Biological Weapons Research and Physicians: Historical and Ethical Analysis

Victor W. Sidel, M.D.*

Analysis of the historical and ethical elements of the role of scientists and physicians in weapons research, of the history and nature of biological weapons, and of the ethical issues posed by the research leads to the conclusion that biological weapons research by physicians is unethical, even for a "just war." Furthermore, since so-called defensive research on such weapons under military sponsorship is widely viewed as highly ambiguous, provocative, and strongly suggestive of offensive goals, it is urged that physicians refuse participation in such research as well. Instead, it is advocated that physicians and others undertake a series of specific efforts to end the biological arms race and to prevent the militarization of biology. PSRQ 1991;1:31–62

Participation of physicians in research on biological weapons raises issues relevant to three overlapping areas: the ethics of research, the ethics of medicine, and the ethics of war. Review of history and ethics in these areas will begin with discussion of the role of scientists and physicians in weapons research, proceed to examine the history and nature of biological weapons, the reasons for the universal abhorrence in which they are held, and the ethics of biological weapons research, and conclude by consideration of the special issues raised by the physician's role in research and action on biological weapons.

THE ROLE OF SCIENTISTS AND PHYSICIANS IN RESEARCH ON WEAPONS OF WAR

Scientists throughout history have been called upon to play a role in preparation for war or in support of the conflict [1,2]. Archimedes used his skills on behalf of Dionysius of Syracuse to construct an arsenal in preparation for war against the Romans [3], Leonardo da Vinci designed fortifications for the Duke of Milan [4], and Galileo calculated trajectories

* VWS is Distinguished University Professor of Social Medicine, Montefiore Medical Center, Albert Einstein College of Medicine, Bronx, New York. Address correspondence and reprint requests to V.W. Sidel, M.D., Department of Epidemiology and Social Medicine, Montefiore Medical Center, 111 East 210th St., Bronx, NY 10467.

of projectiles for the Grand Duke of Tuscany [5]. In this century, Fritz Haber, who was awarded the 1919 Nobel Prize in Chemistry for his synthesis of ammonia, is known as the father of Germany's chemical weapons program of World War I. In his Nobel Prize acceptance speech, Haber declared poison gas "a higher form of killing" [6]. Indeed this century is replete with examples of scientist participation in research on weapons: chemists have worked on explosives and poison gases; physicists worked on nuclear weapons in World War II; biologists worked on herbicides for use in the Vietnam War; and for at least the past 50 years, biologists, biomedical scientists, and physicians have worked on biological weapons.

There have also been numerous examples of scientists who refused to work on the development of weapons of war. While da Vinci was willing to trade design of fortifications for the patronage of his Duke, he was not willing to "publish or divulge" his design for a submarine "on account of the evil nature of men" [4]. During the Crimean War, the British government consulted the noted physicist Michael Faraday on the feasibility of developing poison gases; Faraday responded that it was entirely feasible, but that it was inhuman and he would have nothing to do with it [7]. Other scientists, such as Alfred Nobel, Albert Einstein, and Leo Szilard, participated in the development of weapons or in scientific or theoretical advances that led to weapons and, then based on a realization of what these weapons could do, tried to prevent the weapons they helped develop from being used [8].

SOCIAL RESPONSIBILITY OF THE SCIENTIST

The ethical issues that lie behind the decision of a scientist to participate or to refuse to participate in research are part of the spectrum of issues that relate to the responsibility of scientists for the social consequences of their work [9–13]. At one end of the ethical spectrum lies the view that research (in contrast to development) is value-free and the scientist therefore has no social or moral responsibility for the ways in which his or her scientific work is applied. This argument was stated explicitly by the sociologist Lundberg and his colleagues in 1929:

> It is not the business of a chemist who invents a high explosive to be influenced in his task by considerations as to whether his product will be used to blow up cathedrals or to build tunnels through the mountains [14].

This view of the amorality of science and the freedom from responsibility of the scientist for its consequences followed in part from the assumptions that 1) scientific progress was the road to human perfection, and 2) that science was "an autonomous force working for man's welfare in contrast to the disruptive force of politics" [15].

The assumptions that scientific work is value free and that scientific findings invariably lead to progress were increasingly challenged in the 1930s and 1940s. Applications of science by Nazi Germany shocked many scientists. Other questions were raised about the role of U.S. physicists in research on nuclear weapons, both by the physicists themselves within the constraints of secrecy of the work during World War II, and later publicly by them and many others [16].

