Surveillance Technologies

Biochemical

Section 4

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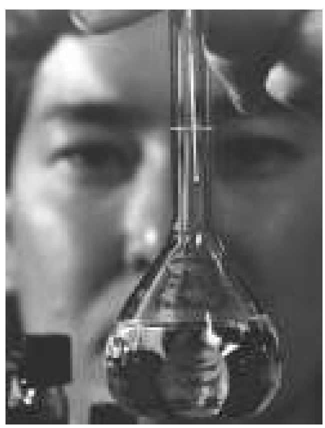
Biochemical Surveillance

12

Chemical & Biological



1. Introduction

Chemical and biological surveillance techniques are not as well-known (outside of scientific circles) as technologies that include familiar consumer devices such as video cameras. They nevertheless comprise an important area of research and application, and while they are not covered in as much depth as other topics in this text, there is sufficient information here to provide a basic understanding of the character and breadth of these closely interrelated fields.

Eugene Mizusawa, a postdoctoral fellow at Lawrence Livermore National Laboratory, peers into a beaker to calibrate a new type of fiber-optic sensor for monitoring chemical contamination of groundwater. The intensity of the yellow fluorescence indicates the amount of carbon tetrachloride present in the solution. LLNL scientists are developing other sensors for identifying and measuring a variety of chemical contaminants and solvents. The system can be used in the field, reducing the need to send samples to the lab. [Lawrence Livermore National Labs news photo by Jim Stoots, released.]

Humans engage in chemical/biological surveillance all the time. When we smell the air, or taste food or other substances, the chemical detectors that are part of our biological senses are providing us with information that can be remarkably accurate in identifying the source or nature of a substance. Many animals have even better chemical sensors than humans. Deer use smell to alert them to the presence of predators. Dogs have keen noses that allow them to hunt for food, mates, objects, or lost people. Insects locate mates and food sources at astonishing distances with their highly sensitive chemical detectors. We have learned a great deal from studying and trying to reproduce natural chemical detection systems.

Chemical and biological surveillance are technical fields, much of it is laboratory work on a microscopic scale, sometimes in sterile or carefully monitored environments. Gradually, ‘minilabs’ that can be used by experts or laypeople in the field have been developed, but even the results of these onsite analyses are often double-checked or analyzed further by a specialist in a lab.

Chemicals are used to detect, mark, track, and influence. Sometimes they are even used to create decoys. Chemical/biological surveillance is widely practiced and includes such applications as the detection and analysis of evidence at a crime scene, vapors at a crash scene, hormones on a chicken farm, or chemical weapons in hostile territory. Chemical/biological devices are used in the preservation of samples, drug detection, industrial quality control and inspection, safety and hazards monitoring, search and rescue, firefighting and arson investigation, and military reconnaissance.

DNA profiling is a form of biochemical surveillance that is sufficiently specialized that it is covered in a separate chapter on Genetics Surveillance. Animals that are used for biological/chemical surveillance tasks such as sniffing out bombs or people are also covered separately in the Animal Surveillance chapter. This chapter focuses on chemical and biological technologies that are used in forensics, archaeology, environmental studies, quality assurance, and national defense. Spectrographic analysis to determine chemical composition is also widely used in astronomy, but that aspect is not covered here and the reader is advised to consult astronomy books for more information on this interesting subject.

2. Types and Variations

2.a. Basic Terms and Concepts

‘Chemical surveillance’ is actually an ambiguous phrase that is easier to explain with a few examples, as it can mean either:

1) using chemicals to surveil other things (which may include other chemicals)
   - Chemical stains can reveal faults in bolts on a production line.
   - Marking powders can indicate tampering on a doorknob.
   - Indelible exploding dye packs can be used in money sacks to mark bank robbers.
   - Luminol™ can be used to reveal blood stains on a garment.
   - Quick-hardening plaster can be used to preserve an impression.

2) using other things to surveil chemicals
   - Ultraviolet can be used to reveal marking ink or faded rock paintings.
   - Infrared can be used to detect spills.
   - MRIs can be used to reveal inflammation.

- A sniffing dog can be used to detect explosives or drugs.
- A microscope can be used to match lipstick marks on a cigarette butt with a mouth print.

Both *chemical surveillance* and *surveillance of chemicals* are introduced in this chapter.

The terms *biological*, *chemical*, and *biochemical* are used somewhat loosely in this text because there is considerable crossover in the technologies. Many of the devices described involve chemicals that have direct impact on biological systems and biological cells are very much like little balloons filled with chemical factories, so the distinctions blur when describing technologies that have both biological and chemical sources or consequences. The casual use of terminology is not intended to mislead, but to simplify statements that refer to biological/chemical technologies that are interchangeable or not easily categorized.

A large part of chemical surveillance involves detecting and identifying substances and diseases that are hazardous to humans, so it is helpful to know some of the basic terms related to poisons and human illnesses.

germ - a generic, colloquial term for any microorganism that may cause disease. It refers to a variety of viruses and bacteria that are too small to see with the unaided eye and thus sometimes difficult to distinguish as causal agents.

infectious diseases - diseases that are transmitted by direct contact.

contagious diseases - diseases that can be transmitted by proximity, usually through air or water vapor. Leprosy is infectious and not easily spread. Most sexually transmitted diseases are infectious; they require the interaction of bodily fluids and are not transmitted by mere proximity or casual interaction. On the other hand, common cold germs are contagious, as they can be carried through the air on saliva through a sneeze or picked up from contact with objects that are infected with the germs.

poison - a fairly generic term that includes a range of substances that can make a person ill. Poisons may be organic or inorganic in origin and may need to exceed a certain quantity in order to be harmful. A *toxin* is a type of poison that is produced through metabolic activity in living organisms (e.g., snake venom) and that generally results in antibody production in the afflicted recipient. The word *toxic* really should refer to an effect specific to *toxins* but in the literature it is broadly used to describe a toxin *or* poison.

pathogen - a specific disease-causing agent (e.g., smallpox virus) while an *antigen* is a substance capable of triggering an immune response.

antibodies - biological immunoglobulins produced by a body in response to antigens to try to counter their effects.

antidote - a remedy intended to counteract the effects of toxins (e.g., antivenon for snake bites) or poisons.

Pathogens, antigens, and toxins can be variously contacted through foods, beverages, injections, bites, and mists.

Due to the breadth and nature of the field, chemical surveillance includes a lot of *jargon* (technical terms specific to the industry) and the terms comprise many chemical compound names, pharmaceutical brands, and medical terms. Unlike the glossaries in other chapters, which are very brief but somewhat complete in themselves (from *a* to *z*), it wasn't possible to create a similar type of glossary for chemical surveillance within the space allotted. Instead, the author has provided a *sample* glossary with mostly *a*-words, rather than a *working* glossary, as would have been preferred because, in this instance, it was the most practical way to illustrate the terminology in the space available.

2.b. Detectors

Chemical detectors (that is, detectors that scout out biological and chemical traces) can be natural or synthetic and there are an increasing number that are electronic. Natural chemical detectors include the taste and smell senses of humans (e.g., scientists have discovered that some people are 'super tasters' able to detect minute amounts of certain substances diluted in water) and other creatures, including dogs and fireflies (which are actually a type of beetle). Synthetic detectors include lab-developed substances and compounds, and computer circuit-boards. Chemical detectors that work somewhat like a dog's nose are colloquially called 'sniffers,' and they are becoming so effective that they may eventually supersede sniffing dogs for certain types of applications.

Detectors range from those which detect only the presence of chemicals, without providing information on their identity, to those which can determine not only their presence, but their identity, composition, and even their direction of origin.

Dusting for fingerprints and coating valuables with ultraviolet inks or dyes are common ways to use chemicals for marking and detecting information and objects. These aspects of chemical/biological surveillance are covered in more detail in the Biometrics Surveillance and Ultraviolet Surveillance chapters.

2.c. Categorization

Chemical surveillance is more complex and varied than other surveillance technologies and more difficult to group into simple categories for the purposes of discussion for the following reasons:

- Chemical use cuts across all industries; a chemical that is used in an industrial refinery may be equally valuable for testing the quality of baked goods or decorating a baby's crib.
- The amount of a chemical/biological agent is important; what is therapeutic in small doses may be toxic in larger doses, for example.
- The specificity of chemicals/biologicals and their unpredictable interactions due to genetic variations add another level of complexity; a bacterial agent that makes one person slightly ill might kill another and have no effects on a third.
- Many biological agents are living organisms; viruses and bacteria are too small to see without special equipment and can change rapidly. We are constantly struggling to determine the presence of these organisms and to understand and adapt to their changes.

For the sake of simplifying a broad topic into something manageable and useful that can be handled in one chapter, four general areas have been emphasized as follows:

archaeology - Chemical surveillance is used to investigate historical art, tools, cultures, records, structures, and fossils.

environmental studies - Chemical surveillance is used to assess the age, composition, character, and status of every aspect of our environment and the creatures that inhabit the ecosystem. This includes research and assessment of weather, geology, marine ecology, forestry, agriculture, and others.

product and cargo inspections - Chemical surveillance is used in agriculture and industry to automate production lines, to assure quality and compliance, and to inspect products during or after growth or manufacture. It is used in customs and local law enforcement to detect contraband and controlled substances, particularly narcotics, regulated agricultural products, and explosives.

search and rescue, forensics, and national defense - Various law enforcement and national defense agencies use chemical surveillance technologies to find and identify lost persons, runaway or kidnapped children, wandering elderly, lost hikers, and victims of bombings or natural disasters. They are further used in investigations of industrial spills, contaminations, arson, vandalism, kidnappings, rapes, and homicides. Chemical surveillance is used to identify, assess, and neutralize poisonous agents that can occur as a result of natural disasters, spills, bombings, and hostile conflicts.

3. Context

Prevalence

Chemicals and biological agents are used in homes, businesses and labs. Biochemical substances are so intrinsic to our lives, we take them for granted. Few of us dwell on chemistry, yet we use chemicals every day to cook and clean, to paint and glue, and to perfume our hair and skin.

Chemicals are not just external substances, they are also part of our bodily makeup. They influence our thoughts, our memories, and our emotions. Of interest to surveillance professionals is the fact that we leave a biochemical trail everywhere we go, as we slough off skin, hair, lotions, and fluids. These residues form a 'trail' that investigators can follow through chemical surveillance.

Chemicals are used in agriculture to grow, transport, clean, ripen, preserve, and process foods for the marketplace. They are used in industry to prospect, mine, refine, fabricate, color, coat, and preserve. They are further used by scientists to test, explore, investigate, and reveal. They are used in every aspect of lab work not just as a focus of scrutiny but as tools to stain, separate, preserve, and selectively destroy. They aid us in surveilling a wide variety of situations, including chemical spills, pollution, environmental trends and changes, weather, health, murders, and genetic relationships.

Use and Abuse

Chemicals can be helpful or harmful. The use of chemicals/biologicals to enhance our lives is an ongoing area of research and chemical surveillance is an important aspect of several fields including health and safety, compliance monitoring, and quality control.

Sometimes chemicals are used by naive individuals to self-medicate or by unscrupulous individuals to cheat, such as in steroid use by competitive athletes. Athletics administrators are constantly being called upon to regulate and detect illegal performance-enhancing drugs. These drugs are regulated and monitored for two reasons: to protect the health of the athlete who might be harmed by taking the drugs or cheap imitations of the drugs, and to protect the competitive rights of the athletes who are endeavoring to excel without breaking the rules.

In agriculture, sometimes growers and breeders will use chemicals in ways that contravene health and safety guidelines.

Because of evidence of abuse in various industries, chemical use is monitored and legislated and chemical surveillance is regularly practiced by watchdog agencies, inspectors, insurance assessors, customs and law enforcement officials, and military reconnaissance teams.

Chemical Weapons Threats

When chemicals are used in the context of war to inflict harm, they are known as *chemical warfare agents*. Chemical warfare is an emotional topic and information about its use and effects is often kept away from the general public. It is feared that reports of epidemics, mass murder, or uncontrolled release of chemical agents or harmful bacteria can create social instability and hysteria. Fears of chemical contamination or uncontrollable consequences are not entirely unjustified. Nature is too adaptable and sophisticated for humans to be able to control every aspect of biological/chemical use. Our ability to locate and create new chemicals far exceeds our ability to anticipate all the possible consequences of their use.

Most chemical threat dangers come from two quarters:

- the deliberate release of biological/chemical agents to do harm, and
- the accidental release of these agents from insecure stockpiles or through incorrect or fraudulent use.

Chemical/biological threats are much like bomb threats; because of their potential for harm, authorities generally prefer to treat them as real until they can establish otherwise.

There is a general feeling on the part of health professionals that more could be done to protect the public from potential harm from chemical warfare agents, and many labs and commercial firms have been seeking ways to develop better detectors and neutralization strategies and technologies. However, on the negative side, there is also a feeling that more sensitive detection instruments and computer data logs are contributing to an erosion of personal privacy, which is to some extent true. Yet, given the complexity of chemicals and their ubiquitous nature, in general, they have served us well and will hopefully continue to be used in ways that enhance the quality of our lives.

4. Origins and Evolution

The Evolution of Chemical Use and Abuse

Some chemicals survive for many thousands of years and others quickly vanish without a trace. Those that remain help scientists learn about ancient civilizations and much of that knowledge can be applied to understanding the customs of people in the past and how we arrived at the current state of our civilization.

Chemicals reveal clues in many ways. Detectives, pathologists, forensic investigators, doctors, paleontologists, astronomers, and environmentalists all use chemical surveillance techniques and technologies to analyze the present, the recent past, and the very distant past. They have learned that humans have been using chemicals for thousands of years to adorn their bodies, cook and preserve their foods, tan their hides, preserve their dead, and record their activities and thoughts. Well-preserved ancient human remains reveal the use of pigments, powders, embalming fluids, and tanning chemicals. We have learned that past civilizations used poisoned darts and arrows to hunt prey and used ochre and charcoal for makeup and paint. They used arsenic and other poisons to do away with unpopular rulers, and noxious materials and fumes to overcome enemies.

