Biological Weapons

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0. Introduction

What are Biological Weapons?

This short introductory video lecture covers the following topics:

- biological agents
- enhanced pathogens
- synthetic agents
- delivery systems
- detection of biological weapons and biowarfare programmes

Biological weapons are complex systems that disseminate disease-causing organisms or toxins to harm or kill humans, animals or plants. They can take many different forms, but generally consist of two parts: a weaponized biological agent and a delivery mechanism.

While almost any pathogenic organism or toxin can be used as a biological weapon, to be useful to the military, biowarfare agents have traditionally been seen to require certain characteristics: They should be dispersible as an aerosol, be economically scalable, remain stable in the air, have a high virulence, and so on. The biological agent of choice will vary depending on the intended effect, be it to kill or incapacitate, contaminate terrain for long periods, trigger a major epidemic, or psychological impact.

Past biological weapon programs have researched and tested a large number of pathogens that eventually were not weaponised. Biological agents that were validated for biological weapons in past programs include those that cause anthrax, brucellosis, Q fever, tularaemia, Venezuelan equine encephalitis, glanders, plague, Marburg virus disease and smallpox.

These are all biological agents found in nature. Biological agents may also be enhanced from their natural state to make them more suitable for use as weapons, as was the case in some of the historical programs.

In future, biological agents might be completely unknown. DNA synthesis techniques, which synthesize DNA strands from off-the-shelf chemicals and assemble them into genes and microbial genomes, may enable the creation of bioengineered agents whose characteristics combine traits from a number of dangerous pathogens, or whose characteristics are entirely novel and possibly more deadly and communicable than those that exist in nature.

The delivery systems of biological weapons can also take a variety of forms. Past programs have constructed missiles, cluster bombs, and drones to deliver biological agents, as well as sprayers and spray-tanks to be fitted to aircraft, cars, trucks and boats. There have also been documented efforts to develop delivery devices for assassinations or sabotage operations, including a variety of sprays, brushes, and injection systems, as well as means for contaminating food and clothing.

Biowarfare programs can also come in all shapes and sizes, as they have done in the past, from the grandiose, resource-rich, high-tech ones to the small, almost primitive efforts funded on a limited budget.

The varied manifestations of biological weapons and BW programs can make them especially hard to detect. This problem is compounded by the fact that there are few aspects of a BW programme that are unique to offensive applications and that are readily detectable by outsiders.

This is unlike nuclear and chemical weapons. Nuclear weapon programs leave unique signatures during the development, production and testing process that can be detected atlong range. Chemical weapon programs require industrial-scale production facilities and large stockpiles of munitions to pose a significant military threat and these are visible to overhead reconnaissance systems. Of course biological weapons—such as munitions designed to disseminate biological agents—and biological defences—such as syringes filled with vaccine—can be readily distinguished when placed side by side, but the research, development, production and testing activities used to develop these capabilities are similar, if not identical, in many ways.

Key Biological Agents Validated for Biological Weapons in Past Programmes

Bacillus anthracis

Anthrax (G) is an acute infectious disease caused by B. anthracis. It was the first disease for which a microbial origin was established – by Robert Koch in 1876.

Inhalation anthrax, the most deadly form of anthrax, is characterised by flulike symptoms including a sore throat, fever, muscle aches and malaise. A brief improvement is followed by respiratory failure and shock, with meningitis also frequently developing.

Bacillus anthracis is one of the most feared BW agents. It can be easily disseminated, can result in high mortality rates, and has the potential for a major public health impact. Like other key biological agents, it can cause public panic and social disruption, and it requires special action for public health preparedness.

Yersinia pestis

Plague is one of the oldest recorded diseases, and caused by the bacterium Yersinia pestis.

There are two forms: classic bubonic plague and pneumonic plague. It is the latter, the inhalation form, that has been targeted in past bioweapons programmes.

Pneumonic plague is characterised by malaise, high fever, chills, headache and muscle pain. This is followed by septicemic shock, respiratory failure, and, often, death.

Yersinia pestis is a strong candidate for biological weapons because it is easy to culture and mass produce, and relatively easy to aerosolize.

Variola major

Smallpox is a highly contagious viral disease caused by the Variola virus (G). It was eradicated in 1980.

Smallpox is characterised by fever, severe headaches, and a rash consisting of small, solid, raised lesions. As the rash progresses the small lesions fill with fluid and become inflamed, pus-filled, blisterlike and typically extremely painful.

Variola major is another strong candidate for biological weapons because it is a hardy virus, highly infectious through the air, can survive explosive delivery, and causes a debilitating disease with high mortality.

Francisella tularensis

Tularemia is an infectious disease of small mammals caused by the bacterium Francisella tularensis.

