

Classification and management of animal anthrax outbreaks based on the source of infection

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Abstract

Anthrax is a non-contagious infectious disease; it primarily affects herbivores, but all mammals, including humans, can be affected. Humans may contract anthrax directly or indirectly from infected animals. Veterinary surveillance systems, providing information about animal and human cases, should increase the efficacy of the animal anthrax management in order to protect population. Any aspect of the disease should be carefully monitored to implement effective prevention and control strategies. In this paper we propose a new, detailed classification of anthrax outbreaks, based on the source of the infection and the risk level for humans. We describe three different types of animal outbreaks and suggest the most effective procedures for their management and prevention.

Key words

- animal
- anthrax
- classification
- human
- outbreak

INTRODUCTION

Anthrax is a non-contagious infectious disease that affects a wide range of animal species including humans. *Bacillus anthracis*, the etiological agent of anthrax, forms long-lasting, highly resistant spores able to persist into environment for several decades [1]. Ruminants such as cattle, sheep and goats are the most susceptible and commonly affected farm animals. They usually contract the disease through ingestion of soil-borne anthrax spores and die acutely. In humans, the disease is acquired from contact with anthrax-infected animals or anthrax-contaminated animal products. Three types of human anthrax occur, depending of exposure: cutaneous, which is usually non-fatal, gastrointestinal and inhalational which are both fatal. Recently, a further fatal form was reported in drug users who have injected drugs contaminated with anthrax spores [2]. Since it is relatively easy and inexpensive to obtain, *B. anthracis* is one of the preferred pathogenic agents for use as bacteriological weapon in bio-terrorist attacks [3], as demonstrated by the events surrounding the September 2011 bio-terrorist attacks in which anthrax spores were intentionally released through contaminated letters.

The risk of humans contracting anthrax is related to many factors, first of all the origin of the infection in the animal outbreak. Veterinary surveillance systems, including collection, collation and analysis of data is crucial for the effective management of animal anthrax to protect populations. Monitoring of changes

in any aspect of the disease is needed to appropriately modify prevention and control activities.

In this paper we propose a detailed classification of anthrax outbreaks, based on the source of the infection and the risk level for humans. We have defined three different types of animal outbreaks and suggest the most effective procedures for their management and the prevention.

Depending on the source of infection, animal anthrax outbreaks can take one of three forms: classic sporadic outbreak, atypical outbreak and epidemic outbreak.

THE CLASSIC SPORADIC OUTBREAK

Description

This form occurs in areas where anthrax is enzootic. Infection results from contaminated pastures. These outbreaks are sporadic, and usually involve initially only 1-3 animals. They originate in the soil, causing animals to become infected by grazing. Contamination arises from buried infected carcasses or when areas are irrigated with effluents from tanneries, or wool or hair mills. Other sources of contamination of the areas are saprophytic carnivores, whose feces can disperse the spores in the environment [4]. Blow flies also play a role when they feed on dead animals, and later vomit the ingested blood containing *B. anthracis* vegetative cells onto leaves where they sporulate, thereby spreading them in the environment [5].

These outbreaks usually occur during the summer and tend to be more frequent during dry summers fol-

lowing brief rain showers, and are limited to alkaline calciferous soils, *e.g.* black steppe soils. The fact that the disease tends to occur mostly in summer leads us to assume that woody forage, which contributes to the formation of small lesions, as well as the scarcity of pasture, forces the animals to eat very close to the ground [6]. The hot dry weather also reduces the innate animal resistance, so that even a small number of spores result in infection.

Risk factors

The sporadic outbreaks are the most widespread, and although they represent a serious health problem they seem to carry a low risk while in reality maintaining soil recontamination with spores. In fact, in areas where anthrax is enzootic, breeders and veterinarians are usually aware of the disease and it is considered every time there is an unexpected death. However in economically very poor regions where vaccination programs fail to be carried out despite awareness of the danger, breeders tend to slaughter sick animals to sell meat at a reduced price or to recover the animal skins to minimize the cost. This causes a high numbers of human cases in several countries, and occurs with particular severity in Bangladesh [7], Central Asia, and southern Africa.