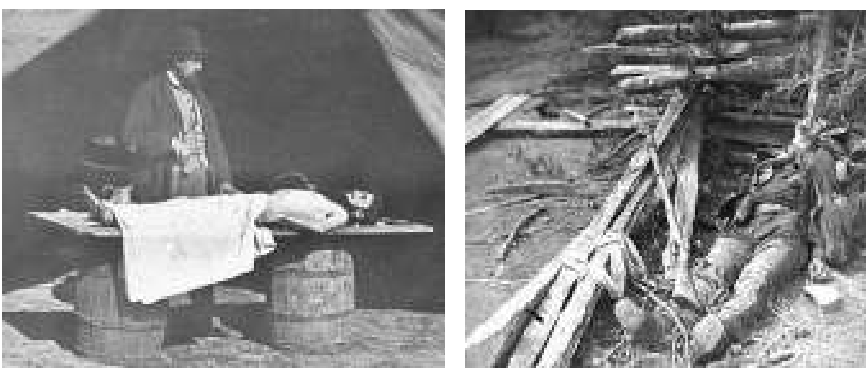
Early Regulations

Chemical substances have been subject to regulation for many centuries as well. Pigments, spices, medicines, liquor, and chemicals considered to be of value for cosmetics or other uses were subject to restrictions or tariffs. Historic river and sea routes were often patrolled regularly to control the movement of goods and to exact tariffs for the treasuries of

Kings, Queens, and feudal Lords. By the 1700s, Europe had set up customs warehouses wherein goods for import or export could be stored and inspected. By the early 1800s, the “Waterguard” or “Coastguard” in Britain served the function of customs and excise officials, regularly boarding boats and other vessels to inspect cargo and luggage.

Disease and Warfare

While medical *science* is a fairly recent development, medical *techniques*, whether effective or not, have been in use for tens of thousands of years. Poultices, tinctures, and herbal medicines have evolved through trial and error and have been passed down through oral and written histories. Germs weren’t really understood until lenses and microscopes were developed, but people in the Middle Ages and earlier must have known that some conditions are contagious, because they took steps to quarantine people with leprosy or plague. They are also reported to have tried to vanquish enemies in besieged cities by catapulting contaminated corpses over their battlements. In letters to his father during the Renaissance, Michelangelo indicated that doctors in Florence understood the source of the Black Plague. Two hundred years later, Russian troops are reported to have used plague-infected corpses against the Swedish. In 1763, British soldiers in North America gave blankets to Native Americans, knowing that they were infected with smallpox. This deliberate act of ‘chemical warfare’ was probably responsible for the smallpox outbreak that decimated bands in the Ohio River region.



Left: A Civil War surgeon needed a working knowledge of chemistry in order to do embalming work on a soldier’s body as is shown here. Right: The body of a slain Confederate soldier, in 1864. When they died and were searched, it was discovered that some of the soldiers were spies, as revealed by secret messages that were found hidden in their boots, buttons, and seams. [Library of Congress Civil War collection photos, photo on right by Timothy O’Sullivan, copyrights expired by date.]

As much as conflict is a part of human lives, there is a part of the human makeup that recoils at the thought of biological/chemical warfare. People sense something unsporting and truly evil about the practice, which has so far prevented us from annihilating ourselves, despite our ability to do so. Yet there is also a segment of society willing to engage in the study and manufacture of biological/chemical weapons and to consider their use.

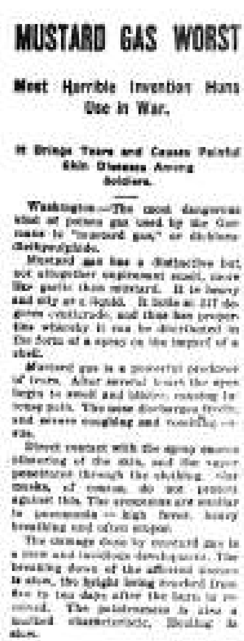
To counter this very small but dangerous minority, society has condemned the use of chemical warfare for at least the last century and a half. In April 1863, the U.S. War Department issued General Order 100, proclaiming, “The use of poison in any manner, be it to poison wells, or foods, or arms, is wholly excluded from modern warfare.” Obviously this statement would not have been made if chemical warfare had not been considered or used in earlier times.

As prohibitions on chemical warfare were being formalized, so were customs practices throughout Europe and America. The import and export of foods, cosmetic pigments, powders, and drugs had been regulated in one way or another for many hundreds of years in Europe and Asia, with inspections and tariffs not unlike what we have now. By 1789, the U.S. had a tariff act and by 1909, the Customs and Excise body in Britain was consolidated and formalized. Many of the current revenue and inspection organizations, including the U.S. Coast Guard and the National Bureau of Standards, originated through the execution of customs responsibilities.

Chemical Warfare

In 1915, the German army used poisonous gas during the battle of Ypres and the British countered by using it in the battle at Loos. Neither side used the gas very effectively. It was discovered that chemical agents were not as controllable as bullets. Bullets went where they were aimed. Gas, on the other hand, was influenced by the wind, which might be blowing right back in the faces of the people who unleashed it. At times the enemy would set the gas cloud ablaze, or the gas would give away the position of the aggressors who would then discover that the other side was better equipped to withstand the effects of the gas.

Many types of gas were tried during the war, including tear gas, mustard gas, chlorine gas, and others. Mustard gas had the most horrific consequences, causing the most deaths and leaving others with severe respiratory problems and ulcerations of the skin and eyes.

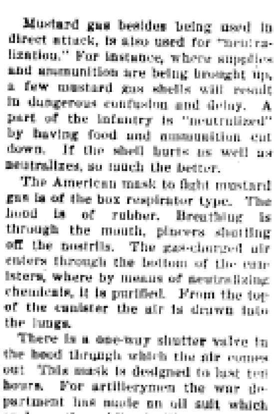

MUSTARD GAS WORST

Most Horrible Invention Huns Use in War.

It Brings Tears and Causes Painful Skin Disease Among Soldiers.

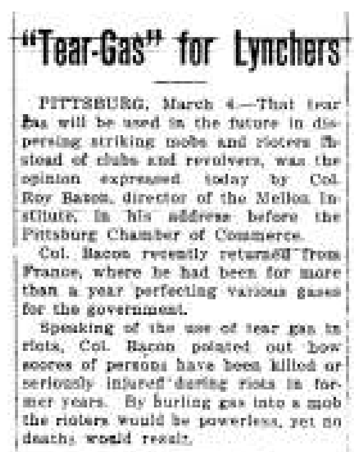
Washington.—The most dangerous kind of poison gas used by the Germans is "mustard gas," or dichlorodiethylsulphide.

[illegible]


Mustard gas besides being used in direct attack, is also used for "neutralization." For instance, where supplies and ammunition are being brought up, a few mustard gas shells will result in dangerous confusion and delay. A part of the infantry is "neutralized" by having food and ammunition cut down. If the shell hurts as well as neutralizes, so much the better.

The American mask to fight mustard gas is of the box respirator type. The hood is of rubber. Breathing is through the mouth, pincers shutting off the nostrils. The gas-charged air enters through the bottom of the canisters, where by means of neutralizing chemicals, it is purified. From the top of the canister the air is drawn into the lungs.

There is a one-way shutter valve in the hood through which the air comes out. This mask is designed to last ten hours. For artillerymen the war department has made an oil suit which encloses the soldier bodily.

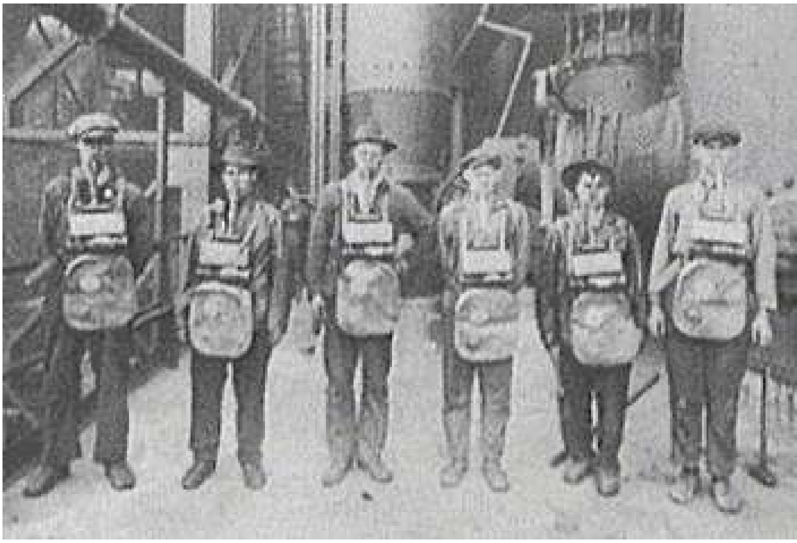

"Tear-Gas" for Lynchers

PITTSBURG, March 4.—That tear gas will be used in the future in dispersing striking mobs and rioters instead of clubs and revolvers, was the opinion expressed today by Col. Roy Bacon, director of the Mellon Institute, in his address before the Pittsburg Chamber of Commerce.

Col. Bacon recently returned from France, where he had been for more than a year perfecting various gases for the government.

Speaking of the use of tear gas in riots, Col. Bacon pointed out how scores of persons have been killed or seriously injured during riots in former years. By hurling gas into a mob the rioters would be powerless, yet no deaths would result.

Left and Middle: A clipping from the Dayton Forum in October 1880, describes some of the horrible consequences of exposure to mustard gas. Right: A nonlethal tear gas alternative is announced for riot control in this 1919 Pittsburg news item that also states that France was 'perfecting various gases for the government' at the time. [Library of Congress, African-American Experience in Ohio Collection, copyrights expired by date.]



Six men wearing gas masks while standing either in an industrial facility or possibly on a government vessel, in June 1920. Masks were apparently ineffective against mustard gas. [Library of Congress Historical Society of Colorado photo, copyright expired by date.]

Prohibitions on Chemical Use

In June 1925, largely due to the use of poison gas in the war, the Geneva *Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous, or Other Gases, and of Bacteriological Methods of Warfare* was instituted.

Left: A chemical laboratory at the House of David in 1940. Right: A U.S. Naval Air Base sailor dressed in new protective clothing and gas mask designed for use in case of chemical warfare. Historic notes describe this 1940s suit as being lighter than chemical-protecting suits from earlier times. [Library of Congress FSA/OWI Collection photos by John Vachon and Howard Hollem, public domain.]

While international agreements were being worked out, nations continued to study chemical agents. In the 1930s, Russia had a Central Military-Chemical Polygon, a chemical warfare research center. In Germany, scientists were developing sarin gas, in the late 1930s. Allied nations were known to have produced sarin during World War II, an organophosphorus compound that can cause nausea, headache, weakness, serious cardiopulmonary problems, and cardiac arrest.

Japan also conducted biochemical research and warfare during this period, using a variety of biological and toxic agents against the Chinese.

During the mid-1930s Disarmament Conference, international agreements were proposed to prohibit the production and stockpiling of biological and chemical weapons, but progress on prohibitions was slow.

By the time World War II broke out, some progress had been made in limiting the use of chemical agents. Even though more lethal biological and chemical weapons were developed during World War II, they were not put into use as they had been in World War I.

During the Vietnam War, the U.S. forces used herbicides to spray crops in Vietnam. These herbicides worked in a number of ways, interfering with plant metabolism or moisture retention, and were sprayed at levels 30 times higher than normal agricultural practices. Within weeks of spraying, leaves, flowers, and fruits were lost and many trees died. Dioxin was one of the chemical sprays that was used, known colloquially as *Agent Orange*. Many deleterious health effects have been attributed to exposure to these herbicides during the War, including a high rate of susceptibility to cancer and a variety of birth defects, including spina bifida. Since the War, the chemicals have been moving up the food chain, becoming apparent not only in foods, but in fish and humans.

Postwar Disease Control and Forensic Chemistry

Many aspects of chemical and biological surveillance have been developed during wartime or after incidences of accidental death or homicide. The human need for closure and ritual in situations related to death has resulted in whole branches of science being devoted to the location, handling, investigation, burial, and exhumation of human bodies.

Another outcome of the War was the study of various diseases contracted by military personnel serving abroad and their potential to spread to populations at home after returning from their tours of duty. Even during peacetime, service members were traveling to distant countries and contracting illnesses that required attention and sometimes quarantine in order to prevent their spread. The forerunner to the Centers for Disease Control and Prevention (CDC) originated in 1946 as the Communicable Disease Center that opened in the offices that had handled malaria control during the war.

Epidemics, such as the polio epidemics of the 1950s, spurred research into the causes, spread, and prevention of disease. Medical surveillance increased so that health warnings could be issued, preventive measures taken, and broadscale vaccination programs implemented. In 1951, the Epidemic Intelligence Service (EIS) was established, and international and domestic disease surveillance programs put in place. In 1955, the Polio Surveillance Unit was established.

The Control and Surveillance of Imports and Exports

In the 1950s and 1960s, commercial air travel, automobiles and trucks, and the booming postwar population all increased steadily. The bigger population and increased mobility put greater strains on customs bodies throughout the world to maintain order at borders and to continue to manage customs inspections and tariffs.

Until the 1960s, the vast majority of customs, border patrol, and immigration surveillance techniques were hands-on visual inspections by human agents. Gradually, however, mechanical and electronic means to inspect cargo and luggage were added to stem the tide of illegal aliens and monitor controlled substances (foodstuffs, pharmaceuticals, narcotics, and various dutiable items).

Customs inspections and administration couldn't be handled entirely on a country-by-country basis. Clearly, international cooperation would be needed to manage the increased movement of goods and global conventions were held. In 1961, for example, the United Nations held a conference to bring together international drug control under one convention. This was adopted as the *Single Convention on Narcotic Drugs* which defined various narcotic substances and established the International Narcotics Control Board. The role of the Board was to promote government compliance with the terms of the Convention and to assist them in their efforts.

Increased mobility had another important consequence for the global populace. It was now more common for illnesses to be spread from one country to another, through airplane and train travel. Thus, a global perspective had to be taken in order to control the spread of disease pathogens, which are indifferent to human political borders. In 1966, the Communicable Disease Center established the Smallpox Eradication Program to eradicate smallpox and to control measles in almost two dozen African countries.

Negotiation on various arms treaties continued, impeded somewhat by suspicious and sometimes hostile relations between the U.S. and the Soviet Union. In spite of the various treaties and attempts to eliminate chemical and biological warfare, there were reports that the U.S. armed forces shipped a 'small amount' of sarin nerve gas to Vietnam in 1967, though it has been claimed that it was never used.

