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BIOLOGICAL AND CHEMICAL WARFARE: A CHALLENGE FOR AIR FORCE MEDICAL READINESS

by

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Preface

This research project was stimulated, in part, by an assessment in the United States General Accounting Office report of March 1996. This report noted a training deficiency in units that would be among the first to deploy into an environment that would be subject to potential or actual use of biological or chemical agents. While medical units, and in particular Air Force medical units, are not the most likely to be intentionally deployed into such an environment, the risk of attack upon a previously deployed unit or one in garrison exists. Additionally, Air Force installations, both within the continental United States and overseas, are subject to terrorist attack. It is also possible that, as the nearest standing military support, the Air Force may find itself called upon to assist civilian authorities in the event of an attack or disaster. In each case, the Air Force medical facility would either serve as the primary medical responder or as knowledgeable medical support to civilian community personnel. Readiness for such an event is expected and necessary if casualties are to be minimized and organizational function restored in the minimal amount of time possible.

Personal experience has suggested that preparation to function in a biologically or chemically contaminated environment may be spotty. At no time was this more apparent as it was when many of us prepared for deployment to Desert Shield/Desert Storm. While all personnel had previously had limited training, for many individuals this was the first time that training really focused on assuring proper mask fit, personal protection, and working in a contaminated environment. This has prompted an evaluation of what the threat might be and how we might best prepare to meet it.

I would like to express my appreciation to Colonel Bruce Oksol for his review and assistance with this work and to thank Captain Chad B. McKee, USA for a draft copy of the forthcoming *The Medical NBC Battlebook.*

As this project is being performed, rapid changes are occurring to resolve many of the concerns that have been expressed, but assessment and reminder remain relevant. Any work now written on the subject of biological and chemical warfare must be considered a work in progress. This is not to be discouraging. It merely assures the reader that in the face of a changing world the United States continues to adapt to meet the challenges of today while anticipating those of tomorrow.

Abstract

One of our best defenses and deterrents against the use of chemical and biological weapons may be our ability to survive and function despite their use. It is essential that Air Force medical personnel are prepared to survive and to provide the highest quality of medical care possible in an environment contaminated with biological and chemical agents. Despite this requirement, there is considerable opportunity for improvement in medical doctrine, education and training of personnel, effectiveness of exercises, and verification of proficiency. Lack of adequate familiarity with operations in this environment can result in fear limiting the willingness of medical personnel to enter a contaminated area when needed, diminished capabilities at the scene of a response, and potentially increased morbidity and mortality among treated and treating personnel. Additionally, as potential terrorist threats increase, units must be prepared to assist in many different scenarios involving the use of biological or chemical agents both abroad and in the United States. The United States General Accounting Office report of March 1996 specifically noted a training deficiency among units that would be among the first to deploy. This study uses an evaluation of history, current reports, training guidelines, interviews, and available systems to assess the threat presented by biological and chemical agents and the readiness of Air Force medical personnel. Some ongoing improvements are discussed and several proposals are made to further improve the preparedness of both personnel and units.

Chapter 1

Introduction

> *Force to counter opposing force, equips itself with the inventions of art and science. Attached to force are certain self-imposed, imperceptible limitations hardly worth mentioning, known as international law and custom, but they scarcely weaken it. Force-that is, physical force, for moral force has no existence save as expressed in the state and the law-is thus the means of war; to impose our will on the enemy is its object. To secure that object we must render the enemy powerless; and that, in theory, is the true aim of warfare.*
>
> — Carl von Clausewitz
> *On War*

Though written in the 19th century the assertions of Clausewitz are still equally, if not more, applicable today. War has taken on new dimensions and new participants, but the object remains the same, to render the enemy powerless and unable to oppose the victor's will. The "inventions of art and science" have taken directions of which Clausewitz could not have conceived and the lack of "moral force" whether among nations or among non-national organizations will continue to provide growing challenges in an uncertain future. Today the discoveries and creations of science include chemicals that can incapacitate or kill and biological agents that can create overwhelming epidemics of massive proportions. These tools of force are light, cheap, and available to almost anyone seeking to acquire them and they may indeed leave an unprepared enemy powerless. It is not necessarily going to be the tanks or fighter aircraft of the future that the United States will need to defend against, but these weapons that, inadvertently, through its success in conventional weaponry the United States has encouraged others to develop.

In January 1991, millions of people around the world watched on television as the United States and its Gulf War coalition unleashed decisive conventional military might on Iraq and its army that had long been reputed as one of the most powerful in the world. Among the viewers of this spectacle were civilian and military leaders around the world, members of terrorist organizations, and lone extremists everywhere. Not only were they able to observe the unmatched, and perhaps unmatchable, technological and material prowess of the allies, but also to observe the terror created among allied personnel and the populace of Israel at the possibility of attack by Scud missiles containing biological or chemical warheads. Knowledgeable military leaders would note the effort and resources that allied air forces had committed to attempt to locate and destroy the relatively small number of inaccurate Scud missiles in answer to this threat. All of these lessons serve as valuable information as leaders build their own militaries whether their goal is to attempt future regional domination, to export terrorist disruption, or to defend against attacks involving biological or chemical agents.

The United States is also one of the nations that must learn from the lessons of its prior successes. With its extensive global commitments, its reputation as the remaining world military superpower, and its desire to maintain peace and stability, there is a virtual certainty that the United States will find itself in an environment where biological or chemical agents have been used. Even when not engaged in combat activities, forward-based US personnel are under the threat of terrorist attack. Additionally, in a free society in which diverse sometimes passionate views are able to flourish and the national borders are relatively open, both internally and externally organized terrorist actions have the potential to bring biological and chemical attacks directly to the American public. Deterrence of such attacks is first and foremost the goal of all agencies involved whether the methods involve diplomacy, military action or the threat of military action, or law enforcement efforts. Failing deterrence, preparedness is essential in order to successfully operate in an environment contaminated by biological and/or chemical agents and to provide critical medical care to those affected.

Medical personnel, whether civilian or military, will inevitably find themselves faced with the results should an attack occur. Particularly in the case of deployed military members, medical personnel may themselves be victims or subject to the same conditions that their patients face. Adequate and ongoing training of medical personnel for personal protection and timely provision of effective care to injured or infected patients is essential. The threat and preparation, principally medical preparedness, to meet it are the subjects of this examination.

Chapter 2

History

Early Use

In order to understand the threat as it now exists, it is important to appreciate the historical context of biological and chemical warfare and their application. The development and use of biological and chemical weapons is not new to the world stage. Biologic agents, living organisms or their products in the form of toxins, are among the oldest weapons of man. Aboriginal South Americans have utilized curare, a paralyzing poison, and other amphibian-derived toxins since antiquity and it was recognized early by European and Asian peoples that disease had devastating effects on armies and civilian populations. Filth, and human and animal bodies have been used to contaminate water supplies from ancient times through the 20th century.[1]

Proof of biologic attack was and is difficult to prove, but there are two striking possible examples that can be cited from past centuries. During the 14th century the Tatars were besieging the city of Kaffa, which is located in the area now known as the Ukraine. The Tatars, experiencing an epidemic of plague, catapulted their dead into the walled city. The subsequent plague epidemic in the city may or may not have been related to this act of biological warfare, but did result in the retreat of forces defending the city and its defeat. Ships carried infected refugees and merchants, and possibly rats carrying infected fleas, to Constantinople, Venice, Genoa, and other ports along the Mediterranean. This may have been a major contributor to the second plague pandemic to strike Europe.[2]

The second incident occurred during the French and Indian War in North America. During this war, Native Americans were allied with the French against the British. Sir Jeffrey Amherst, commander of the British forces in North America, is reported to have suggested that smallpox be introduced to the Native Americans as a means to reduce their numbers. An outbreak of smallpox at Fort Pitt provided just such an opportunity and, on June 24, 1763, blankets and handkerchiefs from the smallpox hospital were given to the Native Americans. Epidemic smallpox among these previously unexposed people followed killing large numbers. The epidemic may or may not have resulted from this attempt as other epidemics had occurred earlier and would subsequently when Europeans came into contact with the native peoples. Blankets are a poor source of transmission of the disease, but the significance lies more in the attempt than the result.[3]

Unlike the more ancient and frequent use of biologic warfare, chemical warfare is primarily a more recent development. The primary early use occurred when the Spartans of ancient Greece used burning sulfur and pitch to send clouds of noxious sulfur dioxide gas over the cities of their enemies.[4] It took the developments of modern chemistry in the late 19th century to bring true chemical warfare to the world. It was commonly found that the by-products of some chemical processes, particularly dye manufacturing, resulted in disabling effects that were soon thought to be potentially useful against enemies.[5]

During the American Civil War, Confederate soldiers poisoned the drinking water of Union soldiers using the decaying corpses of animals. In response, the Union forces considered using shells filled with chlorine. So concerning were developments after the Civil War in the area of chemical warfare that the First International Peace Conference in The Hague in 1899 addressed the issue. Agreement was made to "abstain from the use of projectiles, the object of which is the diffusion of asphyxiating or deleterious gases." Of note is that United States military leaders opposed such a ban and the United States did not sign the policy.[6]

Twentieth Century Development and Use

Despite these efforts at control, the new century and a world war would result in the disregard of prior goodwill and bring biological and chemical warfare to a new level. It is useful to consider both biological and chemical weapons together, but to separate time periods for the purpose of discussion.

World War I

When one thinks of the First World War the use of biologic warfare is not prominently considered. Multiple "attacks" occurred, but the targets were primarily livestock. Nineteenth century developments in microbiology had resulted in the ability to produce significant stocks of pathogens and Germany had an active biological warfare program. Germany used *Bacillus anthracis* and *Burkholderia (Pseudomonas) mallei*, the etiologic agents of anthrax and glanders respectively, to infect Romanian sheep due to be shipped to Russia. German saboteurs are alleged to have used *B mallei* to infect 4,500 mules in Mesopotamia and French cavalry horses in France. Both *B anthracis* and *B mallei* were used to infect Argentinian livestock intended for the Allies resulting in the deaths of over 200 mules. Additionally, attempts were made to contaminate animal feed and horses intended for export from the United States.[7] The results of these efforts were minimal, but true biological warfare had been born.

The story of chemical warfare during the First World War was far different, indeed chemical warfare was considered one of the hallmarks of the war. It was the French who initially introduced chemicals to the battlefield. In 1912, they acquired hand grenades filled with *ethyl bromoacetate*, a non-disabling tear gas, intended for use in flushing the enemy from bunkers. In its initial use in August 1914, it was utilized in the open and was dispersed quickly resulting in no appreciable effect. The Germans were not far behind and, in October 1914, fired 105 mm howitzer shells containing an agent that irritates mucous membranes at British troops in the Neuve-Chappelle area and, in January 1915, used another agent against Russian troops near Bolimov. In both cases environmental considerations rendered the agents useless and the attacked troops were essentially unaware that such an attack had occurred.[8]

The date from which it is generally accepted that large scale chemical warfare began is 22 April 1915, when German forces released chlorine gas from nearly 6,000 cylinders placed in trenches along a four-mile area of the front in Flanders Field near the Belgian town of Ypres. The attack resulted in 5,000 dead and 10,000 wounded Allied troops.[9] The Germans had sought to break the stalemate of the trenches and indeed entire units broke and ran. Large areas of the Allied lines were left undefended, but the Germans had not anticipated the magnitude of the success of the attack and were unprepared to take advantage of the situation before the Allies could recover.[10]

The impact of subsequent attacks would never be as great. By the time of the next attack two days later, Allied troops already had their first crude protective respirators.[11]

Within months the Allies would also be using gas and new developments continued throughout the war. Phosgene followed chlorine and with the introduction of mustard gas, referred to as “the king of gas” at a subsequent attack at Ypres in 1917, effects would be delayed and include skin blisters and eye damage along with respiratory problems.[12] This now resulted in the need for whole-body protection for the first time.

