

# Revisiting Biological Warfare and Bioweapons: Historical Narratives and Future Realities

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## Abstract

From the antique to the contemporary era, humans have often used high-risk pathogens to gain leverage in warfare. In ancient and medieval times, people crudely contaminated arrows or poisoned wells. During World War II, the Japanese precisely deployed anthrax and plague. Humankind has suffered catastrophic consequences from bioweapons. This review explores the historical use of bioweapons to highlight the future realities of biological warfare. We used secondary sources from common databases. Our findings reveal that smallpox was the most lethal bioweapon in history. Advances in microbiology, especially the Germ theory, have changed biological warfare. It has evolved from rudimentary contaminations to advanced deployment. Today, it is difficult to distinguish between accidental and intentional deployment of microorganisms and natural epidemics. In the future, epidemics and pandemics may become a new form of biological warfare. International prohibitions make future bioweapons use more likely to be small in scale. However, such incidents could have a

sensational impact in the information age. Therefore, the United Nations should ensure member nations comply with the Bioweapons Conventions Treaty. It should also help prevent rogue elements and terrorists from accessing bioweapons technologies.

**Keywords:** bioweapons, biological warfare, epidemics, high-risk pathogens, bioweapon technologies

## 1. Introduction

Biological weapons are the instruments of biological warfare. A biological weapon consists of an agent and some delivery mechanism. Highly transmissible microorganisms are considered high-risk pathogens and are potential biological weapons in modern warfare (Carus, 2015). Biological weapons and toxins are derived from highly virulent viruses, bacteria, fungi, or other toxic substances of biological origin; they are deliberately produced and consciously deployed to cause death and devastation in mankind and his ecosystem (WHO Biological Weapons, 2026). Thus, they are purposely used in conflicts or warfare. In earlier periods, the use of bioweapons relied on crude methods such as contaminating water supplies or poisoning horses and personal belongings. At that time, users lacked understanding of how pathogens caused disease. Later, the development of germ theory by Pasteur and Koch in the late 19th century advanced knowledge of microorganisms (Forrester, 2016). This scientific progression led to the concept of biological warfare emerging after the link between microorganisms and disease was clarified. Nonetheless, the history of crude contaminations and poisonings remains relevant to the discourse of bioweapons. Early users recognized the serious public health impacts and potential military advantages. This historical context illustrates the evolution of bioweapons from ancient practices to postmodern threats. It is important to note that biological weapons have rarely been used in isolation throughout history, often accompanying chemical weapons and sometimes becoming contextually indistinct. Especially since the late modern era, they have been classified as part of the broader group of unconventional or weapons of mass destruction (WHO Biological Weapons, 2026), alongside chemical, nuclear, and radiological weapons.

The devastation caused by the recent pandemic is a stark reminder of the catastrophic capabilities of virulent microorganisms. For instance, as of 25 March 2026, COVID -19 killed over 7.1 million out of over 779 million cases globally since late 2019 (WHO Data, 2026). The world grappled with the consequent economic disruptions and social dislocations resulting from massive mortalities, quarantines, and lockdowns. From 2014 to 2016, in West Africa, Ebola was responsible for over 11,300 deaths with massive displacements and further widening of poverty gaps in an already impoverished clime (Izudi & Bajurniwe, 2024). It is unimaginable the calamities that conscious deployment of extremely virulent agents such as anthrax, botulinum, COVID-19, Ebola, Marburg, Lassa, and others could cause to mankind. In this light, public health authorities have categorized bioweapons based on their virulence and transmissibility. Category A, like anthrax, botulinum toxins, plague, smallpox, and a group of hemorrhagic viruses, poses the greatest threat due to their extremely high transmissibility and resultant mortalities. Such hemorrhagic viruses include Marburg, Ebola, Lassa, Congo-Crimean, Chikungunya, and so on (History of Vaccines, 2022). Despite the

global elimination of smallpox by the WHO in 1980, some live samples are preserved in US and Russian laboratories to the present (Muula, 2022). Thus, there are concerns of genetic reengineering resulting in heightened virulence for post-modern warfare (Gostin et al., 2024). Category B bioweapons are easier to disseminate and have a lower mortality than Category A organisms. These comprise brucellosis, glanders, Q fever, ricin toxin, typhus fever, and other microorganisms. Category C agents comprise evolving pathogens capable of being genetically engineered for mass propagation in the future, like the Nipah virus (History of Vaccines, 2022). In a post-modern world laden with wars and hostilities, there are increasing concerns of biological warfare. To safeguard global health, a brief knowledge of the use of bioweapons throughout history is imperative. Moreover, the impacts of current world realities, such as Artificial Intelligence and genetic engineering, could revolutionize the theme of bioweapons and cause greater calamities in the future. This information could be invaluable to highlight the present and future trends of bioterrorism. Hence, the focus of this review.