The 1970s - International Control of Disease, Arms, and Drugs

The emphasis on global management of diseases, weapons of warfare, and narcotic substances continued into the 1970s. Hence, surveillance of compliance to these regulations was of importance, as well.

In 1970, the Communicable Disease Center was making progress in eradicating smallpox worldwide. The CDC's name was changed to the Center for Disease Control to reflect a broader health-centered focus.

The Pentagon reported (in 1998) that chemical agents stored in Okinawa were removed in 1971.

The General Assembly and the Conference of the Committee on Disarmament (CCD) did not result in agreement, but in 1971, the Soviets and their allies introduced a revision limited to biological weapons and toxins and an agreement was worked out with western nations. In December, the General Assembly unanimously adopted prohibitions. France abstained but, the following year, enacted internal legislation prohibiting biological weapons.

In 1971, the United Nations held the *Convention on Psychotropic Substances* in response to the various new drugs that were being synthesized in labs at the time and which had been reported widely in the media. The articles of the Convention sought cooperation with the World Health Organization in assessing the degree of impact on physical or psychological health that might be associated with various substances. The information would aid in determining substance controls, such as which ones should be dispensed with prescriptions, how they should be manufactured, how they might be imported and exported or whether they should be prohibited or permitted for medical and scientific uses, etc., in order to develop policy and controls. In 1972, the Single Convention on Narcotic Drugs was amended to reflect changes and additions.

The international community was busy that year, not only was it working on amendments for global narcotics control, but in April 1972, more than 100 countries signed the *Convention on the Prohibition of the Development, Production, and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction.* Existing stocks of biological weapons were destroyed and only defensive research with these materials could be continued according to the terms of the Convention.

In spite of international efforts to banish chemical and biological warfare agents, some of the middle eastern countries are suspected of having biological weapons.

In the late 1970s, the Center for Disease Control made progress in its programs to eradicate communicable diseases, including the apparent eradication of smallpox and wild polio (wild strains tend to mutate and may differ from vaccine-related strains). In the 1978, the CDC opened a special maximum-containment laboratory for the safe study and handling of dangerous viruses. In 1980, the CDC, which had grown to many branch offices at this time, was renamed the Centers for Disease Control.

1980s and 1990s - Biochemical Warfare and Health Concerns

In 1988, the United Nations made adjustments to previous conventions and took further steps to promote cooperation among international parties to effectively administrate aspects of various drugs with the Convention Against Illicit Traffic in Narcotic Drugs and Psychotropic Substances.

In the early 1990s, reports of persistent illness from American service members who had served in the Gulf War began to filter out. It was not known whether these illnesses were caused by emotional trauma, exposure to chemical agents, or side effects from antibiological/chemical warfare medications given to service members to protect them from possible harm.

The Mid-1990s - Treaties, Training, and Terrorism

In terms of the politics and science of biochemical surveillance, the mid-1990s were an active time. Various international agreements were being worked out, response teams were being set up, certification programs were being implemented and, in a shocking setback, terrorist chemical weapons were used in Japan.

The Army Corps of Engineers was involved in the renovation of a Central Chemical Weapons Destruction Analytical Laboratory as part of the Cooperative Threat Reduction Russian Chemical Weapons Destruction program. This lab is located in Moscow, with the project administrated through the Transatlantic Programs Center. Left: A new entrance being constructed for the facility. Right: Putting up a new wall for the lab. [U.S. Army Corps of Engineers news photo, released.]

In January 1993, it looked like progress was being made in international agreements to ban chemical weapons. The *Chemical and Biological Weapons Nonproliferation* project was launched to examine the issues that had been debated since the 1920s. The project was pursued in part to support the implementation of the *Chemical Weapons Convention* and to further strengthen the 1972 *Biological and Toxin Weapons Convention.* More than 120 countries were signatories to the *Convention of the Prohibition of the Development, Production, Stockpiling, and Use of Chemical Weapons and on Their Destruction*.

In the mid-1990s, a U.S. presidential initiative funded a prototype for Metropolitan Medical Strike Teams consisting of trained personnel organized to assist community response to potentially hazardous events. This was further developed to become the Metropolitan Medical Response System (MMRS) to link the resources of first-response, health care, and public health systems.

In June 1994, residents in Matsumoto, Japan, sought medical attention and were found to have reduced cholinesterase levels. They were treated for poisoning, but several died and hundreds became ill. It was later determined that they had been exposed to sarin nerve gas. The toxin was identified through gas chromatography and a document called "The Matsumoto Incident: Sarin Poisoning in a Japanese Residential Community" was prepared in the fall of 1994 to discuss the event and relevant issues [available online at www.cbaci.org].

In March 1995, the world was stunned to hear that a sarin gas attack on Tokyo subway travelers had left hundreds of people sick and about a dozen dead. It thus appeared, in hindsight, that the June 1994 incident may have been a 'test' for the 1995 attack.

Certification and Countermeasures Programs

In 1995, the American Board of Criminalistics was funded to develop written certification tests for a number of specialties in the field of forensic science, including forensic biology, fire debris analysis, hair and fiber analysis, narcotics identification, and paint and polymer analysis. This project was implemented so that criminal science specialists involved with forensic detection and analysis would be certified to have a level of knowledge and experience appropriate for making recommendations to investigators and attorneys.

This ink drawing represents an artist's rendering of the Tarhunah underground chemical plant said to be located in Libya. [U.S. DoD 1996 news photo, released.]

In 1996, DARPA launched the Biological Warfare Defense Program to develop technologies that could aid in thwarting the use of biological warfare agents by military opponents and terrorists.

Also in 1996, the Nunn-Lugar-Domenici Amendment was made to the FY 97 Defense Authorization Act "Defense Against Weapons of Mass Destruction, Subtitle A: Domestic Preparedness."

Progress on Treaties

In 1997, the Chemical and Biological Weapons Threat Reduction Act was proposed in the U.S. Senate and passed as amended. The intent of the Act was to make it U.S. policy to take preventive measures against and to discourage and prohibit chemical and biological weapons.

The status of weapons in the world was being scrutinized with global human intelligence and with technological surveillance devices that became available in the 1990s with the result that the Pentagon reported that more than 25 nations had developed or might be developing nuclear, biological, and chemical weapons. In 1997, China pledged not to engage in any new nuclear cooperation with Iran and, in November, Russia ratified the Convention on Chemical Prohibitions of 1993.

Russian experts slated a number of chemical-weapons production sites for destruction late in 1999. The sites apparently had been used to produce toxic chemicals including mustard, sarin, and soman gas, VX, and lewisite, and munitions laced with hydrogen cyanide and phosgene. The removal process would take several years due to the complexity of safely reactivating and removing chemical agents and decontamination of surrounding support structures. Financially stressed over the last several years, Russia sought funding assistance from other nations.

Left: In spring 1997, the U.S., Canada, Germany, and The Netherlands participated in exercises to refine operations skills under simulated high-threat environments. In this case, participants were garbed in chemical gear, chemical attacks were executed by helicopter, and the service members briefed after the exercise. Crew members headed for the Persian Gulf were trained, prior to the trip, for chemical and biological warfare. Right: A room full of chemical protective suits are inspected by fireman Russell Legett on the USS George Washington (CVN 73) as it heads for the Persian Gulf in November 1997. [U.S. DoD news photos by James Mossman and Joseph Hendricks, released.]

Preventive Health Measures

Late in 1997, a decision was announced by the U.S. Defense Secretary to inoculate about 1.5 million service members against anthrax, considered to be a highly lethal candidate for use as a biological weapon. As a first step, in 1998, personnel deployed to Korea and Southwest Asia were inoculated. Trials of a newer, cleaner smallpox vaccine, grown in a sterile lab, were carried out on U.S. Army participants.

Left: P 1st Class Suderman draws blood from P 1st Class Lavenhous, one of 150 volunteers in clinical trials for a new smallpox vaccine at the Army Medical Research Institute for Infectious Diseases. Right: Dr. Coster, Chief of Clinical Studies examines Army Spc. Winnona Yanson, another volunteer. [U.S. DoD news photos by Douglas J. Gillert, released.]

Customs and Border Control

Throughout the years, the U.S. Customs department had been updating and improving inspection practices and incorporated new technologies as they became commercially viable. In the late 1990s, new equipment and sensors were added to a number of border stations and canine sniffing programs were continued or expanded. Operation Brass Ring was instituted in 1998, a program in which random and unpredictable strategies were used to make it difficult to anticipate the inspection actions of Customs personnel. At the West Texas and New Mexico border region in one year alone, agents seized more than 200,000 pounds of narcotics that individuals had attempted to smuggle across the border undetected.

International Affairs in 1998

There were many events in 1998 related to the development of international treaties and worldwide control of chemical weapons production and stockpiling.

The United Nations Special Commission, a body charged with eliminating Iraq's weapons of mass destruction, claimed that the Iraqi government was trying to conceal some of its programs.

In 1998, the U.S. presented new devices intended for the detection of weapons and chemicals.

In June 1998, the U.S. claimed that Syria had installed sarin nerve gas in missiles, artillery, and on board aircraft. In July, a U.S. Pentagon review denied any evidence to support allegations that U.S. troops used sarin nerve gas in 1970 to hunt down American defectors. Iraq was accused by the U.S. of having laced a missile warhead with VX nerve agent, resulting in continued sanctions against Saddam Hussein, the Iraqi leader. At one point it was claimed that the material was being used in equipment calibration and Iraqi supporters demanded analysis to confirm the presence of the nerve agent. It was also claimed that U.N. inspectors had planted the VX nerve agent in the missile warheads. Experts later destroyed tiny quantities of the VX and Iraq refused to comment further on the matter.


Left: An aerial reconnaissance photo announced by the U.S. as being the Shifa Pharmaceutical Plant in the Sudan. The U.S. military had launched a strike on an apparent chemical weapons plant in the Sudan and used this as an exhibit in press briefings. Right: A simulated casualty from a chemical attack is loaded by service members in chemical suits. This exercise was executed jointly with the U.S. and the Republic of Korea as Exercise Foal Eagle, in October 1998. [U.S. DoD news photo on right by Jeffrey Allen, released.]

In the fall, the U.S. and the Republic of Korea participated in joint training exercises to test rear area protection in which chemical attacks were simulated.

Terrorist Acts

Terrorist acts in recent years have resulted in increased security and surveillance.

Left: A victim of the tragic bombing of the U.S. Embassy in Nairobi, Kenya, is honored in a ceremony at the Andrews Air Force Base, Md. in August 1998. [U.S. DoD news photo by Mark Suban, released.]

On 7 August 1998, U.S. embassy buildings in Kenya and Tanzania were devastated by terrorist bombs, with thousands of people injured and more than two hundred lives lost. This act raised concerns that terrorists who were willing to kill so many people with bombs might also be willing to kill people with biological or chemical weapons.

On 20 August, the U.S. government launched missile attacks on installations in Afghanistan and the al-Shifa pharmaceutical factory, claiming it was being used for making chemical weapons, a claim that stirred international controversy. Sudan requested that the United Nations Security Council pursue a fact-finding mission to verify American claims. Such a mission would include chemical surveillance to locate evidence of alleged chemicals in the soil and debris at the bombing site.

The U.N. Security Council postponed a decision on the mission. The Sudanese claimed that if al-Shifa had, in fact, been a chemical weapons site, then bombing it would risk releasing the chemicals into the immediate vicinity, endangering thousands of civilians. The counterargument was that the precursors used to developing toxic weapons such as nerve gas, are not of the same toxicity as the final product. Westerners who had been at the factory claimed they had seen no sign of chemical weapons. Some still feel, at this point in time, that the incident was a false alarm and the actions were taken in haste. The U.S. continues to defend its actions.

Chemical and Crime

Because biochemical warfare is such a frightening prospect, a good deal of surveillance is focused on anticipating and preventing its use. However, biochemical warfare is not the only aspect of surveillance that involves chemical agents. Chemicals are sometimes used in more specific and direct ways to inflict harm. Cyanide, arsenic, and strychnine are poisons that are sometimes used to kill people or pets and thus are of concern to forensic pathologists. When older people are poisoned, there may not be an autopsy performed, due to the age of the victim. This makes it harder to detect if chemicals were sometimes related to the death. In recent years, however, improvements in spectrophotometry, mass spectrometry, and X-ray analysis techniques have made it easier to determine if there are toxic chemicals in a person's body tissues that could indicate foul play. By the late 1990s, lab techniques to detect poisoning had greatly improved.

Chemicals are not always used in direct ways to commit crimes. Sometimes they are an indirect means to obscure other objects, activities, or goods intended to be hidden, installed, or detonated. In 1999, in one customs seizure of goods, it was discovered that smugglers had chemically altered cocaine to darken it and make it look like metal.

Industrial Spills

Not much has been said so far about industrial chemical spills, but these have been a problem for decades, with factories either not being sufficiently regulated or illegally dumping effluent and toxins into watersheds, oceans, lakes, and landfills. Chemical surveillance is one of the most important tools used to manage industrial effluent and detect serious breaches of regulations designed to protect the health and safety of employees and the public.

A few examples from 1999 and 2000 help to provide a picture of the prevalence and variety of types of industrial spills that occur. It also underlines the challenges facing investigators and experts who often must determine the chemical composition of the spills, their potential danger to humans, and the best strategies and materials for cleanup. Chemical surveillance can provide early warnings of spills, chemical composition indicators, and evidence for prosecution in instances of negligence or where responsibility and funding for cleanup must be established.

April 1999 - a chemical spill at a milk-processing plant in Wisconsin sent a yellow plume high into the sky. Hundreds of residents and workers were evacuated.

June 1999 - Washington State, a pipeline leak into a creek ignited a series of explosions near a chlorine water treatment plant. Residents didn't know if the thick billows of smoke were toxic. Early warning signs included a strong smell of 'gasoline' near the creek. One report claimed that computers correctly recognized the problem and shut off the system but that personnel turned it back on again prior to the explosions. Since loss of lives was involved, the proof or denial of these allegations is ongoing, as are cleanup efforts.

July 1999 - a corrosive chemical spill during unloading at a toiletries factory in Iowa necessitated the evacuation of about five thousand people.

August 1999 - a barge collision on the Ohio River caused a gasoline spill to contaminate the water.

June 2000 - a test of a well in British Columbia revealed mercury levels in the ground near a landfill to be thousands of times higher than established safety limits, raising concerns about leakage into the water table and nearby residential area.

