Anthrax: Real Threat or Useful Scare Tactic?

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At the signing of the Public Health Security and Bioterrorism Preparedness and Response Act on June 12, 2002, President George W. Bush proclaimed that, "on September 11th, the world learned how evil men can use airplanes as weapons of terror, [and] shortly thereafter, we learned how microscopic spores [can also be used] as weapons of terror. Bioterrorism is a real threat to our country. It's a threat to every nation that loves freedom, [and] it's important that we confront these real threats and prepare for future emergencies." The bill was a reaction to the 2001 anthrax attacks, in which letters containing anthrax spores were mailed to the offices of two Democratic U.S. Senators and to several news media outlets. "Amerithrax," as the attacks were named in the FBI case, resulted in the deaths of five people and the infection of seventeen others. The turbulent events of 2001 generated public anxiety about bioterrorism's imminent danger to the United States and its allies. However, as professor of international security policy Andreas Wenger notes, the risk of biological warfare use is not well understood, and bioterrorism is a threat without precedent. The extremely low incidence of real biological events in the early 21st century contrasts with the outburst of political rhetoric and mass-media coverage surrounding the subject. Thus, the question arises whether bioterrorism is a real threat or merely a useful scare tactic.

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Bioterrorism is defined by the United States Centers for Disease Control and Prevention (CDC) as the intentional release of viruses, bacteria, or other biological agents that cause illness or death in people, animals, or plants. Although these agents are typically naturally-occurring, they can be made more potent, dispersible, and resistant to antibiotics through deliberate mutation.[3] Importantly, the use of biological agents in warfare is by no means a 21st century phenomenon. Armies during the Middle Ages launched the bodies of bubonic plague victims into enemy territory; 15th century conquerors and settlers of the Americas deliberately infected the natives with diseases such as smallpox; both World War I and World War II soldiers carried out biowarfare attacks; and in 1984 the Rajneeshee cult contaminated salad bars with *Salmonella* bacteria.[4] However, 2001 marked a major turning point in biological warfare as the Al-Qaeda attacks on September 11th, and especially the subsequent anthrax postal attacks, pushed the issue of bioterrorism to the forefront of the national security agenda.[5] Anthrax has been called the perfect military pathogen due to the durability and lethal power of its spore.[6] The toxin is classified by the CDC as a Category A agent, which indicates that the bacterium has both a high potential for adverse public health impact and also a serious

potential for large-scale dissemination.[7] However, some critics argue that far more disruptive than the use of anthrax as a weapon of mass destruction is its use as a "weapon of mass media." Indeed, the political, economic, media, and psychological impact of the anthrax letters seems to have been disproportionate to the actual effects of the attacks.[8] Thus, anthrax is both a real threat—on account of its contagiousness, durable spore structure, complex lethal toxin, and demonstrated use as a weapon of biological warfare—and a useful scare tactic as the bacterium has become a public obsession and the subject of countless hoaxes.

The word "anthrax" is derived from the Greek word *anthracis* for "coal," which refers to the black skin lesions developed by victims of cutaneous infection.[9] Anthrax is one of the oldest documented diseases of grazing animals; it is generally considered to be the Sixth Plague in the Book of Exodus in the Bible and even makes an appearance in the works of Greek and Roman authors such as Homer's *The Iliad* and Vergil's *Georgics*.[10] In 1876, the rod-shaped, Gram-positive bacterium *Bacillus anthracis*, which measures only about one by nine micrometers, was proved by German physician Robert Koch to cause disease. For the first time, Koch was able to grow the isolated bacterium in vitro and then to transmit anthrax to test animals—experimental proof of the contagiousness of disease. This revolutionary discovery, in conjunction with other epidemiological observations, became the key for defining pathogens as microorganisms that have the ability to infect higher organisms under certain circumstances and cause disease.[11]