## 2. Literature Review

In the 21st century, given the growing hostilities and the growing risks of bioweapons, some researchers have done a historical review on this theme. Riedel (2004) and Barras and Greub (2014) highlighted the concepts of biological warfare and its stages of development, its utilization, and the attempts to control its proliferation throughout history. On a different vein, recent works are focusing on potential microorganisms that could be deployed as agents of bioterrorism. For instance, Clark and Pazdernik (2016) ascribe some bacteria as the main potential culprits of biological weapons due to their innate abilities to produce toxins that are harmful to host cells. They exposed the growing trend of antibiotic resistance. More importantly, they state the plausibility of new antibiotics, phage therapy, genetic engineering, and nanotechnology to tackle antibiotic-resistant pathogens. From a different perspective, Oliveira et al. (2020) underscored the significance of microbial forensics in delineating accidental and incidental releases of microorganisms. They emphasize the importance of early prevention and preparedness to ensure timely intervention and prevent unnecessary human suffering and loss. Related to this review, Gisselsson (2022) examines the potential use of bioweapons in the future. He asserts that future use is more likely to be rare and small in scale, but more sensational. However, this study departs from previous works by juxtaposing current world realities with the theme of bioweapons and biological warfare. We aim to elucidate the effects of information warfare, Artificial Intelligence, machine learning, and genetic engineering on high-risk microorganisms in a post-modernistic world.

## 3. Methodology

This is historical research reviewing the evolution of biological warfare to gain insights regarding future dynamics of the theme. We deployed secondary sources from major databases such as PubMed, Web of Science, Directory of Open Access Journals, Google Scholar, and so on. We extracted peer-reviewed articles detailing biological weapons and warfare. Then, they were curated based on historical relevance and themes from the antique to the contemporary era. Subsequently, we deployed narrative analysis to detail the historical trajectory of bioweapons and, most importantly, highlight future realities of biological

warfare. Non-peer-reviewed articles were excluded from the selected articles. Moreover, articles strictly on bioterrorism were not selected. However, few were used in analyzing specific parts of this work when they were found relevant.

#### **4. History of Biological Warfare from the Ancient Era to the Postmodern Era**

Contaminations and poisonings have been deployed to gain leverage in warfare since antiquity. However, the documented record of bioweapons began gaining traction from the late 19th century, when the Germ theory ascribed the causation of diseases to microorganisms. Prior to this period, the miasmatic theory, which attributed disease causation to bad air in the atmosphere, held sway for many centuries. Nevertheless, the contaminations from the early eras evolved into the definitive biological weaponry in the later epochs. Table 1 illustrates the historical evolution of biological weapons from ancient to contemporary times. It shows that humans have leveraged various means in wars and hostilities since ancient times. Ancient armies relied on military strength, tactics, and methods. However, they also deployed various biological weapons to gain an advantage over their adversaries. As shown in Table 1, the Hittites, Scythians, Carthaginians, Romans, Athenians, and Parthians employed biologicals as a means of leverage at various times. They poisoned wells and arrows, and deployed live organisms such as snakes and scorpions. These tactics were employed to intimidate, destabilize, weaken, and subdue enemies on the battlefield. In this era, armies did not comprehend the microbiological basis of their actions. However, they understood the basic mechanisms of common diseases and their diffusion. Thus, they used them to their advantage in warfare and hostilities.