Chemical Surveillance Measures

In March 1999, federal researchers were encouraged to step up development of better chemical and biological agent detection systems so they could be put into place by the next Winter Olympics. The Chief United Nations weapons inspector reported that Iraq had converted a livestock vaccine facility into a production facility for biological warfare agents.

In July 1999, chemical experts in Baghdad were ordered to destroy VX nerve agent in a United Nations laboratory after Iraq's allies failed to convince the Security Council that they should be held for further analysis.

Left: A chemical suit stands in mute testimony on the left while Secretary of Defense William Cohen holds up a copy of "Proliferation: Threat and Response" which discusses nuclear, chemical, and biological threats and DoD countermeasures. Right: A treaty signing in the Pentagon committed the U.S. and Azerbaijan to cooperation in the counter-proliferation of nuclear, chemical, and biological weapons and related materials. The signing between the U.S. Deputy Secretary of Defense and the Minister of Foreign Affairs took place in September 1999. [U.S. DoD news photo by Helene C. Stikkel and Jerome Howard, released.]

In 1999, the U.S. Director of the CIA reported on weapons acquisition in various nations. He reported that Iraq had stockpiled chemical weapons, "including blister, blood, and choking agents and the bombs and artillery shells for delivering them." He further reported that North Korea was producing "a wide variety of chemical and possibly biological agents, as well as their delivery means" and that Syria had "a stockpile of the nerve agent sarin and apparently is trying to develop more toxic and persistent nerve agents."

In October 1999, Hurricane Floyd battered the east coast, causing concerns that bacteria and chemicals may have contaminated the North Carolina waterways.

The Year 2000

The year 2000 was characterized by continued international efforts to reduce the proliferation of biological and chemical weapons and by environmental concerns about contamination from industrial effluents, spills, PCB storage, and nuclear wastes.

In January 2000, in armed conflicts between Russia and rebels in Chechnya, the Russians reported that Chechens had detonated bombs containing poisonous chlorine and ammonia.

The U.S. Government sought funding for developing blood tests to measure toxic exposure in humans. Agents within the FBI were assigned to counter-terrorism, which included biological/chemical investigation and countermeasures.

In February, 2000, equipment repair personnel at a chemical weapons incinerator in Utah experienced accidental exposure from a leak into the room in which they were working. The same month, San Martin Lake, in Texas, was fouled by a toxic chemical spill that killed about six million fish and large numbers of birds.

In a development that probably surprised Westerners more than Asians, the cult accused of attacking subway commuters with sarin gas in Tokyo in 1995 offered to pay compensation to the victims of the attack.

5. Description and Functions

Biological and chemical surveillance activities are primarily concerned with the detection of synthetic and biological chemicals associated with crimes. The analysis of these chemicals may include not only identification, but the determination of their origin and composition. The neutralization, cleanup, and decontamination of chemicals are closely related to chemical surveillance and so are briefly discussed here.

Surveillance measures are further used to determine compliance with international and domestic biological/chemical nonproliferation treaties and bans, and to detect the presence of biochemical weapons.

5.a. General Guidelines

Detection of biological/chemical and, in some cases, nuclear contamination, requires a strategy and one or more synthetic or biological devices or detection systems. Biological agents may be detected with various electromagnetic (EM) devices to get a general idea of whether there is contamination. EM devices can sometimes also provide information on the location and general extent of any biochemical agents. However, to get more precise data, chemical kits, and laboratory follow-ups (if possible) are often used. In food and water supplies, it is important to test before adding any other chemical agents (e.g., chlorine) that might obscure the testing results.

Protective Environments and Gear

When dealing with chemicals, it is always important to use appropriate safety gear, including suits, masks, gloves, and goggles. In some cases, as in the military and medical fields, preventive steps such as vaccinations and X-rays are given to personnel who might be working with chemicals and biological organisms on a regular basis or might be exposed to them in the course of their duties.

Decontamination tents, trailers, and quarantine/isolation rooms are used in some circumstances, as in the space program and in certain military and medical stations.

Decontamination and Sterilization Products

When chemical agents are detected, they can sometimes be contained or moved, but sometimes it is necessary to neutralize or destroy them, especially in the case of those that are potentially hazardous. This is usually done by decontamination or sterilization. Medical wastes, bacteria, viruses, toxins, and poisons are often routinely treated or sterilized to render them less harmful to humans and the environment.

There is a lot of overlap in the chemicals and processes used to sterilize and those used to decontaminate, but given the complexity of chemicals and the differences between decontaminating a person and sterilizing an object, there is not 100% overlap. Sometimes the processes are used in conjunction with one another.

Because the focus of this book is surveillance rather than remediation, decontamination and sterilization are not covered. It is sufficient to mention that heat, electricity, and chemical agents are the primary means for decontaminating and sterilizing. Anything that breaks or reshapes chemical bonds is a potential candidate for these purposes. Those which cause the least harm to the object or living organism being decontaminated or sterilized are usually favored though. In a few instances, economic factors take precedence and there are cases where preservation of the original contaminated object or substance is not required and it may be incinerated or otherwise destroyed.

Preservation

The preservation of evidence through chemical means is an important aspect of law enforcement. Getting good samples for DNA analysis is discussed in the Genetics Surveillance chapter. Preserving latent prints and other bodily remnants is described in the Biometrics Surveillance chapter. A few general methods are described here.

Tapes and Samples

Specialized clear tapes are used to ‘lift’ and preserve many types of evidence including blood smears, paints, spills, and fingerprints. Once a print has been made more visible with a powder, adhesive tape or precut strips can be placed over the print, pressed gently, and placed over a non-acidic card or paper to protect the image on the tape. This takes practice. The tape must be large enough to cover the area to be lifted and must be laid down gently and evenly so as not to create creases in the tape or distort the image by adhering part of it and then accidentally pulling on it. Then the correct amount of pressure must be applied. Too much pressure can ‘squash’ a print. Too little can cause some of it to remain on the original surface and the odds of correctly lining up the tape a second time to get the rest of the print are almost zero.

Since tape glue is itself a chemical substance that might interfere with the analysis of trace materials, it is not always appropriate to use evidence tape. Some samples should be put in dry, clean, acid-free envelopes or bags instead of using tape. Tweezers and small jars can be used for fragmentary evidence such as carpet and clothing fibers that might be used to connect a victim or suspect with a crime scene.

When hairs are being sampled from a living person, as in a poisoning investigation, the entire hair should be taken and pulled (if the person can tolerate it) rather than cut. This serves two purposes. Since the ‘history’ of chemical use is contained in various parts of the hair, it preserves the entire timeline. The second reason is that cutting the hair might make it unclear which end of the hair is most recent. If checking a poisoning timetable, it can be important to know if arsenic, for example, was administered six months previously or immediately before the report of the crime (or admission to a hospital). A cut hair makes it possible to get the timeline backward, confusing the investigation and leading to the wrong conclusions. If the hair roots cannot be pulled, then the hairs should be oriented in the same direction and clearly labeled as to which end was near the scalp.

Light is sometimes used to reveal very faint prints that cannot be brought up by powders. In these cases, photographic evidence must be taken as there is no way to use a tape or other medium to physically transfer the prints. The same is sometimes true of other bodily residues.

Preservatives

Chemical preservatives such as formaldehyde may be used to preserve certain specimens such as animal/human tissues. If the tissues are to be used for DNA sampling, Luminol™ and formaldehyde should not be used, as they will chemically alter the sample. It is better to freeze or air-dry and bag. Chemical preservatives should be handled carefully (or not handled at all) as some are poisonous and some may provoke allergic reactions.

5.b. Biochemical Markers

Chemicals are used to mark targets or vehicles so they can be easily located by lights or special vision enhancers. This could help find a person in a crowd or a vehicle in a parking lot. Chemicals are often chosen because they show up in special lighting or with special infrared or ultraviolet viewers or imaging systems. Chemical markers are sometimes used in conjunction with radio tracking beacons.

Chemical dyes are sometimes used in bags that hold banknotes or other important negotiable items. If the bag is not opened correctly, the dyes may disperse or 'explode' onto the hands and clothing of the unauthorized person holding the bag. Dyes that cannot be washed off by any normal means are used. It is important to make the dyes work in such a way that they do not spray in the eyes, as indelible inks can cause temporary or permanent blindness.

5.c. Detection of Chemical Prints

Fingerprinting

Fingerprinting is an important form of biochemical surveillance as chemical means are used to locate and preserve the prints and the prints themselves are a combination of chemicals contained in perspiration and body oils. Fingerprinting is discussed in the Biometrics Surveillance chapter.

Chemical 'Fingerprinting'

Chemical forensics continues to improve, with many new techniques having been added in the last decade. Chemical forensics is also being used in conjunction with electronic chemical detectors and accessories. One innovative development in chemical surveillance is *molecular fingerprinting* in which the molecules of synthetic products such as plastics are manipulated to create a coded layer that can be applied to many products. Horcom, based in Ireland, has announced that they have succeeded in creating a coded liquid suspension that is invisible to unaided eyes but which can be detected with a spectrometer.

Identifying Remains

One of the more important aspects of biochemical surveillance is the identification of human (and sometimes animal) remains in association with accidental death, suicide, homicide, or warfare. This is principally carried out by *forensic anthropologists* though many other branches of science are involved. Identification aids in convicting criminals, in establishing evidence for war crimes, in detecting and preventing the spread of diseases, and in notifying distraught relatives and providing them with closure so they can move on with their lives with a few sensitive questions answered and put to rest.

Entomology is the study of insects. When forensics is used to determine information about a corpse, how and when a person died, and sometimes even where, it is sometimes necessary to have a good understanding of insect habits and lifespans in order to make good scientific observations. This is the field of *forensic entomology*. It's a rather gruesome area of study, but insects are so quick to move in on what they perceive as a free meal that it would be irresponsible for scientists and technicians to ignore the information that can be gleaned from observing their habitation of a dead body. In fact, training programs in which corpses are buried or left to decay and then studied are an important aspect of law enforcement. Forensic entomology can aid in establishing the time of death, the possible origin or other locations of the corpse, if it has been moved, and sometimes even the cause of death.

Changes in body temperature can help establish time of death in criminal investigations, but if the body has been dead for more than about three days, other methods must be used. Gail Anderson, a Canadian forensic entomologist with Simon Fraser University's criminology school, is creating a national database of bug-colonization patterns to aid investigators in determining various geographic and climatic conditions that can help establish time of death if an extended period of time has passed. Anderson began the project in 1992, and has since catalogued millions of insects. These databases are important because of the vast differences in insect species and behaviors over different climates and geographic ranges.

Left: Criminology professor Gail Anderson smiles between cages of buzzing insects. Anderson, who has spent eight years building a forensic entomology database, has received a grant for equipping the first forensic entomology lab in Canada Middle: Akbar Syed is a forensic entomologist who manages one of the best insectaries in North America. Syed has developed techniques for using insects to estimate time of death and has assisted the RCMP and the coroner's office. Right: Niki MacDonell, a graduate student with plans to be a coroner, made routine visits to a series of clothed and submerged pig carcasses to study the life cycles of insects that colonize the dead bodies. [Simon Fraser University 1999, 1998, and 1997 news photos, released.]

The identification of remains is discussed further in the Biometrics and Genetics Surveillance chapters.

5.d. Chemical Microscopy and Analysis

Paint Identification

Vehicles are frequently used in crimes. Sometimes the vehicle is the subject of the crime itself as in car theft or smuggling. In other cases, cars and trucks are used as getaway vehicles, and may be associated with violent crimes such as homicides and kidnappings. Sometimes it is important to be able to tie a vehicle's location at a particular time to the scene of a crime.

It is often important to chemically assess a vehicle's paint to see where it has been or where it originated. Other types of vehicles or industrial equipment may be subject to the same types of investigation. The carpet fibers, dirt in the tires, contents, and paint are important subjects of investigation.

Paint is generally a combination of pigments, additives, waxes, solvents, and polymers. Microscopes and chemical processes can be used to evaluate the layers, their composition, color, and age. Sometimes it's even possible to determine if the vehicle has been subjected to unusual temperatures, storms, or other environmental conditions that might indicate where it has been and for how long.

Weathering tests can be conducted to see if a particular paint responds to environmental influences in a certain way. In some cases (and with some luck), a paint chip can be traced not only to the make and model of the vehicle, but sometimes even to the time of year the vehicle was first released, as paint mixtures are sometimes changed by manufacturers during the course of the year. More often, however, a forensic scientist will be asked whether paint chips match a particular vehicle, an easier question to answer than finding the origin of a particular chip.

Paint evidence should be put in noncontaminating (acid-free) containers or bags whenever possible, as the chemicals in adhesive tape could interfere with analysis of the paint.

Paint can vary from one part of a vehicle to another (e.g., the trunk may have been repainted following a rear-end collision), so it is best to collect samples as near as possible to where the chips may have originated. It is also a good idea to collect samples from various parts of the vehicle, labeling them carefully, because information about different paint on different parts of a vehicle can sometimes by tied to the repair and body work history of the vehicle. For example, a hit-and-run suspect may have had the damaged hood of the car replaced.

When collecting samples, the various layers down to the bare metal should be collected in one piece, if possible, as the composition and order of the layers may aid in identification.

The same general principles apply when collecting paint from furniture or walls. When possible, collect below the lowest layer of paint.

Infrared microscopy is one of the tools used in paint identification and matching.

5.e. Chemical Detection and Identification

Chemical detection is used to detect illegal smuggling or use of foodstuffs, accelerants, explosives, and controlled substances. It is also used in many aspects of forensics related to finding out whether an individual committed suicide or was murdered by poisoning.

Arson and Explosives

An important aspect of chemical detection is the investigation of arson or the detection or investigation of explosives. There are thousands of incidences of arson every year and about 2,500 attempted and actual bombings. Bomb threats also result in a variety of surveillance technologies, including chemical surveillance used to detect the bomb, to determine what type of bomb it might be in order to disarm it, and the process of detonating or disarming it.

When arson is suspected, the presence of accelerants or suspicious electrical anomalies can give clues as to whether a fire was accidental or deliberate. Fire follows patterns of behavior that are known to arson specialists and chemical residues from accelerants are not necessarily destroyed by the subsequent fire. Dogs are used to locate specific accelerants (and sometimes victims and survivors) and also have been trained to recognize a variety of types of explosives.

