

Misperceptions in preparing for biological attack: an historical survey

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Summary

Preparing for a biological attack involves analysing and co-ordinating information and events in the scientific, political and social arenas. The information that must be evaluated is, by definition, incomplete. It is not surprising that such interactions have regularly resulted in erroneous conclusions and flawed interventions. This historical survey examines instances where significant errors have occurred. The author describes several examples in each of three broad categories: misapprehensions of the risk of biological attack; misappraisals of an anomalous event as a biological attack; and misadventures in pre-emptive action to protect against a biological attack. The study identifies significant common elements in each of these errors that may be useful in avoiding future mistakes. In evaluating the effects of these errors, the study concludes that such mistakes often increase the dangers that they seek to avoid.

Keywords

Anthrax – Biological weapons – Botulinum toxoid – Disinformation – Germ warfare – History – Immunisation – Military medicine – Misinformation – Misperception – Propaganda – Smallpox – Vaccine – Yellow fever – Yellow rain.

Introduction

Biological scientists are sometimes asked to advise political policy-makers on the appropriate responses to threats of biological attack. Such decisions can only partly depend on orthodox biology, in which established scientific principles are applied to reliable data. The science applied to possible biological attack is, of necessity, somewhat tentative. Empirical field data on biological attacks are scarce, laboratory experience does not reliably translate into field behaviour, and many hypotheses on the sequelae of biological attacks must be speculative. Equally importantly, biological attacks and the threat of attack are political as well as biological events. History demonstrates that political perceptions play an important role in decisions on the magnitude of the threat.

In this paper, the author surveys a number of episodes in which science and politics were deciding factors in

assessing the threat of biological attack. Since both the scientific and political aspects of any attack involve much uncertainty, it is not surprising that significant errors have occurred. These errors will be examined as 'cautionary tales'.

This paper will address three broad areas of scientific/political interaction:

- estimating the risk of a biological attack
- evaluating whether an outbreak is the result of a biological attack
- taking pre-emptive measures to counter the threat of a biological attack.

Since examples involving animal diseases are rare, this survey will rely on the more plentiful examples involving human disease.

Global misapprehensions in risk evaluation

The specific nature and probability of biological attacks are crucial elements in all decisions on possible attack. On four occasions, major powers have mistakenly concluded that an adversary posed a risk of using biological weapons when, in fact, no such risk existed.

These conclusions were by no means unreasonable. In each case, the adversary had a 'suspect history'. In each case, the adversary used force to promote basic policy. In the case of 'suspect' countries, each had previously developed and used chemical weapons in violation of international law, and already had a biological weapons capability. Unfortunately, such misapprehensions have not been harmless and cannot be accepted uncritically as 'erring on the side of caution'. They have diverted vital scientific resources, both human and economic, from actual threats of natural disease, and have had the paradoxical effect of increasing, rather than decreasing, the risk of biological warfare (BW).

One important element in these global failures of risk evaluation is that, in each case, the most important intelligence indicating a BW programme came from sources that were ultimately proved to be deliberately fabricated. In two cases, pivotal information came from émigrés who invented evidence that a regime they opposed actually held biological weapons. In another instance, a 'friendly' agent apparently made a biological attack on his or her own country to raise the level of concern and stimulate defensive measures. Such agents may be termed 'alarmist hoaxers'. In two cases, a government disseminated erroneous 'incriminating' information on its own capability as part of a disinformation or psychological warfare campaign. Important supporting fabrications have been created by opportunists who wish to profit by producing marketable espionage information.

The misapprehension of a German biological warfare threat during World War II

In World War I, Germany had initiated both chemical and biological warfare in violation of existing arms control treaties. When Nazi Germany re-armed, it withdrew from arms control negotiations and the League of Nations, and soon made territorial demands on its weaker neighbours. It was clearly a suspect regime.

The governments of France, Britain, Canada and the United States of America (USA) eventually concluded that Germany had pursued a biological weapons programme since the early 1930s. As a direct consequence, these countries established or expanded their own biological

weapons programmes. However, in reality, Hitler had forbidden any development of offensive biological weapons. In fact, the German BW programme was insignificant and posed no threat to the Allies (30).

A central event in the Allied conclusion that Germany was developing biological weapons occurred in 1934, when Wickham Steed, a respected British investigative journalist and one-time editor of *The Times*, published a series of allegations on the subject (79). These allegations were based on documents supplied by an anti-Nazi German émigré. The documents were claimed to be German military reports from 1931 to 1933, describing an active BW programme, both before and after the rise of Hitler. These papers also reported the results of alleged German field trials in the subway system of Paris in August 1933. (These trials apparently used *Serratia marcescens*, a bacterium then commonly used to trace airborne microbial contamination, which was considered harmless at the time.) Steed appeared convinced of the validity of the documents, and shared them with British intelligence before publication (35).

Investigators have always felt that, because of internal scientific blunders, all or some of the Paris subway data were likely to have been fabricated (13, 30, 35). Access to German military archives after re-unification has allowed clarification of the remaining Steed documents. Writing before these archives were opened, Hugh-Jones felt that the Steed documents describing a German BW programme between 1931 and 1933 were probably genuine, based on their concurrence with statements by German BW advocates in the public literature and with independent British intelligence reports of German BW activity. Geissler, working in the German military archives, found a significant body of discussion on BW from the early 1930s, but these official deliberations expressed considerable scepticism about the military usefulness of BW. Geissler failed to find evidence of an active BW programme as described in the Steed documents. No records of subway field tests in foreign countries were found and tests and lectures cited in British intelligence reports could not be corroborated in German records. Indeed, Geissler found indications of an internal German military investigation of the Steed allegations in 1934 that found no evidence for their validity. Geissler concludes that Steed was the victim of a hoax (30).

The Steed documents were part of a larger campaign mounted by anti-Nazi émigré writers to alert the world to the dangers of German re-armament. Allegations that the Nazis were developing biological weapons occupied a prominent place in this campaign. The BW element may have been motivated by a genuine concern that Germany was indeed pursuing such weapons, or a desire to associate the Hitler regime with outlawed weapons that threatened European civilian populations, or a combination of these

motives. Certainly, this campaign progressed to clearly erroneous, fabricated allegations. Helmut Klotz raised the alarm in 1934 (49), when he reported that the German Army had developed BW before Hitler came to power, and that Hitler supported BW as a military tactic. These charges mirror those in the documents given to Steed in 1934. Klotz published a series of books with progressively more threatening descriptions of Nazi BW capability. In 1934, he added a *bona fide* citation of a Nazi publication advocating BW (48). However, in 1935, he made the unlikely (and, in retrospect, clearly wrong) allegation that an aerosol-generating 'Himmeler Bomb' had been developed within six weeks of the Nazi Party gaining power, and that a single bomb, only 25 cm tall and 16 cm in diameter, could infect between 500,000 and 800,000 urban inhabitants (50). In 1937, Klotz described additional erroneous German BW capabilities, identifying anthrax as a BW agent and describing glass aerial bacteriological bombs (51). Otto Lehmann-Russbuehdt (who supplied the German documents to Steed in 1934) published *Germany's Air Force* in 1935 (53), with a chapter devoted to German preparations for chemical and biological warfare. Moreover, he reprinted the articles written by Steed in an appendix. Heinz Liepmann, who had examined the Steed documents in 1936, echoed the Klotz allegations in his 1937 book, *Death from the Skies* (58).

These warnings resulted in the acceleration of the small French BW programme (57) and the establishment of a British BW programme. The British programme initially concentrated on defensive measures, such as establishing a national system of Public Health laboratories, but later began offensive research as well (8).

With the beginning of World War II in 1939, opportunists began to capitalise on the Allied concern regarding German BW, and created false reports of German BW activities. Some reports were public, such as that of Hermann Rauschnig, who began his 1940 memoir by recounting that Hitler had advocated using bacteriological weapons in 1932 (68). Others, including a report by Rauschnig in 1941 of German plans for BW attacks on British ports, were provided directly to British intelligence for payment or favourable treatment as refugees. These reports in general, and the work of Rauschnig in particular, have been discredited by recent scholarship (30, 45).

After 1941, there were few reports of German BW efforts (59), except for several in early 1944, before the Normandy invasion, which warned that:

- rats were being collected and infected with rabies to be dropped on Britain
- BW warheads would be used on the new V-1 and V-2 missiles

– BW attacks would be used against the expected Allied invasion of Europe (5, 87).

All of these reports were initially treated seriously, but soon appeared to be part of a German psychological warfare disinformation campaign to seed fear of BW attack. The validity of these reports was strongly doubted before the invasion, and discredited afterwards (88).

Throughout the war, the intelligence branch of the US BW programme remained convinced that Germany was pursuing the development of biological weapons. Those in the British and Canadian programmes concurred. This was despite the fact that other sources of information consistently failed to indicate any German preparations for BW, either offensive or defensive. Revision of the standard German gas masks did not increase their protection against BW agents. Moreover, monitoring the immunisation records and serum antibodies of captured German troops gave no indication of any immunisation programme to protect against potential BW agents (88).

