Bacillus Anthracis As An Agent Of Bioterrorism

Introduction

Bacillus anthracis (B. anthracis) which is the causative agent of anthrax comes from the genus Bacillus. It is a common disease occurring in livestock and human. It is a gram-positive bacterium with rod-shaped and endospore-forming. Anthrax is believed to be first discovered during ancient times around 700 BC according to ancient writings. Then, in 1877 Robert Koch studied about Bacillus anthracis and find out that bacteria forming spores and can survive in extreme environments and finally develop the Koch Postulates. Next, in 1881, Louis Pasteur developed the first vaccine ever for anthrax (U.S. Department of Health & Human Services, 2016)

Anthrax as a Biological Weapon

The first case related to the used of anthrax bioterrorism was reported during first World War. Next, in 1979, an outbreak occurs in Sverdlovsk, Soviet Union due to the accidental release of anthrax from a Soviet military research facility. However, the most recent biological attack was reported in 2001 in the United States after 25 years of their first outbreak experiences in 1976. According to Centers for Disease Control and Prevention (CDC), an anonymous letter containing white powder with deadly anthrax were mailed to US Senator and media news offices a week after World Trade Centre's attacks. Approximately, there are 22 cases reported where 11 of the cases are cutaneous anthrax while another 11 are inhalational anthrax which five people died from it (U.S. Department of Health & Human Services, 2016)

Diagnosis and Transmission

Cutaneous Anthrax

This type of infection is the most common form. The incubation period is between 1 to 10 days after direct exposure. It will affect an exposed area such as skin, head, neck and extremities. At first, people affected with cutaneous anthrax will find that pruritic papule-like insect or spider bite. After one or two day, vesicles that has a clear to serosanguineous fluid start to form around the lesion from 1 to 2 cm. Gram stain test shows that the vesicles have quite number of bacilli but lack of leukocytes. Gram stain and culture of lesion may counterpart infected site culture-negative of B. anthracis due to antibiotics (Bell, Kozarsky, & Stephens, 2002). In addition, the vesicles are thin and easily rupture to form ulcers with edema. Soon after its matured, the black eschar will be formed (Roche, Chang, & Lazarus, 2001) Cutaneous anthrax had been said to be painless. Usually, without a secondary spread, lesions will heal in 1 to 3 weeks where the eschars fall off without leaving a scar. But in some serious cases, malignant edema might accelerate from neck to groin. This might come with inflammation skin with pain, toxaemia and even bacteremia. In fact, any untreated cutaneous anthrax can cause fatality (Doganay, Metan, & Alp, 2010). Serologic testing, punch biopsy, silver staining, immunohistochemical testing are usually conducted to diagnosis cutaneous anthrax (Bell, Kozarsky, & Stephens, 2002).

Gastrointestinal Anthrax

Gastrointestinal anthrax or intestinal infections commonly occurs in animals but rarely happen in humans. It may happen when undercooked meat from an animal infected with anthrax were ingested. Most of these cases were reported in rural areas of Africa and Asia. For the persons who infected with gastrointestinal anthrax will develop the symptoms in 2 to 5 days after exposure. The first symptoms are signs of swelling, dysphagia, severe pharyngitis, odynophagia and ulcer may be found in the mouth or pharynx. This will cause a respiratory problem to occur due to pharyngeal edema that lead to dysphagia (Binkley, Cinti, Simeone, & Colletti, 2002). Another symptom is neck swelling or related to neck adema. Subsequently, spore can also develop in the terminal ileum and cecum. As well as the spore germinate. Patient diagnosis with gastrointestinal anthrax will show symptoms like fever, vomiting, nausea, severe abdominal pain, hematemesis, bloody diarrhea, massive ascites and secondary meningitis. Diagnostic test can be conducted by using blood, stool, and ascites samples for culture and PCR testing (Bell, Kozarsky, & Stephens, 2002).

