Contents lists available at ScienceDirect

Asian Pacific Journal of Tropical Biomedicine

journal homepage:www.elsevier.com/locate/apjtb

Document heading

Anthrax: an update

Kamal SM[1*], Rashid AKM M[2], Bakar MA[1], Ahad MA[3]

[1]*Department of Medicine, Khulna Medical College, Khulna*
[2]*Department of Paediatrics, Khulna Medical College, Khulna*
[3]*Department of Gastroenterology, Khulna Medical College, Khulna*

ARTICLE INFO

Article history:
Received 1 April 2011
Received in revised form 20 April 2011
Accepted 2 May 2011
Available online 20 May 2011

Keywords:
Anthrax
Bacillus anthracis
Zoonotic disease
Contagious disease
Cutaneous anthrax
Inhalational anthrax
Gastrointestinal anthrax
Human anthrax

ABSTRACT

Anthrax is a zoonotic disease caused by *Bacillus anthracis*. It is potentially fatal and highly contagious disease. Herbivores are the natural host. Human acquire the disease incidentally by contact with infected animal or animal products. In the 18th century an epidemic destroyed approximately half of the sheep in Europe. In 1900 human inhalational anthrax occured sporadically in the United States. In 1979 an outbreak of human anthrax occured in Sverdlovsk of Soviet Union. Anthrax continued to represent a world wide presence. The incidence of the disease has decreased in developed countries as a result of vaccination and improved industrial hygiene. Human anthrax clinically presents in three forms, *i.e.* cutaneous, gastrointestinal and inhalational. About 95% of human anthrax is cutaneous and 5% is inhalational. Gastrointestinal anthrax is very rare (less than 1%). Inhalational form is used as a biological warefare agent. Penicillin, ciprofloxacin (and other quinolones), doxicyclin, ampicillin, imipenem, clindamycin, clarithromycin, vancomycin, chloramphenicol, rifampicin are effective antimicrobials. Antimicrobial therapy for 60 days is recommended. Human anthrax vaccine is available. Administration of anti-protective antigen (PA) antibody in combination with ciprofloxacin produced 90%-100% survival. The combination of CPG-adjuvanted anthrax vaccine adsorbed (AVA) plus dalbavancin significantly improved survival.

1. Introduction

The term "anthrax" derives from the Greek word "anthrakites" meaning coal-like referring to the typical black eschar seen in cutaneous involvement of the disease[1]. Anthrax is a zoonotic infection with world wide distribution. It is a potentially fatal and highly contagious disease. The causative bacteria is *Bacillus anthracis* (*B. anthracis*). Herbivore animals are the natural host of the disease and all warm blooded animals are susceptible. Human acquire the disease incidentally by contact with infected animal or animal products or by ingestion or handling of the infected animal meat. Anthrax can be transmitted from animal to animal or from animal to human. No human to human transmission has been documented. Anthrax endospores are resistant to drying, heat, ultraviolet light, gamma radiation and many disinfectants[2,3]. The spores can persist in dry soil for decades but can be destroyed by boiling in water for 10 minutes. Grazing animals often swallow these spores which develop into the encapsulated vegetative mature bacilli in the circulation[4].

The disease has cutaneous, inhalational and gastrointestinal forms, which occur when endospores enter the body through breaks in the skin or by inhalation or by ingestion, respectively. About 95% of human anthrax is cutaneous and 5% inhalational. Gastrointestinal anthrax is very rare and has been reported in less than 1% of all cases. Anthrax meningitis is a rare complication of any of the other three forms of the disease. Inhalational anthrax become known in Victorian England as woolsorters' disease. This was because of the frequency of infection in mill workers exposed to animal fibers contaminated with *B. anthracis* spore[1,4].

In 1850 Pierre Raver and Casimir Joseph Davaine discovered the microorganism causing anthrax. In 1876 Robert Koch first described the complete life cycle of the anthrax bacillus. In 1881 Louis Pasteur developed the first animal vaccine containing attenuated live organism. Human anthrax vaccine was licensed in 1970[1,5]. Anthrax continued to represent a world wide presence with an annual occurrence of 20 000-100 000 cases in the first half of the

*Corresponding author: Dr. Kamal SM, FCPS, Associate Professor, Department of Medicine, Khulna Medical College, Khulna.
Tel: 0088-01716208746
E-mail: smkamal10@gmail.com

20th century and subsequently the incidence declined with approximately 2 000 cases yearly during the second half of the 20th century. The majority of these cases were cuteneous anthrax[6]. In the whole 20th century there was only 18 cases of human inhalational anthrax reported in the United States, of these 16 was fatal. No cases of gastrointestinal form had been reported[1,7].

