for others until they have been shown to no longer be carrying the Salmonella bacterium.

People should wash their hands after contact with animal feces. Since reptiles are particularly likely to have Salmonella, everyone should immediately wash their hands after handling reptiles. Reptiles (including turtles) are not appropriate pets for small children and should not be in the same house as an infant.

How common is salmonellosis?
Every year, approximately 40,000 cases of salmonellosis are reported in the United States. Because many milder cases are not diagnosed or reported, the actual number of infections may be twenty or more times greater. Salmonellosis is more common in the summer than winter.

Children are the most likely to get salmonellosis. Young children, the elderly, and the immunocompromised are the most likely to have severe infections. It is estimated that approximately 1,000 persons die each year with acute salmonellosis.

What else can be done to prevent salmonellosis?
It is important for the public health department to know about cases of salmonellosis. It is important for clinical laboratories to send isolates of Salmonella to the City, County, or State Public Health Laboratories so the specific type can be determined and compared with other Salmonella in the community. If many cases occur at the same time, it may mean that a restaurant, food or water supply has a problem which needs correction by the public health department.

Some prevention steps occur everyday without you thinking about it. Pasteurization of milk and treating municipal water supplies are highly effective prevention measures that have been in place for many years. In the 1970s, small pet turtles were a common source of salmonellosis in the United States, and in 1975, the sale of small turtles was halted in this country. Improvements in farm animal hygiene, in slaughter plant practices, and in vegetable and fruit harvesting and packing operations may help prevent salmonellosis caused by contaminated foods. Better education of food industry workers in basic food safety and restaurant inspection procedures, may

prevent cross-contamination and other food handling errors that can lead to outbreaks. Wider use of pasteurized egg in restaurants, hospitals, and nursing homes is an important prevention measure. In the future, irradiation or other treatments may greatly reduce contamination of raw meat.

What is the government doing about salmonellosis?
The Centers for Disease Control and Prevention (CDC) monitors the frequency of Salmonella infections in the country and assists the local and State Health Departments to investigate outbreaks and devise control measures. CDC also conducts research to better identify specific types of Salmonella. The Food and Drug Administration inspects imported foods, milk pasteurization plants, promotes better food preparation techniques in restaurants and food processing plants, and regulates the sale of turtles. The FDA also regulates the use of specific antibiotics as growth promotants in food animals. The US Department of Agriculture monitors the health of food animals, inspects egg pasteurization plants, and is responsible for the quality of slaughtered and processed meat. The US Environmental Protection Agency regulates and monitors the safety of our drinking water supplies.

How can I learn more about this and other public health problems?
You can discuss any medical concerns you may have with your doctor or other heath care provider. Your local City or County Health Department can provide more information about this and other public health problems that are occurring in your area. General information about the public health of the nation is published every week in the "Morbidity and Mortality Weekly Report", by the CDC in Atlanta, GA. Epidemiologists in your local and State Health Departments are tracking a number of important public health problems, investigating special problems that arise, and helping to prevent them from occurring in the first place, or from spreading if they do occur.

What can I do to prevent salmonellosis?
Cook poultry, ground beef, and eggs thoroughly before eating. Do not eat or drink foods containing raw eggs, or raw unpasteurized milk.

If you are served undercooked meat, poultry or eggs in a restaurant, don't hesitate to send it back to the kitchen for further cooking.

Wash hands, kitchen work surfaces, and utensils with soap and water immediately after they have been in contact with raw meat or poultry.

Be particularly careful with foods prepared for infants, the elderly, and the immunocompromised.

Wash hands with soap after handling reptiles or birds, or after contact with pet feces.

Avoid direct or even indirect contact between reptiles (turtles, iguanas, other lizards, snakes) and infants or immunocompromised persons.

Don't work with raw poultry or meat, and an infant (e.g., feed, change diaper) at the same time.

Mother's milk is the safest food for young infants. Breast-feeding prevents salmonellosis and many other health problems.

CHOLERA

Frequently Asked Questions

In January 1991, epidemic cholera appeared in South America and quickly spread to several countries. A few cases have occurred in the United States among persons who traveled to South America or ate contaminated food brought back by travelers.

Cholera has been very rare in industrialized nations for the last 100 years; however, the disease is still common today in other parts of the world, including the Indian subcontinent and sub-Saharan Africa.

Although cholera can be life-threatening, it is easily prevented and treated. In the United States, because of advanced water and sanitation systems, cholera is not a major threat; however, everyone, especially travelers, should be aware of how the disease is transmitted and what can be done to prevent it.

What is cholera?
Cholera is an acute, diarrheal illness caused by infection of the intestine with the bacterium Vibrio cholerae. The infection is often mild or without symptoms, but sometimes it can be severe. Approximately one in 20 infected persons has severe disease characterized by profuse watery diarrhea, vomiting, and leg cramps. In these persons, rapid loss of body fluids leads to dehydration and shock. Without treatment, death can occur within hours.

How does a person get cholera?
A person may get cholera by drinking water or eating food contaminated with the cholera bacterium. In an epidemic, the source of the contamination is usually the feces of an infected person. The disease can spread rapidly in areas with inadequate treatment of sewage and drinking water.

The cholera bacterium may also live in the environment in brackish rivers and coastal waters. Shellfish eaten raw have been a source of cholera, and a few persons in the United States have contracted cholera after eating raw or undercooked shellfish from the Gulf of Mexico. The disease is not likely to spread directly from one person to another; therefore, casual contact with an infected person is not a risk for becoming ill.

What is the risk for cholera in the United States?
In the United States, cholera was prevalent in the 1800s but has been virtually eliminated by modern sewage and water treatment systems. However, as a result of improved transportation, more persons from the United States travel to parts of Latin America, Africa, or Asia where epidemic cholera is occurring. U.S. travelers to areas with epidemic cholera may be exposed to the cholera bacterium. In addition, travelers may bring contaminated seafood back to the United States; foodborne outbreaks have been caused by contaminated seafood brought into this country by travelers.

What should travelers do to avoid getting cholera?
The risk for cholera is very low for U.S. travelers visiting areas with epidemic cholera. When simple precautions are observed, contracting the disease is unlikely.

All travelers to areas where cholera has occured should observe the following recomendations:

Drink only water that you have boiled or treated with chlorine or iodine. Other safe beverages include tea and coffee made with boiled
water and carbonated, bottled beverages with no ice.

Eat only foods that have been thoroughly cooked and are still hot, or fruit that you have peeled yourself.

Avoid undercooked or raw fish or shellfish, including ceviche.

Make sure all vegetables are cookedavoid salads.

Avoid foods and beverages from street vendors.

Do not bring perishable seafood back to the United States.

A simple rule of thumb is "Boil it, cook it, peel it, or forget it. "

Is a vaccine available to prevent cholera?

At the present time, the manufacture and sale of the only licensed cholera vaccine in the United States (Wyeth-Ayerst) has been discontinued. It has not been recommended for travelers because of the brief and incomplete immunity if offers. No cholera vaccination requirements exist for entry or exit in any country.

Two recently developed vaccines for cholera are licensed and available in other countries (Dukoral®, Biotec AB and Mutacol®, Berna). Both vaccines appear to provide a somewhat better immunity and fewer side-effects than the previously available vaccine. However, neither of these two vaccines is recommended for travelers nor are they available in the United States.

Use of trade names e.g. Dukoral®, Biotec AB and Mutacol®, Berna is for identification only and does not imply endorsement by the U.S. Department of Health and Human Services, this publisher or editor.

Chapter 6

CHEMICAL AGENTS/CHEMICAL WARFARE AGENTS

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In this book, the term Chemical Agent is used to describe "a substance which is intended for use in military operations to kill, seriously injure or incapacitate people because of its physiological effects. Excluded from this definition are riot control agents, herbicides, smoke and flame."

Note:
When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You are exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking the substance, or by skin contact.

If you are exposed to a chemical agent, many factors determine whether you'll be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with it. You must also consider the other chemicals you're exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

NERVE AGENTS (GA, GB, GD, VX) Tabun (GA) Sarin (GB) Soman (GD) VX

The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to nerve agents can occur due to accidental release from a military storage facility. Nerve agents are highly toxic regardless of the route of exposure. Exposure to nerve agents can cause tightness of the chest, excessive salivation, abdominal cramps, diarrhea, blurred vision, tremors, and death. Nerve agents (GA, GB, GD, VX) have been identified at 5 of the 1,585 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What are nerve agents GA, GB, GD, and VX?
Nerve agents GA (tabun), GB (sarin), GD (soman), and VX are manufactured compounds. The G-type agents are clear, colorless, tasteless liquids miscible in water and most organic solvents. GB is odorless and is the most volatile nerve agent. GA has a slightly fruity odor, and GD has a slight camphor-like odor. VX is a clear, amber-colored odorless, oily liquid. It is miscible with water and dissolves in all solvents. VX is the least volatile nerve agent.

Most of the nerve agents were originally produced in a search for insecticides, but because of their toxicity, they were evaluated for military use. Nerve agents have been used in wars and by terrorists. They are known to be stored by several nations, including the United States.

What **happens to nerve agents GA, GB, GD, and VX when they enter the environment**?

Nerve agents GA, GB, GD, and VX could enter the environment from an accidental release.

When released to air, GA, GB, GD, and VX will be broken down by compounds that are found in the air, but they may persist in air for a few days before being broken down.

GA, GB, GD, and VX will be broken down in water quickly, but small amounts may evaporate.

GA, GB, GD, and VX will be broken down in moist soil quickly. Small amounts may evaporate into air or travel below the soil surface and contaminate groundwater.

GA, GB, GD, and VX do not accumulate in the food chain.

How might I be exposed to nerve agents GA, GB, GD, and VX?

The United States no longer produces nerve agents GA, GB, GD, and VX.

The general population will not be exposed to nerve agents GA, GB, GD, or VX unless there is an accidental release from a military storage facility.

People who work at military sites where these compounds are stored may be potentially exposed to nerve agents GA, GB, GD, and VX.

How can nerve agents GA, GB, GD, and VX affect my health?

Even in very small amounts, nerve agents are highly toxic if you inhale or swallow them, or if they come in contact with your skin or eyes. In general, the manifestation of toxic effects is faster if you inhale or swallow nerve agents than if they contact your skin. The initial effects also depend on the amount you are exposed to. The onset of mild to moderate effects after dermal exposure may be delayed for as long as 18 hours.

Regardless of the route of exposure, the manifestation of nerve agent exposure includes runny nose, chest tightness, pinpoint pupils, shortness of breath, excessive salivation and sweating, nausea, vomiting, abdominal cramps, involuntary defecation and urination, muscle twitching, confusion, seizures, paralysis, coma, respiratory paralysis, and death. Incapacitating effects occur within 1 to 10 minutes and fatal effects can occur within 1 to 10 minutes for GA, GB, and GD, and within 4 to 42 hours for VX. Fatigue, irritability, nervousness, and memory defects may persist for as long as 6 weeks after recovery from an exposure episode.

We do not know if exposure to the nerve agents GA, GB, GD, or VX might result in reproductive effects in humans.

How likely are nerve agents GA, GB, GD, and VX to cause cancer?

The Department of Heath and Human Services (DHHS), the International Agency for Research on Cancer (IARC), and the EPA have not classified GA, GB, GD, and VX as to their carcinogenicity to humans. Limited data in animals indicate that nerve agents are not likely to be carcinogenic.

How can nerve agents GA, GB, GD, and VX affect children?

Children exposed to nerve agents are likely to experience the same toxic effects experienced by exposed adults. We do not know whether children differ from adults in their susceptibility to

nerve agents. We do not know if exposure to the nerve agents GA, GB, GD, or VX might result in developmental effects in humans.

How can families reduce the risk of exposure to nerve agents GA, GB, GD and VX?
It is unlikely that the general population will be exposed to nerve agents.

Is there a medical test to show whether I've been exposed to nerve agents GA, GB, GD, and VX?
There are medical tests available to determine whether you have been exposed to nerve agents. There are tests to measure degradation products of nerve agents in the urine, but are not generally useful. A different kind of test measures the levels of a substance called cholinesterase in the blood. If these levels are less than half what they should be, and you were exposed to nerve gases, you may get symptoms of poisoning. Cholinesterase levels in the blood can stay low for months after you have been exposed to nerve agents. Measurement of cholinesterase levels in blood is not specific for exposure to nerve agents.

Has the federal government made recommendations to protect human health?
An Airborne Exposure Limit (as recommended by the Surgeon General's Working Group, U.S. Department of Health and Human Services) of 0.003 micrograms of GA, GB, GD, or VX per cubic meter of air (0.003 μg/m3) has been established as a time-weighted average (TWA) for the workplace.

Where can I get more information?
ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

SOMAN

What soman is

- Soman is a human-made chemical warfare agent classified as a nerve agent. Nerve agents are the most toxic and rapidly acting of the known chemical warfare agents. They are similar to pesticides (insect killers) called organophosphates in terms of how they work and the kinds of harmful effects they cause. However, nerve agents are much more potent than organophosphate pesticides.
- Soman was originally developed as an insecticide in Germany in 1944.
- Soman is also known as "GD."
- Soman is a clear, colorless, tasteless liquid with a slight camphor odor (for example, Vicks Vapo-Rub®) or rotting fruit odor. It can become a vapor if heated.

Where soman is found and how it is used

- It is possible that soman or other nerve agents were used in chemical warfare during the Iran-Iraq War in the 1980s.
- Soman is not found naturally in the environment.

How people can be exposed to soman

- Following release of soman into the air, people can be exposed through skin contact, eye contact, or inhalation (breathing in the soman).

- Soman mixes easily with water, so it could be used to poison water. Following release of soman into water, people can be exposed by drinking contaminated water or getting contaminated water on their skin.
- Following contamination of food with soman, people can be exposed by eating the contaminated food.
- A person's clothing can release soman for about 30 minutes after contact with soman vapor, which can lead to exposure of other people.
- Soman breaks down slowly in the body, meaning that repeated exposures to soman and/or other nerve agents can have a cumulative effect (build up in the body).
- Because soman vapor is heavier than air, it will sink to low-lying areas and create a greater exposure hazard there.

How soman works

- The extent of poisoning caused by soman depends on the amount of soman to which a person was exposed, how the person was exposed, and the length of time of the exposure.
- Symptoms will appear within a few seconds after exposure to the vapor form of soman, and within a few minutes to up to 18 hours after exposure to the liquid form.
- All the nerve agents cause their toxic effects by preventing the proper operation of the chemical that acts as the body's "off switch" for glands and muscles. Without an "off switch," the glands and muscles are constantly being stimulated. They may tire and no longer be able to sustain breathing function.
- Compared with other nerve agents, soman is more volatile than VX but less volatile than sarin. The higher a chemical's volatility, the more likely it will evaporate from a liquid into a vapor and disperse into the environment. People can be exposed to the vapor even if they do not come in contact with the liquid form.
- Because of its high volatility, soman is an immediate but short-lived threat and does not last a long time in the environment.
- Because soman is more volatile than the nerve agent VX (the most potent nerve agent), it will remain on exposed surfaces for a shorter period of time compared with VX.

Immediate signs and symptoms of soman exposure

- Although soman has a camphor or fruity odor, the odor may not be noticeable enough to give people sufficient warning against a toxic exposure.
- People exposed to a low or moderate dose of soman by inhalation, ingestion (swallowing), or skin absorption may experience some or all of the following symptoms within seconds to hours of exposure:
    - Runny nose
    - Watery eyes
    - Small, pinpoint pupils
    - Eye pain
    - Blurred vision
    - Drooling and excessive sweating
    - Cough
    - Chest tightness
    - Rapid breathing
    - Diarrhea
    - Increased urination

    - Confusion
    - Drowsiness
    - Weakness
    - Headache
    - Nausea, vomiting, and/or abdominal pain
    - Slow or fast heart rate
    - Abnormally low or high blood pressure
- Even a tiny drop of nerve agent on the skin can cause sweating and muscle twitching where the agent touched the skin.
- Exposure to a large dose of soman by any route may result in these additional health effects:
    - Loss of consciousness
    - Convulsions
    - Paralysis
    - Respiratory failure possibly leading to death
- Showing these signs and symptoms does not necessarily mean that a person has been exposed to soman.

What the long-term health effects are

Mild or moderately exposed people usually recover completely. Severely exposed people are not likely to survive. Unlike some organophosphate pesticides, nerve agents have not been associated with neurological problems lasting more than 1 to 2 weeks after the exposure.

How people can protect themselves, and what they should do if they are exposed to soman

- Recovery from soman exposure is possible with treatment, but the antidotes available must be used quickly (within minutes) to be effective. Therefore, the best thing to do is avoid exposure:
    - Leave the area where the soman was released and get to fresh air. Quickly moving to an area where fresh air is available is highly effective in reducing the possibility of death from exposure to soman vapor.
        - If the soman release was outdoors, move away from the area where the soman was released. Go to the highest ground possible, because soman is heavier than air and will sink to low-lying areas.
        - If the soman release was indoors, get out of the building.

If people think they may have been exposed, they should remove their clothing, rapidly wash their entire body with soap and water, and get medical care as quickly as possible. Please See *"PERSONAL CLEANING AND DISPOSAL OF CONTAMINATED CLOTHING."*

How soman exposure is treated

Treatment consists of removing soman from the body as soon as possible and providing supportive medical care in a hospital setting. Antidotes are available for soman. They are most useful if given as soon as possible after exposure.

TABUN

What tabun is

- Tabun is a man-made chemical warfare agent classified as a nerve agent. Nerve agents are the most toxic and rapidly acting of the known chemical warfare agents. They are similar to pesticides (insect killers) called organophosphates in terms of how they work and what kinds of harmful effects they cause. However, nerve agents are much more potent than organophosphate pesticides.
- Tabun was originally developed as a pesticide in Germany in 1936.
- Tabun is also known as "GA."
- Tabun is a clear, colorless, tasteless liquid with a faint fruity odor. Tabun can become a vapor if heated.

Where tabun is found and how it is used

- It is possible that tabun or other nerve agents were used in chemical warfare during the Iran-Iraq War in the 1980s.
- Tabun is not found naturally in the environment.

How people can be exposed to tabun

- Following release of tabun into the air, people can be exposed through skin contact, eye contact, or inhalation (breathing in the tabun).
- Tabun mixes easily with water, so it could be used to poison water. Following release of tabun into water, people can be exposed by drinking contaminated water or getting contaminated water on their skin.
- Following contamination of food with tabun, people can be exposed by eating the contaminated food.
- A person's clothing can release tabun for about 30 minutes after contact with tabun vapor, which can lead to exposure of other people.
- Tabun breaks down slowly in the body, meaning that repeated exposures to tabun and/or other nerve agents can have a cumulative effect (build up in the body).
- Because tabun vapor is heavier than air, it will sink to low-lying areas and create a greater exposure hazard there.

How tabun works

- The extent of poisoning caused by tabun depends on the amount of tabun to which a person was exposed, how the person was exposed, and the length of time of the exposure.
- Symptoms will appear within a few seconds after exposure to the vapor form of tabun, and within a few minutes to up to 18 hours after exposure to the liquid form.
- All the nerve agents cause their toxic effects by preventing the proper operation of the chemical that acts as the body's "off switch" for glands and muscles. Without an "off switch," the glands and muscles are constantly being stimulated. They may tire and no longer be able to sustain breathing function.
- Compared with other nerve agents, tabun is more volatile than VX but less volatile than sarin. The higher a chemical's volatility, the more likely it will evaporate from a liquid into a vapor and disperse into the environment. People can be exposed to the vapor even if they do not come in contact with the liquid form.
- Because of its high volatility, tabun is an immediate but short-lived threat and does not last a long time in the environment.
- Because tabun is more volatile than VX, it will remain on exposed surfaces for a shorter period of time compared with VX.

- Because tabun is less volatile than sarin, it will remain on exposed surfaces for a longer period of time compared with sarin.

Immediate signs and symptoms of tabun exposure

- Although tabun has a faint fruity odor, the odor may not be noticeable enough to give people sufficient warning about a toxic exposure.
- People exposed to a low or moderate dose of tabun by inhalation, ingestion (swallowing), or skin absorption may experience some or all of the following symptoms within seconds to hours of exposure:
    - Runny nose
    - Watery eyes
    - Small, pinpoint pupils
    - Eye pain
    - Blurred vision
    - Drooling and excessive sweating
    - Cough
    - Chest tightness
    - Rapid breathing
    - Diarrhea
    - Increased urination
    - Confusion
    - Drowsiness
    - Weakness
    - Headache
    - Nausea, vomiting, and/or abdominal pain
    - Slow or fast heart rate
    - Abnormally low or high blood pressure
- Even a tiny drop of nerve agent on the skin can cause sweating and muscle twitching where the agent touched the skin.
- Exposure to a large dose of tabun by any route may result in these additional health effects:
    - Loss of consciousness
    - Convulsions
    - Paralysis
    - Respiratory failure possibly leading to death
- Showing these signs and symptoms does not necessarily mean that a person has been exposed to tabun.

What the long-term health effects are

Mild or moderately exposed people usually recover completely. Severely exposed people are not likely to survive. Unlike some organophosphate pesticides, nerve agents have not been associated with neurological problems lasting more than 1 to 2 weeks after the exposure

How people can protect themselves, and what they should do if they are exposed to tabun

- Recovery from tabun exposure is possible with treatment, but the antidotes available must be used quickly to be effective. Therefore, the best thing to do is avoid exposure:

- Leave the area where the tabun was released and get to fresh air. Quickly moving to an area where fresh air is available is highly effective in reducing the possibility of death from exposure to tabun vapor.
    - If the tabun release was outdoors, move away from the area where the tabun was released. Go to the highest ground possible, because tabun is heavier than air and will sink to low-lying areas.
    - If the tabun release was indoors, get out of the building.

If people think they may have been exposed, they should remove their clothing, rapidly wash their entire body with soap and water, and get medical care as quickly as possible. Please See *"PERSONAL CLEANING AND DISPOSAL OF CONTAMINATED CLOTHING."*

How tabun exposure is treated

Treatment consists of removing tabun from the body as soon as possible and providing supportive medical care in a hospital setting. Antidotes are available for tabun. They are most useful if given as soon as possible after exposure.

SARIN

What sarin is

Sarin is a human-made chemical warfare agent classified as a nerve agent. Nerve agents are the most toxic and rapidly acting of the known chemical warfare agents. They are similar to certain kinds of pesticides (insect killers) called organophosphates in terms of how they work and what kind of harmful effects they cause. However, nerve agents are much more potent than organophosphate pesticides.

Sarin originally was developed in 1938 in Germany as a pesticide.

Sarin is a clear, colorless, and tasteless liquid that has no odor in its pure form. However, sarin can evaporate into a vapor (gas) and spread into the environment.

Sarin is also known as GB.

Where sarin is found and how it is used

Sarin and other nerve agents may have been used in chemical warfare during the Iran-Iraq War in the 1980s.

Sarin was used in two terrorist attacks in Japan in 1994 and 1995.

Sarin is not found naturally in the environment.

How people can be exposed to sarin

Following release of sarin into the air, people can be exposed through skin contact or eye contact. They can also be exposed by breathing air that contains sarin.

Sarin mixes easily with water, so it could be used to poison water. Following release of sarin into water, people can be exposed by touching or drinking water that contains sarin.

Following contamination of food with sarin, people can be exposed by eating the contaminated food.

A person's clothing can release sarin for about 30 minutes after it has come in contact with sarin vapor, which can lead to exposure of other people.

Because sarin breaks down slowly in the body, people who are repeatedly exposed to sarin may suffer more harmful health effects.

Because sarin vapor is heavier than air, it will sink to low-lying areas and create a greater exposure hazard there.

How sarin works

The extent of poisoning caused by sarin depends on the amount of sarin to which a person was exposed, how the person was exposed, and the length of time of the exposure.

Symptoms will appear within a few seconds after exposure to the vapor form of sarin and within a few minutes up to 18 hours after exposure to the liquid form.

All the nerve agents cause their toxic effects by preventing the proper operation of the chemical that acts as the body's "off switch" for glands and muscles. Without an "off switch," the glands and muscles are constantly being stimulated. They may tire and no longer be able to sustain breathing function.

Sarin is the most volatile of the nerve agents, which means that it can easily and quickly evaporate from a liquid into a vapor and spread into the environment. People can be exposed to the vapor even if they do not come in contact with the liquid form of sarin.

Because it evaporates so quickly, sarin presents an immediate but short-lived threat.

Immediate signs and symptoms of sarin exposure

People may not know that they were exposed because sarin has no odor.

People exposed to a low or moderate dose of sarin by breathing contaminated air, eating contaminated food, drinking contaminated water, or touching contaminated surfaces may experience some or all of the following symptoms within seconds to hours of exposure:

Runny nose
Watery eyes
Small, pinpoint pupils
Eye pain
Blurred vision
Drooling and excessive sweating
Cough
Chest tightness
Rapid breathing
Diarrhea
Increased urination
Confusion
Drowsiness
Weakness
Headache
Nausea, vomiting, and/or abdominal pain
Slow or fast heart rate
Low or high blood pressure

Even a small drop of sarin on the skin can cause sweating and muscle twitching where sarin touched the skin.

Exposure to large doses of sarin by any route may result in the following harmful health effects:

Loss of consciousness
Convulsions
Paralysis
Respiratory failure possibly leading to death

Showing these signs and symptoms does not necessarily mean that a person has been exposed to sarin.

What the long-term health effects are

Mild or moderately exposed people usually recover completely. Severely exposed people are not likely to survive. Unlike some organophosphate pesticides, nerve agents have not been associated with neurological problems lasting more than 1 to 2 weeks after the exposure.

How people can protect themselves, and what they should do if they are exposed to sarin

Recovery from sarin exposure is possible with treatment, but the antidotes available must be used quickly to be effective. Therefore, the best thing to do is avoid exposure:

Leave the area where the sarin was released and get to fresh air. Quickly moving to an area where fresh air is available is highly effective in reducing the possibility of death from exposure to sarin vapor.

If the sarin release was outdoors, move away from the area where the sarin was released. Go to the highest ground possible, because sarin is heavier than air and will sink to low-lying areas.

If the sarin release was indoors, get out of the building.

If people think they may have been exposed, they should remove their clothing, rapidly wash their entire body with soap and water, and get medical care as quickly as possible. Please See *"PERSONAL CLEANING AND DISPOSAL OF CONTAMINATED CLOTHING."*

How sarin exposure is treated

Treatment consists of removing sarin from the body as soon as possible and providing supportive medical care in a hospital setting. Antidotes are available for sarin. They are most useful if given as soon as possible after exposure.

VX

What VX is

VX is a human-made chemical warfare agent classified as a nerve agent. Nerve agents are the most toxic and rapidly acting of the known chemical warfare agents. They are similar to pesticides (insect killers) called organophosphates in terms of how they work and what kinds of harmful effects they cause. However, nerve agents are much more potent than organophosphate pesticides.

VX was originally developed in the United Kingdom in the early 1950s.

VX is odorless and tasteless.

VX is an oily liquid that is amber in color and very slow to evaporate. It evaporates about as slowly as motor oil.

Where VX is found and how it is used

It is possible that VX or other nerve agents were used in chemical warfare during the Iran-Iraq War in the 1980s.

VX is not found naturally in the environment.

How people can be exposed to VX

Following release of VX into the air, people can be exposed through skin contact, eye contact, or inhalation (breathing in the VX mist).

Though VX does not mix with water as easily as other nerve agents do, it could be released into water. Following release of VX into water, people can be exposed by drinking contaminated water or getting contaminated water on their skin.

Following contamination of food with VX, people can be exposed by eating the contaminated food.

VX is primarily a liquid exposure hazard, but if it is heated to very high temperatures, it can turn into small amounts of vapor (gas).

A person's clothing can release VX for about 30 minutes after contact with VX vapor, which can lead to exposure of other people.

VX breaks down slowly in the body, meaning that repeated exposures to VX and/or other nerve agents can have a cumulative effect (build up in the body).

Because VX vapor is heavier than air, it will sink to low-lying areas and create a greater exposure hazard there.

How VX works

The extent of poisoning caused by VX depends on the amount of VX to which a person was exposed, how the person was exposed, and the length of time of the exposure.

Symptoms will appear within a few seconds after exposure to the vapor form of VX, and within a few minutes to up to 18 hours after exposure to the liquid form.

VX is the most potent of all nerve agents. Compared with the nerve agent sarin (also known as GB), VX is considered to be much more toxic by entry through the skin and somewhat more toxic by inhalation.

It is possible that any visible VX liquid contact on the skin, unless washed off immediately, would be lethal.

All the nerve agents cause their toxic effects by preventing the proper operation of the chemical that acts as the body's "off switch" for glands and muscles. Without an "off switch," the glands and muscles are constantly being stimulated. They may tire and no longer be able to sustain breathing function.

VX is the least volatile of the nerve agents, which means that it is the slowest to evaporate from a liquid into a vapor. Therefore, VX is very persistent in the environment. Under average weather conditions, VX can last for days on objects that it has come in contact with. Under very cold conditions, VX can last for months.

Because it evaporates so slowly, VX can be a long-term threat as well as a short-term threat. Surfaces contaminated with VX should therefore be considered a long-term hazard.

Immediate signs and symptoms of VX exposure

People may not know they were exposed to VX because it has no odor.

People exposed to a low or moderate dose of VX by inhalation, ingestion (swallowing), or skin absorption may experience some or all of the following symptoms within seconds to hours of exposure:

Runny nose
Watery eyes
Small, pinpoint pupils
Eye pain
Blurred vision
Drooling and excessive sweating
Cough
Chest tightness
Rapid breathing
Diarrhea
Increased urination
Confusion

Drowsiness
Weakness
Headache
Nausea, vomiting, and/or abdominal pain
Slow or fast heart rate
Abnormally low or high blood pressure
Even a tiny drop of nerve agent on the skin can cause sweating and muscle twitching where the agent touched the skin.
Exposure to a large dose of VX by any route may result in these additional health effects:
Loss of consciousness
Convulsions
Paralysis
Respiratory failure possibly leading to death
Showing these signs and symptoms does not necessarily mean that a person has been exposed to VX.

What the long-term health effects are
Mild or moderately exposed people usually recover completely. Severely exposed people are not likely to survive. Unlike some organophosphate pesticides, nerve agents have not been associated with neurological problems lasting more than 1 to 2 weeks after the exposure.

How people can protect themselves, and what they should do if they are exposed to VX
Recovery from VX exposure is possible with treatment, but the antidotes available must be used quickly to be effective. Therefore, the best thing to do is avoid exposure:
Leave the area where the VX was released and get to fresh air. Quickly moving to an area where fresh air is available is highly effective in reducing the possibility of death from exposure to VX vapor.
If the VX release was outdoors, move away from the area where the VX was released. Go to the highest ground possible, because VX is heavier than air and will sink to low-lying areas.
If the VX release was indoors, get out of the building.

If people think they may have been exposed, they should remove their clothing, rapidly wash their entire body with soap and water, and get medical care as quickly as possible. Please See *"PERSONAL CLEANING AND DISPOSAL OF CONTAMINATED CLOTHING."*

How VX exposure is treated
Treatment consists of removing VX from the body as soon as possible and providing supportive medical care in a hospital setting. Antidotes are available for VX. They are most useful if given as soon as possible after exposure.

BLISTER OR VERSICANT AGENTS

LEWISITE (L); MUSTARD-LEWISITE MIXTURE (HL)

What are lewisite and mustard-lewisite?
Lewisite is an oily, colorless liquid with an odor like geraniums. Mustard-Lewisite Mixture is a liquid with a garlic-like odor. Mustard-Lewisite is a mixture of Lewisite and a sulfur mustard known as HD.

Lewisite might have been used as a chemical weapon by Japan against Chinese forces in the 1930s, but such reports have not been confirmed. Any stored Lewisite in the United States must be destroyed before April 2007, as mandated by the Chemical Weapons Convention.

What happens to lewisite and mustard-lewisite when it enters the environment?

- Blister agents Lewisite and Mustard-Lewisite could enter the environment from an accidental release.
- In air, blister agents Lewisite and Mustard-Lewisite will be broken down by compounds that are found in the air, but they may persist in air for a few days before being broken down.
- Lewisite and Mustard-Lewisite will be broken down in water quickly, but small amounts may evaporate.
- Lewisite and Mustard-Lewisite will be broken down in moist soil quickly, but small amounts may evaporate.
- Lewisite and Mustard-Lewisite do not accumulate in the food chain.

How might I be exposed to lewisite and mustard-lewisite?

- The general population will not be exposed to blister agents Lewisite or Mustard-Lewisite.
- Lewisite and Mustard-Lewisite are no longer produced in the United States.
- It is used in many industries and in hospitals and laboratories.
- People that are potentially exposed to Lewisite or Mustard-Lewisite are soldiers who might be exposed to chemical weapons or people who work at military sites where these compounds are stored.

How can lewisite and mustard-lewisite affect my health?

If you breathe Lewisite or Mustard-Lewisite vapors, your airways will immediately become irritated. You could experience burning pain in the nose and sinuses, laryngitis, cough, shortness of breath, nausea, and vomiting. You could also experience airway tissue damage and accumulation of fluid in your lungs, which could result in death.

Contact of the skin with Lewisite or Mustard-Lewisite vapors or liquid will result in local pain, swelling, and rash, followed by blistering that might be delayed for hours. If Lewisite or Mustard-Lewisite vapors or liquid contact your eyes, you will suffer immediate pain and rapid swelling, as well as serious damage to the cornea and other parts of the eye.

Ingestion of Lewisite or Mustard-Lewisite will burn your mouth and throat, will cause severe stomach pain, nausea, vomiting, and bloody stools.

If some of the Lewisite and Mustard-Lewisite that you breathe, touch, or ingest, pass to your blood stream, it can cause bone marrow damage and fluid loss from your blood vessels, which could result in low blood pressure and damage to the rest of your body.

It is not known if exposure to Lewisite or Mustard-Lewisite causes reproductive effects in humans.

How likely are lewisite and mustard-lewisite to cause cancer?

The Department of Health and Human Services (DHHS), the International Agency for Research on Cancer (IARC), and the EPA have not classified Lewisite as to its carcinogenicity. Both the

DHHS and IARC have classified the blister agent H/HD (the sulfur mustard used in the Mustard-Lewisite mixture) as a human carcinogen. It is not known whether the Mustard-Lewisite mixture might also be a human carcinogen.

How does lewisite and mustard-lewisite affect children?
There is no information on children exposed to Lewisite or Mustard-Lewisite, but children would probably be affected in the same ways as adults. We do not know whether children differ from adults in their susceptibility to these blister agents.

We do not know whether Lewisite or Mustard-Lewisite can cause developmental effects in humans.

How can families reduce the risk of exposure to lewisite and mustard-lewisite?
It is unlikely that families will be exposed to Lewisite or Mustard-Lewisite.

Is there a medical test to show whether I've been exposed to lewisite and mustard-lewisite?
There are no specific tests to indicate whether you have been exposed to Lewisite or Mustard-Lewisite. The presence of arsenic in the urine could indicate if you have been exposed to one of these blister agents.

Has the federal government made recommendations to protect human health?
An Airborne Exposure Limit (as recommended by the Surgeon General's Working Group, U.S. Department of Health and Human Services) of 0.003 milligrams of Lewisite and Mustard-Lewisite per cubic meter of air (0.003 mg/m^3) has been established as a time-weighted average (TWA) for the workplace.

About Lewisite

What lewisite is

- Lewisite is a type of chemical warfare agent. This kind of agent is called a vesicant or blistering agent, because it causes blistering of the skin and mucous membranes on contact.
- Lewisite is an oily, colorless liquid in its pure form and can appear amber to black in its impure form.
- Lewisite has an odor like geraniums.
- Lewisite contains arsenic, a poisonous element.
- Lewisite is also known by its military designation, "L."

Where lewisite is found and how it is used

- Lewisite was produced in 1918 to be used in World War I, but its production was too late for it to be used in the war.
- Lewisite has been used only as a chemical warfare agent. It has no medical or other practical use.
- Lewisite is not found naturally in the environment.

How people can be exposed to lewisite

- People's risk for exposure depends on how close they are to the place where the lewisite was released.

- If lewisite gas is released into the air, people may be exposed through skin contact or eye contact. They may also be exposed by breathing air that contains lewisite.
- If lewisite liquid is released into water, people may be exposed by drinking water that contains lewisite or by getting the water on their bodies.
- If lewisite liquid comes into contact with food, people may be exposed by eating the contaminated food.
- People can be exposed by coming into direct contact with liquid lewisite.
- Lewisite vapor is heavier than air, so it will settle in low-lying areas.
- Lewisite remains a liquid under a wide range of environmental conditions, from below freezing to very hot temperatures. Therefore, it could last for a long time in the environment.

How lewisite works

- Adverse health effects caused by lewisite depend on the amount people are exposed to, the route of exposure, and the length of time that people are exposed.
- Lewisite is a powerful irritant and blistering agent that immediately damages the skin, eyes, and respiratory (breathing) tract.
- Because it contains arsenic, lewisite has some effects that are similar to arsenic poisoning, including stomach ailments and low blood pressure.

Immediate signs and symptoms of lewisite exposure

- Most information on the health effects of lewisite is based on animal studies.
- Signs and symptoms occur immediately following a lewisite exposure. Lewisite can have the following effects on specific parts of the body:
    - *Skin:* pain and irritation within seconds to minutes, redness within 15 to 30 minutes followed by blister formation within several hours. The blister begins as a small blister in the middle of the red areas and then expands to cover the entire reddened area of skin. The lesions (sores) from lewisite heal much faster than lesions caused by the other blistering agents, sulfur mustard and nitrogen mustards, and the discoloring of the skin that occurs later is much less noticeable.
    - *Eyes:* irritation, pain, swelling, and tearing may occur on contact.
    - *Respiratory tract:* runny nose, sneezing, hoarseness, bloody nose, sinus pain, shortness of breath, and cough
    - *Digestive tract:* diarrhea, nausea, and vomiting.
    - *Cardiovascular:* "Lewisite shock" or low blood pressure may occur
- Showing these signs and symptoms does not necessarily mean that a person has been exposed to lewisite.

What the long-term health effects may be

- Extensive skin burning, as seen with sulfur mustard, is less likely.
- Extensive breathing in of the vapors may cause chronic respiratory disease.
- Extensive eye exposure may cause permanent blindness.
- Unlike sulfur mustard, lewisite is not known to suppress the immune system.

How people can protect themselves and what they should do if they are exposed to lewisite

- Leave the area where the lewisite was released and get to fresh air. Quickly moving to an area where fresh air is available is highly effective in reducing the possibility of death from exposure to lewisite.
    - If the lewisite release was outdoors, move away from the area where the lewisite was released. Go to the highest ground possible, because lewisite is heavier than air and will sink to low-lying areas.
    - If the lewisite release was indoors, get out of the building.
- If you think you may have been exposed, remove your clothing, rapidly wash your entire body with soap and water, and get medical care as quickly as possible. Please See "*PERSONAL CLEANING AND DISPOSAL OF CONTAMINATED CLOTHING.*"

How lewisite exposure is treated

- Treatment consists of removing lewisite from the body as soon as possible and providing supportive medical care in a hospital setting. An antidote for lewisite is available and is most useful if given as soon as possible after exposure.

NITROGEN MUSTARDS: HN-1, HN-2, HN-3

What are nitrogen mustards?

Nitrogen mustards (HN-1, HN-2, HN-3) are colorless to yellow, oily liquids that evaporate very slowly. HN-1 has a faint, fishy or musty odor. HN-2 has a soapy odor at low concentrations and a fruity odor at higher concentrations. HN-3 may smell like butter almond.

Although nitrogen mustards could be used in chemical warfare, there are presently no records of such use. HN-1 has been used to remove warts in the past, and HN-2 has been used sparingly in chemotherapy.

What happens to nitrogen mustards when they enter the environment?

- Nitrogen mustards HN-1, HN-2, and HN-3 could enter the environment from an accidental release.
- When released to air, nitrogen mustards will be broken down by compounds that are found in the air, but they may persist in air for a few days before being broken down.
- Nitrogen mustards will be broken down in water quickly, and only small amounts may evaporate.
- Nitrogen mustards will be broken down in moist soil quickly, and only small amounts may evaporate.
- Nitrogen mustards do not accumulate in the food chain.