Gas usage became relatively commonplace and by the conclusion of the war it was estimated that over 125,000 tons of toxic chemicals had been used resulting in approximately 1.3 million casualties with 100,000 deaths.[13]

The Interwar Period

Use of chemical weapons did not cease with the conclusion of the war. The British dropped agents from the air on the Bolsheviks during the Russian Civil War and the French and Spanish used chemical agents against tribesmen in their areas of Morocco.[14] The visions of injured soldiers returning from the war, however, provoked public proclamation for a ban on future use of chemical weapons and, in 1925, the Geneva Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare was established. Though prohibiting their use, this treaty did not proscribe basic research, production, or possession of such weapons and there were no inspection provisions. Many of the signing nations reserved the right of retaliation and among these signers, in addition to existing programs in chemical weaponry, such countries as Belgium, Canada, France, Great Britain, Italy, the Netherlands, Poland, and the Soviet Union proceeded in the development of biological weaponry programs.[15] In 1936, German scientists noted the dramatic lethality of some insecticides and research into these agents and properties led to the development of nerve gases. The treaty would eventually be signed by 129 nations including the United States. Though it adhered to the terms of the treaty, the United States did not ratify it until 1975.[16]

It did not take long for overt violations to occur. Italy used mustard agents against tribesmen in Ethiopia in 1935 and Japan employed mustard and other chemical agents in China beginning in 1937.[17] Japan, through its Unit 731, located near the town of Pingfan in occupied Manchuria began conducting research in the development and use of biological weapons beginning in 1932. Prisoners there and at other sites in China including Mukden, Changchun, and Nanking were infected with *Bacillus anthracis* (anthrax), *Neisseria meningitidis* (meningitis), *Shigella* species (shigellosis), *Vibrio cholerae* (cholera), and *Yersinia pestis* (plague). This experimentation led to the deaths of at least 10,000 prisoners between 1932 and 1945. In addition, at least 12 large-scale tests were conducted involving 11 Chinese cities. Water supplies were contaminated, bacteria were placed in homes and sprayed from aircraft, and as many as 15 million plague-infected fleas were dropped from aircraft over Chinese cities. The Japanese soldiers were themselves poorly prepared and in one attack in 1941, 10,000 casualties occurred among the Japanese themselves with 1,700 deaths.[18]

World War II

Other than the activities of Japan the Second World War was remarkably free from employment of biological and chemical agents. Chemical weapons, though plentiful, were not used. Germany experimented on prisoners in concentration camps using rickettsial diseases, hepatitis A virus, and malaria, but these were to test vaccines and drugs to treat these diseases and not as means for developing warfare agents. There was only one known actual biologic agent use involving the contamination of a large reservoir in Bohemia with sewage in May 1945.[19] The German biologic agent program was not as far advanced as those of the Allies, but the reason Germany withheld use of its significant stockpiles of chemical agents is unclear. Speculation is that Hitler was reluctant to use gas having been himself a victim of a chemical attack during World War I. Other explanations include the concern for massive retaliation by the Allies and the simple logistical concern that his mobile army was still highly dependent upon horse-drawn transport and, lacking adequate protection for his draft animals, Hitler could not afford loss of his own transport system.[20]

The Allies were prepared for retaliatory use had the need arisen. The United States had chemical weapons and the British were prepared to use mustard agents if Germany had invaded Great Britain in 1940.[21] British efforts at biological warfare led to testing of bombs containing *B anthracis* on Gruinard Island off the Scotland coast. Heavy contamination with viable anthrax spores persisted until decontamination with seawater and formaldehyde in 1986. The United States had begun an offensive biological program in 1942, but success was limited and large-scale weapons production did not take place during the war.[22]

The Cold War

Active research continued and even accelerated in the Cold War era. The United States had granted immunity from war crimes prosecution to some Japanese scientists who had participated in the Japanese Unit 731 program in exchange for information. The United States biologic weapons program continued to expand rapidly in the period after World War II and into the Korean War era. Large-scale production of weaponized microorganisms began in 1954 after a countermeasures program had been started the year before. Animal studies were conducted and human experimentation was begun on volunteers in 1955. Some "live agent" testing was done to determine the efficacy of vaccines, prophylactic therapy, and treatment, but much research was done with "simulants," organisms thought not to cause disease. These were used to test storage and production techniques, dispersal, and the effects of sun and weather on the organisms. American cities were covertly used as test areas to assess aerosolization and dispersal patterns. New York City, San Francisco, and other areas were used in tests between 1949 and 1968. Some charges were made that these tests had resulted in small outbreaks of disease, but this seems unlikely since those who became ill did so with strains different than those being used by the Army. By the late 1960s, the United States had an arsenal that included multiple bacterial pathogens, toxins, and fungal plant pathogens that might be used against crops.[23]

The United States continued development of chemical agents producing nerve gas artillery shells beginning in the 1950s. Cluster bombs were also developed to disperse ricin, a toxin derived from the castor bean and more potent than nerve gas. Not all agents were deadly with the United States developing a hallucinogen as an incapacitating agent.[24]

Soviet development was continuing as well with multiple charges being made of use of agents during the Cold War by all sides. The United States was accused of testing biological weapons against Canadian Eskimos, using biological agents along with Columbia to attack Colombian and Bolivian peasants, and planning cholera attacks in

China and dengue in Cuba. The Soviets were accused of use of trichothecene mycotoxins (yellow rain) in Laos, Kampuchea, and Afghanistan.[25]

The United States was not responsible for those acts attributed to it, but did use low lethality chemical agents during the Vietnam War. Chloroacetophenone (CN) and ortho-chlorobenzalmalononitrile (CS), both tear gases, and adamsite (DM), a vomiting agent, were used. Additionally, there is a report that the hallucinogen, 3-Quinuclidinyl benzilate (BZ) was used at least once, in Bong-san, in March 1966.[26] Most publicized was the use of the defoliants, known as Orange, Blue, and White for the colors of the stripes on their containers, to deforest areas in an attempt to deny cover to the Vietcong, but also falling on crop areas. By the end of the war, it is estimated that 5 to 15 percent of South Vietnam and Laos had been treated with these agents. Originally cited as nontoxic, Agent Orange, particularly the dioxin component, has since been charged as a cause of multiple health problems in those exposed.[27]

Other nations were active as well and Egypt was known to have used gas including mustard and possibly nerve gas between 1963 and 1967 in the Yemeni Civil War in support of their allies.[28]

Modern Control Efforts

Once again, in the late 1960s, concern regarding the stockpiling and use, particularly of biologic agents, prompted international concern. In 1969 (for microorganisms) and 1970 (for toxins) the United States renounced research and production of these agents. Stockpiles were destroyed between 1971 and 1973 and only research into defensive measures such as vaccines, diagnostic tests, and therapies were continued. At this time the 1972 Convention on the Prohibition of the Development, Production, and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction was created. Its purpose was to prohibit development, possession, and stockpiling of these agents in amounts more than those required for prophylactic, protective, or other peaceful purposes. Stocks and delivery systems were to be destroyed and the transfer of technology to non-signers was forbidden. The United Nations Security Council would initiate inspections and address infractions. Not addressed were the issues of Security Council members having the right to veto proposed inspections and the lack of definition as to what constituted the amount of agents allowed for benevolent research or the definition of defensive research. The treaty was ratified in 1972 and became effective in March 1975 with over 100 nations having signed, including Iraq and all members of the Security Council.[29]

Despite the signatures to this treaty, the toxin ricin was weaponized by the Soviet Union and used by the Bulgarians for assassinations and attempted assassinations at least through 1978. Clandestine Soviet research continued and in April 1979 an accidental escape of anthrax occurred downwind of the Soviet military research facility in Sverdlovsk. At least 77 cases occurred with 66 deaths. In 1992 Russia stated it would end offensive biological research and production, but as late as 1995 the program continued to employ 25,000 to 30,000 people.[30]

During this period, there were also continued violations of treaties concerning chemical weapons. During its eight-year war with Iran between 1980 and 1988 and in direct violation of the Geneva Protocol of 1925 that it had signed, Iraq initiated chemical warfare against Iran using mustard and probably nerve agents. Iraq also attacked its own Kurdish population at Halabja killing 5,000 and injuring another 7,000 unarmed civilians, many of them women and children. The international reactions to these events were merely rhetorical. Many world powers were more concerned with the possibility of an Iranian victory than with the fact of Iraqi use of chemical weapons. As a result, the violations went essentially unpunished.[31]

Following this period, the world again sought control through international law resulting in the Chemical Weapons Convention. Parties to it agree to never, under any circumstances, develop, produce, acquire, stockpile, or retain chemical weapons; to transfer, directly or indirectly, chemical weapons to anyone; to use chemical weapons or to prepare to use them; or to assist or encourage another party to do any of these. All signers are to destroy all chemical weapons and their production facilities. The document was opened for signature in 1993 and had 161 signers as of March 1997. It entered force in April 1997.[32] This treaty is recognized as the most intrusive arms control agreement ever created. It has a vigorous verification regime with mandatory declarations of chemical weapons and specified chemical-related activities, routine inspections to verify declarations, and short-notice challenge inspections.[33] At last, treaties exist banning the production, possession, and use of both biological and chemical weapons by all nations.

This extensive historical presentation has shown some of the important difficulties apparent when considering international relations, warfare, and the threat from biological and chemical weapons. It is evident that, despite past treaties, when a national interest is involved prohibited weapons research, development, and use in warfare has occurred. Nations have elected to refuse to sign or ratify agreements, to sign them with stipulations, to rely upon subtleties of language and loopholes to continue their programs, to hide behind lack of inspection or enforcement provisions, and to blatantly disregard the signed agreements. The international community has also failed to aggressively punish violators either economically or militarily. These are just some of the reasons that the threat not only remains real, but is even greater than in the past.

Notes

[1] LTC George W. Christopher et al., "Biological Warfare: A Historical Perspective," *JAMA: The Journal of the American Medical Association* 278, no. 5 (6 August 1997): 412.
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[4] Elaine Landau, *Chemical and Biological Warfare* (New York, N.Y.: Lodestar Books, 1991), 51.
[5] T. J. Gander, *Nuclear, Biological & Chemical Warfare* (New York, N.Y.: Hippocrene Books, Inc., 1987), 13.
[6] Landau, 52.
[7] Christopher et al., 413.
[8] Gander, 13.
[9] Landau, 52-53.
[10] Gander, 14.
[11] Ibid.
[12] Landau, 53.
[13] United Nations Department of Political and Security Council Affairs, *Chemical and Bacteriological (Biological) Weapons And The Effects of Their Possible Use: Report of the Secretary-General* (New York, N.Y.: United Nations Publication, November 1969), 1.
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[15] Christopher et al., 413.
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[19] Ibid.
[20] Gander, 17-18.
[21] Ibid., 18.
[22] Christopher et al., 413.
[23] Ibid., 414.
[24] J. Perry Robinson, "Chemical Weapons," in *CBW: Chemical and Biological Warfare,* ed. Steven Rose (Boston, Mass.: Beacon Press, 1969), 25-27.
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[26] M. F. Kahn, "Vietnam," in *CBW: Chemical and Biological Warfare,* ed. Steven Rose (Boston, Mass.: Beacon Press, 1969), 90-91.
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[28] M. Meselson and D. E. Viney, "The Yemen," in *CBW: Chemical and Biological Warfare,* ed. Steven Rose (Boston, Mass.: Beacon Press, 1969), 99-100.

Notes

[29] Christopher, 415.

[30] Ibid., 416.

[31] Landau, 1-5.

