MILITARY MEDICINE, 162, 3:156, 1997

Deterrence of Biological and Chemical Warfare: A Review of Policy Options

Frank J. Lebeda, PhD

The deployment of biological and chemical weapons by aggressor states is not a hypothetical scenario but a life-threatening contingency. Although Iraq was deterred from using its biological and chemical weapons during Operation Desert Storm, what forms of deterrence must be considered in preventing the use of these weapons of mass destruction in the future? Traditional deterrents against their use have ranged from the threat of a military response to the ratification of diplomatic treaties and agreements. An overall strategy to deter the use of these weapons includes an additional, less frequently discussed approach—force protection—which encompasses defensive biomedical countermeasures (e.g., antibiotics, drugs, vaccines, diagnostic tests) and nonmedical protective devices (e.g., masks, specialized clothing/shelters, detectors). A combined, integrated approach to deterrence is reviewed in this article with regard to current policies and the roles played by Department of Defense research and development programs for biological and chemical defense.

The Reality of the Threat

The Iran-Iraq war in the 1980s removed any lingering doubts that chemical weapons remain viable threats. Nor was the danger of unconventional weapons in the post-Cold War era viewed as an alarmist's scenario. World attention was abruptly focused during Operation Desert Storm (ODS) on the real potential of biological and chemical weapons being used against United States military personnel, members of the coalition force, and civilian populations.[1,2] The recognition of the reality of these threats is a positive step toward developing a stronger deterrence policy and argues for continued support in defending personnel of the U.S., its friends, and allies against biological and chemical weapons. This article summarizes various deterrence policies that are designed to prevent the use of these weapons, in general, and emphasizes the critical role played by Department of Defense (DOD)-supported medical and nonmedical research, development, test, and evaluation programs.

Although biological and chemical threats are discussed together here, it must be emphasized that they represent separate domains within the context of weapons of mass destruction and are associated with different perceptions and issues.[3–5] For example, even the possession of biological weapons is, by international treaty, illegal, whereas there is no general prohibition against the use of potentially far more destructive nuclear weapons.[6] Biological threat agents also differ from nuclear and chemical weapons in dual-use research, development, and production (e.g., for the legitimate manufacture of pharmaceuticals vs. the illegal production of weapons), which complicates verification of compliance agreements. Perhaps more importantly for members of the military health care community is the fact that biological and chemical agents differ from conventional and nuclear weapons because personnel, in general, can be protected from them.

In common usage, "deter" means to discourage, restrain, or prevent a person's action by means of doubt or fear. In the academic language of deterrence theory, it means to convince an adversary that the cost of aggression exceeds any possible gain[7]—to increase the cost-to-benefit ratio for an adversary. The various types of deterrence that will be discussed here are summarized in Table I. The roles played by military, diplomatic, and defensive approaches in providing deterrence to biological and chemical warfare are highlighted. To provide a framework to shape this discussion about deterrence, it will also be useful to refer to strategic policies that have been considered historically to prevent the state (government)-sponsored use of nuclear weapons.

Deterrence by Military Action

From World War I until the Cold War era, the response to attacks upon U.S. armed forces with chemical weapons was a threat to retaliate in kind. President Roosevelt pledged in 1943 that the U.S. would not use chemical weapons unless first attacked by the enemy with these agents.[8] The concept of nuclear deterrence that emerged as a policy issue during the 1950s centered on military retaliation to quell the imminent nuclear threat posed by the former Soviet Union. Deterrence of nuclear warfare during the Cold War was the threat of counterviolence[9] that would punish in kind or at a higher level of destruction.[10]

The U.S. ratified the 1925 Geneva Protocol in 1975 (see below), but it still reserved the right to retaliate in kind to chemical attack. During ODS, there was not a clearly enunciated policy by the members of the coalition force in responding to an Iraqi attack with biological or chemical weapons.[11] In contrast to the official declaratory policies regarding nuclear weapons, the vagueness in the policy dealing with biological and chemical threats allowed "ambiguous signals" to be perceived by the Iraqi government.[12] The use of a deliberately ambiguous policy is not new and was previously used in NATO's "flexible response" as part of its extended deterrence strategy against the former Warsaw Pact.[13]

Nuclear retaliation to the use of chemical weapons was reported to have been perceived by senior Iraqi officials as a credible possibility. This perception arose from the pronouncements regarding U.S. actions by President Bush and Secretary of

Chief, Department of Cell Biology and Biochemistry, Toxinology Division, U.S. Army Medical Research Institute of Infectious Diseases, Fort Detrick, Frederick, MD 21702-5011.

