The apparent role of climate change in a recent anthrax outbreak in cattle

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Summary

An anthrax outbreak recently occurred in cattle in a region that had heretofore been free of the disease for more than two decades. This event followed heavy springtime rains that had caused flooding, and a hot dry summer. These temporally connected events may indicate a new link between climate change and increased incidence of bacterial diseases with environmental reservoirs.

Keywords

Anthrax outbreak – Cattle – Climate change – Vaccination – Weather conditions.

Introduction

The occurrence and distribution of emerging infectious diseases, particularly zoonotic diseases, has significant importance to both animal and public health. Recent studies have connected climate changes to increases in infectious diseases of animals and humans (1, 2). To date, this relationship has been suggested to be due to its effects on animal or insect reservoirs and disease transmission cycles (3). However, most studies have been limited to vector-borne and parasitic diseases (1), or to water- and food-borne diseases (3). There is little known regarding direct relationships between climate change and bacterial diseases, especially those with environmental reservoirs, such as anthrax. Anthrax is a rapidly lethal zoonosis that is transmitted to humans through contact with infected animals or animal products (4). The spores of *Bacillus anthracis* survive in the environment for decades, owing to their resistance to extremes of pH and temperature, desiccation and some chemical agents (5). Certain environmental conditions appear to produce 'anthrax belts', in which the soil becomes heavily contaminated with anthrax spores. These prerequisites include soil rich in organic matter (with pH > 6.0) and weather changes which include abundant rainfall followed by prolonged, significantly dry conditions (6, 7). The aim of this communication is to describe a recent anthrax outbreak in cattle that coincided with recent climate and weather changes.

Materials and methods

During the period between 20 August and 10 October 2010, 20 head of cattle suffered acute death in Livanjsko field (Fig. 1), which is located near to Livno town, in a small region in south-western Bosnia and Herzegovina (B&H). The field has an area of about 450 km^2 and lies between the Karst Mountains. The local terrain is dominated by rocky limestone soil with overlying networks of aqueducts, several lakes and some small rivers which are part of the Adriatic watershed.

Insert Figure 1

The region experienced an extremely wet year in 2010, with a deviation in precipitation that rose above the annual average in the Livno area, ranging from 287% in January to 146.2% in March, which led to increased river flows and flooding (8). Livanjsko field was affected by flooding, especially in the south-eastern region where animals are grazed, until March, when the flood waters began to recede. The flooding was followed by a dry, hot summer. Temperatures during the summer rose well above annual averages (9).

Out of the approximately 2,500 cattle maintained in the Livno area, about 700 were located in the villages near Livanjsko field. Most of these animals may have been exposed to contaminated vegetation while grazing in the field as part of routine husbandry practice. Of the 20 cattle deaths reported, 12 occurred in August, followed by 4 during each of the months of September and October. All affected animals had grazed the same pasture or received forage originating from this field. The predominant clinical findings in the affected animals were sudden death (within a few hours), bloody discharge from the nostrils and anus, a bloated carcass and unclotted, cherry-coloured blood. Several animals demonstrated atypical clinical signs including oedema of the legs and neck, apathy, decreased milk production and diarrhoea. Cattle with atypical clinical signs died within two or three days. Absence of *rigor mortis* was not noted in all carcasses. Three animals with atypical clinical signs were treated with antibiotics (procaine benzylpenicillin and dihydrostreptomycin) prior to death. Eighteen blood samples, and specimens comprising a spleen and an ear (with surrounding muscles) were submitted for bacteriological examination (7). The sample of ear tissue was found not to be appropriate for bacterial isolation and was therefore used for the detection of thermostable anthrax antigen by the Ascoli test (10).

Results

Bacillus anthracis was isolated from eight of the blood samples and the spleen, and the ear tissue sample reacted positively in the Ascoli test. Eight positive samples were obtained during the period 20–30 August. One positive sample was obtained during each of the months of September and October.

Discussion

Although sporadic cases of anthrax occur in B&H, this is the first outbreak to be reported. The last reported case in the Livno area was in 1986, and a vaccination programme was consequently implemented until 1992. However, given the lack of any data on infectious diseases during the war in B&H (1992–1995), the occurrence of anthrax cases in this period cannot be excluded.

During the outbreak, the highest numbers of cases occurred in and around the south-eastern part of Livanjsko field (Fig. 1), where most of the animal population is located.