Inhalational Anthrax

Inhalational anthrax is the most popular and widely used during biological attacks. Usually, this accident related to release of aerosolized spores. There are three level staging systems for characterization of inhalational anthrax. The first stages occur in 1 to 6 days after exposure. Anthrax spores about 1-5µm entered the bronchioles and alveoli then transported to lymph nodes. This stage is known as early prodromal stage. At this stage, patients develop fever, malaise, fatigue, myalgias, blurred vision, photophobia, dry cough, mild precordial discomfort or biphasic illness after 2 to 3 days. Next is the intermediate progressive stage which patient may accelerate to high fever, pulmonary status declining, dyspnea, respiratory distress, marked diaphoresis, confusion and pleuritic chest pain. Last but not least is the late fulminant stage which the patients faced sepsis, meningitis and multiorgan failure due to bacteremia. In fact, this will bring causalities within 24 hours (Martin & Friedlander, 2015). Diagnostic test by using chest computed tomography scan is used to identify hemorrhagic mediastinal lymph nodes, edema, thickening of peribronchial and pleural effusions. Blood cultures, polymerase chain reaction (PCR), serologic testing. Moreover, an enzyme-linked immunosorbent assay (ELISA) is said to be highly sensitive which detects 98.6% of true positive immunoglobulin (Ig) G response to B. anthracis protective antigen (PA). However, it is only 80% specific. Thus, to increase the specificity, a PA-competitive inhibition ELISA is run as the second step for confirmation. Early studies stated that specific IgG anti-PA antibodies can be identified in 10 days while peak IgG may not be observed until 40 days. Immunohistochemical examination of pleural fluid or transbronchial biopsy specimen is conducted to patients that had the antibodies to counter-attack B. anthracis cell wall and capsule and detect B. anthracis antigens (Bell, Kozarsky, & Stephens, 2002). All of these can be run in a laboratory tests.

Injectional anthrax

Injectional anthrax is an uncommon form of cutaneous anthrax. Based on the previous report in 2009 to 2010, there are 119 cases amidst people who injected heroin contaminated with B. anthracis in Europe. Later, it is reported that injectional anthrax related to injection of drugs. Incubation period for injectional anthrax is about 1 to 2 days after the injection. It is quite difficult to see the different between it as skin infections is a normal situation for drug users. However,

patient with injectional anthrax will develop soft tissues infection with disproportionate edema. Inflammation at the injection site may accelerate to necrotizing fasciitis or sepsis. Patients are treated with antibiotics and surgical debridement for necrosis related. This is opposite to the normal cutaneous anthrax with no surgical debridement needed (Hicks, Sweeney, Cui, Li, & Eichacker, 2012)

Prevention and Treatment

Antibiotics

Antibiotics can be used before and after exposure of anthrax. Most of cutaneous anthrax can be treated with antibiotics. These are the recommended antibiotics such as ciprofloxacin, levofloxacin, doxycycline, amoxicillin and penicillin (UPMC Center for Health Security, 2014). During the biological attacks in 2001, ciprofloxacin, doxycycline and amoxicillin served as an option for children and pregnant woman considering the fetal risks (Delman, et al., 2014)

Vaccine

Anthrax vaccine adsorbed (AVA) is a non-infectious or cell free filtrate made from strains of B. anthracis that has protective antigen exotoxin in order for give immune protection to the body (UPMC Center for Health Security, 2014). The vaccine has been licensed and considered safe to be use for pre-exposure and post-exposure prophylaxis (PEP) of anthrax. However, the PEP concern arises due to anthrax spore that might be present after 60 days of antibiotics treatment. Therefore, antibiotics must continue be used along with vaccine during PEP (Martin & Friedlander, 2015). Three doses of AVA at weeks 0, 2 and 4 as scheduled by CDC (UPMC Center for Health Security, 2014).

References

1. Bell, D. M., Kozarsky, P. E., & Stephens, D. S. (2002). Clinical Issues in the Prophylaxis, Diagnosis, and Treatment of Anthrax. Emerging Infectious Diseases, 222-225.
2. Binkley, C. E., Cinti, S., Simeone, D. M., & Colletti, L. M. (2002). Bacillus Anthracis as an Agent of Bioterrorism A Review Emphasizing Surgical Treatment. Annals of Surgery.
3. Delman, D. M., Zotti, M. E., Creange, A. A., Misegades, L. K., Wako, E., Treadwell, T. A., . . . Jamieson, D. J. (2014). Special Considerations for Prophylaxis for and Treatment of Anthrax in Pregnant and Postpartum Women. Emerging Infectious Disease.
4. Doganay, M., Metan, G., & Alp, E. (2010). A review of cutaneous anthrax and its outcome. Journal of infection and public health.
5. Hicks, C. W., Sweeney, D. A., Cui, X., Li, Y., & Eichacker, P. Q. (2012). An overview of anthrax infection including the recently identified form of disease in injection drug users. Intensive Care Med.
6. Martin, G. J., & Friedlander, A. M. (2015). Bacillus anthracis (Anthrax). In J. E. Bennett, R. Dolin, & M. J. Blaser, Mandell, Douglas, and Bennett's Principles and Practice of Infectious Diseases (pp. 2550-2569). Churchill Livingstone.
7. Roche, K. J., Chang, M. W., & Lazarus, H. (2001). Cutaneous Anthrax Infection. Journal of Medicine.
8. U.S. Department of Health & Human Services. (2016, August 15). History of Anthrax. Retrieved from Centers for Disease Control and Prevention:

https://www.cdc.gov/anthrax/resources/history/index.html
9. UPMC Center for Health Security. (2014). Bacillus anthracis (Anthrax). Center for Health Security.