In the Middle Ages, this pattern continued. Some armies poisoned water supplies and used manure and excrement to infect enemies. Hurling infected or dead bodies was a new tactic that marked the history of biological warfare. Notably, the Mongol conquests were cited as the main cause of the Black Death in Europe. It was claimed they brought the plague from the Mongolian Highlands and Eastern Asia, where it was endemic, into Europe. In 1346, reports say they hurled plague-infected corpses over the walls at Caffa, which is said to have triggered the Black Death. The pandemic raged from 1346 to 1353. It caused more deaths by a single pathogen than any other event. This scourge killed about 200 million people, destroying one-third to one-fifth of Europe's population (Piret & Boivin, 2021). Some writers disputed whether trebuchets could hurl corpses at Caffa (Field, 2023). Still, the Mongols' role in spreading plague into Europe remains significant. Their peak military campaigns coincided with the arrival of the Black Death.

Moreover, as shown in Table 1, from the 16th century in Africa, the Borgu and Senegambian armies poisoned the horses and water supplies of their enemies. This pattern continued from the antique era. The conveyance of plague bodies to potentiate epidemics continued unabated. In 1710, the Russian armies hurled plague-dead bodies into the Swedish army's camp in Estonia. The landmark use of fomites and clothing from diseased bodies to transmit infections emerged in this era. In the late 18th century, it is noteworthy that Jeffrey Amherst weaponized smallpox against the Native Americans. They deployed smallpox blankets on local populations in the war against the Indigenous Americans. This decimated the

populations of the Native Americans to the advantage of the colonizers. Prior to this period, there were records of conscious deployment of smallpox. In the early 16th century, the Spaniards introduced smallpox, which contributed to the extermination of the Aztecs and the Incas tribes in the Americas (Henderson et al, 1999).

Similarly, in Australia, smallpox was introduced by European colonizers in 1789 and 1829 (Fenner et al., 1988). It substantially contributed to the high fatalities among the Aborigines from 1780 to 1870 (Glynn & Glynn, 2004). Due to its devastating impact, smallpox remained the most lethal bioweapon known to humans. Over time, the use of bioweapons evolved. In the early modern era, strategies shifted from crude contamination and poisoning to the targeted deployment of high-risk pathogens. The advent of Germ theory in the late 19th century further enabled the precise use of microorganisms in modern combat. For instance, as shown in Table 1, during the First World War, the Germans infected the Russian armies with anthrax. Later, during WWII, Japan's Unit 731, led by Shiroishi, experimented with biological weapons, including air-dropping plague-infected fleas over some Chinese cities. Consequently, they triggered severe epidemics and resultant mortalities. In the Cold War era, the USSR developed a clandestine program, *Biopreparat*, to weaponize anthrax and smallpox. Meanwhile, in the 1950s, the US researched and developed bioweapons such as anthrax, tularemia, brucellosis, Q fever, and others (Clark, 2008). By the early 21st century, however, the deployment of high-risk pathogens began to shift toward acts of terrorism. In the US, for example, Salmonella and anthrax attacks occurred in 2001 and 2009, respectively.

## **5. Some Pictorial Representations of Biological Warfare in History**

**In 184BCE, the Carthage General, Hannibal weaponized venomous snakes against the Greeks to secure victory.**



Image of Hannibal from Mommsen's "Römische Geschichte" page 265, Phaidon Verlag, 1932, via Dickson College Commentaries.

Adapted from.  
<https://www.thecollector.com/crazy-examples-of-biological-warfare-throughout-history/>

**Shiro Ishii was a Japanese microbiologist and head of Unit 731 biological warfare unit of the Imperial Japanese Army. He researched and experimented with anthrax, plague and other virulent pathogens during the Second Sino-Japanese War (1937-1945) and**

World War II.



Adapted from Getty Images, Pictures from History.  
<https://www.gettyimages.in/detail/news-photo/unit-731-was-a-covert-biological-and-chemical-warfare-news-photo/1354451973?adppopup=true>