In humans, pneumonic tularemia is characterised by fever, headaches, chills, cough, chest pain and difficulty breathing. Skin lesions and swollen lymph nodes also develop. Can be fatal.

Francisella tularensis is dangerous because it can be released as an aerosol to cause large tularemia epidemics in both human and animal populations at the same time. It is hardy, tolerant of cold temperatures, extremely infectious in humans, and persists in the environment in water, moist soil, hay, straw and decaying animal carcasses.

Brucella

Brucella bacteria (G) can infect humans through ingestion of contaminated milk or meat, as well as through broken skin.

Brucellosis occurs mostly in animals, particularly pigs, sheep, cattle and dogs. In humans, infection with flulike symptoms including fever, headache, chills and general malaise. Nausea, vomiting and diarrhea may develop. In a small number of cases, the disease affects the heart and nervous system.

Brucella is primarily viewed as an incapacitant or as antianimal disease to cause disruption in the agricultural sector.

Venezuelan equine encephalitis (VEE) virus

In nature, VEE normally exists in a rodent-mosquito cycle that causes human cases only sporadically in restricted localities. When mutations occur that allow the virus to replicate in horses, large-scale equine outbreaks occur that can kill thousands of horses, spread for hundreds of kilometers, and persist for years.

In humans, VEE displays considerable variation in severity. Some strains have signficant mortality and permanent neurological damage.

The virus (G) grows well in the lab and is highly infectious, but contemporary medicine indicates it is considerably less controllable than was believed during the period it served as a US biological agent.

1. Biological Warfare and Bioterrorism

Biological weapons, bioterrorism and the fear of intentional disease have a long history and are not new thoughts; we knew how to spread disease long before we understood the science behind it.

This video highlights two well-documented accounts from:

- the 1346 siege of Kaffa
- Fort Pitt in the late 1700s

Biological weapons, bioterrorism and the fear of intentional disease have a long history and are not new thoughts; we knew how to spread disease long before we understood the science behind it.

Among the older military techniques that can be considered biowarfare is the use of corpses of humans or animals to contaminate wells and other sources of drinking water. While the principal objective was thought to be the denial of clean water to the enemy, a secondary effect was to spread disease among people and animals that consumed the contaminated water. The earliest recorded account of armies using infectious disease as a weapon is the 1346 siege of the heavily fortified Crimean city of Kaffa, an important trading hub on the Black Sea between Europe and the Far East controlled by the Maritime Republic of Genoa.

The Mongol forces besieging Kaffa suffered a severe natural outbreak of bubonic plague that was killing "thousands upon thousands every day." A contemporary Arabic source estimates 85,000 plague fatalities among the Mongol forces in the Kaffa region during this epidemic.

But the Mongols turned this to their advantage and catapulted the plague-infected corpses of their dead comrades over the city walls to spread the disease to the European traders taking refuge in Kaffa. The Mongols were skilled siege warriors, and their artillery at Kaffa was likely numerous and sophisticated. The numbers of cadavers hurled into the city could well have been in the thousands. The Mongol's tactic finally broke the three-year stalemate; the Genoese were crippled by the plague and fled Kaffa by sea back to Europe.

A second well-documented account comes from North America and the wars against the Native Americans. Of the many new diseases that the Europeans brought with them to the New World in the 1700s and 1800s, smallpox was the most feared.

Among Europeans, smallpox epidemics typically had a case fatality rate of 20-40 percent; but among Native Americans, who had not previously been exposed to smallpox and who had not built up immunity towards the disease, fatality rates of 90 percent or higher were common. In the late 1700s, at Fort Pitt on the Ohio River—in present day Pittsburg—conditions were extremely crowded. Traders and settlers had been driven in by the hostilities, and smallpox had just broken out. Journal entries, ledgers and other documents from the time indicate that the ranking British officers at the fort met with a delegation from the native Delaware tribe, and handed over smallpox-contaminated sheets and linens from the fort's hospital under the false pretence of a gift.

A smallpox epidemic is reported to have broken out in the Delaware tribe at this time. Of course, the extent to which the spreading epidemic can be attributed to the blankets is impossible to determine, but the incident is indicative of what appears to be a history of sporadic British and American efforts to infect North American tribes with smallpox.

Twentieth Century Biowarfare Programmes

The revolution in microbiology in the late nineteenth century transformed ignorance about infection into sophisticated understanding. These advances were first applied to unconventional weapons at an industrial scale by Japan, closely followed by the United States and the USSR.

This video provides an historical overview of the main twentieth century biowarfare programmes and introduces the disarmament (G) and non-proliferation (G) efforts to control them.