Some scientists have maintained in recent years that the realm of value-free science includes not only work in pure science, such as the original discovery of chlorine or the development of the special theory of relativity, long before there was any application for them in war, but also applied science work on what is clearly intended to be a weapon of war. Professor Louis Fieser, for example, had been leader of a team of Harvard University scientists who developed napalm—jellied gasoline used as an incendiary weapon—during World War II. When asked in 1967 about the use of napalm in that war and later in the Indochina War, he said that he felt free of guilt:

> You don't know what's coming. That wasn't my business. That is for other people. I was working on a technical problem that was considered pressing . . . I distinguish between developing a munition of some kind and using it. You can't blame the outfit that put out the rifle that killed the President. I'd do it again, if called upon, in defense of the country [17].

Fieser, midway in his comment, seems to shift his argument somewhat from absence of any responsibility for the use of the weapon to a justification of his work on the basis of its usefulness "in defense of the country." Many other scientists who explicitly recognize the ethical conflicts involved in work on

weapons argue that a higher ethical principle—the imperative of defending one's country or of helping to curb what is perceived as evil or destructive, leads to a decision to participate in such work. The German, later American, rocket scientist Wernher von Braun wrote in a letter in 1968:

> While right from the beginning I deeply deplored the war and the misery and suffering it spread all over the world, I found myself caught in a maelstrom in which I simply felt that, like it or not, it was my duty to work for my country at war [18]

Dr. Theodor Rosebury, who worked on biological weapons during World War II, explained his participation in a different way. His argument relied not on the defense of his country, but on danger to the world and on his belief that crisis circumstances, expected to pass in a limited time, required that he act as he did. "We were fighting a fire, and it seemed necessary to risk getting dirty as well as burnt," he later wrote [19].

Many of the U.S. and British scientists who worked in the development of controlled nuclear fission for use in weapons shared this sense that their role was to save the world from a greater evil. After it became clear that Nazi Germany had not developed nuclear weapons, a number of scientists felt the work should be suspended and raised objections as it became clear the weapon they helped develop would be used against Japan. Following the nuclear bombing of Hiroshima and Nagasaki, a recognition of the destruction and of the potential future consequences led many of those who had participated to initiate public discussion of the morality of what they had done. J. Robert Oppenheimer wrote in 1949, "the physicists have known sin" and, in 1956, "we did the Devil's work" [18]. The founding of the *Bulletin of the Atomic Scientists* and of the Federation of American Scientists after World War II reflected this moral concern [8,20].

Other scientists who recognized an ethical dilemma in work on weapons resolved it by arguing that their work was designed to reduce the devastation of war. For example, Dr. Knut Krieger, while working on "nonlethal" chemical and biological weapons in the 1960s, argued in defense of his work that the research would lead to decreased fatalities: "... if we do indeed succeed in creating incapacitating systems and are able to substitute incapacitation for death it appears to me that, next to stopping war, this would be an important step forward" [18].

Paradoxically, other scientists argued that development of horrible new weapons made war less likely and was therefore a contribution to lessening its devastation. In 1892 Albert Nobel defended his development of dynamite by predicting that "on the day that two army corps can mutually annihilate each other in a second, all civilized nations will surely recoil with horror and disband their troops" [18]. This concept that research on highly destructive weapons would lead to a lessening of the probability of war was expressed in 1958 by Professor Hans Bethe, a physicist who had worked on the development of the hydrogen bomb. He argued that scientists must help preserve the precarious balance of armament that would make it disastrous for either side to start a war, the basis for the current U.S. strategic nuclear policy of mutually assured destruction (MAD). "Only then," Bethe reasoned, "can we argue for and embark on more constructive ventures like disarmament and international cooperation which may eventually lead to a more definite peace" [21].

Some scientists who felt on ethical grounds they should participate in weapons research in a particular war refused to participate when that war was over. Dr. Rosebury, who believed during World War II that his work on the development of biological weapons, although "dirty," could be morally justified because of the special moral imperative of the fight against Hitler, shortly after the end of the war refused any further participation in such work [22]. Many of the nuclear physicists who began to question work on nuclear weapons after it became clear Germany had no such weapons, or after they were used in Japan, refused to do any further work on them.