Foodstuffs

When foodstuffs that threaten local agriculture or business economics are suspected of being smuggled, various surveillance techniques are used to detect and locate the materials, including visual inspection, substance-sniffing dogs, X-ray detectors, and even gamma-ray detectors for checking large shipments of cargo.

Food Diagnostics

It is estimated that there are as many as 33 million incidences of food-induced illnesses each year in the U.S. alone. Biological/chemical surveillance is used by growers, manufacturers, and distributors to ensure safe products.

BSD sensors - A series of biosensor products designed to detect pathogens and toxic substances in realtime. The sensors can be configured for species-specific microorganisms for use in identifying specific food pathogens. Biosensor Systems Design, Inc.

Narcotics

Narcotics-detection is often done with the aid of dogs, as described in the Animal Surveillance chapter. However, there are steadily improving electronic 'sniffers' that may someday supersede canine corps for certain types of detection and identification tasks. These electronic devices can be set to sniff out a variety of substances and some can even indicate the direction from which the chemicals are coming, which makes them potentially useful for other tasks, such as finding chemical contaminants and chemical warfare agents.

The U.S. Customs service is responsible for the detection of illegal foodstuffs, undeclared goods, restricted pharmaceuticals, narcotics, and explosives. Left: Canines are trained to detect a number of specific substances. Beagles aid in detecting foods, and Yellow Labs and Golden Retrievers are used in a variety of explosives and drug detection activities. Here, Big Nick zeroes in on drugs underneath a car while in training. Right: After a canine hit on a boat hull, the hull was drilled and the hit confirmed with a chemical detection kit. The chemical turned blue, indicating cocaine, which was subsequently found stashed in the hull. [U.S. Customs news photos by James R. Tourtellotte, released.]

These are examples of some chemical detectors:

Ionscan 400 - A hybrid drug and explosives detector designed to detect and identify up to 30 different substances. Automated operation, self-calibrating. Suitable for use by law enforcement agents, airport security agents, and investigative scientists. Available from American Security.

NDS-2000 - A portable, handheld, battery-operated narcotics detector for detecting cocaine, cannabis, crack, heroin, methamphetamines, and others. Available from American Security.

Drugs and Poisons

It is sometimes difficult to determine whether someone who has died of poisoning or an overdose of drugs did so intentionally or accidently, or was perhaps murdered.

Forensic toxicologists regularly examine a number of chemical indicators that are found during autopsies or collected at the scene of the death.

Air Quality

Various detectors and measuring instruments have been developed to surveil air quality, particularly in large cities and industrial centers. These monitors are used by companies to ensure compliance with regulations and are used by newscasters and government monitoring agencies to check and report air quality. People with illnesses or compromised immune systems can be particularly susceptible to air pollution.

Dr. John Kauer and chemist David Walt of Tufts University teamed up to create a fiber-optic sniffer that can identify various substances by their smells. It has many applications in surveillance, including the capability to monitor internal and external air quality, changes in blood chemistry in the human circulatory system, or chemical leaks in a tanker or factory.

Explosives Detectors

Explosives detectors work on a number of different principles, from X-ray machines that might indicate a bomb in a briefcase, to dogs trained to sniff out certain chemicals. A new type of machine was certified by the FAA in late 1998. Also, in 1998, it was reported by the U.S. Dept. of Transportation that bomb detection machines for screening luggage were not working as well as was hoped, partly due to slow implementation by airlines.

EVD-3000 - An example of a handheld, rapid-response, high-sensitivity explosives detector. It is available from American Security.

Firearms Matching and Gun Residues

Firearms identification and matching is accomplished through a variety of surveillance technologies, including visual, infrared, and physical, but since a portion of it involves residues analysis and chemical and microscopic techniques, firearms are mentioned in this chapter.

Identifying or matching a firearm is an interesting aspect of forensic science. It involves inspecting, comparing, loading, firing, tracing, and sometimes chemically treating the firearm in order to determine its characteristics. Firearms used in crimes are sometimes modified or will have the serial number filed off. Thermal, magnetic, and chemical processes can sometimes be used to retrieve the information even when the number is no longer visible. A computer floppy diskette that has been erased still has minute traces of patterns on its surfaces that can be discerned with the proper tools and techniques and the same goes for gun serial numbers. The very act of stamping the serial number may have disturbed the metal enough that the information can be revealed. (These techniques can sometimes also be used to retrieve numbers from stolen vehicles or tools.)

Each gun has a unique ‘signature’ in the sense that the marks in the barrel and the marks in the projectile will have certain characteristics in common. In a more general sense, firearms will share characteristics with those of the same type or from the same manufacturer or plant. This information can also be helpful if the weapon itself is not available, with only evidence of its having been fired.

The FBI and related organizations maintain a number of databases and collections of firearms to aid forensic scientists in learning the characteristics of individual types of guns and using them in comparison tests. They are also used in experiments to determine their range and the types of effects they inflict on different sorts of materials. Samples can help answer many questions including How far do the bullets penetrate? How do angles affect their influence, or temperature, or precipitation? How strong do you have to be to pull the trigger? How far away can you hear the shot? How widely does the shot scatter? How much does the bullet deform on impact?

Reference Fired Specimen File - an FBI Firearms-Toolmarks Unit that includes examples of ammunition that show what happens to them after they are fired.

Reference Firearms Collection (RFC) - a physical repository of firearms with more than 5,000 items. This aids in classification and parts identification in cases of evidence derived from a crime scene or from surveillance images.

Standard Ammunition File (SAF) - a physical collection of more than 15,000 commercial and military specimens of foreign and domestic ammunition. Both whole and disassembled versions are available as well as pellets, bullets, cases, etc. The information is being transferred to a computer database for faster search and retrieval for initial investigations.

DRUGFIRE - an FBI database that provides examiners with a means to compare and link evidence obtained in serial shooting investigations. After a weapon has been test-fired, images of the results can be digitally stored to add to the system for comparison with thousands of other categorized images. Since this can be accessed over a network, crimes committed in one area can be linked with crimes in another. This is gradually being absorbed into the National Integrated Ballistics Information Network (NIBIN).

National Crime Information Center (NCIC) - NCIC maintains a database of serial numbers of firearms. Weapons reported stolen are included in the list.

5.f. Industrial Prospecting and Production Monitoring

Chemical surveillance is an important aspect of resource- and manufacturing-based industries. Mining, refining, food production, pharmaceutical research and production, and cosmetics are just a few of the areas that use chemical surveillance to ensure uniformity, compliance, and quality in their products. What was once accomplished by following certain protocols and procedures is increasingly being accomplished with the use of sensors and detection methods that provide more objective measures of performance and can provide automation when integrated with computer algorithms.

SeptiStat - A pathogen-specific sensor system which allows quick assessment of contamination levels in food and industrial environments. Sensors can be used individually, or can be multiplexed for pathogen specificity. Available from Biosensor Systems Design, Inc.

Production Analysis

Chemical surveillance is widely used in the manufacture of consumer products to determine their composition and to ensure uniformity. It is also sometimes used by companies to analyze the components of competing products. It is further used by production managers and inspectors to make sure products comply with health and safety guidelines.

Minispec - A sensitive nondestructive analyzer which has a number of options that allow further types of analyses, including fat composition (e.g., margarine production), fluorine content (e.g., toothpaste products), hydrogen. It is suitable for food, polymer, petroleum, and medical industries. Available from Bruker.

Process Analysis and Control

There are many industries in which chemical reactions and interactions determine when the process is ready for the next step. Wine-making, paper-making, dying, cheese-making, and metals refining and fabrication are all examples of processes that go through a number of stages which are at some points critically linked to the previous stage or a chemical state of readiness. Chemical surveillance products can assist in determining when to stop a process or when the right stage of 'readiness' has been reached for continuing to the next process and further can allow quality control monitoring during various stages of production.

Process Control Sensors - Sensors which can be set and calibrated and operated online or offline to alert personnel or machines as to the status or state of readiness of a batch being set up for the next step.

5.g. Biochemical Warfare Agents and Medical Diagnostics

There have been many biological/chemical agents used in the past to try to deliberately poison or infect others, including instances of assassination, warfare, and homicide. Archaeologists have studied disinterred remains that indicate that arsenic poisoning has been around for a long time.

Biological and chemical agents that can be used to inflict harm include anthrax, the plague, ebola, pox viruses (e.g., smallpox), botulism (which is produced in anaerobic environments), tularemia, venoms, and various nerve gases. Unlike most weapons, many biochemical agents cannot be controlled once they are 'fired.' The chances of injuring the person who unleashed them may be quite high in the case of disease pathogens unless they have been specifically immunized or are wearing special protective gear. Fortunately, many of these agents of warfare are not as easy to manufacture as is generally thought, and humans have built-in protections against many biological agents. There are also a large number of organizations working tirelessly for the destruction of biochemical weapons and for laws to eliminate their manufacture and they are achieving some degree of success.

DNA analysis and profiling can provide information on biological agents, which sometimes provides great specificity in their type and origins.

OptiSense Technology™ - This represents a series of biosensor products. The medical diagnostic products are designed to detect pathogens or critical molecules in body fluids. Ex vivo and multiple blood and urine analyses can be performed in less than a minute. A handheld analyzer works in conjunction with disposable cartridges. Bacterial- and viral-screening sensors are also in development. Available through Biosensor Systems Design, Inc.

There are a number of experimental technologies in development, including

DARPA - is considering a nitric oxide detector, since infected people may exhibit higher levels than those who are not, before any overt symptoms may be noticed.

IatroQuest Corporation in Ottawa, Canada - is working on a pocket-sized chemical and biological warfare detector designed to replace larger machines used in military operations. It could also be used in vulnerable urban settings. It combines biological molecules with inorganic material such that it behaves like a 'smart antibody,' reacting to chemicals somewhat similar to the human immune system reacting to foreign agents. It then performs a spectral analysis and alerts the user, specifying the direction from which the foreign matter was detected, and optionally displaying instructions. It is projected to be ready for mass production at a cost of about $5,000 by 2001.

There are many motivations for developing smaller, more sensitive detection kits. Besides being more cost-effective and potentially 'expendable' (usable in high-risk situations), small kits can potentially be catapulted or parachuted into suspected hazardous areas ahead of investigators and can be packed and hidden more readily than larger units.

Chemically separating mixtures into pure components, called *capillary chromatography capillary electrophoresis*, is used to analyze blood and tissue samples in medicine and forensics, for drug discovery, and in medical research (especially pharmaceuticals). A *chromatograph* is an instrument used in both purification and analysis processes.

Purdue researcher Fred Regnier (right), and doctoral student Bing He, examine a silicon wafer that contains a scaled-down version of a liquid chromatograph, a system used to separate chemical compounds. This miniature laboratory can carry out many of the chemical functions of the larger chromatograph on the desk. Regnier has placed multiple mini-labs on a computer chip to create a micro-chromatograph with no moving parts. This trend to miniaturization of complex lab procedures and equipment is expected to continue for some time and is a boon to field scientists and forensic experts who need hands-on methods to analyze data at a scene before the site becomes contaminated or the trail 'gets cold.' [Purdue news photo, released.]

6. Applications

6.a. Chemical Contaminants Detection

Chemical contaminants occur in many situations from urban and industrial pollutions and spills, to deliberate contamination by terrorists and hostile agents. Food and water supplies are monitored for pesticides, heavy metals, and contaminants. Chemical surveillance tools allow scientists to assess many different substances and to help determine whether contamination has occurred and what contaminants might be present. This, in turn, can aid in preventing further contamination and cleanup measures.

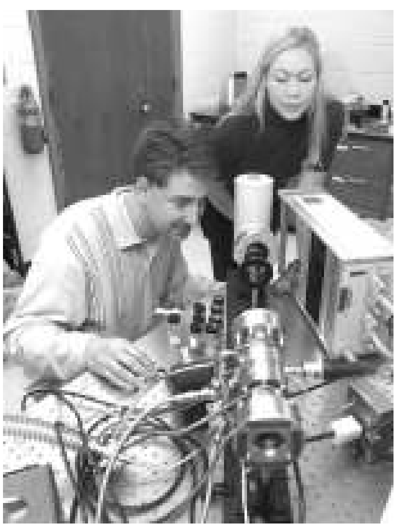
In the U.K., the Food Advisory Committee monitors and reports on food standards, labeling, and food chemical surveillance. The Committee advises government Ministers on general matters related to food safety and specific matters related to the Food Safety Act of 1990. Their recommendations form the basis of much of the U.K.'s food legislation.

The U.S. Army Corps of Engineers has been involved in a number of projects related to cleaning up industrial spills, and storage facilities. Top Left: An example of a HTRW Level B protective chemical suit used in the Detroit District for cleanup. Top Right: Drums have been compacted in preparation for removal from Barter Island, Alaska in 1998. Bottom Left: Engineer Mark Wheeler in protective gear inspects the oily lagoon at the Bridgeport BROS Superfund site in New Jersey in the process of remediating the hazardous environment. Bottom Right: Soil contaminated with low levels of nuclear waste from the former Fort Greely Nuclear Power Plant are systematically removed in 1998. [U.S. Army Corps of Engineers news photos, released.]

An important aspect of chemical detection is identifying the types of chemicals that may be present. This is important in pollution-monitoring, chemical manufacturing processes, and the detection of chemical contamination.

At Purdue University, missile technology has been used to develop an instrument that can search rapidly for chemical catalysts which could then be incorporated into an extensive database for reference for future projects. This new nondestructive technique can apparently create and test thousands of chemical samples in the time it used to take to sample just one. The system uses infrared technology developed for heat-seeking missiles which has recently been declassified.

Another chemical analysis system at Purdue is a near-infrared Raman Imaging Microscope (NIRIM) which uses laser light to analyze composite materials thousands of times faster than older methods. When a laser stimulates a chemical, it reacts with molecular vibrations that produce color changes in a process called Raman scattering, thus producing a reaction unique to that chemical. This can potentially be used in industrial and robotic vision and detection systems, in industrial separators, and for medical diagnostics.




In projects funded in part by the National Science Foundation, two new rapid chemical analysis systems have been produced at Purdue. Left: Chemical engineer Jochen Lauterbach and grad student Gudbjorg Oskarsdottir use a *rapid-scan Fourier transform infrared imaging system* to rapid-scan chemical catalysts. Infrared reveals a unique signature corresponding to each chemical, in essence, a molecular 'fingerprint.' Right: Chemist Dor Ben-Amotz uses a *Raman-scattering spectroscopic microscope* to analyze chemical components in a plant cell. The system uses laser light to analyze and identify materials in realtime. Both systems allow faster, more automated detection and identification of chemicals. [Purdue 2000 news photos by David Umberger, released.]