When Germany fell, Allied intelligence services rigorously investigated German BW efforts, and found that all research on offensive BW weapons had been forbidden by Hitler. Some defensive research had been conducted following the German discovery of the French BW programme. What little offensive research existed had been conducted against the order from Hitler. The German BW programme was insignificant and posed no threat (30).

This global intelligence failure had ironic, unintended consequences. Biological weapons had been considered militarily impractical by a League of Nations expert panel in 1925, and the military of most countries had agreed. Only France, Japan and the Union of Soviet Socialist Republics (USSR) had BW programmes before the Steed publications. The Steed and associated émigré publications served to stimulate the establishment of offensive BW programmes in the USA, Britain and Canada. These large, well-funded, national military BW programmes ultimately developed the very weapons that the alarmist hoaxers had raised such concern over.

The Soviet misapprehension that the United States of America continued an offensive biological warfare programme post 1969

In 1969, the USA unilaterally renounced biological weapons and dismantled its offensive BW programme. The USA ratified the 1925 Geneva Protocol (4) and promoted the Biological Weapons Treaty (6) (later passed in 1975), which outlawed the production or possession of biological weapons. The US BW programme was limited to defensive research. At least until the 1990s, no classified or clandestine BW research seems to have occurred. However,

in the 1970s, 1980s and 1990s, despite signing the Biological Weapons Treaty, the USSR began a massive clandestine programme to expand and modernise its offensive BW capability. This campaign was motivated, at least in part, by the conviction that the USA was also pursuing an offensive BW programme, in violation of the Treaty (1). It is true that the polarisation of these two superpowers during the Cold War supplied ample reason for mutual distrust, and that the USSR might well have decided to violate the Treaty in any case. Nevertheless, the Soviet belief that the USA was already violating the Treaty allowed BW advocates in the USSR to cite this supposed BW arms race to justify placing a high priority on the Soviet BW programme.

From the Soviet viewpoint, the USA met the criteria for a suspect regime. The USA was willing to make military interventions in areas of vital interest, such as Vietnam and Latin America. The USA had used very large amounts of chemical defoliants and riot control agents (tear gases) during the Vietnam War. Most countries considered these agents to be violations of the 1925 Geneva Protocol banning chemical warfare, as expressed in an 83-to-3 vote in the United Nations (UN) General Assembly Resolution in 1969 (64). Only the USA and a few other close allies maintained that use of non-lethal riot control agents and herbicides in war was not prohibited by the 1925 Geneva Protocol. The USA had acknowledged the existence of an offensive BW programme before the 1969 disavowal. The effectiveness of the order by President Nixon, disavowing biological and biotoxin weapons, was called into doubt in 1975 when it was discovered that the Central Intelligence Agency (CIA) had maintained a stockpile of biotoxins, in defiance of his intent (96).

Suspicion that the USA might be breaking the Treaty increased when the USSR received espionage information that the USA was indeed continuing to pursue an offensive BW programme. This information was part of an ill-considered disinformation campaign of the CIA, which was intended to divert Soviet resources into unrewarding paths (29). Not until the early 1990s, when the Trilateral Agreement (7) for mutual inspection of BW facilities allowed direct Soviet access to suspected US BW facilities, did the Soviets begin to doubt that the USA had a secret programme. Inspections revealed only facilities that had been abandoned for over 20 years (1).

The erroneous Soviet belief that the USA was continuing its offensive BW programme resulted in the following:

- a massive expansion of Soviet BW facilities
- the development of effective anthrax and smallpox biological weapons
- the training of a large cadre of technical personnel in bioweapons skills.

This legacy complicates efforts to control biological weapons to this day.

The 2001 postal anthrax attacks in the United States and the misapprehension that Al-Qaeda possessed a biological warfare capability

Immediately after the attacks of 11 September 2001, the US Government stated that it believed Al-Qaeda may already have the capability to use biological weapons in terrorist attacks (23). In October, the USA launched its military operations against Al-Qaeda and the Taliban in Afghanistan.

In mid-October, cases of anthrax were recognised in Florida, New York and Washington, DC, and investigators immediately saw links to the 11 September Al-Qaeda terrorists (41, 42). President Bush stated on 24 October that he felt that Al-Qaeda was responsible for the anthrax attacks (12). Previous assessments (23) had concluded that terrorist groups such as Al-Qaeda might receive biological weapons from states which sponsored terrorism, and on 27 October a report was released linking Al-Qaeda with Iraq (83). A persistent assumption that Al-Qaeda, Iraq and biological weapons were linked was expressed in US government policy and became established in the popular consciousness of many in the USA.

Subsequent events showed this assumption to be wrong. The perpetrator appeared to be a scientifically trained American alarmist hoaxer who, while trying to implicate Islamic terrorists, had simultaneously attempted to minimise fatalities by identifying the material as anthrax and warning that immediate antibiotics were needed.

The lack of any subsequent anthrax attacks was consistent with the action of an alarmist hoaxer who had succeeded in raising the alarm about biological weapons, and had no interest in causing further American casualties. Scientific investigation revealed that the material was not related to the Iraqi weapon strain (10), but was a closely held US anthrax strain, which resembled anthrax preparations produced by the US weapons programme (9, 11).

Military successes in Afghanistan allowed the inspection of many core Al-Qaeda facilities and resulted in the capture of many Al-Qaeda documents. These revealed that, despite some interest expressed in biological weapons in training manuals, there was no sophisticated understanding of the topic. No evidence of imported BW pathogens or biological weapons was found, and there were no facilities capable of producing biological weapons (43).

The alarmist hoaxer of the 2001 postal attacks presumably wanted to force the USA to address the potential danger of biological attack by terrorists. This apparent hoax

succeeded. The attack demonstrated the practicality and disruptive effect of even a small biological attack using anthrax on an element of the infrastructure, such as the US Postal Service. However, the increased emphasis now placed on bioterrorism response means that it competes directly for funds and scientific expertise with existing requirements in orthodox public health and medical research. In addition, the great attention paid to biological weapons after the 2001 postal attacks can only increase the interest of terrorists in obtaining such weapons.

The misapprehension of an Iraqi biological warfare capability before the 2003 invasion by the Coalition

The USA justified the invasion of Iraq in 2003 by the 'Coalition of the Willing' principally with the assertion that pre-emptive military action was needed to neutralise illegal Iraqi 'weapons of mass destruction'. However, inspections by the International Atomic Energy Agency had already led the agency to conclude that Iraq had no nuclear weapons programme (24). Thus, the US justification for military action relied heavily upon the alleged possession of a biological weapons capability (93). Subsequent investigations by the USA after the invasion failed to reveal any biological weapons or production facilities (39, 40).

Iraq certainly met the criteria of a suspect regime. Iraq had invaded Iran in 1980 and Kuwait in 1990. Iraq had initiated chemical warfare in the Iran-Iraq War and against Kurdish separatists. The UN inspections in the aftermath of the 1991 Gulf War discovered an offensive BW programme that had not been disclosed and had remained hidden for several years (85).

Although known Iraqi BW facilities were destroyed under UN supervision following the 1991 Gulf War, UN inspections ceased after 1998. From 2000, US intelligence received reports from a small number of Iraqi defectors that the BW programme had been reconstituted. These sources were considered valid by US policy-makers, despite failures to confirm their descriptions of the supposed Iraqi programme.

A well-publicised early source was Adnan Ihsan Saeed al-Haideri, a civil engineer who defected in 2001 and stated he had worked on or visited over 20 underground BW production facilities, and produced construction contracts for them (60). His accounts continued to be cited by US policy-makers (61, 100), even after UN inspectors returned to Iraq in November 2002 and could not locate the supposed underground facilities, even using ground-penetrating radar (33). Another major source was an informant called 'Curveball', a chemical engineer, who described mobile BW production facilities (22). Like al-Haideri, his information continued to be accepted as valid,

despite evidence from satellite surveillance that his description of fixed facilities was incorrect and the mobile units could not have been serviced as he reported.

Moreover, his description of the operation of the mobile facilities failed on a fundamental microbiological fact. 'Curveball' claimed that Iraq operated the mobile units only during the Moslem Sabbath, to avoid UN inspections, and US Secretary of State Colin Powell used this 'Sabbath production' scenario at the UN in his justification for military intervention, on 5 February 2003. However, the production of anthrax spores requires more than the allotted 24 hours. This was pointed out by a recognised biological expert immediately after the UN presentation (98).

Ultimately, the reports of Iraqi BW production proved to be fabrications generated by an Iraqi exile group anxious to provide evidence that would motivate the USA to invade Iraq, overthrow Saddam Hussein, and thus provide political opportunities for these exiles in a subsequent Iraqi regime (22).

The mistaken contention that Iraq possessed biological weapons in 2003 called into question US ability to detect illegal biological activities. This reduction in US credibility, in turn, prejudiced efforts to institute pre-emptive defence measures against biological attack.