## 6. Future Realities of Biological Warfare and Weapons

The use of biological weapons is a perversion of medicine and scientific discovery. Its use should be discouraged in strong terms by all and sundry. The devastation it has wrought in history and the catastrophe it could portend in the future should be a great concern for mankind. Unfortunately, in the future, the current trend of clandestine development and usage of chemical and biological weapons is more likely to continue. It would be increasingly difficult to distinguish between biological and chemical armaments regarding their usage and impacts. More importantly, in the present era, it is difficult to determine natural or accidental outbreaks of epidemics from intentional deployment of high-risk pathogens into populations. The catastrophic sequelae are similar in humans, animals, and the environment. For example, COVID-19 annihilated 7.1 million people since 2019, with widespread socio-economic and political upheavals (WHO Data, 2026). There is still doubt regarding the true origin of COV-SARS 2 from Wuhan in China. Some could not totally pin the origin of the pathogen to bats or pangolin in the Wuhan wet markets in China. Some discovered that the delay in early management of the virus escalated the transmission outside China. They allude to the ambiguity of the origin of the COVID-19 pandemic (Ojo & Okoror, 2025). In this light, the next biological warfare might not be between nations and countries. It might masquerade as a pandemic, most likely involving high-risk pathogens and category A bioweapons. Biological warfare is more likely to mimic an epidemic or pandemic in the future. More troubling is that the rapid urbanization and migration in the contemporary world are a bane. They would always aid the rapid dispersal of high-risk organisms globally, regardless of the region of intentional release.

To prevent the recurrence of COVID-19, the WHO organization made a proclamation. In 2022, they marshalled an action plan to increase promotion and awareness of high-risk pathogens that could trigger the next pandemic (WHO News, 2022). Such microorganisms include COVID-19, Ebola, Marburg, Chikungunya, Congo Crimean, and the imaginary and placeholder Disease X. The aim is to increase funding and vaccination research for those lethal pathogens. Some high-income countries and the Global North could capitalize on and leverage this regulation to start or continue their secret biological weapons research and stockpiling for future use.

The Geneva Protocol prohibited the use of biological weapons after World War I. Given the ignominious effects of its nominal use during the war and the future catastrophe it could wreak on the world, the League of Nations decided to ban its further use. In 1925, the *Geneva Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare* was ratified, and it banned further use of bioweapons (Christopher et al., 1999). However, they did not stop biological weapons' research or stockpiling by member countries. In this light, countries that had sanctioned the treaty, such as France, the UK, Italy, Canada, Belgium, the Soviet Union, and the US, commenced biological weapon development (Christopher et al., 1997). Most times, advanced scientific discoveries often require testing to evaluate their efficacy. In this regard, the Japanese defied the 1925 convention dictates banning the deployment of biologicals in warfare. They intentionally deployed reengineered anthrax and plague on Chinese prisoners

and cities with devastating effects during the WWII (Barras and Greub, 2014). Taking a cue from this dastardly event, the United Nations prohibited member states from stockpiling and using bioweapons in the late 20th century. In 1972, during the Biological Weapons Convention, they banned member countries from developing, producing, and stockpiling biological weapons (Barras and Greub, 2014). Despite being one of the member countries that sanctioned the agreement, the Soviet Union continued to develop a large bioweapon research program named *Biopreparat*. This giant programme had about 50,000 people working in its laboratories at its peak (Alibek & Handelman, 1999). They developed and stored large quantities of anthrax and smallpox partly for intercontinental ballistic missiles (Frischknecht, 2003). Moreover, they researched deadly hemorrhagic viruses, including Marburg, and engineered multidrug-resistant bacteria, including plague. In 2001, the Soviet Union disintegrated with the cessation of those programs and conversion of the facilities to other uses (Frischknecht, 2003). However, in the present era, some Western countries nurse fear of the uncertainty of Russia's claim of destruction of the bioweapons. Some security experts claim they are being kept and reengineered for future use, or they might have fallen into rogue hands (Charatan, 2001).

In the contemporary world, laden with geopolitical wars and power tussles, biological and chemical weapons are bound to continue into the future. Albeit clandestinely because of the extant laws prohibiting overt and conventional use. The world's superpowers, including G7 countries as well as Russia, China, Israel, India, and North Korea, could develop chemical and biological weapons despite the prohibitive laws. Moreover, some countries in the Islamic world, such as Iran and Pakistan, could also embark on or continue biological weapons research for different political reasons. Apart from nuclear weapons, chemical and biological weapons could prove pivotal in geopolitics. They could be deployed clandestinely in short military operations, covert operations, counteroperations, and secret assassinations. If US Intelligence reports are to be trusted, there are indications that South Africa, Iraq, Iran, Israel, and several other nations have developed or are researching biological weapons (Liebenberg, 2001).