Management

Proper management of an outbreak involves:

- a) avoid the dispersion of biological fluids during sample collection;
- b) correct handling of carcasses;
- c) check the temperatures of all animals and vaccinate animals quickly with normal temperatures that are at risk of infection;
- d) delay the vaccination of animals with suspected illness and initiate antibiotic treatment;
- e) vaccinate these latter animals ten days after suspension of antibiotic treatment;
- f) perform a genotypic analysis of the isolated strain(s) to verify the origin of infection;
- g) suspend the sale of milk and meat from the animals on the infected farm for 10 days after vaccination or the last known death.

Preventive activity

To prevent this type of outbreak, measures to reduce environmental contamination must be taken. These include:

- a) implement programs of annual herd vaccination, especially of known affected herds and animals on adjoining farms;
- b) identification of areas at risk through environmental analysis;
- c) avoid producing forage on soils with high levels of contamination;
- d) compensate farmers who report illness and do not slaughter sick animals;
- e) sensitize stakeholders: farmers, butchers, veterinarian and physicians;
- f) training and information, with particular reference to school students and rural populations living in high-risk areas.

THE ATYPICAL OUTBREAK

Description

This form is associated with the use of forages (*e.g.*, hay, silage) produced on contaminated land ("champs maudits"), and with products of animal origin such as inadequately sterilized meat and bone meals derived from the infected carcasses. These products are very dangerous because they can cause unexpected anthrax outbreaks in conditions and situations epidemiologically very different from the classic episodes of telluric origin.

Risk factors

The risk factors associated with atypical anthrax outbreaks can be identified as follows:

- a) they may occur in areas where the disease is unknown, or has disappeared, or has been eradicated for many years;
- b) they can occur at any time of the year and in epidemiological situations very different from the classic form;
- c) typically they involve animals that are not on pasture, but are housed, and receiving supplemental feeds, *e.g.* pigs, and dairy cows in winter or monsoon seasons;
- d) simultaneous outbreaks may occur on several non-adjointing farms in the same area, or on distant farms sharing the same contaminated feed source.

Atypical anthrax outbreaks are the most dangerous to humans, especially when they develop in areas considered to be free of risk and where the disease is forgotten. The worst risk is an incorrect animal diagnosis that can result in humans becoming infected due to mismanagement of the carcasses, *e.g.*, skinning. Another aspect that should not be underestimated is that physicians, not knowing the disease, may give a wrong diagnosis, with serious consequences for the patient's health [8].

Management

The management of this kind of outbreak is all the more difficult in areas where the disease is unknown, because a correct diagnosis nearly always comes with a certain delay. The following steps must be taken:

- a) avoid the dispersion of biological fluids during sample collection;
- b) correct handling of carcasses, such as incineration, hollowing and site boundaries;
- c) immediately cease using the suspect feeds;
- d) carry out laboratory tests on samples of the suspect feeds;
- e) inform the sanitary authorities, who will prohibit the sale of the suspect feed until sterilization certification can be instituted in relation to meat and bone meals;
- f) check the temperatures of all animals and quickly vaccinate all animals at risk of infection with normal temperatures;
- g) delay the vaccination of animals with suspected illness and initiate antibiotic treatment;
- h) vaccinate these latter animals ten days after suspension of antibiotic treatment;

- i) perform a genotypic analysis of the isolated strains and verify its correspondence with the strains isolated at the origin of the forage;
- j) suspend the sale of milk and meat from the animals on the infected farm for 10 days after vaccination or the last known death.

Preventive activity

This form of the disease is very difficult to predict and prevent but when the potential is recognised farmers and ranchers can be quickly warned of the risk, and when it involves contaminated feedstuffs a programme for overseen and certified sterilization can be put in place. Regular monitoring of meat and bone meals is more cost affective than reactive livestock vaccination. A proper epidemiological investigation is needed to verify that the animals have not been fed with fodder from areas at risk or with supplemental bone meal. The give-away is when the outbreak occurs at a time or place where the disease is not usually seen outside the known surveillance areas.