The most all-encompassing expression of the view that it is the responsibility of scientists to refuse to participate in any research on weapons of war was given in an oath proposed by one of the participants in the 1962 Pugwash Conference on Science and World Affairs, one of a series of meetings of scientists from different countries to discuss problems of disarmament and world peace:

> Under no circumstances shall I work for war, neither directly nor through any advice. Only

> those who take the same oath shall be admitted to my laboratory and to any learned societies of which I am a member [23].

The Society for Social Responsibility in Science cites the following among its principles:

> To foster throughout the world a . . . tradition of personal moral responsibility for the consequences for humanity of professional activity, with emphasis on constructive alternatives to militarism; to embody in this tradition the principle that the individual must abstain from destructive work and devote himself to constructive work, according to his own moral judgment; to ascertain . . . the boundary between constructive and destructive work to serve as a guide for individual and group decisions and action [24].

Along with the decision whether or not to participate in weapons research is the ethical responsibility to inform and warn the public, and this responsibility is shared by both pure and applied scientists. Those who assert this responsibility note that scientists are often in a unique position to warn the public of specific dangers that special scientific knowledge permits them to perceive earlier or more clearly than others. Debate arises, however, on whether scientists should simply state the facts (which in itself involves deciding what is a fact, which facts to present, and how and where to present them) or should go beyond the facts to state their opinions on the courses of action to which they have been led by their analysis of the facts. Furthermore, many scientists, like others in the community, do not carefully distinguish between fact and opinion in their statements. Since the expertise of scientists in most societies often lends considerable weight to their views, and since there are usually elements of the analysis that lie outside purely scientific expertise, the propriety of public policy statements by scientists has at times been questioned. On the other hand, silence by scientists on urgent public policy issues on which they have relevant technical information has also been questioned as evasion of moral responsibility. The problem of how to avoid scientists' undue power to influence societal decisions, while at the same time maintaining responsibility for the consequences of scientific work is still unsolved.

In summary, we see a spectrum of views on the ethical responsibilities of scientists in relation to work on weapons: complete denial of moral responsibility for the consequences of any scientific work, including work directly contributing to weapons development; recognition of moral responsibility for the consequences of work leading to weapons, but citing of competing obligations that require such work, such as doing one's country's bidding whatever the consequences, or reducing the possibility of war or its devastation; recognition of moral responsibility by refusing any work on weapons; and responsibility to inform or to lead public opinion on policies related to the weapons the scientist helped develop.

SOCIAL RESPONSIBILITY OF THE PHYSICIAN

Narrowing the focus from a consideration of the work of scientists in general in the development of weapons to a consideration of the specific case of the physician-scientist or physician-technologist, the question that first arises is whether it is constructive to view certain ethical responsibilities as peculiar to the physician's social role. The view that appears to be most prevalent holds that along with sharing the moral responsibilities of all scientists and indeed of all people, the physician has special additional ethical responsibilities because of his or her role in preserving life and health [19,25]. Others argue that to assert a special form of medical ethics is arrogant, elitist, and in some ways destructive to the role of the physician, because it conveys increased power and adds social distance between physician and patient.

As evidence for the view that many physicians feel they have special ethical responsibilities, Rosebury described the response to physician participation in work on biological weapons during World War II: "There was much quiet but searching discussion among us regarding the place of doctors in such work . . . a certain delicacy concentrated most of the physicians into principally or primarily defensive operations" [19]. Rosebury goes on to point out that the modifiers principally and primarily are needed "because military operations can never be exclusively defensive," a point which will be discussed below.

The special responsibility of physicians is perceived largely as an ethical responsibility not to use

their power to do harm (primum non nocere). Although only a very small percentage of U.S. medical students now swear to a literal translation of the Hippocratic Oath, this code for physicians is often cited as an expression of their special responsibility: "I will apply dietetic measures for the benefit of the sick according to my ability and judgment; I will keep them from harm and injustice. I will neither give a deadly drug to anybody if asked for it, nor will I make a suggestion to this effect" [26]. While the oath as written seems to apply to the relationship of the physician to an individual patient, its meaning has been broadened by many to proscribe physician participation in actions harmful to others.

A modern version of the Hippocratic Oath, the Declaration of Geneva, developed and regularly revised by the World Medical Association, is sworn to by more graduating U.S. medical students than is the original oath. The relevant portion reads:

> I will not permit considerations of religion, nationality, race, party politics, or social standing to intervene between my duty and my patient; I will maintain the utmost respect for human life from its beginning even under threat and I will not use my medical knowledge contrary to the laws of humanity [27].

