Originally Published in the December 1996 Issue

The Specter of Biological Weapons

States and terrorists alike have shown a growing interest in germ warfare. More stringent arms-control efforts are needed to discourage attacks

by Leonard A. Cole

In 1995, on a whim, I asked a friend: Which would worry you more, being attacked with a biological weapon or a chemical weapon? He looked quizzical. "Frankly, I'm afraid of Alzheimer's," he replied, and we shared a laugh. He had elegantly dismissed my question as an irrelevancy. In civilized society, people do not think about such things.

The next day, on March 20, the nerve agent sarin was unleashed in the Tokyo subway system, killing 12 people and injuring 5,500. In Japan, no less, one of the safest countries in the world. I called my friend, and we lingered over the coincidental timing of my question. A seemingly frivolous speculation one day, a deadly serious matter the next.

That thousands did not die from the Tokyo attack was attributed to an impure mixture of the agent. A tiny drop of sarin, which was originally developed in Germany in the 1930s, can kill within minutes after skin contact or inhalation of its vapor. Like all other nerve agents, sarin blocks the action of acetylcholinesterase, an enzyme necessary for the transmission of nerve impulses.

The cult responsible for the sarin attack, Aum Shinrikyo ("Supreme Truth"), was developing biological agents as well. If a chemical attack is frightening, a biological weapon poses a worse nightmare. Chemical agents are inanimate, but bacteria, viruses and other live agents may be contagious and reproductive. If they become established in the environment, they may multiply. Unlike any other weapon, they can become more dangerous over time.

Certain biological agents incapacitate, whereas others kill. The Ebola virus, for example, kills as many as 90 percent of its victims in little more than a week. Connective tissue liquefies; every orifice bleeds. In the final stages, Ebola victims become convulsive, splashing contaminated blood around them as they twitch, shake and thrash to their deaths.

For Ebola, there is no cure, no treatment. Even the manner in which it spreads is unclear, by close contact with victims and their blood, bodily fluids or remains or by just breathing the surrounding air. Recent outbreaks in Zaire prompted the quarantine of sections of the country until the disease had run its course.

The horror is only magnified by the thought that individuals and nations would consider attacking others with such viruses. In October 1992 Shoko Asahara, head of the Aum Shinrikyo cult, and 40 followers traveled to Zaire, ostensibly to help treat Ebola victims. But the group's real intention, according to an October 31, 1995, report by the U.S. Senate's Permanent Subcommittee on Investigations, was probably to obtain virus samples, culture them and use them in biological attacks.

Interest in acquiring killer organisms for sinister purposes is not limited to groups outside the U.S. On May 5, 1995, six weeks after the Tokyo subway incident, Larry Harris, a laboratory technician in Ohio, ordered the bacterium that causes bubonic plague from a Maryland biomedical supply firm. The company, the American Type Culture Collection in Rockville, Md., mailed him three vials of *Yersinia pestis*.

Harris drew suspicion only when he called the firm four days after placing his order to find out why it had not arrived. Company officials wondered about his impatience and his apparent unfamiliarity with laboratory techniques, so they contacted federal authorities. He was later found to be a member of a white supremacist organization. In November 1995 he pled guilty in federal court to mail fraud.

To get the plague bacteria, Harris needed no more than a credit card and a false letterhead. Partially in response to this incident, an antiterrorism law enacted this past April required the Centers for Disease Control and Prevention to monitor more closely shipments of infectious agents.

What would Harris have done with the bacteria? He claimed he wanted to conduct research to counteract Iraqi rats carrying "supergerms." But if he had cared to grow a biological arsenal, the task would have been frighteningly simple. By dividing every 20 minutes, a single bacterium gives rise to more than a billion copies in 10 hours. A small vial of microorganisms can yield a huge number in less than a week. For some diseases, such as anthrax, inhaling a few thousand bacteria—which would cover an area smaller than the period at the end of this sentence—can be fatal.