Misappraisals when evaluating events: erroneous allegations of biological warfare use

Misappraisals can occur when a *bona fide* threat of BW use exists but suspicious events are interpreted as BW attacks when in fact they are not. As with global misapprehensions of BW risk, such allegations do not appear unreasonable. These misappraisals typically occur in circumstances:

- a) where an adversary has a well-established, credible BW capacity
- b) when there is continuing military or secret sabotage, in which biological attacks might reasonably be considered
- c) when anomalous outbreaks of disease are reported.

The urgent need to implement defensive measures may result in action being taken on the basis of a preliminary scientific assessment, before a more complete investigation can be conducted. History indicates that investigating scientists may be presented with fabricated data. Even extensive scientific investigation may not be definitive, and the final appraisal may depend upon political assumptions rather than scientific determination.

Once a public allegation of a biological attack is made, the political and propaganda aspects often overwhelm the scientific evaluation of the event.

Misappraisals of biological attack are not benign. The allegation that successful biological attacks have been made erodes the international consensus against BW use. A country that believes it has been the victim of a BW attack may feel justified in developing its own offensive BW capability so that it can retaliate in kind. Hence, mistaken conclusions of BW use, even in good faith, only make future biological attacks more likely.

Korean War allegations that the United States of America used biological warfare

In 1952 and 1953, the governments of North Korea and the People's Republic of China accused the USA of waging biological attacks against them during the Korean War. The USSR echoed these charges in an intense propaganda campaign. These allegations, and the US response, present a very complex political, military and scientific event, one where all participants indulged in deliberate exaggeration and fabrication, to some degree (28). A complete discussion of all these facets is beyond the scope of this paper. Instead, this survey focuses on the difficulties faced by those Chinese biological scientists who were asked, in early 1952, to evaluate a possible biological attack, in the midst of a complicating political and military crisis.

The underlying threat of a biological attack by the USA was considered high by the Chinese in the early months of 1952. The fighting in Korea had reached a stalemate, and there had been repeated threats by the USA to introduce 'new weapons' to break the impasse (73). The USA made no secret it was pursuing a biological weapons programme. The People's Republic of China was aware that the USA had protected Japanese war criminals in exchange for information from the World War II Japanese BW programme. 'Dual use' activities by the USA in 1951 further alarmed the Chinese. For instance, the USA renewed contact with Japanese BW experts and sent a laboratory ship to investigate an epidemic in North Korea and to monitor an epidemic in a US-controlled prisoner-of-war camp. The USA began immunising troops against yellow fever (89) (which is not endemic in Korea), and intensified insect-control activities along the front lines.

These actions suggested US preparations for a Japanese-style BW attack using insect vectors. Although historical records reveal that these activities were not related to plans for a BW attack in Korea (28), the Chinese concern was prudent. By January 1952, the Chinese Government increased its level of surveillance for BW attack by sending bacteriologists to military medical laboratories in North Korea, and by alerting field commanders to be vigilant for

evidence of a Japanese-type BW attack, especially insects or other odd objects falling from overflying aircraft (25).

The orders to be alert for unexplained groups of insects produced responses from Chinese field units in Korea, despite the fact that January in Korea is frigid, and insects are normally extremely rare. The insects sent to military laboratories for analysis consisted of an odd combination of human fleas, domestic spiders, domestic and garden flies, and an obligate bat parasite. These appear to have been overwintering in sheltered areas, and may have been exposed by war damage to buildings or gardens, or perhaps collected by field units wishing to appear zealous in conducting their surveillance mission.

In mid-February 1952, a North Korean military laboratory reported isolating plague bacilli from the human fleas, and cholera bacilli from flies (19). These initial reports triggered allegations of a BW attack, and resulted in the implementation of extensive military and civilian defence programmes (25).

It is now clear that at least the laboratory report of plague from North Korea was fabricated. In mid-1952, a sympathetic international commission (the International Scientific Commission for the Investigation of the Facts Concerning Bacterial Warfare in Korea and China) investigated the allegations. Correlation of its published (38) and unpublished records (63), combined with original documents from the Republic of China from the 1940s (18, 46), reveals that the Soviet member of the commission and a Chinese bacteriologist attached to a North Korean laboratory conspired to misrepresent technical elements of Japanese BW attacks (34, 66), to cover a scientific inconsistency in the original report.

Exactly who instigated the original fabrications is unclear. Soviet documents admit that local Soviet agents participated in some subsequent fabrications of BW incidents in North Korea, but do not mention the crucial initial reports (54, 55, 56, 99). The Politburo later claimed (perhaps ingenuously) that it was unaware the allegations were based on fabrications until 1953. The Soviet propaganda 'machine' reacted only slowly to the allegations, supporting the view that it was reacting to rather than creating them. The actions of the Chinese Government also suggest that it was unaware the initial reports were fabricated, because it took extensive defence measures and began an independent investigation of the attacks: unlikely responses if it knew the reports were fallacious. It is possible that the initial laboratory report fabrications may have been the independent action of an alarmist hoaxer. The prime candidate would be the Chinese bacteriologist who wrote the initial plague report and who later helped to deceive the international commission. He was familiar with the Japanese BW attacks of the 1940s, and had been seconded to the North Korean

military bacteriology laboratory during the period of high alert for BW attacks.

Increased surveillance for BW attacks in both Korea and the People's Republic of China quickly produced more reports of suspicious events (36, 37). These were investigated by Chinese scientists with remarkable scientific rigour (20, 21, 38). Their investigations encountered significant problems. An unseasonable outbreak of encephalitis occurred, and an unidentified virus was isolated from swarms of 'mosquitoes' seen unseasonably in the area. Similarly, a rickettsia bacterium was isolated from unseasonable swarms of insects.

These two isolates were used to justify allegations that the US had widened its BW attacks to include Chinese territory. Embarrassingly, the 'mosquitoes' were later identified as non-vector crane flies, and the virus proved unrelated to the encephalitis outbreak when tested serologically. The rickettsia sample was lost after the initial animal isolation and could not be characterised. Much to the credit of the Chinese investigation, these critical preliminary findings were retracted publicly.

A significant problem mentioned by the Chinese field investigators was the extra vigilance of citizens asked to report suspicious activity which could be linked to BW attacks. Field reports indicate that natural occurrences were frequently misinterpreted as BW attacks. There was suspicion that the desire to appear politically conscientious may have influenced these reports, either because their makers exaggerated or 'embroidered' facts, or because the reports were invented outright. Many such reports were examined and dismissed by the Chinese field investigators (25).

The few field reports that seemed to describe possible BW attacks generally relied upon the assumption that BW attacks were likely. Most reported otherwise unexplained swarms of insects or other suspicious objects, discovered after US aircraft had flown overhead. Pathogens were isolated from these insects in only a small minority of cases and, in most of these, the pathogens could have been present naturally, such as enteric diseases in flies (36). Human disease was only very rarely associated with these events.

After May 1952, public reports of suspected BW attacks ceased, and the allegations entered an overtly political Cold War propaganda phase. Internal Chinese government summaries of the BW situation in May 1952 identified only four outbreaks of disease ascribed to BW attacks. Although considered significant, they were modest in their overall scale. The largest was the encephalitis outbreak, with 42 confirmed cases in total and 20 deaths. An additional 40 cases, including eight deaths, were suspected to be encephalitis. An outbreak of plague in the Chinese forces

in Korea accounted for 18 confirmed cases with eight deaths, and eight suspected cases with three deaths. Four fatal cases of inhalation anthrax were identified in the north-east of the People's Republic of China. An additional four fatal cases of paratyphoid were also ascribed to BW attacks (25). Although the propaganda phase of the allegations continued until after the Korean armistice, the Chinese identified no significant increase in infectious diseases, and few new scientific data appeared for analysis.

Shortly after the death of Stalin in March 1953, the Soviet Government abruptly discontinued its propaganda campaign, and requested the Chinese to cease its campaign as well, citing the belated discovery of the North Korean fabrications. The Soviets never again mentioned the Korean War BW allegations, even in their own military histories of BW. The Chinese interrupted their campaign briefly, while they re-investigated the scientific findings, but ultimately continued it. They incorporated the BW allegations into their histories of the Korean War as fact, and adopted the technical findings of their scientists into their military and civil defence doctrines (17, 25, 67, 73, 102).

Not until the late 1990s would important scientific data resolve the most troubling of the unresolved allegations (27). Modern genomic analysis of multiple Chinese anthrax isolates from 1952, from the area of the suspected BW attacks, indicated they were indigenous to Asia, and did not correspond to US weapons strains in use at the time (28).

Allegations by Cuba

Cuba has accused the USA of attacking it with biological agents on several occasions. These allegations accord with the typical circumstances: the USA had a known BW capability before 1969, and Cuba, like the USSR, might well have doubted that the USA had really ended this capability. The USA supported a vigorous paramilitary and clandestine sabotage programme against Cuba, and a series of disease outbreaks occurred which the Cubans considered suspicious. Clearly, elements of propaganda could have played a role. Blaming the USA for disease outbreaks not only unified the Cuban people against the USA, it shifted the focus from failures in Cuban public health and animal disease control programmes.