This paper was initiated while the author was on assignment at the Pentagon in the Office of the U.S. Army Assistant Surgeon General for Research and Development. The views, opinions, and/or findings contained herein are those of the author and should not be construed as an official Department of the Army position, policy, or decision unless so designated by other documentation.

This manuscript was received for review in August 1996 and was accepted for publication in October 1996.

TABLE I

DETERRENTS TO PREVENT THE USE OF WEAPONS OF MASS DESTRUCTION

Type of Deterrence	Definition
Punishment	Retaliate in kind or at a higher level
Denial	Prevent aggressor from achieving aims
Extended	Protect allies with one's own deterrents
Escalatory	Threaten to use weapons that have a level of destruction higher than those to be used by the adversary
Self	Prevent the use of one's own weapons
Existential	Prevent aggressor's action by possessing (or having the capability to develop) the deterrent
Defensive	Protect forces and convince the adversary that its threat will be ineffective if used

Defense Cheney[14] and in discussions with Secretary of State Baker.[11,15] The Chief of the United Nations Special Commission (UNSCOM), Rolf Ekeus, explained that ". . .Iraq translated those statements with the U.S. responding [to a chemical or biological attack] with very drastic means as meaning a nuclear threat."[11,16] Thus, during ODS, the Iraqi government may have been deterred, in part, from using biological or chemical weapons because they perceived the possibility of a nuclear retaliation (i.e., escalatory deterrence[13,17]).

Iraq's apparent supposition was inconsistent with the "negative security assurance" policy made in 1978 by Secretary of State Vance during the Carter administration.[18] This policy proscribed the U.S. from using nuclear weapons against any state that neither possessed nuclear weapons nor was allied with a state that did.[11] Moreover, when asked to consider using tactical nuclear weapons against conventional forces, General Colin Powell, the chairman of the Joint Chiefs of Staff during ODS, responded that the "political costs outweighed military gain"[12] and that there was no intention of letting "that [nuclear] genie out of the bottle."[19] Thus, nuclear self-deterrence by the U.S. may also have been a significant factor during ODS. Given that numerous variables and conditions could exist for the U.S. in future contingency operations in biological or chemical environments, nuclear retaliation, even the use of a low-yield nuclear weapon,[20–22] may not be a useful option, and the possibility of putting one's own forces at risk may render this military response undesirable.

After ODS, General John Shalikashvili (the present chairman of the Joint Chiefs of Staff) testified at a Senate hearing that retaliation in kind to chemical attacks would not be used, reinforcing President Bush's renunciation of this action in 1991.[23] Instead, General Shalikashvili stated that advanced conventional munitions would likely be used in response to a chemical attack. As with first use of nuclear weapons,[24] retaliation in kind to biological or chemical weapons is also predicted to precipitate long-lasting adverse political reactions and to create barriers in the nuclear arms control arena.[25] Retaliation in kind would also confound efforts at preserving and developing new international treaties and agreements designed to control the proliferation and production of these agents.[26,27]

The problems of relying upon retaliation with nuclear weapons in response to biological or chemical threats stress the necessity to seek alternative measures. Solving these problems reflects a trend in the evolution of deterrence strategy in the realm of these weapons. Rather, stronger arms control agreements and enhanced force protection are clearly the other options that must be sought in future strategies.

Deterrence by Diplomatic Actions

The diplomatic tools summarized in this section provide a foundation "on which to act" against aggressor states using biological or chemical agents.[28] The foreign policy components for the prevention of biological and chemical warfare include two legally binding instruments (the Geneva Protocol of 1925 and the 1972 Biological and Toxin Weapons Convention [BWC],[29] various policy statements, and confidence-building measures among friends, allies, and potential combatants (see Table II). The significant turning point in U.S. policy regarding biological weapons occurred in 1969 with the unilateral renunciation statement by President Nixon,[30] which led to the ratification by the U.S. of the 1925 Geneva Protocol and the 1972 BWC.