In the Prayer of Maimonides, also read at some medical school commencements, the physician beseeches, "Preserve the strength of my body that I may be able to restore the strength of the rich and the poor, the good and the bad, the friend and the foe. Let me see in the sufferer the man alone" [28]. More directly to the point, the Regulations in Time of Armed Conflict adopted by the World Medical Association states:

> The primary task of the medical profession is to preserve health and save life. Hence it is deemed unethical for physicians to: 1) give advice or perform prophylactic, diagnostic, or therapeutic procedures that are not justifiable in the patient's interest, 2) weaken the physical and mental strength of a human being without therapeutic justification, 3) employ scientific knowledge to imperil health or destroy life [29].

Presumably these special proscriptions on the work of physicians are necessary because of the doctor's special skills and special opportunities, both to do good and to do harm. In this context it may be of interest that in Greek mythology, at least until the emergence of Chiron, a good centaur with healing skills, and his pupil Asklepios, a god/human who practiced both protection of health and treatment of disease, the power to heal was closely bound up with the power to harm. Indeed the first deity appealed to in the Hippocratic Oath, "Apollo the Physician," appeared to derive his healing powers in part from the ability he and his twin sister Artemis had to cause acute illness and sudden death by shooting their arrows at mortals. They also had gentle darts that brought the death of old age. Apollo's son, Asklepios, who is the next to be cited in the Hippocratic Oath and whose healing work is mentioned in the *Iliad*, used his skills only for good and is called a "blameless physician" by Homer [30].

In summary, there seems to be a general consensus that physicians participate in weapons research at their ethical peril, even if their country demands it or they think it useful for deterrence or other preventive purposes. Because of the ambiguity of "defensive" work on biological weapons, the dilemma for the physicians is not easily resolved even for those who believe that defensive efforts are ethically permissible.

THE NATURE OF BIOLOGICAL WEAPONS

The horrors of biological weapons are expressed by one of only 10 Genoese and Venetian travellers out of 1,000 who survived a 1346 siege of the walled city of Caffa (now called Feodosia), a seaport on the east coast of the Crimea:

> "The Tartars, fatigued by such a plague and pestiferous disease, stupefied and amazed, observing themselves dying without hope of health, ordered cadavers placed on their hurling machines and thrown into the city of Caffa, so that by means of these intolerable passengers the defenders died widely. Thus there were projected mountains of dead, nor could the Christians hide or flee, or be freed from such disaster. . . . And soon all the air was infected and the water poisoned, corrupt and putrified, and such a great odor increased . . . . So great and so much was the general mortality that great shouts and clamor arose from Chinese,

> Indians, Persians, Nubians, Ethiopians, Egyptians, Arabs, Saracens, Greeks, who cried and wept, and suspected the extreme judgment of God" [31].

Equally evocative is the definition of biological warfare published in 1959 by what was then called the U S. Department of Health, Education and Welfare:

> Biological warfare is the intentional use of living organisms or their toxic products to cause death, disability or damage in man, animals, or plants. The target is man, either by causing sickness or death, or through limitation of his food supplies or other agricultural resources. Man must wage a continuous fight to maintain and defend himself, his animals, and his plants in competition with insects and micro-organisms. The object of biological warfare is to overcome these efforts by deliberately distributing large numbers of organisms of native and foreign origin, or their toxic products, taking full advantage of the ability to utilize more effective methods of dissemination and unusual portals of entry. Biological warfare has been aptly described as public health in reverse [32].

When the Geneva Protocol was negotiated in 1925, prohibition of use of "bacteriological methods of warfare" was added to what had originally been envisaged as purely a chemical weapons treaty. Many of the nations ratifying the Protocol reserved the right to use such weapons in retaliation if they were first used against them, and the Protocol became essentially a no-first-use treaty. Furthermore, the Protocol did not in any way limit the development, production, testing, or stockpiling of either chemical or biological weapons, only their use [33].