Anthrax's ability to cause disease results from its complex spore structure and tripartite toxin. The bacterium possesses a unique cell wall made of sugar, and when conditions are unfavorable, the bacillus forms a spore by curling itself up into a tiny ball and surrounding its outer surface with a hard protein capsule. These inactive spores are extremely stable and are able to preserve their virulence and remain unaffected by the destructive influences of light, heat, radiation, and toxic chemicals for many years.[12] After lying dormant for decades, the right conditions can transform the spores into active, germinating organisms. Ironically, activation of a dormant spore can occur if the spore is engulfed by a macrophage—one of the body's natural defense cells that helps protect it against harmful foreign bodies. In this case, the very cells that are supposed to shield the body from disease actually transport the spores and stimulate the release of a deadly toxin.[13]

Having been inhaled through the lungs (in the case of pulmonary anthrax) and transported through the air passages into the alveoli (the tiny air sacs in the lungs), the macrophages pick up the spores and transport them out of the lungs through small vessels called lymphatics and into the lymph node glands in the central chest cavity. Here, the spores germinate, multiply, and then burst the macrophage cell, releasing many more bacilli into the bloodstream and transferring the bacteria to the entire body. The toxin is then released, takes over the enzymatic function of the adenylate cyclases that catalyze the breaking of chemical bonds, and synthesizes its three factors: a protective antigen, an edema factor, and a lethal factor.[14] The protective antigen is the capsule that is produced by the bacterium and used to enter cells. The edema factor is a protein that causes fluid to accumulate in the area of infection by inactivating neutrophils (the white blood cells that form a very important part of the immune system) so they cannot phagocytose bacteria (a process of engulfing solid particles using the cell membrane). The lethal factor completes the disruption of the cell's signaling pathways and causes apoptosis (a form of programmed cell death). Although three separate genes synthesize these factors, the genetic expression of all three is necessary for the toxin to destroy the body's tissues, which causes bleeding, and finally, death.[15]

Anthrax can be contracted in a number of ways, and there are three basic types of anthrax—cutaneous, gastrointestinal, and inhalational. Bacterial spores normally lie beneath the surface of the soil, and grazing animals may become infected by ingesting or inhaling the spores. Humans then pick up the disease from contact with infected animals or their wool, hair, or hide, and while anthrax cannot spread directly from human to human, clothing, shoes, and other articles can transport the spores.[16] Cutaneous anthrax occurs when spores enter through cuts or other skin openings; after a one to five day incubation period, the victim develops a skin rash at the site of entry, and black scabs appear. If recognized in time, this form of the disease is largely treatable with antibiotics. Gastrointestinal anthrax is contracted by eating infected meat that has not been fully cooked. Symptoms include severe abdominal pain, fever, vomiting, and bloody diarrhea; without treatment, about fifty percent of victims die. The most deadly type of anthrax, inhalational (pulmonary) anthrax, is known as wool-sorter's disease because it often

arises from breathing the microbe from the fur or hides of infected animals. By the time the first symptoms of the disease appear, it is already too late for treatment, and as a result, mortality rates for inhalational anthrax are in the ninety-five percent range.[17]

For example, in 1979 spores of anthrax were accidentally released from a military facility in the Russian city of Sverdlovsk, resulting in the infection of 94 people with inhalational anthrax, 64 of whom died within six weeks of exposure. This was a 68 percent fatality rate, and immediately the Soviet Union worked to cover up the incident in order to avoid both the punitive measures of the Biological Weapons Convention and criticism for the flaws in the Soviet health care system. The government blamed the deaths on the handling and consumption of tainted meat, and the medical records of the victims were altered in order to conceal the symptoms consistent with respiratory exposure to the anthrax spores.[18] In 1992, Harvard professor Matthew Meselson was able to gain access to the Sverdlovsk region and at that time determined that the accident was caused by a faulty filter on an exhaust at the facility. The winds transported the discharged spores to the small area where the victims were living rather than to the city where the pathogen would have been spread to hundreds of thousands of people. Although investigators of the event concluded that the Soviets were not attempting a massive bio-warfare attack at the time of this leak, the Sverdlovsk incident is a prime example of the lethality of anthrax spores.[19]