Kathleen C. Bailey, a former assistant director of the U.S. Arms Control and Disarmament Agency, has visited several biotechnology and pharmaceutical firms. She is "absolutely convinced" that a major biological arsenal could be built with $10,000 worth of equipment in a room 15 feet by 15. After all, one can cultivate trillions of bacteria at relatively little risk to one's self with gear no more sophisticated than a beer fermenter and a protein-based culture, a gas mask and a plastic overgarment.

Fortunately, biological terrorism has thus far been limited to very few cases.

One incident occurred in September 1984, when about 750 people became sick after eating in restaurants in an Oregon town called The Dalles. In 1986 Ma Anand Sheela confessed at a federal trial that she and other members of a nearby cult that had clashed with local Oregonians had spread salmonella bacteria on salad bars in four restaurants; the bacteria had been grown in laboratories on the cult's ranch. After serving two and a half years in prison, Sheela, who had been the chief of staff for the cult leader, Bhagwan Shree Rajneesh, was released and deported to Europe.

But as a 1992 report by the Office of Technology Assessment indicated, both biological and chemical terrorism have been rare. Also rare has been the use of biological agents as weapons of war. Perhaps the first recorded incident occurred in the 14th century, when an army besieging Kaffa, a seaport on the Black Sea in the Crimea in Russia, catapulted plague-infected cadavers over the city walls. In colonial America a British officer reportedly gave germ-infested blankets from a smallpox infirmary to Indians in order to start an epidemic among the tribes. The only confirmed instance in this century was Japan's use of plague and other bacteria against China in the 1930s and 1940s.

Grim Reality

As the 20th century draws to a close, however, an unpleasant paradox has emerged. More states than ever are signing international agreements to eliminate chemical and biological arms. Yet more are also suspected of developing these weapons despite the treaties. In 1980 only one country, the Soviet Union, had been named by the U.S. for violating the 1972 Biological Weapons Convention, a treaty that prohibits the development or possession of biological weapons.

Since then, the number has ballooned. In 1989 Central Intelligence Agency director William Webster reported that "at least 10 countries" were developing biological weapons. By 1995, 17 countries had been named as biological weapons suspects, according to sources cited by the Office of Technology Assessment and at U.S. Senate committee hearings. They include Iran, Iraq, Libya, Syria, North Korea, Taiwan, Israel, Egypt, Vietnam, Laos, Cuba, Bulgaria, India, South Korea, South Africa, China and Russia. (Russian leaders insist that they have terminated their biological program, but U.S. officials doubt that claim.

The first five of these countries—Iran, Iraq, Libya, Syria and North Korea—are especially worrisome in view of their histories of militant behavior. Iraq, for example, has acknowledged the claims of U.N. inspectors that during the 1991 Persian Gulf War it possessed Scud missiles tipped with biological warheads. A 1994 Pentagon report to Congress cited instability in eastern Europe, the Middle East and Southwest Asia as likely to encourage even more nations to develop biological and chemical arms.

As the 20th century draws to a close, an unpleasant paradox has emerged. More states than ever are signing international agreements to eliminate chemical and biological arms. Yet more are also suspected of developing these weapons despite the treaties.

Reversing this trend should be of paramount concern to the community of nations. Indeed, the elimination of biological as well as chemical weaponry is a worthy, if difficult, goal. The failure of this effort may increase the likelihood of the development of a man-made plague from Ebola or some other gruesome agent.

Dedication to biological disarmament in particular should be enhanced by another grim truth: in many scenarios, a large population cannot be protected against a biological attack. Vaccines can prevent some diseases, but unless the causative agent is known in advance, such a safeguard may be worthless. Antibiotics are effective against specific bacteria or classes of biological agents, but not against all. Moreover, the incidence of infectious disease around the world has been rising from newly resistant strains of bacteria that defy treatment. In this era of biotechnology, especially, novel organisms can be engineered against which vaccines or antibiotics are useless.