Despite the Protocol, there is evidence that both chemical and biological weapons were used in the wars of the 1930s and 1940s [34]. It is reliably reported, for example, that in the 1930s invading Japanese troops brought into China rice and wheat mixed with fleas carrying plague, resulting in plague in areas of China that had not experienced plague before. Extensive experiments were conducted in Japanese laboratories on prisoners of war from a number of different countries testing a wide variety of agents including anthrax, plague, gas gangrene, encephalitis, typhus, typhoid, hemorrhagic fever, cholera, smallpox, and tularemia [35]. The U.S. acquired this information after the end of the war but, unlike the 1949 Soviet prosecution of 12 of those involved in work, the U.S. never tried any of the participants. Instead, U.S. researchers met with Japanese biological warfare experts in Tokyo and urged that the experts be "spared embarrassment" so the U.S. could benefit from their knowledge [36–38].

According to testimony at the Nuremberg trials, prisoners at German concentration camps such as Buchenwald were infected to test response to biological agents. The British are known to have released anthrax spores on Gruinard Island off the coast of Scotland to demonstrate the spread of the disease to the animal population of the island; the island remained uninhabitable for many years. Churchill is said to have considered anthrax as a weapon, although it was never used. In the U.S., work on anthrax and brucellosis as weapons was performed and a plant was constructed in southern Indiana for the production of anthrax bombs; only a prototype was actually produced and tested in Utah [39].

Since World War II there have been numerous allegations of biological weapons development and even use, although every one of the reports of actual hostile use are unsubstantiated. In the United States it was revealed in 1969 that in the 1950s and 1960s the University of Utah had, under contract, conducted secret experiments at the U.S. Army Dugway Proving Ground involving large-scale field testing of biological warfare agents including tularemia, Rocky Mountain spotted fever, plague, and Q fever. In 1950, U.S. Navy ships in the San Francisco Bay area released large quantities of aerosolized Serratia marcescens and Bacillus globigii (Bacillus subtilis variant niger), believed to be nonpathogenic, to test dispersal efficiency. Subsequent infections and deaths from Serratia, particularly among immunologically compromised individuals, were later attributed by some analysts to this release. During the 1950s and 1960s, the U.S. conducted 239 top-secret open-air disseminations of simulants, involving such areas as the New York City subways and Washington National Airport [40]. During the 1950s and 1960s, a large infrastructure of laboratories, test facilities, and production plants related to chemical and biological weapons was constructed in the U.S., and by the end of the 1960s, the U.S. government

had at least 10 different biological and toxin weapons available [41].

In 1969 the Nixon Administration, with the concurrence of the Defense Department, which declared that "biological weapons lacked military usefulness," unconditionally renounced U.S. development, production, stockpiling, and use of biological weapons, and announced that the U.S. would unilaterally dismantle its biological weapons program. In 1972, the U.S.S.R. ended its opposition to a separate biological weapons treaty (it had urged a more comprehensive treaty) and the Convention on the Prohibition of the Development, Prevention, and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction was negotiated [42]. The Biological Weapons Convention (BWC) prohibits the development or acquisition of biological agents or toxins, as well as weapons carrying them and means of their production, stockpiling, transfer, or delivery, except for "prophylactic, protective, and other peaceful purposes." The BWC was ratified by the U.S. Senate in 1975 (the same year in which the Senate belatedly ratified the Geneva Protocol of 1925). As of December 31, 1987, 110 nations had ratified the BWC and an additional 25 nations had signed but not yet ratified it [43]. Until the 1988 Intermediate Nuclear Force Treaty, it was the only treaty in modern times to prohibit possession as well as use of weapons.

Invoking the specter of possible new biological weapons produced by genetic engineering techniques, and unproved allegations of aggressive biological weapons programs in other countries, as well as the absence of proscription of defensive efforts by the BWC, the Reagan Administration initiated intensive efforts to conduct "defensive" research. The budget for the U.S. Army Biological Defense Research Program (BDRP), which sponsors programs in a wide variety of academic, commercial, and government laboratories, increased from $15.1 million in 1981 to $60 million in 1988 and the basic research component of BDRP activities increased 60-fold from 1981 to 1986. Much of this research work is medical in nature, including the development of immunizations and of treatment against organisms that might be used as weapons [44].