How might I be exposed to nitrogen mustards?

- The general population will not be exposed to nitrogen mustards.
- The nitrogen mustards HN-1, HN-2, and HN-3 are not manufactured in significant commercial quantities in the United States. Although several of the nitrogen mustards have medicinal uses and as chemical warfare agents, they were never stockpiled as part of the U.S. chemical warfare inventory.

How can nitrogen mustards affect my health?

If you breathe nitrogen mustard vapors, you will likely experience such effects as nasal and sinus pain or discomfort, pharyngitis, laryngitis, cough, and shortness of breath. Damage to cells lining

your airways may begin within hours and get worse over the next several days. Exposure to high levels could cause death.

Skin contact with nitrogen mustard vapors or liquid, will likely cause initial swelling and rash, followed by blistering. Contact with high levels of nitrogen mustards can result in second- and third-degree burns. If nitrogen mustards touch the eye, you may experience eye inflammation, pain, swelling, corneal damage, burns, and even blindness.

If you swallow nitrogen mustards, you will probably experience burning of the mouth, esophagus, and stomach.

When nitrogen mustards are absorbed by the body, they may cause damage to your immune system and bone marrow.
There is some evidence that nitrogen mustard treatment in humans may result in decreased fertility.

How likely are nitrogen mustards to cause cancer?
The International Agency for Research on Cancer (IARC) has classified nitrogen mustard HN-2 as probably carcinogenic to humans, based on evidence that it causes leukemia in humans and cancers of the lung, liver, uterus, and large intestine in animals.

How can nitrogen mustards affect children?
Children exposed to nitrogen mustards would probably experience the same effects seen in exposed adults. But we do not know whether children differ from adults in their susceptibility to nitrogen mustards.

A few case reports have linked treatment with HN-2 in pregnant mothers to changes in the unborn child. Nitrogen mustards have been shown to cause damage to the fetus in animals.

How can families reduce the risk of exposure to nitrogen mustards?
Families are not likely to be exposed to nitrogen mustards.

Is there a medical test to show whether I've been exposed to nitrogen mustards?
There are no specific tests to indicate whether you have been exposed to nitrogen mustards.

Has the federal government made recommendations to protect human health?
An Airborne Exposure Limit (as recommended by the Surgeon General's Working Group, U.S. Department of Health and Human Services) of 0.003 milligrams of HN-1 per cubic meter of air (0.003 mg/m^3) has been established as a time-weighted average (TWA) for the workplace.

SULPHUR MUSTARD (YPERITE) -MUSTARD GAS

What sulfur mustard is

Sulfur mustard is a type of chemical warfare agent. These kinds of agents are called vesicants or blistering agents, because they cause blistering of the skin and mucous membranes on contact.

Sulfur mustard is also known as "mustard gas or mustard agent," or by the military designations H, HD, and HT.

Sulfur mustard sometimes smells like garlic, onions, or mustard and sometimes has no odor. It can be a vapor (the gaseous form of a liquid), an oily-textured liquid, or a solid.

Sulfur mustard can be clear to yellow or brown when it is in liquid or solid form.

Where sulfur mustard is found and how it is used

Sulfur mustard is not found naturally in the environment.

Sulfur mustard was introduced in World War I as a chemical warfare agent. Until recently, it was available for use in the treatment of a skin condition called psoriasis. Currently, it has no medical use.

How people can be exposed to sulfur mustard

If sulfur mustard is released into the air as a vapor, people can be exposed through skin contact, eye contact, or breathing. Sulfur mustard vapor can be carried long distances by wind.

If sulfur mustard is released into water, people can be exposed by drinking the contaminated water or getting it on their skin.

People can be exposed by coming in contact with liquid sulfur mustard.

Sulfur mustard can last from 1 to 2 days in the environment under average weather conditions and from weeks to months under very cold conditions.

Sulfur mustard breaks down slowly in the body, so repeated exposure may have a cumulative effect (that is, it can build up in the body).

How sulfur mustard works

Adverse health effects caused by sulfur mustard depend on the amount people are exposed to, the route of exposure, and the length of time that people are exposed.

Sulfur mustard is a powerful irritant and blistering agent that damages the skin, eyes, and respiratory (breathing) tract.

It damages DNA, a vital component of cells in the body.

Sulfur mustard vapor is heavier than air, so it will settle in low-lying areas.

Immediate signs and symptoms of sulfur mustard exposure

Exposure to sulfur mustard is usually not fatal. When sulfur mustard was used during World War I, it killed fewer than 5% of the people who were exposed and got medical care.

People may not know right away that they have been exposed, because sulfur mustard often has no smell or has a smell that might not cause alarm.

Typically, signs and symptoms do not occur immediately. Depending on the severity of the exposure, symptoms may not occur for 2 to 24 hours. Some people are more sensitive to sulfur mustard than are other people, and may have symptoms sooner.

Sulfur mustard can have the following effects on specific parts of the body:

Skin: redness and itching of the skin may occur 2 to 48 hours after exposure and change eventually to yellow blistering of the skin.

Eyes: irritation, pain, swelling, and tearing may occur within 3 to12 hours of a mild to moderate exposure. A severe exposure may cause symptoms within 1 to 2 hours and may include the symptoms of a mild or moderate exposure plus light sensitivity, severe pain, or blindness (lasting up to 10 days).

Respiratory tract: runny nose, sneezing, hoarseness, bloody nose, sinus pain, shortness of breath, and cough within 12 to 24 hours of a mild exposure and within 2 to 4 hours of a severe exposure.

Digestive tract: abdominal pain, diarrhea, fever, nausea, and vomiting.

Showing these signs and symptoms does not necessarily mean that a person has been exposed to sulfur mustard.

What the long-term health effects may be

Exposure to sulfur mustard liquid is more likely to produce second- and third- degree burns and later scarring than is exposure to sulfur mustard vapor. Extensive skin burning can be fatal.

Extensive breathing in of the vapors can cause chronic respiratory disease, repeated respiratory infections, or death.

Extensive eye exposure can cause permanent blindness.

Exposure to sulfur mustard may increase a person's risk for lung and respiratory cancer.

How people can protect themselves and what they should do if they are exposed to sulfur mustard

Because no antidote exists for sulfur mustard exposure, the best thing to do is avoid it. Immediately leave the area where the sulfur mustard was released. Try to find higher ground, because sulfur mustard is heavier than air and will settle in low-lying areas.

If avoiding sulfur mustard exposure is not possible, rapidly remove the sulfur mustard from the body. Getting the sulfur mustard off as soon as possible after exposure is the only effective way to prevent or decrease tissue damage to the body.

Quickly remove any clothing that has liquid sulfur mustard on it. If possible, seal the clothing in a plastic bag, and then seal that bag inside a second plastic bag.

Immediately wash any exposed part of the body (eyes, skin, etc.) thoroughly with plain, clean water. Eyes need to be flushed with water for 5 to 10 minutes. Do NOT cover eyes with bandages, but do protect them with dark glasses or goggles.

If someone has ingested sulfur mustard, do NOT induce vomiting. Give the person milk to drink.

Seek medical attention right away. Dial 911 and explain what has happened.

How sulfur mustard exposure is treated

The most important factor is removing sulfur mustard from the body. Exposure to sulfur mustard is treated by giving the victim supportive medical care to minimize the effects of the exposure. Though no antidote exists for sulfur mustard, exposure is usually not fatal.

PHOSGENE OXIME (CX)

What is phosgene oxime?

Phosgene oxime is a manufactured chemical that was developed as a potential chemical warfare agent, but its use on the battlefield has never been documented. It has a disagreeable penetrating odor. Pure phosgene oxime is a colorless, crystalline solid; the munitions grade compound is a yellowish-brown liquid. Both the liquid and the solid can give off vapors at ambient temperatures.

What happens to phosgene oxime when it enters the environment?

- When released to air, phosgene oxime will exist solely in the gas-phase. Phosgene oxime vapors are broken down in the atmosphere by reacting with substances commonly found in the air, but this is a very slow process. Phosgene oxime in the air may also react with moisture in clouds or rain and be broken down into other compounds.

- Phosgene oxime will react with water or be broken down into other products by bacteria. Some of the phosgene oxime that is not broken down may evaporate into air.
- Phosgene oxime will not stick to the soil. Small amounts may evaporate into air or travel below the soil surface and contaminate groundwater. Most of the phosgene oxime in soil will be broken down upon contact with moisture or be degraded by bacteria.
- Phosgene oxime does not accumulate in the food chain.

How might I be exposed to phosgene oxime?

- It is not likely that you would be exposed to phosgene oxime; it has never been known to have been used in chemical warfare.

How can phosgene oxime affect my health?

Breathing phosgene oxime vapors can cause severe bronchitis and accumulation of fluid in the lungs. Skin contact with phosgene oxime will cause swelling and itching hives that can also result in immediate and painful skin damage. Eye contact may result in severe pain and conjunctivitis. Phosgene oxime is absorbed through the skin and eye; this can also result in pulmonary edema. Inhaling or directly contacting significant amounts of phosgene oxime can result in death.

We do not know what happens if you swallow phosgene oxime liquid or solid. However, animal studies indicate that if you did, you might suffer swelling and bleeding of the gastrointestinal tract.

The effects of long-term exposure to phosgene oxime in humans are not known.
We do not know if exposure to phosgene oxime might cause reproductive effects in humans.

How likely is phosgene oxime to cause cancer?

The Department of Health and Human Services (DHHS), the International Agency for Research on Cancer (IARC), and the EPA have not classified phosgene oxime for carcinogenicity. There is no information to determine whether exposure to phosgene oxime might cause cancer.

How does phosgene oxime affect children?

There are no studies on the health effects of children exposed to phosgene oxime. It is likely that the health effects seen in children exposed to phosgene oxime would be similar to the effects seen in adults. We do not know whether children differ from adults in their susceptibility to phosgene oxime.

We do not know if exposure to phosgene oxime would result in birth defects or other developmental effects in people and no information exist from animal studies.

How can families reduce the risk of exposure to phosgene oxime?

Most families will not be exposed to phosgene oxime.

Is there a medical test to show whether I've been exposed to phosgene oxime?

There are no tests to positively determine whether you have been exposed to phosgene oxime. If you suspect that you may have been exposed to phosgene oxime, a chest X-ray may be the quickest way to determine if your lungs have been damaged. This can be done in a hospital, clinic, or doctor's office that has an X-ray machine.

Has the federal government made recommendations to protect human health?
No standards or recommendations are available for phosgene oxime.

CHOKING/LUNG/PULMONARY AGENTS

PHOSGENE (CG)

What is phosgene?
Phosgene is a colorless nonflammable gas that has the odor of freshly cut hay. It is a manufactured chemical, but small amounts occur naturally from the break down of chlorinated compounds.

Phosgene is used in the manufacture of other chemicals such as dyestuffs, isocyanates, polycarbonates and acid chlorides; it is also used in the manufacture of pesticides and pharmaceuticals. Phosgene can also be used to separate ores.

Phosgene is a gas at room temperature, but is sometimes stored as a liquid under pressure or refrigeration.

What happens to phosgene when it enters the environment?

- When released to air, phosgene will exist solely as a gas. Phosgene gas is degraded in the atmosphere by reacting with substances commonly found in the air, but this is a very slow process. Phosgene in the air may also react with moisture in clouds or rain and be broken down into other compounds.
- Phosgene will react with water and be broken down into other products. Some of the phosgene that is not broken down may evaporate into air.
- When released to soil, phosgene will not stick to the soil. Small amounts may evaporate into air or pass through the soil surface and contaminate groundwater. Most of the phosgene in soil will be broken down when it comes into contact with moisture.
- Phosgene does not accumulate in the food chain.

How might I be exposed to phosgene?

- The general population may be exposed to very low levels of phosgene by breathing in air.
- Phosgene is released during the welding of metals that have been cleaned up with chlorinated solvents, so welders may be exposed to this compound.
- Phosgene is used to produce a variety of other compounds like dyes and pesticides, so workers employed in these fields may be exposed to this compound.

How can phosgene affect my health?
Phosgene can be harmful if you breathe it. Exposure to low levels can cause eye and throat irritation making you to cough or wheeze. Higher levels of phosgene gas can cause your lungs to swell, making it difficult to breathe. This can happen quickly or might not be noticed until the next day. Even higher levels can result in severe damage to your lungs that might lead to death.

Available studies of workers exposed for long periods of time to low levels of phosgene gas have not shown increased chances of developing lung problems.

If you get phosgene gas or liquid on your skin or in your eyes, you may develop chemical burns. Phosgene liquid may also cause frostbite. However, you are not likely to come into contact with liquid phosgene. In the unlikely case that you swallow phosgene liquid, your mouth, throat, esophagus, and stomach could be damaged.

No information is available regarding the potential of phosgene to cause reproductive effects.

How likely is phosgene to cause cancer?
The Department of Health and Human Services (DHHS), the International Agency for Research on Cancer (IARC), and the EPA have not classified phosgene as to its carcinogenicity. There is no information to determine whether exposure to phosgene might cause cancer.

How does phosgene affect children?
There are no studies on the health effects of children exposed to phosgene. It is likely that the health effects seen in children exposed to phosgene will be similar to the effects seen in adults. We do not know whether children differ from adults in their susceptibility to phosgene.
We do not know if exposure to phosgene will result in birth defects or other developmental effects in humans.

How can families reduce the risk of exposure to phosgene?
Most families will not be exposed to significant levels of phosgene. However, the burning of materials such as certain plastics that contain chlorinated hydrocarbons can produce phosgene gas. You should stay away from fires or other heat sources where such materials may be present.

Is there a medical test to show whether I've been exposed to phosgene?
There are no tests to positively determine whether you have been exposed to phosgene. If you suspect that you may have been exposed to phosgene, a chest X-ray may be the quickest way to determine if your lungs have been damaged. This can be done in a hospital, clinic, or doctor's office that has an X-ray machine.

Has the federal government made recommendations to protect human health?
The Occupational Safety and Health Administration (OSHA) sets a limit of 0.1 part of phosgene in a million parts of air (0.1 ppm) in the workplace for an 8-hour work shift, 40-hour work week.

CHLORINE (CL)

Facts about Chlorine

What chlorine is

- Chlorine is an element used in industry and found in some household products.
- Chlorine is sometimes in the form of a poisonous gas. Chlorine gas can be pressurized and cooled to change it into a liquid so that it can be shipped and stored. When liquid chlorine is released, it quickly turns into a gas that stays close to the ground and spreads rapidly.
- Chlorine gas can be recognized by its pungent, irritating odor, which is like the odor of bleach. The strong smell may provide an adequate warning to people that they have been exposed.
- Chlorine gas appears to be yellow-green in color.

- Chlorine itself is not flammable, but it can react explosively or form explosive compounds with other chemicals such as turpentine and ammonia.
-

Where chlorine is found and how it is used

- Chlorine was used during World War I as a choking (pulmonary) agent.
- Chlorine is one of the most commonly manufactured chemicals in the United States. Its most important use is as a bleach in the manufacture of paper and cloth, but it is also used to make pesticides (insect killers), rubber, and solvents.
- Chlorine is used in drinking water and swimming pool water to kill harmful bacteria. It is also as used as part of the sanitation process for industrial waste and sewage.
- Household chlorine bleach can release chlorine gas if it is mixed with other cleaning agents.

How people can be exposed to chlorine

- People's risk for exposure depends on how close they are to the place where the chlorine was released.
- If chlorine gas is released into the air, people may be exposed through skin contact or eye contact. They may also be exposed by breathing air that contains chlorine.
- If chlorine liquid is released into water, people may be exposed by touching or drinking water that contains chlorine.
- If chlorine liquid comes into contact with food, people may be exposed by eating the contaminated food.
- Chlorine gas is heavier than air, so it would settle in low-lying areas.

How chlorine works

- The extent of poisoning caused by chlorine depends on the amount of chlorine a person is exposed to, how the person was exposed, and the length of time of the exposure.
- When chlorine gas comes into contact with moist tissues such as the eyes, throat, and lungs, an acid is produced that can damage these tissues.

Immediate signs and symptoms of chlorine exposure

- During or immediately after exposure to dangerous concentrations of chlorine, the following signs and symptoms may develop:
    - Coughing
    - Chest tightness
    - Burning sensation in the nose, throat, and eyes
    - Watery eyes
    - Blurred vision
    - Nausea and vomiting
    - Burning pain, redness, and blisters on the skin if exposed to gas, skin injury similar to frostbite if exposed to liquid chlorine
    - Difficulty breathing or shortness of breath (may appear immediately if high concentrations of chlorine gas are inhaled, or may be delayed if low concentrations of chlorine gas are inhaled)
    - Fluid in the lungs (pulmonary edema) within 2 to 4 hours
- Showing these signs or symptoms does not necessarily mean that a person has been exposed to chlorine.

What the long-term health effects are

- Long-term complications from chlorine exposure are not found in people who survive a sudden exposure unless they suffer complications such as pneumonia during therapy. Chronic bronchitis may develop in people who develop pneumonia during therapy.

How people can protect themselves, and what they should do if they are exposed to chlorine

- Leave the area where the chlorine was released and get to fresh air. Quickly moving to an area where fresh air is available is highly effective in reducing exposure to chlorine.
    - If the chlorine release was outdoors, move away from the area where the chlorine was released. Go to the highest ground possible, because chlorine is heavier than air and will sink to low-lying areas.
    - If the chlorine release was indoors, get out of the building.
- If you think you may have been exposed, remove your clothing, rapidly wash your entire body with soap and water, and get medical care as quickly as possible. Please See *"PERSONAL CLEANING AND DISPOSAL OF CONTAMINATED CLOTHING."*

How chlorine exposure is treated

No antidote exists for chlorine exposure. Treatment consists of removing the chlorine from the body as soon as possible and providing supportive medical care in a hospital setting.

PHOSPHINE

What is phosphine?

Phosphine is a colorless, flammable, and explosive gas at ambient temperature that has the odor of garlic or decaying fish. Small amounts occur naturally from the break down of organic matter. It is slightly soluble in water. Phosphine is used in semiconductor and plastics industries, in the production of a flame retardant, and as a pesticide in stored grain.

What happens to phosphine when it enters the environment?

- In the air, phosphine will exist solely as a gas. Phosphine gas reacts with substances commonly found in the air. Half of the phosphine in the air degrades in about 1 day. At high concentrations, phosphine vapors may spontaneously combust in air.
- Phosphine is expected to react with water and be broken down into other products. Some of the phosphine that is not broken down may evaporate into air.
- When released to soil, phosphine is broken down very quickly.
- Phosphine does not accumulate in the food chain.

How might I be exposed to phosphine?

- Phosphine breaks down rapidly in the environment so the general population may only be exposed to small amounts of this compound by inhaling air, drinking water and eating foods.
- Since phosphine is used to kill insects and rodents in stored grain and tobacco, workers who use this product may be exposed to it. People who live near where it is being used may also breathe in small amounts of it.

How can phosphine affect my health?

Inhalation is the most likely route of exposure to phosphine. Early symptoms of acute phosphine intoxication include pain in the diaphragm, nausea, vomiting, excitement, and a phosphorus smell on the breath. Higher levels can cause weakness, bronchitis, pulmonary edema, shortness of

breath, convulsions, and death. Some effects, such as pulmonary edema, convulsions, and liver injury, may appear or continue to be present days after an exposure.

Long-term exposure to very low levels of phosphine can result in anemia, bronchitis, gastrointestinal effects, and visual, speech and motor problems.

Liquid phosphine on your skin can cause frostbite. Ingestion of metal phosphides results in release of phosphine in your stomach which can cause nausea, vomiting, abdominal pain, and diarrhea.

No information is available regarding reproductive effects in humans exposed to phosphine gas. Phosphine has not been shown to cause reproductive effects in laboratory animals.

How likely is phosphine to cause cancer?
The EPA has determined that phosphine is not classifiable as to its human carcinogenicity.

How does phosphine affect children?
Children appear to be affected by exposure to phosphine in the same ways as adults. Accidental exposure of children has resulted in vomiting, headache, fatigue, and damage to the heart. In a fatal case, a 2-year-old child died with congestive heart failure, pulmonary edema, congestion on the membranes that surround the lungs, enlarged spleen, and aspiration of the gastrointestinal contents. It is not known if exposure to phosphine will result in birth defects or other developmental effects in people.

How can families reduce the risk of exposure to phosphine?
Most families will not be exposed to significant levels of phosphine. However, consumption of food contaminated with metal phosphide pesticide can produce phosphine intoxication when the solid phosphide contacts acid in the stomach. Phosphine and metal phosphides are used to kill rats in areas used for grain storage, but should not be used in family dwellings.

Always store pesticides in safe containers, in a safe place out of the reach of children.

Is there a medical test to show whether I've been exposed to phosphine?
There are no specific blood or urine tests for phosphine itself. Breakdown products of phosphine can be measured in urine. If a severe exposure has occurred, blood and urine analyses and other tests may show whether the lungs and heart have been damaged. These tests would most likely be performed in a hospital following severe exposure to phosphine.

Has the federal government made recommendations to protect human health?
The Occupational Safety and Health Administration (OSHA) sets a limit of 0.3 parts of phosphine per million parts of workroom air (0.3 ppm) for an 8-hour work shift, 40 hour work week.

WHITE PHOSPHORUS

What is white phosphorus?

White phosphorus is a colorless, white, or yellow waxy solid with a garlic-like odor. It does not occur naturally, but is manufactured from phosphate rocks.

White phosphorus reacts rapidly with oxygen, easily catching fire at temperatures 10 to 15 degrees above room temperature.

White phosphorus is used by the military in various types of ammunition, and to produce smoke for concealing troop movements and identifying targets.

It is also used by industry to produce phosphoric acid and other chemicals for use in fertilizers, food additives, and cleaning compounds. Small amounts of white phosphorus were used in the past in pesticides and fireworks.

What happens to white phosphorus when it enters the environment?

- White phosphorus can enter the environment when it is made, used in manufacturing or by the military, or accidentally spilled during transport and storage.
- It can be found in the water and bottom sediment of rivers and lakes near facilities that make or use it.
- In the air, white phosphorus reacts rapidly with oxygen to produce relatively harmless chemicals within minutes.
- In water, white phosphorus reacts with oxygen within hours or days.
- In water with low oxygen, white phosphorus may degrade to a highly toxic compound called phosphine, which eventually evaporates to the air and is changed to less harmful chemicals.
- White phosphorus can build up slightly in the bodies of fish that live in contaminated lakes or streams.
- In soil, white phosphorus may stick to particles and be changed within a few days to less harmful compounds.
- In deep soil or sediments with little oxygen, white phosphorus may remain unchanged for many years.

How might I be exposed to white phosphorus?

- Breathing contaminated air near a facility that is using white phosphorus.
- Eating contaminated fish or game birds from sites containing white phosphorus.
- Drinking or swimming in water that has been contaminated with white phosphorus.
- Touching soil contaminated with white phosphorus.
- If you work in industries that use or manufacture white phosphorus or munitions containing white phosphorus.

How can white phosphorus affect my health?

Little information is available about the health effects that may be caused by white phosphorus. Most of what is known about the effects of breathing white phosphorus is from studies of workers. Most of what is known about the effects of eating white phosphorus is from reports of people eating rat poison or fireworks that contained it.

Breathing white phosphorus for short periods may cause coughing and irritation of the throat and lungs. Breathing white phosphorus for long periods may cause a condition known as "phossy jaw" which involves poor wound healing of the mouth and breakdown of the jaw bone.

Eating or drinking small amounts of white phosphorus may cause liver, heart, or kidney damage, vomiting, stomach cramps, drowsiness, or death. We do not know what the effects are from eating or drinking very small amounts of white phosphorus-containing substances over long periods of time. Skin contact with burning white phosphorus may burn skin or cause liver, heart, and kidney damage.

We do not know whether or not white phosphorus can affect the ability to have children or cause birth defects in people.

How likely is white phosphorus to cause cancer?
The EPA has determined that white phosphorus is not classifiable as to its carcinogenicity in humans. There are no studies available in people or animals that suggest white phosphorus causes cancer.

Is there a medical test to show whether I've been exposed to white phosphorus?
There is no medical test that shows if you have been exposed to white phosphorus. However, the above health effects may lead your doctor to suspect that you have been exposed if you have a history of exposure.
Has the federal government made recommendations to protect human health?
The EPA has listed white phosphorus as a Hazardous Air Pollutant. The EPA requires that spills or accidental releases into the environment of 1 pound or more of white phosphorus be reported to the EPA.

The National Institute for Occupational Safety and Health (NIOSH), the Occupational Safety and Health Administration (OSHA), and the American Conference of Governmental Industrial Hygienists (ACGIH) have all set the inhalation exposure limit for white phosphorus in the workplace during an 8-hour workday at 0.1 milligram of white phosphorus per cubic meter of air (0.1 mg/m^3).

BIOTOXINS

ABRIN

What abrin is

- Abrin is a natural poison that is found in the seeds of a plant called the rosary pea or jequirity pea. These seeds are red with a black spot covering one end.
- Abrin is similar to ricin, a toxin that is also found in the seeds of a plant (the castor bean plant). However, abrin is much more poisonous than ricin.
- Abrin can be made in the form of a powder, a mist, or a pellet, or it can be dissolved in water.
- Powdered abrin is yellowish-white in color.

- Abrin is a stable substance, meaning that it can last for a long time in the environment despite extreme conditions such as very hot or very cold temperatures.

Where abrin is found and how it is used

- Abrin is not known to have been used in any wars or terrorist attacks.
- The rosary pea, which is the source of abrin, is common to many tropical areas throughout the world and is sometimes used as an herbal remedy.
- The seeds of the rosary pea have been used to make beaded jewelry, which can lead to abrin poisoning if the seeds are swallowed.
- Abrin has some potential medical uses, such as in treatment to kill cancer cells.

How you could be exposed to abrin

- It would take a deliberate act to obtain abrin from rosary pea seeds and use it to poison people. Accidental exposure to abrin is not likely.
- You could inhale (breathe in) abrin if it is in the form of a mist or a powder.
- You could be exposed if you touch surfaces on which abrin particles or droplets have landed, or if particles or droplets of abrin land on your skin or in your eyes.
- You could ingest (swallow) abrin if it is in food or water.
- Pellets of abrin, or abrin dissolved in a liquid, could be injected into a person's body.
- Abrin poisoning is not contagious. It cannot be spread from person to person through casual contact.

How abrin works

- Abrin works by getting inside the cells of a person's body and preventing the cells from making the proteins they need. Without the proteins, cells die. Eventually this is harmful to the whole body, and death may occur.
- Effects of abrin poisoning depend on whether abrin was inhaled, ingested, or injected.

Signs and symptoms of abrin exposure

- The major symptoms of abrin poisoning depend on the route of exposure and the dose received, though many organs may be affected in severe cases.

- Initial symptoms of abrin poisoning by inhalation may occur within 8 hours of exposure. Following ingestion of abrin, initial symptoms may occur in less than 6 hours but usually are delayed for 1 to 3 days.

- **Inhalation:** Within a few hours of inhaling significant amounts of abrin, the likely symptoms would be respiratory distress (difficulty breathing), fever, cough, nausea, and tightness in the chest. Heavy sweating may follow as well as fluid building up in the lungs (pulmonary edema). This would make breathing even more difficult, and the skin might turn blue. Excess fluid in the lungs would be diagnosed by x-ray or by listening to the chest with a stethoscope. Finally, low blood pressure and respiratory failure may occur, leading to death.

- **Ingestion:** If someone swallows a significant amount of abrin, he or she would develop vomiting and diarrhea that may become bloody. Severe dehydration may be the result, followed by low blood pressure. Other signs or symptoms may include hallucinations, seizures, and blood in the urine. Within several days, the person's liver, spleen, and kidneys might stop working, and the person could die.

- Skin and eye exposure: Abrin in the powder or mist form can cause redness and pain of the skin and the eyes.

- Death from abrin poisoning could take place within 36 to 72 hours of exposure, depending on the route of exposure (inhalation, ingestion, or injection) and the dose received. If death has not occurred in 3 to 5 days, the victim usually recovers.

- Showing these signs and symptoms does not necessarily mean that a person has been exposed to abrin.

How abrin poisoning is treated

Because no antidote exists for abrin, the most important factor is avoiding abrin exposure in the first place. If exposure cannot be avoided, the most important factor is then getting the abrin off or out of the body as quickly as possible. Abrin poisoning is treated by giving victims supportive medical care to minimize the effects of the poisoning. The types of supportive medical care would depend on several factors, such as the route by which victims were poisoned (that is, whether poisoning was by inhalation, ingestion, or skin or eye exposure). Care could include such measures as helping victims breathe, giving them intravenous fluids (fluids given through a needle inserted into a vein), giving them medications to treat conditions such as seizure and low blood pressure, flushing their stomachs with activated charcoal (if the abrin has been very recently ingested), or washing out their eyes with water if their eyes are irritated.

How you can know whether you have been exposed to abrin

- If there is a suspicion that people have inhaled abrin, a potential clue would be that a large number of people who had been close to each other suddenly developed fever, cough, and excess fluid in their lungs. These symptoms could be followed by severe breathing problems and possibly death.

- No widely available, reliable test exists to confirm that a person has been exposed to abrin.

How you can protect yourself, and what to do if you are exposed to abrin

- First, get fresh air by leaving the area where the abrin was released. Moving to an area with fresh air is a good way to reduce the possibility of death from exposure to abrin.
    - If the abrin release was outside, move away from the area where the abrin was released.
    - If the abrin release was indoors, get out of the building.
- If you are near a release of abrin, emergency coordinators may tell you to either evacuate the area or to "shelter in place" inside a building to avoid being exposed to the chemical. For more information on evacuation during a chemical emergency, see " *EVACUATION.*" For more information on sheltering in place during a chemical emergency, see "*SHELTERING IN PLACE DURING A CHEMICAL DISASTER OR ATTACK.*"

If you think you may have been exposed to abrin, you should take the following steps and precautions: Please See "*PERSONAL CLEANING AND DISPOSAL OF CONTAMINATED CLOTHING.*"

RICIN

What Is Ricin?

Ricin is a poison that can be made from the waste left over from processing castor beans.

It can be in the form of a powder, a mist, or a pellet, or it can be dissolved in water or weak acid.

It is a stable substance. For example, it is not affected much by extreme conditions such as very hot or very cold temperatures.

Where Is Ricin Found, and How Is It Used?

Castor beans are processed throughout the world to make castor oil. Ricin is part of the waste "mash" produced when castor oil is made. Amateurs can make ricin from castor beans.

Ricin has some potential medical uses, such as bone marrow transplants and cancer treatment (to kill cancer cells).

How Can People Be Exposed to Ricin?

It would take a deliberate act to make ricin and use it to poison people. Accidental exposure to ricin is highly unlikely.

People can breathe in ricin mist or powder and be poisoned.

Ricin can also get into water or food and then be swallowed.

Pellets of ricin, or ricin dissolved in a liquid, can be injected into people's bodies.

Depending on the route of exposure (such as injection), as little as 500 micrograms of ricin could be enough to kill an adult. A 500-microgram dose of ricin would be about the size of the

head of a pin. A much greater amount would be needed to kill people if the ricin were inhaled (breathed in) or swallowed.

Ricin poisoning is not contagious. It cannot be spread from person to person through casual contact.

In 1978, Georgi Markov, a Bulgarian writer and journalist who was living in London, died after he was attacked by a man with an umbrella. The umbrella had been rigged to inject a poison ricin pellet under Markov's skin.

Some reports have indicated that ricin may have been used in the Iran-Iraq war during the 1980s and that quantities of ricin were found in Al Qaeda caves in Afghanistan.

How Does Ricin Work?

Ricin works by getting inside the cells of a person's body and preventing the cells from making the proteins they need. Without the proteins, cells die, and eventually the whole body can shut down and die.

Specific effects of ricin poisoning depend on whether ricin was inhaled, swallowed, or injected.

What Are the Signs and Symptoms of Ricin Exposure?

Inhalation: Within a few hours of inhaling significant amounts of ricin, the likely symptoms would be coughing, tightness in the chest, difficulty breathing, nausea, and aching muscles. Within the next few hours, the body's airways (such as lungs) would become severely inflamed (swollen and hot), excess fluid would build up in the lungs, breathing would become even more difficult, and the skin might turn blue. Excess fluid in the lungs would be diagnosed by x-ray or by listening to the chest with a stethoscope.

Ingestion: If someone swallows a significant amount of ricin, he or she would have internal bleeding of the stomach and intestines that would lead to vomiting and bloody diarrhea. Eventually, the person's liver, spleen, and kidneys might stop working, and the person could die.

Injection: Injection of a lethal amount of ricin at first would cause the muscles and lymph nodes near the injection site to die. Eventually, the liver, kidneys, and spleen would stop working, and the person would have massive bleeding from the stomach and intestines. The person would die from multiple organ failure.

Death from ricin poisoning could take place within 36 to 48 hours of exposure, whether by injection, ingestion, or inhalation. If the person lives longer than 5 days without complications, he or she will probably not die.

Showing these signs and symptoms does not necessarily mean that a person has been exposed to ricin.

How Is Ricin Poisoning Treated?

No antidote exists for ricin. Ricin poisoning is treated by giving the victim supportive medical care to minimize the effects of the poisoning. The types of supportive medical care would depend on several factors, such as the route by which the victim was poisoned (that is, by inhalation, ingestion, or injection). Care could include such measures as helping the victim breathe and giving him or her intravenous fluids and medications to treat swelling.

How Do We Know for Sure Whether People Have Been Exposed to Ricin?

If we suspect that people have inhaled ricin, a possible clue would be that a large number of people who had been close to each other suddenly developed fever, cough, and excess fluid in their lungs. These symptoms could be followed by severe breathing problems and possibly death.

No widely available, reliable test exists to confirm that a person has been exposed to ricin.

What Can People Do If They Think They May Have Been Exposed to Ricin?
Unintentional ricin poisoning is highly unlikely. CDC has no reports of intentional ricin poisoning. If people think they might have been exposed to ricin, however, they should contact the regional poison control center at 1-800-222-1222.

STRYCHNINE

What strychnine is

- Strychnine is a white, odorless, bitter crystalline powder that can be taken by mouth, inhaled (breathed in), or mixed in a solution and given intravenously (injected directly into a vein).

- Strychnine is a strong poison; only a small amount is needed to produce severe effects in people. Strychnine poisoning can cause extremely serious adverse health effects, including death.

Where strychnine is found and how it is used

- The primary natural source of strychnine is the plant Strychnos nux vomica. This plant is found in southern Asia (India, Sri Lanka, and East Indies) and Australia.

- In the past, strychnine was available in a pill form and was used to treat many human ailments.

- Today, strychnine is used primarily as a pesticide, particularly to kill rats.

- Uncommonly, strychnine is found mixed with "street" drugs such as LSD, heroin, and cocaine.

How you could be exposed to strychnine

- Following release of strychnine into water, you could be exposed by drinking contaminated water.

- Following contamination of food with strychnine, you could be exposed by eating the contaminated food.

- It is also possible to absorb strychnine through the membranes in the nose, eyes, or mouth. For example, a person could be poisoned by inhaling strychnine powder that has been released in the air.

- Strychnine could be smoked or snorted as a component of street drugs.

- Poisoning has been reported from strychnine given intravenously and through the nose.

How strychnine works

- The extent of poisoning caused by strychnine depends on the amount and route of strychnine exposure and the person's condition of health at the time of the exposure.

- Strychnine prevents the proper operation of the chemical that controls nerve signals to the muscles. The chemical controlling nerve signals works like the body's "off switch" for muscles. When this "off switch" does not work correctly, muscles throughout the body have severe, painful spasms. Even though the person's consciousness or thinking are not affected at first (except that the person is very excitable and in pain), eventually the muscles tire and the person can't breathe.

Immediate signs and symptoms of strychnine exposure

- Following the ingestion (swallowing) of strychnine, symptoms of poisoning usually appear within 15 to 60 minutes.

- People exposed to low or moderate doses of strychnine by any route will have the following signs or symptoms:
    - Agitation
    - Apprehension or fear
    - Ability to be easily startled
    - Restlessness
    - Painful muscle spasms possibly leading to fever and to kidney and liver injury
    - Uncontrollable arching of the neck and back
    - Rigid arms and legs
    - Jaw tightness
    - Muscle pain and soreness
    - Difficulty breathing
    - Dark urine
    - Initial consciousness and awareness of symptoms

- People exposed to high doses of strychnine may have the following signs and symptoms within the first 15 to 30 minutes of exposure:
    - Respiratory failure (inability to breathe), possibly leading to death

- Brain death

- Showing these signs and symptoms does not necessarily mean that a person has been exposed to strychnine.

What the long-term health effects are

If the person survives the toxic effects of strychnine poisoning, long-term health effects are unlikely. However, long-term effects may result from damage caused by the poisoning (for example, brain damage from low oxygen, kidney failure). People severely affected by strychnine poisoning are not likely to survive.

How you can protect yourself, and what you should do if you are exposed to strychnine

- Since ingestion is likely to be the primary route of exposure, if poisoning is suspected, avoid any further ingestion and call 911 immediately.

- Recovery from strychnine exposure is possible with early hospital treatment. Therefore, the best thing to do is get medical care as quickly as possible.

- Do not induce vomiting or give fluids to drink.

- If you think strychnine may have been released into the air, the best thing to do is avoid it. If the strychnine release was indoors, get out of the building. If the release was outdoors, move away from the area of the release, stay upwind if possible, and seek higher ground. Quickly moving to an area where fresh air is available is highly effective in reducing the possibility of death from exposure to a chemical that has been released into the air.

- If you are near a release of strychnine, emergency coordinators may tell you to either evacuate the area or "shelter in place" inside a building to avoid being exposed to the chemical. . For more information on evacuation during a chemical emergency, see " *EVACUATION.*" For more information on sheltering in place during a chemical emergency, see "*SHELTERING IN PLACE DURING A CHEMICAL DISASTER OR ATTACK.*"

- Please See "*PERSONAL CLEANING AND DISPOSAL OF CONTAMINATED CLOTHING.*"

How strychnine exposure is treated

Treatment consists of removing the drug from the body (decontamination) and getting supportive medical care in a hospital setting. Supportive care includes intravenous fluids (fluids injected directly into a vein), medications for convulsions and spasms, and cooling measures for high temperature.

BLOOD AGENTS

ARSINE

About Arsine

What arsine is

- Arsine is a colorless, nonirritating toxic gas with a mild garlic odor. The odor can be detected only at levels greater than those necessary to cause poisoning.
- Arsine is formed when arsenic comes in contact with an acid.
- Arsine is similar to a gas called stibine, which is formed when the metal antimony comes in contact with an acid. Stibine has health effects similar to those of arsine, but it is not as widely available, and it has a much more noticeable odor (like rotten eggs).

Where arsine is found and how it is used

- Although arsine was investigated as a warfare agent during WWII, it was never used on the battlefield.
- Arsine is most commonly used in the semiconductor and metals refining industries.

How you could be exposed to arsine

- Most common reports of exposure to arsine have been after accidental formation of arsine in the workplace.
- Inhalation (breathing in the gas) is the most likely route of exposure after arsine is released into the air.
- Absorption into the body through the eyes and the skin has not been known to occur.
- Arsine vapor is heavier than air, so it would be more likely to settle in low-lying areas.

How arsine works

- The extent of poisoning caused by arsine depends on the amount of arsine to which a person has been exposed and on the length of time of the exposure.
- Depending on the intensity of exposure to arsine, symptoms may occur 2 to 24 hours after exposure. However, exposure to high doses of arsine can be immediately fatal.
- After arsine enters the bloodstream, it damages the red blood cells and leads to symptoms as a direct result of this damage.

Signs and symptoms of arsine exposure

At lower doses, people may not know they have been exposed to arsine, because it has no odor. At higher doses, a mild garlic odor has been reported. Stibine, on the other hand, has a strong odor, so people will probably be aware that they may have been exposed to something. People exposed to a low or moderate dose of arsine by inhalation may experience some or all of the following symptoms within 2 to 24 hours of exposure:

- Weakness
- Fatigue
- Headache
- Drowsiness
- Confusion
- Shortness of breath
- Rapid breathing
- Nausea, vomiting, and/or abdominal pain
- Red or dark urine

- Yellow skin and eyes (jaundice)
- Muscle cramps

Exposure to a large dose of arsine by any route may result in these additional health effects:

- Loss of consciousness
- Convulsions
- Paralysis
- Respiratory failure, possibly leading to death
- Showing these signs and symptoms does not necessarily mean that a person has been exposed to arsine.