This review article describes the update of anthrax. Anthrax can reemerge infrequently in some area of the world leading to death of many animals and human. There is also apprehension of it's use as biological warfare. So this review article will be useful for clinicians to suspect and manage a case of anthrax.

2. History of anthrax

Anthrax is a potentially fatal and highly contagious zoonotic disease. Anthrax can be transmitted from animal to animal or from animal to human. No human to human transmission has been documented[2,3]. It is an illness well described in antiquity. There have been suggestions that the famous plaque of Athens (430-427 BCE) was an epidemic of inhalational anthrax. Anthrax continued to be a pestilence affecting both human and animal throughout the middle ages. In the 18th century an epidemic destroyed approximately half of the sheep in Europe. Inhalational anthrax becomes known to Victoriam England as Woolsorters' disease. This was because of the frequency of infection in mill workers exposed to animal fibers contaminated with *B. anthracis* spores, though it was a misnomer in the sense that infection was more often the result of contact with goat hair or alpaca than wool.

The 19th century was to find anthrax as the focal point of one of the central development in the history of medicine. In 1850 Pierre Raver and Casimir Joseph Davaine discovered small filiform bodies about twice the length of a blood corpuscle in the circulation of sleep with anthrax. Although there is no evidence that they initially regarded these as being significant, they were subsequently to find the organisms consistently in animals with the disease. Davaine suggested that because of the presence of the bacilli in the blood of affected animals it was conceivable that these microorganisms were causing the disease rather than the products of diseased tissue, as was then accepted thinking[1]. Anthrax was studied extensively in the 1870s by several researchers including Robert Koch and Louis Pasteur. In 1876 Koch used suspended drop culture method to trace the complete life cycle of the anthrax bacillus for the first time. He found that the bacillus could form spores that remained viable for long period in adverse environment. He also stated that anthrax could only be transmitted from one host to another by transfer of the bacilli. In the following year Koch grew the organism *in vitro* and induced the disease in healthy animals by inoculating them with bacterial cultures. Anthrax was thus the prototype for Koch's famous postulates regarding the transmission of infections disease. In 1881 Louis Pasteur developed the first animal anthrax vaccine containing attenuated live organisms. In the early 1900s human cases of inhalational anthrax occurred in the United States, among which were workers in textile and tanning industries processing goat hair, goat skin or wool[5]. The incidence of the disease was decreased significantly during the 20th century. Among animal workers, this was postulated to be due to vaccination as well as improved animal husbandry and processing of animal products. Anthrax continued to represent a world wide presence outside the United States, with an annual occurrence of 20 000-100 000 cases in the first half of the 20th century and approximately 2 000 cases yearly during the second half. The majority of these cases were cutaneous[6]. A human anthrax vaccine was developed by the army chemical corps in the 1950 and this was replaced by a vaccine licensed in 1970[6]. In the whole 20th century there was only 18 cases of human inhalational anthrax reported in United States, of these 16 was fatal. No cases of gastrointestinal form had been reported[2]. There occured an outbreak among livestock in Sverdlovsk near a Soviet Microbiology Facility in 1979, with some of the surrounding population subsequently developing gastrointestinal anthrax after eating contaminated meat or cutaneous anthrax after contact with diseased animal. This outbreak caused 96 cases of human anthrax, of these 79 were said to be gastrointestinal (of which 64 were fatal) and the remainder cutaneous. This epidemic represented the largest documented outbreak of human anthrax in history. In October and November 2001, 22 cases of confirmed or suspected inhalational and cutaneous anthrax were reported associated with the intentional release of the organism in the United States. An additional cases of cutaneous disease occurred in March of 2002[1].

Potential for use of anthrax as an agent of biological warfare has existed since world war II when investigation was done regarding anthrax along with several other infectious agents for use as biological weapons. Characteristics of anthrax that make it a good biological weapon are low visibility, high potency, relatively easy delivery, accessibility and its ability to form spores that are resistant to drying[8].

3. Description of microorganism

B. anthracis is the causative pathogenic organism of anthrax (Figure 1). This large, aerobic, Gram-positive rod (1-1.5 μm by 3-10 μm) is a member of the *Bacillus cereus* group of Bacilli. Mucoid colonies are formed when cultured on standard blood or nutrient agar. Endospores are seen in 2 to 3 days old cultures. *B. anthracis* is non-motile and non-haemolytic on blood agar. *In vitro* the organism exist as single or in short chains but form long chains *in vivo*. *B. anthracis* has two major virulence factors, which are encoded on separate plasmids. Plasmid X01 codes for the three proteins *i.e.* protective antigen (PA), edema factor (EF) and lethal factor (LF), that make up two exotoxins. PA is the central component of both toxins. PA binds to target cell