Nor do physical barriers against infection offer great comfort. Fortunately, most biological agents have no effect on or through intact skin, so respiratory masks and clothing would provide adequate protection for most people. After a short while, the danger could recede as sunlight and ambient temperatures destroyed the agents. But certain microorganisms can persist indefinitely in an environment. Gruinard Island, off the coast of Scotland, remained infected with anthrax spores for 40 years after biological warfare tests were carried out there in the 1940s. And in 1981 Rex Watson, then head of Britain's Chemical and Biological Defense Establishment, asserted that if Berlin had been bombarded with anthrax bacteria during World War II, the city would still be contaminated.

Although many Israelis did become accustomed to wearing gas masks during the 1991 Persian Gulf War, it seems unrealistic to expect large populations of civilians to wear such gear for months or years, especially in warm regions. U.N. inspectors in Iraq report that in hot weather they can scarcely tolerate wearing a mask for more than 15 minutes at a time.

Calls for more robust biological defense programs have grown, particularly after the Persian Gulf War. Proponents of increased funding for biological defense research often imply that vaccines and special gear developed through such work can protect the public as well as troops. But the same truths hold for both the military and civilians: unless an attack organism is known in advance and is vulnerable to medical interventions, defense can be illusory.

Indeed, the Gulf War experience was in certain respects misleading. Iraq's biological weapons were understood to be anthrax bacilli and botulinum toxin. (Although toxins are inanimate products of microorganisms, they are treated as biological agents under the terms of the 1972 Biological Weapons Convention.) Both are susceptible to existing vaccines and treatments, and protection of military forces therefore seemed possible. Research that would lead to enhanced defense against these agents is thus generally warranted.

But the improbabilities of warding off attacks from less traditional agents deserve full appreciation. Anticipating that research can come up with defens-

A 1969 United Nations report indicated that the expense of stockpiling gas masks, antibiotics, vaccines and other defensive measures for civilians could exceed $20 billion. That figure, when adjusted for inflation, would now be about $80 billion.

es against attack organisms whose nature is not known in advance seems fanciful. Moreover, even with all its limitations, the cost of building a national civil defense system against biological and chemical weapons would be substantial. A 1969 United Nations report indicated that the expense of stockpiling gas masks, antibiotics, vaccines and other defensive measures for civilians could exceed $20 billion. That figure, when adjusted for inflation, would now be about $80 billion.

Vaccines and protective gear are not the only challenges to biological defense. Identifying an organism quickly in a battlefield situation, too, is problematic. Even determining whether a biological attack has been launched can be uncertain. Consequently, the Pentagon has begun to focus more on detection.

In May 1994 Deputy Secretary of Defense John Deutch produced an interagency report on counterproliferation activities concerning weapons of mass destruction. Biological agent detectors in particular, he wrote, were "not being pursued adequately." To the annual $110 million budgeted for the development of biological and chemical weapons detection, the report recommended adding $75 million. Already under way were Pentagon-sponsored programs involving such technologies as ion-trap mass spectrometry and laser-induced breakdown spectroscopy, approaches that look for characteristic chemical signatures of dangerous agents in the air. The army's hope, which its spokespersons admit is a long way from being realized, is to find a "generic" detector that can identify classes of pathogens.

Meanwhile the military is also advancing a more limited approach that identifies specific agents through antibody-antigen combinations. The Biological Integrated Detection System (BIDS) exposes suspected air samples to antibodies that react with a particular biological agent. A reaction of the antibody would signify the agent is present, a process that takes about 30 minutes.

BIDS can now identify four agents through antibody-antigen reactions: *Bacillus anthracis* (anthrax bacterium), *Y. pestis* (bubonic plague), botulinum toxin (the poison released by botulism organisms) and staphylococcus enterotoxin B (released by certain staph bacteria). Laboratory investigations to identify additional agents through antibody-antigen reactions are in progress. But scores of organisms and toxins are viewed as potential warfare agents. Whether the full range, or even most, will be detectable by BIDS remains uncertain.