The 1972 BWC represents an enhancement of the 1925 Geneva Protocol to prevent the use of biological weapons. A major problem with the BWC is a lack of a satisfactory program for verification of compliance. Biological agents, because of their potential dual-use capabilities, are not as readily amenable to agreements that seek a "zero-option," as is the case with nuclear weapons.[31,32] This verification dilemma is one of the apparent barriers that has stalled the Chemical Weapons Convention ratification in the U.S. Senate.[26,33,34] The difficulties encountered during UNSCOM's intrusive verification of Iraq's potential dual-use equipment suggest that this procedure would be too impractical to be implemented in a multinational verification scheme.[41] Another perceived problem involves allowing inspectors to have access to confidential and proprietary information at commercial facilities. This issue, however, has been under study and will probably be addressed to the satisfaction of the key players.[35] Furthermore, although inspections can verify capability, they cannot verify intent.[36,37] Despite these problems, verification is secondary to the primary issue that is addressed by these diplomatic efforts in preventing unchecked proliferation and development of these weapons.[38]

Besides verification, another less acknowledged problem potentially exists with the BWC. Article X (which is, as yet, not implemented) calls for ratifying states to share, albeit without specific commitments, biotechnological information on defensive capabilities.[39–41] Assistance to less developed countries may be one of the major costs of the BWC. Paradoxically, if one of these states becomes a future U.S. adversary, especially a suspected proliferant or developer of threat agents, then this shared information may put the U.S. and other technologically advanced signatory states at a disadvantage.

Two agreements that do not have legal force, but are nevertheless important, have also been established. The 29 nations that presently constitute the Australia Group began to develop an agreement in 1985 restricting the export of material (e.g., toxins) and equipment from member to nonmember states.[41] Concerns have been raised that these traditional controls are unfairly selective against nonmember, developing nations.[23,26,42] The other agreement, involving the United States, the United Kingdom, and

TABLE II

CHRONOLOGY OF MAJOR TREATIES, POLICIES, AND AGREEMENTS THAT ADDRESS BIOLOGICAL OR CHEMICAL WARFARE

Date	Treaty/Policy/Agreement	Goals
Signed, 1925; ratified by U.S., 1975	Geneva Convention	Prohibit first use of biological/chemical weapons
1969–1970	Nixon statements	Renounce unilaterally offensive biological weapon development, stockpiling, and usage
Signed, 1972; ratified by U.S., 1975; reviews, 1981, 1986, 1991	Biological Weapons Convention	Develop biological weapon anti-proliferation measures and exchange information
1984 for chemical warfare and 1993 for biological warfare agents	The Australia Group	Control export of technology
1989–1994	Wyoming Memorandum of Understanding	Inspect and exchange chemical weapon stockpile data by U.S. and Russia
1990	Enhanced Proliferation Control Initiative (Executive Order 12735)	Control export of technology and set forth sanctions
1991	Cooperative Threat Reduction Program (Nunn-Lugar program)	Destroy Russia's chemical weapon stockpile
1992	Trilateral Joint Statement (U.S., United Kingdom, Russia)	Terminate Russia's offensive biological weapon research
Signed, 1993; (not ratified by U.S.)	Chemical Weapons Convention	Develop chemical weapon anti-proliferation measures and exchange information
Planned for, 1997–2004	U.S. Soviet Bilateral Destruction Agreement	Stop production and reduce chemical weapon stockpile

Russia, is the 1992 Trilateral Joint Statement on biological weapons. As with the treaties, compliance with these agreements still awaits practical and credible verification procedures.

Deterrence by Defensive Actions

In addition to political pressure against development, proliferation, and use of these weapons, a defensive approach to biological and chemical weapon deterrence must be considered. The present biological and chemical defensive programs supported by the DOD represent existing components of an integrated and overlapping system and serve an important role in the "web of deterrence"[43] (see Fig. 1). This system includes the continued development of adequate agent detection and warning devices, individual and collective protection (masks and protective overgarments, shelters), and medical countermeasures (antibiotics, drugs, vaccines, diagnostic tests).

The major deterrent role played by medical and nonmedical countermeasures is to deny an adversary maximum benefit from using these weapons.[44,45] Opposing a force that is protected with these countermeasures would further deny the adversary from using a biological or chemical agent of choice. Protected personnel could cause the adversary to dismiss the use of the available threat agent or to use extra resources (time, money, manpower) to weaponize a different one. For example, tetanus toxin, which is almost as potent as *C. botulinum* toxin, is not generally viewed as a potential biological threat to U.S. personnel because they are already immunized. By protecting individuals against the most lethal and readily deployable threat agents, the remaining available choices may be less toxic, less stable in the environment,[43] and more costly to produce. Having to spend resources to develop novel (designer) biological and chemical agents would also delay and, thus, deter the aggressor further. Doubts about the utility of biological or chemical weapons as effective offensive weapons could be created or fostered by convincing an adversary that the opposing forces are already or could be, in a contingency, effectively protected.