EPIDEMIC OUTBREAKS

Description

This form is an evolution of the classic sporadic form due to the activities of haemophagic flies. Tabanids feeding on moribund animals, especially during the bacteraemic phase, are able to transfer the pathogen to healthy animals in the same or neighbouring herds, causing a disease characterized by extensive oedema. However under the right circumstances it can result in singular cases stretching some 10 to 15 kilometers from the source outbreak. Generally, the gadflies suck the blood of large herbivores, such as horses and large ruminants in broad daylight on hot windless days, hence the greatest intensity in middle and late summer [9]. The pathogen does not establish any biological relationship with the carrier. However, the danger for humans comes from bites by disease-carrying insects. A cutaneous case of human anthrax due to the bite of horse fly was recently reported [10].

Risk factors

This form is an exceptional evolution of a classic anthrax outbreak:

- a) epidemic-like anthrax develops in areas where the disease is enzootic and where vaccination programs may have been suspended or have never been implemented;
- b) characteristically they follow heavier than usual winter or spring rains resulting in a markedly increased fly hatch, and a triggering sporadic outbreak but with some 4-6 or more animals sick or dead before veterinary help is sought by the owner;
- c) it occurs during the end of summer, erratically as a result of a coincidental hatch of flies, and is characterized by many outbreaks involving an extensive area and a large number of animals.

Management

The management of these outbreaks is not easy because

it requires measures to block the spread of bacteria:

- a) avoid the dispersion of biological fluids during sample collection;
- b) correct handling of carcasses, such as incineration, hollowing and site boundaries;
- c) mass vaccination of animals in at least a 15 km radius of the index outbreak;
- d) quarantine in closed placed of animals with suspected septicemia to avoid contact with the blood-sucking insects or, in case of inability for the high costs, sprinkle the body of animals with insect repellents;
- e) antibiotic treatment of animals with suspected illness;
- f) vaccination of animals after verifying that body temperature is normal;
- g) a second vaccination two weeks after the first;
- h) suspend handling of animals to minimize stress;
- i) greater attention by physicians to possible increases of skin lesions in the exposed population.

Preventive activity

To prevent this type of outbreak it is necessary to adopt the same measures to prevent the classical anthrax outbreaks:

- a) implement programs of mass vaccination in the affected area for at least five years following the epidemic;
- b) identification of areas at risk through environmental analysis for increased surveillance;
- c) avoid producing and exporting crop soils with high levels of contamination by anthrax spores;
- d) compensate farmers who report illness and do not slaughter sick animals;
- e) sensitize stakeholders: farmers, butchers, veterinarians and physicians;
- f) training and information, with particular reference to school students and rural populations living in high-risk areas.

CONCLUSION

Anthrax is present in many parts of the world, sporadic cases occurring in animals worldwide. The use of anthrax in bioterrorism and the pathology of the disease intensify the need of improved surveillance system and efficient prophylactic measures. Anthrax should be considered as a neglected disease, especially the atypical outbreaks. The awareness by the veterinary and medical health authorities should be increased, to avoid missing cases.

To intensify the fight against the disease, the improvement of the Sterne vaccine is essential, because while it is valid in programs of disease control, in emergency situations only 80% of vaccinated animals are protected starting from 7 days from vaccination [11]. In addition, the Sterne vaccine is a live attenuated vaccine and therefore cannot be used in animals during antibiotic therapy. A cheap, improved, livestock vaccine is needed that can be used with antibiotics.

Moreover, efforts should be increased to improve the accuracy and reliability of traditional methods

of identifying *B. anthracis*, with particular regard to molecular tools, in order to rapidly detect the pathogen in environmental samples with low levels of contamination. In areas where the disease is endemic, it is important to improve the information and training of personnel as well as making the public aware of the dangers resulting from the manipulation of infected animals and their products. To reduce this risk, international cooperation must provide resources to encourage farmers to destroy infected animals.

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Conflict of interest statement

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