[32] Department of Defense, *Annual Report to the President and the Congress*, March 1997, on-line Internet, 5 January 1998, available from http://www.dtic.mil/execsec/adr97/chap6.html.

[33] Dr. Ted Prociv, "Thoughts from the Pentagon," *Chemical and Biological Defense Information Analysis Center Newsletter* 2, no. 2 (Spring 1996): 2.

Chapter 3

The Threat

> *We have long understood that terrorism is an insidious scourge that must be fought aggressively and with eternal vigilance. But today this threat is becoming even more complex and difficult to counter as old and new bad actors take advantage of weak governments in newly independent states, new technologies and rekindled ethnic rivalries.*
>
> — William J. Perry
> U.S. Secretary of Defense

Secretary of Defense Perry's comments reflect a new dimension in concern for the United States both internationally and domestically. While traditional threats remain, new actors are appearing and old ones continue to develop new and greater capabilities. The United States with its strategy of "engagement" will doubtlessly need to be prepared to confront these new realities.

Why Biological and Chemical Weapons

The United States possesses the most formidable military in the world today and arguably the most formidable the world has ever seen, but this is at a significant cost in both monetary and technological expenditure. For nations who might be faced with opposing US forces, the prospects of success in conventional warfare are minimal at best. They can neither expend the money, nor do they possess the technological expertise to become high-level military powers. One of the alternatives to this problem for those nations wishing to demonstrate regional dominance or defend against conventionally stronger neighbors at minimal cost is the development of weapons of mass destruction. These weapons also provide a ready and portable alternative for terrorist organizations seeking to have major impact on a minimal budget. The cheapest and easiest to obtain and produce are biologic agents followed by chemical agents. As Table 1 shows, the economic benefits alone make unconventional weapons an attractive alternative if one is willing to ignore international concern for proliferation of these weapons.

Table 1. Relative Weapons Cost

Weapons Type Used	Cost Per Kilometer of Population Affected
Conventional Weapons	$6,000
Nuclear Weapons	$800
Nerve Gas Weapons	$600
Biological Weapons	$1

Source: United Nations data adapted from Leonard A. Cole, *The Eleventh Plague: The Politics of Biological and Chemical Warfare* (New York, N.Y.: W. H. Freeman and Company, 1997), 8.

Cost is only one benefit offered by weapons of mass destruction. Another distinct advantage, particularly in the case of biological agents, is the ease of production. It has been noted that a biological arsenal could be created using only $10,000 in equipment and a room 15 by 15 feet. It requires no more than a beer fermenter, a culture medium, a gas mask, and a plastic overgarment.[1] Indeed, virtually any university with a microbiology laboratory could serve for the production of significant quantities of a number of agents with appropriate care and a small starter culture.

Starter cultures are now becoming more difficult to obtain as tighter controls have been implemented, but this was not always so. Between 1985 and 1987, Iraq was able to obtain *Bacillus anthracis* from culture collections in France and the United States and a reference strain of *Clostridium perfringens* from the United States.[2] Noteworthy is the fact that, between 1984 and 1989, Iraq obtained more than 80 agents and associated materials from the Centers for Disease Control, a United States government agency. These included agents responsible for plague, dengue fever, and West Nile fever. While these were sent as research materials, there were no controls over their use for other means.[3]

Easy access continued even later. In May 1995, Larry Harris, an Ohio laboratory technician and member of a white supremacist organization, was able to order *Yersinia pestis*, the causative agent of bubonic plague, from the American Type Culture Collection, a Maryland biomedical supply firm. Using a credit card and false letterhead he was able to have three vials shipped to him. His actions were discovered only when he called the company impatiently asking if the shipment had been made stimulating suspicions among company officials.[4] Ultimately the effects of any controls on sales of agents can only be of limited value since these organisms occur naturally and can be isolated, in many cases, from the soil or other sources.

Chemical agents are somewhat more difficult to produce, particularly in large quantities, but many nations already have the basic components of a number of agents that result from common industrial processes. Phosgene is commonly produced in highly developed countries as an intermediary in the production of plastics, herbicides, insecticides, paints, and pharmaceuticals. Hydrogen cyanide is also an intermediate in the production of synthetic organic products and is produced in large quantities. Ethylene-oxide, which can easily be used to produce mustard gas, is also produced worldwide in large quantities. It is a starting material in the production of such things as detergents, disinfectants, and wetting agents. Even intermediates used to produce nerve agents have peacetime applications in the production of pesticides.[5] As a result of these ongoing industrial processes the difficulty in production of chemical weapons is not only alleviated, but made harder to expose.

Concern must now not only be for industrial production by nations. Old assumptions must now be revised. As late as 1969, the United Nations noted, “The production of highly toxic nerve agents, including organophosphorus compounds, presents problems which, because they are relatively difficult, could be very costly to overcome.”[6] This view was shattered in March 20, 1995, when the Aum Shinrikyo cult unleashed a sarin nerve gas attack in the Tokyo subway. Twelve people were killed and 5,500 were sickened. When the cult’s compound was searched, a concealed $700,000 lab was found. This facility was estimated to be capable of producing 132 to 176 pounds of nerve gas a month, enough to kill six to eight million people. Chemical weapons had become the tools of terrorists as well.[7]

Another advantage to the use of biological and chemical weapons is the relative ease of dispersal and difficulty in detection. Both biological and chemical agents can be dispersed by means as simple as an aircraft equipped with commercially available tanks and aerial spraying equipment. Foodstuffs and water supplies can be contaminated as history has shown. Even release of infected vectors such as fleas infected with plague is a possibility. Detection becomes extremely difficult when an agent may be carried in devices ranging from soda cans to missile warheads. An agent dispersed from a small plane several miles upwind may go completely undetected until symptoms become apparent. Victims may ingest food and water and the source of their subsequent illnesses remain unknown or discernable only by epidemiological methods. Without active surveillance programs and high indexes of suspicion, major epidemics may occur or attacks may otherwise go undetected until severe compromise of forces or population has occurred. What has been initially diagnosed as an outbreak of the "flu" may not be recognized as more serious until it is too late for standard available medical treatments to remain effective.

Coinciding with the cost data presented is the aspect of efficiency that biological and chemical weapons offer. Biologic warfare agents are highly effective under the proper conditions. It has been estimated that 50 kg of *Bacillus anthracis* aerially dispersed 2 km upwind of an unprotected population of 500,000 under ideal conditions could travel over 20 km and affect nearly half of those in the path of the cloud killing or incapacitating up to 220,000.[8] Other agents are less deadly, but severe outbreaks of nonlethal illnesses can rapidly immobilize a fighting force. Table 2 shows the incubation period and fatality rates for some of the most common biological warfare agents. This is only a partial list. Other agents such as ricin and Ebola virus also have the potential for effective use as biologic agents. One additional advantage that some biologic agents, particularly viruses and bacteria, may have over toxins and chemical agents exist in the ability for epidemics to be generated resulting in an even magnified response from that of the original attack.

Table 2. Major Known Biological Warfare Agents

Disease	Agent	Days of Incubation	Percent Fatal
Anthrax	Bacillus anthracis	1-5	80
Plague	Yersinia pestis	1-3	90
Tularemia	Francisella tularensis		5-20
Cholera	Vibrio cholerae	2-5	25-50
Venezuelan equine encephalitis	VEE virus	2-5	Less than 1
Q-fever	Coxiella burnetti	12-21	Less than 1
Botulism	Clostridium botulinum toxin	3	30
Staphylococcal enterotoxemia (food poisoning)	Staphylococcus Enterotoxin Type B	1-6	Less than 1
Multiple organ toxicity	Trichothecene Mycotoxin	Dose dependent	Dose dependent

Source: U.S. intelligence data adapted from Bill Gertz, "Horror Weapons," *AIR FORCE Magazine* 79, no. 1 (January 1996): 47.

Chemical agents have the distinct advantage over most biologic agents in being more rapid in onset of effect. It is for this reason that chemical agents may be a more useful battlefield weapon than biologic agents if a subsequent conventional attack is planned in less than a few days. Nerve agents may show effects in as little as a few seconds from the time of exposure and, unlike with biologic agents, intact skin offers no protection even if inhalation does not occur. Table 3 lists common chemical warfare agents and includes some nonlethal or low-lethality agents not usually thought of as "warfare" agents. As with biologic agents, the desired results can be tailored to give death or incapacitation. They can also be selected to be rapid in onset or delayed and rapidly dispersing or persistent.

Table 3. Major Known Chemical Warfare Agents

Agent Class	Agent	Persistence	Rate of Action
Nerve	Tabun (GA)	Low	Very rapid
	Sarin (GB)	Low	Very rapid
	Soman (GD)	Moderate	Very rapid
	GF	Moderate	Very rapid
	VX	Very high	Rapid
Blister	Sulfur mustard	Very high	Delayed
	Nitrogen mustard	Moderate-Very High	Delayed
	Phosgene oxime	Low	Immediate
	Lewisite	High	Rapid
	Phenyldichloroarsine	Low-Moderate	Rapid
	Ethyldichloroarsine	Moderate	Delayed
	Methyldichloroarsine	Low	Rapid
Choking	Phosgene	Low	Delayed
	Diphosgene	Low	Variable
Blood	Hydrogen cyanide	Low	Rapid
	Cyanogen chloride	Low	Rapid
	Arsine	Low	Delayed
Riot control (vomiting)	Diphenylchloroarsine	Low	Rapid
	Diphenylcyanoarsine	Low	Rapid
	Adamsite		Rapid
Riot control (tear gas)	Chloroacetophenone	Low	Immediate
	Chloropicrin	Low-High	Immediate
	Bromobenzylcyanide	Moderate-Very high	Immediate
	O-chlorobenzylidene Malononitrile	Low-High	Immediate
Psychochemicals	3-Quinuclidinyl benzilate	High	Delayed

Source: U.S. intelligence data adapted from Bill Gertz, "Horror Weapons," *AIR FORCE Magazine* 79, no. 1 (January 1996): 46.

Possession by a nation or terrorist of biological and chemical weapons offers additional advantages even if their use never occurs. The mere possibility of deployment and employment of these weapons has both a psychological and a material effect on an opposing force. Unless foolproof surveillance methods and adequate countermeasures exist, personnel must always be aware of the possibility of such an attack and that protective measures, when implemented, may degrade performance. It has been noted that if an opponent possesses a credible threat for the use of biological or chemical weapons, it would require the United States and any coalition partners to alter operational plans making activities more difficult and costly. This was evident during Desert Storm when valuable resources needed to be diverted to search for mobile Scud missiles. In addition, the threat of such weapons may dissuade potential partners from joining the United States in a coalition and impact basing and other support for operations.[9]

Finally, the increased ability to deliver biological and chemical agents at long range, the proliferation of entities with potential availability of these weapons, the portability of these agents, and, particularly in the case of biological agents, their effectiveness in small quantities mean that the United States is no longer as immune to the impact of weapons of mass destruction as it once was. Defense of the US homeland becomes a greater problem both from nations and from terrorists, both external and internal.

The advantages to possession and threat of use are substantial. There are economic, military, and political advantages that compare favorably with conventional weapons. The advantages to actual use are more limited, however, since with use comes the responsibility for that use and the ramifications that will occur. Thus, whether nation or terrorist group, the cost must always be weighed against any potential benefit.

Why Not Biological and Chemical Weapons

While biological and chemical weapons offer a number of advantages to both nations and terrorists willing to use them, there are also distinct disadvantages beginning with the international consequences that may come from their possession and use. Other disadvantages include danger to their creators, increasing difficulty with obtaining raw materials for production, and inherent weaknesses in the agents themselves.