The use of medical and nonmedical countermeasures in deterring these threat agents has been viewed favorably by several authors[3,43,46–49] but has also been criticized by others.[50–53] A review of the main points of their arguments is presented here.

Potential adversaries must be convinced that defensive deterrence against biological and chemical threats exists and is effective. This process was initiated by the 1969–1970 speeches by President Nixon and is, in part, established by the existence of a congressionally mandated Joint Program Office for Biological Defense (JPO/BD) and defensive research programs in which the U.S. Army is the executive agent (e.g., the most recent congressional language for the Biological Defense Research Program is in Public Law 103-160, November 30, 1993). The development of future medical countermeasures is coordinated through the JPO/BD and implemented in a number of defense research laboratories within the U.S. Army Medical Research and Materiel Command, the U.S. Army Chemical and Biological Defense Command, and the Office of Naval Research. These programs represent open and transparent forms of deterrence[3] and constitute a part of the confidence-building measures described by the BWC Second Review Conference in 1986.

The underlying foundation for these programs consists of policy and planning components, both of which provide a funding rationale. For example, the present biological warfare defense vaccination policy provides an outline of essential features including "vaccine research, development, testing, evaluation, acquisition, and stockpiling" and of efforts to improve "existing vaccines and the development of new medicines against all validated biological warfare threat agents."[54] This vaccination policy is in keeping with the planning and budgeting processes that

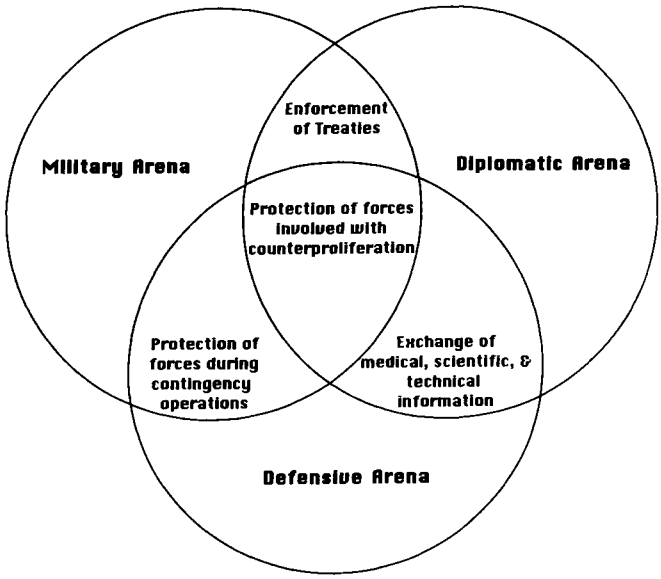

Fig. 1. An integrated and overlapping approach to the deterrence of biological and chemical warfare. The three arenas of action are military (contingency operations), diplomatic (e.g., treaties), and defensive (medical and nonmedical countermeasures).

are strongly influenced by the recommendations made by the Pentagon's Joint Requirements Oversight Council and the Joint Warfighting Capability Assessments (JWCA).[55] Of the nine assessment areas presently covered in the JWCA process, the area of "deterrence and counter-proliferation of weapons of mass destruction" was designed "to fill gaps in U.S. capability to fight in" an environment contaminated by nuclear, biological, or chemical weapons.[56] These sets of problems are addressed by the Counterproliferation Support Program and the Biological Defense Research Program.

As stated in the "Deutch Report,"[57] "The activities of the DOD across the full range of U.S. efforts to combat proliferation, including diplomacy, arms control, export controls, and intelligence collection and analysis" have "the particular responsibility for assuring" the "protection" of "U.S. forces and interests. . .should they confront an adversary armed with weapons of mass destruction or missiles." This new counterproliferation strategy has been characterized to include "all policy instruments from diplomacy and deterrence to active and passive defenses."[58] Indeed, any operations calling for interdiction, sample collection, and verification[59] would require force protection, "protective suits, shelters, vaccines and antidotes."[58]

The deterrent capabilities of research and development efforts of the defensive biological and chemical programs, which include extramural and intramural research activities, are already in evidence. Broad Agency Announcements and Requests For Proposals for extramural research programs are routinely made (e.g., in the *Commerce Business Daily*) for contract proposals. Material Transfer Agreements and Cooperative Research and Development Agreements also lend support to these efforts. The results from extramural and intramural research programs are made public at open conferences[60] and by publication in the scientific literature.