Long-term health effects of arsine exposure

Severely exposed people are not likely to survive. If people survive the initial exposure, long-term effects may include kidney damage, numbness and pain in the extremities, and neuropsychological symptoms such as memory loss, confusion, and irritability.

How you can protect yourself, and what to do if you are exposed to arsine

- Because no antidote exists for arsine exposure, the best thing to do is avoid it. First, get fresh air by leaving the area where the arsine was released. Moving to an area with fresh air is a good way to reduce the possibility of death from exposure to arsine.
    - If the arsine release was outside, move away from the area where the arsine was released.
    - If the arsine release was indoors, get out of the building.
- If you are near a release of arsine, emergency coordinators may tell you to either evacuate the area or to "shelter in place" inside a building to avoid being exposed to the chemical. For more information on evacuation during a chemical emergency,
- see the sections on "Evacuation," and "Sheltering in Place."

- If you think you may have been exposed to arsine, Please See "*PERSONAL CLEANING AND DISPOSAL OF CONTAMINATED CLOTHING.*"

How arsine exposure is treated

Treatment consists of providing supportive medical care in a hospital setting. Blood transfusions and intravenous fluids (that is, fluids injected directly into a vein) may be needed. Some people may require hemodialysis (artificial kidneys) for kidney failure. No antidotes are available for arsine.

CYANIDE

About Cyanide

What cyanide is?

Cyanide is a rapidly acting, potentially deadly chemical that can exist in various forms.

Cyanide can be a colorless gas, such as hydrogen cyanide (HCN) or cyanogen chloride (CNCl), or a crystal form such as sodium cyanide (NaCN) or potassium cyanide (KCN).

Cyanide sometimes is described as having a "bitter almond" smell, but it does not always give off an odor, and not everyone can detect this odor.

Cyanide is also known by the military designations AN (for hydrogen cyanide) and CK (for cyanogen chloride).

Where cyanide is found and how it is used?

Hydrogen cyanide, under the name Zyklon B, was used as a genocidal agent by the Germans in World War II.

Reports have indicated that during the Iran-Iraq War in the 1980s, hydrogen cyanide gas may have been used along with other chemical agents against the inhabitants of the Kurdish city of Halabja in northern Iraq.

Cyanide is naturally present in some foods and in certain plants such as cassava. Cyanide is contained in cigarette smoke and the combustion products of synthetic materials such as plastics. Combustion products are substances given off when things burn.

In manufacturing, cyanide is used to make paper, textiles, and plastics. It is present in the chemicals used to develop photographs. Cyanide salts are used in metallurgy for electroplating, metal cleaning, and removing gold from its ore. Cyanide gas is used to exterminate pests and vermin in ships and buildings.

If accidentally ingested (swallowed), chemicals found in acetonitrile-based products that are used to remove artificial nails can produce cyanide.

How people can be exposed to cyanide

People may be exposed to cyanide by breathing air, drinking water, eating food, or touching soil that contains cyanide.

Cyanide enters water, soil, or air as a result of both natural processes and industrial activities. In air, cyanide is present mainly as gaseous hydrogen cyanide.

Smoking cigarettes is probably one of the major sources of cyanide exposure for people who do not work in cyanide-related industries.

How cyanide works

Poisoning caused by cyanide depends on the amount of cyanide a person is exposed to, the route of exposure, and the length of time that a person is exposed.

Breathing cyanide gas causes the most harm, but ingesting cyanide can be toxic as well.

Cyanide gas is most dangerous in enclosed places where the gas will be trapped.

Cyanide gas evaporates and disperses quickly in open spaces, making it less harmful outdoors.

Cyanide gas is less dense than air, so it will rise.

Cyanide prevents the cells of the body from getting oxygen. When this happens, the cells die.

Cyanide is more harmful to the heart and brain than to other organs because the heart and brain use a lot of oxygen.

Immediate signs and symptoms of cyanide exposure

People exposed to a small amount of cyanide by breathing it, absorbing it through their skin, or eating foods that contain it may have some or all of the following symptoms within minutes:

Rapid breathing
Restlessness
Dizziness
Weakness
Headache
Nausea and vomiting
Rapid heart rate

Exposure to a large amount of cyanide by any route may cause these other health effects as well:

Convulsions
Low blood pressure

Slow heart rate
Loss of consciousness
Lung injury
Respiratory failure leading to death

Showing these signs and symptoms does not necessarily mean that a person has been exposed to cyanide.

What the long-term health effects may be?

Survivors of serious cyanide poisoning may develop heart and brain damage.

How people can protect themselves and what they should do if they are exposed to cyanide

First, get fresh air by leaving the area where the cyanide was released. Moving to an area with fresh air is a good way to reduce the possibility of death from exposure to cyanide gas.

If the cyanide release was outside, move away from the area where the cyanide was released.

If the cyanide release was indoors, get out of the building.

If leaving the area that was exposed to cyanide is not an option, stay as low to the ground as possible.

Remove any clothing that has liquid cyanide on it. If possible, seal the clothing in a plastic bag, and then seal that bag inside a second plastic bag. Removing and sealing the clothing in this way will help protect people from any chemicals that might be on their clothes.

If clothes were placed in plastic bags, inform either the local or state health department or emergency coordinators upon their arrival. Do not handle the plastic bags.

Rinse the eyes with plain water for 10 to 15 minutes if they are burning or vision is blurred.

Wash any liquid cyanide from the skin thoroughly with soap and water.

If cyanide is known to be ingested (swallowed), do not induce vomiting or give fluids to drink.

Seek medical attention right away. Dial 911 and explain what has happened.

HIGHLIGHTS: Cyanide is a very poisonous chemical. Exposure to high levels of cyanide harms the brain and heart, and may cause coma and death. Exposure to lower levels may result in breathing difficulties, heart pains, vomiting, blood changes, headaches, and enlargement of the thyroid gland. Cyanide has been found in at least 415 of the 1,430 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is cyanide?

Cyanide is usually found joined with other chemicals to form compounds. Examples of simple cyanide compounds are hydrogen cyanide, sodium cyanide and potassium cyanide. Cyanide can be produced by certain bacteria, fungi, and algae, and it is found in a number of foods and plants. In the body, cyanide combines with a chemical to form Vitamin B12. Cyanide occurs naturally in cassava roots, which are potato-like tubers of cassava plants grown in tropical countries.

Hydrogen cyanide is a colorless gas with a faint, bitter, almond-like odor. Sodium cyanide and potassium cyanide are both white solids with a bitter, almond-like odor in damp air. Cyanide and hydrogen cyanide are used in electroplating, metallurgy, production of chemicals, photographic development, making plastics, fumigating ships, and some mining processes.

What happens to cyanide when it enters the environment?

Cyanide enters the environment from both natural processes and human industrial activities.

In air, cyanide is mainly found as gaseous hydrogen cyanide; a small amount is present as fine dust particles.

It takes about 1–3 years for half of the hydrogen cyanide to disappear from the air.

Most cyanide in surface water will form hydrogen cyanide and evaporate.

Cyanide in water does not build up in the bodies of fish.

At high concentrations, cyanide becomes toxic to soil microorganisms and can pass through soil into underground water.

How might I be exposed to cyanide?

Breathing air, drinking water, touching soil, or eating foods containing cyanide.

Smoking cigarettes and breathing smoke-filled air during fires are major sources of cyanide exposure.

Breathing air near a hazardous waste site containing cyanide.

Eating foods containing cyanide compounds, such as cassava roots, lima beans, and almonds.

Working in an industry where cyanide is used or produced, such as electroplating, metallurgy, metal cleaning, and photography.

How can cyanide affect my health?

In large amounts, cyanide is very harmful to people. Exposure to high levels of cyanide in the air for a short time harms the brain and heart, and may cause coma and death.

Exposure to lower levels of cyanide for a long time may result in breathing difficulties, heart pains, vomiting, blood changes, headaches, and enlargement of the thyroid gland.

People who eat large amounts of cyanide may have symptoms including deep breathing and shortness of breath, convulsions, and loss of consciousness, and may die. Use of cassava roots as a primary food source in tropical Africa has led to high blood cyanide levels.

People with high blood cyanide levels have also shown harmful effects such as weakness of the fingers and toes, difficulty walking, dimness of vision, deafness, and decreased thyroid gland function, but chemicals other than cyanide may have contributed to these effects. Skin contact with cyanide can produce irritation and sores.

It is not known whether cyanide can directly cause birth defects in people. Birth defects were seen in rats that ate diets of cassava roots. Effects on the reproductive system were seen in rats and mice that drank water containing sodium cyanide

How likely is cyanide to cause cancer?

The EPA has determined that cyanide is not classifiable as to its human carcinogenicity. There are no reports that cyanide can cause cancer in people or animals.

Is there a medical test to show whether I've been exposed to cyanide?

There are medical tests to measure blood and urine levels of cyanide; however, small amounts of cyanide are always detectable in blood and urine. Tissue levels of cyanide can be measured if cyanide poisoning is suspected, but cyanide is rapidly cleared from the body, so the tests must be done soon after the exposure. An almond-like odor in the breath may alert a doctor that a person was exposed to cyanide.

How cyanide poisoning is treated

Cyanide poisoning is treated with specific antidotes and supportive medical care in a hospital setting. The most important thing is for victims to seek medical treatment as soon as possible.

Has the federal government made recommendations to protect human health?

The EPA has set a maximum contaminant level of cyanide in drinking water of 0.2 milligrams cyanide per liter of water (0.2 mg/L). The EPA requires that spills or accidental releases into the environment of 1 pound or more of hydrogen cyanide, potassium cyanide, sodium cyanide, calcium cyanide or copper cyanide be reported to the EPA.

The Occupational Safety and Health Administration (OSHA) and (other recommendations) the American Conference of Governmental Industrial Hygienists (ACGIH) have set a permissible exposure limit of 5 milligrams of cyanide per cubic meter of air (5 mg/m3) in the workplace during an 8-hour workday, 40-hour workweek.

Where can I get more information?

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

METALS

ARSENIC

What is arsenic?

Arsenic is a naturally occurring element widely distributed in the earth's crust. In the environment, arsenic is combined with oxygen, chlorine, and sulfur to form inorganic arsenic compounds. Arsenic in animals and plants combines with carbon and hydrogen to form organic arsenic compounds.

Inorganic arsenic compounds are mainly used to preserve wood. Organic arsenic compounds are used as pesticides, primarily on cotton plants.

What happens to arsenic when it enters the environment?

- Arsenic cannot be destroyed in the environment. It can only change its form.
- Arsenic in air will settle to the ground or is washed out of the air by rain.
- Many arsenic compounds can dissolve in water.
- Fish and shellfish can accumulate arsenic, but the arsenic in fish is mostly in a form that is not harmful.

How might I be exposed to arsenic?

- Eating food, drinking water, or breathing air containing arsenic.
- Breathing contaminated workplace air.
- Breathing sawdust or burning smoke from wood treated with arsenic.
- Living near uncontrolled hazardous waste sites containing arsenic.
- Living in areas with unusually high natural levels of arsenic in rock.

How can arsenic affect my health?

Breathing high levels of inorganic arsenic can give you a sore throat or irritated lungs. Ingesting high levels of inorganic arsenic can result in death. Lower levels of arsenic can cause nausea and vomiting, decreased production of red and white blood cells, abnormal heart rhythm, damage to blood vessels, and a sensation of "pins and needles" in hands and feet.

Ingesting or breathing low levels of inorganic arsenic for a long time can cause a darkening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso.

Skin contact with inorganic arsenic may cause redness and swelling.

Organic arsenic compounds are less toxic than inorganic arsenic compounds. Exposure to high levels of some organic arsenic compounds may cause similar effects as inorganic arsenic.

How likely is arsenic to cause cancer?
Several studies have shown that inorganic arsenic can increase the risk of lung cancer, skin cancer, bladder cancer, liver cancer, kidney cancer, and prostate cancer. The World Health Organization (WHO), the Department of Health and Human Services (DHHS), and the EPA have determined that inorganic arsenic is a human carcinogen.

How does arsenic affect children?
We do not know if exposure to arsenic will result in birth defects or other developmental effects in people. Birth defects have been observed in animals exposed to inorganic arsenic.
It is likely that health effects seen in children exposed to high amounts of arsenic will be similar to the effects seen in adults.

How can families reduce the risk of exposure to arsenic?

- If you use arsenic-treated wood in home projects, you should wear dust masks, gloves, and protective clothing to decrease exposure to sawdust.
- If you live in an area with high levels of arsenic in water or soil, you should use cleaner sources of water and limit contact with soil.

Is there a medical test to show whether I've been exposed to arsenic?
There are tests to measure the level of arsenic in blood, urine, hair, or fingernails. The urine test is the most reliable test for arsenic exposure within the last few days. Tests on hair and fingernails can measure exposure to high levels or arsenic over the past 6-12 months. These tests can determine if you have been exposed to above-average levels of arsenic. They cannot predict how the arsenic levels in your body will affect your health.

Has the federal government made recommendations to protect human health?
EPA has set limits on the amount of arsenic that industrial sources can release to the environment and has restricted or canceled many uses of arsenic in pesticides. EPA has set a limit of 0.05 parts per million (ppm) for arsenic in drinking water. The EPA arsenic drinking water standard of 0.01 ppm (10 ppb) reported in the ATSDR February 2001 Arsenic ToxFAQs was based on the EPA final rule for arsenic in drinking water, published on January 22, 2001, in the Federal Register. However, the EPA is currently reviewing the science and cost estimate supporting this rule, and, in the interim, has reverted to the previous standard for arsenic. Thus, the current EPA arsenic drinking water standard remains at 0.05 ppm (50 ppb).

The Occupational Safety and Health Administration has set limits of 10 microgram arsenic per cubic meter of workplace air (10 $\mu g/m^3$) for 8 hour shifts and 40 hour work weeks.

MERCURY

What is mercury?

Mercury is a naturally occurring metal which has several forms. The metallic mercury is a shiny, silver-white, odorless liquid. If heated, it is a colorless, odorless gas.

Mercury combines with other elements, such as chlorine, sulfur, or oxygen, to form inorganic mercury compounds or "salts," which are usually white powders or crystals. Mercury also combines with carbon to make organic mercury compounds. The most common one, methylmercury, is produced mainly by microscopic organisms in the water and soil. More mercury in the environment can increase the amounts of methylmercury that these small organisms make.

Metallic mercury is used to produce chlorine gas and caustic soda, and is also used in thermometers, dental fillings, and batteries. Mercury salts are sometimes used in skin lightening creams and as antiseptic creams and ointments.

What happens to mercury when it enters the environment?

- Inorganic mercury (metallic mercury and inorganic mercury compounds) enters the air from mining ore deposits, burning coal and waste, and from manufacturing plants.
- It enters the water or soil from natural deposits, disposal of wastes, and volcanic activity.
- Methylmercury may be formed in water and soil by small organisms called bacteria.
- Methylmercury builds up in the tissues of fish. Larger and older fish tend to have the highest levels of mercury.

How might I be exposed to mercury?

- Eating fish or shellfish contaminated with methylmercury.
- Breathing vapors in air from spills, incinerators, and industries that burn mercury-containing fuels.
- Release of mercury from dental work and medical treatments.
- Breathing contaminated workplace air or skin contact during use in the workplace (dental, health services, chemical, and other industries that use mercury).
- Practicing rituals that include mercury.

How can mercury affect my health?

The nervous system is very sensitive to all forms of mercury. Methylmercury and metallic mercury vapors are more harmful than other forms, because more mercury in these forms reaches the brain. Exposure to high levels of metallic, inorganic, or organic mercury can permanently damage the brain, kidneys, and developing fetus. Effects on brain functioning may result in irritability, shyness, tremors, changes in vision or hearing, and memory problems.
Short-term exposure to high levels of metallic mercury vapors may cause effects including lung damage, nausea, vomiting, diarrhea, increases in blood pressure or heart rate, skin rashes, and eye irritation.

How likely is mercury to cause cancer?

There are inadequate human cancer data available for all forms of mercury. Mercuric chloride has caused increases in several types of tumors in rats and mice, and methylmercury has caused kidney tumors in male mice. The EPA has determined that mercuric chloride and methylmercury are possible human carcinogens.

How does mercury affect children?
Very young children are more sensitive to mercury than adults. Mercury in the mother's body passes to the fetus and may accumulate there. It can also can pass to a nursing infant through breast milk. However, the benefits of breast feeding may be greater than the possible adverse effects of mercury in breast milk.

Mercury's harmful effects that may be passed from the mother to the fetus include brain damage, mental retardation, incoordination, blindness, seizures, and inability to speak. Children poisoned by mercury may develop problems of their nervous and digestive systems, and kidney damage.

How can families reduce the risk of exposure to mercury?
Carefully handle and dispose of products that contain mercury, such as thermometers or fluorescent light bulbs. Do not vacuum up spilled mercury, because it will vaporize and increase exposure. If a large amount of mercury has been spilled, contact your health department. Teach children not to play with shiny, silver liquids.

Properly dispose of older medicines that contain mercury. Keep all mercury-containing medicines away from children.

Pregnant women and children should keep away from rooms where liquid mercury has been used.

Learn about wildlife and fish advisories in your area from your public health or natural resources department.

Is there a medical test to show whether I've been exposed to mercury?
Tests are available to measure mercury levels in the body. Blood or urine samples are used to test for exposure to metallic mercury and to inorganic forms of mercury. Mercury in whole blood or in scalp hair is measured to determine exposure to methylmercury. Your doctor can take samples and send them to a testing laboratory.

Has the federal government made recommendations to protect human health?
The EPA has set a limit of 2 parts of mercury per billion parts of drinking water (2 ppb).
The Food and Drug Administration (FDA) has set a maximum permissible level of 1 part of methylmercury in a million parts of seafood (1 ppm).

The Occupational Safety and Health Administration (OSHA) has set limits of 0.1 milligram of organic mercury per cubic meter of workplace air (0.1 mg/m^3) and 0.05 mg/m^3 of metallic mercury vapor for 8-hour shifts and 40-hour work weeks.

THALLIUM

What is thallium?

Pure thallium is a bluish-white metal that is found in trace amounts in the earth's crust. In the past, thallium was obtained as a by-product from smelting other metals; however, it has not been produced in the United States since 1984. Currently, all the thallium is obtained from imports and from thallium reserves.

In its pure form, thallium is odorless and tasteless. It can also be found combined with other substances such as bromine, chlorine, fluorine, and iodine. When it's combined, it appears colorless-to-white or yellow.

Thallium is used mostly in manufacturing electronic devices, switches, and closures, primarily for the semiconductor industry. It also has limited use in the manufacture of special glass and for certain medical procedures.

What happens to thallium when it enters the environment?

- Thallium enters the environment primarily from coal-burning and smelting, in which it is a trace contaminant of the raw materials.
- It stays in the air, water, and soil for a long time and is not broken down.
- Some thallium compounds are removed from the atmosphere in rain and snow.
- It's absorbed by plants and enters the food chain.
- It builds up in fish and shellfish.

How might I be exposed to thallium?

- Eating food contaminated with thallium may be a major source of exposure for most people.
- Breathing workplace air in industries that use thallium.
- Smoking cigarettes.
- Living near hazardous waste sites containing thallium (may result in higher than normal exposures).
- Touching or, for children, eating soil contaminated with thallium.
- Breathing low levels in air and water.

How can thallium affect my health?

Exposure to high levels of thallium can result in harmful health effects. A study on workers exposed on the job over several years reported nervous system effects, such as numbness of fingers and toes, from breathing thallium.

Studies in people who ingested large amounts of thallium over a short time have reported vomiting, diarrhea, temporary hair loss, and effects on the nervous system, lungs, heart, liver, and kidneys. It has caused death. It is not known what the effects are from ingesting low levels of thallium over a long time.

Birth defects were not reported in the children of mothers exposed to low levels from eating vegetables and fruits contaminated with thallium. Studies in rats, however, exposed to high levels of thallium, showed adverse developmental effects.

It is not known if breathing or ingesting thallium affects human reproduction. Studies showed that rats that ingested thallium for several weeks had some adverse reproductive effects. Animal data suggest that the male reproductive system may be susceptible to damage by low levels of thallium.

There is no information available on the health effects of skin contact with thallium in people or animals.

How likely is thallium to cause cancer?

The Department of Health and Human Services, the International Agency for Research on Cancer, and the Environmental Protection Agency (EPA) have not classified thallium as to its human carcinogenicity.

No studies are available in people or animals on the carcinogenic effects of breathing, ingesting, or touching thallium.

Is there a medical test to show whether I've been exposed to thallium?
There are medical tests available to measure levels of thallium in urine and hair. In addition, thallium can also be measured in blood; however, this is not a good indicator of exposure since thallium only stays in blood a very short time.

These tests require special equipment that is not usually available in most doctor's offices. In addition, these tests cannot determine if adverse health effects will occur from the exposure to thallium.

Has the federal government made recommendations to protect human health?
The EPA requires that discharges or accidental spills into the environment of 1,000 pounds or more of thallium be reported.

The Occupational Safety and Health Administration (OSHA) has set an exposure limit of 0.1 milligrams per cubic meter (0.1 mg/m^3) for thallium in workplace air. The American Conference of Governmental Industrial Hygienists (ACGIH) has established the same guidelines as OSHA for the workplace.

The National Institute for Occupational Safety and Health (NIOSH) has recommended that 15 mg/m^3 of thallium be considered immediately dangerous to life and health. This is the exposure level of a chemical that is likely to cause permanent health problems or death.

ORGANIC SOLVENTS

BENZENE

What is benzene?

Benzene is a colorless liquid with a sweet odor. It evaporates into the air very quickly and dissolves slightly in water. It is highly flammable and is formed from both natural processes and human activities.

Benzene is widely used in the United States; it ranks in the top 20 chemicals for production volume. Some industries use benzene to make other chemicals which are used to make plastics, resins, and nylon and synthetic fibers. Benzene is also used to make some types of rubbers, lubricants, dyes, detergents, drugs, and pesticides. Natural sources of benzene include volcanoes and forest fires. Benzene is also a natural part of crude oil, gasoline, and cigarette smoke.

What happens to benzene when it enters the environment?

- Industrial processes are the main source of benzene in the environment.
- Benzene can pass into the air from water and soil.
- It reacts with other chemicals in the air and breaks down within a few days.

- Benzene in the air can attach to rain or snow and be carried back down to the ground.
- It breaks down more slowly in water and soil, and can pass through the soil into underground water.
- Benzene does not build up in plants or animals.

How might I be exposed to benzene?

- Outdoor air contains low levels of benzene from tobacco smoke, automobile service stations, exhaust from motor vehicles, and industrial emissions.
- Indoor air generally contains higher levels of benzene from products that contain it such as glues, paints, furniture wax, and detergents.
- Air around hazardous waste sites or gas stations will contain higher levels of benzene.
- Leakage from underground storage tanks or from hazardous waste sites containing benzene can result in benzene contamination of well water.
- People working in industries that make or use benzene may be exposed to the highest levels of it.
- A major source of benzene exposure is tobacco smoke.

How can benzene affect my health?

Breathing very high levels of benzene can result in death, while high levels can cause drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion, and unconsciousness. Eating or drinking foods containing high levels of benzene can cause vomiting, irritation of the stomach, dizziness, sleepiness, convulsions, rapid heart rate, and death.

The major effect of benzene from long-term (365 days or longer) exposure is on the blood. Benzene causes harmful effects on the bone marrow and can cause a decrease in red blood cells leading to anemia. It can also cause excessive bleeding and can affect the immune system, increasing the chance for infection.

Some women who breathed high levels of benzene for many months had irregular menstrual periods and a decrease in the size of their ovaries. It is not known whether benzene exposure affects the developing fetus in pregnant women or fertility in men.

Animal studies have shown low birth weights, delayed bone formation, and bone marrow damage when pregnant animals breathed benzene.

How likely is benzene to cause cancer?

The Department of Health and Human Services (DHHS) has determined that benzene is a known human carcinogen. Long-term exposure to high levels of benzene in the air can cause leukemia, cancer of the blood-forming organs.

Is there a medical test to show whether I've been exposed to benzene?

Several tests can show if you have been exposed to benzene. There is test for measuring benzene in the breath; this test must be done shortly after exposure. Benzene can also be measured in the blood, however, since benzene disappears rapidly from the blood, measurements are accurate only for recent exposures.

In the body, benzene is converted to products called metabolites. Certain metabolites can be measured in the urine. However, this test must be done shortly after exposure and is not a reliable indicator of how much benzene you have been exposed to, since the metabolites may be present in urine from other sources.

Has the federal government made recommendations to protect human health?
The EPA has set the maximum permissible level of benzene in drinking water at 0.005 milligrams per liter (0.005 mg/L). The EPA requires that spills or accidental releases into the environment of 10 pounds or more of benzene be reported to the EPA.

The Occupational Safety and Health Administration (OSHA) has set a permissible exposure limit of 1 part of benzene per million parts of air (1 ppm) in the workplace during an 8-hour workday, 40-hour workweek.

Animal testing is sometimes necessary to find out how toxic substances might harm people and how to treat people who have been exposed. Laws today protect the welfare of research animals and scientists must follow strict guidelines.

RIOT CONTROL GENTS

What riot control agents are

- Riot control agents (sometimes referred to as "tear gas") are chemical compounds that temporarily make people unable to function by causing irritation to the eyes, mouth, throat, lungs, and skin.

- Several different compounds are considered to be riot control agents. The most common compounds are known as chloroacetophenone (CN) and chlorobenzylidenemalononitrile (CS). Other examples include chloropicrin (PS), which is also used as a fumigant (that is, a substance that uses fumes to disinfect an area); bromobenzylcyanide (CA); dibenzoxazepine (CR); and combinations of various agents.

Where riot control agents are found and how they are used

- Riot control agents are used by law enforcement officials for crowd control and by individuals and the general public for personal protection (for example, pepper spray).

- CS is also used in military settings to test the speed and ability of military personnel to use their gas masks.

How you could be exposed to riot control agents

- Because they are liquids or solids (for example, powder), riot control agents such as CN and CS could be released in the air as fine droplets or particles.

- If agents are released into the air, people could be exposed to them through skin contact, eye contact, or breathing.

How riot control agents work

- The extent of poisoning caused by riot control agents depends on the amount of riot control agent to which a person was exposed, the location of exposure (indoors versus outdoors), how the person was exposed, and the length of time of the exposure.

- Riot control agents work by causing irritation to the area of contact (for example, eyes, skin, nose) within seconds of exposure.

- The effects of exposure to a riot control agent are usually short-lived (15–30 minutes) after the person has been removed from the source and decontaminated (cleaned off).

Immediate signs and symptoms of exposure to a riot control agent

People exposed to riot control agents may experience some or all of the following symptoms immediately after exposure:

- Eyes: excessive tearing, burning, blurred vision, redness

- Nose: runny nose, burning, swelling

- Mouth: burning, irritation, difficulty swallowing, drooling

- Lungs: chest tightness, coughing, choking sensation, noisy breathing (wheezing), shortness of breath

- Skin: burns, rash

- Other: nausea and vomiting

Long-lasting exposure or exposure to a large dose of riot control agent, especially in a closed setting, may cause severe effects such as the following:

- Blindness

- Glaucoma (a serious eye condition that can lead to blindness)

- Immediate death due to severe chemical burns to the throat and lungs

- Respiratory failure possibly resulting in death

Showing these signs and symptoms does not necessarily mean that a person has been exposed to riot control agents.

Long-term health effects of exposure to riot control agents

- Prolonged exposure, especially in an enclosed area, may lead to long-term effects such as eye problems including scarring, glaucoma, and cataracts, and may possibly cause breathing problems such as asthma.

- If symptoms go away soon after a person is removed from exposure to riot control agents, long-term health effects are unlikely to occur.

How you can protect yourself, and what to do if you are exposed to riot control agents

- Since inhalation is likely to be the primary route of exposure, leave the area where the riot control agents were released and get to fresh air. Quickly moving to an area where fresh air is available is highly effective in reducing exposure to riot control agents.
    - If the riot control agents were released outdoors, move away from the area where the agents were released. Avoid dense, low-lying clouds of riot control agent vapor.
    - Go to the highest ground possible, because riot control agents will form a dense vapor cloud that can travel close to the ground.
    - If the release of riot control agents was indoors, get out of the building.
- If you are near a release of riot control agent, emergency coordinators may tell you to either evacuate the area or "shelter in place" inside a building to avoid being exposed to the chemical. For more information on evacuation during a chemical emergency, see *"EVACUATION"*. For more information on sheltering in place during a chemical emergency, see " *SHELTERING IN PLACE DURING A CHEMICAL DISASTER OR ATTACK"*.
- If you think you may have been exposed to riot control agent, you should remove your clothing, rapidly wash your entire body with soap and water, and get medical care as quickly as possible.

Please see "PERSONAL CLEANING AND DISPOSAL OF CONTAMINATED CLOTHING".

- Seek medical attention right away. Dial 911 and explain what has happened.

How exposure to riot control agents is treated

- Treatment consists of helping the affected person get more oxygen in his or her blood and of stopping agent-caused chemical burns from getting worse. Medications that are used to treat asthma (such as bronchodilators and steroids) may also be used to help the person breathe.
- Eye exposures are treated by rinsing the eyes with water until there is no evidence of riot control agents in the eyes.
- No antidote exists for poisoning from riot control agents.
- Burn injuries to the skin are treated with standard burn management techniques, including use of medicated bandages.

OTHER CHEMICAL AGENTS

ETHYLENE GLYCOL AND PROPYLENE GLYCOL

What are ethylene glycol and propylene glycol?

Both ethylene glycol and propylene glycol are clear, colorless, slightly syrupy liquids at room temperature. Either compound may exist in air in the vapor form, although propylene glycol must be heated or briskly shaken to produce a vapor. Ethylene glycol is odorless but has a sweet taste. Propylene glycol is practically odorless and tasteless.

Both compounds are used to make antifreeze and de-icing solutions for cars, airplanes, and boats; to make polyester compounds; and as solvents in the paint and plastics industries. Ethylene glycol is also an ingredient in photographic developing solutions, hydraulic brake fluids and in inks used in stamp pads, ballpoint pens, and print shops.

The Food and Drug Administration (FDA) has classified propylene glycol as an additive that is "generally recognized as safe" for use in food. It is used to absorb extra water and maintain moisture in certain medicines, cosmetics, or food products. It is a solvent for food colors and flavors.

Propylene glycol is also used to create artificial smoke or fog used in fire-fighting training and in theatrical productions.

What happens to ethylene glycol and propylene glycol when they enter the environment?

- Neither compound is likely to exist in large amounts in air.
- About half of the compounds that enter the air will break down in 24–50 hours.
- Both compounds break down within several days to a week in water and soil.

How might I be exposed to ethylene glycol and propylene glycol?

- You can be exposed to ethylene glycol when you use antifreeze, photographic developing solutions, coolants, and brake fluid.
- You can be exposed to propylene glycol by eating food products, using cosmetics, or taking medicine that contains it.
- If you work in an industry that uses ethylene glycol or propylene glycol, you could be exposed by breathing or touching these substances.

How can ethylene glycol and propylene glycol affect my health?

Eating or drinking very large amounts of ethylene glycol can result in death, while large amounts can result in nausea, convulsions, slurred speech, disorientation, and heart and kidney problems. Female animals that ate large amounts of ethylene glycol had babies with birth defects, while male animals had reduced sperm counts. However, these effects were seen at very high levels and would not be expected in people exposed to lower levels at hazardous waste sites.

Ethylene glycol affects the body's chemistry by increasing the amount of acid, resulting in metabolic problems. Similar to ethylene glycol, propylene glycol increases the amount of acid in the body. However, larger amounts of propylene glycol are needed to cause this effect.

How likely are ethylene glycol and propylene glycol to cause cancer?
The Department of Health and Human Services (DHHS), the International Agency for Research on Cancer (IARC), and the EPA have not classified ethylene glycol and propylene glycol for carcinogenicity. Studies with people who used ethylene glycol did not show carcinogenic effects. Animal studies also have not shown these chemicals to be carcinogens.

Is there a medical test to show whether I've been exposed to ethylene glycol and propylene glycol?
Tests are available to determine if you have been exposed to ethylene glycol. These tests are only used on people who are showing symptoms of ethylene glycol poisoning (but they could be used in other situations). The tests are most often used on people who have intentionally consumed, or who suspect they have consumed, large amounts of ethylene glycol.

Propylene glycol is generally considered to be a safe chemical, and is not routinely tested for, unless specific exposure, such as to a medicine or cosmetic, can be linked with symptoms. Since both chemicals break down very quickly in the body, they are very difficult to detect, even though symptoms may be present.

Has the federal government made recommendations to protect human health?
The EPA has set a drinking water guideline for ethylene glycol of 7,000 micrograms (7,000 μg/L) in a liter of water for an adult.

The Food and Drug Administration (FDA) has classified propylene glycol as "generally recognized as safe," which means that it is acceptable for use in flavorings, drugs, and cosmetics, and as a direct food additive. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends a maximum level of 127 milligrams of ethylene glycol per cubic meter of air (127 mg/m^3) for a 15-minute exposure.

FLUORIDE, HYDROGEN FLUORIDE, AND FLUORINE

What are fluoride, hydrogen fluoride, and fluorine?
Fluorine, hydrogen fluoride, and fluorides are chemically related. Fluorine is a naturally occurring, pale yellow-green gas with a sharp odor. It combines with hydrogen to make hydrogen fluoride, a colorless gas. Hydrogen fluoride dissolves in water to form hydrofluoric acid. Fluorine also combines with metals to make fluorides such as sodium fluoride and calcium fluoride, both white solids. Sodium fluoride dissolves easily in water, but calcium fluoride does not.

Fluorine and hydrogen fluoride are used to make certain chemical compounds. Hydrofluoric acid is used for etching glass. Fluorides are used in making steel, chemicals, ceramics, lubricants, dyes, plastics and pesticides (for ants and roaches). Fluorides are often added to drinking water supplies and to a variety of dental products, including toothpaste and mouth rinses, to prevent dental cavities.

What happens to fluoride, hydrogen fluoride, and fluorine when they enter the environment?

- Fluorine can not be destroyed in the environment, it can only change its form. Fluorine forms salts with minerals in soil, and doesn't evaporate back into air as a gas.
- Hydrogen fluoride gas will be absorbed by rain and into clouds and fog to form hydrofluoric acid, which will fall to the ground.
- Fluorides if released to the air from volcanoes and industry are carried by wind and rain to nearby water, soil, and food sources.
- Fluorides in water and soil will form strong associations with sediment or soil particles.
- Fluorides will accumulate in plants and animals. In animals, the fluoride accumulates primarily in the bones or shell rather than in edible meat.

How might I be exposed to fluoride, hydrogen fluoride, and fluorine?

- The general populations can be exposed to fluorides in contaminated air, food, drinking water and soil.
- People living in communities with fluoridated water or high levels of naturally-occurring fluoride may be exposed to higher levels.
- People who work or live near industries where fluoride-containing substances are used may be exposed to higher levels.

How can fluoride, hydrogen fluoride, and fluorine affect my health?

Fluorine and hydrogen fluoride are very irritating to the skin, eyes, and respiratory tract. At high levels, hydrogen fluoride can also damage the heart.

Small amounts of fluoride help prevent tooth cavities, but high levels can harm your health. In adults, high fluoride exposure over a long time can lead to skeletal fluorosis with denser bones, joint pain, and a limited range of joint movement. Although fluoride exposure results in denser bones, the bone appears to be weaker than normal bone and there may be a greater risk of breaking the bone. In animals, exposure to high doses of fluoride can result in decreased fertility and sperm and testes damage.

How likely are fluoride, hydrogen fluoride, and fluorine to cause cancer?

Most of the studies of people living in areas with fluoridated water or naturally high levels of fluoride in drinking water did not find an association between fluoride and cancer risk. Two animal cancer studies were inconclusive. The international Agency for Research on Cancer (IARC) has determined that the carcinogenicity of fluoride to humans is not classifiable.

How can fluorine, hydrogen fluoride, and fluorides affect children?

When used appropriately, fluoride is both safe and effective in preventing and controlling cavities. Drinking or eating excessive fluoride during the time teeth are being formed (before 6 years of age) can cause visible changes in teeth. This condition is called dental fluorosis. At very high concentrations of fluoride, the teeth can become more fragile and sometimes develop a greater number of cavities.

No studies have addressed whether low levels of fluoride will cause birth defects in humans. Birth defects have not been found in most studies of animals.

How can families reduce the risk of exposure to fluorine, hydrogen fluoride, and fluorides?

Because fluorides are found naturally in the environment, we cannot avoid being exposed to them.

Children may be exposed to high levels of fluorides if they swallow dental products containing fluoridated toothpaste, gels, or rinses. Parents should supervise brushing and place at most, a small pea size dab of toothpaste on the brush and teach children not to swallow dental products.

Is there a medical test to show whether I've been exposed to fluoride, hydrogen fluoride, and fluorine?

Tests are available to measure fluoride levels in urine; these tests can determine if you have been exposed to higher-than-normal levels of fluorides. The urine test must be performed soon after exposure because fluoride that is not stored in bones leaves the body within a few days. The test can not be performed in the doctor's office, but can be done at most laboratories that test for chemical exposure. The urine fluoride test cannot be used to predict the nature or severity of toxic effects. Bone sampling can be done in special cases to measure long-term exposure to fluorides.

Has the federal government made recommendations to protect human health?

The EPA has set a maximum amount of fluoride allowable in drinking water of 4.0 milligrams per liter of water (4.0 mg/L). For the prevention of dental decay, the Public Health Service (PHS) has, since 1962, recommended that public water supplies contain between 0.7 and 1.2 milligrams of fluoride per liter of drinking water.

The Occupational Safety and Health Administration (OSHA) has set limits of 0.2 milligrams per cubic meter (0.2 mg/m^3) for fluorine, 2.0 mg/m^3 for hydrogen fluoride, and 2.5 mg/m^3 for fluoride in workroom air to protect workers during an 8-hour shift over a 40-hour work week.

AMMONIA

What is ammonia?

Ammonia is a colorless gas with a very sharp odor. It is made both by humans and by nature. It dissolves easily in water and evaporates quickly. It is commonly sold in liquid forms.

The amount of ammonia produced by humans every year is almost equal to that produced by nature every year. Ammonia is produced naturally in soil by bacteria, decaying plants and animals, and animal wastes. Ammonia is essential for many biological processes.

Most of the ammonia produced in chemical factories is used to make fertilizers. The remaining is used in textiles, plastics, explosives, pulp and paper production, food and beverages, household cleaning products, refrigerants, and other products. It is also used in smelling salts.

What happens to ammonia when it enters the environment?

- Because ammonia occurs naturally, it is found throughout the environment in soil, air, and water.
- Most of the ammonia in water changes to ammonium, an odorless liquid. Ammonia and ammonium can change back and forth in water.
- Ammonia is recycled naturally in the environment as part of the nitrogen cycle. It does not last very long in the environment.
- Plants and bacteria rapidly take up ammonia from soil and water.

- Some ammonia in water and soil is changed to nitrate and nitrite by bacteria.
- Ammonia released to air is rapidly removed by rain or snow or by reactions with other chemicals.
- Ammonia does not build up in the food chain, but serves as a nutrient source for plants and bacteria.

How might I be exposed to ammonia?

- Everybody is regularly exposed to low levels of ammonia in air, food, soil, and water.
- Ammonia has a strong irritating odor that people can easily smell before it may cause harm.
- If you use ammonia cleaning products at home, you will be exposed to ammonia released to the air and through contact with your skin.
- If you apply ammonia fertilizers or live near farms where these fertilizers have been applied, you can breath ammonia released to the air.
- You may be exposed to ammonia from leaks and spills from production plants, storage facilities, pipelines, tank trucks, and rail cars.

How can ammonia affect my health?

Exposure to high concentrations of ammonia in the air may cause severe burns in your skin, eyes, throat, and lungs. In extreme cases, blindness, lung damage, or death could occur. Breathing lower concentrations will cause coughing and nose and throat irritation.