The most effective safeguard against biological warfare and biological terrorism is, and will be, prevention. To this end, enhanced intelligence and regulation of commercial orders for pathogens are important. Both approaches have been strengthened by provisions in the antiterrorism bill enacted earlier this year. At the same time, attempts to identify and control emerging diseases are gaining attention. One such effort is ProMED (Program to Monitor Emerging Diseases), which was proposed in 1993 by the 3,000-member Federation of American Scientists.

Although focusing on disease outbreaks in general, supporters of ProMED are sensitive to the possibility of man-made epidemics. The ProMED surveillance system would include developing baseline data on endemic diseases throughout the world, rapid reporting of unusual outbreaks, and responses aimed at containing disease, such as providing advice on trade and travel. Such a program could probably distinguish disease outbreaks from hostile sources more effectively than is currently possible.

In addition, steps to strengthen the 1972 Biological Weapons Convention through verification arrangements—including on-site inspections—should be encouraged. The 139 countries that are parties to the convention are expected to discuss incorporating verification measures at a review conference in December of this year. After the last review conference, in 1991, a committee to explore such measures was established. VEREX, as the group was called, has listed various possibilities ranging from surveillance of the scientific literature to on-site inspections of potential production areas, such as laboratories, breweries and pharmaceutical companies.

Given the ease with which bioweapons can be produced, individuals will always be able to circumvent international agreements. But the absence of such agents from national arsenals—and tightened regulations on the acquisition and transfer of pathogens—will make them more difficult to obtain for hostile purposes. Verification can never be foolproof, and therefore some critics argue that verification efforts are a waste of time. Proponents nonetheless assert that sanctions following a detected violation would provide at least some disincentive to cheaters and are thus preferable to no sanctions at all. Furthermore, a strengthened global treaty underscores a commitment by the nations of the world not to traffic in these weapons.

The infrequent use of biological weapons to date might be explained in many ways. Some potential users have probably lacked familiarity with how to de-

velop pathogens as weapons; moreover, they may have been afraid of infecting themselves. Nations and terrorists alike might furthermore be disinclined to use bioagents because they are by nature unpredictable. Through mutations, a bacterium or virus can gain or lose virulence over time, which may be contrary to the strategic desires of the people who released it. And once introduced into the environment, a pathogen may pose a threat to anybody who goes there, making it difficult to occupy territory.

But beneath all these pragmatic concerns lies another dimension that deserves more emphasis than it generally receives: the moral repugnance of these weapons. Their ability to cause great suffering, coupled with their indiscriminate character, no doubt contributes to the deep-seated aversion most people have for them. And that aversion seems central to explaining why bioweapons have so rarely been used in the past. Contrary to analyses that commonly ignore or belittle the phenomenon, this natural antipathy should be appreciated and exploited. Even some terrorists could be reluctant to use a weapon so fearsome that it would permanently alienate the public from their cause.

The Poison Taboo

In recognition of these sentiments, the 1972 Biological Weapons Convention describes germ weaponry as "repugnant to the conscience of mankind." Such descriptions have roots that reach back thousands of years. (Not until the 19th century were microorganisms understood to be the cause of infection; before then, poison and disease were commonly seen as the same. Indeed, the Latin word for "poison" is "virus.")

Among prohibitions in many civilizations were the poisoning of food and wells and the use of poison weapons. The Greeks and Romans condemned the use of poison in war as a violation of *ius gentium*—the law of nations. Poisons and other weapons considered inhumane were forbidden by the Manu Law of India around 500 B.C. and among the Saracens 1,000 years later. The prohibitions were reiterated by Dutch statesman Hugo Grotius in his 1625 opus *The Law of War and Peace*, and they were, for the most part, maintained during the harsh European religious conflicts of the time.