The Cuban Government has released too little scientific and historical information for a definitive, disinterested analysis. However, an analysis of the 1962 Newcastle disease outbreak has been described in some detail by Wheelis (25). This outbreak was alleged by Cuba to be the result of BW sabotage of an avian influenza vaccine with the live Newcastle disease virus, causing a widespread Newcastle disease outbreak. However, it would be

impossible to determine the precise spread or aetiology of the outbreak or to state that contaminated vaccine was the cause, without detailed information on the following:

- the pattern of the outbreak
- the movements of vaccinators in the avian influenza programme
- specific analyses of suspected lots of contaminated vaccine
- an account of activities at the vaccine production facilities.

Newcastle disease was endemic in Cuba in 1962 and, since it is highly transmissible, Wheelis concluded that an equally possible aetiology of the outbreak would be inadvertent transmission by vaccinators and vaccinating equipment during the avian influenza immunisation programme. Newcastle disease could have been widely spread through carelessness during the veterinary vaccination programme without the need for deliberate sabotage.

Wheelis provides an important insight into this outbreak. He was able to access extensive CIA documents on sabotage programmes against Cuba from that period, which had been declassified under the Kennedy Assassination Investigation. Wheelis concludes that Cuban concern that the USA might have been responsible for this outbreak in 1962 was valid, because the USA was openly pursuing an offensive BW programme at the time, and the CIA was engaged in an active sabotage programme against Cuban industry and agriculture. This sabotage programme was well known to the Cubans from its results, as well as from interrogating captured CIA agents.

Moreover, Wheelis found that the CIA did explore the possibility of using clandestine BW releases in its sabotage programme. However, the specific proposal was to use incapacitating biological agents spread by insects to target field workers, disrupting the Cuban sugar and tobacco harvests. The goal was to 'cripple' Cuban exports to discredit the Castro Government with the Cuban people. The US sabotage policy specifically avoided damage that would alienate ordinary Cubans, such as attacks on domestic food production. In fact, the US BW programme could not provide a suitable BW agent in 1962, and the proposal was not acted upon. There is no documentary evidence that the 1962 Newcastle disease outbreak was the result of a CIA sabotage programme.

Allegations of 'yellow rain'

In 1981, the USA alleged that Soviet client regimes in Laos and Vietnam had used biotoxin weapons against the Hmong minority people and Kampuchean insurgents, and

that the USSR itself had used similar weapons against mujahidin rebels in Afghanistan. Although a wide variety of attacks and resulting symptoms were reported, the most characteristic attack was described in the allegations as 'yellow rain'. These occurrences collectively came to be known as 'yellow rain attacks' (69).

The allegations accorded with the pattern already demonstrated. The USSR had a BW programme before the signing of the Biological Weapons Treaty, and the USA was clearly suspicious that the USSR was in violation of that Treaty, a conviction strengthened by an outbreak of anthrax near a suspected BW facility in the city of Sverdlovsk in 1979. (The US suspicions of a continuing Soviet BW program ultimately proved valid.)

The releases occurred in military actions sponsored or made directly by the USSR. The reports of illnesses associated with military attacks were clearly suspicious.

As early as 1978, the USA made initial investigations into yellow rain, collecting both physical evidence and extensive testimony from survivors. The initial laboratory findings identified no classical chemical or biological agents, but a university laboratory reported trace amounts of trichothecene mycotoxins in some specimens. In 1982, the US Government issued allegations in which the symptoms were described as typical of trichothecene mycotoxin poisoning and mycotoxins were reported as being identified in multiple specimens from the attack sites.

However, the persuasiveness of the initial data suffered in 1983 and 1984, when 'follow-up' investigators from a US Army/State Department team re-interviewed many of the original 'victims' and they admitted they had fabricated their stories or passed on hearsay as personal experience to gain political asylum. The symptom complex reported by victims corresponded to mycotoxin toxicity in only five of the 217 alleged victims interviewed. The first laboratory analysis of trichothecene mycotoxins in the original specimens could not be confirmed by more specific assay in the chemical warfare laboratory of the US Army. Nor could mycotoxins be identified by French, Swedish or Canadian government BW laboratories in the original or subsequent specimens of yellow rain. The credibility of the allegations was dealt a severe blow when it was demonstrated that samples of the 'yellow rain' material recovered from leaves were in fact honey bee faeces, and the yellow rain phenomenon was due to collective defecation of honey bee swarms (75).

Despite the apparent discrediting of the 'yellow rain' claims and the negative scientific data from its own laboratories, the USA has never retracted the allegations. In fact, the conviction that important elements of the yellow rain allegations are true persists in US military thinking. United

States military manuals on chemical and biological warfare cited mycotoxin attacks in Vietnam in the 1970s and 1980s as proof of the military effectiveness of biotoxin weapons until 2003 (86), and still list 'chemical weapon attacks' as having occurred in Laos and Cambodia in the 1970s, and Afghanistan in the 1980s (90). Katz (44) has recently presented newly declassified data from the yellow rain investigation, and her analysis supports this aspect of US military editorial policy. Katz admits that the official yellow rain investigation failed to convince academics, the United Nations or the general public, but she weights the early 'positive' data more heavily than the later 'discrediting' data because she believes that publicity contaminated the later information. Katz concludes that, while incomplete, the available information supports a 'confident assessment' that biochemical weapons attacks of some sort did occur, though she finds little evidence to support the original charges that trichothecene mycotoxins were used in large amounts as a primary biotoxin agent directed against personnel.

Misadventures in pre-emptive interventions

When the risk of biological attack is considered high, biological scientists may be asked to advise on appropriate pre-emptive defence measures. Such decisions differ from similar risk/benefit evaluations undertaken in orthodox public health or veterinary situations because the actual risk of an outbreak is hypothetical, depending on the actions of an adversary. Moreover, the risks and benefits of a pre-emptive intervention and its public acceptance may be poorly predictable in the context of a BW threat.

Even prudent pre-emptive interventions have had unintended negative results. Some salient examples follow. While these examples use human immunisation programmes, the principles should be applicable to veterinary circumstances.

For instance, in case of a BW threat, advisers may propose pre-emptive vaccination in areas where a disease has been eradicated. However, vaccine shortages can be expected because, in contrast to containment immunisation programmes for focal outbreaks, pre-emptive vaccination campaigns must protect against multiple releases in vulnerable areas, and therefore require universal coverage. The political sensitivities of allies or economic partners may influence the timing of pre-emptive immunisation programmes, particularly if such vaccination will cause prolonged quarantine and disruption of normal trade. Using experimental or developmental 'indicator' vaccines to differentiate infected from non-infected (but vaccinated) herds may lessen these problems but guaranteeing the

safety of any developmental vaccine is difficult, particularly in a crisis. Popular distrust may significantly disrupt an immunisation programme recommended by veterinary professionals. Sceptical farmers may refuse to co-operate with a voluntary programme, or take legal action against the imposition of a mandatory policy. Consumers may refuse to buy meat from vaccinated herds.

Misadventures in pre-emptive immunisation have not been benign. Some have had direct adverse effects on the health of the recipients, and others have failed to offer the desired protection. Moreover, these misadventures have had the indirect effect of eroding the credibility of such interventions. This can only complicate future efforts to provide pre-emptive protection against possible BW attacks.

The Japanese biological warfare capability and the 1942 yellow fever vaccination programme

The Japanese began a secret BW programme in the early 1930s (32). In 1939, a Japanese virologist attempted to obtain virulent and vaccine strains of yellow fever virus from the Rockefeller Institute. There was no legitimate reason for the Japanese to work with yellow fever, since it did not occur in Asia or the Pacific region. Shortly after the official request was refused, because international agreements forbade the transfer of yellow fever virus to Asia, a Rockefeller Institute employee was approached and offered a large bribe to provide the virus preparations illegally. The Federal Bureau of Investigation initially investigated this event, but the US Army was not informed until January 1941 (59).

General James Simmons, Chief of Preventive Medicine in the US Army, had long considered biological attacks to be a real threat. He proceeded to implement defensive measures against Japanese BW, aided by a US decision to explore the potential of BW and reports of Japanese BW attacks in the Republic of China (59). Simmons realised that the artificial introduction of yellow fever into Panama and Hawaii would disrupt critical 'chokepoints' or passageways of military and industrial transport. Moreover, the yellow fever mosquito was widely distributed in North America, Europe, Asia and the Pacific, and introducing the yellow fever virus might cause massive outbreaks in crucial European and Pacific theatres of war. In mid-1941, Simmons arranged with the Rockefeller Institute for large amounts of yellow fever vaccine to be manufactured and held in reserve.