Mass spectrometry is another laboratory method used to identify the chemical nature of a substance. Researchers from the Scripps Research Institute and Purdue University have been teaming up to combine the properties of porous silicon with mass spectrometry to streamline and automate the analysis of biological molecules. The pores in the silicon give the material photoluminescent properties; the substance emits light when stimulated with an electric current. When exposed to ultraviolet, the pores absorb and emit light.

The researchers found that porous silicon could be used in place of traditional materials for a wide range of biomolecules, including sugars, drug molecules, and peptides. This led Buriak, Wei, and Siuzdak to develop a new technique, called *desorption ionization on silicon* (DIOS) that could overcome some of the limitations of distinguishing drugs with a relatively low mass, which are difficult to detect with traditional laser spectrometry.

6.b. Biological Hazards

Biological hazards that exist in nature can be anticipated to some extent, allowing us to protect ourselves against them, but there are still situations where it is useful to have technology to help assess an environment's safety. In regions where there have been natural disasters resulting in the deaths of people and animals, detection systems for disease and biological pathogens can help assess what medical assistance and relief supplies might be necessary.

The Centers for Disease Control monitors health on a global scale, since the health of other nations affects all of us, particularly those who travel or are stationed abroad. Information from the CDC is available on epidemics, medical assistance, inoculation programs, and much more. The U.S. Department of Agriculture also has information on biological hazards that can be contracted through agricultural products.

6.c. Terrorism

In the 1970s, an individual apparently poisoned store supplies of pain-killers. Since then, most over-the-counter drugs come with plastic wraps and other 'tamper-proof' safeguards. In the 1980s, a cult poisoned restaurant food with salmonella. A more serious attack occurred in March 1995, when a religious cult released toxin sarin gas into Tokyo subway stations, injuring thousands of commuters. Sarin exposure can result in pupil dilation, numbness, nausea, coughing, and sometimes more serious convulsions. Depending on the strength of the solution and the amount of exposure, sarin gas exposure can be fatal.

When terrorists release harmful biological agents biochemical surveillance is needed to determine the type of agent, in order to mobilize medical, defensive, and cleanup operations.

Toxic agent attacks in urban environments can have serious secondary consequences as it takes time for medical professionals to determine the cause the illness and how to contain it.

In warfare, biological agents can be released to confuse, impede, or disable a hostile force. Releasing an agent for which one side has been immunized might provide an immediate or longer-term advantage.

6.d. Biological/Chemical Warfare

Bacteria and viruses are microscopic and difficult to detect; we often don't recognize them until numbers of people become ill with similar symptoms. Gases may also be difficult to see or smell and thus are strong potential warfare agents that may be deployed in hostile situations.

Biological and chemical weapons are unsettling for many reasons. Besides their relative invisibility, they can be inserted in the head of a missile and launched into the center of an opposing force, scattering gas, bacteria, and viruses in a cloud far from the source of the missile. Countermeasures in the form of sensitive detectors, evacuation strategies, antidotes, and special chemical suits and accessories are some of the ways that the military responds to this type of weapon. Chemical plants throughout the world are monitored to prevent this type of scenario through chemical weapons bans and international inspections help stem the proliferation of biological/chemical warfare.


Left: Danielle Williams of the U.S. Army dons protective goggles and gloves in a nuclear, chemical, and biological skills challenge held in the Republic of Korea, in 1998. Right: A U.S. Air Force member talking to a radio link through a chemical/biological protective mask in an exercise to accustom service members to working with protective gear, in 1999. [U.S. DoD news photos by Steve Faulisi and Lance Cheung, released.]

One of the better-understood methods of counteracting biological warfare is to immunize the population or selected populations that might be exposed to infections and contagions. Anthrax and pox viruses are two threats for which immunization has been carried out by the U.S. Army.


Left: Gas masks are adjusted as part of a simulated chemical attack exercise carried out in the Republic of Korea in October 1998. Right: A pressure washing system is used to decontaminate an M-3 vehicle as part of a chemical training exercise conducted by the U.S. Army in 1998. Spc. D. Shewfelt is dressed in chemical goggles and gloves for carrying out the task. [U.S. DoD news photo by Steve Faulisi, released.]

Drugs that provide temporary immunity or at least some measure of protection are also used, such as drugs to help prevent malaria. The antinerve-agent drug pyridostigmine bromide was given to service members in the Gulf War in 1991 to help protect against soman, a toxic nerve agent. Unfortunately, some of these medications can have mild to severe side effects and there is always a small percentage of individuals who do not tolerate them well or suffer allergic reactions.

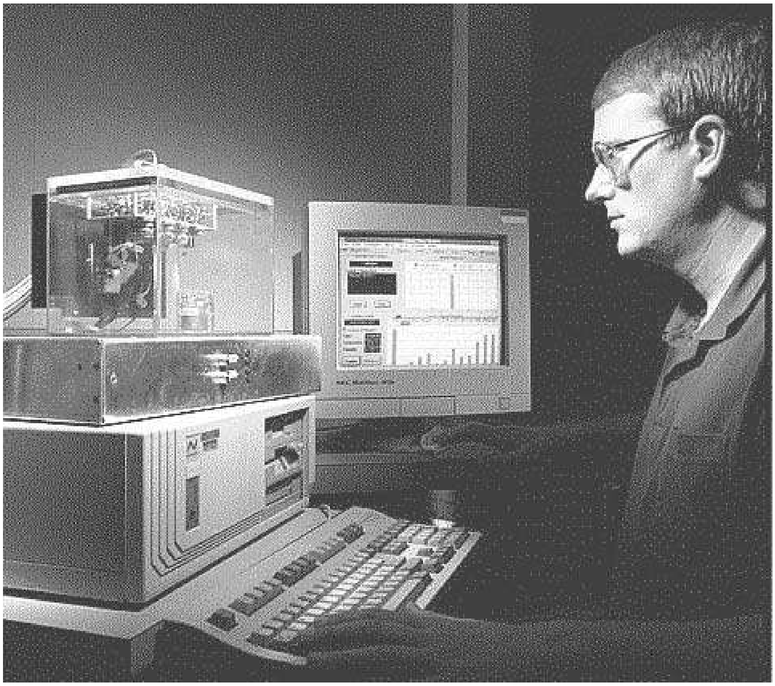
Protective clothing in the form of masks, suits, gloves, and hoods are intended to provide some protection in contaminated areas or while evacuating from a region suspected of containing hazardous substances.

Chemical sniffers and vapor detectors can provide a certain amount of advance warning of some types of agents, and more sophisticated detection systems are under development all the time.

Water spray from a fire truck is used as part of a decontamination procedure in a simulated chemical agent exposure held at the Pentagon in May 1998. The exercise was hosted by the Defense Protective Service along with the Office of the Secretary of Defense. The exercise was carried out to test civilian emergency response procedures. [U.S. DoD news photos by Jeffrey Allen and Renée Sitler, released.]

The U.S. Army has developed a Long Range Biological Standoff Detection System which uses a number of different surveillance technologies to detect biological hazards. It is specifically designed to detect, track, and map large aerosol clouds. The system uses an eye-safe laser transmitter, a 24-inch receiving telescope, and a transferred electron-intensified photodiode detector.

This system is designed to detect biological aerosol clouds at ranges up to about 30-50 km (depending on the system). The cloud configuration is then digitally mapped. [U.S. Army news photos, released.]



Electronic chemical sniffers aren't limited to any one area of surveillance. They have a broad range of applications that include food testing, medical diagnosis, pharmaceuticals monitoring, detection for customs or law enforcement, air quality monitoring, and the development of fragrances and scented products. This system at the Pacific Northwest National Laboratory is integrated with a computer that has an algorithmic neural network, a type of artificial intelligence programming, implemented in software. [Courtesy of the Pacific Northwest National Laboratory, 1995 news photo.]

A Nuclear-Biological-Chemical (NBC) reconnaissance vehicle (XM-93) from the 91st Chemical Company on display in October 1990. [U.S. Army 1990 Airborne Corps History Office photo by Randall M. Yackiel, released.]

Public safety organizations should be particularly concerned that genetics-targeted biological/chemical weapons could become a reality. DNA-specific agents could be used to single out and harm people of a certain gender, color, or with identifiable genetic abnormalities.

6.e. Natural Resources Management and Protection

The protection and management of natural resources, whether or not they are food sources, are an important aspect of a nation's cultural and economic survival. Surveillance strategies and technologies are used to monitor commercial harvesting, wildlife ecology, and poaching activities throughout the world. Without these protections, our resources might soon be completely depleted, as has happened in the past in unregulated areas. DNA-monitoring, radio collar tracking, sonar, and optical surveillance are examples of technologies that are used regularly to monitor natural resources and those who seek to abuse them.

6.f. Commercial Products

Bags and Vials

Clean, plain bags and envelopes and glass vials are regularly used for holding evidence gathered at a crime scene. Gloves are worn when collecting the evidence and clean, or preferably sterile tweezers are used to pick up small objects. Bags and envelopes that are preprinted so that they can be consistently labeled are commercially available. Vials usually have caps and come in a variety of sizes.

Evidence Tapes

Evidence tapes are frequently used to 'lift' small items without touching them. Delicate evidence, such as latent fingerprint dust, are often lifted with tape after being photographed. Clear tape, poly tape, Handi-Lifts™, Lightening Lifts™ pre-cut strips are common commercial products. The best tapes are those that are clear, don't wrinkle easily, and have the least intrusive chemicals in the adhesive itself. If the evidence is to be stored for any length of time, it is best to get acid-free products.

Backing Cards

Blank and printed cards are used for marking or storing evidence. Lifted prints, stains, and other evidence are often lifted with specialized tapes which may then be adhered to a card and labeled. Since chemical analysis of the stains is often carried out, it is important to use cards that do not interfere with the chemicals and which last a long time. Acid-free *archival* cards are preferred. Preprinted cards sometimes simplify the task of labeling and may aid in reducing the number of inadvertent omissions. They may also be numbered for file references to other documents. Numbers may further reduce the chance of fraudulent evidence.

Computerized Analysis and Databanking Products

CAL-ID - computerized fingerprint-processing system used to store and retrieve records.

Automated Fingerprint Identification System (AFIS) - search and retrieval from inked fingerprint cards.

Automated Latent Print System (ALPS) - latent print search for matches that generates a candidate list for a qualified examiner to investigate.

7. Problems and Limitations

The main problems associated with the tools of chemical surveillance and chemicals that are used in surveillance are related to health and safety. With the exception of forensic fingerprint dust and a few other common items, most chemicals are used by trained lab technicians and specialists. They should be used carefully, according to instructions, and disposed of in environmentally responsible ways.

Individual chemical and biological hazards are too diverse to discuss in any detail in this section. The surveillance of biological and chemical hazards is undertaken by hundreds of agencies who provide specialized information on problems and limitations. Some of these are listed in the *Resources* section and you are encouraged to contact the many government bodies that provide free printed pamphlets and information on their Web sites.

8. Restrictions and Regulations

Because of their potential for harm to biological organisms, the use and distribution of chemicals are heavily regulated. However, due to their diversity and differences in quantities used by individual industries, regulations on specific chemicals cannot be listed here. Some of the more general regulations regarding chemical and biological warfare include

1925 Geneva Protocol - This Protocol expressly prohibited the use of poisonous gas and bacteriological warfare.

1962 Eighteen-Nation Disarmament Committee (ENDC) - This group's recommendations included strategies for disarmament which included provisions for eliminating chemical/biological weapons.

Chemical Weapons Convention - This international convention aided in implementation of the Convention of the Prohibition of the Development, Production, Stockpiling, and Use of Chemical Weapons and on Their Destruction and strengthened the 1972 Biological and Toxin Weapons Convention. In the 1990s, over a hundred countries signed the Convention of the Prohibition of the Development, Production, Stockpiling, and Use of Chemical Weapons and on Their Destruction.

Armed Forces 1994 Joint Service Agreement - The armed forces Agreement established an internal structure and process for developing and validating operational requirements to support chemical/biological defense needs.

Chemical and Biological Weapons Threat Reduction Act - This is a U.S. policy intended to take preventive steps to reducing biochemical threats.

Public Law 102-585 - This established the Veterans Association's Persian Gulf Registry in August 1992 in which veterans are eligible for physical examinations with basic lab studies. This was as a response to various persistent health complaints collectively called 'Gulf War Sickness.'

American Board of Criminalistics - This organization has developed a number of written certification tests for forensics-related activities, some of which include contact with chemicals in the course of investigative duties.

Federal Bureau of Investigation (FBI) - The FBI publishes a number of standards related to evidence that are relevant to chemical/biological surveillance pertaining to crime scene investigation and forensics. The FBI publishes some of this information on their Web site and in printed bulletins. http://www.fbi.gov/

9. Implications of Use

Chemicals have many beneficial uses and are inseparable from life itself. They can be used to help solve crimes and to detect and combat disease. Used well, they contribute to the quality of our lives and, in some cases, to our longevity.

When biological or chemical agents are used to deliberately inflict harm, through terrorist bombs, poisonings, or chemical warfare, it is important to have means to detect and ideally to prevent the use of chemicals as weapons of destruction. Considerable effort has been made on an international scale to try to reduce and prevent chemical warfare. There is still work that needs to be done and technologies that can aid in controlling their proliferation, but some progress has been made in these areas.

The various U.S. governmental and health organizations have admitted that more could be done to prepare and protect from chemical contamination and biological warfare, but at least the understanding that we can improve our systems is there and hopefully a greater awareness of the relevant issues will improve public support for future efforts.

10. Resources

Inclusion of the following companies does not constitute nor imply an endorsement of their products and services and, conversely, does not imply their endorsement of the contents of this text.