The advent of the internet, machine learning, and artificial intelligence defined the contemporary world. The advancement in genetic engineering, globalization of biological competencies, and heightened accessibility could result in more use of bioweapons. It could also potentiate more deadly bioweapon attacks masquerading as epidemics on large populations. During the Cold War, only the US and the Soviet Union had enhanced bioweapon delivery capabilities capable of delivering bioweapons to far distances via bomblets carrying ballistic missile warheads with a sophisticated spray device (Carus, 2017, p.28). They also had the capacity to keep microorganisms viable under certain environmental conditions for maximal impacts. However, globalization and technological advancement have made some of the underlying technical capacities accessible to other nations. Even non-state actors, such as wealthy organizations and individuals, could access bioweapons technologies in the contemporary era. Newer technologies could be adapted for the diffusion of bioweapons. For instance, in the future, drones and robots could be deployed to transfer deadly microorganisms from one region to another or across nations. Thus, the threat of

biological weapons in the hands of non-state actors is better imagined. The rogue non-state actors, such as Islamic terrorists and other unscrupulous elements, could access vital information and develop lethal bioweapons for their nefarious activities. Given that they are not bound by any regulations, they could deploy chemical or biological weapons to cause mass casualties. Most especially, if their demands are unmet by government authorities or corporate organizations. Hence, the need to prevent their access to such weapons by any means necessary.

In future epochs, the rapidity and ease of information access could also trigger disinformation and misinformation. This could trigger propaganda leading to extreme fear and tensions from the attempted use of biological weapons. In the future, rogue elements are more likely to deploy social media for their heinous missions and threats across different nations and communities. The news is more likely to be peddled by more unconventional channels. Thus, there is plausibility of heightened panic, apprehension, and great fear resulting from the usage or attempted usage of bioweapons. As Gisselsson (2022) asserts, the next generation of biowarfare is most likely to be small in scale but paradoxically sensational in nature. Presently, there is often information asymmetry between the conventional and unconventional news channels. The latter is driven by clickbaits, widespread validation, and pecuniary purposes. In this era, such channels include Facebook, YouTube, Twitter, and other social media platforms. They often peddle some news, which often promotes sensationalism, which could heighten fears, negative emotions, and social tensions among populations (Mousoulidou et al., 2024). However, we believe conventional government channels would continue information censorship to dampen fears and public tensions. In an extreme situation, they could engage in information propaganda or warfare with the enemy's news channels.

## **7. Recommendation**

Apart from the Japanese brazen use of biological warfare against the Chinese during WWII, other widespread occurrences have been rare. From the Cold War era, they have been covertly used by the superpowers for espionage and in proxy capacities. Even those deployments are subject to allegations and counter-allegations without real evidence. Since 2001, there has been an emerging threat of bioterrorism, as evidenced by the anthrax letter attacks in the US. Then, there is a plausibility of rogue elements accessing biological or chemical weapon technologies via the internet or research centers. Thus, appropriate regulating bodies must severely restrict advanced technologies of biological or chemical weapons to scientists of impeccable repute. There should be enhanced encryption to prevent all and sundry from accessing bioweapon information.

Regarding international regulation, as of February 2025, 189 countries were signatories to the Biological Weapons Convention that banned bioweapons research and stockpiling (United Nations Biological Weapons Convention, 2025). However, research for prophylactic and peaceful purposes is permitted. Such purposes include medical research, vaccine development, and diagnostic uses. Peaceful biological research and offensive bioweapon research usually deploy similar high-risk pathogens. Hence, it is difficult to delineate their purposes. Nevertheless, for any nation, an excessive research focus on the development of

category A bioweapons such as anthrax, botulinum, or hemorrhagic viruses should raise suspicion. There should be a minimum threshold and quantities for category A bioweapons research, even for diagnostic purposes. More significantly, for a peaceful world, there should be a formal arm of the United Nations to monitor compliance with the Bioweapons Convention Treaty as it exists for the Chemical Weapons Conventions.