If you swallow ammonia, you could suffer burns in your mouth, throat, and stomach. Concentrated ammonia spilled on the skin will cause burns. Animal studies show effects similar to those observed in people. We do not know if ammonia affects reproduction in humans.

How likely is ammonia to cause cancer?

We do not know whether ammonia can cause cancer in humans or in laboratory animals. The Department of Health and Human Services (DHHS), the International Agency for Research on Cancer (IARC), and the EPA have not classified ammonia for carcinogenicity.

How can ammonia affect children?

Children are less likely to be exposed to concentrated ammonia because most exposures of that kind occur in occupational settings. Children can still be exposed the same way as adults to ammonia gas from spills or leaks from ammonia tanks or pipelines, especially on farms where it is used as a fertilizer. Children can also be exposed to dilute ammonia solutions from household cleaners containing ammonia.

The effects of ammonia on children are likely to be the same as for adults. We do not know if exposure to ammonia causes birth defects, or if it can pass to the fetus across the placenta or to infants via breast milk.

How can families reduce the risk of exposure to ammonia?

- Keep products containing ammonia out of the reach of children.
- Maintain adequate room ventilation when using cleaners containing ammonia and wear proper clothing and eye protection.
- Prevent children from entering a room where ammonia is being used.

- Never store cleaning solutions in containers that may be attractive to children, such as soda bottles.
- Avoid entering fields when ammonia fertilizers is being applied.

Is there a medical test to show whether I've been exposed to ammonia?
There are tests that can detect ammonia in blood and urine. However, these tests cannot definitely determine if you have been exposed because ammonia is normally found in the body.
If you were exposed to harmful amounts of ammonia you would notice it immediately because of the strong, unpleasant smell and strong taste. Your skin, eyes, nose, and throat would also be irritated.

Has the federal government made recommendations to protect human health?
The Occupational Safety and Health Administration (OSHA) has set a limit of 25 parts of ammonia per million parts of air (25 ppm) in the workplace during an 8-hour shift and a short-term limit (15 minutes) of 35 ppm.

PARAQUAT

What paraquat is

- Paraquat is a toxic chemical that is widely used as an herbicide (plant killer), primarily for weed and grass control.

- In the United States, paraquat is available primarily as a liquid in various strengths. It is classified as "restricted use," which means that it can be used only by people who are licensed applicators.

- Because paraquat is highly poisonous, the form of it that is marketed in the United States has a blue dye to keep it from being confused with beverages such as coffee, a sharp odor to serve as a warning, and an added agent to cause vomiting if someone drinks it. Paraquat from outside the United States may not have these safeguards added.

Where paraquat is found and how it is used

- Paraquat was first produced for commercial purposes in 1961.

- Worldwide, paraquat is still one of the most commonly used herbicides.

- In the United States, due to its toxicity, paraquat is available for use only by commercially licensed users.

How you could be exposed to paraquat

- Paraquat is not known to have been used in any terrorist attacks or wars.

- The most likely route of exposure to paraquat that would lead to poisoning is ingestion (swallowing).

- Paraquat can be easily mixed with food, water, or other beverages. If the form of paraquat that is used is the form that does not contain the safeguard additives (dye, odor, and vomiting agent), people might not know that the food, water, or other beverages are contaminated. Eating or drinking paraquat-contaminated food or beverages could poison people.

- Paraquat poisoning is also possible after skin exposure. Poisoning is more likely to occur if the skin exposure lasts for a long time, involves a concentrated version of paraquat, or occurs through skin that is not intact (skin that has sores, cuts, or a severe rash).

- If it is inhaled, paraquat could cause poisoning leading to lung damage. In the past, some marijuana in the United States has been found to contain paraquat.

- Licensed applicators of paraquat are the people most at risk for exposure.

How paraquat works

- The extent of poisoning caused by paraquat depends on the amount, route, and duration of exposure and the person's condition of health at the time of the exposure.

- Paraquat causes direct damage when it comes into contact with the lining of the mouth, stomach, or intestines.

- After paraquat enters the body, it is distributed to all areas of the body. Toxic chemical reactions occur throughout many parts of the body, primarily the lungs, liver, and kidneys.

- The actual mechanism by which paraquat damages the lungs is not known.

Immediate signs and symptoms of paraquat exposure

- After a person ingests a large amount of paraquat, he or she is likely to immediately have pain and swelling of the mouth and throat. The next signs of illness following ingestion are gastrointestinal (digestive tract) symptoms, such as nausea, vomiting, abdominal pain, and diarrhea (which may become bloody).

- Severe gastrointestinal symptoms may result in dehydration (not enough fluids in the body), electrolyte abnormalities (not enough sodium and potassium in the body), and low blood pressure.

- Ingestion of small to medium amounts of paraquat may lead to development of the following adverse health effects within several days to several weeks:

    - Liver failure
    - Kidney failure
    - Heart failure

- Lung scarring (may evolve over several weeks)

- In general, ingestion of large amounts of paraquat leads to the following signs/symptoms within a few hours to a few days:
  - Pulmonary edema (fluid in the lungs)
  - Lung scarring (evolves more quickly than when small to medium amounts have been ingested)
  - Liver failure
  - Kidney failure
  - Confusion
  - Coma
  - Seizures
  - Injury to the heart
  - Fast heart rate
  - Muscle weakness
  - Respiratory (breathing) failure, possibly leading to death

- Showing these signs and symptoms does not necessarily mean that a person has been exposed to paraquat.

What the long-term health effects are

- If a person survives the toxic effects of paraquat poisoning, long-term lung damage (scarring) is highly likely. Other long-term effects may also occur, including kidney failure, heart failure, and esophageal strictures (scarring of the swallowing tube that makes it hard for a person to swallow).

- People with high-dose exposure to paraquat are not likely to survive.

How you can protect yourself, and what you should do if you are exposed to paraquat

- Since ingestion is likely to be the primary route of exposure, if poisoning is suspected, avoid any further ingestion and call 911 immediately.

- Inducing vomiting (giving ipecac) is unlikely to be of any benefit unless done within a few minutes of ingestion. Activated charcoal should be ingested if it is available. Ingestion of food (or even plain dirt) may be of some benefit if charcoal is not readily available.

- If you think you may have been exposed to liquid paraquat on your clothes or body, : Please See *"PERSONAL CLEANING AND DISPOSAL OF CONTAMINATED CLOTHING."*

How paraquat exposure is treated

Treatment consists of removing the paraquat from the body (decontamination) and providing supportive medical care in a hospital setting. Supportive care includes intravenous fluids (fluids given through a needle inserted directly into a vein), medications to help with breathing and to raise low blood pressure, a ventilator to support breathing, and possibly dialysis for kidney failure (artificial kidneys). No proven antidote or cure exists for paraquat poisoning.

SODIUM AZIDE

What sodium azide is

- Sodium azide is a rapidly acting, potentially deadly chemical that exists as an odorless white solid.

- When it is mixed with water or an acid, sodium azide changes rapidly to a toxic gas with a pungent (sharp) odor. It also changes into a toxic gas when it comes in contact with solid metals (for example, when it is poured into a drain pipe containing lead or copper).

- The odor of the gas may not be sharp enough, however, to give people sufficient warning of the danger.

Where sodium azide is found and how it is used

- Sodium azide is best known as the chemical found in automobile airbags. An electrical charge triggered by automobile impact causes sodium azide to explode and release nitrogen gas inside the airbag.

- Sodium azide is used as a chemical preservative in hospitals and laboratories. Accidents have occurred in these settings. In one case, sodium azide was poured into a drain, where it exploded and the toxic gas was inhaled (breathed in).

- Sodium azide is used in agriculture (farming) for pest control.

- Sodium azide is also used in detonators and other explosives.

How you could be exposed to sodium azide

- Following release of sodium azide into water, you could be exposed to sodium azide by drinking the contaminated water.

- Following contamination of food with sodium azide, you could be exposed to sodium azide by eating the contaminated food.
- Following release of sodium azide into the air, you could be exposed by breathing in the dust or the gas that is formed.
- Sodium azide can also enter the body and cause symptoms through skin contact.
- An explosion involving sodium azide may cause burn injury as well as expose people to the toxic gas, hydrozoic acid.
- CDC has received no reports of sodium azide exposure following automobile airbag deployment.

How sodium azide works

- The seriousness of poisoning caused by sodium azide depends on the amount, route, and length of time of exposure, as well as the age and preexisting medical condition of the person exposed.
- Breathing the gas that is formed from sodium azide causes the most harm, but ingesting (swallowing) sodium azide can be toxic as well.
- The gas formed from sodium azide is most dangerous in enclosed places where the gas will be trapped. The toxic gas quickly disperses in open spaces, making it less harmful outdoors.
- The gas formed from sodium azide is less dense (lighter) than air, so it will rise.
- Sodium azide prevents the cells of the body from using oxygen. When this happens, the cells die.
- Sodium azide is more harmful to the heart and the brain than to other organs, because the heart and the brain use a lot of oxygen.

Immediate signs and symptoms of sodium azide exposure

- People exposed to a small amount of sodium azide by breathing it, absorbing it through their skin, or eating foods that contain it may have some or all of the following symptoms within minutes:
    - Rapid breathing
    - Restlessness
    - Dizziness
    - Weakness

- Headache
- Nausea and vomiting
- Rapid heart rate
- Red eyes (gas or dust exposure)
- Clear drainage from the nose (gas or dust exposure)
- Cough (gas or dust exposure)
- Skin burns and blisters (explosion or direct skin contact)

- Exposure to a large amount of sodium azide by any route may cause these other health effects as well:
  - Convulsions
  - Low blood pressure
  - Slow heart rate
  - Loss of consciousness
  - Lung injury
  - Respiratory failure leading to death

- Showing these signs and symptoms does not necessarily mean that a person has been exposed to sodium azide.

What the long-term health effects may be

Survivors of serious sodium azide poisoning may have heart and brain damage.

How people can protect themselves and what they should do if they are exposed to sodium azide

- First, get fresh air by leaving the area where the sodium azide was released. Moving to an area with fresh air is a good way to reduce the possibility of death from exposure to sodium azide.
  - If the sodium azide release was outside, move away from the area where the sodium azide was released.
  - If the sodium azide release was indoors, get out of the building.
  - If leaving the area that was exposed to sodium azide is not an option, stay as low to the ground as possible, because sodium azide fumes rise.

- If you are near a release of sodium azide, emergency coordinators may tell you to either evacuate the area or to "shelter in place" inside a building to avoid being exposed to the chemical. . For more information on evacuation during a chemical emergency, see " *EVACUATION.*" For more information on sheltering in place during a chemical emergency, see "*SHELTERING IN PLACE DURING A CHEMICAL DISASTER OR ATTACK.*"

    - If you think you may have been exposed to sodium azide, you should do the following : Please See "*PERSONAL CLEANING AND DISPOSAL OF CONTAMINATED CLOTHING.*"

How sodium azide poisoning is treated

Sodium azide poisoning is treated with supportive medical care in a hospital setting. No specific antidote exists for sodium azide poisoning. The most important thing is for victims to seek medical treatment as soon as possible.

PERSONAL CLEANING AND DISPOSAL OF CONTAMINATED CLOTHING

Some kinds of accidents or attacks may cause people to come in contact with dangerous chemicals. Coming in contact with a dangerous chemical may make it necessary for people to remove and dispose of their clothing right away and then wash themselves. Removing their clothing and washing their bodies will reduce or remove the chemical so that it is no longer a hazard. This process is called decontamination.

Decontamination is performed for two reasons:
to prevent the chemical from being further absorbed by a person's body or from spreading on a person's body, and to prevent the chemical from spreading to other people, including medical personnel, who must handle or who might come in contact with the person who is contaminated with the chemical.

Most chemical agents can penetrate clothing and are absorbed rapidly through the skin. Therefore, the most important and most effective decontamination for any chemical exposure is decontamination done within the first minute or two after exposure.

How people will know if they need to wash themselves and dispose of their clothing
In most cases, emergency coordinators will let people know if a dangerous chemical has been released and will tell people what to do.

In general, exposure to a chemical in its liquid or solid form will require people to remove their clothing and then thoroughly wash their exposed skin. Exposure to a chemical in its vapor (gas) form generally requires people only to remove their clothing and the source of the toxic vapor.

If people think they have been exposed to a chemical release, but they have not heard from emergency coordinators, they can follow the washing and clothing disposal advice in the next section.

What to do

People should act quickly and follow the instructions of local emergency coordinators. Every situation can be different, so local emergency coordinators might have special instructions for people to follow.

If you think you may have been exposed to a chemical release, you should remove your clothing, rapidly wash your entire body with soap and water, and get medical care as quickly as possible.

- *Removing your clothing:*
    - Quickly take off clothing that may have abrin on it. Any clothing that has to be pulled over the head should be cut off the body instead of pulled over the head.
    - If you are helping other people remove their clothing, try to avoid touching any contaminated areas, and remove the clothing as quickly as possible.
- *Washing yourself:*

- As quickly as possible, wash any abrin from your skin with large amounts of soap and water. Washing with soap and water will help protect people from any chemicals on their bodies.

- If your eyes are burning or your vision is blurred, rinse your eyes with plain water for 10 to 15 minutes. If you wear contacts, remove them and put them with the contaminated clothing. Do not put the contacts back in your eyes (even if they are not disposable contacts). If you wear eyeglasses, wash them with soap and water. You can put your eyeglasses back on after you wash them.

- *Disposing of your clothes:*

  - After you have washed yourself, place your clothing inside a plastic bag. Avoid touching contaminated areas of the clothing. If you can't avoid touching contaminated areas, or you aren't sure where the contaminated areas are, wear rubber gloves or put the clothing in the bag using tongs, tool handles, sticks, or similar objects. Anything that touches the contaminated clothing should also be placed in the bag. If you wear contacts, put them in the plastic bag, too.

  - Seal the bag, and then seal that bag inside another plastic bag. Disposing of your clothing in this way will help protect you and other people from any chemicals that might be on your clothes.

  - When the local or state health department or emergency personnel arrive, tell them what you did with your clothes. The health department or emergency personnel will arrange for further disposal. Do not handle the plastic bags yourself.

- If someone has ingested chemical, do not induce vomiting or give fluids to drink.

- Seek medical attention right away. Dial 911 and explain what has happened.

After people have removed their clothing, washed themselves, and disposed of their clothing, they should dress in clothing that is not contaminated. Clothing that has been stored in drawers or closets is unlikely to be contaminated, so it would be a good choice for people to wear.

People should avoid coming in contact with other people who may have been exposed but have not yet changed their clothes or washed. People should move away from the area where the chemical was released when emergency coordinators tell them to do so.

EVACUATION

Some kinds of chemical accidents or attacks may make staying put dangerous. In such cases, it may be safer for people to evacuate, or leave the immediate area. People may need to go to an emergency shelter after they leave the immediate area.

How people will know if they need to evacuate
People will hear from the local police, emergency coordinators, or government on the radio and/or television if they need to evacuate.

If there is a "code red" or "severe" terror alert, people should pay attention to radio and/or television broadcasts so they will know right away if an evacuation order is made for their area.

What to do
People must act quickly and follow the instructions of local emergency coordinators. Every situation can be different, so local coordinators could have special instructions that people need to follow.

Local emergency coordinators may direct people to evacuate homes or offices and go to an emergency shelter. If so, emergency coordinators will tell people how to get to the shelter. If children are in school, they may be sheltered at the school. Parents should not try to get to the school.

The shelter will have most supplies that people need. The emergency coordinators will tell people which supplies to bring with them. People should be sure to bring any medications they are taking.

If people have time, they should call a friend or relative in another state to tell them where they are going and that they are safe. Local telephone lines may be jammed in an emergency, so people should plan ahead to have an out-of-state contact with whom to leave messages. People who do not have private transportation should make plans in advance of an emergency to identify people who can provide a ride.

Evacuating and sheltering in this way should keep people safer than if they stayed at home or at their workplace. People will most likely not be in the shelter for more than a few hours. Emergency coordinators will let people know when it is safe to leave the shelter.

SHELTERING IN PLACE DURING A CHEMICAL DISASTER OR ATTACK

What "sheltering in place" means
Some kinds of accidents or attacks may make going outdoors dangerous. Leaving the area might take too long or put people in harm's way. In such a case it may be safer for people to stay indoors than to go outside.

"Sheltering in place" is when people make a shelter out of the place they are in. It is a way for people to make the building as safe as possible to protect themselves until help arrives.

How to prepare to shelter in place
People should choose a room in their house or apartment for their shelter. The best room to use for the shelter is a room with as few windows and doors as possible. A large room, preferably with a water supply, is desirable—something like a master bedroom that is connected to a bathroom. For chemical events, this room should be as high in the structure as possible to avoid

vapors (gases) that sink. **Note:** This guideline is different from the sheltering-in-place technique used in tornadoes and other severe weather, when the shelter should be low in the home.

People might not be at home if the need to shelter in place ever arises, but if they are; it is good to have the following items on hand. (Ideally, all of these items should be kept in that room to save time.)

First aid kit

Food and bottled water. One gallon of water per person in plastic bottles as well as ready-to-eat foods that will keep without refrigeration should be stored at the shelter-in-place location. If bottled water no longer is available, water in a toilet tank (not the toilet bowl) is suitable for drinking.

Flashlight, battery-powered radio, and extra batteries for both.

Duct tape and scissors.

Towels and plastic sheeting.

A working telephone.

How people will know if they need to shelter in place

People will hear from the local police, emergency coordinators, or government on radio and television if they need to shelter in place.

If there is a "code red" or "severe" terror alert, people should pay attention to radio and television broadcasts to know right away whether a shelter-in-place alert is announced for their area.

If people are away from their shelter-in-place location when a chemical event occurs, they should follow the instructions of emergency coordinators to find the nearest shelter. If children are at school, they will be sheltered there. Unless instructed to do so, parents should not try to get to the school to bring their children home.

What to do

People should act quickly and follow the instructions of their local emergency coordinators. Every situation can be different, so local emergency coordinators might have special instructions to follow. In general, do the following:

Go inside as quickly as possible.

If there is time, shut and lock all outside doors and windows. Locking them may provide a tighter seal against the chemical. Turn off the air conditioner or heater. Turn off all fans, too. Close the fireplace damper and any other place that air can come in from the outside.

Go in the shelter-in-place room and shut the door.

Tape plastic over any windows in the room. Use duct tape around the windows and doors and make an unbroken seal. Use the tape over any vents into the room and seal any electrical outlets or other openings. Sink and toilet drain traps should have water in them (you can use the sink and toilet as you normally would). Push a wet towel up against the crack between the door and the floor to seal it. If it is necessary to drink water, drink the stored water, not water from the tap.

Turn on the radio. Keep a telephone close at hand, but don't use it unless there is a serious emergency.

Sheltering in this way should keep people safer than if they are outdoors. They will most likely not be in the shelter for more than a few hours. People should listen to the radio for an announcement indicating that it is safe to leave the shelter.

Chapter 7

RADIOLOGICAL/NUCLEAR ACCIDENTS AND EXPOSURE

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RADIATION

What is radiation?

Radiation is a form of energy. It comes from man-made sources such as x-ray machines, from the sun and outer space, and from some radioactive materials such as uranium in soil.

Radiation & Health Effects

Radiation and Health

Radiation is a form of energy.

Radiation comes from man-made sources such as x-ray machines, from the sun and outer space, and from some radioactive materials such as uranium in soil.

Small quantities of radioactive materials occur naturally in the air we breathe, the water we drink, the food we eat, and even in our own bodies. Radiation that goes inside our bodies causes what we refer to as internal exposure.

External exposure is from radiation from sources outside our body, such as radiation from sunlight and man-made and naturally occurring radioactive materials.

Radiation doses that people receive are measured in units called "rem" or "sievert." (One sievert is equal to 100 rem.) Scientists estimate that the average person in the United States receives a dose of about one-third of a rem per year.

Eighty percent of typical human exposure comes from natural sources and 20 percent comes from artificial radiation sources, primarily medical X-rays .

How Can Exposure Occur?

People are exposed to small amounts of radiation every day, both from naturally occurring sources (such as elements in the soil or cosmic rays from the sun), and man-made sources. Man-made sources include some electronic equipment (such as microwave ovens and television sets), medical sources (such as x-rays, certain diagnostic tests, and treatments), and from nuclear weapons testing.

The amount of radiation from natural or man-made sources to which people are exposed is usually small; a radiation emergency (such as a nuclear power plant accident or a terrorist event) could expose people to small or large doses of radiation, depending on the situation.

Scientists estimate that the average person in the United States receives a dose of about one-third of a rem per year. About 80% of human exposure comes from natural sources and the remaining 20% comes from man-made radiation sources – mainly medical x-rays.

Internal exposure refers to radioactive material that is taken into the body through breathing, eating, or drinking.

External exposure refers to an exposure to a radioactive source outside of our bodies.

Contamination refers to particles of radioactive material that are deposited anywhere that they are not supposed to be, such as on an object or on a person's skin.

Health Effects of Radiation Exposure

Radiation affects the body in different ways, but the adverse health consequences of exposure may not be seen for many years.

Adverse health effects range from mild effects, such as skin reddening, to serious effect such as cancer and death. These adverse health effects are determined by the amount of radiation absorbed by the body (the dose), the type of radiation, the route of exposure, and the length of time a person is exposed.

Acute radiation syndrome (ARS), or radiation sickness, is usually caused when a person receives a high dose of radiation to much of the body in a matter of minutes. Survivors of the Hiroshima and Nagasaki atomic bombs and firefighters responding to the Chernobyl nuclear power plant event in 1986 experienced ARS. The immediate symptoms of ARS are nausea, vomiting, and diarrhea; later, bone marrow depletion may lead to weight loss, loss of appetite, feeling like you have the flu, infection, and bleeding. The survival rate depends on the radiation dose.

For those who do survive, full recovery takes from a few weeks to 2 years.

Children exposed to radiation may be more at risk than adults. Radiation exposure to the unborn child is of special concern because the human embryo or fetus is extremely sensitive to radiation.

Radiation exposure, like exposure to the sun, is cumulative.

Protecting & Minimizing Against Radiation Exposure

The three basic ways to reduce radiation exposure are through—

TIME

Decrease the amount of time you spend near the source of radiation.

DISTANCE

Increase your distance from a radiation source.

SHIELDING

Increase the shielding between you and the radiation source. Shielding is anything that creates a barrier between people and the radiation source. Depending on the type of radiation, the shielding can range from something as thin as a plate of window glass or as thick as several feet of concrete. Being inside a building or a vehicle can provide shielding from some kinds of radiation.

Possible Health Effects of Radiation Exposure on Unborn Babies

With recent discussion about the possibility of a terrorist attack involving radioactive materials, some people may be concerned about radiation exposure to unborn babies. This section will help you understand the possible health effects to your unborn baby from exposure to radiation.

Prenatal Radiation Exposure

The exposure of an unborn baby to radiation is referred to as prenatal radiation exposure. This can occur when the mother's abdomen is exposed to radiation from outside her body. Also, a pregnant woman who accidentally swallows or breathes in radioactive materials may absorb that substance into her bloodstream. From the mother's blood, radioactive materials may pass through the umbilical cord to the baby or concentrate in areas of the mother's body near the womb (such as the bladder) and expose the unborn baby to radiation.

The possibility of severe health effects depends on the gestational age of the unborn baby at the time of exposure and the amount of radiation it is exposed to. Unborn babies are less sensitive during some stages of pregnancy than others. However, unborn babies are particularly sensitive to radiation during their early development, between weeks 2 and 15 of pregnancy. The health consequences can be severe, even at radiation doses too low to make the mother sick. Such consequences can include stunted growth, deformities, abnormal brain function, or cancer that may develop sometime later in life. However, since the baby is shielded by the mother's abdomen, it is protected in the womb from radioactive sources outside the mother's body. Consequently, the radiation dose to the unborn baby is lower than the dose to the mother for most radiation exposure events.

Pregnant women should consult with their physicians if they have any concern about radiation exposure to their unborn baby.

Increased Cancer Risk

Radiation exposure before birth can increase a person's risk of getting cancer later in life.
Unborn babies are especially sensitive to the cancer-causing effects of radiation. However, the increased risks depend on the amount of radiation to which the baby was exposed and the amount of time that it was exposed. For example, if the radiation dose to the unborn baby was roughly equivalent to 500 chest x-rays at one time, the increase in lifetime cancer risk would be less than 2% (above the normal lifetime cancer risk of 40 to 50%).

Other Risks from Radiation Exposure

Health effects other than cancer from radiation exposure are not likely when the dose to the unborn baby is very low.

Most researchers agree that babies who receive a small dose of radiation (equal to 500 chest x-rays or less) at any time during pregnancy do not have an increased risk for birth defects. The only increased risk to these babies is a slightly higher chance of having cancer later in life (less than 2% higher than the normal expected cancer risk of 40 to 50%).

During the first 2 weeks of pregnancy, the radiation-related health effect of greatest concern is the death of the baby.

The unborn baby is made up of only a few cells during the first 2 weeks of pregnancy. Damage to one cell can cause the death of the embryo before the mother even knows that she is pregnant. Of the babies that survive, however, few will have birth defects related to the exposure, regardless of how much radiation they were exposed to.

Large radiation doses to the unborn baby during the more sensitive stages of development (between weeks 2 and 15 of pregnancy) can cause birth defects, especially to the brain.

When an unborn baby is exposed to large doses of radiation (above the dose received from 500 chest x-rays) during the more sensitive stages of development (especially between weeks 8 and 15 of pregnancy), the health consequences can be severe, especially to the brain. Babies exposed to the atomic bombs dropped on Hiroshima and Nagasaki during the 8- to15-week stage of pregnancy were found to have a high rate of brain damage that resulted in lower IQ and even severe mental retardation. They also suffered stunted growth (up to 4% shorter than average people) and an increased risk of other birth defects.

Between the 16th week of pregnancy and birth, radiation-induced health effects (besides cancer) are unlikely unless the unborn baby receives an extremely large dose of radiation.

In the 16- to 25-week stage of pregnancy, health consequences similar to those seen in the 8- to 15-week stage could occur, but only when the doses are extremely large (more than about 5,000 chest x-rays received at one time). At this dose level, the mother could be showing signs of acute radiation syndrome, which is sometimes known as radiation sickness.

After the 26th week of pregnancy, the radiation sensitivity of the unborn baby is similar to that of a newborn.

At the 26th week of pregnancy, the unborn baby is fully developed though not fully grown. Unborn babies exposed to radiation in the womb during this stage of pregnancy are no more sensitive to the effects of radiation than are newborns. This means that birth defects are not likely to occur, and only a slight increase in the risk of having cancer later in life is expected.

Again, it is important for women who are concerned about radiation exposure to their unborn babies to c consult their physician.

Radiological Accidents & Emergencies

Radiological accidents can occur wherever radioactive materials are used, stored or transported. In addition to nuclear power plants, hospitals, universities, research laboratories, industries, major highways, railroads or shipping yards could be the site of a radiological accident.

Know these facts about radiation and materials.

- Radioactive materials are composed of atoms that are unstable. An unstable atom gives off its excess energy until it becomes stable. The energy emitted is radiation.

- The process by which an atom changes from an unstable state to a more stable state by emitting radiation is called radioactive decay or radioactivity.

- Radioactive materials are dangerous because of the harmful effect of certain types of radiation on the cells of the body. The longer a person is exposed to radiation, the greater the risk.

- People receive some radiation exposure each day from the sun, radioactive elements in the soil and rocks, household appliances like television sets and microwave ovens, and medical and dental x-rays.

- Radiation cannot be detected by sight, smell, or any other sense.

Contact your local emergency manager for information about how to respond to a radiological accident, and to learn emergency plans for schools, day care centers, nursing homes--anywhere family members might be.

Communities located on major transportation routes should develop and practice an emergency plan for handling transportation accidents involving radiological materials.

Learn your community's warning systems.

Obtain information about official evacuation routes from local officials.

Have disaster supplies on hand. *(See Preparing Emergency Supplies)*

BEFORE

Be prepared to evacuate or shelter in your home.

Develop an emergency communication plan.

In case family members are separated from one another during a disaster (a real possibility during the day when adults are at work and children are at school), have a plan for getting back together.

Ask an out-of-state relative or friend to serve as the "family contact." After a disaster, it's often easier to call long distance. Make sure everyone know the name, address, and phone number of the contact person.

DURING

Listen to the radio or television for official information.

If advised to remain at home:

- Bring pets inside.
- Close and lock windows and doors.
- Turn off air conditioning, vents, fans, and furnace.
- Close fireplace dampers.
- Go to the basement or other underground area.
- Stay inside until authorities say it is safe.
- If you must go out, cover mouth and nose with a damp towel. Be prepared to evacuate or shelter in your home.

When coming in from outdoors:

- Shower and change clothing and shoes.
- Put items worn outdoors in a plastic bag and seal it.

If advised to evacuate:

- Listen to a radio or television for information on evacuation routes, temporary shelters, and procedures.
- Minimize contamination in house.
- Close and lock windows and doors.
- Turn off air conditioning, vents, fans, and furnace.
- Close fireplace dampers.
- Take disaster supplies.

Remember your neighbors who may require special assistance--infants, elderly people, and people with disabilities.

AFTER THE EVENT

When the immediate danger has passed, avoid using foods from your garden or milk from your cows or goats until these can be inspected by a local emergency official. Contamination could affect areas as far as 50 miles from the accident site.

Nuclear Terrorism & Health Effects

Q: Is the United States in danger of a terrorist nuclear attack? Is the Centers for Disease Control and Prevention (CDC) prepared to respond to such an attack?
A: CDC is not able to assess the level of threat of a terrorist nuclear attack. However, for many years CDC has participated regularly in emergency-response drills where we have worked closely with other federal, state, and local agencies to develop, test, and implement extensive national radiological emergency- response plans.

Q: What are the potential adverse health consequences from a terrorist nuclear attack?
A: The adverse health consequences of a terrorist nuclear attack vary according to the type of attack and the distance a person is from the attack. Potential terrorist attacks may include a small radioactive source with a limited range of impact or a nuclear detonation involving a wide area of impact.

In the event of a terrorist nuclear attack, people may experience two types of exposure from radioactive materials: external exposure and internal exposure. External exposure occurs when a person comes in contact with radioactive material outside the body. Internal exposure occurs when people eat food or breathe air that is contaminated with radioactive material. Exposure to very large doses of external radiation may cause death within a few days or months. External exposure to lower doses of radiation and internal exposure from breathing or eating radioactive contaminated material may lead to an increased risk of developing cancer and other adverse health effects. These adverse effects range from mild, such as skin reddening, to severe effects such as cancer and death, depending on the amount of radiation absorbed by the body (the dose), the type of radiation, the route of exposure, and the length of time of the exposure.

If there is a nuclear detonation, bodily injury or death may occur as a result of the blast itself or as a result of debris thrown from the blast. People may experience moderate to severe skin burns, depending on their distance from the blast site. Those who look directly at the blast could experience eye damage ranging from temporary blindness to severe retinal burns.

Q: How can I protect my family and myself from a terrorist nuclear attack?
A: In the event of a terrorist nuclear attack, a national emergency-response plan would be activated and would include federal, state, and local agencies. You should seek shelter in a stable building and listen to local radio or television stations for national emergency-alert information. Your local emergency-response organizations, police agencies, and public health facilities may be able to supply you with additional information. You should follow the protective-action recommendations that are made by your state or local health department in accordance with this plan. As a general rule, you can reduce the potential exposure and subsequent health consequences by limiting your time near the radiation source, increasing your distance from the source, or keeping a physical barrier (such as the wall of a building) between you and the source.

Q: What should I do if there is a terrorist attack on a nuclear power plant near my home?

A: A terrorist attack on a nuclear power plant will initiate a national emergency response that has been carefully planned and rehearsed by local, state, and federal agencies for more than 20 years. If you live near a nuclear power plant and you have not received information that describes the emergency plan for that facility, you can contact the plant and ask for a copy of that information. Your local emergency-response organizations, police agencies, and public health facilities have been actively involved in this emergency plan, and they may be able to supply you with additional information. You and your family should study these plans and be prepared to follow the instructions that local and state public health officials provide in the event of a terrorist incident involving the nuclear power plant near your home.

NUCLEAR POWER PLANT EMERGENCY

Since 1980, each utility that owns a commercial nuclear power plant in the United States has been required to have both an onsite and offsite emergency response plan as a condition of obtaining and maintaining a license to operate that plant. Onsite emergency response plans are approved by the Nuclear Regulatory Commission (NRC). Offsite plans (which are closely coordinated with the utility's onsite emergency response plan) are evaluated by the Federal Emergency Management Agency (FEMA) and provided to the NRC, who must consider the FEMA findings when issuing or maintaining a license.

Federal law establishes the criterion for determining the adequacy of offsite planning and preparedness, i.e: "Plans and preparedness must be determined to adequately protect the public health and safety by providing reasonable assurance that appropriate measures can be taken offsite in the event of a radiological emergency."

Although construction and operation of nuclear power plants are closely monitored and regulated by the NRC, an accident, though unlikely, is possible. The potential danger from an accident at a nuclear power plant is exposure to radiation. This exposure could come from the release of radioactive material from the plant into the environment, usually characterized by a plume (cloud-like) formation. The area the radioactive release may affect is determined by the amount released from the plant, wind direction and speed and weather conditions (i.e., rain, snow, etc.) which would quickly drive the radioactive material to the ground, hence causing increased deposition of radionuclides.

If a release of radiation occurs, the levels of radioactivity will be monitored by authorities from Federal and State governments, and the utility, to determine the potential danger in order to protect the public.

Preparing For An Emergency

Federal, State and local officials work together to develop site-specific emergency response plans for nuclear power plant accidents. These plans are tested through exercises that include protective actions for schools and nursing homes.

The plans also delineate evacuation routes, reception centers for those seeking radiological monitoring and location of congregate care centers for temporary lodging.

State and local governments, with support from the Federal government and utilities, develop plans that include a plume emergency planning zone with a radius of 10 miles from the plant, and an ingestion planning zone within a radius of 50 miles from the plant.

Residents within the 10-mile emergency planning zone are regularly disseminated emergency information materials (via brochures, the phone book, calendars, utility bills, etc.). These materials contain educational information on radiation, instructions for evacuation and sheltering, special arrangements for the handicapped, contacts for additional information, etc. Residents should be familiar with these emergency information materials.

Radiological emergency plans call for a prompt Alert and Notification system. If needed, this prompt Alert and Notification System will be activated quickly to inform the public of any potential threat from natural or man-made events. This system uses either sirens, tone alert radios, route alerting (the "Paul Revere" method), or a combination to notify the public to tune their radios or television to an Emergency Alert System (EAS) station.

The EAS stations will provide information and emergency instructions for the public to follow. If you are alerted, tune to your local EAS station which includes radio stations, television stations, NOAA weather radio, and the cable TV system.

Special plans must be made to assist and care for persons who are medically disabled or handicapped. If you or someone you know lives within ten miles of a nuclear facility, please notify and register with your local emergency management agency. Adequate assistance will be provided during an emergency.

In the most serious case, evacuations will be recommended based on particular plant conditions rather than waiting for the situation to deteriorate and an actual release of radionuclides to occur.

Emergency Classification Levels

Preparedness for commercial nuclear power plants includes a system for notifying the public if a problem occurs at a plant. The emergency classification level of the problem is defined by these four categories:

Notification of Unusual Event is the least serious of the four levels. The event poses no threat to you or to plant employees, but emergency officials are notified. No action by the public is necessary.

Alert is declared when an event has occurred that could reduce the plant's level of safety, but backup plant systems still work. Emergency agencies are notified and kept informed, but no action by the public is necessary.

Site Area Emergency is declared when an event involving major problems with the plant's safety systems has progressed to the point that a release of some radioactivity into the air or water is possible, but is not expected to exceed Environmental Protection Agency Protective Action Guidelines (PAGs) beyond the site boundary. Thus, no action by the public is necessary.

General Emergency is the most serious of the four classifications and is declared when an event at the plant has caused a loss of safety systems. If such an event occurs, radiation could be

released that would travel beyond the site boundary. State and local authorities will take action to protect the residents living near the plant. The alert and notification system will be sounded. People in the affected areas could be advised to evacuate promptly or, in some situations, to shelter in place. When the sirens are sounded, you should listen to your radio, television and tone alert radios for site-specific information and instructions.

If You Are Alerted

- Remember that hearing a siren or tone alert radio does not mean you should evacuate. It means you should promptly turn to an EAS station to determine whether it is only a test or an actual emergency.

- Tune to your local radio or television station for information. The warning siren could mean a nuclear power plant emergency or the sirens could be used as a warning for tornado, fire, flood, chemical spill, etc.

- Check on your neighbors.

- Do not call 911. Special rumor control numbers and information will be provided to the public for a nuclear power plant emergency, either during the EAS message, in the utilities' public information brochure, or both.

- In a nuclear power plant emergency, you may be advised to go indoors and, if so, to close all windows, doors, chimney dampers, other sources of outside air, and turn off forced air heating and cooling equipment, etc.

If You Are Advised to Evacuate the Area

- Stay calm and do not rush
- Listen to emergency information
- Close and lock windows and doors
- Turn off air conditioning, vents, fans, and furnace
- Close fire place dampers

Take a few items with you. Gather personal items you or your family might need:

- Flash light and extra batteries
- Portable, battery operated radio and extra batteries
- First aid kit and manual
- Emergency food and water
- Essential medicines
- Cash and credit cards

Use your own transportation or make arrangements to ride with a neighbor. Public transportation should be available for those who have not made arrangements. Keep car windows and air vents closed and listen to an EAS radio station.

Follow the evacuation routes provided. If you need a place to stay, congregate care information will be provided.

If Advised to remain at Home

- Bring pets inside.
- Close and lock windows and doors
- Turn off air conditioning, vents, fans and furnace
- Close fireplace dampers
- Go to the basement or other underground area
- Stay inside until authorities say it is safe

When Coming In From Outdoors

- Shower and change clothing and shoes
- Put items worn outdoors in a plastic bag and seal it.

•The thyroid gland is vulnerable to the uptake of radioactive iodine. If a radiological release occurs at a nuclear power plant, States may decide to provide the public with a stable iodine, potassium iodide, which saturates the thyroid and protects it from the uptake of radioactive iodine. Such a protective action is at the option of State, and in some cases, local government.

Remember your neighbors may require special assistance--infants, elderly people, and people with disabilities.

School Evacuations

If an incident involving an actual or potential radiological release occurs, consideration is given to the safety of the children. If an emergency is declared, students in the 10-mile emergency planning zone will be relocated to designated facilities in a safe area. Usually, as a precautionary measure, school children are relocated prior to the evacuation of the general public.

For Farmers and Home Gardeners

If a radiological incident occurs at the nuclear facility, periodic information concerning the safety of farm and home grown products will be provided. Information on actions you can take to protect crops and livestock is available from your agricultural extension agent.

Crops

Normal harvesting and processing may still be possible if time permits. Unharvested crops are hard to protect.

Crops already harvested should be stored inside if possible.

Wash and peel vegetables and fruits before use if they were not already harvested.

Livestock

Provide as much shelter as possible. Take care of milk-producing animals.
Provide plenty of food and water and make sure shelters are well-ventilated. Use stored feed and water, when possible.

What you can do to stay informed:

Attend public information meetings. You may also want to attend post-exercise meetings that include the media and the public.

Contact local emergency management officials, who can provide information about radioactivity, safety precautions, and state, local, industry and federal plans.

Ask about the hazards radiation may pose to your family, especially with respect to young children, pregnant women and the elderly.

Be familiar with emergency information materials that are regularly disseminated to your home (via brochures, the phone book, calendars, utility bills, etc.) These materials contain educational information on radiation, instructions for evacuation and sheltering, special arrangements for the handicapped, contacts for additional information, etc

What Happens When People Are Exposed to Radiation?

Radiation can affect the body in a number of ways, and the adverse health effects of exposure may not be apparent for many years.

These adverse health effects can range from mild effects, such as skin reddening, to serious effects such as cancer and death, depending on the amount of radiation absorbed by the body (the dose), the type of radiation, the route of exposure, and the length of time a person was exposed.

Exposure to very large doses of radiation may cause death within a few days or months.

Exposure to lower doses of radiation may lead to an increased risk of developing cancer or other adverse health effects later in life.

