Anthrax

Research provided by the Kansas Association of Local Health Departments

This month we will be talking about a lesser-known vaccine preventable disease known as anthrax. You've probably seen news stories about anthrax being sent to politicians as a toxin, but there is a lot more that can be learned about this disease and it's origins all the way back to 700 BC and the downfall of the Roman Empire.

What Is It?

Anthrax is a serious, life-threating, infectious disease that is caused by the bacteria called *Bacillus anthracis.* This bacterium occurs in soil, and typically will affect animals including cows and can infect humans when they have close contact with an infected animal. However, despite its classification as a "infectious" disease, anthrax infections are not contagious.

Anthrax is typically spread to both humans and animals through exposure to anthrax bacteria spores that become activated and multiply in the body. Once exposed to the bacteria, an infection can develop from 1 day to more than 2 months after initial exposure. There are four types of anthrax infection that have very distinct symptoms:

Cutaneous and injection (Skin Exposure): a group of small, painless ulcers can form with a distinct black center. While these typically are not painful, they can ulcerate the skin around the blister. A distinction between cutaneous and injection anthrax infection is that injection infections are harder to treat and move quicker.

Inhalation: typical flu like symptoms including chest pain, fever, and coughing.

Gastrointestinal (ingesting): painful swallowing and swelling of the neck and lymph nodes. A notable symptom is nausea and vomiting, particularly bloody vomiting.

In addition, anthrax infections are rare in the United States, however, outbreaks do occur, particularly in grazing animals and through "anthrax attacks", that we will discuss later.

Treatments

While serums like the anti-toxin for tetanus and diphtheria were used, penicillin is the antibiotic of choice for anthrax infections. If you are interested in learning more about the discovery of penicillin and it's impact on infection, you can read this article here: https://www.pbs.org/newshour/health/the-real-story-behind-the-worlds-first-antibiotic

History

Because anthrax infections are well documented, we have a good understanding of how the bacteria spreads to both animals and humans. It is believed that sicknesses that closely resemble anthrax infections were documented from 700 BC and in biblical times as well, as it is believed that "shehin", one of the ten deadly plagues in Egypt, closely resembles anthrax infection. In addition, anthrax infections also occurred in Greece, Rome, and other parts of Mesopotamia – even going as far as to be described not only in the Bible and Torah, but also in Homer's *The Iliad.* Many even suggest that anthrax was a contributing factor to the fall of the Roman empire.

By the 1700s, two early scientists provided a clinical description of cutaneous (skin exposure) anthrax infections. During the early 1800s in the United States and Europe, there were various cases of naturally occurring anthrax infections. However, there was no scientific cause for the disease. Doctors during this time noticed a link between anthrax and animal hair, as many factories of the industrial revolution were producing animal hair (wool) rugs, clothing, and even wigs. The disease became known as the "wool sorters" disease to many.

Koch postulates

In 1877, scientist Robert Koch was able to study the bacteria that causes anthrax on a micro-level. He learned that the bacteria created "spores" that were able to survive for long periods of time in various environments. From his study of the anthrax bacteria, he was able to demonstrate a casual relationship between microorganisms and disease – he is credited as the first scientist to do this.

Vaccine Development for both Animals and Humans – and the first attenuated vaccine

While the disease was well documented in Western Europe and the North America, anthrax was much harder to track in Eastern Europe (Russia, in particular), Asia, and Africa – as a high number of contaminated animal products were imported to and from these counties. As of 2022, anthrax infections are still considered endemic in parts of Asia and Africa.

In 1881, French scientist and chemist Louis Pasteur (yes, the namesake of Sanofi Pasteur), developed the first anthrax vaccine using Koch's postulates. His tests in sheep, goats, and cows would later be used to develop the rabies vaccine. Pasteur is also considered the "father" of attenuated vaccines, because of his work on both the anthrax and rabies vaccine. by using attenuated viruses from rabbits spinal cords, he was able to actively protect humans from viruses like anthrax.