For most of human history, attempts to transmit infections were rare and clumsy; they probably seldom worked out and, when they did, they were in all likelihood redundant with natural routes of transmission. Lack of knowledge about infectious disease and how they're transmitted prevented rational design of methods of biological attack.

This changed in the twentieth century. The revolution in microbiology transformed ignorance about infection into sophisticated understanding. Over the period 1880 to 1900, the microbial basis of infectious disease was proven, the pathogens causing virtually every common bacterial disease of importance were identified and studied, and their mechanisms of transmission worked out. Coupled with new organisational links between the military and sciences, this paved the way for manipulating infection and the systematic design and improvement of biological weapons.

Advances in science were applied to unconventional weapons at an industrial scale for the first time in World War I, and the horrors of gas warfare led to several arms limitation treaties. A key treaty was the League of Nations' 1925 Geneva Protocol prohibiting the use of chemical weapons in international armed conflicts.

A prohibition on the use of 'bacteriological methods of warfare' was added to the treaty late in the negotiations, almost as an afterthought, because unlike chemistry, there were no indications at the time that biology was being militarised. Yet shortly after the treaty was signed, the Japanese did exactly that. They developed a bioweapons programme on a significant scale that included the most atrocious human-subjects experiments on thousands of Chinese prisoners of war and attacks on civilians with biological agents – actions unique in military history.

Most major World War II combatants conducted research on biological weapons, but none of these programmes were on the scale of the Japanese programme.

The postwar nuclear age set a high standard for the next twenty years of biological weapons development; they made it imperative for bioweaponeers to show how pathogens could devastate populations at the same enormous scale as the bombs dropped on Hiroshima and Nagasaki.

Postwar American efforts to show that biological warfare could rival nuclear warfare were extensive, and involved laboratory and human subjects research into potential pathogens, the industrial production and stockpiling of agents, the manufacture of bombs and spray generators, fitting of airplanes and ships for dispersal, the indoctrination of troops, and large-scale field trials.

Yet, despite the intensive development and testing, and simulations of disease attacks on civilians that grew larger and more elaborate until they verged on reality, biological weapons were neither assimilated into the thinking and planning of the regular military, nor used by the United States or its partners—the United Kingdom and Canada, and, later, Australia.

In a political move that caught the bioweaponeers off-guard, the newly-elected President Richard Nixon unilaterally renounced biological weapons in 1969, paving the way for the multilateral Biological Weapons Convention, introduced three years later.

The U.S. bioweapon programme was dismantled in the early 1970s, the considerable stockpiles destroyed and the facilities converted. Ironically, it was only after signing the Biological Weapons Convention—the multilateral treaty banning biological weapons—that the Soviet programme began its incredible expansion.

The expansion and redirection of the program was proposed by a small but very influential group of scientists arguing for exploiting the new field of genetic engineering that was just beginning to emerge in the West. New pathogen properties, such as antibiotic resistance and enhanced stability, were to be engineered directly into pathogens, including agents not on classical bioweapons agent lists. These altered pathogens formed a novel arsenal of weapons that could not be predicted by western intelligence.

The tightly controlled programme was even more secret than the USSR's efforts in the realm of nuclear weapons. Rather than expanding the Soviet military biological institutions, the new offensive programme was established in the civilian sphere. Western intelligence services most likely knew about the military biological institutions and kept them under observation, so the better option was to 'hide' the new institutions in plain sight.

An entirely new, ostensibly commercial, network of institutes, production plants and storage facilities was constructed. Collectively known as Biopreparat, it worked both sides of the street: it cured diseases and invented new ones.

In the years following the USSR's collapse, the Cooperative Threat Reduction programme decommissioned the main production plant and testing site, and transformed the majority of the know Biopreparat facilities into more open research facilities some of which began international collaborations on peaceful microbial research, including international scientist exchanges.

The three key military institutes involved in the BW program remain closed to outsiders, and it is not possible to ascertain whether the biological weapons program has been terminated in its entirety. Russia's current official position is that no offensive BW program ever existed in the Soviet Union.

Case Studies: The US and the USSR Biowarfare Programmes

Case Study US Program

In the US programme, research, development and pilot-scale production were located at Fort Detrick and at the Edgewood Arsenal in Maryland, with additional facilities at the animal research station at Plum Island, New York. Biological agent and munitions production took place in a large purpose-built ten-floor facility at Pine Bluff, Arkansas. Early trials were carried out at Dugway Proving Ground in Utah.

Open-air field trials to test aerosol dispersion patterns were conducted at a large number of locations throughout the U.S. A series of trials initiated in 1953 under the St Jo programme simulated anthrax attacks on urban targets to estimate munitions requirements for the strategic use of biological agents against typical target cities. Three North American cities were chosen to approximate Soviet cities: St. Louis, Minneapolis and Winnipeg, Canada.