Even though offensive work on biological weapons has been internationally outlawed, it is important to reiterate the special ethical issues involved in their development and potential use. First, these are weapons of indiscriminate mass destruction. If noncombatants are specific targets, as they have been in recent years for chemical weapons, civilians constitute the most vulnerable and least protected segment of the population and widespread civilian casualties would likely result. Even if attempts are made to target only hostile military forces, biological agents spread through populations in highly unpredictable ways and could cause vast unintended damage to both combatants and noncombatants. Examples of such unpredictability can be found even among naturally occurring diseases. The measles virus, although usually relatively benign, can cause extremely high case fatality rates under certain conditions. A measles epidemic in Fiji in 1875 killed 20–25% of the unprotected islanders, and an epidemic in Boer concentration camps in 1900 caused many deaths among the weakened women and children [45]. In short, because of their potential impact on noncombatants and their inherent failure to limit destructiveness to the minimum necessary to achieve a defined military purpose, use of these weapons cannot be justified even in what has been defined ethically as a "just" war.

Second, development or use of biological weapons systems may lead to further attrition of international law. The Geneva Protocol of 1925, which outlawed their use, has been weakened. In 1969, for example, the majority of nations party to the Protocol declared via their positions on United Nations General Assembly resolution 2603A (XXIV), that the use of harassing incapacitants is forbidden by the Protocol. Yet the U.S. used such weapons, calling them riot control agents, and stated that it considered them outside the scope of the Protocol [46]. More recently weapons that are unquestionably covered by the Protocol have been used with impunity by several nations. For example, the use of mustard gas, nerve gas, and perhaps other chemical weapons by Iraq in its war with Iran, and against its own Kurdish population evoked no effective protest by the U.S. or by the world community. With regard to the BWC, it has been recently conjectured that Iran is developing biological weapons [47] and that less developed nations and terrorists may be capable of producing and using them [48,49]. The more biological weapons are developed, and the more widespread the knowledge of them becomes, the weaker the BWC will become. Damage to these existing arms

control treaties threatens all arms control and disarmament efforts [50].

Turning from the ethical issues posed by offensive research to those of defensive research, a number of concerns about defensive research have been raised.

1. There is ample precedent for masking the work of facilities developing biological weapons by calling them preventive laboratories. The Japanese laboratory established in 1933 for developing such weapons was called the Epidemic Prevention Laboratory. One of its activities was supplying vaccines for troops bound for Manchuria, but its major work was developing and testing weapons [38]. Military forces today could knowingly conduct research on offensive use of biological weapons under the cover of defensive research since, as we have noted, offensive and defensive research are inextricably joined for at least some phases of the work. During the parts of the work in which offensive and defensive efforts parallel each other, it is possible (indeed probable, if military researchers are conscientiously working to explore forms of organisms against which defenses might be needed) that new forms of organisms may be found or developed that would be *more* effective as biological weapons (Table 1). Indeed, it is difficult to imagine testing medical defenses against organisms not ordinarily found in nature except by producing such organisms. There may be a temptation to test the defense by trying it out against the offensive organism. And someone in a military-sponsored laboratory may be tempted, ostensibly in the interest of defense, to go further in the study of more virulent or more stable or more easily disseminated organisms.

The possibility that offensive work is being done in the U.S. under the cover of defensive work has been denied by the leadership of the BDRP, who point out the divergence between the two types of research [51]. Nonetheless, critics of the BDRP programs raise questions about the ambiguity of the BDRP defensive research [52]. Piller and Yamamoto, for example, argue that "these efforts are highly ambiguous, provocative and strongly suggestive of offensive goals" [44] (Table 2). Given what is known of the secrecy and duplicity of military efforts in many nations, it is surely possible that a physician-scientist in some nation might either consent to or be misled into work intended for offensive use under the guise of recruitment for defensive work.

Table 1. Potential Offensive Applications That May Be Masked by Stated Defensive Goals

Stated defensive goals	Potential offensive applications
Vaccine development	Novel BW agents, defeat vaccines, increased toxin production, supertoxins
Toxin and antigen isolation and characterization	Novel BW agents, defeat vaccines, increased toxin production, supertoxins, biological vector delivery
Diagnostics and ultra-sensors	Biological vector delivery, novel BW agents, defeat vaccines
Development and use of antibodies as therapeutics	Novel BW agents, defeat vaccines, inhibit diagnosis

Adapted from data in Piller and Yamamoto, p. 140 [44]

2. Analyists believe that biological weapons research, even if truly defensive in intent, may be dangerous to surrounding communities if virulent infectious organisms are accidentally released, although no examples of such release have yet been convincingly documented. Concern has been raised about the safety of several aspects of the work of the BDRP. The proposals for construction of a Biosafety Level 4 Laboratory in Utah for testing aerosals of virulent organisms were modified, as a result of protest, to a proposal for a Biosafety Level 3 Laboratory at which testing of the most dangerous aerosols would be prohibited [44]. Research on anthrax being conducted under BDRP sponsorship at the University of Massachusetts has been the subject of intense protest [53,53a].