The deadly anthrax spores were realized as "God's gift to germ warfare" after a series of tests performed by British and American scientists during the early years of World War II.[20] The experimenters wanted to determine how lethal anthrax spores would be after they were released by explosive devices, and they chose Gruinard Island, a small body of land two miles off the northwest coast of Scotland, as the location for their biological warfare research.[21] On the island, workmen built a six-foot high wooden scaffold from which bombs filled with the anthrax microbe (code-named "N") were detonated. The anthrax vapors from the explosion were then blown by the wind across a line of sheep. Sheep were chosen as the experimental subjects because they weigh approximately the same as human beings, are highly susceptible to the anthrax infection in general (because they are grazing animals), and were plentiful in the area.[22] On September 26, 1942, a two-engine Vickers Wellington bomber flew over Gruinard Island and released a thirty-pound anthrax bomb into an area containing fifty sheep. However, the bomb sank into a bog and discharged its anthrax filling into the ground rather than into the air. A month later, the scientists tried again and conducted the experiment on a hard sand beach at Penclawdd on the coast of Wales. This time, the device hit the hard ground, and anthrax burst from the bomb in a fine spray. The sheep were quickly infected and died.

However, the Gruinard Island tests were not a complete disaster because the British successfully performed a second type of experiment there with anthrax-filled bullets. A supply of twenty-millimeter bullets were hollowed out, filled with anthrax spores, and then fired through armor plating into a closed cubical tank holding live sheep. All of the sheep died from the attack, but being hit with the bullets was not the single cause of their deaths—the anthrax-filled atmosphere that resulted from the bullets' release of spores also contributed to their mortality. This experiment proved that anthrax-filled bullets could be very useful antitank weapons, as not only would they kill the people in the tank, but the vehicles would also become contaminated with the toxin so that other soldiers would be prevented from using them. The Gruinard Island and Penclawdd trials sent a crystal clear message to both British and American military personnel: "germ warfare was no longer science fiction or a lurid Sunday-supplement mirage, [but] biological bombs could be, and were, practical and deadly weapons."[23] These experiments provide very strong evidence for the claim that the use of anthrax as a biological weapon is a real threat. When the testing program ended in 1943, Gruinard Island was set ablaze in an attempt to destroy the spores. However, by the end of the war the scientists were surprised to find that spore counts in the soil remained the same. For more than 40 years, the island was closed off, and in 1990, after soaking portions of the island in formaldehyde and sea water, the British government declared that the earth was once again safe for human visitation.[24] Thus, Gruinard Island stands as a sort of monument to the hazardous and robust nature of anthrax spores.[25]

In October 1942, after their discovery of the effectiveness of anthrax as a lethal agent in warfare, the British launched "Operation Vegetarian," in which workers mass-produced five million units of the United Kingdom's first operational biological weapon, the anthrax-filled cattle cake. The cattle cakes were made of ground linseed meal and small

doses of anthrax were inserted into the center of each "bun." The plan was for Allied bombers to drop the anthrax-filled buns into Germany's cattle-grazing pastures where the animals would eat the cakes, contract the disease, and quickly die. However, by the time the operation was ready to be launched in 1944, the invasion of Normandy had already taken place, and the Allies were winning the War by conventional means.[26] The five million buns were eventually burned after the War, but the Allies did not give up on the idea of biological warfare.