10.a. Organizations

American Academy of Forensic Sciences (AAFS) - A professional organization of physicians, criminalists, toxicologists, anthropologists, engineers and others involved in the application of science to law. http://www.aafs.org/

American Board of Forensic Anthropology, Inc. (ABFA) - This nonprofit board was established in 1977 to provide a program of certification in forensic anthropology that can be used to identify forensic scientists qualified to provide professional services to judicial and executive government bodies. http://www.csuchico.edu/anth/ABFA/

American Chemical Society (ACS) - Provides members with technical and educational information resources, professional development assistance, industry advocacy, awards, and insurance programs. Supports over 30 specialty divisions, including Analytical Chemistry (ANYL) and Chemical Toxicology (TOXI) which have their own publications in addition to the ACS publications. http://www.acs.org/

American Society for Investigative Pathology (ASIP) - A society for biomedical scientists who investigate the mechanisms of disease. The discipline uses a variety of structural, functional, and genetic techniques, applying the research results to the diagnosis and treatment of disease. ASIP supports professional development and education of its members. http://asip.uthscsa.edu/

American Society of Clinical Pathologists (ACSP) - The ACSP is a not-for-profit medical society engaged in educational, scientific, and charitable activities which promote public health and safety through the appropriate application of pathology and laboratory medicine. http://www.ascp.org/

Bonn International Center for Conversion (BICC) - Deals with issues and policies related to dismantling weapons remaining from conflicts or resulting from arms reductions actions and the conversion of military resources for civilian purposes. http://www.bicc.de/weapons/

Center for International Security and Cooperation (CISAC) - A multidisciplinary community within Stanford University's Institute for International Studies dedicated to research and training in issues of national security. http://www.stanford.edu/group/CISAC/

Center for Research on Occupational and Environmental Toxicology (CROET) - CROET is an organization of scientists, educators, and information specialists within the Oregon Health Sciences University in Portland, Oregon who conduct applied research with labor, industry, government, and community members. CROET maintains the *Oregon Chemical Surveillance Project* on the Web, which charts the distribution, use, trends, and possible adverse effects of potentially hazardous substances distributed around the state of Oregon. http://www.ohsu.edu/croet/

Centers for Disease Control and Prevention (CDC) - An agency of the U.S. Department of Health and Human Services which promotes health and quality of life by preventing and controlling disease, injury, and disability. The CDC has almost a dozen specialist centers and provides data and statistics, publications, and funding opportunities. It also performs many administrative functions for its sister agency, the Agency for Toxic Substances and Disease Registry. The site is searchable and includes more than 100 references to documents about chemical warfare, bioterrorism, and the safe disposal of chemical arsenals. http://www.cdc.gov/

Chemical and Biological Arms Control Institute (CBACI) - A nonprofit corporation established to promote arms control and nonproliferation, especially of chemical and biological weapons. CBACI stresses assistance to global industries in implementing the Chemical Weapons Convention. http://www.cbaci.org/

Chemical Science and Technology Laboratory (CSTL) - Within the U.S. Department of Commerce, the CSTL is one of seven NIST measurement and standards laboratories. It works to promote U.S. economic growth by working with industry to develop and apply technology, measurements, and standards. It includes five divisions: analytical chemistry, biotechnology, physical and chemical properties, process measurements, and surface and microanalysis science. http://www.cstl.nist.gov/

Chemical Warfare/Chemical Biological Defense (CW/CBD) Information Analysis Center (CBIAC) - CBIAC collects, reviews, analyzes, appraises, and analyzes information related to CW/CBD and provides a searchable database and some well-chosen links to other sites on a number of topic areas. http://www.cbiac.apgea.army.mil/

Department of Peace Studies, University of Bradford - This U.K. university center provides research and degree programs in peace studies. It includes the Centre for Conflict Resolution and a number of projects including the ongoing improvement of the *Biological and Toxin Weapons Convention* database. http://www.brad.ac.uk/acad/peace/

Federation of American Scientists (FAS) - Since 1990, the Biological and Toxin Weapons Verification Group has endeavored to explore access to biotechnologies in the pursuit of peace and to develop technical and political confidence-building measures to encourage the adoption of strong verification protocols. The group archives a number of working/briefing papers online. http://www.fas.org/bwc/

Harvard Sussex Program (HSP) - A collaboration with the Belfer Center for Science and International Affairs at Harvard University. Research is conducted on chemical- and biological warfare-related technologies and their policy implications. HSP publishes the CBW Conventions Bulletin.

Henry L. Stimson Center - The Center hosts the *Chemical and Biological Weapons Nonproliferation Project* which examines issues associated with biochemical weapons. The project was launched in 1993 and includes problem-solving and information-dissemination on topics such as the implementation of chemical weapons conventions, weapons destruction technologies, and export controls. The project is funded primarily by the Carnegie Corporation and a number of foundations. http://www.stimson.org/cwc/index.html

International Association for Identification (IAI) - A nonprofit, professional organization for professionals engaged in forensic identification and scientific examination of physical evidence. The IAI provides a range of education and certification programs including latent fingerprint examination, crime scene certification, forensic artist, etc. Descended from the International Association for Criminal Identification, founded in 1915. http://www.theiai.org/

International Association of Forensic Toxicologists (TIAFT) - Established in the early 1960s, this association has over 1400 members worldwide who are engaged in analytical toxicology and related areas. TIAFT promotes and encourages research in forensic toxicology, hosts meetings, and provides case notes, online reviews, and other member resources. http://www.tiaft.org/

International Narcotics Control Board (INCB) - An independent, quasi-judicial control organization for implementation of United Nations Drug Conventions established in 1968. Members are elected by the United Nations Economic and Social Council (ECOSOC). International Drug Conventions are archived on the site along with technical reports and information on the General Assembly. http://www.incb.org

Lightning Powder Company, Inc. Supplies chemicals, including powders, to crime scene investigators and provides informational articles on their Web site on fingerprint technology. http://www.redwop.com/

National Climatic Data Center (NCDC) - A national environmental data center operated by the National Oceanic and Atmospheric Administration (NOAA) of the U.S. Department of Commerce. The NCDC maintains the world's largest active archive of weather data. http://www.ncdc.noaa.gov/

National Disaster Medical System (NDMS) - Created by the Federal Government to serve as a national medical system for responding to major mass casualty situations resulting from civilian disasters or overseas conflicts.

National Geophysical Data Center (NGDC) - A national environmental data center operated by the National Oceanic and Atmospheric Administration (NOAA) of the U.S. Department of Commerce. The NGDC is a national repository for geophysical data, providing science data services and information. http://www.ngdc.noaa.gov/

National Ground Intelligence Center (NGIC) - One of the services of the NGIC is a Web-based network that provides information on the estimated consequences of biological, chemical, nuclear, or radiological materials to assist decision-makers in formulating emergency responses.

National Institute of Standards and Technology (NIST) - NIST is an agency of the U.S. Department of Commerce's Technology Administration, established in 1901 as the National Bureau of Standards and renamed in 1988. It aids industry in developing and applying technology, measurements, and standards through four major programs. The Chemical Science and Technology Laboratory is one of seven NIST measurement and standards laboratories. http://www.nist.gov/

National Law Enforcement and Corrections Technology Center (NLECTC) - A program of the National Institute of Justice which includes timely news and Internet information resources, many of which are relevant to forensics and various aspects of surveillance. http://nlectc.org/inthenews/

National Oceanographic Data Center (NODC) - A national environmental data center operated by the National Oceanic and Atmospheric Administration (NOAA) of the U.S. Department of Commerce. The NODC was established in 1961 and serves to acquire, process, preserve, and disseminate oceanographic data. This includes physical, chemical, and biological data, some of which are related to the presence and composition of chemical substances and pollutants. Selected data are available on magnetic media or CD-ROM and, in some cases, over ftp links. http://www.nodc.noaa.gov/

Office of Emergency Preparedness (OEP) - A department of the U.S. Public Health Service.

Organization for the Prohibition of Chemical Weapons (OPCW) - OPCW maintains the Chemical Weapons Convention Website with information about member states, activities, courses, and the text of the Chemical Weapons Convention. http://www.opcw.nl/

Southern California Association of Fingerprint Officers (SCAFO) - A nonprofit organization founded in 1837 to support professional identifiers. It now includes members in more than 50 law enforcement agencies. The Web site has an excellent fingerprint bibliography. http://www.scafo.org/

Stockholm International Peace Research Institute (SIPRI) - SIPRI was established in 1964 to contribute to the understanding of the preconditions for a stable peace and for peaceful solutions to international conflicts. As an independent foundation, SIPRI researches from open sources, and makes available, information on weapons development, arms transfers and conduction, military expenditures, and arms limitations and disarmament activities. SIPRI research includes the Chemical and Biological Warfare Project. http://www.sipri.se/

SWGFAST - The Scientific Working Group on Friction Ridge Analysis, Study, and Technology was founded as the result of a 1995 FBI meeting of latent print examiners. SWGFAST (formerly TWGFAST) provides guidelines, discusses analysis methods and protocols, and provides support for the latent print professional community. Information is available through the FBI Laboratory. The Scientific Working Gorup on Materials Analysis (SWGMAT) group is similar. http://www.fbi.gov/

U.S. Armed Forces Joint Nuclear, Biological, and Chemical Defense Board - This board and its subgroups help articulate, coordinate, and expedite tactics, doctrine, training, and equipment. http://www.chembiodef.navy.mil/

See also the U.S. Navy Chemical-Biological Defense. http://www.cbd.navy.mil/

U.S. Army Chemical Defense - The U.S. Army has a number of departments that deal with Biological/Chemical detection as it pertains to defense and warfare, including

> The Edgewood Chemical Biological Center (ECBC), the principal R&D center for chemical/biological defense technology, engineering, and service.
>
> The Office of the Program Director for Biological Defense Systems (PD Bio), responsible for the development, production, fielding, and logistics support of assigned biological defense systems in the area of detection. This office includes
>
> > The Biological Integrated Detection System (BIDS)
> >
> > The Long Range Biological Standoff Detection System (LR-BSDS)
> >
> > The Short Range Biological Standoff Detection System (SR-BSDS)
> >
> > The Integrated Biodetection Advanced Technology Demonstration (ATD)
> >
> > The Chemical Biological Mass Spectrometer (CBMS)

U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID) - USAMRIID is the lead biological warfare defense laboratory for the U.S. Department of Defense. It researches drug development and diagnostics for lab and field use. It also formulates strategies, information, procedures, and training programs for medical defense against biological threats. USAMRIID collaborates with the Centers for Disease Control and Prevention, the World Health Organization and a number of academic centers. http://www.usamriid.army.mil/

U.S. Army Soldier & Biological Chemical Command (SBCCOM) - This command provides support in defense research, development, and acquisition; emergency preparedness and response; and safe, secure chemical weapons storage, remediation, and demilitarization. http://www.sbccom.army.mil/

10.b Print Resources

The author has endeavored to read and review as many mentioned resources as possible or to seek the recommendations of colleagues. In a few cases, it was necessary to rely on publishers' descriptions on books that were very recent, or difficult to acquire. It is hoped that the annotations will assist the reader in selecting additional reading.

These annotated listings may include both current and out-of-print books and journals. Those not currently in print are sometimes available in local libraries and second-hand book stores, or through interlibrary loan systems.

Alibeck, Ken; Handelman, Stephen, "Biohazard: The Chilling True Story of the Largest Covert Bio-

logical Weapons Program in the World," Random House, 1999. A Russian Colonel who left in 1992 was involved in the U.S.S.R.'s biological warfare program. He tells his story and reinforces the importance of keeping these weapons out of the hands of terrorists and suggests responses to biological warfare.

Dando, Malcolm, "Biological Warfare in the 21st Century," London, New York: Brasseys, 1994. The author, a professor of International Security in the Department of Peace Studies at the University of Bradford, describes biochemical weapons developed by several nations, the implications of their existence and use, and how proliferation might be contained and controlled.

"A FOA Briefing Book on Chemical Weapons," FOA, S-172 90, Stockholm, Sweden.

Geberth, Vernon, "Practical Homicide Investigation," Boca Raton, Fl.: CRC Press, 1998.

"American Journal of Pathology: Cellular and Molecular Biology of Disease," American Society for Investigative Pathology. This is now available online with searchable back issues.
http://www.amjpathol.org/

Office of Technology Assessment, U.S. Congress, "Proliferation of Weapons of Mass Destruction: Assessing the Risks. Publication OTA-ISC-559," Washington, D. C., U.S. Government Printing Office, 1993.

Price, Richard M., "The Chemical Weapons Taboo," Ithaca: Cornell University Press, 1997, 233 pages.

Preston, Richard, "The Cobra Event," Ballantine Books reprint, 1998, 432 pages. A novel about a biological terror attack on the city of New York.

Report to Congress: Response to Threats of Terrorist Use of Weapons of Mass Destruction, Washington, D.C.: U.S. Dept. of Defense, 31 January 1997.

Tenet, George J., "Statement by the Director of Central Intelligence Before the Senate Select Committee on Intelligence on the Worldwide Threat in 2000: Global Realities of Our National Security," www.cia.gov, 2 February 2000. This statement describes a variety of threats, nation by nation, some of which include chemical/biological warfare. Also related to the subject in this report is another from the CIA Nonproliferation Center, "Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions," January through June of 1999.

Zatchuk, R., Editor, "Textbook of Military Medicine," Washington, D.C.: U.S. Dept. of Army, Surgeon General, and the Borden Institute, 1997.

Articles

Carnes, S.; Watson, A., "Disposing of the U.S. chemical weapons stockpile," *Journal of the American Medical Association,* 1989, V.262, pp. 653-659.

Centers for Disease Control and Prevention, "CDC recommendations for civilian communities near chemical weapons depots," *60 Federal Register,* 1995, pp. 33307-33318.

Franz, D.; Jahrling, P.; Friedlander, A. et al., "Clinical recognition and management of patients exposed to biological warfare agents," *Journal of the American Medical Association,* 1997, V.278, pp. 399-411.

Inglesby, T.; Henderson, D.; Bartlett, J. et al., "Anthrax as a biological weapon," *Journal of the American Medical Association,* 1999, V.281, pp. 1735-1745.

Ibid., "Smallpox as a biological weapon," pp. 2127-2137.

Kent, Terry, "Recent Research on Superflue, Vacuum Metal Deposition and Fluorescence Examination," *PSDB,* July 1990, pp. 1-4.

Kern M., Kaufmann, A., "Principles for emergency response to bioterrorism," *Ann. Emergency Medicine,* 1999, V.34, pp. 177-182.

Lee, Henry C.; Gaensslen, R. E., "Cyanoacrylate Fuming," *Identification News,* June 1984, pp. 8-14.