3. Biological weapons research, even if truly defensive in intent, can be viewed by a potential military adversary as an attempt to develop protection for a nation's military forces against an organism that the nation itself might wish to use for offensive purposes, thus permitting that nation to protect its own personnel in a biological first strike. Adversaries know that any nation secretly preparing a stockpile of biological weapons for use in war (whether intended as deterrence, retaliation, or first use) would be likely to prepare vaccines and other defensive measures to protect its own troops and population. Indeed, the reason military leaders are

Table 2. Ambiguous Research Projects Sponsored By The BDRP

Project	Probability of effective end use		
	Public Health	Biological warfare	
		Defense	Offense
Aerosols of anthrax, T-2 mycotoxin, Junin virus	zero	zero-low	medium-high
Anthrax vaccine	low-medium	zero-low	medium-high
Cloning of toxin genes	low	zero-low	medium-high
Virulence factors	medium-high	zero	low
Hibernation induction trigger	zero-low	zero-low	low-medium

Source: Wright p 185 [52]. Reprinted with permission of publisher, from Wright S, ed. Preventing a biological arms race Cambridge, MA: MIT Press, 1990

likely to give for the preparation of any form of altered bacilli or viruses, in order to give the appearance of compliance with the BWC, is that these organisms are needed for preparation of defenses. It is impossible for adversaries to determine whether a nation's defensive efforts are part of preparation for offensive use of weapons.

Many of the fears of other nations (shared by a number of analysts in the U.S) are based on the military sponsorship of defensive research. Other nations may view with suspicion, even if the research is relatively open, the intense interest of military forces (in contrast to civilian medical researchers) in vaccines or treatment against specific organisms, particularly organisms that are not found in nature or cause few problems unless purposely spread. Such fears about the work of the BDRP, as well as concern about defensive programs in other nations, help feed a continuing arms race in biological weapons. Just as the U.S. Army supports its requests for appropriation of funds in this area by citing suspicions and possible exaggerations of what others are doing, so the armies of other countries try to maximize their resources by casting not unreasonable suspicions on what the U S. is doing. Indeed it was Dr. Shiro Ishii's 1930 report, almost certainly untrue, but unfortunately very plausible, that the most powerful Western countries were secretly studying biological weapons that led to Japan's embrace of biological weapons research and eventual use [37].

Concern has also been expressed about the militarization of genetic engineering and of biology in general, just as much of physics was militarized during World War II. Characterization of biological weapons as "public health in reverse," may therefore have an even broader and more sinister meaning than simply the use of specific forms of disease in military armamentaria. The entire field of biology—and particular aspects of it such as the Human Genome Research Project—may be in danger of military subversion to destructive ends [54,55]

WHAT SHOULD BE THE PHYSICIAN'S ROLE?

Some proponents of defensive research on biological weapons have argued that it is entirely ethical that physicians work on the defensive aspects of biological weapons, and in fact that responsibility demands it [56]. Advocates for the BDRP support this argument with the possibility of the use of such weapons against the U.S , and their opinion that work on defenses may also be useful in developing protection against naturally occurring diseases, both diseases we already face and those that may arise in the future. Huxsoll, Orient, and others believe it is the obligation of physicians and other medical scientists to work on such defensive measures and argue there is no ethical reason for this work not to be done within the BDRP [51,57].

Many other analysts, including the author of this paper, take a different position [58–60]. Joining Piller and Yamamoto in viewing the BDRP program as "highly ambiguous, provocative and strongly suggestive of offensive goals," we believe it unethical for physicians to play a role in it. Such work, we believe, rather than reducing the possibility of the use of biological weapons or reducing the consequences of their use, has a strong potential for intensifying a biological arms race and helping to militarize the science of biology, thereby increasing the risk of the use of biological weapons and the destructiveness of their effects if they are used.