The results of these programs are credible. Scientific assessments by independent panels of peer reviewers are performed. Information appears in the open literature about the laboratories working within the program, the personnel involved, and their fields of expertise. Furthermore, information is disseminated electronically (e.g., by the recently established Chemical and Biological Defense Information Analysis Center on the Internet World Wide Web server: http://www.battelle.org/cbiac/cbiachp.html). As a last point, the protection offered by medical and nonmedical countermeasures is viewed to be technically feasible. Assessing the functionality of the countermeasures has been achieved, in part, by publishing research results in peer-reviewed journals and by obtaining, when necessary, approval from the appropriate regulatory agency.

The conduct of these comprehensive programs does not come without some risks. It has been pointed out that the monetary costs of medical and nonmedical countermeasures will take funds away from other projects.[51,53] Compared to weapons research, development, testing, and evaluation programs, however, the costs to support these defensive efforts are small. Strauss and King[53] have also argued that the entire target population cannot be protected. This view is valid only when considering an attack on an unarmed civilian population and is not valid when attacks are directed against military personnel who can be protected. Concerns over environmental issues in conducting defensive research have also been raised.[53] As in civilian laboratories that are faced with similar containment problems, the risks can be minimized or eliminated in defense research facilities with vigilant supervision, good laboratory practices, and proper training. Politically, there is the possible risk that aggressors may view (or advance the perception) that any defensive program supported by an opponent is offensive and, therefore, a potential threat.[50] Alternatively, the dismantling of defensive research programs has prompted at least one author to speculate that an adversary could perceive such an action as making these research programs secret, and, thus, intensify its own offensive efforts.[61] Potential adversaries could also use the research information published in the open literature to acquire and develop or strengthen their own offensive biological or chemical programs.

Despite these arguments, the costs are heavily outweighed by the expected benefits. First and foremost, at-risk personnel will be protected against some biological or chemical threats. Second, a public acknowledgment can emerge that conscientious efforts have been made to protect at-risk personnel. Finally, the research information is made available to the worldwide scientific and public health care communities in a manner consistent with open and transparent policies.

A strategy of deterrence against the use of biological or chemical weapons needs to be an integrated effort that uses the threat of military retaliation against an aggressor state as a reaction of last resort. Medical and nonmedical countermeasures for the most lethal and readily weaponized biological and chemical weapons will provide protection and deny an adversary's use of these weapons or will force the aggressor to use less efficient and more costly agents. By providing effective countermeasures, the DOD biological and chemical defense programs should convincingly increase the cost/benefit ratio for a potential aggressor. A continued commitment in the form of doctrine, training, logistics, and material for using medical and nonmedical counter-

measures is needed to develop them into operational components of an integrated deterrence policy and a strong defensive posture.

Acknowledgments

I particularly thank LTC Terry Rauch for his sage guidance on medical countermeasures as deterrents. Valuable insights, comments, and suggestions were also given to me by LTC Bill Forrester, LTC Edward Eitzen, COL David R. Franz, Dr. Anna Johnson-Winegar, MAJ Rebecca K. LaChance, Dr. Carol Linden, and Dr. Daniel Rickett.