In January 1942, immediately after the Japanese attack on Pearl Harbor, Simmons succeeded in instituting a programme to immunise all US military personnel against yellow fever. The programme was justified as a defensive measure against biological attack, although this aim was

not made public. The Rockefeller Institute chick embryo vaccine was used, which required the inclusion of human serum in the original inoculum. Unfortunately, this source of human plasma was contaminated by the hepatitis B virus, and a massive epidemic of 'homologous serum jaundice' (hepatitis B) occurred in recipients of certain lots of the vaccine, beginning in March 1942. The source was quickly traced to the yellow fever vaccine, and the immunisation programme was halted on 15 April 1942. Ultimately, 50,000 US servicemen and servicewomen were hospitalised with post-yellow-fever-vaccine hepatitis B, and an estimated 330,000 cases occurred (74). This was the largest single-source outbreak of hepatitis B ever recorded. A military disaster was avoided only because few US troops were in combat so early in the war.

The debacle of the 1942 yellow fever vaccination programme interrupted, but did not end, efforts to pre-emptively vaccinate against yellow fever and other potential Japanese biological attacks. Importantly, and in contrast with the putative German BW programme, multiple mutually supporting data had been received to confirm that the Japanese had an advanced BW programme. Many Western-trained scientists 'on the ground' in the Republic of China confirmed that Japanese BW attacks had been made on Chinese cities, using plague (59). Military intelligence reported that Japanese troops had been trained to make BW attacks and, as the war progressed, captured Japanese documents confirmed this training and indicated that Japan had developed BW munitions (87). Captured Japanese medical officers eventually reported the location and named the commander of the Japanese BW facility in Manchuria (88). A report in March 1942, from Brazil, of another Japanese attempt to obtain yellow fever re-emphasised the yellow fever risk (59). A more focused yellow fever immunisation campaign was begun in Hawaii and Panama between 1943 and 1945, after a serum-free vaccine had been developed. Since Japanese attacks using plague had been identified in the Republic of China, immunisation against the plague was instituted for soldiers in the Pacific, even in areas where no plague had ever been reported naturally, notably for the invasions of Iwo Jima and Okinawa (91).

No Japanese BW attacks were experienced by US troops, but the pre-emptive immunisations were justified. Although Japan did not acquire yellow fever virus in its 1939 and 1942 attempts, its interest remained high. The Japanese Government apparently also requested yellow fever virus from Germany (30). Germany and Japan did exchange strategic materials by long-distance submarine voyage, but no record exists of any yellow fever virus being received by Japan. At a critical point in the war, Japan decided to use biological weapons against the USA. The Japanese dispatched a BW team with biological agents, including plague from the Republic of China, to the Mariana Islands in 1944, but the ship was sunk en route (31).

Pre-empting Nazi biological warfare: the botulism toxoid controversy before the Normandy invasion

As discussed previously, Allied intelligence believed that Germany was pursuing an active BW programme, and émigré sources had reported that botulism toxin was being developed as a biological agent. This, and the fact that a major British BW researcher was interested in botulism, resulted in the development of an experimental toxoid against botulism toxin. Sufficient toxoid was produced by the BW programme to allow immunisation of the entire force for the Normandy landings.

The lack of solid corroboration for the émigré reports of German BW efforts was an important factor when BW scientists urged that the invasion force be pre-emptively immunised against botulism toxin. The US Theater Surgeon, directly responsible for the health of the combat troops, was sceptical of the safety of an untried vaccine, pointedly recalling the disastrous yellow fever vaccination programme of 1942 (82). More importantly, perhaps, the Allies had broken the German military codes and Eisenhower knew that the Germans had made no preparation for a BW attack. Much to the displeasure of the BW scientists (47), Eisenhower refused to order pre-emptive immunisation.

Pre-emptive immunisation against anthrax and botulism in the 1991 Gulf War

Iraq had acquired virulent strains of BW pathogens from the USA during the Iran-Iraq War of the 1980s. Before Iraq invaded Kuwait on 2 August 1990, US intelligence services had concluded that Iraq possessed a biological weapons capability. Anthrax and botulism toxin were reported as agents. The USA alerted its forces in the Gulf region to the possibility of Iraqi biological attacks on 9 August (62, 76).

Although, on 30 August, an expert advisory board recommended that troops be immunised against anthrax and botulism toxin as soon as possible, only 150,000 doses of anthrax vaccine and 34,000 doses of botulism toxoid were available to the USA. Since primary immunisation protocols called for three doses for each recipient, these stocks were clearly insufficient to immunise all of the 700,000 USA forces expected to be deployed in the Persian Gulf area during the anticipated hostilities with Iraq (77). Morale problems were feared if only some units were vaccinated. Moreover, grave political complications were foreseen if vaccines could not be offered to the military personnel of coalition partners and civilians in host Persian Gulf countries (76).

By 21 September, the Joint Chiefs of Staff decided that the decision was no longer 'medical' but rather 'political, social

and military/operational' (76). Any public discussion of BW or defensive immunisation was delayed while troops and materials were moved into the war theatre. The political and military authorities deliberated BW defensive options, but shared their concern with few allies. France learned of the US concern when the USA immunisation campaign was announced in late December 1990 (94). Not until 5 January 1991 was a targeted vaccination programme begun for US troops. The 1991 Gulf War began on 17 January and ended on 28 February 1991.

As a result of the shortages of vaccine and time, immunisation could only be partially implemented. The US military plan truncated a six-dose, 18-month anthrax protocol to a two-dose, two-week schedule. Only 150,000 of the 700,000 US military personnel in the region received anthrax vaccine, and only a fraction of those received two doses. The botulism toxoid had not been licensed, and was treated as an investigational drug, administered voluntarily with informed consent. No more than 8,000 personnel received even one dose of botulism toxoid. An evaluation of the US pre-emptive immunisation against anthrax during the 1991 Gulf War is problematic. Although Iraq used no BW weapons in the 1991 Gulf War, the threat assessment that Iraq possessed delivery systems and military quantities of anthrax and botulism proved accurate (85). Both the agent preparations and munitions later proved to be primitive; nevertheless, some agent/delivery scenarios could have caused mass casualties. A pre-emptive effort to counter this threat was prudent.

However, there is considerable doubt that the US immunisation campaign would have been effective in preserving military efficiency or protecting individual soldiers from a BW attack. Only about 20% of US military personnel received any anthrax vaccination at all, and it is not known how many received two doses. Anthrax vaccine was known to produce immunity only slowly and after multiple inoculations, hence the six-dose, 18-month protocol. Primate studies found that protective immunity could be demonstrated six weeks after a second dose (78). Since initial immunisations did not begin until the week of 5 to 12 January, this immunity would not have been reliably present in the first cohort immunised until the week of 2 to 9 March. The Gulf War ended on 28 February. The botulism programme was even less effective: no more than 1% of US troops were immunised, and botulism toxoid produced immunity even more slowly: a state of 'minimal immunity' did not occur until late April, well after the war was over.

Pre-emptive measures against anthrax, botulism and plague in the 1991 Gulf War

The United Kingdom (UK) had also come to the conclusion, before the Iraqi invasion of Kuwait, that Iraq

possessed a military BW capability, with anthrax and botulism toxin. The UK had sufficient anthrax vaccine for a complete course for all of its 53,500 troops deployed in the Gulf. The UK had no botulism toxoid but did have 20,000 doses of botulism antitoxin, suitable for treatment after an attack. Since a unilateral decision to vaccinate against anthrax would have been politically sensitive, the UK delayed implementing its anthrax immunisation programme, in deference to US government indecision. However, by early December, time had run out if the UK wanted to complete its seven-week, three-dose immunisation schedule before the 15 January 1991 UN deadline for military action. The UK expressed a desire to begin vaccinations, regardless of US plans. This may have stimulated the USA to begin its programme. In any case, the UK co-ordinated its anthrax vaccination programme with that of the USA, and began immunising on 2 January 1991. The UK administration, aware that the vaccine produced immunity only slowly, administered pertussis (whooping cough) vaccine as an adjuvant, hoping to speed the development of immunity. In November 1990, the UK had assessed that Iraq might also have the ability to use plague as a weapon. Thus, it instituted a programme of plague immunisation on 21 January 1991, after the war had begun (84).

Despite the UK beginning the war with sufficient time and vaccine stocks to complete the full primary immunisation schedule, the delay in implementation caused the UK anthrax vaccination campaign to be incomplete. Although 75% of UK forces received the first anthrax inoculation, fewer received the second because hostilities had already begun, and very few received the third because the war ended before the final dose was due. Post-war research in animals did not confirm that the pertussis vaccine adjuvant speeded the development of anthrax antibodies after anthrax vaccination.

Subsequent pre-emptive campaigns of anthrax immunisation by the United States of America, from 1998 to 2005

Following the 1991 Gulf War, unexplained chronic illnesses appeared in Gulf War veterans. Exposure to many substances, including experimental and investigational drugs and vaccines, was hypothesised as the cause (52). Legislation was passed, prohibiting the compulsory administration of investigational drugs or vaccines to military personnel without a Presidential finding of military necessity (92). This popular distrust extended to the anthrax vaccine, particularly when the licence of the vaccine manufacturer was revoked for multiple safety and potency violations (26). The reputation of the vaccine was further tarnished when the manufacturer was unable to regain the licence for two more years (65).