What Types of Terrorist Events Might Involve Radiation?

Possible terrorist events could involve introducing radioactive material into the food or water supply, using explosives (like dynamite) to scatter radioactive materials (called a "dirty bomb"), bombing or destroying a nuclear facility, or exploding a small nuclear device.

Although introducing radioactive material into the food or water supply most likely would cause great concern or fear, it probably would not cause much contamination or increase the danger of adverse health effects.

Although a dirty bomb could cause serious injuries from the explosion, it most likely would not have enough radioactive material in a form that would cause serious radiation sickness among large numbers of people. However, people who were exposed to radiation scattered by the bomb could have a greater risk of developing cancer later in life, depending on their dose.

A meltdown or explosion at a nuclear facility could cause a large amount of radioactive material to be released. People at the facility would probably be contaminated with radioactive material and possibly be injured if there was an explosion. Those people who received a large dose might develop acute radiation syndrome. People in the surrounding area could be exposed or contaminated.

Clearly, an exploded nuclear device could result in a lot of property damage. People would be killed or injured from the blast and might be contaminated by radioactive material. Many people could have symptoms of acute radiation syndrome. After a nuclear explosion, radioactive fallout would extend over a large region far from the point of impact, potentially increasing people's risk of developing cancer over time.

What Preparations Can I Make for a Radiation Emergency?

Your community should have a plan in place in case of a radiation emergency. Check with community leaders to learn more about the plan and possible evacuation routes.

Check with your child's school, the nursing home of a family member, and your employer to see what their plans are for dealing with a radiation emergency.

Develop your own family emergency plan so that every family member knows what to do.

At home, put together an emergency kit that would be appropriate for any emergency. *(See Preparing Emergency Supplies)*

How Can I Protect Myself During a Radiation Emergency?

After a release of radioactive materials, local authorities will monitor the levels of radiation and determine what protective actions to take.

The most appropriate action will depend on the situation. Tune to the local emergency response network or news station for information and instructions during any emergency.

If a radiation emergency involves the release of large amounts of radioactive materials, you may be advised to "shelter in place," which means to stay in your home or office; or you may be advised to move to another location.

If you are advised to shelter in place, you should do the following:

Close and lock all doors and windows.

Turn off fans, air conditioners, and forced-air heating units that bring in fresh air from the outside. Only use units to recirculate air that is already in the building.

Close fireplace dampers.

If possible, bring pets inside.

Move to an inner room or basement.

Keep your radio tuned to the emergency response network or local news to find out what else you need to do.

If you are advised to evacuate, follow the directions that your local officials provide. Leave the area as quickly and orderly as possible. In addition –

Take a flashlight, portable radio, batteries, first-aid kit, supply of sealed food and water, hand-operated can opener, essential medicines, and cash and credit cards.

Take pets only if you are using your own vehicle and going to a place you know will accept animals. Emergency vehicles and shelters usually will not accept animals.

Should I Take Potassium Iodide During a Radiation Emergency?

Potassium iodide (KI) should only be taken in a radiation emergency that involves the release of radioactive iodine, such as an accident at a nuclear power plant or the explosion of a nuclear bomb. A "dirty bomb" most likely will not contain radioactive iodine.

A person who is internally exposure to radioactive iodine may experience thyroid disease later in life. The thyroid gland will absorb radioactive iodine and may develop cancer or abnormal growths later on. KI will saturate the thyroid gland with iodine, decreasing the amount of harmful radioactive iodine that can be absorbed.

KI only protects the thyroid gland and does not provide protection from any other radiation exposure.

Some people are allergic to iodine and should not take KI. Check with your doctor about any concerns you have about potassium iodide.

SHELTERING IN PLACE DURING RADIATION EMERGENCY

With recent terrorist events, many people have wondered about the possibility of a terrorist attack involving radioactive materials. People who live near but not in the immediate area of the attack may be asked to stay home and take shelter rather than try to evacuate. This action is called "sheltering in place." Because many radioactive materials rapidly decay and dissipate, staying in your home may protect your from exposure to radiation. The thick walls of your home may block much of the harmful radiation. Taking a few simple precautions can help you reduce your exposure to radiation. The Centers for Disease Control and Prevention has prepared this fact

sheet to help you protect yourself and your family and to help you prepare a safe and well-stocked shelter.

Preparing a Shelter in Your Home

The safest place in your home during an emergency involving radioactive materials is a centrally located room or basement. This area should have as few windows as possible. The further your shelter is from windows, the safer you will be.

Preparation is the key. Store emergency supplies in this area. An emergency could happen at any time, so it is best to stock supplies in advance and have everything that you need stored in the shelter.

Every 6 months, check the supplies in your shelter. Replace any expired medications, food, or batteries. Also, replace the water in your shelter every 6 months to keep it fresh.

Make sure that all family members know where the shelter is and what it is for. Caution them not to take any items from that area. If someone "borrows" items from your shelter, you may find that important items are missing when they are most needed.

If you have pets, prepare a place for them to relieve themselves in the shelter. Pets should not go outside during a radiation emergency because they may track radioactive materials from fallout into the shelter. Preparing a place for pets will keep the radioactive materials from getting inside the shelter.

Preparing Emergency Supplies

Stock up on supplies, just as you would in case of severe weather conditions or other emergencies.

Following is a list of things to consider when preparing your emergency kit.

Food with a long shelf life – Examples of this include canned, dried, and packaged food products. Store enough food for each member of the household for at least 3 days.

Water – In preparation for an emergency, purchase and store bottled water or simply store water from the tap. Each person in the household will need about 1 gallon per day; plan on storing enough water for at least 3 days.

A change of clothes and shoes – Check clothing every 6 months and remove clothes that no longer fit or are unsuitable for seasonal weather. Remember to include underwear, socks, sturdy shoes or work boots, and winter or summer clothes as needed.

Paper plates, paper towels, and plastic utensils – Store disposable dishware and utensils because you will not have enough water to wash dishes and because community water sources may be contaminated.

Plastic bags – Because you may not be able to leave your shelter for several days, you will need to collect your waste in plastic bags until it can be removed.

Bedding – Store sheets, blankets, towels, and cots for use during the time that you cannot leave your shelter.

Battery-operated radio and batteries – Electrical power may not be on for several days. A battery-operated radio will allow you to listen to emergency messages.

Medicines – Have 2-3 days' dose of your current prescription medicines in a childproof bottle for your shelter medical kit; label with the name and expiration date of the medicine. (Discuss with your doctor the best way to obtain this small amount of extra medicine.) Be sure to check medicines in your kit every 6 months to make sure they are not past the expiration date.

Toiletries – Keep a supply of soap, hand sanitizer, toilet paper, deodorant, disinfectants, etc.

Flashlight and batteries – Electrical power may be out for several days. A flashlight will help you see in your shelter.

A telephone or cell phone – Although cell phone or ground phone service may be interrupted, there is still a chance that you will be able to use a phone to call outside for information and advice from emergency services.

Extra eyeglasses or contact lenses and cleaning supplies.

Duct tape and heavy plastic sheeting – You can use these items to seal the door to your shelter and to seal any vents that open into your shelter.

Pet food, baby formula, diapers, etc. – Don't forget the other members of your family. If you have an infant, store extra formula and diapers. If you have pets keep a 3-day supply of pet food.

First aid kit – You can purchase a first-aid kit or prepare one yourself. Be sure to include the following items:

Sterile adhesive bandages
Sterile gauze pads in 2 inch and 4 inch sizes
Adhesive tape
Sterile rolled bandages
Scissors
Tweezers
Needle
Thermometer
Moistened towelettes
Antiseptic ointment
Tube of petroleum jelly or other lubricant
Soap or hand sanitizer
Latex or vinyl gloves
Safety pins
Aspirin or aspirin free pain reliever
Antidiarrhea medication
Laxatives
Antacids for stomach upset
Syrup of ipecac to cause vomiting if advised by the Poison Control Center

Activated charcoal to stop vomiting if advised by the Poison Control Center

Games, books and other entertainment – Because you may be in your shelter for several days, keep items on hand to occupy your family during that time. Children are likely to get bored if they have to stay in one place for long periods. Think of activities that they will enjoy doing while in the shelter – finger painting, coloring, playing games, etc.

Tips Before Entering a Shelter

If you are outside when the alert is given, try to remove clothing and shoes and place them in a plastic bag before entering the house. During sever weather, such as extreme cold, remove at least the outer layer of clothes before entering the home to avoid bringing radioactive material into your shelter. Leave clothing and shoes outside. Shower and wash your body with soap and water. Removing clothing will eliminate 90% of radioactive contamination. By taking this simple step, you will reduce the time that you are exposed and also your risk of injury from the radiation.

Before entering the shelter, turn off fans, air conditioners, and forced-air heating units that bring air in from the outside. Close and lock all windows and doors, and close fireplace dampers.

When you move to your shelter, use duct tape and plastic sheeting to seal any doors, windows, or vents.

Keep your radio tuned to an emergency response network at all times for updates on the situation. The announcers will provide information about when you may leave your shelter and whether you need to take other emergency measures.

DIRTY BOMBS

"Dirty Bombs" and the Harmful Effects of Radiation from the Event

What a "dirty bomb" is

A dirty bomb, or radiological dispersion device, is a bomb that combines conventional explosives, such as dynamite, with radioactive materials in the form of powder or pellets. The idea behind a dirty bomb is to blast radioactive material into the area around the explosion. This could possibly cause buildings and people to be exposed to radioactive material. The main purpose of a dirty bomb is to frighten people and make buildings or land unusable for a long period of time.

Dirty bomb versus atomic bombs in Hiroshima and Nagasaki. The atomic explosions that occurred in Hiroshima and Nagasaki were conventional nuclear weapons involving a fission reaction. A dirty bomb is designed to spread radioactive material and contaminate a small area. It does not include the fission products necessary to create a large blast like those seen in Hiroshima and Nagasaki.

Sources of the radioactive material

There has been a lot of speculation about where terrorists could get radioactive material to place in a dirty bomb. The most harmful radioactive materials are found in nuclear power plants and nuclear weapons sites. However, increased security at these facilities makes obtaining materials from them more difficult.

Because of the dangerous and difficult aspects of obtaining high-level radioactive materials from a nuclear facility, there is a greater chance that the radioactive materials used in a dirty bomb would come from low-level radioactive sources. Low-level radioactive sources are found in hospitals, on construction sites, and at food irradiation plants. The sources in these areas are used to diagnose and treat illnesses, sterilize equipment, inspect welding seams, and irradiate food to kill harmful microbes.

Dangers of a dirty bomb

If low-level radioactive sources were to be used, the primary danger from a dirty bomb would be the blast itself. Gauging how much radiation might be present is difficult when the source of the radiation is unknown. However, at the levels created by most probable sources, not enough radiation would be present in a dirty bomb to cause severe illness from exposure to radiation.

Past use of dirty bombs

According to a United Nations report, Iraq tested a dirty bomb device in 1987 but found that the radiation levels were too low to cause significant damage. Thus, Iraq abandoned any further use of the device.

What people should do following an explosion

Radiation cannot be seen, smelled, felt, or tasted by humans. Therefore, if people are present at the scene of an explosion, they will not know whether radioactive materials were involved at the time of the explosion. If people are not too severely injured by the initial blast, they should:

Leave the immediate area on foot. Do not panic. Do not take public or private transportation such as buses, subways, or cars because if radioactive materials were involved, they may contaminate cars or the public transportation system.

Go inside the nearest building. Staying inside will reduce people's exposure to any radioactive material that may be on dust at the scene.

Remove their clothes as soon as possible, place them in a plastic bag, and seal it. Removing clothing will remove most of the contamination caused by external exposure to radioactive materials. Saving the contaminated clothing would allow testing for exposure without invasive sampling.

Take a shower or wash themselves as best they can. Washing will reduce the amount of radioactive contamination on the body and will effectively reduce total exposure.

Be on the lookout for information. Once emergency personnel can assess the scene and the damage, they will be able to tell people whether radiation was involved.

Even if people do not know whether radioactive materials were present, following these simple steps can help reduce their injury from other chemicals that might have been present in the blast.

Taking potassium iodide (KI)

Potassium iodide, also called KI, only protects a person's thyroid gland from exposure to radioactive iodine. KI will not protect a person from other radioactive materials or protect other parts of the body from exposure to radiation. It must be taken prior to exposure (for example, if people hear that a radioactive cloud is coming their way) or immediately after exposure to be effective. Since there is no way to know at the time of an incident whether radioactive iodine was used in the explosive device, taking KI would probably not be beneficial.Also, KI can be dangerous to some people. Taking KI is not recommended unless there is a risk of exposure to radioactive iodine.

If radioactive materials were involved

Keep televisions or radios tuned to local news networks. If a radioactive material was released, people will be told where to report for radiation monitoring and blood tests to determine whether they were exposed to the radiation as well as what steps to take to protect their health.

Risk of cancer from a dirty bomb

Some cancers can be caused by exposure to radiation. Being at the site where a dirty bomb exploded does not guarantee that people were exposed to the radioactive material. Until doctors are able to check people's skin with sensitive radiation detection devices, it will not be clear whether they were exposed. Just because people are near a radioactive source for a short time or get a small amount of radioactive material on them does not mean that they will get cancer. Doctors will be able to assess risks after the exposure level has been determined.

ACUTE RADIATION SYNDROME

Radiation sickness, known as acute radiation sickness (ARS), is a serious illness that occurs when the entire body (or most of it) receives a high dose of radiation, usually over a short period of time. Many survivors of the Hiroshima and Nagasaki atomic bombs in the 1940s and many of the firefighters who first responded after the Chernobyl Nuclear Power Plant accident in 1986 became ill with ARS.

People exposed to radiation will get ARS only if:

The radiation dose was high (doses from medical procedures such as chest X-rays are too low to cause ARS; however, doses from radiation therapy to treat cancer may be high enough to cause some ARS symptoms),

The radiation was penetrating (that is, able to reach internal organs),

The person's entire body, or most of it, received the dose, and

The radiation was received in a short time, usually within minutes.

The first symptoms of ARS typically are nausea, vomiting, and diarrhea. These symptoms will start within minutes to days after the exposure, will last for minutes up to several days, and may come and go. Then the person usually looks and feels healthy for a short time, after which he or she will become sick again with loss of appetite, fatigue, fever, nausea, vomiting, diarrhea, and possibly even seizures and coma. This seriously ill stage may last from a few hours up to several months.

People with ARS typically also have some skin damage. This damage can start to show within a few hours after exposure and can include swelling, itching, and redness of the skin (like a bad sunburn). There also can be hair loss. As with the other symptoms, the skin may heal for a short time, followed by the return of swelling, itching, and redness days or weeks later. Complete healing of the skin may take from several weeks up to a few years depending on the radiation dose the person's skin received.

The chance of survival for people with ARS decreases with increasing radiation dose. Most people who do not recover from ARS will die within several months of exposure. The cause of death in most cases is the destruction of the person's bone marrow, which results in infections and internal bleeding. For the survivors, the recovery process may last from several weeks up to 2 years.

If a radiation emergency occurs that exposes people to high doses of radiation in a short period of time, they should immediately seek medical care from their doctor or local hospital.

POTASSIUM IODIDE (KI)

Recent terrorist events have many people concerned about potential future attacks using radioactive materials. Taking potassium iodide (KI) tablets after an incident involving radioactive materials may or may not limit the risk of damage to a person's thyroid gland from ionizing radiation. In this section, we examine when KI might be appropriate and what people should consider before making a decision to take KI.

When to take KI

Local emergency management officials will tell people when to take KI. If a nuclear incident occurs, officials will have to find out which radioactive substances are present before recommending that people take KI. If radioactive iodine is not present, then taking KI will not protect people. If radioactive iodine is present, then taking KI will help protect a person's thyroid gland from the radioactive iodine. Taking KI will not protect people from other radioactive substances that may be present along with the radioactive iodine.

The Food and Drug Administration (FDA) recommends that KI be taken as soon as the radioactive cloud containing iodine from the explosion is close by. KI may still have some protective effect even if it is taken 3 to 4 hours after exposure to radioactive iodine. Because the radioactive iodine will be present in the initial blast and decays quickly, a single dose of KI may be all that is required. The FDA recommendations on KI can be reviewed on the Web at http://www.fda.gov/cder/guidance/4825fnl.htm.

Forms of KI, and how much should be taken

KI comes in tablets of 130 mg. A one-time dose at the levels recommended in this fact sheet is usually all that is required. However, if a person expects to be exposed to radioactive iodine for more than 24 hours, another dose should be taken every 24 hours. People should listen to emergency management officials for recommendations after an incident. According to the FDA,

Adults should take one 130-mg tablet.

Children between 3 and 18 years of age should take one-half of a 130-mg tablet (65 mg).

Children between 1 month and 3 years of age should take one-fourth of a 130-mg tablet (32 mg).

Infants from birth to 1 month of age should be given one-eighth of a 130-mg tablet (16 mg).

Women who are breastfeeding should take the adult dose, and their infants should receive the recommended infant dose.

Children who are approaching adult size (greater than or equal to 150 pounds) should take the adult dose regardless of their age.

KI tablets can be stored for at least 5 years without losing their potency.

People should remember that taking a higher dose of KI, or taking KI more often than recommended, will not offer more protection and can cause severe illness and death due to allergic reaction.

How a nuclear incident might cause thyroid damage

Some types of radioactive incidents release radioactive iodine. The thyroid gland, which will use any iodine that is in a person's bloodstream, cannot tell the difference between radioactive and

nonradioactive forms of iodine. Because of this, the thyroid would rapidly absorb radioactive iodine just as it does iodine from a person's diet. The radioactive iodine releases energy (radiation) that, in high concentrations, can damage the cells of the thyroid gland. In some people, especially young children, this damage can cause thyroid cancer or other diseases of the thyroid within a few years of the exposure.

What KI is

KI is a salt of iodine. It is one of several ingredients that can be added to table salt to make it iodized. KI has also been approved by the FDA as a nonprescription drug for use as a "blocking agent" to prevent the human thyroid gland from absorbing radioactive iodine. However, KI may not provide people with 100% protection against all radioactive iodine. Its effectiveness will depend on a variety of factors, including when a person takes it, how much iodine is already in the person's thyroid, how fast the person's body processes it, and the amount of radioactive iodine the person is exposed to. Iodized table salt will not provide enough iodine to protect the thyroid and should not be used as a substitute.

Why KI would be important in the event of a nuclear incident

Because the thyroid will rapidly absorb any iodine that is in the body, people may need to take KI tablets soon after an incident that involves radioactive iodine. The KI will saturate the thyroid gland with iodine and help prevent it from absorbing radioactive iodine. However, KI does not prevent the effects of other radioactive elements. Using KI will only protect the thyroid gland from radioactive iodine. It will not protect other parts of the body from radioactive iodine, and it will not protect a person from other radioactive materials that may be released.

Who should or should not take KI when the public is told to do so

Children are the most susceptible to the dangerous effects of radioactive iodine. The FDA and the World Health Organization (WHO) recommend that children from newborn to 18 years of age all take KI unless they have a known allergy to iodine.

Women who are breastfeeding should also take KI, according to the FDA and WHO, to protect both themselves and their breast milk. However, breastfeeding infants should still be given the recommended dosage of KI to protect them from any radioactive iodine that they may breathe in or drink in breast milk.

Young adults between the ages of 18 and 40 have a smaller chance of developing thyroid cancer or thyroid disease from exposure to radioactive iodine than do children. However, the FDA and WHO still recommend that people ages 18 to 40 take the recommended dose of KI. This includes pregnant and breast-feeding women, who should take the same dose as other young adults.

Adults over the age of 40 have the smallest chance of developing thyroid cancer or thyroid disease after an exposure to radioactive iodine, but they have a greater chance of having an allergic reaction to the high dose of iodine in KI. Because of this, they are not recommended to take KI unless a very large dose of radioactive iodine is expected. People should listen to emergency management officials for recommendations after an incident.

Medical conditions that make it dangerous to take KI

The high concentration of iodine in KI can be harmful to some people. People should not take KI if they:

have ever had thyroid disease (such as hyperthyroidism, thyroid nodules, or goiter).

know they are allergic to iodine (if you are allergic to shellfish, ask your doctor or pharmacist about taking KI).

have certain skin disorders (such as dermatitis herpetiformis or urticaria vasculitis).

People should consult their doctor if they are unsure whether or not to take KI.

Facts about the thyroid gland

The thyroid is a small gland located in a person's neck on either side of the breathing tube (trachea). The thyroid has two parts, a right lobe and a left lobe, that are connected by a small strip of tissue called the isthmus. The main function of the thyroid gland is to create, store, and release thyroid hormones. These hormones regulate the body's metabolism.

Why iodine is important to the thyroid gland

The thyroid gland takes iodine from the bloodstream and uses it to make thyroid hormones. Without the required amounts of iodine, the thyroid will not be able to make these hormones. Most of the iodine in people's bodies comes from the food they eat.

Radiation Exposure Registry

Following an incident involving radioactive materials, CDC would work with Agency for Toxic Substances and Disease Registry (ATSDR) to establish an exposure registry. The purpose of this registry would be to monitor people's exposure to radiation and perform dose reconstructions to determine the exact amount of radiation to which people were exposed. This registry would help CDC determine the necessary long-term medical follow-up for those who were affected by the incident

Prussian Blue

About Prussian Blue

Prussian blue can remove select radioactive materials from people's bodies, but must be taken under the guidance of the Radiation Emergency Assistance Center/Training Site (REAC/TS) of the Oak Ridge Institute.

People may become internally contaminated (inside their bodies) with radioactive materials by accidentally ingesting (eating or drinking) or inhaling (breathing) them. The sooner that these materials are removed from the body, the fewer and less severe the health effects of the contamination will be. Prussian blue is a substance that can help remove certain radioactive materials from people's bodies. However, Prussian blue currently is available only when doctors have determined that a person is internally contaminated.

What Prussian blue is

Prussian blue was first produced as a blue dye in 1704 and has been used by artists and manufacturers ever since. It got its name from its use as a dye for Prussian military uniforms. Prussian blue dye and paint are still available today from art supply stores.

Use of Prussian blue to treat radioactive contamination

Since the 1960s, Prussian blue has been used to treat people who have been internally contaminated with radioactive cesium (mainly Cs-137) or thallium (mainly Tl-201). Prussian blue can be given at any point after doctors have determined that a person is internally contaminated. Prussian blue will help speed up the removal of cesium and thallium from the body.

How Prussian blue works

Radioactive cesium and thallium, whether ingested or inhaled, will end up in the intestines. Prussian blue traps these materials in the intestines and keeps them from being absorbed by the body. The radioactive materials then move through the intestines and are excreted in bowel movements. Prussian blue reduces the biological half-life of cesium in the body from about 115 days to about 40 days. Prussian blue reduces the biological half-life of thallium from about 8 days to about 3 days. Because Prussian blue reduces the time that radioactive cesium and thallium stay in the body, it helps limit the amount of time the body is exposed to radiation.

Who can take Prussian blue

People may be prescribed Prussian blue during an emergency when cesium or thallium has entered their bodies. Because Prussian blue is only approved for limited use it must be taken under the guidance of REAC/TS. The drug is safe for all adults, children, and infants, including pregnant women and women who are breast-feeding their babies. Prussian blue may not be recommended for people who have had constipation or blockages in the intestines.

Side effects of Prussian blue

The most common side effects of Prussian blue are upset stomach and constipation. These side effects can easily be treated with other medications. People will have blue feces during the time that they are taking Prussian blue.

Where you can get Prussian blue

Prussian blue is not routinely available. When approved for use by REAC/TS it is supplied in 500-milligram capsules that can be swallowed whole or mixed in liquid for children to drink. The amount to be taken depends on how badly a person is

contaminated. Prussian blue must be taken 3-4 times a day for up to 150 days, depending on the extent of the contamination, under the supervision of a doctor.

People **SHOULD NOT** take Prussian blue artist's dye in an attempt to treat themselves. This type of Prussian blue is not designed to treat radioactive contamination and is not manufactured in a germ-free area. People who are concerned about the possibility of being contaminated with radioactive cesium or thallium should go to their doctors for advice and treatment.

Where you can get more information

More detailed information on Prussian blue can be found at the REAC/TS web site, at the National Institutes of Health web site, or at the U.S. Food and Drug Administration web site. You may also call the CDC Public Response line at 1-800-311-3435 or visit the CDC web site to request more information.

Chapter 8

REFERENCES AND SOURCES FOR ADDITIONAL INFORMATION

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REFERENCES AND SOURCES:

CENTERS FOR DISEASE CONTROL

FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

FEDERATION OF AMERICAN SCIENTISTS

DEFENSE TECHNICAL INFORMATION CENTER (DTIC) -MILITARY CRITICAL TECHNOLOGIES LIST (MCTL)

AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY (ATSDR).

THE NUCLEAR REGULATORY COMMISSION

THE RADIATION EMERGENCY ASSISTANCE CENTER/TRAINING SITE (REAC/TS)

**Information contained in chapter 2, and the glossary were adapted from DTIC "weapons of Mass Destruction Technologies Military Critical Tecnlology List."*

*** ProfileS of chemical, nuclear and biological agents and diseases came primarily from the CDC and ATSDR.*

SOURCES FOR ADDITIONAL INFORMATION

CHEMICAL

How people can get more information about Chemical Agents including those discussed in this book

People can contact one of the following:

Regional poison control center (1-800-222-1222)
Centers for Disease Control and Prevention
Public Response Hotline (CDC)

English (888) 246-2675
Español (888) 246-2857
TTY (866) 874-2646
Emergency Preparedness and Response Web site (http://www.bt.cdc.gov/)
E-mail inquiries: cdcresponse@ashastd.org

Mail inquiries:
Public Inquiry c/o BPRP
Bioterrorism Preparedness and Response Planning
Centers for Disease Control and Prevention
Mailstop C-18
1600 Clifton Road
Atlanta, GA 30333
Phone: 1-888-422-8737
FAX: (404)498-0057

Agency for Toxic Substances and Disease Registry (ATSDR) (1-888-422-8737)
E-mail inquiries: atsdric@cdc.gov
Mail inquiries:
Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, Mailstop E-29
Atlanta, GA 30333
Centers for Disease Control and Prevention (CDC), National Institute for Occupational Safety and Health (NIOSH), Pocket Guide to Chemical Hazards
(http://www.cdc.gov/niosh/npg/npgd0000.html)

Agency for Toxic Substances and Disease Registry (ATSDR). Various Years. Toxicological profiles. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

To Get more information about "*PERSONAL CLEANING* AND DISPOSAL OF CONTAMINATED CLOTHING", 'SHELTERING IN PLACE," or about "*EVACUATION*," people can contact one of the following:

State and local health departments

Centers for Disease Control and Prevention Public Response Hotline (CDC)
Public Response Hotline (CDC)
English (888) 246-2675
Español (888) 246-2857
TTY (866) 874-2646
Emergency Preparedness and Response Web site (http://www.bt.cdc.gov/)
E-mail inquiries: cdcresponse@ashastd.org
Mail inquiries:
Public Inquiry c/o BPRP

Bioterrorism Preparedness and Response Planning
Centers for Disease Control and Prevention
Mailstop C-18

1600 Clifton Road
Atlanta, GA 30333

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BIOLOGICAL

To learn more about food safety and foodborne diseases?
National Food Safety Initiative
CDC's Food Safety Initiative home page
U.S. Food and Drug Administration
U.S. Food Safety and Inspection Service (FSIS)
U.S. Environmental Protection Agency
Role of the federal agencies in food safety
Gateway to government food safety information
Partnership for Food Safety Education/Fight BAC!TM
Food Safety Training and Education Alliance
Foodborne Illness Information Center
National Food Safety Education Month
Travelers' Health

RADIOLOGICAL/NUCLEAR

Where can I get more information about radiation, radiation health effects and emergency response?
More information can be obtained from the following U.S. government sources:

The Environmental Protection Agency

The Nuclear Regulatory Commission Radiation Protection and Emergency Response Program can be reached at (301) 415-8200

The Federal Emergency Management Agency (FEMA) can be reached at (202) 646-4600.

The Radiation Emergency Assistance Center/Training Site (REAC/TS) can be reached at (865) 576-3131 (ask for REAC/TS).

The U.S. National Response Team.

The U.S. Department of Energy (DOE) can be reached at 1-800-dial-DOE

You can find out your state radiation control director by contacting The Conference of Radiation Control Program Directors (CRCPD) at (502) 227-4543 or you may visit the CRCPD Web site.

IMPORTANT WEBSITES

For more information, see CDC's websites at http://www.cdc.gov, http://www.bt.cdc.gov, and http://www.cdc.gov/nceh/radiation/response.htm.

For more information about radiation and emergency response, see the Centers for Disease Control and Prevention's website at http://www.bt.cdc.gov or contact the following organizations:

To request more information, you may call the CDC Public Response line at 1-800-311-3435 or visit the web site at http://www.cdc.gov/netinfo.htm.

For more information about health effects from radiation exposure, check the following Web sites: www.epa.gov/radiation; www.orau.gov/reacts/injury.htm, www.cdc.gov/nceh/radiation/basicfacts.htm

For more information about preparing for a radiation emergency event or emergency response, check the following Web sites: www.fema.gov; www.redcross.org/services/disaster/beprepared/, www.epa.gov/swercepp/, www.ojp.usdoj.gov/bja

For more information about Potassium Iodide (KI), check the following Web sites: www.cdc.gov/nceh/radiation/ki.htm, www.fda.gov/cder/drugprepare/KI_Q&A.htm, www.fda.gov/cder/guidance/4825fnl.htm

For more information about radiation terrorist events, check the following Web sites: www.cdc.gov/nceh/radiation/Q&A.htm, www.orau.gov/reacts, www.nrt.org, www.energy.gov, www.nrc.gov, www.epa.gov

Radioactive Isotopes (Radioisotopes): For more information about radioisotopes [Americium - 241 (Am-241); Celsium-137 (Cs-137); Cobalt-60 (C0-60); Iodine (I-129 & I-131); Plutonium-239 (Pu-239); Strontium-90 (Sr-90) ; Uranium-235 (U-235) and Uranium-238 (U-238)]see the Public Health Statement by the Agency for Toxic Substances and Disease Registry at http://www.atsdr.cdc.gov/toxprofiles, or visit the Environmental Protection Agency at http://www.epa.gov/radiation/radionuclides/americium.htm.

For more information about health effects related to these radioisotopes see CDC's fact sheet on "Radiation and Health Effects," at www.bt.cdc.gov/radiation/healthfacts.asp.

For more information on protecting yourself before or during a radiologic emergency, see CDC's fact sheet titled "Frequently Asked Questions (FAQs) About a Radiation Emergency" at www.bt.cdc.gov/radiation/emergencyfaq.asp, and "Sheltering in Place During a Radiation Emergency," at www.bt.cdc.gov/radiation/shelter.asp

GLOSSARY & DEFINITIONS

This section includes definitions of terms used in this book. When a definition from another document is identified, that source is given in parentheses at the end of the definition, according to the following:

CWC Chemical Weapons Convention

DoD Department of Defense

EAR Export Administration Regulations

ISO International Standards Organization

ITAR International Traffic in Arms Regulations

JP Joint Publication

NATO North Atlantic Treaty Organization

WA Wassenaar Arrangement

AG agents. Australia Group agents.

Alpha Particles are subatomic particles made up of two neutrons and two protons ejected from the nucleus of an unstable atom. These particles are not able to penetrate most materials-even a piece of paper or the outer layer of human skin can block an alpha particle. However, when alpha-emitting unstable atoms are inhaled, alpha particles become particularly dangerous because they will kill lung cells, which could lead to scarring and possible cancer. Gamma radiation is a packet of energy, sometimes called a photon, that is emitted from the nucleus of an unstable atom.

Anemia. Decreased ability of the blood to transport oxygen.

Australia Group. An informal international forum, chaired by Australia, that seeks to discourage and impede the proliferation of chemical and biological weapons by harmonizing national export controls on chemical materials, biological organisms, and dual-use equipment that could be used in production of chemical and biological weapons.

Bacteria. Bacteria are small free-living organisms, most of which may be grown on solid or liquid culture media. The organisms have a structure consisting of nuclear material, cytoplasm, and cell membrane. They reproduce by simple division. The diseases they produce often respond to specific therapy with antibiotics.

ballistic missile. Any missile which does not rely upon aerodynamic surfaces to produce lift and consequently follows a ballistic trajectory when thrust is terminated.

Beta particles are subatomic particles that are ejected from the nucleus of unstable atoms. Beta particles can travel through several layers of human skin, and exposure to large sources of beta radiation can cause burns or skin reddening. Beta particles that enter the body can damage cells, which may lead to cell death or, later in life, to cancer.

binary chemical munition. A munition in which chemical substances, held in separate containers, react when mixed or combined as a result of being fired, launched, or otherwise initiated to produce a chemical agent.

biological agent. A microorganism that causes disease in personnel, plants, or animals, or causes the deteriora-tion of material. (JP 1-02)

Biological Attack
A biological attack is the deliberate release of germs or other biological substances that can make you sick. Many agents must be inhaled, enter through a cut in the skin or be eaten to make you sick. Some biological agents, such as anthrax, do not cause contagious diseases. Others, like the smallpox virus, can result in diseases you can catch from other people.

biological defense. The methods, plans, and procedures involved in establishing and executing defensive measures against attacks using biological agents. (JP 1-02)

Biological half-life is the time that it takes a substance in the body to be reduced by ½.
biological weapon. An item of materiel which projects, disperses, or disseminates a biological agent including arthropod vectors. (JP 1-02)

Biological Weapons Convention (BWC). An inter-national agreement in which parties agree not to develop, produce, stockpile, or acquire biological agents or toxins "of types and in quantities that have no justification for prophylactic, protective, and other peaceful purposes," as well as related weapons and means for delivery. It was signed on April 10, 1972, and entered into force on March 26, 1975.

blister agent (vesicant). An agent that burns and blisters the skin, eyes, respiratory tract, or lungs. See also **vesicant.**

blood agent. An agent that prevents the normal transfer of oxygen from the blood to body tissues.

Brilliant munition. A many-on-many munition that operates autonomously to search for, detect, identify, acquire, and attack specific classes of targets. The sensor on each munition acquires and attacks one among the class of targets, so that in a battlefield situation two munitions may attack the same target leaving others inviolate.
CAS. Chemical Abstracts Service.
Carcinogen. A substance with the ability to cause cancer
Carcinogenicity. Ability to cause cancer.
chemical agent. A chemical substance which is intended for use in military operations to kill, seriously injure, or incapacitate personnel through its physio-logical effects. The term excludes riot control agents, herbicides, smoke, and flame (JP 1-02). (Note that the USML definition is more inclusive than the JointPub 1-02 definition). See also **chemical warfare agent.**

Chemical Attack
A chemical attack is the deliberate release of a toxic gas, liquid or solid that can poison people and the environment.

chemical defense. The methods, plans, and procedures involved in establishing and executing defensive meas-ures against attack utilizing chemical agents. (JP 1-02)

chemical warfare agent. A chemical substance which, because of its physiological, psychological, or pharma-cological (chemical agent) effects, is intended for use in military operations to kill, seriously injure, or incapaci-tate humans (or animals) through its toxicological

effects. Excluded are riot control agents, chemical herbicides, and smoke and flame materials. Chemical agents are nerve agents, incapacitating agents, blister agents (vesicants), lung-damaging agents, blood agents, and vomiting agents.

chemical weapon (CW). "(a) Toxic chemicals and their precursors, except where intended for purposes not prohibited under this Convention, as long as the types and quantities are consistent with such purposes; (b) Munitions and devices, specifically designed to cause death or other harm through the toxic properties of those toxic chemicals specified in subparagraph (a), which would be released as a result of the employment of such munitions and devices; (c) Any equipment specifically designed for use directly in connection with the employment of munitions and devices specified in subparagraph (b)." (CWC, Article II)

Chemical Weapons Convention (CWC). A multi-lateral treaty that bans the development, production, acquisition, stockpiling, retention, and direct or indirect transfer of chemical weapons. It also prohibits the use or preparation for use of CW and the assistance, encouragement, or inducement of anyone else to engage in activities prohibited by the treaty. It further requires participating states to destroy existing chemical weapons and any CW production facilities.

Chemical Weapon Convention (CWC) Schedules. In the CWC, the three categories into which toxic chemicals and their precursors are divided based on the threat the chemicals/precursors pose to the purpose and objectives of the treaty and the extent of their commercial use.

chemotactic events. The response of living cells to chemicals in the environment. Usually describing the swimming of bacteria toward (positive chemotaxis) or away from (negative chemotaxis) a specific chemical. The chemotactic event results from the interaction of the chemical in the medium with receptors in the living cell.

Chlamydia. Chlamydia are obligatory intracellular parasites incapable of generating their own energy source. Like bacteria, they are responsive to broad-spectrum antibiotics. Like viruses, they require living cells for multiplication.

choking agent. An agent that attacks the eyes and respiratory tract from the nose to the lungs, primarily causing pulmonary edema ("dry drowning").

Chromosomes. Parts of the cells responsible for the development of hereditary characteristics.

combinatorial chemistry. Methods of synthesizing rapidly large numbers of peptides, polynucleotides, or other low-molecular-weight compounds. Thousands to millions of compounds can be synthesized simultaneously in hours. These compounds are synthesized in solution or on a solid-state matrix. The resulting com-pounds can be tested for highly selective and high affinity binding to biological/ chemical agents, to biological receptors, or to portions of genetic materials. Because of their binding properties, the compounds or the information obtained from their use can be used in the design and fabrication of sensors, pharmaceuticals, behavior modifiers, and food stabilizers. As described in an article by James Krieger, *C&EN*, May 12, 1997, p. 30, "combinatorial chemistry generates lead com-pounds that could exhibit biological activity against a particular target.... For drug hunters, helping to identify targets is a function of bioinformatics. That branch of computer-based information management deals with genomic information, from gene discovery to DNA and protein sequence...." Companies involved include MSI; Oxford Molecular Group, California; and MDL Information Systems, California. The conceptual framework for this emerged in part from the work of Merrifield at Rockefeller University in the early 1970's.

communications. The process of representing, transferring, interpreting, or processing

information (data) among persons, places, or machines. Communications implies a sender, a receiver, and a transmission medium over which the information travels. The meaning assigned to the data must be recoverable without degra-dation. See also **telecommunications**.

contamination. (1) The deposit, absorption, or adsorp-tion of radioactive material, or of biological or chemical agents on or by structures, areas, personnel, or objects. (2) Food and/or water made unfit for consumption by humans or animals because of the presence of environ-mental chemicals, radioactive elements, bacteria or organisms, the byproduct of the growth of bacteria or organisms, the decomposing material (to include the food substance itself), or waste in the food or water. (JP 1-02)

Conventional unguided projectiles. Those which do not incorporate directional warheads, including warheads employing multi-point initiation to achieve focused blast/ fragmentation characteristics; submunitions or submunition capacity; fuel/air explosives; provisions for increasing the range or impact velocity; kinetic energy armor penetration capability; mid-flight guidance; terminal guidance.

cruise missile. An unmanned, self-propelled, guided vehicle that sustains flight through aerodynamic lift for most of its flight path and whose primary mission is to place an ordnance or special payload on a target.

CWC Schedules. In the CWC, the three categories into which toxic chemicals and their precursors are divided based on the threat the chemicals/precursors pose to the purpose and objectives of the Treaty and the extent of their commercial use.

decontamination (DECON). The process of making any person, object, or area safe by absorbing, destroying, neutralizing, making harmless, or removing chemical or biological agents or by removing radio-active material clinging to or around it.

Detonation (high-explosive). A violent chemical reaction with a chemical compound or mechanical mixture evolving heat and pressures.

detonation, nuclear. A nuclear explosion resulting from fission or fusion reactions in nuclear materials, such as that from a nuclear weapon.

detonator. (1) An explosive train component that can be activated by either a nonexplosive impulse or a primer and can reliably initiate high-order detonation in a subsequent high-explosive component of the train. When activated by a nonexplosive impulse, a detonator includes a primer. In general, detonators are classified by method of initiation, such as percussion, stab, electric, flash, etc. See specific definitions. (2) An explosive charge placed in certain equipment and set to destroy the equipment under certain conditions.