For months, its experimenters used generators mounted on top of cars parked in various urban locations to disperse clouds of simulants. Many of the open-air field trials were held at sea for fear of soil contamination, public disclosure and possible danger to local populations. 'Project 112' was a land and sea project for expanded offensive testing of chemical and biological weapons.

At least fifty Project 112 trials took place, involving warships, bombers and airplanes fitted with spray generators. In the late summer of 1968, the final and probably most elaborate open-air biological tests took place over the Pacific Ocean downwind of Johnston Atoll, a thousand miles southwest of Hawaii.

Bill Patrick, Fort Detrick's chief of product development and one of the top US bioweaponeers, recalls the trial. "At sunset, just as the sun touched the horizon, a Marine Phantom jet flew in low…a single pod under its wings releasing a weaponised powder. The powder trailed into the air like a whiff of smoke and disappeared completely. … The jet was disseminating a small amount of biopowder for every mile of flight [in a single-source laydown]. …At Johnston Atoll, the line of particles moved with the wind over the sea, somewhat like a windshield wiper sweeping over glass. Stationed in the path of the particles, at intervals extending many miles away, were barges full of monkeys, manned by nervous Navy crews wearing biohazard spacesuits. The line of bioparticles passed over the barges one by one. Then the monkeys were taken back to Johnston Atoll, and over the next few days half of them died. Half of the monkeys survived, and were fine."

It was clear that a jet that did a laydown of a modest amount of military bioweapon over a city like Los Angeles could kill half the city's population. The open-air biological trials decisively removed any doubts whether bioweapons worked. Bill Patrick recalls: "When we saw those test results, we knew beyond a doubt that biological weapons are strategic weapons. We were surprised. Even we didn't think they would work that well."

Case Study Soviet Program

The extensive, multiagency Soviet bioweapons programme encompassed both military and civilian research facilities. This posed challenges to keeping the programme secret, and a new classification level higher than Top Secret called 'series F' clearance was established to cover up the programme.

By the end of the 1980s, Biopreparat controlled three dozen institutes, mobilisation plants, and other types of facilities that were either involved in biological weapons R&D or supported it in some way. These were spread throughout the Soviet Union: they were in Moscow and Leningrad (now St. Petersburg); in Kirov, five hundred miles east of Moscow; and, still further away, in Kazakhstan, Uzbekistan and Siberia.

Biopreparat created new biological weapons enclaves, at Obolensk and at Koltsovo, and built factories dedicated to biological-agent production, most impressively an enormous plant at Stepnogorsk. It is estimated that at least 30,000 people worked for the Biopreparat system, though many argue that figure could be substantially higher.

The first defector to emerge from Biopreparat was Vladimir Pasechnik, a microbiologist and director of one of the major bioweapon facilities, who arrived in Great Britain in late 1989, just as the Soviet Union was beginning to crumble. Pasechnik's revelations shocked his Anglo-American debriefers. When President Yeltsin took office in January 1992, the U.S. forced his public admission that there had been an offensive Soviet bioweapons programme and that it had continued into his presidency.

In the years following the USSR's collapse, the U.S. developed a Cooperative Threat Reduction programme to reach Soviet bioweaponeers with collaborative research grants that could provide them with gainful employment. Recipients of these 'brain drain' prevention grants were told that they must not share their advanced knowledge of how to develop, produce, test and disperse biowarfare agents or peddle weapons materials, particularly genetically engineered pathogens. This condition seems to have been an effective deterrent; there is little evidence of proliferation and black marketeering from the Soviet bioweapons programme.

Bioterrorism

Bioterrorism is a relatively new concept that emerged during the early 1990s in the United States to describe terrorists' use of biological weapons. This video considers the politics of bioterrorism: threat assessments and government response. There is a dedicated learning unit on WMD (G) terrorism.

Bioterrorism is a relatively new concept that emerged during the early 1990s in the United States to describe terrorists' use of biological weapons. In the last years of the Cold War, a new set of threats posed by rising third-world states and terrorists supported by these states began to be projected by some U.S. security analysts and national security commissions—particularly on the right of the political spectrum and with ties to the Pentagon—and among these threats were terrorists armed with biological weapons and other 'weapons of mass destruction.'

As the Cold War faded, the threat of biological weapons from third-world states and terrorists hostile to the United States began to replace the Soviet threat. Although little credible evidence existed at the time that such states or terrorists would, or even could, resort to biological weapons, the newly perceived threat became the driving force behind U.S. preparedness and biodefense programmes of considerable institutional proportions.