Like the taboos against incest, cannibalism and other widely reviled acts, the taboo against poison weapons was sometimes violated. But the frequency of such violations may have been minimized because of their castigation as a "defalcation of proper principles," in the words of the 18th- and 19th-century English jurist Robert P. Ward. Under the law of nations, Ward wrote, "Nothing is more expressly forbidden than the use of *poisoned* arms" (emphasis in original).

Historian John Ellis van Courtland Moon, now professor emeritus at Fitchburg State College in Massachusetts, contends that growing nationalism in the 18th century weakened the disinclinations about poison weapons. As a result of what Moon calls "the nationalization of ethics," military necessity began to displace moral considerations in state policies; nations were more likely to employ any means possible to attain their aims in warfare.

In the mid-19th century, a few military leaders proposed that toxic weapons be employed, although none actually were. Nevertheless, gas was used in World War I. The experience of large-scale chemical warfare was so horrifying that it led to the 1925 Geneva Protocol, which forbids the use of chemical and bacteriological agents in war. Images of victims gasping, frothing and choking to death had a profound impact. The text of the protocol reflects the global sense of abhorrence. It affirmed that these weapons had been "justly condemned by the general opinion of the civilized world."

Chemical and biological weapons were used in almost none of the hundreds of wars and skirmishes in subsequent decades—until Iraq's extensive chemical attacks during the Iran-Iraq war. Regrettably, the international response to Iraqi behavior was muted or ineffective. From 1983 until the war ended in 1988, Iraq was permitted to get away with chemical murder. Fear of an Iranian victory stifled serious outcries against a form of weaponry that had been universally condemned.

The consequences of silence about Iraq's behavior, though unfortunate, were not surprising. Iraqi ability to use chemical weapons with impunity, and their apparent effectiveness against Iran,

Potential Biological Agents

Bacillus anthracis. Causes anthrax. If bacteria are inhaled, symptoms may develop in two to three days. Initial symptoms resembling common respiratory infection are followed by high fever, vomiting, joint ache and labored breathing, and internal and external bleeding lesions. Exposure may be fatal. Vaccine and antibiotics provide protection unless exposure is very high.

Botulinum toxin. Cause of botulism, produced by *Clostridium botulinum* bacteria. Symptoms appear 12 to 72 hours after ingestion or inhalation. Initial symptoms are nausea and diarrhea, followed by weakness, dizziness and respiratory paralysis, often leading to death. Antitoxin can sometimes arrest the process.

Yersinia pestis. Causes bubonic plague, the Black Death of the Middle Ages. If bacteria reach the lungs, symptoms—including fever and delirium—may appear in three or four days. Untreated cases are nearly always fatal. Vaccines can offer immunity, and antibiotics are usually effective if administered promptly.

Ebola virus. Highly contagious and lethal. May not be desirable as a biological agent because of uncertain stability outside of animal host. Symptoms, appearing two or three days after exposure, include high fever, delirium, severe joint pain, bleeding from body orifices, and convulsions, followed by death. No known treatment.

prompted more countries to arm themselves with chemical and biological weapons. Ironically, in 1991 many of the countries that had been silent about the Iraqi chemical attacks had to face a chemically and biologically equipped Iraq on the battlefield.

To its credit, since the Persian Gulf War, much of the international community has pressed Iraq about its unconventional weapons programs by maintaining sanctions through the U.N. Security Council. Council resolutions require elimination of Iraq's biological weapons (and other weapons of mass destruction), as well as information about past programs to develop them. Iraq has been only partially forthcoming, and U.N. inspectors continue to seek full disclosure.

But even now, U.N. reports are commonly dry recitations. Expressions of outrage are rare. Any country or group that develops these weapons deserves forceful condemnation. We need continuing reminders that civilized people do not traffic in, or use, such weaponry. The agreement by the U.S. and Russia to destroy their chemical stockpiles within a decade should help.