Notes

1. After repeated denials to representatives of the United Nations Special Commission, Iraqi officials admitted in 1995 that their government did indeed "have an active offensive biological weapons program prior to the Persian Gulf War" (Zilinskas RA: Symposium of United Nations Biological Weapons Experts. Politics and Life Sciences 1995; Aug: 229). Iraq possessed massive quantities of bacteria (*Bacillus anthracis, Clostridium perfringens*), bacterial toxins (from *Clostridium botulinum*), and the synthetic anticholinesterase nerve agents sarin and VX (Starr B: Iraq reveals a startling range of toxic weapons. Jane's Defense Weekly 1995; November 11: 4; Iraq finally admits building biological weapon arsenal. Jane's Defense Weekly, 1995; July 15: 5). Other examples of the existence of these threats are also available (Mirzayanov VS: Dismantling the Soviet/Russian chemical weapons complex: an insider's view. In Chemical Weapons Disarmament in Russia. Report no. 17, October; pp 21–33. Washington, DC, The Henry L. Stimson Center, 1995).
2. The use of unconventional weapons was given heightened public awareness by the recent activities of the Aum Shinrikyo, a doomsday cult originating in Japan. To date, this cult's actions are most completely summarized in the testimonies given by John F. Sopko (Head, Minority Staff), Michael Moodie, Connie Fenchel, Kyle B. Olson, M. Leitenberg, and others (Hearings before the U.S. Senate Committee on Governmental Affairs, Permanent Subcommittee on Investigations: Global proliferation of weapons of mass destruction, 104th Congress, 1st session, 1995). The motives and logic underlying non-state activities with biological and chemical weapons is distinct from state-sponsored use and is discussed in detail elsewhere (e.g., Metz S: Deterring conflicts short of war. Strategic Review 1995; 24: 44–51; Douglass JD, Livingston NC: America the Vulnerable, pp 178–80. Lexington, KY, Lexington Books, 1987).
3. Dashiell TR: The need for a defensive biological research program. Politics and the Life Sciences 1990; 9: 85–92.
4. Franz DR: Inventory control of dual-use equipment. Politics and the Life Sciences 1995; 14: 244–7.
5. Typically used phrases such as weapons of mass destruction (WMD), and nuclear, biological, and chemical weapons are potentially misleading because they implicitly lend equal weight to the associated deterrence and proliferation issues involved and to the differential destructive power of these weapons. The phrase "weapons of indiscriminate destruction" has been used in a context that conveys an added sense of destructiveness by suggesting that these weapons could cause devastating effects in both military and civilian populations (Toffler A, Toffler H: War and Antiwar, p 280, New York, Warner Bros., 1993). Alternatively, "mass casualty biological [toxin] weapon [MCBW]" has been used to emphasize the distinction between WMDs, which are associated with "destroyed cities, bomb craters and great loss of life," and MCBWs, which might connote a "loss of life only" (Franz DR: Defense Against Toxin Weapons, pp 4–5. Frederick, MD, US Army Medical Research and Materiel Command, US Army Medical Research Institute of Infectious Diseases, 1994).
6. Reisman WM, Antoniou CT: The Laws of War, pp 57–9. New York, Vintage Books, 1994.
7. Tritten JJ: Our New National Security Strategy. Westport, CT, Praeger Publications, 1992.
8. Piller C, Yamamoto KR: Gene Wars, p 46. New York, Beach Tree Books, 1988.
9. Brzezinski Z: Power and Principle, p 455. New York, Farrar, Straus, Giroux, 1983.
10. Deterrence by denial was formulated during the Cold War as an alternative to deterrence by punishment to lessen the possibility of mutual annihilation. Traditionally, deterrence by denial of war goals involved preventing the adversary from gaining territory or materiel, or from removing locally positioned opposition forces. Initiated in the 1960s and given considerable support in 1983 by the Reagan administration, deterrence by denial was to be implemented through an active defense, in which launched strategic nuclear weapons of the aggressor could be destroyed before reaching their targets with interceptor missiles (Milton AF, Davis MS, Parmentola JA: Making Space Defense Work, pp 1–23. Washington, DC, International Defense Publishers, 1988).
11. Hackett J: Lethal germs in the arsenal. Washington Times 1995; September 19: 14.
12. Fitchett J: Nuclear states see vindication. International Herald-Tribune 1995; September 12: 2.