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Table 1. Historical trajectory of biological warfare from the ancient to the Post Modern Era

Eras	Time	Actors	Events	Source
Ancient (1500BCE-500)	1500-1200	Hittites	They convey tularemia patients into enemy camps triggering epidemics	Mayor (2003)
	590	Athenians	They poison the water supply of a besieged town named Kirrha with toxic plant Helloborre	Mayor (2003)
	In the 4 <sup>th</sup> Century BCE	Scythians	Scythian archers dip their arrow tips into decomposing cadavers of humans and snakes or manure	Maves et al., (2020) and Flora (2020)
	184 BCE	Hannibal of Carthage	He instructs his sailors to fill clay pots with venomous snakes and	Rothschild (1964)

	130BCE	Roman Commander – Manius Aquilius	throw them to the into the deck of the Greek enemies, Pergamonians.  Poisons the wells of enemy states	Croddy et al., (2002)
	198 AD	Parthians	Deploy live scorpions to repel Roman Armies  The Romans also dip their swords into excreta and cadaver to infect the Parthians	Croddy et al., (2002)
Middle Ages (500-1500)	1155	Emperor Barborossa	He poisons wells with human bodies in Tortona, Italy	Barras and Greub (2014)
	1346	The Mongols	They throw plague sufferers over the wall of besieged cities such as Caffa	Wheelis (2002)
	1422	Hussites	Hurl manure and dead bodies of infected victims into Carolstein in Bohemia	Hobbes (2003)
	1495	Spanish Army	Mix wine with blood of lepers and sell to their French adversaries	Barras and Greub (2014)

Early Modern Era (1500-1800)	From the 16 <sup>th</sup> Century in Africa	Borgu Army	Poison arrow, horses and water supply of the enemies	Akinwunmi (1995)	
		South Sudan (people of the Kaolit Hills)	Weaponize tsetse flies against Arab invasion	Archibald (1927)	
		Mali's Gambian Army	Deploy poisoned arrows against Portuguese invaders in Senegambia	Thornton (2002)	
		1650	Polish Army	They fire saliva of rabid dogs towards their enemies	Barras and Greub (2014)
		1710	Russian Army	Transport plague cadavers to the Swedish troops in Estonia	Carus & Seth (2016)
		1763	British Officers	Distribute smallpox – infested blanks to Native Americans	Henderson et al. (1999)
		1797	Napoleonic Army	Flood the plains around Mantua in Italy to trigger malaria among the enemy camps	Barras and Greub (2014)
	1785	Tunisian Army	Fling diseased clothing into the city of La Calle	Hobbes (2003)	

Late Modern era (1800-1945)	1916 (During WW1)	German saboteurs in Finland	Place ampoules of anthrax in stables of Russian Horses	Croddy et al. (2002)
		French operatives in Switzerland	Infect Horses transported to Germany with Burkholderia	Croddy et al. (2002)
	1939 (WWII Era)	Imperial Japanese Army	Contaminate the Hornstein River near the Soviets' troop	Gold (1996)
	1940	Imperial Japanese Army	Bomb Ningbo (a sub provincial city in Zhejiang Province in China) with fleas carrying plague pathogen	Yamaguchi (2001)
	1941	Imperial Japanese Army	40 members of Unit 731 air-drops plague -infested fleas on Changde (Northwest of Hunan Province). These operations provoked plague epidemics.	Barenblatt (2004)
Post Modern / Contemporary Era (1945 till present)	1984	Bhagwan Shree Rajneesh's followers	Infects 751 citizens of The Dalles, Oregon, with salmonella	Weaver (2001)
	1993	Aum Shinrikyo (Japanese Cult)	Try to release poison at the wedding of the Japanese crown	Kellman (2001)

			prince They attempt to spray anthrax spores from the roof of a building in Tokyo	
	2001	-----	Letters with Anthracis Bacillus sent to US media houses and politicians killing 5 and infecting 17 others	Juling (2023)
	Since 2009	-----	Increasing use or attempted use of ricin for assassination targeting individuals or small groups of people	Juling (2023)

For full rationalization and explanation of categorization into eras as depicted in Table (1) refer to Ojo, O. B. (2025). A Historical Correlation of Medical Advancements with Socio-Political and Technological Epochs. *Journal of Arts, Humanities and Social Science*, 2(3), 68-76. <https://doi.org/10.69739/jahss.v2i3.998>

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