Different assessments of the importance, urgency and scale of the threat were present in the early political debates on bioterrorism. 'Alarmists,' who included prominent scientific and technical advisers, tended to emphasise the vulnerability of the civilian population, and they would apply their impressive scientific and technical skills to the possibility of 'apocalyptic' attacks with natural pathogens and genetically engineered hybrids.

They were less focused on the identities of 'bioterrorists,' and in their interests in pursuing such attacks or their capacities to do so. In contrast, 'sceptics' tended to have backgrounds and training in the history, politics and culture of terrorism, and for them, questions of the identity, interests and details of past attackers were the primary questions to ask.

Ultimately, alarmism trumped scepticism and federal funds poured into major new US civilian biodefense programmes.

The 'Amerithrax' attacks, as the FBI code-named the anthrax mailings immediately following 9/11, revealed serious shortcomings in U.S. biosecurity, and also raised fears about the growing potential for bioterrorism on American soil. The threat of bioterrorism became one of the Bush administration's key security concerns during its two terms in office, and it initiated a series of new regulations, policies and programs in the early- to mid-2000s to strengthen U.S. preparedness against a bioweapon attack.

Concern about the threat of international terrorism coupled with WMD proliferation was also exported from the United States to international security forums and back to capitals around the world following 9/11 and the Amerithrax attacks. 'Bioterrorism' became an international problem requiring a policy response, and counteroffensives materialized in international risk and security strategies.

In Europe, the European Commission launched a programme to respond to the consequences of WMD attacks, and particularly bioterrorism attacks, already within a few weeks of 9/11 andAmerithrax. The European security strategy, drawn up for the first time in 2003, focused heavily on the new threat from WMD and terrorists committed to maximum violence. In parallel, the European Union also adopted a strategy against proliferation of weapons of mass destruction.

The change in government in the US saw an evolution in US thinking about its response to bioterrorism. The Obama administration announced its first major policy initiative on biosecurity in 2009. While the Bush Administration's efforts had been focused on biodefense, Obama's National Strategy for Countering Biological Threats was focused on prevention. It emphasized linking deliberate disease outbreaks from bioterrorism attacks with naturally occurring disease outbreaks, to create a more seamless and integrated link across all types of biological threats – echoing what the WHO had been pushing multilaterally for years.

The Obama administration's strategy also worked to create more linkages between health and security, by enhancing disease surveillance and fostering cooperation between the public health, life science and security communities. The strategy emphasized the need for international cooperation and partnerships to deal with the global nature of the threat, and called for expansion of bioengagement activities into Africa and South Asia.

More than $70 billion have been spent on civilian biodefence across the federal government since 2001.

Current threat assessments suggest there have been some concerns about Al Qaeda's efforts to obtain a bioweapon capability, and it has been leaked that Israel secretly detained a suspected Al Qaeda bioweapons expert for a number of years. There have also been some reports indicating that ISIS might have an interest in bioterrorism. Yet, despite these concerns, the suggestive features of past bioterrorism incidents indicate that while the risk of a crude, small-scale bioterrorism attack is possible and likely, the risk of a sophisticated large-scale bioterrorism attack with mass fatalities and severe consequences is low.

Bioterrorism Incidents and Lessons Learned

Case Study Bioterrorism Incidents

Despite the widespread attention given to the risks from bioterrorism, few terrorists have contemplated using biological agents, and fewer still have made any serious effort to develop a capability to employ biological agents. Still fewer ever tried to use them.

There are four commonly identified past bioterrorism incidents. Three of these attacks took place in the US, one in Japan. There have been no reported bioterrorism acts in Europe.

In the first incident, a group of teenagers with fantasies of apocalyptic regeneration for humankind created a group called R.I.S.E. They obtained several biological agents and learned how to grow them, but failed to mount planned attacks before being arrested.

In a second, more serious case, a cult known as the Rajneeshees actually spread a biological agent. They deliberately contaminated salad bars with Salmonella to sicken voters and make them stay away from the polls during local elections in Oregon in 1984. Salmonella rarely kills, and no one died in this attack, but more than 750 people were infected, some of them severely. The third instance was an unsuccessful attempt to develop and disseminate anthrax by the Japanese Aum Shinrikyo cult. They had more success with chemicals. In 1995, they went on to carry out the sarin attack on the Tokyo underground.

The most lethal biological attacks were the 2001 anthrax letters, which killed five and sickened another 17 people. The series of five anonymous letters containing a deadly strain of anthrax were sent to media outlets and the U.S. Senate within weeks of the unprecedented terrorist attacks on New York and Washington on 11 September 2001. The letters overtly linked the two attacks, with its messages of "09-11-01 you can not stop us" and "this is next".