Words of outrage alone, obviously, are not enough. Intelligence is important, as are controls over domestic and international shipments of pathogens and enhanced global surveillance of disease outbreaks. Moreover, institutions that reinforce positive behavior and values are essential.

The highest priority of the moment in this regard is implementation of the Chemical Weapons Convention, which outlaws the possession of chemical weapons. It lists chemicals that signatory nations must declare to have in their possession. Unlike the Biological Weapons Convention, the chemical treaty has extensive provisions to verify compliance, including short-notice inspections of suspected violations. It also provides added inducements to join through information exchanges and commercial privileges among the signatories.

In 1993 the chemical treaty was opened for signature. By October 1996, the pact had been signed by 160 countries and ratified by 64, one less than the number required for the agreement to enter into force. One disappointing holdout is the U.S. In part because of disagreements over the treaty's verification provisions, the U.S. Senate recently delayed a vote on the pact.

Implementing this chemical weapons treaty should add momentum to the current negotiations over strengthening the Biological Weapons Convention. Conversely, failure of the Chemical Weapons Convention to fulfill expectations will dampen prospects for a verification regime for the biological treaty. The most likely consequence would be the continued proliferation of chemical and biological arsenals around the world. The longer these weapons persist, the more their sense of illegitimacy erodes, and the more likely they will be used—by armies and by terrorists.

As analysts have noted, subnational groups commonly use the types of weapons that are in national arsenals. The absence of biological and chemical weapons from national military inventories may diminish their attractiveness to terrorists. According to terrorism expert Brian M. Jenkins, leaders of Aum Shinrikyo indicated that their interest in chemical weapons was inspired by Iraq's use of chemicals during its war with Iran.

Treaties, verification regimes, global surveillance, controlled exchanges of pathogens—all are the muscle of arms control. Their effectiveness ultimately depends on the moral backbone that supports them and the will to enforce them rigorously.

By underscoring the moral sense behind the formal exclusion of biological weapons, sustaining their prohibition becomes more likely.

Defenses against Biological Weapons

Respirator or gas mask. Filters, usually made of activated charcoal, must block particles larger than one micron. Overgarments are also advisable to protect against contact with open wounds or otherwise broken skin.

Protective shelter. Best if a closed room, ideally insulated with plastic or some other nonpermeable material and ventilated with filtered air.

Decontamination. Such traditional disinfectants as formaldehyde are effective for sterilizing surfaces.

Vaccination. Must be for specific agent. Some agents require several inoculations over an extended period before immunity is conferred. For many agents, no vaccine is available.

Antibiotics. Effective against some but not all bacterial agents (and not effective against viruses). For some susceptible bacteria, antibiotic therapy must begin within a few hours of exposure—before symptoms appear.

Detection systems. Only rudimentary field units currently available for a few specific agents. Research is under way to expand the number of agents that can be detected in battlefield situations or elsewhere.

The Author

LEONARD A. COLE is an adjunct professor of political science and an associate in the program in science, technology and society at Rutgers University in Newark, N.J. He is an authority in the area of science and public policy, with special expertise in policy concerning biological and chemical warfare, radon and various health issues. He received a B.A. in political science from the University of California, Berkeley, in 1961 and a Ph.D. in political science from Columbia University in 1970.

Further Reading

CLOUDS OF SECRECY: THE ARMY'S GERM WARFARE TESTS OVER POPULATED AREAS. Leonard A. Cole. Rowman and Littlefield, 1990.

BIOLOGICAL WEAPONS: WEAPONS OF THE FUTURE? Edited by Brad Roberts. Center for Strategic and International Studies, 1993.

BIOLOGICAL WARFARE IN THE 21ST CENTURY. Malcolm Dando. Macmillan, 1994.

THE ELEVENTH PLAGUE: THE POLITICS OF BIOLOGICAL AND CHEMICAL WARFARE. Leonard A. Cole. W. H. Freeman and Company, 1996.