When compulsory universal military anthrax immunisation began again in 1998, significant resistance to the programme developed among forces on active duty and reserve. This resulted in, as follows:

- several hundred personnel being court-martialled for refusing immunisation
- many reserve personnel leaving the armed services (95)
- a protracted legal battle that did not end until December 2005.

The existing programme, at present, remains voluntary, focused narrowly on those personnel who are deployed in high-risk areas (101).

Popular distrust of the anthrax vaccine was highlighted in late 2001, when the US Government offered anthrax vaccine to any worker potentially exposed to anthrax in the 2001 postal attacks (97). The experts at the Centers for Disease Control refused to recommend vaccination (70, 71), and demanded a liability waiver from the participants, who would have received unlicensed lots of vaccine from the still uncertified manufacturer. Given the already tarnished reputation of the vaccine, it is not surprising that only 138 of the 10,000 postal workers and congressional staff who had been potentially exposed to the postal anthrax releases chose to participate in the vaccine trial (81).

A pre-emptive campaign of smallpox vaccination by the United States of America, 2003

As early as the late 1990s, there had been calls for pre-emptive vaccination of some health-care workers against smallpox (2), but before the terrorist attacks of 11 September 2001, official sanction was withheld (72). During 2002, preliminary recommendations for limited pre-emptive vaccination were debated (3). In late 2002, in anticipation of the 2003 US invasion of Iraq, President Bush ordered a pre-emptive smallpox immunisation programme for US military and civilian health-care workers and emergency response personnel, targeting 500,000 troops and 10.5 million civilians (80). While the compulsory military programme was completed, the voluntary civilian programme was never met with

enthusiasm. Only 25,645 (6%) of the targeted 439,000 health-care workers were immunised before the war began (14). Moreover, this programme revealed increased cardiac complications post-vaccination (14). After no biological weapons were found in Iraq, the programme virtually ceased: fewer than 1,000 workers volunteered between 9 August and 31 December (15, 16). In total, only 39,213 (< 9%) of the targeted 439,000 health-care workers participated (16), and plans to immunise an additional ten million emergency response personnel were cancelled.

Conclusion

Although it may appear that policy-makers should 'err on the side of safety' when evaluating and responding to threats of biological attack, it is an ironic finding of this study that such errors tend to degrade rather than augment the safety they seek to obtain. Repeated misapprehensions that an adversary possessed biological weapons have only encouraged the development of these weapons. Misappraisals of biological weapon use have increased the risk that such weapons might actually be used, and flawed and unnecessary pre-emptive interventions have discredited such efforts and prejudiced future programmes. It would seem prudent to demand considerable rigour in any such evaluations of BW in times to come.

Acknowledgements

The author thanks Dr Martin Hugh-Jones for providing the dissertation of Dr Rebecca Katz and for his previous provision of essential genomic information on the 1952 Chinese anthrax isolates. The author also wishes to thank Dr Rebecca Katz for supplying additional information.



Erreurs d'interprétation en préparation à une attaque biologique : une étude rétrospective

M. Furmanski

Résumé

Se préparer à une attaque biologique implique d'analyser et de coordonner les informations et les événements relevant des domaines scientifique, politique et social. Or, les informations qui doivent être évaluées sont, par définition, incomplètes. Il n'est donc pas surprenant que ces interactions aient régulièrement abouti à des conclusions erronées et à des interventions imparfaites. Cette étude rétrospective examine les cas dans lesquels des erreurs majeures ont été commises. L'auteur décrit plusieurs exemples pris dans chacune des trois grandes catégories : méprises concernant les risques d'attaque biologique ; évaluation erronée d'un événement isolé perçu comme étant une attaque biologique ; suites accidentelles nuisibles d'une action préventive visant à se protéger contre une attaque biologique. L'étude identifie des éléments communs à chacune de ces erreurs qui peuvent servir à éviter d'en commettre à l'avenir. L'étude conclut, en évaluant les conséquences de ces erreurs, qu'elles accroissent souvent les dangers que l'on cherche à éviter.

Mots-clés

Arme biologique – Déformation de l'information – Désinformation – Fièvre charbonneuse – Fièvre jaune – Guerre bactériologique – Histoire – Médecine militaire – Perception erronée – Pluie jaune – Propagande – Toxine botulinique – Vaccin – Vaccination – Variole.



Errores de juicio en la preparación para ataques biológicos: análisis histórico

M. Furmanski

Resumen

Prepararse ante un eventual ataque biológico supone analizar y coordinar información y acontecimientos en los terrenos científico, político y social. La información que debe evaluarse es, por definición, incompleta. No resulta sorprendente que las interacciones de ese tipo hayan llevado con frecuencia a conclusiones erróneas e intervenciones defectuosas. En este repaso histórico, el autor examina una serie de casos en los que se han producido errores de envergadura. En primer lugar describe varios ejemplos de tres clases distintas: apreciación errónea del riesgo de ataque biológico; definición errónea de un episodio anómalo como ataque biológico; y percances a la hora de actuar preventivamente contra un ataque biológico. Después señala una serie de

elementos importantes en cada una de esas actuaciones erróneas que pueden ser de utilidad para evitar futuros tropiezos. Tras evaluar sus consecuencias, el autor concluye que esos errores de juicio sirven a menudo para alimentar el peligro que pretenden evitar.

Palabras clave

Ántrax – Arma biológica – Desinformación – Error de juicio – Fiebre amarilla – Guerra microbiana – Historia – Información errónea – Inmunización – Lluvia amarilla – Medicina militar – Propaganda – Toxide botulínico – Vacuna – Viruela.



References

1. Alibek K. & Handelman S. (1999). – Biohazard: the chilling true story of the largest covert biological weapons program in the world – told from inside by the man who ran it. Random House, New York, 180-183.
2. Altman L.K. (1998). – Smallpox vaccine urged to fight terrorist attacks. *NY Times*, 11 March, A21.
3. Altman L.K. (2002). – Threats and responses: biological readiness; smallpox inoculation urged for employees of hospitals. *NY Times*, 17 October.
4. Anon. (1925). – Protocol for the prohibition of the use of asphyxiating, poisonous or other gases, and of bacteriological methods of warfare, Geneva, 17 June 1925. League of Nations, Geneva. Available at: the International Committee of the Red Cross, <http://www.icrc.org/IHL.nsf/INTRO/280?OpenDocument> (accessed on 13 March 2006).
5. Anon. (1944). – Recent reports on German activities in BW. Document BIO/3970, 7 January. National Archives and Records Administration (NARA), College Park, Maryland. Record Group 112, Entry 295A, Box 12.
6. Anon. (1972). – Convention on the prohibition of the development, production and stockpiling of bacteriological (biological) and toxin weapons and on their destruction, opened for signature at London, Moscow and Washington, 10 April 1972. United Nations, New York. Available at: <http://www.icrc.org/ihl.nsf/INTRO/450?OpenDocument> (accessed on 13 March 2006).
7. Anon. (1992). – Trilateral agreement on biological weapons: joint statement on biological weapons by the Governments of the United Kingdom, the United States and the Russian Federation (10-11 September 1992). Available at: Stockholm International Peace Research Institute (SIPRI): http://www.sipri.org/contents/cbwarfare/cbw_research_doc/cbw_historical/cbw-trilateralagree.html (accessed on 13 March 2006).
8. Balmer B. (2001). – Britain and biological warfare: expert advice and science policy, 1930-1965. Palgrave, New York, 14-53.
9. Broad WJ. (2001). – A nation challenged: the spores; terror anthrax resembles type made by U.S. *NY Times*, 3 December, A1.
10. Broad WJ. & Johnston D. (2001). – A nation challenged: the anthrax trail; U.S. inquiry tried, but failed, to link Iraq to anthrax attack. *NY Times*, 22 December, A1.
11. Broad WJ. & Miller J. (2001). – A nation challenged: the investigation; U.S. recently produced anthrax in a highly lethal powder form. *NY Times*, 13 December, A1.
12. Bumiller E. (2001). – A nation challenged: the President Bush emphasizes, more than once, that he doesn't have anthrax. *NY Times*, 24 October, B8.
13. Burkhardt E. (1934). – Aerial warfare: secret German plans: revelations or forgeries? *The Nineteenth Century and After*, **116** (7), 1-16; 116 (9), 331-339.
14. Centers for Disease Control and Prevention (CDC) (2003). – Cardiac adverse events following smallpox vaccination – United States, 2003. *MMWR*, **52** (12), 248-250. Erratum: *MMWR*, **52** (13), 284.
15. Centers for Disease Control and Prevention (CDC) (2003). – Update: adverse events following civilian smallpox vaccination – United States, 2003. *MMWR*, **52** (34), 819-820.
16. Centers for Disease Control and Prevention (CDC) (2004). – Update: adverse events following civilian smallpox vaccination – United States, 2003. *MMWR*, **53** (5), 106-107.
17. Chen J. (2001). – Mao's China and the Cold War (The New Cold War History). University of North Carolina Press, Chapel Hill, 109-110.