13. Zagare FC, Kilgour DM: Assessing competing defense postures: the strategic implications of "flexible response." World Politics 1995; 47: 373–417.
14. Bailey KC: Responding to the threat of biological weapons. Security Dialogue 1995; 2–6: 383–97.
15. Waller D: Saddam spills secrets. Time 1995; September 4: 41.
16. U.N. envoy: Iraqi change ended crisis. Washington Times 1995; August 30: 10.
17. A nuclear response to the use of chemical or other weapons of mass destruction has also been discussed by others (Gertzen J: U.S. nuclear weapons deter aggression, StratCom chief says. Omaha World-Herald 1995; October 17: 22; McCall S: A higher form of killing. Proc US Naval Inst 1995; February: 40–5; Utgoff VA: The biotechnology revolution and its potential military implications [pp 28–34]; and Roberts B: New challenges and new policy priorities for the 1990s [pp 68–101]; the latter two articles are in Biological Weapons: Weapons of the Future? Edited by Roberts B. Washington, DC, The Center for Strategic and International Studies, 1993). Indeed, a disproportionate retaliation to attacks with unconventional weapons is a perception held by some with regard to Israel's deterrence posture (US Congress, Office of Technology Assessment: Proliferation of Weapons of Mass Destruction: Assessing the Risks. OTA-ICA-559, p 55*n*. Washington DC, US Government Printing Office, 1993; Hackett J, note 11; Cigar N: Chemical weapons and the Gulf War. Studies on Conflict and Terrorism 1992; 15: 145–55), although that government also has a defensive "posture of deliberate ambiguity" (Beres LR: The "peace process" and Israel's nuclear strategy. Strategic Review 1995; 23: 35–47).
18. Bundy M: Nuclear weapons and the Gulf. Foreign Affairs 1991; 70: 83–94.
19. Power J: Deterrence without nukes. Baltimore Sun 1995; September 15: 25.
20. Kissinger HA: Nuclear Weapons and Foreign Policy, pp 174–202. New York, Harper, 1956.
21. Bailey KC, note 14.
22. Ritcheson PL: Proliferation and the challenge to deterrence. Strategic Review 1995; 24: 38–48.
23. Smithson AE: The United States, Russia, and chemical weapons disarmament: choices ahead. In Chemical Weapons Disarmament in Russia. Report no. 17, October, pp 49–63. Washington, DC, The Henry L. Stimson Center, 1995.
24. Kaufmann WF: Crisis in military affairs. World Politics 1958; 48: 579–603.
25. Utgoff VA, note 17.
26. Moodie M: Verification, compliance, and the CWC. In The U.S. Senate and the Chemical Weapons Convention: The Price of Inaction. Report no. 18, October, pp 7–12. Washington, DC, The Henry L. Stimson Center, 1995.
27. On the other hand, the concepts of deterrence against weapons of indiscriminate destruction have themselves been described as excuses for a lack of preparedness to retaliate (Douglass JD, Livingston NC, note 2). According to these authors, deterrence has been naively treated as the "mere presence" of nuclear weapons (existential deterrence; Bundy M, note 18) or the existence of biological or chemical retaliatory weapons (that may be, nonetheless, unsuitable or ineffectual). In contrast, a "weaponless deterrence" maintaining that knowledge to build a weapon is itself a sufficient deterrent has been promulgated (Mazarr M, quoted in Power J, note 19).
28. Carus WS: The proliferation of biological weapons. In Biological Weapons: Weapons of the Future?, pp 19–27. Edited by Roberts B. Washington, DC, The Center for Strategic and International Studies, 1993.
29. Formally, the 1925 Geneva Protocol: Protocol for the prohibition of the use in war of asphyxiating, poisonous or other gases, and of bacteriological methods of warfare; The 1972 Biological Warfare Convention: Convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction (Reisman WM, Antoniou CT, note 6).
30. In November 1969, President Nixon summarized some of the contents of National Security Decision Memorandum, no. 35, which recommended that his administration should submit to the Senate for ratification, the Geneva Protocol of 1925, which prohibits in war the first use of chemical and bacteriological weapons (Nixon R: Public papers of the Presidents of the United States. Statement on chemical and biological defense policies and programs, No. 461, November 25, 1969, pp 968–9. Washington, DC, US Government Printing Office, 1969; Nixon R: Public papers of the Presidents of the United States. Remarks announcing decisions on chemical and biological defense policies and programs, No. 462, November 25, 1969, pp 969–70. Washington, DC, US Government Printing Of-