Case Study Bioterrorism Lessons Learned

While there have been relatively few instances of bioterrorism, and future cases may differ significantly from past ones, there are suggestive features of the past bioterrorism incidents that can enrich assessments of the current and future threats.

First, bioterrorism can take many forms. It might be motivated by a desire to cause mass casualties, as was true for R.I.S.E. and Aum Shinrikyo. But, it is equally true that the perpetrators may not be focused on killing people at all. The Rajneeshees wanted to disrupt an election, so hoped that their attack would appear to be a natural outbreak. Similarly, if Bruce Ivins was the Amerithrax perpetrator as the FBI claims, his motivations clearly did not fit the typical terrorism model. So, bioterrorism incidents may be motivated by very different political and personal considerations.

Second, the skills required to undertake even rudimentary bioterrorism attacks are greater than often assumed. Certain technical and scientific skills are required to culture and disseminate microorganisms, even in crude ways. More sophisticated attacks, involving larger quantities of agent and more complex dissemination methods, as attempted by Aum Shinrikyo, may be beyond the capabilities of even well-organized and funded terrorist groups. While the problems may not be technically insurmountable, terrorist groups rarely engage in the required types of complex research and development, and some of the needed expertise may require access to difficult to obtain so-called tacit knowledge.

Third, organizational factors may be critical. While simpler forms of bioterrorism are within the reach of lone actors, a group effort would be necessary to mount larger, more sophisticated attacks. As Aum Shinrikyo's experience suggests, this may create serious obstacles to the many technical challenges facing a would-be bioterrorist. The complexities of undertaking such activities in a covert manner should not be underestimated.

Finally, the scarcity of bioterrorism incidents is telling. The Rajneeshees demonstrated that it should be possible to undertake crude bioterrorism attacks with little difficulty, and the Amerithrax case showed how disruptive they could become. Yet, despite this, few terrorists have shown a serious interest in developing biological weapons.

2. The Norm against Biological Weapons

Biological Arms Control and Disarmament

The international community has laid down clear red lines about the misuse of biology. The two biological cornerstones of the rules of war are the Geneva Protocol (G) and the Biological Weapons Convention (G). Together, they prohibit the development, production, stockpiling and use of biological weapons.

The following slides provide overviews of the two agreements.

The video in this slide provides more details about the Biological Weapons Convention and the challenges of verifying compliance with the treaty.

There is a dedicated learning unit on export controls.

The cornerstone of the biological arms control and disarmament regime is the Biological Weapons Convention.

The BWC is an extraordinary treaty. Negotiated in a relatively short period of time, it was the first treaty to outlaw an entire class of weapons. The political atmosphere in the late 1960s, early 1970s when the BWC was negotiated was dramatically different from the international political situation today. The Cold War was severely limited progress in arms control and disarmament. Occasionally, however, there were windows of opportunity to advance arms control. BWC negotiators took advantage of one of these windows to successfully draft and approve the final text of the Convention.

The BWC opened for signature in 1972 and entered into force in 1975. The UK, U.S. and USSR acted as depository powers. Unusually for an arms control treaty, the BWC was agreed without routine on-site verification mechanisms to enhance assurance of compliance. Some states argued that the nature of biological weapons is such that they are inherently impossible to verify: not only can significant quantities of biological agents be produced in small and readily concealable facilities, but most of the equipment required—the fermenters, centrifuges and freeze-dryers—is ubiquitous in public, private and commercial laboratories. Other states argued that, while the same level of accuracy and reliability as the verification of, for example, nuclear arms control treaties is unattainable, it is possible to build a satisfactory level of confidence that biology is only used for peaceful purposes.

The lack of a verification mechanism had immediate impacts on the treaty. Shortly after the USSR signed the treaty in 1972, analysis of CIA spy plane photographs raised suspicions that the Soviet Union was defying its obligations to dismantle its BW program.

These photographs and U.S. suspicions continued after the Convention entered into force in 1975. What the spy plane photos appeared to show was that the Soviets were constructing new structures at their BW installations rather than getting rid of BW agents and munitions.

The first conference to review the operations of the BWC was held in March 1980, in the period often referred to as the 'second Cold War.' At that conference Sweden proposed establishing a Consultative Committee to investigate issues of noncompliance with the treaty. The Committee would have the ability to conduct fact-finding missions with on-site inspections. The USSR objected, arguing that a review conference was not the appropriate forum to introduce amendments to the Convention.