In 1937, a full live-spore vaccine was created for animals and is still used in most countries today. As discussed last month, the best treatment for zoonotic diseases is to prevent them from getting to humans by preventing them in animals – and, but the end of the 20th century,

the anthrax vaccine for animals reduced human anthrax infections exponentially. During the 1950s, a full vaccine for humans was created that was 92.5% effective in cutaneous anthrax infections. By the 1970s, an updated vaccine was released that is still in use today. While vaccination for anthrax is not typically available to the public the United States, it is possible to receive the vaccine prior to exposure, including those who work in the laboratories, veterinarians, and the military. It can also be used after exposure in an emergency situation.

A Disease Becomes a Biological Weapon

Due to the research of Robert Koch, the anthrax bacteria are well documented and easily recreated into spores and powders. While natural infections of anthrax are rare in the United States, anthrax is commonly used as a biological weapon.

A biological weapon is considered any type of germ, disease, or toxin that is used with the intent to kill or harm. It can be done using both naturally occurring toxins (such as anthrax) and chemically manipulated toxins that cause a harmful response in the body. For more information about biological weapons and their effect on war, I encourage you to read this study: https://www.sciencedirect.com/science/article/pii/S1198743X14626343

From a historical perspective, anthrax bacteria were used during World War I and World War II as a weapon of war. In 1972, a treaty was signed by the Convention on the Prohibition of the Development, Production, and Stockpiling of Biological and Toxin Weapons on Their Destruction was created by Great Britain and members of the Warsaw Pact to prohibit the development and use of biological weapons in war.

However, it can also be used on a small scale – which is how we commonly see it today. Anthrax can be sent as a white powder via mail to be used as a weapon against notable and political figures. For example, after the September 11, 2001, attacks on the World Trade Center, letters containing anthrax powder were sent to United States officials.

As we are discussing biological weapons, it is important to also address the rumors that the current pandemic was started because of biological weapon development. While scientists don't believe that the pandemic was a planned weapon, it is still important to prepare for natural and bioterrorism attacks. You can view a study published on the pandemic here: https://www.sciencedirect.com/science/article/pii/S1198743X14626343

What We Can Learn from Anthrax

For one, anthrax was an incredibly common disease from early biblical times to just recently. While it occurs naturally, anthrax is a good example of what can happen when disease becomes a weapon – and how education on prevention and vaccination is eroded due to biological

warfare. Particularly with persisting rumors of the current COVID-19 outbreak being a biological weapon transfer, it is important to continue to promote vaccination as a safety measure for both biological weapons and naturally occurring ones too.

Further Reading and Resources:

Guide to Understanding Anthrax (CDC):
https://www.cdc.gov/anthrax/pdf/evergreen-pdfs/anthrax-evergreen-content-english.pdf

Anthrax as a Tier 1 Biological Agent (CDC):
https://www.cdc.gov/anthrax/bioterrorism/threat.html

Full Timeline of Developments and History of Anthrax (CDC):
https://www.cdc.gov/anthrax/basics/anthrax-history.html

Biological Warfare Through a Historical Lens (Study published in ScienceDirect by the Swedish Government):
https://www.sciencedirect.com/science/article/pii/S1198743X14626343

Anthrax in History – the Story of Shehin in the Christian Bible (Published by the National Library of Medicine):
https://pubmed.ncbi.nlm.nih.gov/12170553/#:~:text=In%20the%20Bible%2C%20Shehin%20is,as%20we%20know%20it%20today

Anthrax Vaccination Information and VIS (CDC):
https://www.cdc.gov/anthrax/prevention/vaccine/index.html

Citations:

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8300139/
https://www.cdc.gov/anthrax/symptoms/index.html
https://www.cdc.gov/anthrax/basics/anthrax-history.html
https://www.cdc.gov/anthrax/basics/index.html
https://www.cdc.gov/anthrax/prevention/vaccine/index.html