Potentially the strongest of these disadvantages for both nations and terrorists continues to lie in the risk of repercussions resulting from their actions. For nations these may include economic, diplomatic, and military actions. Since few, if any, nations are completely self-sufficient, one completely isolated by the international community will have great difficulty withstanding pressure to change its practices. In reality this has been, and will remain, more of a potential weapon against such nations than an applied one. History has shown that if other nations have some political or economic interest in not imposing or maintaining sanctions little effort will be made to uphold treaty obligations or punish violators of international standards. As noted earlier, despite having acceded to the 1925 Geneva Protocol on the use of asphyxiating and poisonous gas, Iraq violated this prohibition in 1983. This use was denounced, but lacking concrete enforcement measures in the treaty and international desire to act further, Iraq continued "business quite cheerfully, leaving their international censors to weep over the impotent clauses of the protocol."[10] Indeed fear of Iranian victory appears to have stifled action against Iraq resulting in tacit approval by the world community.[11]

International condemnation requires more direct action. Sanctions were imposed upon Iraq following the Gulf War in 1991, but have failed to generate clear-cut biological and chemical disarmament of a highly resistant government. Military action is an alternative, and may be a strong deterrent, yet even this can only temporarily remove the threat from large volumes of munitions, since it does not permanently remove the capacity to produce them. Stronger treaties may afford better prevention for the future, but are dependent upon a nation's willingness to comply, the strength of potential enforcement measures, and international willingness to impose punishment.

Ultimately the threat of massive retaliatory force may be the strongest deterrent for a national use of such weapons. It was likely this fear that restrained the Iraqi leadership from the use of biological and chemical capabilities it possessed and had deployed during the Gulf War. In January 1991, US Secretary of State James Baker indicated to the Iraqi foreign minister that the use of such weapons against American forces would mean the end of the Iraqi regime. When Iraq fired Scud missiles against Israel, US Secretary of Defense Richard Chaney warned that if chemical weapons were used, retaliation with weapons of mass destruction might occur.[12] A government or leader's fear for self-survival can be a powerful motivator.

Unlike national governments, terrorist organizations are less susceptible to international pressures or sanctions. All terrorist organizations require a source of funding and some kind of base of popular support. Potential loss of this support and funding can also be a powerful deterrent to use of biological or chemical weapons due to the widespread outrage that such action could generate.

Another disadvantage to development and employment of these weapons lies in their inherent danger to their producers and users. While those who work with these agents certainly exercise care, it will never be known how many scientists and would-be terrorists became victims of their own agents. On the battlefield, biological and chemical agents will, given the opportunity, attack friend and foe alike. This must be also kept in mind as an attacker plans to occupy territory once an attack has been successful. Finally, once developed, if not used, they pose a storage risk that may be significant particularly for chemical agents.

As previously noted, biologic agents were once more easily obtained in pure cultures than is now possible. In April 1996 a law was enacted that required the Centers for Disease Control and Prevention to monitor more closely shipments of any infectious agents.[13] Tighter export controls exist for raw materials, but multiple potential uses for any given material make practical control difficult. Efforts continue to be made to curb acquisition of agents or raw materials, but unless these are worldwide there is little expectation that such measures will be effective.

Still another major disadvantage to the employment of biological and chemical weapons either by nations or by terrorists lies in the nature of the agents themselves. More than with any other class of weapons, both biological and chemical weapons are affected by extraneous factors such as climate, terrain, living conditions of intended targets, protective measures taken, and individual susceptibilities of target populations. These will have significant impact on both the reliability and predictability of agent effects.

The method of delivery of most biological and chemical agents is through atmospheric dispersion such as the creation of a cloud of vapor, liquid droplets, or aerosol. Once the weapon is released there is no means of controlling it so a change in the wind could bring it back upon the attackers and a brisk wind could disperse the agent too rapidly or widely to be effective in the concentrations achieved. This is less an issue for bacterial biologic agents that are effective in such low concentrations that the effective area of dispersal could be increased dramatically by wind. To an attacker this may be either a desirable or an undesirable effect depending upon the results intended. Temperature in the normal ranges encountered do not significantly affect biological agents except to alter particle size changing rate of entry into the lungs, but sunlight, specifically the ultraviolet component, results in partial inactivation of many agents. Low relative humidity also leads to greater inactivation of bacteriologic agents though concentrations may remain high enough to be effective. In general, biologic agents are more susceptible to environmental influences than chemical agents due to the need to disperse them as aerosols, but methods exist to protect the agents or select appropriate strains to diminish these effects.[14]

Chemical agents are affected differently by atmospheric conditions. The dilution effects of wind are more significant so that sunny days with unstable air are poorer days for employment. Precipitation can either result in a decreased activity of an agent by washing a vapor to earth or, in the case of snow, slowing evaporation of an agent such as mustard causing it to persist for a prolonged period. For example, while mustard will persist for a day and a half at 25 degrees Centigrade, it will persist for several days or even weeks at 10 degrees. If the temperature and humidity are both high, individuals will tend to perspire heavily intensifying the effects of mustard agents and increasing the rate of penetration of skin by nerve agents.[15]

Terrain and vegetation have impact on agent dispersal and effectiveness. Hills and mountains affect wind direction and speed. Proximity of land to large bodies of water results in changes in wind speed and direction depending upon time of day due to differential surface heating by solar radiation.[16] Vegetation may break up a cloud and prevent contaminants such as liquids from reaching the ground. The leaves will serve as a source of potential contamination and the agent that does get to the ground or below a canopy of vegetation will persist for a longer period since factors that cause evaporation and dispersal will be minimized.[17]

Other factors moderating effectiveness such as protective environments and induced decreased susceptibility will be discussed in detail later, but natural individual variation in susceptibility exists to both biological and chemical agents. It is well known that among human populations exposed to epidemic diseases, some varying number will be more mildly effected and some may be completely resistant. The toxicity of chemical agents also varies from individual to individual. Physiologic factors will render some people more resistant than others. The effects of an agent will also be influenced by the route of exposure, whether it is oral or percutaneous, the dosage received, and over what period of time. These factors are of such importance that the dose is expressed as the LD50 and ID50 or lethal dose and incapacitating dose effecting 50 percent of a population exposed.[18]

One additional factor that must be considered is that person-to-person spread can occur with biological agents and secondary infectious aerosols can be generated from contaminated surfaces. The clothes or skin of an individual contaminated by either biological or chemical agent can be a danger to friend or foe alike if not properly recognized.

The limitations of speed of action, susceptibility to destruction, potential individual resistance, and even the potential for treatment make biological weapons less effective battlefield weapons than terrorism agents. In order to be effective on the battlefield, an agent would need to be very toxic, fast acting, predictable in its effects, able to survive in the air or water long enough to infect a victim, and not able to be destroyed by usual water treatment or air purification methods. Ideally it should also be highly contagious and not susceptible to common medical treatments, but susceptible to antidotes or prophylactic treatments available to the group that uses it.[19] While ideal agents may not now exist, technological developments in the fields of genetics and biochemistry make such agents a possibility.

Ultimately, it can be seen that some of the characteristics of biological and chemical agents can be either desirable or undesirable depending upon conditions. It is even more frightening to realize that chemical and genetic engineering may enable development of more deadly agents not subject to the same limitations as existing ones. Regardless of the agent, whether now or in the future, use by either nations or terrorists will have both predictable and unpredictable effects. While biological and chemical weapons may represent the poor man's nuclear bomb, they too will have fallout that is difficult or impossible to control.

The Players

National Holders

Recognizing the described risks and benefits of biological and chemical weapons, there are a number of nations that have active programs for the development and stockpiling of these weapons of mass destruction. While in 1989 the Central Intelligence Agency reported that at least 10 countries were developing biological weapons, as of 1995, 17 countries were suspected of possessing biological weapons. These included Iran, Iraq, Libya, Syria, North Korea, Taiwan, Israel, Egypt, Vietnam, Laos, Cuba, Bulgaria, India, South Korea, South Africa, China, and Russia.[20] By 1996 the number of nations capable of biological weapons development was as high as 100 with more than 20 actively pursuing biological weapons programs.[21] Chemical weapons are possessed by even more nations with both biological and chemical weapons posing a threat for any future conflict.

Due to events following the Gulf War, more is thought known about Iraqi biological capabilities than about other potential possessors. Initially the Iraqis denied having any program at all and then, with pressure, admitted to a limited defensive program employing about 10 people at two sites. United Nations inspectors visited nearly 80 facilities, but found only shards of evidence of a program. It was not until March 1995 that hard evidence of large amounts of bacteriological culture medium was found. Shortly thereafter the Iraqis admitted to production of biologic agents though they insisted no weaponization had occurred. Finally, after the defection of General Hassan Kamal, Baghdad was forced to provide a more detailed picture of its program. The results were astounding considering all the effort expended up to that time to search for evidence of a program with only minimal success.[22]

The arsenal that Iraq had prepared prior to the Gulf War had been based upon years of preparation and was extensive. In 1990, 200 R-400 (400 pound) bombs had been filled with biological agents and deployed to two sites. One hundred of these were filled with botulinum toxin and another 50 with anthrax. Twenty-five Al Hussein missiles, Scuds modified to double their range, were fitted with biological warheads and deployed in tunnels and holes along the Tigris River. Some 155 mm artillery shells and 122 mm rockets had been armed with biologic agents, but field-testing had not gone well and these were not deployed. While these systems presented a threat, they were not very good battlefield munitions. Bombs require that aircraft get close enough to drop them, which would have been difficult in an environment of coalition air supremacy, and the available missiles were highly inaccurate. More importantly, since they all required impact for detonation, their effects would have been severely limited. The necessary explosion would have rendered a portion of the agent inactive, the impact would have buried another substantial amount into the ground, and the aerosolized agent would have been limited to a small area around the impact zone. The particle size of the aerosol would be variable and likely sub-optimal for significant infectivity. More concerning were the modern Italian-made pesticide dispersal systems possessed by the Iraqis having sprayer nozzles generating aerosols of the optimal size for biological warfare. Some sprayers and tanks were fitted on aircraft while others were on land vehicles. In 1990, the Iraqis had modified a MIG-21 fighter to be remotely piloted and fitted it with a belly tank and sprayer mechanism. While Iraq claims to have destroyed all of these munitions and agents, inspectors have only seen some of the evidence, particularly relating to the R-400 bombs. The fate of the other agents is unproven and Iraq has always been less than forthcoming with details of its program.[23] Even though Iraq initially admitted to producing 650 liters of anthrax, the amount is more likely 8,400 liters.[24] Even if destruction of these weapons is proven, reconstitution of a credible threat could be rapid in the absence of continued monitoring.

This is but one of the obvious examples of an active biological warfare program that has been exposed to the light of day. It demonstrates the extreme difficulty in proving the presence of a program and its extent once discovered if the government is intent upon concealment. Other countries are equally capable of such an extensive program and their progress in development of weapons and available stockpiles remain unknown.

At the time of the Gulf War it was also known that Iraq possessed an extensive chemical weapons stockpile. The exact extent of the arsenal may never be known, but even after nearly seven years of inspections over 31,000 chemical munitions have yet to be accounted for and it is believed that Iraq possesses enough precursor to still produce 200 tons of VX nerve gas.[25] It has also been recently noted that Iraq may have a stock of a nerve agent known as Agent 15, which is designed to cause dizziness, disorientation, hallucinations, and loss of coordination.[26]

Much has been made of the Iraqi chemical stockpile, but the former Soviet Union had 40,000 tons of chemical agents and the United States had 30,000 tons as late as the early 1990s.[27] Destruction of stockpiles has begun, but is far from completed and many other countries possess agents that have yet to be addressed. Despite this, the outlook is encouraging with regard to chemical weapons based upon the number of countries that have signed the Chemical Weapons Convention. To date, 160 countries have signed, with only 30 remaining to sign. Of those that have yet to sign, however, the absence of such nations as Iraq, Libya, North Korea, Sudan, Somalia, Syria, Taiwan, and Egypt are notable given the regions in which they are located and their suspected capabilities.[28]

The potential for the use of chemical weapons by most nations is diminishing, but the risk remains. The number of nations possessing biological weapons is increasing and with it the very real threat that these weapons will someday be used.