18. Chen W.K. (1941). – Notes on examination of grain dropped by enemy plane. Microfilm copy, 12 December, attached to letter from J.H. Defendorf to K.F. Meyer, dated 22 January 1943. In K.F. Meyer papers, Bancroft Library, University of California, Berkeley.
19. Commission de la Direction de l'Armée Populaire Coréenne sur les cas d'utilisation de l'arme bactériologique (1952). – Rapport de la Commission de la Direction de l'Armée Populaire Coréenne sur les cas d'utilisation de l'arme bactériologique. In Bulletin No. 1, Documentation sur le guerre (Secrétariat du Conseil Mondial de la Paix [SCMP], ed.). Prague document SIA-1. SCMP: Palais SIA, Prague, 1-5. In Joseph Needham papers, Imperial War Museum, London.
20. Commission for Investigating the American Crime of Waging Bacteriological Warfare (CIACWBW) (1952). – Report of the northeast China group, 1 April 1952. *People's China*, (Suppl.), 3-6.
21. Commission for Investigating the American Crime of Waging Bacteriological Warfare (CIACWBW) (1952). – Report on the crime of American imperialists in spreading bacteria in Korea, released 24 April. CIACWBW, Peking, 1-22.
22. Commission on the Intelligence Capabilities of the United States Regarding Weapons of Mass Destruction (2005). – Report to the President of the United States, 31 March. US Government Printing Office, Washington, DC. Available at: www.gpoaccess.gov/wmd/ (accessed on 12 September 2005).
23. Dao J. (2001). – A nation challenged: the threats; Defense Secretary warns of unconventional attacks. *NY Times*, 1 October, B5.
24. ElBaradei M. (2003). – The status of nuclear inspections in Iraq: an update, a statement to the United Nations Security Council, New York, 7 March 2003. Available at: www.un.org/News/dh/iraq/elbaradei-7mar03.pdf (accessed on 13 March 2006).
25. Endicott S. & Hagerman E. (1998). – The United States and biological warfare: secrets from the early Cold War and Korea. Indiana University Press, Bloomington, 6-9, 14-15.
26. Funk D. (1999). – Anthrax drug supplier fails FDA manufacturing inspection. *Air Force Times*, 26 December.
27. Furmanski M. (2000). – Biological warfare in the 1940s and 1950s. Letter to editor, 2 August. *JAMA*, **284** (5), 561-562.
28. Furmanski M. & Wheelis M. (2005). – Allegations of biological weapons use. In *Deadly cultures: biological weapons since 1945* (M. Wheelis, L. Rozsa & M. Dando, eds), Chapter 13. Harvard University Press, Cambridge, Massachusetts, 252-283.
29. Garthoff R. (2000). – Polyakov's run. *Bull. Atomic Scientists*, **56** (5), 37-40.
30. Geissler E. (1999). – Biological warfare activities in Germany, 1923-1945. In *Biological and toxin weapons: research, development and use from the Middle Ages to 1945* (E. Geissler & J.E. van Courtland Moon, eds), Chapter 6. Stockholm International Peace Research Institute, Oxford University Press, Oxford, 91-126.
31. Gold H. (1996). – Unit 731 testimony. Yenbooks, Tokyo, 86.
32. Harris S.H. (2002). – Factories of death: Japanese biological warfare, 1932-1945 and the American cover-up. Routledge, New York.
33. Hersh S.M. (2004). – Chain of command. HarperCollins, New York.
34. Hudson B.W. & Prince F.M. (1958). – Culture methods for the fleas *Pulex irritans* (L) and *Pulex simulans* (Baker). *Bull. WHO*, **19**, 1129-1133.
35. Hugh-Jones M. (1992). – Wickham Steed and German biological warfare research. *Intellig. nat. Secur.*, **7** (4), 379-402.
36. International Association of Lawyers (1952). – Report on the use of bacterial weapons in Chinese territory by the armed forces of the United States, 2 April, Peking. United Nations document S/2684, 30 June.
37. International Association of Lawyers (1952). – Report on US crimes in Korea, 31 March, Peking. United Nations document S/2684, 30 June.
38. International Scientific Commission for the Investigation of the Facts Concerning Bacterial Warfare in Korea and China (ISCIFCBWKC) (1952). – Report of the ISCIFCBWKC (with appendices). ISCIFCBWKC, Peking, Appendix S, 304-306, Appendix TT, 638. [The report summary without appendices is available in United Nations document S/2802.]
39. Iraq Survey Group (2004/2005). – Comprehensive report, 30 September 2004 and Addendum, March 2005. Superintendent of Documents, Washington, DC.
40. Jehl D. (2003). – After the war: arms; Iraqi trailers said to make hydrogen, not biological arms. *NY Times*, 9 August, A1.
41. Johnston D. (2001). – A nation challenged: the investigation; in shift, officials look into possibility anthrax cases have bin Laden ties. *NY Times*, 16 October, B5.
42. Johnston D. & Broad W.J. (2001). – A nation challenged: the investigation; link suspected in anthrax and hijackings. *NY Times*, 19 October, B5.
43. Johnston D. & Risen J. (2002). – A nation challenged: weapons; US concludes Al Qaeda lacked a chemical or biological stockpile. *NY Times*, 20 March, A14.

44. Katz R.L. (2005). – Yellow rain revisited: lessons learned for the investigation of chemical and biological weapons allegations (Vietnam, Cambodia, Laos, Afghanistan, Russia). PhD dissertation. Woodrow Wilson School of Public and International Affairs, Princeton University, New Jersey. Epub.: ProQuest Information and Learning, pdf.
45. Kershaw I. (1998). – Hitler: 1889-1936; hubris. W.W. Norton & Co., New York.
46. King P.Z. (1942). – Japanese attempt at bacteriological war in China. Microfilm copy, 31 March, attached to letter from J.H. Defandorf to K.F. Meyer, dated 22 January 1943. In K.F. Meyer papers, Bancroft Library, University of California, Berkeley.
47. Kirk N.T. (Surgeon General, US Army) (1944). – Memo for General Styer: subject BW, 29 May. National Archives and Records Administration (NARA), College Park, Maryland. Record Group 112, Entry 295A, Box 4.
48. Klotz H. (1934). – Germany's secret armaments (transl. by H.J. Stenning). Jarrolds, London, 168-178.
49. Klotz H. (1934). – The Berlin diaries, Vol. I. W. Morrow & Co., New York, 13, 242, 265-266.
50. Klotz H. (1935). – The Berlin diaries, Vol. II. Jarrolds, London, 50-52, 156-157, 211.
51. Klotz H. (1937). – Der neue deutsche Krieg. Selbstverlag des Verfassers, Paris, 179-197.
52. Leary W.E. (1994). – Experimental drugs linked to Gulf War veterans' ills. *NY Times*, May 7, section 1, 9.
53. Lehmann-Russbuehldt O. (1935). – Germany's Air Force. George Allen & Unwin, London, 71-83, 115-145.
54. Leitenberg M. (1998). – New Russian evidence on the Korean War biological warfare allegations: background and analysis. *Cold War int. History Project Bull.*, **11**, 185-200.
55. Leitenberg M. (1998). – Resolution of the Korean War biological warfare allegations. *Crit. Rev. Microbiol.*, **24** (3), 169-194.
56. Leitenberg M. (2000). – The Korean War biological weapons allegations: additional information and disclosures. *Asian Perspect.*, **24** (3), 159-172.
57. Lepick O. (1999). – French activities related to biological warfare, 1919-1945. In *Biological and toxin weapons: research, development and use from the Middle Ages to 1945* (E. Geissler & J.E. van Courtland Moon, eds), Chapter 5. Stockholm International Peace Research Institute, Oxford University Press, Oxford, 70-90.
58. Liepmann H. (1937). – Death from the skies. Martin Secker & Warburg Ltd, London, 242-274. Also known as *Poison in the air* (US Ed.). Lippincott, Philadelphia, 261-296.
59. Marquand J.P. (1943). – Digest of information regarding Axis activities in the field of bacteriological warfare. Report to Colonel S. Bayne-Jones, 8 January. National Archives and Records Administration (NARA), College Park, Maryland. Record Group 112, Entry 295A, Box 6.
60. Miller J. (2001). – A nation challenged: secret sites; Iraqi tells of renovations at sites for chemical and nuclear arms. *NY Times*, 20 December, A1.
61. Miller J. (2003). – Threats and responses: intelligence; defectors bolster U.S. case against Iraq, officials say. *NY Times*, 24 January, A11.
62. Miller J., Engelberg S. & Broad W. (2001). – Germs: biological weapons and America's secret war. Simon & Schuster, New York, 98-123.
63. Needham J. (1952). – Commentary on the Kang-sou incident (plague); replies of eye-witnesses and statements by scientific experts (draft) 2, 3. Unpaginated manuscript notes headed: Dr Chen Wen-Kuei: referring to same. In Joseph Needham papers, Imperial War Museum, London.
64. New York Times (1969). – Banning tear gas. *NY Times*, 21 December, E14.
65. New York Times (2002). – A nation challenged: the vaccine maker; troubled company is allowed to resume making vaccine. *NY Times*, 1 February, news section.
66. Ohta M. (1945). – 731 Menseki no Keifu. Translation of Niizuma File: record of the interrogation of Atsuhiro Tanaka, 30 October by Lieutenant-Colonel Sanders. In S.H. Harris papers, Hoover Institution Archives, Palo Alto, California. Box 4, Folder 4N.
67. People's Air-raid Commando of the City of Qingdao's Revolutionary Committee (2003). – Basic information about protection from atomic, chemical and biological weapons: biological agents used by the American army. No. 3 of a series of 14 posters, originally published in 1970. In *Chinese propaganda posters* (A. Min, D. Duo & S.R. Landsberger, eds). Taschen, Cologne, p. 80.
68. Rauschnig H. (1940). – Gespräche mit Hitler. Europa Verlag, Zurich. Published in English as: *Hitler speaks* (British Ed.), London, and *The voice of destruction* (US Ed.), Putnam, New York, 3-4.
69. Robinson J., Guillemin J. & Meselson M. (1990). – Yellow rain in southeast Asia; the story collapses. In *Preventing a biological arms race* (S. Wright, ed.). MIT Press, Cambridge, Massachusetts, 220-238.
70. Rosenbaum D.E. (2001). – A nation challenged: the disease; frustration at health agency over critics of anthrax policy. *NY Times*, 21 December, national news section.
71. Rosenbaum D.E. & Stolberg S.G. (2001). – A nation challenged: the vaccine; as U.S. offers anthrax shots, safety debate begins again. *NY Times*, 20 December, national news section.