Developing Critical Technologies (DCT). Technolo-gies which will produce increasingly superior performance of military systems or maintain a superior capability more affordably.

explosive ordnance. All munitions containing explosives, nuclear fission or fusion materials, and biological and chemical agents. This includes bombs and war-heads; guided and ballistic missiles, artillery, mortar, rocket, and small arms ammunition; all mines, torpedoes, and depth charges; demolition charges; pyro-technics; clusters and dispensers; cartridge- and propellant-actuated devices; electro-explosive devices; clandestine and improvised explosive devices; and all similar or related items or components explosive in nature. (DoD, NATO)

extra-national groups. Groups that are not generally bound by the same constraints and mores or motivated by the same factors as nation-states. In some cases they cross national or regional boundaries; they are also referred to as transnational groups.

extranational organizations. See extra-national groups.

first responders. Those who are the first to respond to an emergency situation, generally law enforcement, fire fighters, and emergency medical personnel.

fixed ammunition. Ammunition rounds in which the cartridge with propellant and the loaded shell or bullet are all in one unit. With semifixed rounds the cartridge case is not permanently fixed to the projectile, so that zone charges within cases can be adjusted to obtain desired ranges, but each round is inserted into a weapon as a unit.

fixed-sequence manipulation mechanisms. Automated moving devices, operating according to mechanically fixed programmed motions. The program is mechanically limited by fixed stops, such as pins or cams. The sequence of motions and the selection of paths or angles are not variable or changeable by mechanical, electronic, or electrical means.

Fungi. Fungi are primitive plants which do not utilize photosynthesis, are capable of anaerobic growth, and draw nutrition from decaying vegetable matter. Most fungi form spores, and free-living forms are found in soil. The spore forms of fungi are operationally significant. Fungal diseases may respond to various antimicrobial.

Gamma radiation can penetrate most substances because of its high energy (lead is the best barrier against gamma radiation). Gamma radiation can penetrate the human body and damage cells, which could lead to cancer later in life.

Gene Probes - These are polynucleotides that are 20–30 units bend, under stringent conditions, complementory nucleic acid fragments characteristic of biological agents. These units provide the basis of rapid detection and identification.

genetic engineering. The development and application of scientific methods, procedures, and technologies that permit direct manipulation of genetic material to alter the hereditary traits of a cell, organism, or population.

Geneva Protocol of 1925. A multilateral agreement that prohibits the use of poisonous gases and bacteriological weapons in war. It was opened for signature in 1925 and was ratified by the United States in 1975.

grenade. A small explosive or chemical missile, originally to be thrown by hand, but now also to be projected from special grenade launchers, usually fitted to rifles or carbines. Grenades may be classified as either rifle or hand. Many variations of these have been used, including improvisations.

G-series nerve agents. This series of nonpersistent nerve agents includes tabun, sarin, soman, and GF. They are organophosphorus compounds that inhibit action of a key nervous system enzyme (acetylcholinesterase).

guidance munition. A "one-on-one" munition: a specific munition engages a specific target, which is advantageous during close-combat situations. An operator is required in the loop to select the target and often assist in the guidance. The munitions may be either CLOS or "terminal homing" devices.

hit to kill. A munition system incorporating integrated seeker, guidance and control, and fuze subsystems, the warhead of which is initiated upon target impact or in close proximity thereto.

ICt50. The ICt (incapacitating concentration time)50 is the time in which 50 percent of the exposed population will be incapacitated.

ID50. The ID (incapacitating dose)50 is the dose which incapacitates 50 percent of the exposed population.

igniter. Any chemical, electrical, or mechanical device used to ignite.

incapacitation. The state which is achieved when weapons effects result in physical inability (real or perceived) or mental disinclination to act in a hostile or threatening manner.

incapacitating agent. An agent that produces temporary physiological or mental effects, or both, which will render individuals incapable of concerted effort in the performance of their assigned duties. (JP 1-02)

information. Characteristics, quantities, properties, designators, or instructions (elements of information) of any material or immaterial entity or process.

Information security. All the means and functions ensuring the accessibility, confidentiality or integrity of information or communications, excluding the means and functions intended to safeguard against malfunctions. This includes "cryptography," "cryptanalysis," protection against compromising emanations, and computer security.

Information system. People, technologies, and machines used to capture or generate, collect, record, store, retrieve, process, display and transfer or communicate information to multiple users at appropriate levels of an organization to accomplish a specified set of functions.

Information systems. The entire infrastructure, organization, personnel, and components that collect, process, store, disseminate, and act on information.

information warfare. Actions taken to achieve information superiority by affecting adversary information, information-based processes, information systems, and computer-based networks while defending one's own information, information-based processes, information systems, and computer-based networks.

laser (light amplification by stimulated emission of radiation). An assembly of components which produce both spatially and temporally coherent light that is amplified by the stimulated emission of radiation. (WA)

LCt50. The LCt (lethal concentration time)50 is the exposure time which will kill 50 percent of the exposed population.

LD50. The dose (LD is lethal dose) that will kill 50 percent of the exposed population.

lethality. A descriptive term used to indicate the amount of a substance that would be required to kill.

liquid explosive. Explosive which is fluid at normal temperatures. (JP 1-02)

liquid propellant. (1) Any liquid combustible fed to the combustion chamber of a rocket engine. (JP 1-02) **(2)** Any liquid energetic material designed for use as a propellant charge (e.g., a gun propellant).

local area network (LAN). A communications network of limited geographic extent that interconnects attached equipment and may provide gateway connections to other networks.

low explosive (LE). An explosive that, when used in its normal manner, deflagrates or burns rather than detonates.

magnetic gradiometers. Instruments designed to detect the spatial variation of magnetic fields from sources external to the instrument. They consist of multiple "magnetometers" and

associated electronics, the output of which is a measure of magnetic field gradient. (WA). See also **intrinsic magnetic gradiometer**.

magnetometers. Instruments designed to detect magnetic fields from sources external to the instrument. They consist of a single magnetic field-sensing element and associated electronics, the output of which is a measure of the magnetic field. (WA)

Metabolites: Breakdown products of chemicals.

Militarily critical technologies. Technologies, the technical performance parameters of which are at or above the minimum level necessary to ensure continuing superior performance of U.S. military systems.

Military high explosives. Solid, liquid, or gaseous substances or mixtures of substances which are required to detonate in their application as primary, booster, ormain charge in warhead, demolition, and other military applications.

Milligram (mg). One thousandth of a gram.

Milligram (mg). One thousandth of a gram.

Monoclonal Antibodies - In the early 1970's, Kohler and Milstein developed a procedure to produce antibodies for a single antigenic epitope. An epitope is the region of a molecule that initiates the production of a single antibody species. The dimensions of an epitope approximate a surface area 50 50 Angstroms. These antibodies are called monoclonal antibodies. With quality control, these antibodies can be produced in gram quantities in a highly reproducible manner, and therefore, they are suited for industrial uses. The industries currently using monoclonal antibodies include medical diagnostics, food, environmental protection, and cosmetics.

munition. A complete device charged with explosives, propellants, pyrotechnics, initiating composition, or nuclear, biological or chemical material for use in military operations, including demolitions. Certain suitably modified munitions can be used for training, ceremonial, or nonoperational purposes. Also called ammuni-tion. [Note: In common usage, "munitions" (plural) can be military weapons, ammunition, and equipment.] (DoD, NATO). See also **explosive ordnance**.

mustard (HD). A vesicant chemical warfare agent which has been used extensively in warfare. Creates destruction of epidermis, eye and pulmonary injury, and, in high doses, bone-marrow depression.

nerve agent. Extremely toxic compounds that produce convulsions and rapid death by inactivating an enzyme (acetylcholinesterase) essential for the normal trans-mission of nerve impulses.

nitrogen mustard. A vesicant which attacks deoxy-ribonucleic acid (DNA). Is also used as a antineoplastic agent (classed as an alkylating agent). Several were developed as CW agents. Also produces pulmonary injury and bone-marrow depression.

nonpersistent agent. A chemical agent that disperses or vaporizes rapidly after release and presents an immediate short duration hazard. These agents are generally released as aerosols, gases, vapors, liquids, or solids.

Nuclear Blast

A nuclear blast is an explosion with intense light and heat, a damaging pressure wave and widespread radioactive material that can contaminate the air, water and ground surfaces for miles around. While experts may predict at this time that a nuclear attack is less likely than other types, terrorism by its nature is unpredictable.

nuclear reactor. A device containing fissionable material in sufficient quantity arranged in a manner to sustain a controlled nuclear reaction.

pathogen. Any agent capable of causing disease, although usually applied to living agents.

persistent agent. A chemical agent that, when released, remains able to cause casualties for more than 24 hours to several days or weeks. (JP 1-02)

Pesticide. A substance that kills pests.
Ppm. Parts per million.

precision-guided munition. A munition equipped with a sensor that interacts with its aerodynamic control surfaces and falls into one of the following categories: "guided," "smart," or "brilliant."

precursor. A specialty chemical compound from which another product such as explosives, chemical agents, or high-strength/high-modulus ceramic or carbon fibers are derived.

Production. All production stages, such as product engineering, manufacture, integration, assembly (mounting), inspection, testing, and quality assurance.

propellant. That source which provides the energy required for propelling a projectile. Specifically, an explosive charge for propelling a projectile; also a fuel, either solid or liquid, for propelling a rocket or missile.

prophylaxis. Measures designed to preserve health and prevent the spread of disease, that is, protective, preservative treatment.

protocols. Communication instruction sets which include rules governing how data is structured into packets and sent from one machine to another.

Radiation Threat

A radiation threat, commonly referred to as a "dirty bomb" or "radiological dispersion device (RDD)", is the use of common explosives to spread radioactive materials over a targeted area. It is not a nuclear blast. The force of the explosion and radioactive contamination will be more localized. While the blast will be immediately obvious, the presence of radiation will not be clearly defined until trained personnel with specialized equipment are on the scene. As with any radiation, you want to try to limit exposure.

Rickettsiae. Rickettsiae are microorganisms which have characteristics common to both bacteria and viruses. Like bacteria, they possess metabolic enzymes and cell membranes, utilize oxygen, and are susceptible to broad spectrum antibiotics. They resemble viruses in that they grow only within living cells.

riot control agents. Substances which in low concen-trations produce temporarily irritating or disabling physical effects that disappear within minutes of removal from exposure. There is minimal risk of permanent injury, and medical treatment is rarely required. (WA)

rogue nations. While there is no standard definition, rogue nations are generally those that defy the civilized world and operate outside of international norm, especially with respect to the development of weapons of mass destruction, drugs, and counterfeiting.

rogue states. See rogue nations.

sarin. A nerve agent of the organophosphate group which inhibits acetylcholinesterase.

Seeker. A device that orients a munition's sensor to survey, acquire, lock-on, and track a target.
Sensor fuzed munition. A "shoot-to-kill," "smart" munition of relatively low complexity and cost, which is most effective "close-in" against targets with a narrowly defined location and for which there are small delivery errors.

signature. Any or all of the properties of an object that may be used for the detection, identification, or engagement of the object or its origin. Plume signature characteristics include smoke, radiation emissions, visibility, radar absorption, self absorption, etc.

Shoot-to-kill system. A sensor-fuzed munition that does not incorporate expensive seeker and guidance and control subsystems. The warhead is initiated tens of meters from the target while the munition is aimed at the target.
Smart materials. Materials that have the capability to respond to an external stimulus by changing, in a controlled manner according to prescribed functional relationships or control algorithms, their energy dissipation properties and geometric configuration, or by changing their stiffness.

smart munition. A "many-on-many" munition with target selection capability that does not require an operator in the loop.

soman. A nerve agent member of the organophosphate group, it inhibits acetylcholinesterase and is used as a chemical warfare agent.

Sufficient Technology. The level of technology required for a proliferant to produce entry level WMD, delivery systems, or other hardware or software useful in WMD development integration or use.

tabun. A nerve agent member of the organophosphate group which inhibits acetylcholinesterase. It is used as a chemical warfare agent and is the least toxic of the nerve agents, but can cause death rapidly.

tear gases. Gases which produce temporarily irritating or disabling effects which disappear within minutes of removal from exposure. (WA)

technologies for weapons of mass destruction. Tech-nologies required for development, integration, or employment of biological, chemical, or nuclear weapons and their means of delivery.

technology. Specific information and know-how necessary for the development, production, or use of a product. This includes engineering and integration for systems (groups of interacting elements acting as a complex whole) as well as individual hardware and soft-ware elements necessary to achieve that purpose.

telecommunications. Any process that enables one or more users to pass to one or more other users infor-mation of any nature delivered in any usable form by wire, radio, visual, or other electrical, electromagnetic, or optical means. The word is derived from the Greek *tele*, "far off." and the Latin *communicare,* "to share." See also **communications.**

toxic chemical. Any chemical which through its chemical action on life processes can cause death, temporary incapacitation, or permanent harm to humans or animals in military feasible quantities.

toxin. Poisonous substances produced by living organisms. Toxins are poisonous substances produced and derived from living plants, animals, or microorganisms; some toxins may also be

produced or altered by chemical means. Toxins may be countered by specific antisera and selected pharmacologic agents.

Turnkey plant. Consists of all the hardware, software, technical data, and technical assistance necessary for the installation of a complete operating facility for the production of the commodity, a chemical substance, at defined production rates and to specified product qualities. Hardware consists of all the equipment, components, control valves, instruments, reaction vessels, feed lines, and exposition proof barriers necessary for the conduct of the unit operations of the overall production process, whether the items are assembled or disassembled for transportation. The plant may be designed for installation at a prepared site that includes locally constructed and installed explosion-proof barricades

uranium enriched in the isotopes 235 or 233. Uranium containing the isotopes 235, 233, or both in the amount such that the abundance ratio of the sum of these isotopes to the isotope 238 is more than the ratio of the isotope 235 to the isotope 238 occurring in nature (isotopic ratio: 0.72 percent).

use. Operation, installation (including on-site instal-lation), maintenance (checking), repair, overhaul, and refurbishing. (WA)

vaccines. Materials that when appropriately admin-istered into immune, competent, responsive persons and animals will enable the human and animal recipient to become resistant to infection. The body produces anti-bodies that react with the infectious agent. Multi-component and multivalent vaccines specifically protect populations against two or more pathogens.

vesicant. Toxic chemicals that have a blistering effect on the skin.

virus. Any of a large group of submicroscopic agents infecting plants, animals, and bacteria and unable to reproduce outside the tissues of the host. A fully formed virus consists of nucleic acid (DNA or RNA) surrounded by a protein or protein and lipid coat. Viruses are organisms which require living cells in which to replicate. They are therefore intimately dependent upon the cells of the host which they infect. They produce diseases which generally do not respond to antibiotics but which may be responsive to antiviral compounds, of which there are few available, and those that are available are of limited use.

V-series nerve agents A class of chemical agents developed in the 1950's that act by inhibiting a key nervous system enzyme. They are generally persistent and have moderate to high toxicity. Examples are VE, VG, VM, VS, and VX. See also **nerve agent**.

Wassenaar Arrangement. A multilateral arrangement on export control for conventional weapons and dual-use goods and technologies. It was designed to promote transparency and responsibility in transfers of conventional arms and dual-use goods and technologies, thus preventing destabilizing accumulations that could lead to threats to international and regional peace and security.

warhead. That portion of a rocket or guided missile that contains the load that the vehicle is to deliver. It may be empty or contain high explosives, chemicals, instru-

A-31 A-32 ments, or inert materials. It may also include a booster, fuze(s), adaption kits, and/or burster(s).

weapons of mass destruction. Weapons that are capable of a high order of destruction and/or of being used in such a manner as to destroy large numbers of people. Weapons of mass destruction

can be high explosives or nuclear, biological, chemical, and radio-logical weapons, but exclude the means of transporting or propelling the weapon where such means is a separable and divisible part of the weapon. Also called WMD. (JP 1-02)

Weapons of Mass Destruction (WMD) Technologies. Technologies used in weapons of mass destruction and their means of delivery. "Weapons of Mass Destruction Technologies," addresses those technologies required for development, integration, or employment of biological, chemical, or nuclear weapons and their means of delivery. It addresses technologies that, generally, proliferators might use to develop WMD.

Weapons Systems Technologies (WST). Technologies critical to the development and production of superior weapons.

The following abbreviations are also used:
- USML: United States Munitions List
- CCL*: Commerce Control List
- NRC: Nuclear Regulatory Commission
- WA: Wassenaar Arrangement
- Cat: category designation—CCL and WA Dual Use list
- ML: Munitions List
- NTL: Nuclear Trigger List (Nuclear Suppliers Group)
- NDUL: Nuclear Dual Use List (Nuclear Suppliers Group)
- MTCR: Missile Technology Control Regime
- AG List: Australia Group List
- BWC: Biological Weapons Convention
- CWC: Chemical Weapons Convention

APPENDIXES

APPENDIX A: THE CENTERS FOR DISEASE CONTROL AND PREVENTION (CDC)

About CDC

The Centers for Disease Control and Prevention (CDC) is recognized as the lead federal agency for protecting the health and safety of people - at home and abroad, providing credible information to enhance health decisions, and promoting health through strong partnerships. CDC serves as the national focus for developing and applying disease prevention and control, environmental health, and health promotion and education activities designed to improve the health of the people of the United States.

CDC, located in Atlanta, Georgia, USA, is an agency of the Department of Health and Human Services

CDC's Mission

To promote health and quality of life by preventing and controlling disease, injury, and disability.

CDC seeks to accomplish its mission by working with partners throughout the nation and world to monitor health, detect and investigate health problems, conduct research to enhance prevention, develop and advocate sound public health policies, implement prevention strategies, promote healthy behaviors, foster safe and healthful environments, and provide leadership and training.

The Centers for Disease Control and Prevention (CDC) protects people's health and safety by preventing and controlling diseases and injuries; enhances health decisions by providing credible information on critical health issues; and promotes healthy living through strong partnerships with local, national, and international organizations

CDC's Roles in the Event of a Radiological Terrorist Event

Lead Federal Agencies

In the event of a radiological accident or terrorist attack, the agency that is responsible for the site of the incident also has responsibility for responding to the emergency and protecting the people, property, and environment around the area. For example, if the incident occurs on property owned by the federal government, such as a military base, research facility, or nuclear facility, then the federal government takes responsibility. In areas that are not controlled by the federal government, the state and local governments have the responsibility to respond to the emergency and protect people, property, and the environment.

Regardless of whether the state, local, or federal government is responsible for responding to the emergency, a federal agency would be sent to the terrorist incident site and would act as the Lead Federal Agency (LFA). This agency would work with the state and local government and might be the Nuclear Regulatory Commission (NRC), the Federal Bureau of Investigation (FBI), or another agency depending on what type of incident occurred (accidental or intentional release of radioactive materials) and where it occurred (nuclear power plant versus a spilled radioactive material in an urban or suburban area). The LFA would implement the Federal Radiological

Emergency Response Plan (FRERP); within this plan, the Department of Health and Human Services (HHS) has the major role in protecting people's health through:

Monitoring, assessing, and following up on people's health
Ensuring the safety of workers involved in and responding to the incident
Ensuring that the food supply is safe
Providing medical and public health advice

CDC's Roles

As part of Department of Health & Human Services (HHS), CDC would be the chief public health entity to respond to a radiological incident, whether accidental or intentional. As the chief public health entity, CDC's specific roles and responsibilities would include:

Assessing the health of people affected by the incident

Assessing the medical effects of radiological exposures on people in the community, emergency responders and other workers, and high-risk populations (such as children, pregnant women, and those with immune deficiencies)

Advising state and local health departments on how to protect people, animals, and food and water supplies from contamination by radioactive materials

Providing technical assistance and consultation to state and local health departments on medical treatment, follow-up, and decontamination of victims exposed to radioactive materials

Establishing and maintaining a registry of people exposed to or contaminated by radioactive materials

CDC's Partners

To carry out its roles, CDC would work with many other agencies to ensure that people's health is protected. These agencies may include:

State and Local Health Departments
Department of Defense (DoD)
Department of Energy (DOE)
Department of Transportation (DOT)
HHS
Food and Drug Administration (FDA)
Agency for Toxic Substances and Disease Registry (ATSDR)
Office of Emergency Response (OER)
Health Resources and Services Administration (HRSA)
Substance Abuse and Mental Health Services Administration (SAMHSA)
Environmental Protection Agency (EPA)
FBI
Federal Emergency Management Agency (FEMA)
NRC
Department of Agriculture (USDA)

CDC's Actions

In the hours and days following a radiological incident, CDC would assist and advise the LFA and the state and local health departments on recommendations that the community would need to:

Protect people from radioactive fallout
Protect people from radioactive contamination in the area
Safely use food and water supplies from the area
Assess and explain the dangers in the area of the incident

If necessary, CDC would also deploy the National Pharmaceutical Stockpile, a federal store of drugs and medical supplies set aside for emergency situations.

In addition, CDC would give workers in the area information on:
The amount of time they can safely work in an area contaminated with radioactive materials
Equipment needed to protect themselves from radiation and radioactive materials
Types of respiratory devices needed to work in the contaminated area
How to use radiation monitoring devices

Radiation Exposure Registry

Following an incident involving radioactive materials, CDC would work with Agency for Toxic Substances and Disease Registry (ATSDR) to establish an exposure registry. The purpose of this registry would be to monitor people's exposure to radiation and perform dose reconstructions to determine the exact amount of radiation to which people were exposed. This registry would help CDC determine the necessary long-term medical follow-up for those who were affected by the incident.

APPENDIX B: FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

The Federal Emergency Management Agency - a former independent agency, in March 2003 joined 22 other federal agencies, programs and offices in becoming the Department of Homeland Security.

As it has for more than 20 years, FEMA's mission remains: to lead America to prepare for, prevent, respond to and recover from disasters with a vision of "A Nation Prepared." Fema is tasked with responding to, planning for, recovering from and mitigating against disasters. At no time in its history has this vision been more important to the country than in the aftermath of Sept. 11th.

MITIGATION DIVISION OF FEMA

About This Division

The Mitigation Division manages the National Flood Insurance Program and oversees FEMA's mitigation programs. It includes organizational activities to promote Protection, Prevention, and Partnerships at the Federal, State, local, and individual levels.

In the aftermath of the terrorist attacks against America on September 11th, 2001, President George W. Bush decided 22 previously disparate domestic agencies needed to be coordinated into one department to protect the nation against threats to the homeland. As part of the major reorganization into the Department of Homeland Security (www.dhs.gov) during March 2003, the former Mitigation Division was named the Mitigation Division. The staff, resources, authorities, missions and functions of this organization will continue with the closest coordination possible in the delivery of the nation's natural hazard reduction programs.

The overall mission is to protect lives and prevent the loss of property from natural hazards. We will continue FEMA's efforts to reduce the loss of life and property and to protect our nation's institutions from all types of hazards through a comprehensive, risk-based emergency management program of preparedness & preventive techniques. The work of our national programs is a major component of emergency management since these programs focus on protection of life and property and the prevention of future losses through partnerships with governments at the State and local levels as well as the private sector. The Mitigation Division administers the following nationwide, risk-reduction programs and Congressionally-authorized efforts:

The National Flood Insurance Program
The National Dam Safety Program
The National Earthquake Hazards Reduction Program
The National Hurricane Program
The Hazard Mitigation Grant Program
Flood Mitigation Assistance Program, and
Pre-Disaster Mitigation authorized by the Disaster Mitigation Act of 2000

FEMA REGIONAL OFFICES

FEMA has ten regional offices, and two area offices. Each region serves several states, and regional staff work directly with the states to help plan for disasters, develop mitigation programs, and meet needs when major disasters occur.

FEMA Region I serves the federal emergency management needs of the State of Maine, the State of New Hampshire, the State of Vermont, the State of Rhode Island, the State of Connecticut, and the Commonwealth of Massachusetts.

FEMA Region II serves the federal emergency management needs of the State of New York, the State of New Jersey, the Commonwealth of Puerto Rico and the Territory of the U.S. Virgin Islands.

FEMA Region III

FEMA's Region III serves the District of Columbia, Delaware, Maryland, Pennsylvania, Virginia and West Virginia.

FEMA Region V serves the Midwest states of Illinois, Indiana, Michigan, Minnesota, Ohio and Wisconsin. V.

FEMA Region VI states include Arkansas, Louisiana, New Mexico, Oklahoma and Texas.

FEMA Region VII serves the states of Iowa, Kansas Missouri and Nebraska

FEMA Region VIII serves the states of Colorado • Montana • North Dakota • South Dakota • Utah • Wyoming

FEMA Region IX serves the states of Arizona, California, Hawaii and Nevada, as well as the territories of American Samoa and Guam, the Commonwealth of the Northern Mariana Islands, the Republic of the Marshall Islands and the Federated States of Micronesia.

FEMA Region X states include Alaska, Idaho, Oregon and Washington.

State Offices and Agencies of Emergency Management

Alabama Emergency Management Agency
5898 County Road 41
P.O. Drawer 2160
Clanton, Alabama 35046-2160
(205) 280-2200
(205) 280-2495 FAX
http://www.aema.state.al.us/

Alaska Division of Emergency Services
P.O. Box 5750
Fort Richardson, Alaska 99505-5750
(907) 428-7000
(907) 428-7009 FAX
http://www.ak-prepared.com

American Samoa Territorial Emergency Management Coordination (TEMCO)
American Samoa Government

P.O. Box 1086
Pogo Pogo, American Samoa 96799
(011)(684) 699-6415
(011)(684) 699-6414 FAX

Arizona Division of Emergency Management
5636 E. McDowell Rd
Phoenix, Arizona 85008
(602) 244-0504 or 1-800-411-2336
http://www.dem.state.az.us

Arkansas Department of Emergency Management
P.O. Box 758
Conway, Arkansas 72033
(501) 730-9750
(501) 730-9754 FAX
http://www.adem.state.ar.us/

California Governor's Office of Emergency Services
P.O. Box 419047
Rancho Cordova, CA 95741-9047
(916) 845-8510
(916) 845-8511 FAX
http://www.oes.ca.gov/

Colorado Office of Emergency Management
Division of Local Government
Department of Local Affairs
15075 South Golden Road
Golden, Colorado 80401-3979
(303) 273-1622
(303) 273-1795 FAX
www.dola.state.co.us/oem/oemindex.htm

Connecticut Office of Emergency Management
Military Department
360 Broad Street
Hartford, Connecticut 06105
(860) 566-3180
(860) 247-0664 FAX
http://www.mil.state.ct.us/OEM.htm

Delaware Emergency Management Agency
165 Brick Store Landing Road
Smyrna, Delaware 19977
(302) 659-3362
(302) 659-6855 FAX
http://www.state.de.us/dema/index.htm

District of Columbia Emergency Management Agency
2000 14th Street, NW, 8th Floor
Washington, D.C. 20009
(202) 727-6161
(202) 673-2290 FAX
http://www.dcema.dc.gov

Florida Division of Emergency Management
2555 Shumard Oak Blvd.
Tallahassee, Florida 32399-2100
(850) 413-9969
(850) 488-1016 FAX
www.floridadisaster.org

Georgia Emergency Management Agency
P.O. Box 18055
Atlanta, Georgia 30316-0055
(404) 635-7000
(404) 635-7205 FAX
http://www.State.Ga.US/GEMA/

Office of Civil Defense
Government of Guam
P.O. Box 2877
Hagatna, Guam 96932
(011)(671) 475-9600
(011)(671) 477-3727 FAX
http://ns.gov.gu/

Hawaii State Civil Defense
3949 Diamond Head Road
Honolulu, Hawaii 96816-4495
(808) 733-4300
(808) 733-4287 FAX
http://www.scd.state.hi.us

Idaho Bureau of Disaster Services
4040 Guard Street, Bldg. 600
Boise, Idaho 83705-5004
(208) 334-3460
(208) 334-2322 FAX
http://www.state.id.us/bds/bds.html

Illinois Emergency Management Agency
110 East Adams Street
Springfield, Illinois 62701
(217) 782-2700
(217) 524-7967 FAX
http://www.state.il.us/iema

Indiana State Emergency Management Agency
302 West Washington Street
Room E-208 A
Indianapolis, Indiana 46204-2767
(317) 232-3986
(317) 232-3895 FAX
http://www.ai.org/sema/index.html

Iowa Division of Emergency Management
Department of Public Defense
Hoover Office Building
Des Moines, Iowa 50319
(641) 281-3231
(641) 281-7539 FAX
http://www.state.ia.us/government/dpd/emd/index.htm

Kansas Division of Emergency Management
2800 S.W. Topeka Boulevard
Topeka, Kansas 66611-1287
(785) 274-1401
(785) 274-1426 FAX
http://www.ink.org/public/kdem/

Kentucky Emergency Management
EOC Building
100 Minuteman Parkway Bldg. 100
Frankfort, Kentucky 40601-6168
(502) 607-1682
(502) 607-1614 FAX
http://kyem.dma.state.ky.us

Louisiana Office of Emergency Preparedness
7667 Independence Blvd.
Baton Rouge, Louisiana 70806
(225) 925-7500
(225) 925-7501 FAX
http://www.loep.state.la.us

Maine Emergency Management Agency
State Office Building, Station 72
Augusta, Maine 04333
(207) 626-4503
(207) 626-4499 FAX
http://www.state.me.us/mema/memahome.htm

CNMI Emergency Management Office
Office of the Governor
Commonwealth of the Northern Mariana Islands
P.O. Box 10007
Saipan, Mariana Islands 96950
(670) 322-9529
(670) 322-7743 FAX
http://www.cnmiemo.org/

National Disaster Management Office
Office of the Chief Secretary
P.O. Box 15
Majuro, Republic of the Marshall Islands
96960-0015
(011)(692) 625-5181
(011)(692) 625-6896 FAX

Maryland Emergency Management Agency
Camp Fretterd Military Reservation
5401 Rue Saint Lo Drive
Reistertown, Maryland 21136
(410) 517-3600
(877) 636-2872 Toll-Free
(410) 517-3610 FAX
http://www.mema.state.md.us/

Massachusetts Emergency Management Agency
400 Worcester Road
Framingham, Massachusetts 01702-5399
(508) 820-2000
(508) 820-2030 FAX
http://www.state.ma.us/mema

Michigan Division of Emergency Management
4000 Collins Road
P.O. Box 30636
Lansing, Michigan 48909-8136
(517) 333-5042
(517) 333-4987 FAX
http://www.michigan.gov/msp/1,1607,7-123-1593_3507---,00.html

National Disaster Control Officer
Federated States of Micronesia
P.O. Box PS-53
Kolonia, Pohnpei - Micronesia 96941
(011)(691) 320-8815
(001)(691) 320-2785 FAX

Minnesota Division of Emergency Management
Department of Public Safety
Suite 223
444 Cedar Street
St. Paul, Minnesota 55101-6223
(651) 296-2233
(651) 296-0459 FAX
http://www.dps.state.mn.us/emermgt/

Mississippi Emergency Management Agency
P.O. Box 4501 - Fondren Station
Jackson, Mississippi 39296-4501
(601) 352-9100
(800) 442-6362 Toll Free
(601) 352-8314 FAX
http://www.mema.state.ms.us
http://www.memaorg.com

Missouri Emergency Management Agency
P.O. Box 16
2302 Militia Drive
Jefferson City, Missouri 65102
(573) 526-9100
(573) 634-7966 FAX
http://www.sema.state.mo.us/semapage.htm

Montana Division of Disaster & Emergency Services
1100 North Main
P.O. Box 4789
Helena, Montana 59604-4789
(406) 841-3911
(406) 444-3965 FAX
http://www.state.mt.us/dma/des/index.shtml

Nebraska Emergency Management Agency
1300 Military Road
Lincoln, Nebraska 68508-1090
(402) 471-7410
(402) 471-7433 FAX
http://www.nebema.org

Nevada Division of Emergency Management
2525 South Carson Street
Carson City, Nevada 89711
(775) 687-4240
(775) 687-6788 FAX
http://dem.state.nv.us/

Governor's Office of Emergency Management
State Office Park South
107 Pleasant Street
Concord, New Hampshire 03301
(603) 271-2231
(603) 225-7341 FAX

New Jersey Office of Emergency Management
Emergency Management Bureau
P.O. Box 7068
West Trenton, New Jersey 08628-0068
(609) 538-6050 Monday-Friday
(609) 882-2000 ext 6311 (24/7)
(609) 538-0345 FAX
http://www.state.nj.us/oem/county/

New Mexico Department of Public Safety
Office of Emergency Services & Security
P.O. Box 1628
13 Bataan Boulevard
Santa Fe, New Mexico 87505
(505) 476-9600
(505) 476-9695 FAX
http://www.dps.nm.org/emergency/index.htm
Emergency Management Bureau
Department of Public Safety
P.O. Box 1628
13 Bataan Boulevard
Santa Fe, New Mexico 87505
(505) 476-9606
(505) 476-9650
http://www.dps.nm.org/emc.htm

New York State Emergency Management Office
1220 Washington Avenue
Building 22, Suite 101
Albany, New York 12226-2251
(518) 457-2222
(518) 457-9995 FAX
http://www.nysemo.state.ny.us/

North Carolina Division of Emergency Management
116 West Jones Street
Raleigh, North Carolina 27603
(919) 733-3867
(919) 733-5406 FAX
http://www.dem.dcc.state.nc.us/

North Dakota Division of Emergency Management
P.O. Box 5511
Bismarck, North Dakota 58506-5511
(701) 328-8100
(701) 328-8181 FAX
http://www.state.nd.us/dem

Ohio Emergency Management Agency
2855 W. Dublin Granville Road
Columbus, Ohio 43235-2206
(614) 889-7150
(614) 889-7183 FAX
http://www.state.oh.us/odps/division/ema/

Office of Civil Emergency Management
Will Rogers Sequoia Tunnel 2401 N. Lincoln
Oklahoma City, Oklahoma 73152
(405) 521-2481
(405) 521-4053 FAX

http://www.odcem.state.ok.us/

Oregon Emergency Management
Department of State Police
595 Cottage Street, NE
Salem, Oregon 97310
(503) 378-2911 ext. 225
(503) 588-1378
http://www.osp.state.or.us/oem/oem.htm

Palau NEMO Coordinator
Office of the President
P.O. Box 100
Koror, Republic of Palau 96940
(011)(680) 488-2422
(011)(680) 488-3312

Pennsylvania Emergency Management Agency
P.O. Box 3321
Harrisburg, Pennsylvania 17105-3321
(717) 651-2001
(717) 651-2040 FAX
http://www.pema.state.pa.us/

Puerto Rico Emergency Management Agency
P.O. Box 966597
San Juan, Puerto Rico 00906-6597
(787) 724-0124
(787) 725-4244 FAX

Rhode Island Emergency Management Agency
645 New London Ave
Cranston, Rhode Island 02920-3003
(401) 946-9996
(401) 944-1891 FAX
http://www.state.ri.us/riema/riemaaa.html

South Carolina Emergency Management Division
1100 Fish Hatchery Road
West Columbia South Carolina 29172
(803) 737-8500
(803) 737-8570 FAX
http://www.state.sc.us/epd/

South Dakota Division of Emergency Management
500 East Capitol
Pierre, South Dakota 57501-5070
(605) 773-6426
(605) 773-3580 FAX
http://www.state.sd.us/state/executive/military/sddem.htm

Tennessee Emergency Management Agency
3041 Sidco Drive
Nashville, Tennessee 37204-1502
(615) 741-4332
(615) 242-9635 FAX
http://www.tnema.org

Texas Division of Emergency Management
5805 N. Lamar
Austin, Texas 78752
(512) 424-2138
(512) 424-2444 or 7160 FAX
http://www.txdps.state.tx.us/dem/

Utah Division of Emergency Services and Homeland Security
1110 State Office Building
P.O. Box 141710
Salt Lake City, Utah 84114-1710
(801) 538-3400
(801) 538-3770 FAX
http://www.des.utah.gov

Vermont Emergency Management Agency
Department of Public Safety
Waterbury State Complex
103 South Main Street
Waterbury, Vermont 05671-2101
(802) 244-8721
(802) 244-8655 FAX
http://www.dps.state.vt.us/

Virgin Islands Territorial Emergency Management - VITEMA
2-C Contant, A-Q Building
Virgin Islands 00820
(340) 774-2244
(340) 774-1491

Virginia Department of Emergency Management
10501 Trade Court
Richmond, VA 23236-3713
(804) 897-6502
(804) 897-6506
http://www.vdem.state.va.us

State of Washington Emergency Management Division
Building 20, M/S: TA-20
Camp Murray, Washington 98430-5122
(253) 512-7000
(253) 512-7200 FAX
http://www.wa.gov/wsem/

West Virginia Office of Emergency Services
Building 1, Room EB-80 1900 Kanawha Boulevard, East
Charleston, West Virginia 25305-0360
(304) 558-5380
(304) 344-4538 FAX
http://www.state.wv.us/wvoes

Wisconsin Emergency Management
2400 Wright Street
P.O. Box 7865
Madison, Wisconsin 53707-7865
(608) 242-3232
(608) 242-3247 FAX
http://emergencymanagement.wi.gov/

Wyoming Emergency Management Agency
5500 Bishop Blvd.
Cheyenne, Wyoming 82009-3320
(307) 777-4920
(307) 635-6017 FAX
http://wema.state.wy.us

APPENDIX C: RADIOACTIVE ISOTOPES [Americium - 241 (Am-241); Celsium-137 (Cs-137); Cobalt-60 (C0-60); Iodine (I-129 & I-131); Plutonium-239 (Pu-239); Strontium-90 (Sr-90) ; Uranium-235 (U-235) and Uranium-238 (U-238)]

Americium-241 (Am-241)

Half-life: 432.2 years

Mode of decay: Alpha particles and weak gamma radiation

Chemical properties: Crystalline metal that is solid under normal conditions. Am-241 can be combined with beryllium to produce neutrons.

Uses of Am-241

Am-241 is used in some medical, industrial, and commercial devices.

Sources of Am-241

Am-241 is a manmade metal that is produced from plutonium. Am-241 found in the environment is the result of past nuclear weapons testing.

Forms of Am-241

Am-241 found in the environment is in the form of microscopic dust. Am-241 used in industrial, medical or consumer devices is in the form of small coin-sized metal or plastic discs.

What Ami-241 looks like

Am-241 is a silver-white metal that is solid under normal conditions.

What the health effects may be

As a dust or a fine power, Am-241 may cause certain cancers. When the powder is swallowed, absorbed through a wound or inhaled, it may be retained in the body for long periods of time. Once it circulates through the body, Am-241 concentrates in the bones, liver, and muscles, exposing these organs to alpha particles.

Celsium-137 (Cs-137)

Half-life: 30.17 years

Mode of decay: Beta and gamma radiation

Chemical properties: Liquid at room temperature, but readily bonds with chlorides to form a powder.

What is it used for?

Cs-137 is used in small amounts for calibration of radiation-detection equipment, such as Geiger-Mueller counters. In larger amounts, Cs-137 is used in medical radiation therapy devices for treating cancer; in many industrial gauges that detect the flow of liquid through pipes; and in other industrial devices to measure the thickness of materials, such as paper, photographic film, or sheets of metal.

Where does it come from?

Cs-137 is produced by nuclear fission for use in medical devices and gauges. Cs-137 also is one of the byproducts of nuclear fission processes in nuclear reactors and nuclear weapons testing. Small quantities of Cs-137 can be found in the environment from nuclear weapons tests that occurred in the 1950s and 1960s and from nuclear reactor accidents, as in 1986 when wind currents distributed Cs-137 to many countries in Europe after the Chernobyl power plant accident.

What form is it in?

Because it readily bonds with chlorides, Cs-137 usually occurs as a crystalline powder, rather than in its pure liquid form.

What does it look like?

Small amounts of Cs-137 are incorporated into Lucite disks, rods, and seeds. Larger Cs-137 sources are enclosed in lead containers (such as long tubes that are closed at each end) or small round metal containers. If the lead containers of Cs-137 are opened, the substance inside looks like a white powder and may glow. Cs-137 from nuclear accidents or atomic bomb explosions cannot be seen and will be present in dust and debris from fallout.

How can I be exposed to Cs-137?

Small amounts of Cs-137 are present in the environment from weapons testing in the 1950s and 1960s, so people are exposed to some Cs-137 every day. However, Cs-137 is dangerous in the large, concentrated amounts found in radiation therapy units and industrial gauges. The sources in these devices are designed to remain sealed and keep people from being exposed; however, if these canisters are intentionally or accidentally opened, the Cs-137 inside could be dispersed

How can it hurt me?