Terrorists

In many respects the dangers posed by biological and chemical agents in the hands of terrorists is even more concerning. While nations using these weapons may be held accountable for their actions, use by terrorists often results in no defined target against which retaliation may be made. Terrorists may also be used by national governments in order to give these governments plausible deniability in the event of repercussions. While use against prepared military troops and installations will result in casualties and may even be felt justified in the name of warfare, attacks against unprepared civilian populations would likely result in a far greater number of casualties and larger "terror" impact. While some terrorists may be deterred from use of biological and chemical agents by moral repugnance or fear of loss of funding and popular support, history has shown that this is not always the case. Both biological and chemical agents have been used and will likely be used again in the future.

The previously noted use of nerve gas by Aum Shinrikyo and nearly successful acquisition of the plague bacillus by a white supremacist are but two of a long list of terrorist uses and planned uses of biological and chemical agents. Following the nerve gas attack in the Tokyo subway by Aum in March 1995, two cyanide gas bombs were found at subway stations in Tokyo in July 1995. One was found before detonation and the other malfunctioned releasing only a small amount of gas with no injuries reported. These were also thought attributable to fugitive Aum Shinrikyo members, but some copycats may have been active in three other smaller incidents in Tokyo and two in Yokohama.[29] Aum Shinrikyo was also engaged in the development of agents for biological warfare. The cult had allegedly launched three unsuccessful attacks in Japan using anthrax bacillus and botulinum toxin. During 1992, they are reported to have sent personnel to Zaire during an outbreak of the deadly Ebola virus in an effort to secure it for weapons development.[30]

While the sophistication of the Aum Shinrikyo cult may be unusual, it has not been the only group to prepare to employ biological agents. In 1972, a group in the United States known as the Order of the Rising Sun was found to possess 40 kilograms of typhoid bacteria cultures and the German terrorist group, the Baader-Meinhof gang, in 1980, had a *Clostridium botulinum* culture in a home laboratory.[31] In September and October 1984, there was an outbreak of salmonellosis affecting at least 751 people in The Dalles, Oregon. Investigation revealed that the salad bars at 10 restaurants had been intentionally contaminated with *Salmonella* by the cult followers of Bhagwan Shree Rajneesh. They were apparently concerned that construction of their new international headquarters might be prevented by local elections.[32]

Though the described incidents and attempts at use of biological and chemical agents by terrorists may seem extensive, a 1992 study sponsored by the US Office of Technology Assessment that still appears valid indicated that the preparation of biological and chemical agents by terrorists has been rare.[33] Perhaps this is due to the moral or other disadvantages noted previously. It is by no means certain that these self-limitations will persist if terrorists find that methods that they currently employ to achieve their aims are no longer effective.

Notes

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Chapter 4

Force Protection

> *On a January afternoon at an 82nd Airborne forward camp in Saudi Arabia, sirens shattered the desert calm, warning of incoming Iraqi artillery rounds. Fearing nerve gas, the elite American troops quickly suited up in protective gear. Later when the all-clear sounded, the lowest-ranking soldier in the camp was selected to remove his M-17 gas mask first, while the ranks watched anxiously for signs of twitching or drooling, symptoms of initial chemical exposure.*
>
> —Ben Sherwood
> *New Republic*

This sounds like some bad joke and yet it is a description of the situation during the Gulf War in 1991. This human canary type of approach betrays not only the lack of preparedness of the troops, but the inadequacy of detection capabilities. Understanding the past use of biological and chemical warfare, the strengths and weaknesses of the agents, and the threats for future use enable better preparation to meet and overcome the threats that these weapons present to our fielded forces in conflict, our military in garrison, and our civilian population. Realistically whatever measures taken can only diminish, not eliminate, the threat, but more effective preparation leads to improved assurance of survival. Additionally, the better a force or population is prepared to weather an attack and remain effective the less the incentive to carry out such an attack.

Ideally, the best defense against biological and chemical weapons is to prevent their development. Short of this is the prevention of use of weapons already created. Earlier chapters have addressed these within the scope of this paper. Failing prevention, efforts must be made to provide the most effective protection possible. Levels of protection available include destruction of weapons prior to their use, interdiction of incoming delivery systems, detection and early warning, efforts to neutralize the agents before unit exposure occurs, group protection, individual protection, and treatment for exposure.

The purpose of this paper is not to detail all the various developments in force protection, but as part of medical preparedness it is important to be aware of some of these and a few future possibilities. Interdiction, such as theater missile defense will not be addressed. It applies equally whether incoming missiles or aircraft contain biological/chemical weapons or conventional munitions though the implications for the post-destruction components differ and fall under detection consideration below.

Early Detection and Protection

Initial protection of a unit or facility begins with the ability to detect an incoming attack prior to potential contamination of personnel or physical assets. Early warning and detection of an attack provide valuable time to take protective actions. Personal protective gear can be donned, personnel can be moved into hardened facilities and sealed from contamination, some mobile assets may be removed prior to contamination of the area, adjacent units may be notified, and incoming vehicles or aircraft prevented from entering the contaminated area. An active defense would also be possible if an Unmanned Aerial Vehicle could deliver a counter-cloud of disinfectant or neutralizing agent. If the early warning system is capable of identifying the specific agent used, medical personnel can be prepared to immediately treat anyone unable to escape contamination.

Such early warning devices are being developed with some models now actually being deployed, but the majority of systems available currently are detection and identification systems that provide notification that a biological attack has contaminated an area and the agent responsible rather than warning of an attack in progress. The Biological Integrated Detection System (BIDS) is a manned, sheltered, biological detection laboratory mounted on a High Mobility Multipurpose Wheeled Vehicle (Humvee). The system has seven sampling and detection devices, with additional navigational devices, weather sensors, and communication equipment. The crew of two can sample air and in 30 to 45 minutes presumptively identify a biologic agent and warn personnel.[1] A method is used whereby the samples are exposed to antibodies against known biological agents with reaction indicating presence of the agent.[2] The system was first fielded in 1996 with 38 now deployed and a total planned fielding of 124 units. It is capable of identifying four biological warfare agents, but this can be expanded to eight by the addition of the P3I Eye-Safe Rapid Prototype System. The Navy has a similar Integrated Biological Agent Detector (IBAD) System that can identify five agents.[3]

The next level of identification available is the Long-Range Biological Standoff Detection System (LR-BSDS) which provides detection of manmade particulate clouds with a ranging and tracking capability of 30 km and 50 km respectively. It is capable of cloud detection only and cannot discriminate the nature of the cloud.[4] This is a laser-based system and has been mounted on UH-60 Blackhawk helicopters to improve capabilities as an early warning system.[5]

A system in the process of being deployed further advances this early warning capability. In August 1998, the Portal Shield system is scheduled to be deployed to one base in South Korea and two in the Mideast. This system integrates a network of fixed or mobile sensors to count “aerodynamic particles” in the respirable size range. When the quantity goes above background, a large sample of air is drawn in, exposed to a thin wall of water, and the resulting contaminated water sample collected. If the sample is deemed worrisome, an immunoassay is done on the fluid using a laser to detect changes in color. It can detect eight different agents, but the types are classified. This identification along with wind speed and direction is communicated to commanders for decision making. Currently it detects only biological agents, but will soon have chemical detection capability as well. It is a major step in automation and networking of sensors to provide around-the-clock coverage.[6]

The next step, at the beginning of the century, will be the Joint Biological Detection System that will be able to detect and identify all common biological agents in less than 15 minutes. A total of 771 units will be fielded to all services.[7]

Meanwhile, chemical detection sensors are being developed with some models having been deployed in Korea. The chemical sensor system based on the concept of Surface Acoustic Wave (SAW) technology can detect and identify toxic organic vapors with the ability to distinguish between blister agents and individual nerve agents at trace levels. The system responds rapidly, reproducibly, and reversibly to organic vapors based upon interactions of the vapors with absorbent coatings.[8]

Taking this one step further, as early as 1995, a Pioneer Unmanned Aerial Vehicle was equipped with a Surface Acoustic Wave sensor and flew through clouds of simulant chemical agents successfully detecting the presence of the agent and down-linking the information to a ground control center. This was also done in September 1996 with a

Fiber Optic Biosensor capable of analyzing four different biological agents simultaneously in 5 to 10 minutes. This test was also successful. Future plans call for having sensors for both biological and chemical agents on small, cheap, and essentially disposable planes that could fly close to the ground where they might be subject to risk from the enemy and when contaminated could be destroyed rather than decontaminated.[9]

Great concentration has been focused on these systems, because time means lives. Early detection means time to prepare, time to avoid, and possibly someday time to counter.

Group Protection

The next level of protection is that available to protect groups of personnel from exposure. A number of systems exist, but focus is directed to systems that will be available for use by deployed medical teams. Fixed base facilities are also subject to biological or chemical attack and can potentially be designed to have windows that are sealed to prevent agent access and positive pressure to exclude agent entry when doors are opened. Other steps that may be taken include exterior air collection openings that are located on rooftops or other locations making it more difficult for a terrorist to introduce agents into the ventilation system and development of filters or disinfectant air scrubbers to preclude agent entry particularly in higher risk locations.

Deployed personnel face a more difficult challenge in a higher risk environment. There is currently available the trailer-mounted M51 Chemically Protected Shelter, but this will be replaced by the Chemically and Biologically Protected Shelter (CBPS). It has been specifically designed as a contamination-free environment for use as a Battalion Aid Station, but usage such as for an Air Transportable Clinic might be considered.

Consisting of a dedicated Heavy High Mobility Multipurpose Wheeled Vehicle Variant no wider than a standard Humvee fitted with a lightweight shelter on the back, an air beam supported soft shelter with 300 square feet of space, and a trailer with a generator for auxiliary power. The soft shelter rolls up for transport and the entire unit can be operational in 20 minutes with four personnel. If necessary, it can be moved multiple times daily.[10]

On a larger scale the Chemically Protected Deployable Medical System (CP DEPMEDS) is the world's largest chemically protected field hospital. It has 100,000 square feet of treatment space designed to house 300 patients and 140 staff members free from contamination for 72 hours.

New systems continue to be developed to improve both the level of protection and its duration. These shelters provide a safe environment for both patients and staff and, equally important, alleviate the need to wear chemically protective gear that severely impedes the ability to practice quality health care.

Individual Protection

Lacking group protection, personal protection becomes essential. Individual protection takes several forms including immunization, prophylactic/pretreatment agents, topical protectants, and personal protective gear. To these physical measures must be added education and training as critical to individual protection. More will be written about ongoing personal and medical training later, but it must be noted that individual protection actually begins far earlier than a situation during which exposure to biological or chemical agents might occur. Preparation actually needs to begin in basic training. Personnel unable to tolerate the wearing of protective equipment, particularly protective masks, for significant periods of time despite training must be considered unfit for military service. While their risk for exposure during a tour of duty is small, this incapacity could jeopardize their lives and those of others if circumstances necessitated protection.

Barrier Protectants

In the environment in which exposure to biological or chemical agents are threats, the first line of personal defense is physical protection. While intact skin is protective against virtually all biological agents, it is very poor protection against chemicals. Both biological and chemical agents may enter through an unprotected airway or through mucous membranes of the eyes, nose, and mouth. These vulnerabilities are overcome by use of protective clothing designed to resist both types of agents.