72. Rotz L.D., Dotson D.A., Damon I.K., Becher J.A. (Advisory Committee on Immunization Practices) (2001). Vaccinia (smallpox) vaccine: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR*, **50** (RR-10), 1-25.
73. Ryan M.A. (1989). – Nuclear weapons and Chinese allegations of chemical and biological warfare. *In* Chinese attitudes toward nuclear weapons: China and the United States during the Korean War. ME Sharpe, Armonk, New York, 104-109.
74. Seeff L.B., Beebe G.W., Hoofnagle J.H., Norman J.E., Buskell-Bales Z., Waggoner J.G., Kaplowitz N., Koff R.S., Petrini J.L. Jr, Schiff E.R. *et al.* (1987). – A serologic follow-up of the 1942 epidemic of post-vaccination hepatitis in the United States Army. *N. Eng. J. Med.*, **316** (16), 965-970.
75. Seeley T.D., Nowicke J.W., Meselson M., Guillemin J. & Akkratanakul P. (1985). – Yellow rain. *Sci. Am.*, **253** (3), 128-137.
76. Special Assistant for Gulf War Illnesses (collecting ed.) (1992). – MPOD #3821, Chronology, 12 February. Available at: www.gulfink.osd.mil/declassdocs/otsg/19961211 (accessed on 12 September 2005).
77. Special Assistant for Gulf War Illnesses (collecting ed.) (2000). – Information paper: vaccine use during the Gulf War, 7 December. Available at: www.gulfink.osd.mil/va/ (accessed on 12 September 2005).
78. Special Assistant for Gulf War Illnesses (collecting ed.) (2001). – Close-out report: biological warfare investigation, 13 February, Tab C. Available at: www.gulfink.osd.mil/bw-ii/index.html (accessed on 12 September 2005).
79. Steed W. (1934). – Aerial warfare: secret German plans. *The Nineteenth Century and After*, **116** (7), 1-16; **116** (9), 331-339.
80. Stevenson R.W. & Stolberg S.G. (2002). – Threats and responses: vaccinations; Bush lays out plan on smallpox shots; military is first. *NY Times*, 14 December, national news section.
81. Stolberg S.G. (2002). – A nation challenged: steps against anthrax; civilians are reluctant to join U.S. test of anthrax vaccine. *NY Times*, 8 January, international news section.
82. Stuart M. (1944). – Message to Lieutenant-General J.C. Murchie, 27 May. National Archives and Records Administration (NARA), College Park, Maryland. Record Group 112, Entry 295A, Box 4.
83. Tyler P.E. & Tagliabue J. (2001). – A nation challenged: the investigation; Czechs confirm Iraqi agent met with terror ringleader. *NY Times*, 27 October, A1.
84. United Kingdom Ministry of Defence (MOD) (2000). – Implementation of the immunisation programme against biological warfare agents for UK Forces during the Gulf Conflict 1990/1991. MOD, London. Available at: www.mod.uk/issues/gulfwar/info/medical/bwa.htm (accessed on 12 September 2005).
85. United Nations Special Commission (UNSCOM) (1999). – Report to the Security Council, 25 January. Available at: www.un.org/Depts/unscom/s99-94.htm (accessed on 14 March 2006).
86. United States Army (1996). – Field manual FM 3-100: chemical operations principles and fundamentals. Headquarters Department of the Army, Washington, DC, 1-6; 1-7.
87. United States Army Chemical Weapons Service Special Projects Division (1944). – Special projects periodic intelligence reports Nos 1, 2 & 3, 1 February to 1 July. National Archives and Records Administration (NARA), College Park, Maryland. Record Group 112, Entry 295A, Box 12.
88. United States Army Chemical Weapons Service Special Projects Division (1944). – Special projects periodic intelligence reports Nos 3, 4, 5 & 6, 15 May to 15 December. National Archives and Records Administration (NARA), College Park, Maryland. Record Group 112, Entry 295A, Box 12.
89. United States Army, Eighth United States Army in Korea (EUSAK) (1952). – Letter dated 26 January, instituting diphtheria and yellow fever vaccination for troops in Korea. EUSAK Medical Reports. National Archives and Records Administration (NARA), College Park, Maryland. Record Group 338, Entry A1 204, Box 1553.
90. United States (US) Army, Marine Corps, Navy & Air Force (2003). – Field manual FM 3-11 (FM 3-100): multiservice tactics, techniques, and procedures for nuclear, biological and chemical defense operations. US Army, Washington, DC, 1-7, 1-8. Available at: <http://www.globalsecurity.org/wmd/library/policy/army/fm/3-11/index.html> (accessed on 14 March 2006).
91. United States Army Medical Department (1955). – Preventive medicine in World War II. *In* Personal health measures and immunization (J.B. Coates, ed.), Vol. III. Department of the Army, Washington, DC, 306-319.
92. United States Code (1998) – Public law 105-261, Title 10, Section 1107, as amended Oct. 17, 1998 by Section 731 of the Strom Thurmond National Defense Authorization Act for Fiscal Year 1999 (Defense Authorization Act). Government Printing Office (GPO), Washington, DC.
93. United States Department of State (2003). – Secretary Powell at the UN: Iraq's Failure to Disarm, 5 February. Transcript and PowerPoint presentation. Available at: <http://www.state.gov/p/nea/disarm/> (accessed on 12 September 2005).
94. United States General Accounting Office (GAO) (2001). – Coalition warfare: Gulf War allies differed in chemical and biological threats identified and in use of defensive measures. GAO-01-12 Government Printing Office (GPO). GPO, Washington, DC, 3. Available at: www.gao.gov/cgi-bin/getrpt?GAO-01-13 (accessed on 12 September 2005).

95. United States General Accounting Office (GAO) (2002). – Anthrax vaccine: GAO's survey of guard and reserve pilots and aircrew. GAO 02-445, released 22 October. Available at: www.gao.gov/cgi-bin/getrpt?GAO-02-445 (accessed on 12 September 2005).
 96. United States Senate (1975). – Unauthorized storage of toxic agents. Hearings before Select Committee to Study Government Operations with respect to Intelligence Activities (the 'Church Committee'), 16-18 September. GPO, Washington, DC, 1-245.
 97. Wade N. (2001). – A nation challenged: the prevention; U.S. moves toward making anthrax vaccine available. *NY Times*, 27 October, national news section.
 98. Warrick J. (2003). – Despite defectors' accounts, evidence remains anecdotal. *Washington Post*, 6 February, A28.
 99. Weathersby K. (1998). – Deceiving the deceivers: Moscow, Beijing, Pyongyang and the allegations of bacteriological weapons use in Korea. In Cold War international history project. *Woodrow Wilson int. Center for Scholars Bull.*, **11**, 176-185.
 100. White House (2005). – Saddam Hussein's development of weapons of mass destruction. Available at: www.whitehouse.gov/infocus/iraq/decade/sect3.html (accessed on 12 September 2005).
 101. Winkenwerder W. (Assistant Secretary of Defense) (2005). – Continuation of the Anthrax Vaccine Immunization Program (AVIP). Available at: <http://www.anthrax.osd.mil/resource/policies/policies.asp> (accessed on 13 March 2006).
 102. Xiaobing L., Millet A.R. & Bin Y. (2001). – Mao's generals remember Korea. University Press of Kansas, Lawrence, Kansas, 157-160.
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