The question is where on the slippery slope of physician participation in preparing for war or in binding up the wounds should physicians draw the line? Should physicians, as Ryle suggested in the 1930s, refuse all participation, including noncombatant treatment roles, thus making war more horrible to contemplate and therefore less likely to occur [61]? Should physicians refuse to participate in civil defense planning for nuclear war because these efforts too are ambiguous, provocative and, when conducted in a nation with first-strike nuclear potential, suggestive of offensive goals [62]? Whatever the physician's answer to these questions, which appear to represent even broader potential refusals to participate in preparation for war or in binding up its wounds, we believe it ethically necessary for physicians to draw a line short of participation in military-sponsored defensive research on biological weapons. If physicians engage in civilian-sponsored research that carries an obligation to report all findings in the open literature, even if the research may have implications for defense against biological weapons, we believe physicians who participate cannot be ethically faulted. It is when physicians engage in military-sponsored research, in which the openness of reporting has been disputed and the purposes may be ambiguous, that they cannot be distinguished ethically from those who work on the development or production of weapons.

Fortunately, there is a way to de-escalate the biological arms race, the trend toward militarization of biology, and the ethical dilemmas for physicians. As we have noted, the BWC prohibits any "development, production, stockpiling, transfer, or acquisition of biological agents or toxins" except for "prophylactic, protective, and other peaceful purposes." The responsibility for governmentally sponsored medical research for prophylactic, protective, and other peaceful purposes in the U.S. lies largely with the National Institutes of Health (NIH) and the Centers for Disease Control (CDC). The NIH or the CDC should therefore be given the responsibility, and the resources, for medical research of this type. The U.S Army may still want to conduct nonmedical research and development on defense against biological weapons, such as work on detectors, protective clothing, and other barriers to the spread of organisms, but such research is less likely to be seen as offensive, and is less likely to provoke a biological weapons race, less likely to pervert the science of biology and, for our purposes most importantly, less likely to involve physicians.

In addition to the ethical dilemmas involved in these decisions, it may also be unethical for physicians simply to ignore the issue of biological weapons. One of the greatest dangers of these weapons may be the apathy of the medical profession toward them. The fact that biological weapons are the one with which physicians may become engaged and one about which they have specialized knowledge gives physicians a special responsibility not only to refuse to work on them, but also actively to work to reduce the threat of biological weapons development or use. Such efforts might include support of measures to strengthen the BWC through introduction of more restrictive interpretations to eliminate ambiguities and of new verification proposals that will be considered at the Third BWC Review Conference scheduled for 1991. U.S. physicians may also wish to support legislation to transfer all medical aspects of biological defense from the military to the NIH or the CDC.

More broadly, physicians may wish to explore the connection between production of nuclear weapons and production of chemical or biological weapons. It has been argued that as the nuclear powers refuse to reduce substantially their vast stockpiles of nuclear weapons and refuse to agree to verifiable cessation of nuclear weapons testing and production, nonnuclear powers contemplate development and production of chemical or biological weapons for deterrence against nuclear weapons. The U.S. Defense Intelligence Agency has reported that "... third world nations view chemical weapons as an attractive and inexpensive alternative to nuclear weapons" [63], a view confirmed by statements by Saddam Hussein, President of Iraq [64]. There is much physicians can do, through Physicians for Social Responsibility in the U.S. and the International Physicians for the Prevention of Nuclear War, to reduce the provocation and the proliferation of weapons of mass destruction caused by the nuclear arms race.

Individual physicians and scientists can also add to the awareness of the dangers of biological weapons by signing the pledge, sponsored by the Council for Responsible Genetics (186 South Street, Boston, MA 02111), "not to engage knowingly in research and teaching that will further development of chemical and biological warfare agents." Physicians may

also wish to help awaken the medical profession to the danger of biological, chemical, or nuclear war by adding a clause to the oath taken by medical students at graduation from medical school. This method has already been used in the U.S.S.R. for alerting students to the dangers of nuclear war. All Soviet students are required to sign upon graduation an oath that begins: "Upon having conferred on me the high calling of physician, and entering medical practice I do solemnly swear . . ." In 1983 a clause was added to the oath that reads: "Recognizing the danger that nuclear weapons present for mankind, to struggle tirelessly for peace and for the prevention of nuclear war" [65]. A modified form could be used in the U.S., with wording along the lines of: "Recognizing that nuclear, chemical, and biological arms are weapons of indiscriminate mass destruction and threaten the health of all humanity, I will refuse to play any role that might increase the risk of use of such weapons and will, as part of my professional responsibility, work actively for peace and for the prevention of their use."

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