External exposure to large amounts of Cs-137 can cause burns, acute radiation sickness, and even death. Exposure to Cs-137 can increase the risk for cancer because of exposure to high-energy gamma radiation. Internal exposure to Cs-137, through ingestion or inhalation, allows the radioactive material to be distributed in the soft tissues, especially muscle tissue, exposing these tissues to the beta particles and gamma radiation and increasing cancer risk.

CELSIUM
What is cesium?

Cesium (chemical symbol Cs) is a metal that may be stable (nonradioactive) or unstable (radioactive). The most common radioactive form of cesium is cesium-137. Another fairly common radioisotope is cesium-134. Cesium-137 is much more significant as an environmental contaminant than cesium-134. It is also very useful in industry for its strong radioactivity.

Who discovered cesium and cesium-137?
In 1860, Gustav Kirchhoff and Robert Bunsen discovered nonradioactive cesium in mineral water in Germany. Radioactive cesium-137, and many other radionuclides that are used in nuclear medicine, was discovered in the late 1930s by Glenn T. Seaborg and his coworker, Margaret Melhase.

Where does cesium-137 come from?
Nonradioactive cesium occurs naturally in various minerals. Radioactive cesium-137 is produced when uranium and plutonium absorb neutrons and undergo fission. Examples of the uses of this process are nuclear reactors and nuclear weapons. The splitting of uranium and plutonium in fission creates numerous fission products. Cesium-137 is one of the more well-known fission products.

What are the properties of cesium-137?
Cesium, as well as cesium-137, is a soft, malleable, silvery white metal. Cesium is one of only three metals that is a liquid near room temperature (83 °F). The half-life of cesium-137 is 30 years. It decays by emission of a beta particle and gamma rays to barium-137m.

What is cesium-137 used for?
Cesium-137 is one of the most common radioisotopes used in industry. Thousands of devices use cesium-137:

moisture-density gauges, widely used in the construction industry
leveling gauges, used in industries to detect liquid flow in pipes and tanks
thickness gauges, for measuring thickness of sheet metal, paper, film and many other products
well-logging devices in the drilling industry to help characterize rock strata

Cesium-137 is also used in medical therapy to treat cancer.

Exposure to Cesium and Cesium-137

How does cesium-137 get into the environment?
Cesium-137 in the environment came from a variety of sources. The largest single source was fallout from atmospheric nuclear weapons tests in the 1950s and 1960s, which dispersed and deposited cesium-137 world-wide. However much of the cesium-137 from testing has now decayed.

Nuclear reactor waste and accidental releases such as the Chernobyl accident in the Ukraine release some cesium-137 to the environment. Spent nuclear fuel reprocessing plant wastes may introduce small amounts to the environment. However, the U.S. does not currently reprocess spent nuclear fuel.

Although hospitals and research laboratories generate wastes containing cesium-137. they usually do not enter the environment. Occasionally, industrial instruments containing cesium-137 are lost or stolen. Anyone who unwittingly handles them, may be exposed. These devices are typically

metal, and may be considered scrap metal and sold for recycling. If they find their way into a steel mill and are melted, they can cause significant environmental contamination. They may also be discarded and sent to a municipal landfill, or sold for other reasons.

How does cesium-137 change in the environment?
Cesium-137 undergoes radioactive decay with the emission of beta particles and relatively strong gamma radiation. Cesium-137 decays to barium-137m, a short-lived decay product, which in turn decays to a nonradioactive form of barium. The half-life of cesium-137 is 30.17 years. Because of the chemical nature of cesium, it moves easily through the environment. This makes the cleanup of cesium-137 difficult.

How do people come in contact with cesium-137?
Everyone is exposed to very small amounts of cesium-137 in soil and water as a result of atmospheric fallout. In the Northern Hemisphere, the average annual dose from exposure to cesium-137 associated with atmospheric fallout is less than 1 mrem; this dose continues to diminish every year as cesium-137 decays.

People may also be externally exposed to gamma radiation emitted by cesium-137 by walking on contaminated sites, coming in contact with waste materials at contaminated sites, breathing the air around these sites, and drinking contaminated water. Also, people may unknowingly handle a strong industrial source of cesium-137.

How do I know if I'm near cesium-137?
You need special equipment to detect the presence of any radionuclide. You cannot feel exposure to cesium-137, or taste or smell it.

How does cesium-137 get into the body?
People may ingest cesium-137 with food and water, or may inhale it as dust. If cesium-137 enters the body, it is distributed fairly uniformly throughout the body's soft tissues, resulting in exposure of those tissues. Slightly higher concentrations of the metal are found in muscle, while slightly lower concentrations are found in bone and fat. Compared to some other radionuclides, cesium-137 remains in the body for a relatively short time. It is eliminated through the urine. Exposure to cesium-137 may also be external (that is, exposure to its gamma radiation from outside the body).

Health Effects of Cesium-137

How can cesium-137 affect people's health?
Like all radionuclides, exposure to radiation from cesium-137 results in increased risk of cancer. Everyone is exposed to very small amounts of cesium-137 in soil and water as a result of atmospheric fallout. Exposure to waste materials, from contaminated sites, or from nuclear accidents can result in cancer risks much higher than typical environmental exposures. Great Britain's National Radiological Protection Board predicts that there will be up to 1,000 additional cancers over the next 70 years among the population of Western Europe exposed to fallout from the nuclear accident at Chernobyl, in part due to cesium-137.

If exposures are very high,serious burns, and even death, can result. Instances of such exposure are very rare. One example of a high-exposure situation would be the mishandling a strong industrial cesium-137 source. The magnitude of the health risk depends on exposure conditions.

These include such factors as strength of the source, length of exposure, distance from the source, and whether there was shielding between you and the source (such as metal plating).

Is there a medical test to determine exposure to cesium-137?
Yes, there are several. However, they are not routinely available in a doctor's office, because they require special laboratory equipment. Some tests can measure the amount of radionuclides in urine, or in fecal samples, even at very low levels. A technique called "whole-body counting" can detect gamma radiation emitted by cesium-137 in the body. A variety of portable instruments can directly measure cesium-137 on the skin or hair. Other techniques include directly measuring the level of cesium-137 in soft tissues samples from organs or from blood, bones, and milk.

Protecting People from Cesium-137

What can I do to protect myself and my family from cesium-137?
Cesium-137 that is dispersed in the environment, like that from atmospheric testing, is almost impossible to avoid. However the exposure from cesium-137 in the environment is very small. Serious exposure is unlikely. People most likely to accidentally encounter a cesium-137 source typically work in scrap metal sorting, sales and brokerage, metal melting and casting, and in municipal landfill operations. They may unwittingly encounter an industrial instrument containing a sealed cesium-137 radiation source.

What is EPA doing about Cesium-137?
Both EPA and the Nuclear Regulatory Commission regulate Cesium-137. The Nuclear Regulatroy Comission licenses the its use. EPA has several regulations that protect you from cesium-137 in the environment. These include standards for the maximum amount of cesium-137 that nuclear facilities may release to the air, and maximum levels for cesium-137 in drinking water. EPA also sets risk-based criteria for clean up of soil and groundwater at sites contaminated with cesium-137 that must be met before the site can be approved for public use.

COBALT

Cobalt-60 (Co-60)

Half-life: 5.27 years

Mode of decay: Beta particles and gamma radiation

Chemical properties: Metallic solid that can become magnetically charged

What is it used for?

Co-60 is used medically for radiation therapy as implants and an external source of radiation exposure. It is used industrially in leveling gauges and to x-ray welding seams and other structural elements to detect flaws. Co-60 also is used for food irradiation, a sterilization process.

Where does it come from?

Nonradioactive cobalt occurs naturally in various minerals and has long been used as a blue coloring agent for ceramic and glass. Radioactive Co-60 is produced commercially through linear

acceleration for use in medicine and industry. Co-60 also is a byproduct of nuclear reactor operations, when metal structures, such as steel rods, are exposed to neutron radiation.

What form is it in?

Co-60 occurs as a solid material and might appear as small metal disks or in a tube, enclosed at both ends, that holds the small disks. Co-60 can occur as a powder if the solid sources have been ground or damaged.

What does it look like?

Co-60 is a hard, gray-blue metal. It resembles iron or nickel.

How can it hurt me?
Because it decays by gamma radiation, external exposure to large sources of Co-60 can cause skin burns, acute radiation sickness, or death. Most Co-60 that is ingested is excreted in the feces; however, a small amount is absorbed by the liver, kidneys, and bones. Co-60 absorbed by the liver, kidneys, or bone tissue can cause cancer because of exposure to the gamma radiation.

What is cobalt?
Cobalt (chemical symbol Co) is a metal that may be stable (nonradioactive, as found in nature), or unstable (radioactive, man-made). The most common radioactive isotope of cobalt is cobalt-60.

Who discovered cobalt and cobalt-60?
In 1735, a Swedish scientist, George Brandt, demonstrated that a blue color common in colored glass was caused by a new element, cobalt. Previously, people thought that bismuth, which occurs in nature with cobalt, was the cause. Radioactive cobalt-60 was discovered by Glenn T. Seaborg and John Livingood at the University of California - Berkeley in the late 1930's.

Where do cobalt and cobalt-60 come from?
Nonradioactive cobalt occurs naturally in various minerals, and has been used for thousands of years to impart blue color to ceramic and glass. The radionuclide, cobalt-60, is produced for commercial use in linear accelerators. It is also produced as a by-product of nuclear reactor operations, when structural materials, such as steel, are exposed to neutron radiation.

What are the properties of cobalt-60?
Cobalt (including cobalt-60) is a hard, brittle, gray metal with a bluish tint. It is solid under normal conditions and is generally similar to iron and nickel in its properties. In particular, cobalt has can be magnetized similar to iron.

What is cobalt-60 used for?
Cobalt-60 is used in many common industrial applications, such as in leveling devices and thickness gauges, and in radiotherapy in hospitals. Large sources of cobalt-60 are increasingly used for sterilization of spices and certain foods. The powerful gamma rays kill bacteria and other pathogens, without damaging the product. After the radiation ceases, the product is not left radioactive. This process is sometimes called "cold pasteurization."

Cobalt-60 is also used for industrial radiography, a process similar to an x-ray, to detect structural flaws in metal parts. Radionuclides, such as cobalt-60, that are used in industry or

medical treatment are encased in shielded metal containers or housings, and are referred to as radiation 'sources.' The shielding keeps operators from being exposed to the strong radiation.

Exposure to Cobalt-60

How does cobalt-60 get into the environment?
Occasionally, medical or industrial radiation sources are lost or stolen. We call these "orphan sources." They pose a significant risk:

- On a number of occasions, people have handled them, not knowing what they were, and have been exposed.

- Sometimes sources find their way into municipal landfills, where it is illegal to dispose of them.

- Because of their metallic housings, sources can get mixed in with scrap metal and pass undetected into scrap metal recycling facilities. If melted in a mill, they can contaminate the entire batch of metal and the larger facility, costing millions of dollars in lost productivity and cleanup costs. The scrap industry uses radiation detectors to screen incoming material. However, sources that are under large loads may be undetected initially.

Cobalt-60 can also be released to the environment through leaks or spills at nuclear power plants, and in solid waste originating from nuclear power plants. Nuclear Regulatory Commission regulations allow small amounts of cobalt-60 to be released into the air, or poured down drains as part of a liquid.

How does cobalt-60 change in the environment?
Cobalt-60 undergoes radioactive decay with the emission of beta particles and strong gamma radiation. It ultimately decays to nonradioactive nickel. The half-life of cobalt-60 is 5.27 years. This is short enough to make isolation a useful treatment strategy for contaminated areas. In some cases, simply waiting 10 to 20 years allows for sufficient decay to make the site acceptable for use again.

How do people come in contact with cobalt-60?
Most exposure to cobalt-60 takes place intentionally during medical tests and treatments. Such exposures are carefully controlled to avoid the adverse health impacts and to maximize the benefits of medical care. Accidental exposures may occur as the result of loss or improper disposal of medical and industrial radiation sources. Though relatively rare, exposure has also occurred by accidental mishandling of a source at a metal recycling facility or steel mill.

How does cobalt-60 get into the body?
People may ingest cobalt-60 with food and water that has been contaminated, or may inhale it in contaminated dust. The major concern posed by cobalt-60, however, is external exposure to its strong gamma rays. This may occur if you are exposed to an orphaned source, or if you come in contact with waste from a nuclear reactor (though this is very unlikely).

What does cobalt do once it gets into the body?

Once in the body, some cobalt-60 is quickly eliminated in the feces. The rest is absorbed into the blood and tissues, mainly the liver, kidney, and bones. Absorbed cobalt leaves the body slowly, mainly in the urine.

Health Effects of Cobalt-60
How can cobalt-60 affect people's health?
All ionizing radiation, including that of cobalt-60, is known to cause cancer. Therefore, exposures to gamma radiation from cobalt-60 result in an increased risk of cancer.

External expsosure to cobalt-60 is usually considered a greater threat, because it emits such strong gamma rays. The magnitude of the health risk depends on the quantity of cobalt-60 involved and on exposure conditions:

- length of exposure
- distance from the source (for external exposure)
- whether the cobalt-60 was ingested or inhaled.

Is there a medical test to determine exposure to cobalt-60?
Yes, there are several. However they are not routinely available in a doctor's office because they require special laboratory equipment.

Some tests can measure the amount of cobalt-60 in urine, even at very low levels. Scientist can estimate the amount in the body from the amount measured in the urine.

A technique called "whole-body counting" can detect gamma radiation emitted by cobalt-60 in the body. A variety of portable instruments can directly measure cobalt-60 on the skin or hair.

Other techniques include measuring the level of cobalt-60 in soft tissues (such as organs) and in blood, bones, milk, or feces]

Protecting People from Cobalt-60

How do I know if I'm near cobalt-60?
You need special equipment to detect the presence of any radionuclide.

What can I do to protect myself and my family from cobalt-60?
You are unlikely to encounter cobalt-60 unless you undergo certain medical treatments. Thorough discussions with your doctor about the amount of exposure and potential alternatives allow you to make informed decisions about the relative risks.

Although it is very unlikely, you may accidentally encounter a sealed radiation source containing cobalt-60 that has escaped proper control ("orphaned sources").

What is EPA doing about cobalt-60?
Cobalt-60 is regulated by both the EPA and the Nuclear Regulatory Commission. The Nuclear Regulatory Commission has jurisdiction over the licensing and use of cobalt-60 sources, and disposal of cobalt-60 sources.

EPA has several regulations that control cobalt-60 in the environment, including standards for the maximum amount of cobalt-60 that nuclear facilities may release to the air, maximum contaminant levels for cobalt-60 in drinking water, and risk-based criteria for soil and groundwater at sites previously contaminated with cobalt-60.

IODINE

Iodine-131 (I-131)

Half-life: 8.06 days

Mode of decay: Beta particles and gamma radiation

Chemical properties: I-131 can change directly from a solid to a gas, skipping the liquid phase, in a process called sublimation. I-131 dissolves easily in water or alcohol and is highly reactive.

What is it used for?

I-131 is used in medicine to diagnose and treat cancers of the thyroid gland. I-131 also is used in industrial tracers.

Where does it come from?

I-131 is produced commercially for medical and industrial uses through nuclear fission. It also is a byproduct of nuclear fission processes in nuclear reactors and weapons testing.

What form is it in?

In medicine, I-131 is supplied in capsules or liquid of a specific activity designed to be swallowed by patients. As a product of nuclear fission, it is a dark purple gas that can be inhaled, or absorbed through the skin. I-131 in fallout from nuclear weapons or reactor accidents can occur in particle form, which can be ingested in food or water.

What does it look like?

Pure I-131 is a non-metallic, purplish-black crystalline solid. However, because it readily reacts with other chemicals, I-131 usually is found as a compound rather than in its pure form. For medical purposes, the I-131 capsules contain small granules of I-131 sodium iodide that are designed to be swallowed by patients. Liquid I-131 sodium iodide used to diagnose and treat thyroid disease is a clear liquid.

How can it hurt me?

The thyroid gland, a small organ located in the neck near the Adam's apple, uses iodine to produce thyroid hormones. The thyroid gland cannot distinguish between radioactive iodine and stable (nonradioactive) iodine. If I-131 were released into the atmosphere, people could ingest it in food products, milk, or water, or breathe it in. The thyroid gland would then absorb the I-131 and get a dose of radiation from it, increasing the risk for thyroid cancer or other thyroid

problems. External exposure to large amounts of I-131 can cause burns to the eyes and on the skin.

What is radioactive iodine?
Iodine (chemical symbol I) is a nonmetallic solid element. There are both radioactive and non-radioactive isotopes of iodine. Iodine-129 and -131 are the most important radioactive isotopes in the environment. Some isotopes of iodine, such as I-123 and I-124 are used in medical imaging and treatment, but are generally not a problem in the environment because they have very short half-lives.

Who discovered iodine?
In 1811, Bernard Courtois discovered natural iodine in water that was used to dissolve certain parts of seaweed ash for use. Radioactive iodine-131 was discovered by Glenn T. Seaborg and John Livingood at the University of California - Berkeley in the late 1930's.

Where do iodine-129 and iodine-131 come from?
Both iodine-129 and iodine-131 are produced by the fission of uranium atoms during operation of nuclear reactors and by plutonium (or uranium) in the detonation of nuclear weapons.

What are the properties of iodine-129 and iodine-131?
Radioactive iodines have the same physical properties as stable iodine. However, radioactive iodines decay with time

Iodine is a nonmetallic, purplish-black crystalline solid. It has the unusual property of 'sublimation,' which means that it can go directly from a solid to a gas, without first becoming liquid. It sublimes to a deep violet vapor at room temperature. This vapor is irritating to the eyes, nose and throat. Iodine dissolves in alcohol and in water. It melts at 236 °F.

Iodine reacts easily with other chemicals, and isotopes of iodine are found as compounds rather than as a pure elemental nuclide. Thus, iodine-129 and -131 found in nuclear facilities and waste treatment plants quickly form compounds with the mixture of chemicals present. However, iodine released to the environment from nuclear power plants is usually a gas.

Iodine-129 has a half-life of 15.7 million years; iodine-131 has a half-life of about 8 days. Both emit beta particles upon radioactive decay.

What are iodine radioisotopes used for?
Iodines are among the most widely used radionuclides, mostly in the medical field. Because of its short half-life and useful beta emission, iodine-131 is used extensively in nuclear medicine.

- Its tendency to collect in the thyroid gland makes iodine especially useful for diagnosing and treating thyroid problems. Iodine-123 is widely used in medical imaging, and I-124 is useful in immunotherapy.

- Iodine's chemical properties make it easy to attach to molecules for imaging studies. It is useful in tracking the metabolism of drugs or compounds, or for viewing structural defects in various organs, such as the heart.

- A less common isotope, iodine-125, is sometimes used to treat cancerous tissue.

Iodine-129 has little practical use, but may be used to check some radioactivity counters in diagnostic testing laboratories.

Exposure to Iodine-129 and Iodine-131

How do iodine-129 and iodine-131 get into the environment?
Iodine-129 and iodine-131 are gaseous fission products that form within fuel rods as they fission. Unless reactor chemistry is carefully controlled, they can build up too fast, increasing pressure and causing corrosion in the rods. As the rods age, cracks or wholes may breach the rods.

Cracked rods can release radioactive iodine into the water that surrounds and cools the fuel rods. There, it circulates with the cooling water throughout the system, ending up in the airborne, liquid, and solid wastes from the reactor. From time to time, reactor gas capture systems release gases, including iodine, to the environment under applicable regulations.

Anywhere spent nuclear fuel is handled, there is a chance that iodine-129 and iodine-131 will escape into the environment. Nuclear fuel reprocessing plants dissolve the spent fuel rods in strong acids to recover plutonium and other valuable materials. In the process, they also release iodine-129 and -131 into the airborne, liquid, and solid waste processing systems. In the U.S., spent nuclear fuel is no longer reprocessed, because of concerns about nuclear weapons proliferation.

Currently, spent nuclear fuel remains in temporary storage at nuclear power plants around the country. If the nuclear waste repository at Yucca Mountain opens, it will provide permanent disposal for spent nuclear fuel and other high-level radioactive wastes. Wherever spent nuclear fuel is stored, the short-lived iodine-131 it contains will decay away quickly and completely. However, the long-lived iodine-129 will remain for millions of years. Keeping it from leaking into the environment, requires carefully designed, long-term safeguards.

The detonation of nuclear weapons also releases iodine-129 into the environment. Atmospheric testing in the 1950's and 60's released radioactive iodine to the atmosphere which has disseminated around the world, and is now found at very low levels in the environment. Most I-129 in the environment came from weapons testing.

How do iodine-129 and iodine-131 change in the environment?
Radioactive iodine can disperse rapidly in air and water, under the right conditions. However, it combines easily with organic materials in soil. This is known as 'organic fixation' and slows iodine's movement in the environment. Some soil minerals also attach to, or adsorb, iodine, which also slows its movement.

The long half-life of iodine-129, 15.7 million years, means that it remains in the environment. However, iodine-131's short half-life of 8 days means that it will decay away completely in the environment in a matter of months. Both decay with the emission of a beta particle, accompanied by weak gamma radiation.

How do people come in contact with iodine-129 and iodine-131?
Radioactive iodine can be inhaled as a gas or ingested in food or water. It dissolves in water so it moves easily from the atmosphere into humans and other living organisms. People are exposed to I-129 from the past testing of nuclear weapons, and I-131 from nuclear power plant emissions.

Some industrial facilities also emit radioactive iodine to the environment, as well as medical institutions. Radioactive iodine is usually emitted as a gas, but may contaminate liquids or solid materials as well. If a family member has been treated with I-131, you may have increased exposure to it through their body fluids.

How do iodine-129 and iodine-131 get into the body?
Radioactive iodine can enter the body by ingestion or inhalation. It dissolves in water so it moves easily from the atmosphere into humans and other living organisms. For example, I-129 and -131 can settle on grass where cows can eat it and pass it to humans through their milk. It may settle on leafy vegetables and be ingested by humans. Iodine isotopes also concentrate in marine and freshwater fish, which people may then eat.

Also, doctors may give thyroid patients radioactive iodine, usually iodine-131, to treat or help diagnose certain thyroid problems. The tendency of iodine to collect in the thyroid makes it very useful for highlighting parts of its structure in diagnostic images.

What do iodine-129 and iodine-131 do once they get into the body?
When I-129 or I-131 is ingested, some of it concentrates in the thyroid gland. The rest passes from the body in urine.

Airborne I-129 and I-131 can be inhaled. In the lung, radioactive iodine is absorbed, passes into the blood stream, and collects in the thyroid. Any remaining iodine passes from the body with urine.

In the body, iodine has a biological half-life of about 100 days for the body as a whole. It has different biological half-lives for various organs: thyroid - 100 days, bone - 14 days, and kidney, spleen, and reproductive organs - 7 days.

Health Effects of Iodine-129 and Iodine-131

How can iodine-129 and iodine-131affect people's health?
Radioactive iodine can cause thyroid problems, and help diagnose and treat thyroid problems. Long-term (chronic) exposure to radioactive iodine can cause nodules, or cancer of the thyroid. However, once thyroid cancer occurs, treatment with high doses of I-131 may be used to treat it. Doctors also use lower doses of I-131 to treat overactive thyroids.

Low doses can reduce activity of the thyroid gland, lowering hormone production in the gland. Doctors must maintain the fine balance between the risks and benefits of using radioactive iodine. On one hand, this small, additional exposure may tip the balance in favor of cancer formation. On the other, this small additional exposure can restore health by slowing an overactive thyroid and improve health conditions.

Is there a medical test to determine exposure to iodine-129 and iodine-131?
Since iodine is concentrated in the thyroid gland, a radioassay of the thyroid can determine the level of exposure to many of its isotopes. However, I-129 has very low activity and emits extremely low energy beta particles, making a radioassay much more difficult. Tests for I-131 in the body should be available through most major medical centers.

Protecting People from Iodine-129

What can I do to protect myself and my family from iodine?
The thyroid cannot tell the difference between radioactive and non-radioactive iodine. It will take up radioactive iodine in whatever proportion it is available in the environment.

If large amounts of radioactive iodine are released during an nuclear accident, large doses of stable iodine may be distributed by government agencies to keep your thyroid gland from absorbing too much radioactive iodine: Raising the concentration of stable iodine in the blood, increases the likelihood that the thyroid will absorb it instead of radioactive iodine. (Note: Large doses of stable iodine can be a health hazard and should not be taken except in an emergency. However iodized table salt is an important means of acquiring essential non-radioactive iodine to maintain health.

How do I know if I'm near radioactive iodine?
Living near a nuclear power plant may slightly increase your annual exposure to I-131. Detecting radioactive iodine in the environment requires specialized equipment. Most major medical centers can test for isotopes of iodine in your body.

What is EPA doing about iodine-129 and iodine-131?
EPA has issued a variety of regulations that limit the release of radionuclides, including I-129 and I-131, to the environment. These regulations address airborne and liquid releases from nuclear reactors, airborne emissions from a variety of industrial and governmental facilities, and allowable radioactive releases from radioactive waste disposal systems.

EPA has established Maximum Contaminant Levels that limit the concentration of radioactive iodine and other radionuclides in drinking water from public water suppliers.

Recently, EPA issued its environmental standards for the potential waste repository at Yucca Mountain, Nevada. Iodine-129 is one of the more important radionuclides of concern in the large inventory of spent reactor fuel and defense high-level waste. This standard limits the radiation exposure of individuals, and radionuclide concentrations in ground water from the release of I-129 and other radionuclides in the vicinity of Yucca Mountain.

PLUTONIUM

Plutonium-239 (Pu-239)

Half-life: 24,400 years

Mode of decay: Alpha particles

Chemical properties: Solid under normal conditions. Can form compounds with other elements.

What is it used for?

Pu-239 is used primarily in nuclear weapons development and research. Pu-239 also is used in space probes and satellites to keep electronic components warm and in nuclear power generators that produce energy on satellites and space probes.

Where does it come from?

Pu-239 is produced by fission and is a byproduct of nuclear weapons production and nuclear power operations.

What form is it in?

Pu-239 is a solid material that is fashioned into rods for use in nuclear reactors and into ceramic "buttons" for use in satellite systems.

What does it look like?

Pu-239 is a silvery-gray metal that becomes yellowish when exposed to air. Most Pu-239 in the environment is in the form of microscopic particles that are the remnants of nuclear weapons testing and nuclear reactor accidents.

How can it hurt me?

Because it emits alpha particles, Pu-239 is most dangerous when it is inhaled. When Pu-239 particles are inhaled, they lodge in lung tissue. The alpha particles can kill lung cells, which causes scarring of the lungs, leading to further lung disease and cancer. Pu-239 can enter the blood stream from the lungs and travel to the kidneys, meaning that the blood and the kidneys will be exposed to the alpha particles. Once Pu-239 circulates through the body, it concentrates in the bones, liver, and spleen, exposing these organs. Pu-239 ingested in contaminated food or water does not pose a serious threat to humans because the stomach does not absorb plutonium easily and so it passes out of the body in the feces.

What is plutonium?
Plutonium (chemical symbol Pu) is a radioactive metal with Atomic Number 94. Plutonium is considered a man-made element, although scientists have found trace amounts of naturally occurring plutonium produced under highly unusual geologic circumstances. The most common radioisotopes of plutonium are plutonium-238, plutonium-239, and plutonium-240.

Who discovered plutonium?
Plutonium was discovered by nuclear chemist Glenn T. Seaborg and his colleagues Joseph W. Kennedy, Edwin M. McMillan, and Arthur C. Wahl, in 1941 at the University of California - Berkeley. However, wartime secrecy prevented them from announcing the discovery until 1948.

Where does plutonium come from?
Plutonium is created from uranium in nuclear reactors. When uranium-238 absorbs a neutron, it becomes uranium-239 which ultimately decays to plutonium-239. Different isotopes of uranium and different combinations of neutron absorptions and radioactive decay, create different isotopes of plutonium.

Some plutonium is created as a by-product in commercial nuclear power reactors. The normal operating conditions of these reactors provide conditions for making some plutonium . The

plutonium burns (fissions) in the fuel rods along with uranium and helps produce electricity. Some plutonium remains even when the nuclear fuel is spent.

The majority of plutonium was produced for nuclear weapons in several government reactors designed to maximize the production of plutonium. Between 1944 and 1988, the U.S. built and operated these 'production reactors' at high-security government facilities. In all, the U.S. produced about 100 metric tons of plutonium.

The reactors made plutonium by bombarding special fuel rods containing uranium with neutrons. Once the maximum amount of plutonium was produced, workers removed the fuel rods (now called 'spent fuel') from the reactor. The spent fuel rods were extremely radioactive, and the process for recovering the plutonium used only remote-controlled equipment.

First workers used strong acid to dissolve the fuel rods. Then they treated the mixture with chemicals to precipitate the plutonium so that it would settle out. The process was very expensive and at the time made plutonium about the most expensive material on earth. This processing also left behind over 100 million gallons of exceedingly hazardous mixed wastes of acids and radioactive fission products. Part of our legacy of nuclear weapons production is dealing with these high-level wastes.

In extremely rare cases, rocks with a high localized concentration of uranium can provide the right conditions for making small amounts of plutonium naturally. This natural process is called spontaneous fission. Only very small (trace) amounts of natural plutonium have ever been found in nature.

What are the properties of plutonium?
Plutonium is a silvery-grey metal that becomes yellowish when exposed to air. It is solid under normal conditions, and is chemically reactive.

Plutonium has at least 15 different isotopes, all of which are radioactive. The most common ones are Pu-238, Pu-239, and Pu-240. Pu-238 has a half-life of 87.7 years. Plutonium-239 has a half-life of 24,100, and Pu-240 has a half-life 6,560 years. The isotope Pu-238 gives off useable heat, because of its radioactivity.

What is plutonium used for?
Plutonium-239 is used to make nuclear weapons. For example, the bomb dropped on Nagasaki, Japan, in 1945, contained Pu-239. The plutonium in the bomb undergoes fission in an arrangement that assures enormous energy generation and destructive potential.

The isotope, plutonium-238, is not useful for nuclear weapons. However it generates significant heat through its decay process, which make it useful as a power source. Using a thermocouple, a device that converts heat into electric power, satellites rely on plutonium as a power source. Tiny amounts also provide power to heart pacemakers.

Some foreign countries mix isotopes of plutonium and uranium to manufacture special reactor fuel called mixed-oxide fuel, for commercial nuclear power reactors. The plutonium increases the power output. The U.S. does not currently manufacture mixed-oxide fuel, but is funding research in this type of reactor fuel as a means of dealing with excess plutonium in stockpile.]

Exposure to Plutonium

How does plutonium get into the environment?
Plutonium was dispersed world wide from atmospheric testing of nuclear weapons conducted during the 1950s and '60s. The fallout from these tests left very low concentrations of plutonium in soils around the world.

Nuclear weapons production and testing facilities (Hanford, WA, Savannah River, GA, Rocky Flats, CO, and The Nevada Test Site, in the United States, and Mayak in the former Soviet Union), also released small amounts. The releases occurred in accidents with nuclear weapons, the reentry of satellites that used Pu-238, and by the Chernobyl nuclear reactor accident.

How does plutonium change in the environment?
All isotopes of plutonium undergo radioactive decay. As plutonium decays, it releases radiation and forms other radioactive isotopes. For example, Pu-238 emits an alpha particle and becomes uranium-234; Pu-239 emits an alpha particle and becomes uranium-235.

This process happens slowly since the half-lives of plutonium isotopes tend to be relatively long: Pu-238 has a half-life of 87.7 years; Pu-239 has a half-life is 24,100 years, and Pu-240 has a half-life of 6,560 years. The decay process continues until a stable, non-radioactive element is formed.

How do people come in contact with plutonium?
Residual plutonium from atmospheric nuclear weapons testing is dispersed widely in the environment. As a result, virtually everyone comes into contact with extremely small amounts of plutonium.

People who live near nuclear weapons production or testing sites may have increased exposure to plutonium, primarily through particles in the air, but possibly from water as well.

How does plutonium get into the body?
People may inhale plutonium as a contaminant in dust. It can also be ingested with food or water. Most people have extremely low ingestion and inhalation of plutonium. However, people who live near government weapons production or testing facilities may have increased exposure. Plutonium exposure external to the body poses very little health risk.

What does plutonium do once it gets into the body?
The stomach does not absorb plutonium very well, and most plutonium swallowed with food or water passes from the body through the feces. When inhaled, plutonium can remain in the lungs depending upon its particle size and how well the particular chemical form dissolves. The chemical forms that dissolve less easily may lodge in the lungs or move out with phlegm, and either be swallowed or spit out. But, the lungs may absorb chemical forms that dissolve more easily and pass them into the bloodstream.

Once in the bloodstream, plutonium moves throughout the body and into the bones, liver, or other body organs. Plutonium that reaches body organs generally stays in the body for decades and continues to expose the surrounding tissue to radiation.

Health Effects of Plutonium

How can plutonium affect people's health?
External exposure to plutonium poses very little health risk, since plutonium isotopes emit alpha radiation, and almost no beta or gamma radiation. In contrast, internal exposure to plutonium is an extremely serious health hazard. It generally stays in the body for decades, exposing organs and tissues to radiation, and increasing the risk of cancer. Plutonium is also a toxic metal, and may cause damage to the kidneys.

Is there a medical test to determine exposure to plutonium?
There are tests that can reliably measure the amount of plutonium in a urine sample, even at very low levels. Using these measurements, scientists can estimate the total amount of plutonium present in the body. Other tests can measure plutonium in soft tissues (such as body organs) and in feces, bones, and milk. However, these tests are not routinely available in a doctor's office because they require special laboratory equipment.

Protecting People from Plutonium
What can I do to protect myself and my family from plutonium?
Since plutonium levels in the environment are very low, they pose little risk to most people. However, people who live near government weapons production or testing sites may have higher exposure.

Plutonium particles in dust are the greatest concern, because they pose the greatest health risk. People living near government weapons facilities can track radiation monitoring data made available by site personnel. If radiation levels rise, they should follow the radiation protection instructions given by site personnel.

How do I know if I'm near plutonium?
You must have special equipment to detect the presence of plutonium.

What is EPA doing to protect us from plutonium?
EPA sets health-based limits on radiation in air, soil, and water. Federal government agencies are required to meet EPA standards the same as commercial industries. Using its authority under the Safe Drinking Water Act, EPA limits the amount of radiation in community water systems by establishing maximum contaminant levels. Maximum Contaminant Levels limit the amount of activity from alpha emitters, like plutonium, to 15 picocuries per liter.

EPA also protects people against exposure from soil and ground water from sites that have been contaminated with plutonium. We set criteria that soil and ground water from the sites must meet before releasing the sites for public use.

Rather than limiting the concentration of plutonium itself, the criteria limit the cancer risk the sites pose. A person's added risk of developing cancer is limited to no more than about 1-in-10,000 and if possible to 1-in-1,000,000, or less. Under the Clean Air Act, EPA limits the dose to humans from radionuclides to 10 millirem from emissions to air.

EPA sets standards for radioactive waste storage and disposal facilities. We can't treat plutonium or other radioactive materials to get rid of their radioactivity. We can only isolate and store them until they decay. The extremely long half-lives of some plutonium radioisotopes make the management of spent nuclear fuel, and wastes from nuclear weapons facilities a difficult problem.

One of EPA's responsibilities has been to develop public health and safety standards for the two major U.S. nuclear waste storage and disposal facilities. The Waste Isolation Pilot Plant in New Mexico stores transuranic wastes. They range from slightly contaminated clothing to barrels of waste so radioactive that it can only be handled with remote control equipment. The proposed Yucca Mountain repository is designed to store high-level radioactive waste and spent nuclear fuel.

EPA also responds to radiation emergencies. Additionally, EPA helps state and local governments during emergencies that involve radioactive materials. We provide guidance on ways to protect people from harmful exposure to radiation. We can also monitor radiation levels in the environment and assess the threat to public health. We also work with international radiation protection organizations to prepare for large scale foreign emergencies such as Chernobyl. EPA also works with law enforcement agencies to develop counter terrorism plans.

STRONTIUM

Strontium-90 (Sr-90)

Half-life: 29.1 years

Mode of decay: Beta radiation

Chemical properties: Chemically reactive; can create halide, oxide, and sulfide compounds.

What is it used for?

Because Sr-90 generates heat as it decays, it is used as a power source for space vehicles and for remote weather stations and navigational beacons. It also is used in industrial gauges and medically, in a controlled manner, to treat bone tumors.

Where does it come from?

Sr-90 is produced commercially through nuclear fission for use in medicine and industry. It also is found in the environment from nuclear testing that occurred in the 1950s and 1960s and in nuclear reactor waste and can contaminate reactor parts and fluids.

What form is it in?

Sr-90 is a soft metal. It can be present in dust from nuclear fission after detonation of nuclear weapons or a nuclear power plant accident.

What does it look like?

In its pure form, Sr-90 is a soft, shiny silver metal, but it quickly changes to yellow when exposed to air.

How can it hurt me?

Sr-90 can be inhaled, but ingestion in food and water is the greatest health concern. Once in the body, Sr-90 acts like calcium and it is readily incorporated into bones and teeth, where it can cause cancers of the bone, bone marrow, and soft tissues around the bone.

Sr-90 decays to yttrium 90 (Y-90), which in turn decays by gamma radiation so that wherever Sr-90 is present Y-90 is also present. Because of the gamma radiation, Y-90 poses a risk of burns to the eyes and on the skin from external exposure.

Beta particles are subatomic particles that are ejected from the nucleus of unstable atoms. Beta particles can travel through several layers of human skin, and exposure to large sources of beta radiation can cause burns or skin reddening. Beta particles that enter the body can damage cells, which may lead to cell death or, later in life, to cancer.

Gamma radiation is a packet of energy, called a photon that is emitted from the nucleus of an unstable atom. Gamma radiation is high-energy electromagnetic radiation that can penetrate most substances (lead is the best barrier against gamma radiation). Because of its high energy, gamma radiation can penetrate the human body from outside and damage cells, which could lead to cancer later in life.
Strontium

What is strontium?
Strontium (chemical symbol Sr) is a silvery metal that rapidly turns yellowish in air. Strontium is found naturally as a non-radioactive element. Strontium has 16 known isotopes. Naturally occurring strontium is found as four stable isotopes Sr-84, -86, -87, and -88. Twelve other isotopes are radioactive. Strontium-90 is the most important radioactive isotope in the environment.

Who discovered strontium?
In 1790 Adair Crawford and William Cruikshank first detected non-radioactive strontium in the mineral strontianite in Scotland. Metallic strontium was isolated in 1808 by Sir Humphry Davy. Radioactive Sr-90, like many other radionuclides, was discovered in the 1940s in nuclear experiments connected to the development of the atomic bomb.

Where does strontium-90 come from?
Strontium-90 is a by-product of the fission of uranium and plutonium in nuclear reactors, and in nuclear weapons. Strontium-90 is found in waste from nuclear reactors. It can also contaminate reactor parts and fluids. Large amounts of Sr-90 were produced during atmospheric nuclear weapons tests conducted in the 1950s and 1960s and dispersed worldwide.

What are the properties of strontium-90?
Non-radioactive strontium and its radioactive isotopes have the same physical properties. Strontium is a soft metal similar to lead. Strontium is chemically very reactive, and is only found in compounds in nature.

When freshly cut, it has a silvery luster, but rapidly reacts with air and turns yellow. Finely cut strontium will burst into flame in air. Because of these qualities, it is generally stored in kerosene.

Strontium-90 emits a beta particle with, no gamma radiation, as it decays to yttrium-90 (also radioactive). Strontium-90 has a half-life of 29.1 years. Strontium-90 behaves chemically much like calcium, and therefore tends to concentrate in the bones and teeth.

What is strontium-90 used for?
Strontium-90 is used as a radioactive tracer in medical and agricultural studies. The heat generated by strontium-90's radioactive decay can be converted to electricity for long-lived, light-weight power supplies. These are often used in remote locations, such as in navigational beacons, weather stations, and space vehicles. Strontium-90 is also used in electron tubes, as a radiation source in industrial thickness gauges, and for the treatment of eye diseases. Controlled amounts of strontium-90 have been used as a treatment for bone cancer.