The Soviets may well have had other reasons to object to the Swedish proposal. In the spring of 1979 there was an outbreak of anthrax in the Soviet city of Ekaterinburg, then known as Sverdlovsk. Because the city was home to a facility the U.S. long suspected was a BW lab, intelligence analysts in the West suspected that a leak or explosion at the facility caused the outbreak.

The U.S. made its suspicions public at the first BWC review conference and raised allegations that the outbreak was due to a biological weapon accident, charging the Soviets with treaty violation. The Soviets responded to the allegation by acknowledging the existence of the anthrax epidemic and blaming it on the ingestion of tainted meat.

Ultimately, the controversy was resolved by abandoning the efforts to establish a Consultative Committee to investigate noncompliance. The anthrax outbreak controversy lingered until independent scientific investigations conducted after the collapse of the Soviet Union revealed that the U.S. suspicions of a leak at a biological weapons facility was indeed the cause of the outbreak.

A much larger second attempt to address the lack of verification provisions in the treaty, by adding a legally binding compliance protocol, took place between 1994 and 2001. This attempt failed too. The U.S. rejected the draft protocol on the grounds that it did not offer rigorous enough verification measures to detect clandestine bioweapons activities, but that it was invasive enough to compromise classified and proprietary information form the U.S. biodefense program and pharmaceutical industry. Several other states who also had concerns with the draft protocol were happy to hide behind the formal rejection by the U.S.

A legally binding mechanism with measures to verify compliance with the BWC is a long-term goal for the European Union. In the meantime, the BWC remains an arms control treaty whose provisions are notoriously difficult to verify, and one that provides very few traditional tools to carry out the process of verification and to make an informed and accurate verification judgment.

The 1935 Geneva Protocol

Full name: Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare

Date of adoption: 17 June 1925 Date of entry into force: 8 February 1928 Depository: Government of France States Parties: 145 (as in April 2021) Signatory States: 0

> …the use in war of asphyxiating, poisonous or other gases, and of all analogous liquids, materials or devices, has been justly condemned by the general opinion of the civilised world… …this prohibition shall be universally accepted as a part of International Law, binding alike the conscience and the practice of nations…'

The Biological Weapons Convention

Full name: Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction

Date of adoption: 16 December 1971 (UN General Assembly) Date of opening for signature: 10 April 1972 (London, Moscow, Washington) Date of entry into force: 26 March 1975 Depository: Governments of Russia, United Kingdom and United States States Parties: 183 (as in April 2021) Signatory States: 4 (as in April 2021) More info: www.unog.ch/bwc `[http://www.unog.ch/bwc]`

> …Determined, for the sake of all mankind, to exclude completely the possibility of bacteriological (biological) agents and toxins being used as weapons, Convinced that such use would be repugnant to the conscience of mankind and that no effort should be spared to minmise this risk…'

Cooperative Threat Reduction

The Cooperative Threat Reduction (CTR) programme was established by the United States to provide former USSR states with assistance to destroy their unconventional weapons.

This video describes the biological CTR programme and how it has evolved over the past twenty-five years.

The creation of the Cooperative Threat Reduction program in 1991 was a historically rare innovation in international problem-solving. Prior to the early 1990s, states accomplished the reduction of arms through laboriously negotiated treaties such as the 1991 Strategic Arms Reduction Treaty or the 1990 Conventional Forces in Europe Treaty. Or, states withdrew weapons unilaterally—usually in tandem with the introduction of improved versions of the weapons being retired.

The disintegration of the Soviet Union left several of the fifteen successor states with major nuclear, chemical and biological weapons capabilities. However, they had limited resources to deal with them. The Cooperative Threat Reduction programme was established by the U.S. to provide these states with the necessary assistance to destroy their unconventional weapons; ensure the security and safety of the weapons in storage, and put verifiable safeguards in place against the proliferation of unconventional weapons.

The original focus of CTR was primarily to help Russia and the other Former Soviet Union states meet their obligations under various arms control treaties. The Biological Weapons Convention prohibits biological weapons, but permits research to develop vaccines and therapeutics like antibiotics.

Yet, the treaty offers little specific guidance about when such research, testing and other biological activities crosses over into the military realm. Since the BWC lacked the kind of concrete destroy-this/reduce-that/definitely-do-'x' definitions that you find in the nuclear accords, the biological mission for Cooperative Threat Reduction was not as easily defined or executed in the early 1990s.

A big impetus for the biological CTR work was to transparency and getting Moscow to open up about its bioweapons programme. The Russians did not see a downside to having CTR assistance at the Biopreparat facilities, but Ministry of Defense officials drew a red line and refused Western requests to visit the military biological facilities. The Ministry of Defense also blocked collaborative research grants to military scientists.