In October 1945, American scientist George W. Merck, the "civilian boss" of the United States' biological warfare effort, submitted a report to the Secretary of War detailing the nation's discoveries about anthrax and other biological weapons. In response to Merck's report, the War Research Service assigned a number of biologists across the country the task of investigating defenses against and the offensive possibilities of certain microbial agents. This secret research perfectly illustrates the danger of anthrax and other biological weapons—development of biological warfare can easily proceed undetected in many countries under the guise of legitimate medical or bacteriological research. Unlike the development of other nuclear "weapons of mass destruction," microbes such as anthrax can be produced without large amounts of money and expansive manufacturing facilities.[27] The basic materials needed to generate anthrax are a starter culture, a growth medium, a container, and a pump to drive air through the broth in order for the bacteria to sporulate (the presence of air is unfavorable because *Bacillus anthracis* is an aerobic bacterium).[28] In addition, in contrast to fissile materials, biological pathogens are replicative, highly diverse, unable to be inventoried or detected, and have many other legitimate applications.[29] All of these factors indicate that bioterrorism is indeed a serious concern, and events such as Amerithrax have forever altered the nation's attitude about biological pathogens.

When the story of letters laced with anthrax spores broke in October 2001, widespread panic ensued. The postal system was completely unexpected as a terrorist target, and because the system touches the lives of virtually everyone in the country, there were hundreds of millions possible victims.[30] Of the 89 strains of anthrax, the Ames strain used in the attacks is recognized as the most virulent, and in the single letter that was sent to Senator Tom Daschle, there were enough pathogens to kill hundreds or even thousands of people. However, the envelopes were labeled with the warning "anthrax," which suggests that the perpetrators of the attack did not intend to cause high lethality. Nevertheless, Amerithrax resulted in the deaths of five people and had devastating consequences for the economy and community; the U.S. Postal Service faced billions of dollars in damages, and numerous buildings had to be decontaminated.[31]

In addition, 30,000 people were preventatively treated with antibiotics. An antibiotic called ciprofloxin, or Cipro, was administered to the workers in the congressional and news buildings where the anthrax letters had been sent. Meanwhile, postal workers who might have been exposed to the spores were given a different antibiotic called doxycycline. The difference in antibiotics caused major public outrage as the expensive Cipro, the only drug approved by the U.S. Food and Drug Administration for the treatment of anthrax, was given to the "elite" government and media workers, while the postal staff was given the less expensive doxycycline. Soon, there was a large demand for Cipro as vast numbers of people feared that they too might have come into contact with the lethal spores and wanted to be treated with the "best" antibiotics. However, few people actually completed the full course of Cipro because of the drug's harsh side effects (nausea and diarrhea) and long period of therapy.[32] In fact, it was soon revealed that doxycycline was just as effective as Cipro and lacked the side effects; the only reason the drug was not listed by the FDA as a treatment for anthrax was because it was an older drug and approved at a time when no one would have thought about the use of anthrax as a biological weapon.[33] While these antibiotics offer treatment in the event of exposure, the U.S. government has initiated a more preventative measure by requiring vaccinations for troops and defense contractors.

Thus, while the Department of Defense clearly considers anthrax attacks and other forms of bioterrorism to be real threats, critics such as Philpp Sarasin, the author of *Anthrax: Bioterror as Fact and Fantasy*, believe that the timing (just a week after September 11th) and media frenzy surrounding Amerithrax have transformed the pathogen into a phantasm and a mere figure of speech.[34] Indeed, the vast majority of the anthrax attacks in recent years have been hoaxes, and the threat of employing the bacterium in biological warfare has certainly been a useful scare tactic. Nevertheless, the biological

characteristics and history of anthrax prove that bioterrorism is a real danger, just as President Bush claimed in his speech. Bioterrorism strips nations of their freedom and forever enslaves them to the pathogenic microorganisms released into the environment. While the terrorist attacks on September 11th were truly devastating, the fact remains that the release of anthrax spores could be even more destructive. America and its allies must confront the reality of bioterrorism by organizing defenses for possible attacks and by further investigating the nature and properties of anthrax and other pathogenic agents—after all, knowing your enemy is the best strategy in any type of warfare.

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Notes

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