Protective masks of various designs are available and offer significant protection. They may be cumbersome, stifling in hot, humid climates, and can induce claustrophobic reactions in some people. They are also visually limiting and impair communication. External garments such as the Battle Dress Overgarment offer protection against both biological and chemical agents, including toxins. It provides chemical protection for 22 days, but should be replaced within 24 hours of known contamination by chemical agents.[11] These garments can be extremely uncomfortable, particularly in warm climates, resulting in limitations in the ability to perform duties and occasionally result in heat injuries. Additionally, when the heavy gloves are worn, the loss of manual dexterity limits function and severely hampers many medical procedures requiring fine dexterity. Several new garments are being developed including the Lightweight Chemical/Biological Protective Garment which is designed to reduce the physiological heat burden by at least 20 percent and weigh no more than four pounds. It offers seven days of field wear with six hours of protection against known exposure and can be laundered. An additional possibility for the air base environment is the Duty Uniform Ground Crew Ensemble. It provides protection from the neck down while being light and thus reducing heat stress. It is launderable as well.[12]

In addition to these barriers, testing is being conducted on topical skin protectants that would be effective against vesicant (blister) agents and nerve agents. While not substituting for protective clothing, these topical treatments promising even greater protection should exposure occur.[13]

Biologic Protectants

Though among the last line of defenses, the first defense achieved temporally is through individual immunity. Immunization begins in basic training with initial or booster immunizations for standard population diseases. One of the main avenues for protection from future exposure to biological warfare agents is through immunization of personnel. It is very difficult for an enemy to circumvent vaccine-induced immunization. Essentially this requires both finding and selectively culturing or genetically engineering a strain of a given biological agent that shares too few of the same characteristics as the natural form to be recognized by the body's immune system. This may be possible in very sophisticated laboratory facilities, but is not in the immediate realm of many small national programs or any likely terrorist programs.

Vaccines currently exist for anthrax, plague, botulism, Eastern Equine Encephalitis Virus, Q fever, tularemia, vaccinia, Venezuelan Equine Encephalitis Virus, and Western Equine Encephalitis Virus.[14] It must be noted, however, that all are investigational except for the anthrax and plague vaccines, which are licensed.[15] Current plans call for near-term (Fiscal 97-99) anthrax vaccine relicensure. Over the mid-term period (Fiscal 00-04), it is planned to have licensed vaccines for Q fever, tularemia, vaccinia, and botulinum A/B/E/F. Plans for the distant future (Fiscal 05-11), call for licensed vaccines for botulinum C/D/G monovalents (and a tetravalent form), ricin, Staphylococcal Enterotoxin B, Venezuelan Equine Encephalomyelitis, Western Equine Encephalomyelitis, Eastern Equine Encephalomyelitis, and brucellosis in addition to new anthrax and plague vaccines.[16] While it may not be cost effective to administer all vaccines when a recruit enters the service, it must be noted that immunization takes weeks to months to become effective and, in the case of some vaccines, require multiple doses over several months to attain adequate immunity. Immunity will last for many years, but it will not be attainable if personnel are given vaccines just prior to deployment.

In the immediate predeployment and deployment period, personnel will be given pyridostigmine to take orally as a pretreatment for nerve agents. Pretreatments do not exist for other chemical agents, but efforts are being made to develop enzymatic agents for use against nerve agents and pretreatments against cyanide, vesicant agents, and respiratory agents.[17]

Treatment

Medical personnel and necessary treatment of casualties represent the last line of defense against biological and chemical agents. Indeed, the activation of this line of personnel defense represents the ultimate failure of other preferred modalities. The scope of medical therapy is a subject for a separate paper, but it is important to note some general principles and developments in medical therapy for biological and chemical casualties.

As with any significant injury, time is a critical factor in the recognition of the nature of the injury and the initiation of therapy. Initial treatment may follow the recognition by an individual that he or she has possibly been exposed to nerve agent. Self- or buddy-administration of nerve agent antidote using the Mark I autoinjector is indicated. It is also essential that the kit is attached to the victim or that he or she is marked for identification to medical personnel. This is the current standard of immediate therapy all personnel are taught to use. A new multichambered autoinjector has been developed and is pending Food and Drug Administration approval prior to fielding. This will improve the speed of delivery of antidotes against nerve agents.[18]

For cutaneous exposure to chemical agents, decontamination kits are available to clean affected areas. This depends upon recognition of exposure. A future improvement already noted involves topical skin protectants that are now undergoing testing to protect against vesicant and nerve agents. These protectants may make treatment less necessary or more effective if skin contact can be minimized.

It must always be kept in mind and repeatedly taught that suspicion of contamination must be identified in the field and, after immediate life-saving care is administered, decontamination completed before an individual enters the health care system. Recognition is more common with chemical agents, but is also key with biological agents. Transmission of undetected or inadequately removed contaminates into the health care facility can compromise medical personnel and other patients and cripple care delivery.

Once at the health care facility, more definitive therapy can begin. Therapy varies by exposure type with chemical agent exposure more quickly recognized and treated accordingly. The Appendix includes some reference sources that will prove useful on aspects of medical therapy. Except in the case of toxins, exposure to biological agents generally carries with it a delay in the onset of symptoms, but it is equally critical to begin therapy quickly and to identify the causative agent where possible. Antibiotic therapy must begin immediately and will vary according to the infecting agent, but will not be effective against toxins or viruses. Antitoxin is available for botulinum exposure and antiserum exists for some of the viral hemorrhagic fevers, but only supportive therapy is available for the viral encephalitides. Antiviral medications may also be effective against hemorrhagic fevers and smallpox.[19]

While current therapies are limited to little more than antibiotic therapy for many of the biological warfare agents, active research is being funded by the Defense Advanced Research Projects Agency (DARPA) to develop new modalities to attack biological agents of novel or unknown type after exposure has occurred. Researchers at Stanford University have found that gram-negative organisms use similar virulence factor transport mechanisms to overwhelm host defenses. Interference with this mechanism may offer a degree of broad-spectrum protection. At Harvard, researchers are seeking ways to incite broad antiviral defenses immediately after exposure to a virus. A University of Virginia scientist is demonstrating in animal models that antibodies bound by polymers to red cells can "sweep" the blood of pathogens offering a potential for passive immunization or therapy for acute infections.[20] These are but a few of the efforts at revolutionary approaches that are being explored.

While each of these areas of research has tremendous potential application in treatment of biological warfare casualties their application to general medicine is also obvious. Though vaccination offers the best defense against biological agents, the possible deployment of additional native or genetically engineered agents exists. Research directed at boosting immune responses and nonspecific targeting of infectious agents would be instrumental in overcoming any biological attack even with new organisms not existing in nature. Such capability would go far in protecting forces in the uncertain world of the future.

Force protection must exist at all of these described levels simultaneously. Each of these defenses has the potential to be circumvented or of failing, but taken as a force protection package, the degree of protection is very high. This kind of defensive wall will prove formidable to any opponent and may provide the deterrent needed. The last, and probably most important, element of this deterrence tour de force relies on the readiness of personnel as developed through education and training. All the best equipment will do little good if it is not used effectively and medical treatment will be unsuccessful in unskilled hands.

Notes

[1] Sgt. Terry J. Goodman, "Biological Integrated Detection System Bunker and Unit," *Chemical and Biological Defense Information Analysis Center Newsletter* 3, no. 1 (Winter 1997): 1.

[2] Leonard A. Cole, "The Specter of Biological Weapons," *Scientific American* 275, no. 6 (December 1996): 63.

[3] BG John C. Doesburg, "Biological Defense And Force Protection," Briefing handout, Joint Program Office for Biological Defense, January 1998.

[4] Ibid.

[5] John Donnelly, "Bases In Korea And Mideast To Get Bio-Warning Networks," *Defense Week*, 26 January 1998, 1.

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[6] Ibid.

[7] Doesburg.

[8] Dr. Mildred Donlon, "Smart Sensor Systems to Successfully Counter CBW Proliferation," *Chemical and Biological Defense Information Analysis Center Newsletter* 2, no. 4 (Fall 1996): 1.

[9] Ibid., 3.

[10] Handout, US Army Soldier Systems Command, distributed at the Association of Military Surgeons of the United States 104th Annual Meeting, Nashville, Tennessee, 16-21 November 1997.

[11]Department of Defense, *United States Department of Defense Nuclear/Biological/Chemical Defense Annual Report to Congress 1997*, B-6; on-line, Internet, 7 January 1998, available from http://www.acq.osd.mil/cp/nbc97.htm.

[12] Ibid., B-13-B-15.

[13] Ibid., D-11.

[14] Ibid., D-13.

[15] Col David R. Franz et al., "Clinical Recognition and Management of Patients Exposed to Biological Warfare Agents," *JAMA: The Journal of the American Medical Association* 278, no. 5 (6 August 1997): 400-401.

[16] Department of Defense, 3-15.

[17] Ibid., 3-8.

[18] Ibid., D-11.

[19] Franz, 400-401.

[20] Joan Stephenson, "Pentagon-Funded Research Takes Aim at Agents of Biological Warfare," *JAMA: The Journal of the American Medical Association* 278, no. 5 (6 August 1997): 373-374.

Chapter 5

Medical Readiness

> *I believe the proliferation of weapons of mass destruction presents the greatest threat that the world has ever known. We are finding more and more countries who are acquiring technology—not only missile technology—and are developing chemical weapons and biological weapons capabilities to be used in theater and also on a long-range basis. So I think that is perhaps the greatest threat that any of us will face in the coming years*
>
> —William S. Cohen
> US Secretary of Defense

While Secretary Cohen specifically noted missile technology in his statement on proliferation of weapons of mass destruction, it has been noted earlier that biological and chemical weapons do not require missiles to be long-range weapons. A weapon can be as simple as a flask of botulinum toxin carried aboard a kayak to the unguarded marina at Keesler Air Force Base and put in the base water supply. It could also be a backpack with sarin delivered by boat to Eglin Air Force Base and left in the base exchange, or a small remotely controlled plane spraying anthrax over the training field at Lackland Air Force Base. These are all unlikely examples, but they are no longer as unthinkable as they once might have been. The more likely scenario is the deployed Air Force wing that has a small plane fly by with a sprayer or the air base in Saudi Arabia whose Saudi food handlers have been infiltrated by someone interested in contaminating the evening meal. A determined attacker will find a way to carry out an attack, but no matter what the scenario, the more difficult the attack the less likely it is to occur, and the more prepared the recipients the lower the damage will be.

Readiness Assessment

Preparedness is a combination of both equipment and training. The 1996 General Accounting Office report addressing the issue of biological and chemical defense targeted Army medical units for evaluation. In testimony before the Committee on National Security, Subcommittee on Military Research and Development of the House of Representatives, in March 1996, Mark E. Gebicke, Director, Military Operations and Capabilities Issues, noted that units had only 50 to 60 percent of their authorized patient treatment and decontamination kits. Collective shelters were deficient and few physicians had received formal training on treatment of biological and chemical patients beyond that of the Basic Medical Officer course. It was indicated that, while medical advanced and chemical and biological casualty management courses existed, in 1995, 47 to 81 percent of Army physicians assigned to early deploying units had not attended the advanced course and 70 to 97 percent had not attended the chemical and biological casualty course. At the time of the Gulf War, the casualty course had been taught emergently to already deployed units.[1] In this situation with Army units, both equipment and training were noted deficient.