fice, 1969; Hersh SM: The Price of Power, p 35*n*. New York, Summit Books, 1983). At that time, a new national policy was announced in which the offensive use of biological weapons by the U.S. was unilaterally renounced and that associated U.S. research programs would be limited solely to defensive purposes. In remarks made in February 1970, this policy was expanded by President Nixon to include the offensive use of toxins.
31. Milton AF et al., note 10.
32. Orman S: Faith in G.O.D.S. Stability in the Nuclear Age, pp 10–7. London, Brassey's, 1991.
33. Glenn J: Why the Senate should ratify the Chemical Weapons Convention. In The U.S. Senate and the Chemical Weapons Convention: The Price of Inaction. Report no. 18, October, pp 3–5. Washington, DC, The Henry L. Stimson Center, 1995.
34. Lancaster HM: Why we need the Chemical Weapons Convention. In The U.S. Senate and the Chemical Weapons Convention: The Price of Inaction. Report no. 18, October, pp 25–30. Washington, DC, The Henry L. Stimson Center, 1995.
35. Thränert O: Responding to the threat of biological weapons: a comment. Security Dialogue 1995; 26: 399–403.
36. Roberts B, p 88, note 17.
37. Two forms of verification have been defined (Chevrier MI: Verifying the unverifiable: lessons from the biological weapons convention. Politics and the Life Sciences 1990; 9: 93–105). Verification is "adequate" when the process detects and reports in a timely manner only those violations that threaten national security. An "effective" verification, wherein all violations are considered significant, may not be attainable.
38. Meselson M, cited by Watson R, Barry J, Waller D, Warner MG, Rogers M: The "winds of death." Newsweek 1989; January 16: 22–5.
39. Roberts B, p 91, note 17.
40. Moodie M: Arms control programs and biological weapons. In Biological Weapons: Weapons of the Future?, pp 47–57. Edited by Roberts B. Washington, DC, The Center for Strategic and International Studies, 1993.
41. Chevrier MI: From verification to strengthening compliance: prospects and challenges of the Biological Weapons Convention. Politics and the Life Sciences 1995; 14: 209–19.
42. Roberts B: Rethinking export controls on dual-use materials and technologies. The Arena 1995; 2: 1–6.
43. Pearson GS: Biological weapons: the British view. In Biological Weapons: Weapons of the Future?, pp 7–18. Edited by Roberts B. Washington, DC, The Center for Strategic and International Studies, 1993.
44. Koithara V: Strategy in the age of nuclear deterrence and its application to developing countries. Strategic Analysis 1989; 12: 393–416.
45. With rogue state or non-state actors, deterring the use of biological and chemical weapons in a conflict short of war is associated with special, intangible problems that require an "alternative logic" and an in-depth understanding of the motives of a given outlaw organization (see Metz S, note 2). In this case, massive retaliation in any form will probably not be effective. Furthermore, it may be difficult to convincingly identify and to authenticate who was responsible (plausible deniability) for using biological or chemical weapons (Robertson AG, Robertson LJ: From asps to allegations: biological warfare in history. Milit Med 1995; 160: 369–73). In conflicts short of war, medical and nonmedical countermeasures may, at best, play only a passive defensive role.
46. Carus WS: The Poor Man's Atomic Bomb? Biological Weapons in the Middle East. Policy paper no. 23, Washington, DC, Washington Institute for Near East Policy, 1991.
47. Dasey CF: Medical benefits of the biological defense research program. Politics and the Life Sciences 1990; 9: 77–84.
48. Huxsoll DL, Parrott CD, Patrick WC: Medicine in defense against biological warfare. JAMA 1989; 262: 677–9.
49. Roberts B, pp 68–101, note 17.
50. Jacobson JA, Rosenberg BH: Biological defense research: charting a safer course. JAMA 1989; 262: 675–6.
51. Piller C, Yamamoto KR, pp 153–9, note 8.
52. Rutman RJ, Disch HJ: Commentary on the articles by Charles F. Dasey and Thomas R. Dashiell on the biological defense research program (BDRP). Politics and the Life Sciences 1990; 9: 117–21.
53. Strauss H, King J: The fallacy of defensive biological weapon programmes. In Biological and Toxin Weapons Today, pp 66–73. Edited by Geissler E. London, SIPRI/Oxford University Press, 1986.
54. Perry WJ: DOD immunization program for biological warfare defense. Department of Defense Directive no. 6205.3, November 26, 1993.
55. Boatman J: JWCAs find their footing in Pentagon programming. Jane's Defense Weekly 1995; August 5: 18–9.
56. Hitchens T, Holzer R: U.S. experts warn against JROC program cuts. Defense News 1995; December: 18–24.
57. Office of the Deputy Secretary of Defense: Report on Nonproliferation and Counterproliferation Activities and Programs, p 1. Washington, DC, Department of Defense, May 1994.
58. Domenici PV: Countering weapons of mass destruction. Washington Quarterly 1995; 18: 145–52.
59. Starr B: SOCOM exercises for counterproliferation. Jane's Defense Weekly 1995; August 26: 6.
60. For example, see the Proceedings of the Medical Defense Bioscience Review Conference, U.S. Army Medical Research and Materiel Command, Baltimore, MD, May 12–16, 1996, and the Proceedings of the Scientific Conference on Chemical and Biological Defense, U.S. Army Chemical and Biological Defense Command, Edgewood Area, Aberdeen Proving Ground, MD, November 14–17, 1995.
61. Frisina ME: The offensive-defensive distinction in military biological research. Hastings Center Report 1990; 2012-20, cited by Mobley JA: Biological warfare in the twentieth century: lessons from the past, challenges for the future. Milit Med 1995; 160: 547–53.