Exposure to Strontium-90

How does strontium-90 get into the environment?
Strontium-90 was widely dispersed in the 1950s and 1960s in fall out from atmospheric testing of nuclear weapons. It has been slowly decaying since then so that current levels from these tests are very low.

Strontium-90 is also found in waste from nuclear reactors. It is considered one of the more hazardous constituents of nuclear wastes. The accident at the Chernobyl nuclear power plant also introduced a large amount of Sr-90 into the environment. A large part of the Sr-90 was deposited in the Soviet Republics. The rest was dispersed as fallout over Northern Europe and worldwide. No significant amount of stronium-90 reached the U.S.

How does strontium-90 change in the environment?
As strontium-90 decays, it releases radiation and forms yttrium-90 (Y-90), which in turn decays to stable zirconium. The half-life of Sr-90 is 29.1 years, and that of Yttrium-90 is 64 hours. Sr-90 emits moderate energy beta particles, and Y-90 emits very strong (energetic) beta particles. Strontium-90 can form many chemical compounds, including halides, oxides, and sulfides, and moves easily through the environment.

How do people come in contact with strontium-90?
Everyone is exposed to small amounts of strontium-90, since it is widely dispersed in the environment and the food chain. Dietary intake of Sr-90, however, has steadily fallen over the last 30 years with the suspension of nuclear weapons testing. People who live near or work in nuclear facilities may have increased exposure to Sr-90. The greatest concern would be the exposures from an accident at a nuclear reactor, or an accident involving high-level wastes.

How does strontium-90 get into the body?
People may inhale trace amounts of strontium-90 as a contaminant in dust. But, swallowing Sr-90 with food or water is the primary pathway of intake.

What does strontium-90 do once it gets into the body?

How can it hurt me?

Because uranium decays by alpha particles, external exposure to uranium is not as dangerous as exposure to other radioactive elements because the skin will block the alpha particles. Ingestion of high concentrations of uranium, however, can cause severe health effects, such as cancer of the bone or liver and kidney damage. Inhaling large concentrations of uranium can cause lung cancer from the exposure to alpha particles. Uranium is also a toxic chemical, meaning that ingestion of uranium can cause kidney damage from its chemical properties much sooner than its radioactive properties would cause cancers of the bone or liver.

What is uranium?

Uranium (chemical symbol U) is a naturally-occurring radioactive element, with atomic number 92. Uranium is commonly found in very small amounts in rocks, soil, water, plants, and animals (including humans). Uranium is weakly radioactive and contributes to low levels of natural background radiation in the environment.

Who discovered uranium?

The use of uranium, in its natural oxide form, dates back to at least 79 A.D., when it was used to add color to ceramic glazes.The German chemist Martin Klaproth is credited with discovering uranium in samples of the mineral pitchblende in 1789. It was first isolated as a metal in 1841 by Eugene-Melchior Peligot. Uranium was discovered to be radioactive by French physicist Henri Becquerel in 1896, who first discovered the process of radioactivity with uranium minerals.

Where does uranium come from?

Uranium is a naturally-occurring element found at low levels in virtually all rock, soil, and water. Significant concentrations of uranium occur in some substances such as phosphate rock deposits, and minerals such as uraninite in uranium-rich ores. Because uranium has such a long radioactive half-life (4.47x109 years for U-238), the total amount of it on earth stays almost the same.

What are the properties of uranium?

When refined, uranium is a silvery white, weakly radioactive metal. Uranium metal has very high density, 65% more dense than lead. Uranium in ores can be extracted and chemically converted into uranium dioxide or other chemical forms usable in industry. Uranium found naturally has 3 different isotopes, U-238, U-235, and U-234. Other isotopes can be synthesized. All uranium isotopes are radioactive.

The table below shows the percentage of natural abundance of each natural uranium isotope, and their respective half-lives.

Relative Abundance of Uranium Isotopes

Isotope	U-238	U-235	U-234
Natural Abundance (%)	99.27	0.72	0.0055

Half-life (years)	4.47 billion	700 million	246,000

Uranium isotopes can be separated to increase the concentration of one isotope relative to another. This process is called "enrichment." The enriched fraction has increased U-235. Uranium-235 is better for nuclear power reactors, and for making nuclear weapons. The process produces huge quantities of uranium that are depleted in U-235, but are almost pure U-238, called depleted uranium, or DU.

What is uranium used for?

Uranium metal is very dense and heavy. When it is depleted (DU), uranium is used by the military as shielding to protect Army tanks, and also in parts of bullets and missiles. The military also uses enriched uranium to power nuclear propelled Navy ships and submarines, and in nuclear weapons. Fuel used for Naval reactors is typically highly enriched in U-235 (the exact values are classified information). In nuclear weapons uranium is also highly enriched, usually over 90% (again, the exact values are classified information).

The main use of uranium in the civilian sector is to fuel commercial nuclear power plants, where fuel is typically enriched in U-235 to 2-3%. Depleted uranium is used in helicopters and airplanes as counter weights on certain wing parts. Other uses include ceramic glazes where small amounts of natural uranium (that is, not having gone through the enrichment process) may be added for color. Some lighting fixtures utilize uranium, as do some photographic chemicals. Phosphate fertilizers often contain high amounts of natural uranium, because the mineral material from which they are made is typically high in uranium. Also, people who collect rocks and minerals may have specimens of uranium minerals in their collection such as pitchblende, uraninite, autunite, uranophane, or coffinite.

Exposure to Uranium

How does uranium get into the environment?

Uranium is present naturally in virtually all soil, rock and water. Uranium in soil and rocks is distributed throughout the environment by wind, rain and geologic processes. Rocks weather and break down to form soil, and soil can be washed by water and blown by wind, moving uranium into streams and lakes, and ultimately settling out and reforming as rock. Uranium can also be removed and concentrated by people through mining and refining. These mining and refining processes produce wastes such as mill tailings which may be introduced back into the environment by wind and water if they are not properly controlled. Manufacturing of nuclear fuel, and other human activities also release uranium to the environment.

How does uranium change in the environment?

All uranium isotopes are radioactive. The three natural uranium isotopes found in the environment, U-234, U-235, and U-238, undergo radioactive decay by emission of an alpha particle accompanied by weak gamma radiation. The dominant isotope, U-238, forms a long series of decay products that includes the key radionuclides radium-226, and radon-222. The decay process continues until a stable, non-radioactive decay product is formed (see uranium decay series). The release of radiation during the decay process raises health concerns.

How do people come in contact with uranium?

A person can be exposed to uranium by inhaling dust in air, or ingesting water and food. The general population is exposed to uranium primarily through food and water. The average daily intake of uranium from food ranges from 0.07 to 1.1 micrograms per day. The amount of uranium in air is usually very small. People who live near federal government facilities that made or tested nuclear weapons, or facilities that mine or process uranium ore or enrich uranium for reactor fuel, may have increased exposure to uranium.

How does uranium get into the body?

Uranium can enter the body when it is inhaled or swallowed, or under rare circumstances it may enter through cuts in the skin. Uranium does not absorb through the skin, and alpha particles released by uranium cannot penetrate the skin, so uranium that is outside the body is much less harmful than it would be if it where inhaled or swallowed. When uranium gets inside the body it can lead to cancer or kidney damage.

What does uranium do once it gets into the body?

About 99 percent of the uranium ingested in food or water will leave a person's body in the feces, and the remainder will enter the blood. Most of this absorbed uranium will be removed by the kidneys and excreted in the urine within a few days. A small amount of the uranium in the bloodstream will deposit in a person's bones, where it will remain for years.

Health Effects of Uranium

How can uranium affect people's health?

The greatest health risk from large intakes of uranium is toxic damage to the kidneys, because, in addition to being weakly radioactive, uranium is a toxic metal. Uranium exposure also increases your risk of getting cancer due to its radioactivity. Since uranium tends to concentrate in specific locations in the body, risk of cancer of the bone, liver cancer, and blood diseases (such as leukemia) are increased. Inhaled uranium increases the risk of lung cancer.

Is there a medical test to determine exposure to uranium?

Tests are available to measure the amount of uranium in a urine or stool sample. Hospitals do not perform these tests routinely. These tests are useful if a person is exposed to a large amount of uranium, because most uranium leaves the body in the feces within a few days after ingestion. Uranium can be found in the urine for up to several months after exposure. However, the amount of uranium in the urine and feces does not always accurately show the level of uranium to which you may have been exposed. Since uranium is known to cause kidney damage, special urine tests are often used to determine whether kidney damage has occurred.

Protecting People from Uranium

What can I do to protect myself and my family from uranium?

Most people are not exposed to dangerous levels of uranium. However, people who live near uranium mining areas, or near government weapons facilities or certain industrial facilities may have increased exposure to uranium, especially if their water is from a private well. Analytical laboratories can test water for uranium content. Occasionally, household wares may be found

with uranium in them, such as some older ceramic dishes or plates in which uranium was used in the glaze. These generally do not pose serious health risks, but may nevertheless be retired from use as a prudent avoidance measure. A radiation counter is required to confirm if ceramics contain uranium.

How do I know I'm near uranium?

You need specialized equipment and training to detect uranium in the environment.

What is EPA doing about uranium?

EPA standards under the Clean Air Act limit uranium in the air. The maximum dose to an individual from uranium in the air is 10 millirem. The cleanup of contaminated sites to be released for public use, must meet EPA's risk-based criteria for soil and ground water. EPA's site cleanup standards limit a person's increased chance of developing cancer to between 1 in 10,000 to 1 in 1,000,000 from residual uranium on the ground. Site-specific factors, cost, and community concerns are weighed in establishing the actual clean up value.

Uranium in drinking water is covered under the Safe Drinking Water Act. This law establishes Maximum Contaminant Levels, or MCLs, for radionuclides and other contaminants in drinking water. The uranium limit is 30 μg/l (micrograms per liter) in drinking water.

EPA has issued special regulations for cleaning up uranium mill tailing sites under the "Uranium Mill Tailings Radiation Control Act." The regulations are found in 40CFR192, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings."

APPENDIX D: TABLES & CHARTS

TABLE 1. Australia Group Biological Agents (Excluded in this adapted table are Animal and Plant pathogens)

HUMAN PATHOGENS

Viruses
V1. Chikungunya virus
V2. Congo-Crimean haemorrhagic fever virus
V3. Dengue fever virus
V4. Eastern equine encephalitis virus
V5. Ebola virus
V6. Hantaan virus
V7. Junin virus
V8. Lassa fever virus
V9. Lymphocytic choriomeningitis virus
V10. Machupo virus
V11. Marburg virus
V12. Monkey pox virus
V13. Rift Valley fever virus
V14. Tick-borne encephalitis virus (Russian spring-summer encephalitis virus)
V15. Variola virus
V16. Venezuelan equine encephalitis virus
V17. Western equine encephalitis virus
V18. White pox
V19. Yellow fever virus
V20. Japanese encephalitis virus

Rickettsiae
R1. Coxiella burnetti
R2. Bartonella quintana (Rochlimea quintana, Rickettsia quintana)
R3. Rickettsia prowasecki
R4. Rickettsia rickettsii

Bacteria
B1. Bacillus anthracis
B2. Brucella abortus
B3. Brucella melitensis
B4. Brucella suis
B5. Chlamydia psittaci
B6. Clostridium botulinum
B7. Francisella tularensis
B8. Burkholderia mallei (pseudomonas mallei)
B9. Burkholderia pseudomallei (pseudomonas pseudomallei)
B10. Salmonella typhi
B11. Shigella dysenteriae
B11. Vibrio cholerae
B13. Yersinia pestis

Genetically Modified Microorganisms
G1. Genetically modified microorganisms or genetic elements that contain nucleic acid sequences associated with pathogenicity and are derived from organisms in the core list.
G2. Genetically modified microorganisms or genetic elements that contain nucleic acid sequences coding for any of the toxins in the core list or their subunits.

Toxins
T1. Botulinum toxins
T2. Clostridium perfringens toxins
T3. Conotoxin
T4. Ricin
T5. Saxitoxin
T6. Shiga toxin
T7. Staphylococcus aureus toxins
T8. Tetrodotoxin
T9. Verotoxin
T10. Microcystin (Cyanginosin)
T11. Aflatoxins

Viruses (Warning List)
WV1. Kyasanur Forest virus
WV2. Louping ill virus
WV3. Murray Valley encephalitis virus
WV4. Omsk haemorrhagic fever virus
WV5. Oropouche virus
WV6. Powassan virus
WV7. Rocio virus

WV8. St Louis encephalitis virus

Bacteria (Warning List)
WB1. Clostridium perfringens
WB2. Clostridium tetani
WB3. Enterohaemorrhagic Escherichia coli, serotype 0157 and other verotoxinproducing serotypes
WB4. Legionella pneumophila
WB5. Yersinia pseudotuberculosis

Genetically Modified Microorganisms
WG1. Genetically modified microorganisms or genetic elements that contain nucleic acid sequences associated with pathogenicity and are derived from organisms in the warning list.
WG2. Genetically modified microorganisms or genetic elements that contain nucleic acid sequences coding for any of the toxins in the warning list or their subunits.

Toxins (Warning List)
WT1. Abrin
WT2. Cholera toxin
WT3. Tetanus toxin
WT4. Trichothecene mycotoxins
WT5. Modecin
WT6. Volkensin
WT7. Viscum Album Lectin 1 (Viscumin)

TABLE 2: Biological Warfare Agents (Partial List)

- Anthrax
- Botulinum Toxins
- Brucellosis
- Cholera
- Clostridium Perfringens Toxins
- Congo-Crimean Hemorrhagic Fever
- Ebola Haemorrhagic Fever
- Melioidosis*
- Plague
- Q Fever
- Ricin
- Rift Valley Fever
- Saxitoxin

TABLE 3: BIOTERRORISM: SELECTED AGENT SUMMARY

Disease	Incubation Period	Duration of Illness	Mortality		Person to Person Transmission[2]	Persistence Of Organism
			Untreated	Treated		
Inhalation Anthrax	1 - 6 days	3 - 5 days	~100%	~99%	No	Soil ~40 yrs
Brucellosis	5 - 60 days	weeks to months	~5%[4]	<1%[1]	No	Water/soil ~10 wks
Botulism	6hr - 10 days	24 - 72 hrs	Outbreak: 1st patient: 25% Subsequent cases: 4% Overall: 5-10%		No	Food/water ~weeks
Tularemia	1 - 21 days	~2 weeks	33%	<4%	No	Moist soil ~months
Pneumonic Plague	2 -3 days	1 - 6 days	40 - 70%	5%	YES (high)	Soil ≥1 yr
Smallpox	7 - 17 days	~4 weeks	Variola minor: <1% Variola major:20-50%		YES (high)	Very Stable
VHF	4 - 21 days	7 - 16 days	53 - 88%		YES (moderate)	Unstable

1. Endocarditis accounts for the majority of brucellosis-related deaths.
2. Period of communicability : For **inhalation anthrax, brucellosis, botulism, or tularemia** : **None**, no evidence of person to person transmission; **pneumonic plague :** For 72 hrs, following initiation of appropriate antimicrobial therapy or until sputum culture is negative; **Smallpox : approximately 3 weeks**, usually corresponds with the initial appearance of skin-lesions to their final disappearance, most infectious during the first week of rash via inhalation of virus released from oropharyngeal-lesion secretions of the index case; **VHF: varies with virus, but at minimum, all for the duration of illness** and for Ebola/Marburg transmission through semen may occur up to 7 weeks after clinical recovery.

TABLE 4: BIOLOGICAL WEAPONS FOREIGN TECHNOLOGY ASSESSMENT SUMMARY

COUNTRY	Biological Material Production	Stabilization, Dispersion and Weapons Testing	Detection, Warning and Identification	Biological Defense Systems
Australia[1]	♦♦	♦♦	♦♦	♦♦♦
Austria[1]	♦	♦♦	♦♦♦	♦♦♦
Belgium[1]	♦♦	♦♦	♦♦	♦♦
Brazil	♦♦	♦♦	♦	♦
Bulgaria	♦	♦♦	♦♦	♦♦♦
Canada[1]	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
China	♦♦♦	♦♦♦	♦♦♦	♦♦♦
Cuba	♦♦	♦♦	♦♦	♦
Czech Republic[1]	♦♦	♦♦♦	♦♦♦	♦♦♦♦
Denmark[1]	♦♦	♦♦	♦	♦♦
Egypt	♦	♦♦	♦	♦♦
Finland[1]	♦♦♦	♦♦♦	♦♦♦	♦♦♦
France[1]	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
Germany[1]	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
Greece[1]	♦	♦	♦	♦♦
Hungary[1]	♦♦♦	♦♦	♦♦♦	♦♦♦♦
India	♦♦♦	♦♦♦	♦♦	♦♦
Iran	♦♦	♦♦	♦	♦♦
Iraq	♦♦♦	♦♦	♦	♦♦
Israel	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
Italy[1]	♦♦♦	♦♦	♦♦	♦♦
Japan[1]	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
Korea (North)	♦♦	♦♦	♦	♦♦♦
Korea (South)[1]	♦♦♦	♦♦	♦♦	♦♦♦
Libya	♦♦	♦	♦	♦
Netherlands[1]	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
Norway[1]	♦♦♦	♦♦♦	♦♦	♦♦
Pakistan	♦♦	♦♦	♦♦	♦♦♦
Poland[1]	♦♦	♦♦	♦♦	♦♦♦
Romania[1]	♦♦	♦	♦♦	♦♦♦
Russia	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
Slovak Republic[1]	♦♦	♦♦	♦♦♦	♦♦♦
South Africa	♦♦	♦♦	♦♦♦	♦♦♦
Spain[1]	♦♦	♦	♦	♦
Sweden[1]	♦♦♦♦	♦♦♦	♦♦♦♦	♦♦♦♦
Switzerland[1]	♦♦♦♦	♦♦♦	♦♦♦	♦♦♦
Syria	♦♦	♦♦	♦	♦
Turkey	♦♦	♦♦		
Ukraine	♦♦♦♦	♦♦♦	♦♦♦	♦♦♦
United Kingdom[1]	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
United States[1]	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦

[1] Indicates that the nation is a member of the Australian Group (AG)

Legend: Sufficient Technologies Capabilities
♦♦♦♦ exceeds sufficient level ♦♦♦ sufficient level ♦♦ some ♦limited

Because two or more countries have the same number of diamonds does not mean that their capabilities are the same. An absence of diamonds in countries of concern may indicate an absence of information, not of capability. The absence of a country from this list may indicate an absence of information, not capability.

TABLE 5. Biological Material Production Technology Parameters (Human Pathogens)

Technology	Sufficient Technology Level	Export Control Reference
Viruses	Any quantity is a concern. Less than 20 pounds can incapacitate humans in a 10-km^2 area.	AG List; WA ML 7; CCL Cat 1C; USML XIV
Bacteria	Any quantity is a concern. Less than 220 pounds can incapacitate humans in a 100-km^2 area.	AG List; WA ML 7; CCL Cat 1C; USML XIV
Toxins	Any quantity is a concern. Less than 600 pounds can incapacitate humans in a 100-km^2 area.	AG List; WA ML 7; CCL Cat 1C; USML XIV
Rickettsiae	Any quantity is a concern. Less than 100 pounds can incapacitate humans in a 10-km^2 area.	AG List; WA ML 7; CCL Cat 1C; USML XIV
Genetically Modified Microorganisms	Any quantity is a concern.	AG List; WA ML 7; CCL Cat 1C; USML XIV

TABLE 6: Chemical Warfare Agents

NAME	CODE	TYPE	ACTION	STATE (20 DEG C)	ODOR
PHOSGENE	**CG**	CHOKING	RAPID	COLORLESS GAS	GREEN CORN OR NEW MOWN HAY
DIPHOSGENE	**DP**	CHOKING	RAPID	COLORLESS LIQUID	GREEN CORN OR NEW MOWN HAY
TABUN	**GA**	NERVE	VERY RAPID	COLORLESS TO BROWN LIQUID	FRUITY TO NONE
SARIN	**GB**	NERVE	VERY RAPID	COLORLESS LIQUID	NEAR ODORLESS
SOMAN	**GD**	NERVE	VERY RAPID	COLORLESS LIQUID	CAMPHOR TO FRUITY
VX	**VX**	NERVE	RAPID	COLORLESS LIQUID	ODORLESS
HYDROGEN CYANIDE	**AC**	BLOOD	VERY RAPID	COLORLESS GAS OR LIQUID	BITTER ALMONDS
CYANOGEN CHLORIDE	**CK**	BLOOD	RAPID	COLORLESS GAS	WEAKLY LIKE BITTER ALMONDS
ARSINE	**SA**	BLOOD	DELAYED	COLORLESS GAS	MILD GARLIC
DISTILLED MUSTARD	**HD**	BLISTER	DELAYED	COLORLESS TO PALE YELLOW LIQUID	GARLIC
NITROGEN MUSTARD	**HN-1**	BLISTER	DELAYED	DARK LIQUID	FISHY OR MUSTY
NITROGEN MUSTARD	**HN-2**	BLISTER	DELAYED	DARK LIQUID	SOAPY TO FRUITY
NITROGEN MUSTARD	**HN-3**	BLISTER	DELAYED	DARK LIQUID	NEAR ODORLESS
PHOSGENE OXIME	**CX**	BLISTER	IMMEDIATE	COLORLESS SOLID OR LIQUID	SHARP AND PENETRATING
LEWISITE	**L**	BLISTER	RAPID	DARK BROWN OR YELLOW OIL/LIQUID	MAY RESEMBLE GERANIUMS
MUSTARD LEWISITE	**HL**	BLISTER	DELAYED	DARK BROWN OR YELLOW OIL/LIQUID	GARLIC
ETHYLDICHLOROARSINE	**ED**	BLISTER	IMMEDIATE	COLORLESS LIQUID	FRUITY AND BITING
METHYLDICHLOROARSINE	**MD**	BLISTER	RAPID	COLORLESS LIQUID	ODORLESS
DIPHENYL-DICHLOROARSINE	**DA**	VOMITING	VERY RAPID	WHITE TO BROWN SOLID	ODORLESS
ADAMSITE	**DM**	VOMITING	VERY RAPID	YELLOW TO GREEN SOLID	ODORLESS
DIPHENYLCYANOARSINE	**DC**	VOMITING	VERY RAPID	WHITE TO PALE SOLID	BITTER ALMOND-GARLIC MIX

CHLOROACETOPHENOME	**CN**	RIOT	INSTANT	SOLID	APPLE BLOSSOMS
CHLOROACETOPHENOME IN CHLOROFORM	**CNC**	RIOT	INSTANT	LIQUID	CHLOROFORM
CHLOROACETOPHENOME AND CHLOROPICRIN IN CHLOROFORM	**CNS**	RIOT	INSTANT	LIQUID	FLYPAPER
CHLOROACETOPHENOME IN BENZENE AND CARBON TETRACHLORIDE	**CNB**	RIOT	INSTANT	LIQUID	BENZENE
BROMOBENZYLCYANIDE	**CA**	RIOT	INSTANT	LIQUID	SOURED FRUIT
O-CHLORO-BENZYLMALONONITRILE	**CS**	RIOT	INSTANT	COLORLESS TO WHITE SOLID	PEPPER
BZ	**BZ**	INCAPACI TATING	DELAYED	DUST ?	

Source: adapted from http://www.fas.org/nuke/intro/cw/agent.htm

This file lists the known chemical agents currently in military applications worldwide.

The datafile does not include several agents (chlorine, for example) which have been in disuse, but which could conceivably be revived. Database users must exercise their judgement. Additionally, mixtures of agents (GB/HD, for example) sometimes have slightly different properties and effects than when used separately. Biological agents have extremely difficult parameters and were omitted intentionally; they may be added later if sufficient, easily interpretable data can be obtained at the unclassified level.

The action column describes the relative speed of the agent on exposed personnel. The speed is relative to the other agents listed, with "instant" and "immediate" being the fastest, and "delayed" the slowest - often meaning hours or days later. The degree of exposure, the type of exposure (skin, inhalation, ingestion, etc) and other factors determine the effect on any potential casualty.

The "state" and "odor" columns give observers some reference as to what to expect if an agent is present. However, agents can be mixed with other materials, altering their signatures. These are some potential indicators that agents are present; when suspected, agents are best detected by dedicated chemical detection equipment.

Physiological effects were not added to the table, nor was nation or origin. Oftentimes, agents cause certain effects when inhaled, others when ingested, and still others when absorbed. Nation of origin was regarded as immaterial, given the relative ease of producing most agents. Although some agents are tactically delivered by only selected means, since most can be delivered by a wide range of methods

TABLE 7: CHEMICAL WEAPONS CONVENTION SCHEDULE OF CHEMICALS

The following Schedules list toxic chemicals and their precursors. For the purposes of implementing this Convention, these Schedules identify chemicals for the application of verification measures according to the provisions of the Verification Annex. Pursuant to Article II, subparagraph 1(a), these Schedules do not constitute a definition of chemical weapons.

(Whenever reference is made to groups of dialkylated chemicals, followed by a list of alkyl groups in parentheses, all chemicals possible by all possible combinations of alkyl groups listed in the parentheses are considered as listed in the respective Schedule as long as they are not explicitly exempted. A chemical marked "*" on Schedule 2, part A, is subject to special thresholds for declaration and verification, as specified in Part VII of the Verification Annex.)

Schedule 1 (CAS registry number)

A. Toxic chemicals:

(1) O-Alkyl ($\leq C_{10}$, incl. cycloalkyl) alkyl (Me, Et, n-Pr or i-Pr)-phosphonofluoridates,
e.g., sarin: O-Isopropyl methylphosphonofluoridate (107-44-8)
soman: O-Pinacolyl methylphosphonofluoridate (96-64-0)

(2) O-Alkyl ($\leq C_{10}$, incl. cycloalkyl) N,N-dialkyl (Me, Et, n-Pr or i-Pr) phosphoramidocyanidates,
e.g., tabun: O-Ethyl N,N-dimethyl phosphoramidocyanidate (77-81-6)

(3) O-Alkyl (H or $\leq C_{10}$, incl. cycloalkyl) S-2-dialkyl (Me, Et, n-Pr or i-Pr)-aminoethyl alkyl (Me, Et, n-Pr or i-Pr) phosphonothiolates and corresponding alkylated or protonated salts,
e.g., VX: O-Ethyl S-2-diisopropylaminoethyl methyl phosphonothiolate (50782-69-9)

(4) Sulfur mustards:
2-Chloroethylchloromethylsulfide (2625-76-5)
Mustard gas: Bis(2-chloroethyl)sulfide (505-60-2)
Bis(2-chloroethylthio)methane (63869-13-6)
Sesquimustard: 1,2-Bis(2-chloroethylthio)ethane (3563-36-8)
1,3-Bis(2-chloroethylthio)-n-propane (63905-10-2)
1,4-Bis(2-chloroethylthio)-n-butane (142868-93-7)
1,5-Bis(2-chloroethylthio)-n-pentane (142868-94-8)
Bis(2-chloroethylthiomethyl)ether (63918-90-1)
O-Mustard: bis(2-chloroethylthioethyl)ether (63918-89-8)

(5) Lewisites:
Lewisite 1: 2-Chlorovinyldichloroarsine (541-25-3)
Lewisite 2: Bis(2-chlorovinyl)chloroarsine (40334-69-8)
Lewisite 3: Tris(2-chlorovinyl)arsine (40334-70-1)

(6) Nitrogen mustards:
HN1: Bis(2-chloroethyl)ethylamine (538-07-8)
HN2: Bis(2-chloroethyl)methylamine (51-75-2)
HN3: Tris(2-chloroethyl)amine (555-77-1)

(7) Saxitoxin (35523-89-8)

(8) Ricin (9009-86-3)

B. Precursors:

(9) Alkyl (Me, Et, n-Pr or i-Pr) phosphonyldifluorides
e.g. DF: Methylphosphonyldifluoride (676-99-3)

(10) O-Alkyl (H or $\leq C_{10}$, incl. cycloalkyl) O-2-dialkyl (Me, Et, n-Pr or i-Pr)-aminoethyl alkyl (Me, Et, n-Pr or i-Pr) phosphonites and corresponding alkylated or protonated salts e.g. QL: O-Ethyl O-2-diisopropylaminoethyl methylphosphonite (57856-11-8)

(11) Chlorosarin: O-Isopropyl methylphosphonochloridate (1445-76-7)

(12) Chlorosoman: O-Pinacolyl methylphosphonochloridate (7040-57-5)

TABLE 7: CHEMICAL WEAPONS CONVENTION SCHEDULE OF CHEMICALS (Cont'd)

Schedule 2

A. Toxic chemicals:

(1) Amiton: O,O-Diethyl S-[2-(diethylamino)ethyl] phosphorothiolate (78-53-5) and corresponding alkylated and protonated salts

(2) PFIB: 1,1,3,3,3-Pentafluoro-2-(trifluoromethyl)-1-propene (382-21-8)

(3) BZ: 3-Quinuclidinyl benzilate (*) (6581-06-2)

B. Precursors:

(4) Chemicals, except for those listed in Schedule 1, containing a phosphorus atom to which is bonded one methyl, ethyl, or propyl (normal or iso) group but not further carbon atoms, e.g.,
Methylphosphonyl dichloride (676-97-1)
Dimethyl methylphosphonate (756-79-6)
Exemption: Fonofos: O-Ethyl S-phenyl ethylphosphonothiolothionate (944-22-9)

(5) N,N-Dialkyl (Me, Et, n-Pr or i-Pr) phosphoramidic dihalides

(6) Dialkyl (Me, Et, n-Pr or i-Pr) N,N-dialkyl (Me, Et, n-Pr or i-Pr)-phosphoramidates

(7) Arsenic trichloride (7784-34-1)

(8) 2,2-Diphenyl-2-hydroxyacetic acid (76-93-7)

(9) Quinuclidine-3-ol (1619-34-7)

(10) N,N-Dialkyl (Me, Et, n-Pr or i-Pr) aminoethyl-2-chlorides and corresponding protonated salts

(11) N,N-Dialkyl (Me, Et, n-Pr or i-Pr) aminoethane-2-ols and corresponding protonated salts
Exemptions: N,N-Dimethylaminoethanol (108-01-0) and corresponding protonated salts
N,N-Diethylaminoethanol (100-37-8) and corresponding protonated salts

(12) N,N-Dialkyl (Me, Et, n-Pr or i-Pr) aminoethane-2-thiols and corresponding protonated salts

(13) Thiodiglycol: Bis(2-hydroxyethyl)sulfide (111-48-8)

(14) Pinacolyl alcohol: 3,3-Dimethylbutane-2-ol (464-07-3)

Schedule 3

A. Toxic chemicals:

(1) Phosgene: carbonyl dichloride (75-44-5)

(2) Cyanogen chloride (506-77-4)

(3) Hydrogen cyanide (74-90-8)

(4) Chloropicrin: Trichloronitromethane (76-06-2)

B. Precursors:

(5) Phosphorus oxychloride (10025-87-3)

(6) Phosphorus trichloride (7719-12-2)

(7) Phosphorus pentachloride (10026-13-8)

(8) Trimethyl phosphite (121-45-9)

(9) Triethyl phosphite (122-52-1)

(10) Dimethyl phosphite (868-85-9)

(11) Diethyl phosphite (762-04-9)

(12) Sulfur monochloride(10025-67-9)

(13) Sulfur dichloride (10545-99-0)

(14) Thionyl chloride (7719-09-7)

(15) Ethyldiethanolamine (139-87-7)

(16) Methyldiethanolamine (105-59-9)

(17) Triethanolamine (102-71-6)

Source: *The Chemical Weapons Convention*, "Annex on Chemicals," Part B.

TABLE 8: CHEMICAL WEAPONS FOREIGN TECHNOLOGY ASSESSMENT SUMMARY

COUNTRY	Chemical Material Production	Stabilization, Dispersion and Weapons Testing	Detection, Warning and Identification	Chemical Defense Systems
Australia	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
Bulgaria	♦♦♦	♦♦	♦♦	♦♦
Canada	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
China	♦♦♦♦	♦♦♦♦	♦♦	♦♦
Czech Republic	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
Denmark	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
Egypt	♦♦♦♦	♦♦♦	♦♦	♦♦
Finland	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
France	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
Germany	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
Hungary	♦♦♦♦	♦♦	♦♦♦	♦♦♦
India	♦♦♦♦	♦♦	♦♦	♦♦
Iran	♦♦♦♦	♦♦♦	♦♦	♦♦
Iraq	♦♦♦♦	♦♦♦♦	♦♦	♦♦
Israel	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
Italy	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
Japan	♦♦♦♦	♦♦♦	♦♦♦	♦♦♦
Libya	♦♦♦♦	♦♦♦	♦♦	♦♦
Netherlands	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
North Korea	♦♦♦♦	♦♦	♦♦	♦♦♦
Norway	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
Pakistan	♦♦♦	♦♦	♦♦	♦♦
Poland	♦♦♦	♦♦	♦♦	♦♦
Russia	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
Slovak Republic	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
South Africa	♦♦♦♦	♦♦♦	♦♦♦♦	♦♦♦♦
South Korea	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
Spain	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
Sweden	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
Switzerland	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
Syria	♦♦♦	♦♦♦	♦♦	♦♦
United Kingdom	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
United States	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
Viet Nam	♦♦♦	♦♦	♦♦	♦♦
Subnationals	♦♦♦	♦	♦♦	♦♦

[1] Indicates that the nation is a member of the Australian Group (AG)

Legend: Sufficient Technologies Capabilities
♦♦♦♦ exceeds sufficient level ♦♦♦ sufficient level ♦♦ some ♦limited

Because two or more countries have the same number of diamonds does not mean that their capabilities are the same. An absence of diamonds in countries of concern may indicate an absence of information, not of capability. The absence of a country from this list may indicate an absence of information, not capability.

TABLE 9: NUCLEAR WEAPONS FOREIGN TECHNOLOGY ASSESSMENT SUMMARY

COUNTRY	Enrichment Feedstocks Production	Uranium Enrichment Processes	Nuclear Fission Reactors	Plutonium Extraction (Reprocessing)	Lithium Production	Nuclear Weapons Design and Development	Staffing, Arming, fuzing and Firing	Radiological Weapons	Manufacturing of Nuclear Components	Nuclear Weapons Development testing	Nuclear Weapons Custody, Transport and Control	Heavy Water Production	Tritium Production
Argentina	♦		♦♦			♦♦				♦	♦♦	♦♦♦♦	♦♦
Austria			♦				♦			♦	♦		♦♦
Belgium			♦♦♦♦				♦			♦			♦♦
Brazil	♦♦		♦♦			♦♦				♦	♦♦	♦	♦♦
Canada	♦♦♦		♦♦♦♦			♦♦♦	♦			♦	♦	♦♦♦♦	♦♦♦♦
China	♦♦♦	♦♦♦	♦♦♦	♦♦♦	♦♦♦	♦♦♦♦	♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
Czech Republic			♦♦										
France	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦	♦♦♦♦	♦♦♦♦		♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
Germany		♦♦♦	♦♦♦♦			♦♦♦	♦♦♦		♦♦♦♦		♦♦	♦♦♦	♦♦♦
India	♦♦		♦♦♦♦			♦♦♦♦	♦♦		♦♦	♦♦	♦♦♦	♦♦♦♦	♦♦♦♦
Iran		♦	♦♦			♦♦				♦	♦♦		
Iraq	♦♦	♦	♦♦♦	♦		♦♦♦	♦		♦♦	♦	♦♦		
Italy				♦♦♦			♦♦		♦♦			♦♦	♦♦
Japan		♦♦	♦♦♦♦	♦♦♦		♦♦♦♦	♦♦♦		♦♦♦♦		♦♦	♦♦	♦♦
Netherlands		♦♦♦	♦♦			♦♦	♦♦					♦♦	♦
North Korea	♦♦		♦♦	♦		♦♦♦				♦♦	♦♦		
Pakistan	♦♦	♦♦♦	♦♦			♦♦♦♦	♦		♦♦	♦♦	♦♦	♦	
Russia	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦		♦♦♦♦	♦♦♦♦	♦♦♦	♦♦♦♦	♦♦♦♦
South Africa	♦♦♦♦	♦♦	♦♦♦			♦♦♦	♦♦		♦	♦♦♦♦	♦♦	♦♦	♦♦
South Korea			♦♦♦♦			♦♦♦	♦					♦	♦
Sweden			♦♦♦♦			♦♦♦			♦♦♦♦	♦♦♦	♦♦	♦♦♦	♦♦
Switzerland			♦♦♦♦			♦♦♦			♦♦♦♦	♦♦♦	♦♦	♦♦♦	♦♦
Taiwan			♦♦♦			♦♦♦				♦♦♦		♦	♦
Ukraine			♦♦♦			♦				♦	♦♦	♦	
United Kingdom	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦		♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
United States	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦		♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦

Legend: Sufficient Technologies Capabilities: ♦♦♦♦ exceeds sufficient level ♦♦♦ sufficient level ♦♦ some ♦ limited

Because two or more countries have the same number of diamonds does not mean that their capabilities are the same. An absence of diamonds in countries of concern may indicate an absence of information, not of capability. The absence of a country from this list may indicate an absence of information, not capability.

TABLE 10: SELECTED REGIME PARTICIPANTS

	NSG	GP	BWC	CWC**	AG	MTCR	WA
Argentina	●	●	●	●	●	●	●
Australia	●	●	●	●	●	●	●
Austria	●	●	●	●	●	●	●
Belgium	●	●	●	●	●	●	●
Brazil	●	●	●	●		●	
Bulgaria	●	●	●	●			●
Canada	●	●	●	●	●	●	●
China*	N	●	●	●			
Czech Republic	●	●	●	●	●		●
Denmark	●	●	●	●	●	●	●
Egypt	N	●	S				
Finland	●	●	●	●	●	●	●
France	●	●	●	●	●	●	●
Germany	●	●	●	●	●	●	●
Greece	●	●	●	●	●	●	●
Hungary	●	●	●	●	●	●	●
Iceland	N	●	●	●	●	●	
India		●	●	●			
Iran	N	●	●	●			
Iraq	N	●	●				
Ireland	●	●	●	●	●	●	●
Israel*		●		S			
Italy	●	●	●	●	●	●	●

	NSG	GP	BWC	CWC**	AG	MTCR	WA
Japan	●	●	●	●	●	●	●
Korea, North	N	●	●				
Korea, South	●	●	●	●	●		●
Libya	N	●	●				
Luxembourg	●	●	●	●	●	●	●
Netherlands	●	●	●	●	●	●	●
New Zealand	●	●	●	●	●	●	●
Norway	●	●	●	●	●	●	●
Pakistan		●	●	●			
Poland	●	●	●	●	●		●
Portugal	●	●	●	●	●	●	●
Romania*	●	●	●	●	●		●
Russian Fed.	●	●	●	●		●	●
Slovak Republic	●	●	●	●	●		●
South Africa	●	●	●	●		●	
Spain	●	●	●	●	●	●	●
Sweden	●	●	●	●	●	●	●
Switzerland	●	●	●	●	●	●	●
Syria	N	●	S				
Turkey	N	●	●	●		●	●
Ukraine	●		●	S			●
United Kingdom	●	●	●	●	●	●	●
United States	●	●	●	●	●	●	●

Regime	Total number of participants (as of date)
Nuclear Suppliers Group (**NSG**)	34 (N = NPT: 185) (1/97)
Geneva Protocol (**GP**)	145 (7/96)
Biological Weapons Convention (**BWC**)	140 (S = signed: 158) (5/97)
Chemical Weapons Convention (**CWC**)**	106 (S = signed: 168) (11/97)
Australia Group (**AG**)	30 (10/96)
Missile Technology Control Regime (**MTCR**)	29 (11/97)
Wassenaar Arrangement (**WA**)	33 (12/96)

* China, Israel, and Romania have pledged to abide by the basic tenets of the Missile Technology Control Regime.

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ABOUT THE AUTHOR

Dr. Gladson I. Nwanna (Ph.D.) is a university professor, a former consultant to the World Bank, and a veteran traveler. He has over the past 20 years traveled to several countries of the world, logging thousands of miles in the process. Dr. Nwanna is the author of several books.

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