The Air Force has had similar evaluations performed. In 1996, the Department of Defense evaluated a number of scenarios including a surprise attack by terrorists on an air base supporting United States military activities in a foreign country. It was noted that agent detectors could be used to “direct appropriate and timely medical treatment” and that better collective protection would reduce casualties among personnel indoors.[2] The

Air Force also conducted a comprehensive study on the effects of biological and chemical warfare on air base operations involving attacks on forward bases. The study pointed out needed improvements in individual and collective protection, training standards, automated detectors, base-level contamination assessment models, and education of senior leaders on operations in contaminated environments. It was also identified that more research, more realistic field exercises, and new policies for sustaining operations were needed. As a result, there was creation of the "Air Force NBC Ability-to-Survive-and-Operate" Integrated Process Team addressing passive defense working in concert with an overall "Air Force Counterproliferation" Integrated Process Team.[3]

New effort is being applied by the Air Force to improvements in preparedness at multiple levels in recognition of gaps in passive defense against the threat presented by biological and chemical weapons. At this point, efforts are being focused at protection of personnel and facilities at forward operating bases. This is in keeping with Air Force policy, but current policy may not be adequate to address threats that may exist at all other installations.

Current Training Requirements

The Secretary of Defense has appointed the Army as the Executive Agent for the Department of Defense to coordinate and integrate research, development, testing, evaluation, acquisition, and military construction for the military nuclear, biological, and chemical defense program.[4] The individual services have the responsibility to establish standards for proficiency and currency for training of members.[5]

Air Force standards for preparedness training are contained in Air Force Instruction 32-4001, Disaster Preparedness Planning and Operations. Currently, training of Air Force personnel in preparation for operations in an environment contaminated by biological or chemical agents focuses on those units and individuals either in threat areas or deployable to them. Overall capabilities are maintained "at the lowest level needed to protect lives and critical mission assets during wartime.[6] Within 90 days of assignment to mobility positions or within 30 days of arrival to a threat area, personnel undergo six hours of Nuclear, Biological, Chemical (NBC) Defense training. This includes initial equipment and procedures training including in-mask confidence and contamination control area training. While remaining in mobility positions, individuals are required to have an annual show of competency. Unit level training is conducted on wartime mission critical tasks while wearing the full complement of protective equipment. Additionally, exercises reinforce training for mission tasks in protective gear. Units must conduct attack response exercises annually if in chemical-biological nonthreat areas and twice yearly at installations located in threat areas.[7]

Additional specific medical guidelines are found in Air Force Instruction 41-106, Medical Readiness Planning and Training. All enlisted medical personnel are required to have the Basic Medical Readiness Course and officers must have the Medical Readiness Indoctrination Course. Personnel assigned to activities which are responsible for Status of Resources and Training System (SORTS) reporting are required to have annual training. Non-SORTS organizations and selected individuals in training including interns, residents, and fellows are exempted from this annual Continuing Medical Readiness Training (CMRT) except as required by their Major Command. CMRT core topic lesson plans are available from a central source at Sheppard Air Force Base and include nuclear, biological, and chemical defense training components. Those units that are to deploy to contingency hospitals are to conduct exercises under conditions that simulate those at their contingency hospitals, and centers involved in the National Disaster Medical System are to exercise with local civilian agencies annually.[8]

Assessments of preparedness and training for nuclear, biological, and chemical warfare are performed as an integral part of Operational Readiness Inspections.[9] Realism is attempted using simulators of dispersal and the wearing of full protective equipment, but the simulations do not necessarily extend beyond decontamination and transport to the medical facility.

Air Force Health Services Inspections also assess aspects of preparedness for the biological and chemical environment. In addition to verifying the frequency, coordination, and realism of exercises, inspectors assess the "adequacy" of training including chemical/biological warfare defense training. Inspected units are required to discuss how deploying personnel receive immunizations, and are trained to use protective equipment and medications. Inspectors also assess the mechanisms for distribution of and education in the appropriate use of biological and chemical warfare agent antidotes.[10]

Despite these efforts, assessment is hampered by the lack of Air Force Medical Service doctrine particularly in the realm of addressing biological casualties. Doctrine for the aeromedical evacuation of biological warfare casualties is also nonexistent. The current standard is that patients are not moved through the system if they have been infected, but there really is no reason why this cannot be done safely and quickly. Once external contamination has been removed, standard precautions against known infectious diseases would prove effective. This absence of doctrine is currently being addressed at the level of the Office of the Surgeon General of the Air Force.[11]

Current Training Issues

As previously noted, biological and chemical warfare training really must begin during Basic Military Training. It is here that those who will be unable to wear and function in the appropriate protective clothing, despite efforts at training and building of confidence, should be identified and disqualified from service. Some individuals will become severely claustrophobic in the mask even when worn for short periods. In the operational environment this is a potentially fatal weakness.

The wearing of chemical protective clothing is difficult even for the experienced individual. A recent study indicated that the wearing of the chemical-biological protective mask alone reduced maximal voluntary ventilation by 20 percent.[12] For some individuals, this alone may be enough to cause some anxiety that would be further compounded by the wearing of additional restrictive clothing and equipment. In the case of medical responders to incidents, the wear of protective clothing and masks will make the care of patients more difficult and increase the risk of heat injuries, fatigue, and isolation stress of medical personnel.[13] In the environment contaminated by biological or chemical agents it is not possible for the person who feels confined to partially open his or her mask as many have been known to do in training circumstances and exercises.

Beyond the limitations imposed by the need to wear protective clothing, the actual functioning of personnel in an environment of actual, suspected, or anticipated use of biological and chemical agents is further complicated by the psychological reactions of the caregivers themselves. It has been noted that it is one of the terrorist's goals "to provoke intense emotions that interfere with the capacity of caregivers to react in a thoughtful, organized fashion."[14] Caregivers are not automatically immune to the deep, and potentially paralyzing, fear that accompanies the thought of possibly being infected with a horrible disease. Media stories on television or in print about the terrible deaths that occur secondary to infection with biological warfare agents and the aftermath of chemical attacks on Iraqi citizens have brought these fears into homes across America. In the event of indication of an actual attack, it is expected that both exposed and unexposed individuals will develop acute physiologic arousal. This can be manifest as muscle tension, rapid heartbeat, rapid breathing, sweating, tremor, and a sense of foreboding.[15] It would be naïve to think that, without adequate education and training, medical personnel would remain unaffected by these normal reactions. While medical personnel will usually continue to function despite these fears, their effectiveness may be decreased just when the expectations of them may be the highest.

One functions most effectively in an environment in which he or she has become comfortable and in which one feels competent as to knowledge and skill. This comfort is one way in which the psychological reaction to the environment may be somewhat mitigated. First responders will be able to function best if they have repetitively practiced initial response and triage, as opposed to merely having annual training. Emergency Services personnel will have less fear if they are doing what they have done many times and physicians will care for patients more rapidly and effectively if familiar with the appropriate treatments needed. These capabilities are the result of repetitive, realistic exercises and training not provided by the current mandated standard for annual, or even semi-annual, training.[16] This is an issue that must be addressed by future training guidelines.

Military/Civilian Interaction

Though this paper is focused on the readiness of the Air Force Medical System to meet the biological and chemical threat, something must be said about the need to be prepared to support the civilian communities in which Air Force installations are located. The Air Force is not required to respond directly in the case of a civilian event and may not do so without either a request or some prior agreement. In reality, if a biological or chemical event does occur, a national defense area is likely to be established and military resources mobilized in support. In the case of those Air Force medical centers that are participants in the National Disaster Medical System, involvement will be automatic, but it is also likely for other Air Force medical facilities to be called upon for their expected expertise.

The threat to civilian population centers is real. Army Lieutenant General Patrick Hughes, the director of the Defense Intelligence Agency has noted that biological and chemical weapons pose a constant threat to Americans both in and out of uniform.[17] The realization that long-range biological or chemical attack, whether by nations or terrorists, can now be delivered to a highly vulnerable civilian population of the United States has generated a call for increased preparedness. Not only is the threat to human life, but the estimated monetary cost is staggering. The economic impact of a terrorist attack using biological agents has been estimated as ranging from $477.7 million per 100,000 persons exposed in the case of brucellosis to $26.2 billion per 100,000 exposed in an anthrax scenario. Even these are considered low estimates.[18] Some cities have taken this threat very seriously. New York City, with the vivid memory of the World Trade Center bombing in 1993, engaged in an exercise in November 1997 involving 600 police, fire fighters, and agents from the Federal Bureau of Investigation. The scenario was a mock attack by terrorists using VX nerve gas. The effort was impressive, but, despite millions of dollars spent since the World Trade Center bombing, the city remains unprepared.[19]

The Department of Defense has a vital role in preparing cities to better prepare for the threat of biological or chemical attack. In fiscal 1997, Congress directed the Department of Defense to present a plan for assistance in equipping, training, and providing other needed assistance for civilian first responders to biological/chemical incidents. The resulting report to Congress in May 1997 outlined a plan whereby training support would be provided initially to 27 cities and then spread throughout the nation.[20] Eventually training will be provided to 120 cities over the next several years.[21]

While plans call for local authorities to be prepared to act as first responders, the US Marine Chemical/Biological Incident Response Force (CBIRF) will deploy to an affected area. This will require 18 hours from notification of an incident and, in the meantime, local resources will be required to deal with the event.[22] While National Guard forces are being prepared to assist in this task, it is easy to imagine that a nearby Air Force facility could be called upon to provide support. All units should be prepared should such a call come.

Air Force medical personnel will almost certainly find themselves called upon to operate either in a biologically or chemically contaminated environment or to provide care to those who have come from such an environment. This may occur as a deployed Air Force unit, part of a deployed joint unit, in response to an attack on an Air Force facility or in assistance to civilian authorities. The changing threat and the readiness issues addressed above demand new approaches in preparing Air Force Medical Service personnel.

Notes

[1] Statement of Mark E. Gebicke, "Chemical and Biological Defense: Emphasis Remains Insufficient to Resolve Continuing Problems," testimony before the Committee on National Security, Subcommittee on Military Research and Development, House of Representatives (Washington, D.C.: United States General Accounting Office, 12 March 1996), 5-6.

[2] Department of Defense, *Counterproliferation Program Review Committee Annual Report to Congress 1997*, 5-7; on-line, Internet, 7 January 1998, available from http://www.acq.osd.mil/cp/cprc97.htm.

[3] Ibid., 5-7-5-8.

[4] Department of Defense, *United States Department of Defense Nuclear/Biological/Chemical Defense Annual Report to Congress 1997*, Summary; on-line, Internet, 7 January 1998, available from http://www.acq.osd.mil/cp/nbc97.htm.

[5] Ibid., 5-4.

[6] Air Force Instruction (AFI) 32-4001, *Disaster Preparedness Planning and Operations*, August 1997.

[7] Ibid.

[8] Air Force Instruction (AFI) 41-106, *Medical Readiness Planning and Training*, February 1994.

[9] Department of Defense, *Nuclear/Biological/Chemical Defense Annual Report to Congress 1997*, *5-19.*

[10] Air Force Inspection Agency, *Air Force Health Services Inspection Guide*: *Medical Readiness Program Management*, August 1997; on-line, Internet, January 1998, available from http://www-afia.saia.af.mil/sg/sg_restrict/sgm_his_pcol.html.

[11] Lt Col Pete Walsh, Office of the Air Force Surgeon General. Bolling AFB, Washington, DC, interviewed by author, 3 February 1998.

[12] S. R. Muza, L. E. Banderet, and V. A. Forte, "Effects of Chemical Defense Clothing and Individual Equipment on Ventilatory Function and Subjective Reactions," *Aviation, Space, and Environmental Medicine* 67, no. 12 (December 1996): 1190.

[13] Harry C. Holloway et al., "The Threat of Biological Weapons: Prophylaxis and Mitigation of Psychological and Social Consequences" *JAMA: The Journal of the American Medical Association* 278, no. 5 (6 August 1997): 426.

[14] Ibid.

[15] Ibid., 425.

[16] AFI 32-4001.