Macintyre, Anthony G. et al., "Weapons of Mass Destruction Events With Contaminated Casualties: Effective Planning for Health Care Facilities," *Journal of the American Medical Association,* Special Communication, 12 January 2000. Includes background information, strategies, and references.

National Institute of Justice, "Certification of DNA and Other Forensic Specialists," *National Institute of Justice Update*, September 1995, 3 pages.

Noll, G.; Hildebrand, M.; Yvorra, J., "Personal Protective Clothing and Equipment," in "Hazardous Materials," Stillwater: Fire Protection Publications, Oklahoma State University, 1995, pp. 285-322.

Nozaki, H.; Aikawa, N.; Shinozawa, Y. et al., "Sarin gas poisoning in the Tokyo subway," *Lancet,* 1995, V.345, pp. 980-981.

Nozaki, H.; Aikawa, N.; Shinozawa, Y., "Secondary exposure of medical staff to sarin vapor in the emergency room," *Intensive Care Medicine,* 1995, V.21, pp. 1032-1035.

Sidell F., "What to do in case of the unthinkable chemical warfare attack or accident," *Postgraduate Medicine,* 1990, V.88, pp. 70-84.

Sokes, J.; Banderet, L., "Psychological aspects of chemical defense and warfare," *Military Psychology,* 1997, V.9, pp. 395-415.

Sullivan, J.; Krieger, G., "Hazardous Materials Toxicology," Baltimore, Technical Working Group on Crime Scene Investigation (TWGCSI), "Crime Scene Investigation: A Guide for Law Enforcement," *National Institute of Justice*, Research Report series, January 2000, 49 pages.

Thomas, Evan; Hirsh, Michael, "The Future of Terror," *www.newsweek.com,* 10 January 2000. A discussion of the some of the possible organizational biochemical threats to America.

Torok, T. J.; Tauxe, R.V.; Wise, R.P. et al., "Large community outbreak of salmonellosis caused by intentional contamination of restaurant salad bars," *Journal of the American Medical Association,* 1997, V.278, pp. 389-395.

Walsh, Anne-Marie, "Irish Invention Spots Fakes by 'Fingerprints'," *London Sunday Times Online*, 15 Nov. 1998.

Wheeler, Michael D., "Evidence Analysis: Photonics Cracks Cases from Tiny Clues," *Photonics Spectra*, 1998, V.32(11), p. 100.

Journals

"CBW Conventions Bulletin," formerly the Chemical Weapons Convention Bulletin, quarterly journal of the Harvard Sussex Program. Provides news, background, and opinion on chemical/biological warfare issues.

"Drug Discovery Today," a professional journal of current news and reviews for the drug discovery community.

"Forensic Science Communications," a quarterly journal from the FBI Laboratory personnel (superseding the Crime Laboratory Digest). Previous issues dating back to April 1999 are now available online. Articles are searchable.

"Modern Drug Discovery," a practical professional journal for chemists and scientists in drug discovery with articles on medicinal chemistry and molecular biology. Published by the American Chemical Society.

"Peace Studies News," published three times a year by the Department of Peace Studies, University of Bradford, along with a number of departmental and staff publications.

"SIPRI Chemical & Biological Warfare Studies," a series edited and published by the Stockholm International Peace Research Institute.

"Strategies to Protect the Health of Deployed U.S. Forces," a series of reports by the National Academies' Institute of Medicine and National Research Council, published by the National Academy Press in 1999 and 2000. They discuss the technical aspects of identifying and assessing hazards,

improving surveillance activities, and reducing the risk of exposure. The reports are intended to aid in developing long-term strategies and policies.

"Treatment of Chemical Agent Casualties and Conventional Military Chemical Injuries," Washington, D.C., U.S. Government Printing Office, 1990.

"Xenobiotica," a professional journal which covers general xenobiochemistry, including the metabolism and disposition of drugs and environmental chemicals in animals, plants, and microorganisms and related methodologies and toxicology.

10.c. Conferences and Workshops

Many of these conferences are annual events that are held at approximately the same time each year, so even if the conference listings are outdated, they can still help you determine the frequency and sometimes the time of year of upcoming events. It is very common for international conferences to be held in a different city each year, so contact the organizers for current locations.

Many of these organizations describe the upcoming conferences on the Web and may also archive conference proceedings for purchase or free download.

The following conferences are organized according to the calendar month in which they are usually held.

"Bioterrorism in the United States: Calibrating the Threat," CBACI conference held in conjunction with the Centers for Disease Control and Prevention on 10 Jan. 2000, Washington, D.C.

"Annual Western Spectroscopy Association Conference," 47th conference, Pacific Grove, CA, 26-28 Jan. 2000.

"DoD Medical Initiatives Conference and Exhibition: Weapons of Mass Destruction," Department of Defense conference at Crystal City, POC, 2-6 April 2000.

"ASCP/CAP Spring Meeting," the national meeting of the American Society of Clinical Pathologists, Boston, 8-11 April 2000.

"Drug Discovery Technologies," annual European conference for pharmaceutical and biotechnology drug discovery researchers. Basel, Switzerland, 10-12 Apr. 2000.

"Experimental Biology 2000," annual meeting of the American Society for Investigative Pathology (ASIP), San Diego, CA, 15-18 April 2000.

"Analytica 2000," The 17th International Trade Fair and Conference for Analysis, Biotechnology, Diagnostics, and Laboratory Technology. Munich, Germany, 11-14 April 2000.

"California State Division International Association for Identification," 84th Annual Training Seminar, Laughlin, Nevada, 8-11 May 2000.

"Forensic Sciences and Crime Scene Technology Conference and Expo," Washington, D.C., 10-12 May 2000.

"New York 2000 Fire/Arson Conference," Saratoga Springs, New York, 15-19 May 2000.

"7th NDA Waste Characterization Conference," Salt Lake City, Utah, 23-25 May 2000. A forum for radiological and hazardous waste characterization issues.

"Annual Worldwide Chemical Conference," Armed Forces conference at Fort Leonard Wood, MO, 15-23 June 2000.

"Advanced Narcotic Investigation," Jacksonville, Florida, 26-30 June 2000.

"International Association for Identification," annual professional education conference on forensic identification and investigation, Miami, Florida, 22-28 July, 2001.

"Advanced Death Investigation Conference," St. Louis, Mo., 23-26 July 2001.

"Drug Discovery Technology," 5th Annual Exposition and Symposium of pharmaceutical and biotechnology drug discovery researchers, Boston, MA, 14-18 Aug. 2000. Topics include automation and robotics, assay development and screening, miniaturization and chip-based technologies, integrating chemical, biological and genomic data, and more. http://www.drugdisc.com/

"International Mass Spectrometry Conference," 15th of the conferences which are held every three years, Barcelona, Spain, 27 Aug. - 1 Sept. 2000. The 2003 conference is scheduled for Edinburgh, U.K.

"European Academy of Forensic Science (EAFS) Forensic Science - Challenges for the New Millennium," Krakow, Poland, 12-16 Sept. 2000.

"Bloodstain Pattern Analysis Workshop," Metropolitan Police Institute, Miami, Fl., 10-14 Dec. 2001.

10.d. Online Sites

The following are interesting Web sites relevant to this chapter. The author has tried to limit the listings to links that are stable and likely to remain so for a while. However, since Web sites do sometimes change, keywords in the descriptions below can help you relocate them with a search engine. Sites are moved more often than they are deleted.

Another suggestion, if the site has disappeared, is to go to the upper level of the domain name. Sometimes the site manager has simply changed the name of the file of interest. For example, if you cannot locate http://www.goodsite.com/science/uv.html *try going to* http://www.goodsite.com/science/ *or* http://www.goodsite.com/ *to see if there is a new link to the page. It could be that the filename* uv.html *was changed to* ultraviolet.html*, for example.*

Bradford-SIPRI Chemical and Biological Warfare Project - As an international foundation, SIPRI carries out research and disseminates information related to disarmament and the foundation of peace. The CBW site includes research and documentation, educational modules, publications, and general information about the project. It is being strengthened with support from Bradford University which further hosts the Biological and Toxin Weapons Convention (BTWC) database. http://projects.sipri.se/cbw/cbw-mainpage.html http://www.brad.ac.uk/acad/sbtwc/

Bureau of Nonproliferation - This is a bureau of the U.S. Department of State that has Web pages devoted to information on Weapons of Mass Destruction, including biological and chemical weapons. It provides links to congressional testimony and briefings, fact sheets, and treaties. http://www.state.gov/www/global/arms/bureau_np/wmd_np.html

Oregon Chemical Surveillance Project. The Center for Research on Occupational and Environmental Toxicology (CROET) has established a site based on eight databases that describe hazardous chemicals used and stored in Oregon, the extent of releases, and associated human exposures. It also includes information on adverse health effects and displays the spatial distribution of the chemicals on a map. http://www.ohsu.edu/croet/database.html

Organization for the Prohibition of Chemical Weapons (OPCW) - OPCW maintains the Chemical Weapons Convention Website with information about member states, activities, courses, and the text of the Chemical Weapons Convention in several data formats. The CWC seeks progress toward disarmament, including the elimination of weapons of mass destruction, including asphyxiating, poisonous or other gases, and bacteriological methods of warfare, according to the Geneva protocol of 1925. The site also includes a fact file on chemical weapons. http://www.opcw.nl/

United States Institute of Peace (USIP) - USIP is an independent, nonpartisan federal institution created in 1984 and funded by the U.S. Congress to strengthen the nation's capacity to promote the peaceful resolution of international conflict. The organization sponsors conferences, library services, publications, educational activities, and grants. Publications can be searched on the Web (e.g., discussions of biological, chemical, and nuclear weapons in the Iraq Crisis). Chemical weapons are discussed in White Papers, funded project reports, and Special Commission reports.
http://www.usip.org/

Note: If you don't enjoy typing in long Web addresses (URLs), you can access the links on the support site set up by the author for your convenience. http://www.abiogenesis.com/surveil

10.e. Media Resources

Note that television programs are often available on VHS tape after broadcast. Contact the broadcaster for information.

"Clouds of Death," This *History Channel* History Undercover program traces the history of biochemical warfare from medieval times to the use of sarin gas in World War I and the Tokyo subway incident. Includes interviews and documentary footage. Restricted to the U.S. and Canadian markets. It is available on VHS, 50 minutes.

"Coming Home: Agent Orange/Gulf War," is part of the 20th Century with Mike Wallace series on the *History Channel*. It looks at the aftermath of the after effects of servicemember's possible exposure to toxic agents in the execution of their duties. The case of the Zumwalt family is presented. Restricted to the U.S. and Canadian markets. It is available on VHS, 50 minutes.

"Declassified: Human Experimentation," a *History Channel* History Undercover series program traces the history of top-secret experiments conducted by the U.S. military on human subjects, subjecting them to radiation and poisons without their direct knowledge or consent. Restricted to the U.S. and Canadian markets. It is available on VHS, 50 minutes.

"Insidious Killers: Chemical and Biological Weapons," is part of the 20th Century with Mike Wallace series on the *History Channel*. Traces the development of the proliferation of weapons from World War I to the terrorist attack in Tokyo's subways with sarin gas. Restricted to the U.S. and Canadian markets. It is available on VHS, 50 minutes.

"Into the Fire: Arson: Clues in the Ashes," explores fires in New York City, nearly half of which appear to be deliberately set. Shows fire marshalls looking for clues in the ashes. A *Discovery Channel* TV program aired in spring 2000.

"Into the Fire: From the Ashes," explores insurance torchings, arson murders, and other crimes in which arson appears to have been used as a murder weapon and/or to hide clues of a crime. Shows arson investigation and undercover work. A *Discovery Channel* TV program aired in winter 1999/2000.

11. Glossary

It is more difficult to compile a succinct glossary for this chapter than for most of the others in this text, as it would have to include not only a lot of chemical and surveillance terms, but also many medical and industrial terms. This short selection gives a flavor of some of the types of terms and concepts that are common to chemical surveillance activities and chemical agents. Terms for Biometrics and Genetics Surveillance, aspects of biochemical surveillance, are listed in the chapters specific to those topics.

Titles, product names, organizations, and specific military designations are capitalized; common generic and colloquial terms and phrases are not.

ABC	atomic, biological, and chemical
ABG	arterial blood gas
AC	hydrogen cyanide
ACAA	automatic chemical-agent alarm
ACADA	automatic chemical-agent detector
accessible form	an undiluted agent that has not been decontaminated or neutralized, but which might be removed for unauthorized purposes.

ACPG	advanced chemical-protective garment
ACPLA	agent-containing particle, per liter of air
ACPM	aircrew protective mask
Action Level	a concentration designated in Title 29, Code of Federal Regulations for a specific substance, calculated as an 8-hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.
acute toxicity	immediate toxicity associated with mortality. It should not be confused with acute exposure.
ADI	acceptable daily intake - the estimate of a dose due to exposure to a toxicant that is unlikely to be harmful if continued exposure occurs over a lifetime
ADS	area detection system
adverse effect	a biochemical change, functional impairment, or pathological lesion that impairs performance and reduces the ability of the organism to respond to challenges
adverse effect level	exposure level at which there are statistically or biologically significant increases in frequency or severity of deleterious effects between the exposed population and its appropriate control group
aerosol	airborne solid or liquids such as dusts, fumes, mists, smokes, or fogs
AERP	aircrew eye/respiratory protection
AIC	acceptable intake for chronic exposure - the estimate of health effects from chronic exposure to a chemical. It is similar to a Reference Dose (RfD).
AIS	acceptable intake for subchronic exposure - the estimate of health effects from subchronic exposure to a chemical. It is similar to a Subchronic Reference Dose.
ALAD	automatic liquid-agent detector
AMAD	automatic mustard-agent detector
antidote	a substance or agent that inhibits or counteracts the deleterious effects of a poison
assay	to analyze for one or more specific components
BW	biological warfare
CWC	Chemical Weapons Convention
FDI	forensic digital imaging. Digital scanning, enhancement, and processing of forensic materials to contribute characteristics information and knowledge not obtainable by other means.
GB	sarin, a nerve agent
GD	soman, a nerve agent
GLC	gas/liquid chromatography
GPFU	gas-particulate filter unit
HAZMATs	hazardous materials
incendiary	constructed or consisting of materials intended or predisposed to ignite and/or burn
PPE	personal protective equipment
WMD	weapons of mass destruction
zootoxin	the toxin or poison of an animal, such as venom from a spider, wasp, or snake