Despite this, biological CTR programming in the former Soviet Union was very successful. It upgraded the physical security of a number of facilities and trained staff in more rigorous safety and security practices. It enabled the destruction of Steponogorsk, the main BW production facility in the Soviet Union, and cleaned up much of the BW test site in the Aral Sea so that it poses less of a health threat to local populations, both human and animal—and, of course, the clean-up also limits access to potential BW agents. CTR 'brain drain' prevention grants, through the International Science and Technology Center, kept a lot of bioweaponeers in Russia with gainful work so they did not have to look for other employers who might have exploited their expertise or access to various genetically-engineered pathogens.

The European Union and other Western states began adding funds and projects to the U.S. CTR initiative. This was formalized in 2002 through the Global Partnership, which by 2015 had 26 contributing states.

When the CTR program started, the funds for nuclear and chemical weapons threats far outstripped funds to address the biological threat. Now, biological programs are the largest part of the overall CTR budget, and the focus is on providing states with the capabilities to tackle a disease outbreak, regardless of whether it is naturally occurring or deliberate introduced.

3. Scientific Advances and the Bioweapons Threat

The Misuse of Biology

Research in biology and biomedicine is essential to global health. It provides insights into disease agents, their transmission and how we can treat them.

But these same insights can also be abused.

Trends in bioscience:

- increasing pace of advances in bioscience
- increasing convergence of biology and biomedicine with chemistry, engineering, mathematics, computer science and information theory
- increasing diffusion of capacity in biology and biomedicine around the world, particularly in emerging economies such as China and India
- increasing opening up of science with new tools like wikis, blogs and microblogs altering how information is gathered, handled, disseminated and accessed; and amateur communities, scientific outreach and educational toys increasing access to hardware for wetwork in the life sciences

The trends in bioscience are making it easier to develop biological weapons. Risk assessments by the global network of science academies conclude that scientific advances in biology and biomedicine are significantly eroding technological barriers to acquiring and using biological weapons: iapbwg.pan.pl (www)

Emerging Research Areas with High Misuse Potential

Not all research is of concern. Various efforts have been made, particularly in the United States, to characterise biological research with particularly high misuse potential.

Examples identified of such 'dual use research of concern' include experiments that:

- manipulate the pathogenicity, virulence, host-specificity, transmissibility, resistance to drugs, or ability to overcome host immunity to pathogens
- synthesize pathogens and toxins without cultivation of microorganisms or using other natural sources
- identify new mechanisms to disrupt the healthy functioning of humans, animals and plants
- develop novel means of delivering biological agents and toxins

Early high profile experiments that raised concern:

- made mousepox more deadly (2001)
- synthesized poliovirus from scratch (2002)
- reconstructed the extinct 1918 flu virus (G) (2005)

More recently, entire fields of biological research are raising concern. These include:

- 'gain-of-function' studies where potentially pandemic pathogens are artificially mutated and 'enhanced' to create even more potent strains of some of the world's deadliest diseases
- synthetic biology which aims to engineer biology, and which will likely make it possible to create dangerous viruses from scratch in the near future
- neurobiology, which may improve the operational performance of troops through neuropharmacological agents that enhance functions like perception, attention, learning, memory, language, thinking, planning and decision-making; or which may degrade enemy performance through incapacitating biochemical agents or so-called 'non-lethal' weapons

Security Risks

While there are significant risks of small-scale bioterrorism attacks, the likelihood that scientific advances will be used to 'enhance' these attacks in relatively low.

The most significant security threat from the misuse of advances in bioscience comes from sophisticated biological attacks from professional and well-resourced institutions like national militaries.

New and emerging infectious diseases, and diseases intentionally created in laboratories, are considered some of the biggest threats to national security.

Over half the world's population is now crowded into urban areas. This makes the modern city an ideal breeding ground for disease that can quickly spread across borders and cause a public health emergency.

These emergencies put intense pressures not only on health services, but on society as a whole. What begins as a health problem can become a social, cultural or economic crisis, potentially sparking civil and political unrest.

Q&A

This interview covers:

- the threat of bioweapons use by states and national militaries
- the blurred line between offensive and defensive programmes
- the terrorist threat
- the impact of emerging technologies on the threat of bioweapons

4. Summary and Further Reading

This learning unit has provided an overview of:

- the key biological agents and delivery systems of biological weapons
- the twentieth century biological weapons programmes of Japan, the United States and the Soviet Union
- assessments of the bioterrorism threat and government responses
- the international legal framework banning biological weapons and the main challenges of biological disarmament and non-proliferation
- scientific research areas with high misuse potential and the impact of emerging technologies on the threat of biological weapons
- efforts to foster responsible science

Reading

- Biological Threats in the 21st Century
- Synthetic Biology and Bioweapons