[17] George C. Wilson, "Facing 'a new dimension' of threats," *Air Force Times* 58, no. 28 (16 February 1998): 31.

Notes

[18] Arnold F. Kaufmann, Martin I. Meltzer, and George P. Schmid, "The Economic Impact of a Bioterrorist Attack: Are Prevention and Postattack Intervention Programs Justifiable?" *Emerging Infectious Diseases* 3, no. 2 (April-June 1997), n.p.; on-line, Internet, 8 January 1998, available from http://www.cdc.gov/ncidod/EID/vol3no2/kaufman.htm.

[19] Bruce W. Nelan, "America the Vulnerable," *Time* 150, no. 22 (24 November 1997): 50.

[20] Department of Defense, *Report to the Congress: Domestic Preparedness Program in the Defense Against Weapons of Mass Destruction*, *1 May 1997*, Executive Summary; on-line, Internet, 17 December 1997, available from http://www.defenselink.mil/pubs/domestic/toc.html.

[21] Ibid., Sec 6.0.

[22] Ibid., 5.2.6.1.2.

Chapter 6

Training for a New Reality

Senator John Glenn, during a hearing of the Senate Select Committee on Intelligence, was noted to have asserted that "biological and chemical weapons confront the United States with a 'new dimension' of threat 'which we really haven't dealt with yet.'"[1] Improvements in doctrine, training, and exercise evaluation provide some of the avenues for dealing with this new reality of threat. Significant advances are being made rapidly, but much remains to be done.

It was noted earlier that there is an absence of medical doctrine particularly addressing biologic warfare and casualty management. This issue is currently being addressed in the Air Force at the level of the Office of the Surgeon General.[2] Since doctrine provides fundamental guidance upon which other activities such as force training and utilization are based, its absence is a significant deficiency. In fairness to those who are preparing Air Force medical doctrine, it must be noted that experience with biological and chemical weapons is extremely limited. Knowledge must be gained through examination of the experience of others and some extrapolation of known factors associated with treating personnel with industrial chemical injury and isolation techniques required for patients infected with the severest of infectious diseases. Initially this doctrine may be Air Force-specific, but it will need to be coordinated to address joint issues since that is how we are likely to function in future scenarios. The Air Force is far from alone in needing to address fundamental issues. In November 1997, Brigadier General Richard Lynch, the commander of the 2d Medical Brigade, noted that the type of triage needed for biological and chemical casualties has not yet been developed.[3] Once these issues have been successfully addressed, training can be performed that is both more meaningful and more realistic.

As noted previously, education and training must be more extensive, frequent, realistic, and universal. Steps have already been taken along this path with the US Army Medical Institute of Infectious Diseases and Army Medical Research Institute of Chemical Defense offering the Medical Management of Biological/Chemical Casualties Course for health care providers through videoteleconferencing in September 1997. This reached nearly 5,000 providers of care. It is planned to offer further conferences, offer a compact disk containing the materials for individual viewing, and, among Air Force physicians, require 12 hours of viewing of these programs, particularly for those in critical areas.[4] Along with this training, it might be useful to develop decision matrixes that can be maintained in Emergency Services areas as both training aides and reminders in the case of needed action.

Training to perform duties in a biological or chemical environment needs to be expanded to include virtually all medical units and all personnel except those who would not become involved in a scenario regardless of where it occurred. If only personnel in mobility positions undergo training, it presupposes that circumstances will not arise in which someone will be substituted into a mobility position shortly before a deployment. The reality is that this occurs frequently and the assigned individual is placed at a distinct disadvantage if adequate training has not been provided prior to deployment. The fact that any individual or unit would be trained only after deployment is reminiscent of Gulf War thinking. It assumes that an enemy will wait until American forces are ready before attacking. It is unlikely that any worthy opponent will make this mistake again. Finally, training only forward-based or deployed units ignores the possibility of terrorist attack on military installations and civilian targets leaving the majority of Air Force installations inadequately prepared for what is becoming a real possibility.

It has been noted that personnel function best in an environment with which they are familiar. This requires that training and exercises occur more frequently than on an annual basis. Exercises or training should be at least twice a year, and based upon assessment of results, may be needed quarterly. When exercises are conducted, they should be as realistic as possible and should last for a realistic period of time reflecting operational expectations. The exercise should include the actual triage and care of casualties not merely stopping at the Emergency Room doors or tent entrances. Where possible, chemical and biological simulants should be used. A light, nontoxic oil application or a dye visible under black light can be used as an agent. This will not only test the success of decontamination efforts, but, if all contamination has not been successfully removed, can serve as a reminder to those who receive casualties that they too must be prepared for contamination that could enter the health care facility and potentially contaminate others. Also, the actual functioning in the "real" environment of an attack will not only reveal training deficiencies, it will also identify equipment shortfalls that exist and may even stimulate ideas as to how to do things more effectively.

While it may not be a popular idea, assessment of the level of education and, where possible, training should be a routine part of readiness and Health Services Inspections. As noted previously, the fact that training is done is evaluated and some assessment may be done as to how training has been performed, but the results of training are less readily known. Education may have been a series of lectures with little material remembered. A unit may have sent around a booklet discussing treatment for biological and chemical casualties with an open book quiz. These are efforts at education, but their effectiveness is questionable. Much as pilots are quizzed during Nuclear Surety Inspections and hospital personnel are quizzed about fire safety issues during Joint Commission on Accreditation of Healthcare Organizations inspection, personnel should be asked relevant basic questions about the care of biological and chemical casualties during readiness inspections. This not only assesses knowledge, but is a stimulant to review and perhaps retain some greater degree of knowledge than might be maintained otherwise.

While it is evident that it is not possible to be totally prepared to meet the threat of biological and chemical warfare, these are all steps that can be taken to be better prepared. This will enable leaders to have a more realistic expectation that our personnel will be able to both survive and function effectively should the need arise. These measures are not without cost in both time and money, but are relatively inexpensive with adequate planning. Education programs can readily use videotapes and self-taught programs. Exercises are already conducted with simulated trauma patients. Further elements may be added with maximal effect and minimal additional planning. Assessment guidelines may be added to inspections and education programs geared accordingly to prepare personnel. As noted, these do have a cost, but, if the threat is real, and many have said it is, our priorities must include provision for these costs and adjustment made accordingly if we are to be truly prepared.

Notes

[1] George C. Wilson, “Facing ‘a new dimension’ of threats,” *Air Force Times* 58, no. 28 (16 February 1998): 30.

[2] Lt Col Pete Walsh, Office of the Air Force Surgeon General. Bolling AFB, Washington, DC, interviewed by author, 3 February 1998.

[3] Brig Gen Richard Lynch, “Is the AMEDD Ready for Chemical and Biological Warfare?” lecture at the Association of Military Surgeons of the United States 104th Annual Meeting, Nashville, Tennessee, 17 November 1997.

[4] Walsh.

Chapter 7

Conclusion

Tomorrow's war will be different. It may be fought on the battlefields of the Middle East or it may be fought in the heartland of America. Those who oppose the United States, whether they are internal or external enemies, have been observing the strengths of the United States, its people, and its military. Unless the nation's enemies are grossly incompetent, as was Saddam Hussein during the Gulf War, they will not have been preparing to meet the strengths of the United States on the battlefield. They will have sought the perceived weaknesses and will have prepared to strike at these weak points. It is at these gaps in the armor of the United States that greater effort must be expended in preparation for the possible.

Progress has been made, but more needs to be accomplished. As the military of the United States prepared to engage in action against Iraq in February 1998, forces were better prepared to meet the biological and chemical threat. Antibiotic and known antidote stockpiles had been increased. Chemical agent detectors had been improved to decrease false alarms, have greater sensitivity, and provide faster response time. The Portal Shield unit was fielded along with the Biological Integrated Detection System. Along with these available improvements, development of advanced detection devices had progressed, lighter protective suits had been ordered, and contracting for new vaccines had been done. Despite these developments, ground forces remained dependent on much of the same bulky protective clothing as during the Gulf War and biological agent detectors still required as long as 45 minutes or even more.[1]

Training had been provided to more personnel and American forces were more ready than ever before. Fortunately, warfare did not occur, but the need remains to close those gaps in the armor of the United States with regard to biological and chemical warfare. There may come a time when the deterrence given by the threat of force may no longer prove effective and then American readiness will be tested. Perhaps the United States and its military have once again been given some breathing space to prepare.

While the threat should not be underestimated, it should not be overestimated either. Use of biological and chemical agents has thus far been kept in check for many of the reasons discussed in this presentation and perhaps this will continue to be the case. If use ever does occur, history and modern experience has shown that no place is immune. For Air Force medical personnel, for the United States military as a whole, and for the American public biological and chemical warfare is like nuclear warfare, always be prepared and hope it never happens. If the United States is truly prepared and its adversaries know it, perhaps the proof will never be necessary. If proof is required, the Air Force Medical Service must be ready. Remembering the words of von Clausewitz, if conflict does occur, it must continue to be the United States that is ready to render the enemy powerless and impose its will. Whether over nations or terrorists, victory will go to those prepared to achieve it.

Notes

[1] Bradley Graham, "U.S. Forces Better Equipped for Chemical, Biological Warfare," *Washington Post*, 8 February 1998, 29.

Appendix

Basic List of Information Resources

Government Organizations:
US Department of Defense Chemical and Biological Information Analysis Center:
CBIAC
P.O Box 196
Gunpowder Branch APG, MD 21010-0196
Internet: http://www.CBIAC@apgea.army.mil

US Army Soldier Systems Command
Kansas Street
Natick, MA 01760
Internet: http://www-sscom.army.mil

US Army Medical Research Institute of Infectious Disease (USAMRIID)
US Army Medical Research and Materiel Command
Fort Detrick, MD
Internet: http://www.usamriid.army.mil

Joint Program Office - Biological Defense
5201 Leesburg Pike, Suite 1200
Falls Church, VA 22041
Phone: 703-681-9600
Fax: 703-681-3454

The Office of the Surgeon General
NBC Information Server
Internet: http://www.nbc-med.org

24-Hour Emergency Response:
Chemical Incident
National Response Center   1-800-424-8802

Biological Incident
Within the Department of Defense -
US Army Medical Research Institute of Infectious Diseases 1-888-872-7443

Outside the Department of Defense –
US Public Health Service, Office of Emergency Preparedness –
1-800-USA-NDMS ext. 0
301-443-1167 ext. 0

Regulations and Manuals:
Army Field Manual (FM) 3-7, *NBC Field Handbook.*

Army Field Manual (FM) 8-9, *NATO Handbook on the Medical Aspects of NBC Defensive Operations*

Army Field Manual (FM) 8-10-7, *Health Service Support in a Nuclear, Biological, and Chemical Environment*

Army Field Manual (FM) 8-285, *Treatment of Chemical Agent Casualties and Conventional Chemical Injuries*

Government Courses:
Medical Management of Biological/Chemical Casualties Course (health care providers)
Conducted by the US Army Medical Institute of Infectious Diseases (USAMRIID) and US Army Medical Research Institute of Chemical Defense (USAMICD)
Phone: 410-671-2230

Continuing Medical Readiness Training Materials
82d Medical Training Group
939 Missile Road
Sheppard AFB, TX 76311-2251

Medical/Field Management of Chemical & Biological Casualties Course
United States Army Academy of Health Sciences
Attn: MCCS HPN
3151 Scott Road, Suite 1138
Ft Sam Houston, TX 78234-6142
Internet: http://www.cs.amedd.army.mil/NBCBranch/NBC.html

Commercial (No endorsement given or implied):
Nuclear, Biological and Chemical Casualty Training System
Logicon
950 North Orlando Avenue
Winter Park, FL 32789-2924
E-mail: cwasser@logicon.com

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