Livestock outbreaks that reoccur at intervals of time that range from years to decades are not clearly understood (11). One theory involves the existence of an 'incubator area'. Here, certain soils, rich in calcium and organic matter with a pH above 6.0 and temperatures above 15°C, may favour multiplication and vegetative growth cycles that can result in outbreaks (11, 12). A study by Saile and Koehler (11) showed that *B. anthracis* can survive as a saprophyte outside its host. A more recent study has suggested the potential involvement of bacteriophages and soil-dwelling invertebrates in providing an alternative to sporulation that involves survival or multiplication of *B. anthracis* in the soil, without a mammalian host (12). However, the spores of *B. anthracis* are known to survive in the environment for long periods, owing to their resistance to environmental changes (5), and livestock usually become infected by ingestion or inhalation of spores from the soil while grazing (11).

During this outbreak, *B. anthracis* was not detected in all specimens from suspected cases. The inability to isolate *B. anthracis* from some of the animals may have been due to inappropriate sampling time. Most of the affected animals were found dead in a pasture or nearby forest, and the carcasses were then more than two days old. *Bacillus anthracis* can be destroyed in an intact carcass within this period by putrefactive processes and antagonistic interactions with other bacteria (5). Moreover, the results of bacteriological diagnosis appeared to depend on when antibiotic treatment was initiated: *B. anthracis* was not detected in blood samples from animals who were treated 24 hours prior to death. However, anthrax cannot be excluded as the cause of death in all reported cases, considering the clinical signs and disease confirmation in the area.

The decade 2001–2010 was the warmest on record globally, with above-average precipitation: the level recorded in 2010 broke all previous records (13).

The amount of precipitation occurring in the Livno region during 2010 was the highest ever recorded (14). The resultant flooding probably brought anthrax spores to the surface. The dry weather that followed will have led to evaporation of water and thus concentration of spores, as has been previously observed (5). Severe flooding also occurred in other European countries that reported anthrax outbreaks in 2010 (15). In a similar report from Sweden, an outbreak occurred in a herd of beef cattle after 27 years with no detected cases. There had been no clinical signs noted in the affected animals prior to their death (16). The likely key factor in this outbreak, as with that in B&H, was springtime flooding of the contaminated area followed by a dry summer (17). More recently, anthrax outbreaks have occurred in Siberia, resulting in the death of several thousand reindeer. It had been 75 years since the last reported outbreak. Abnormally high temperatures in the affected area and the resulting thaw of permafrost are believed to have caused anthrax spores to shift to upper soil layers (18).

In the outbreak in B&H, lower numbers of infected cattle were observed in September and October, which may be related to the initiation of a vaccination programme following the first confirmation of anthrax in August. This is in agreement with previous studies which suggested that early vaccination is beneficial in preventing disease and reducing mortality, even in the midst of an outbreak (19). Although the Livno area has a population of nearly 5,000 sheep and goats, there were no confirmed cases of anthrax or reported deaths due to anthrax in small ruminants. The main reason could be a comparatively low level of exposure of these animals to Livanjsko field due to the use of summer grazing in the mountains.

Springtime flooding again occurred in B&H in 2014. This brought new reports of anthrax infection, but with fewer cases. The lower incidence was probably the result of the prophylactic vaccination campaigns that were initiated following the flooding, based on the experiences in 2010. Coincidentally, increased numbers of clostridial infections were reported during the 2014 flood. This finding requires closer scrutiny because, like *B. anthracis*, clostridial bacteria produce spores, and these can be found free in the environment. Varying frequency and intensity of precipitation, as well as temperature changes, resulting from climate change may mobilise pathogens (20). The recent episodes of high rainfall and flooding in B&H created land movement, resulting in numerous landslides, which may have caused the shifting of unregistered older animal burial sites. These factors may also contribute to the release and spread of bacterial spores.

Conclusions

Springtime precipitation has recently increased in B&H. Weather and climate change have already been reported to be risk factors for infectious disease emergence and spread. Most reports relating climate change to increased disease incidence involve increases in vector prevalence. Empirical evidence for this association, however, is incomplete (1). The intensity of precipitation, including heavy rains, is projected to increase and global average temperatures are rising. Consequently, the prevalence of a number of infectious diseases is expected to increase. Control of their occurrence and spread will be highly dependent on early detection and preventive measures (20). The findings of this study indicate a potential for increased anthrax outbreaks in areas where the disease currently occurs only sporadically. This report thus illuminates a possible direct link between climate change and disease incidence that is not mediated through changes in vector prevalence, with emphasis instead being placed on a bacterial disease with an environmental reservoir.

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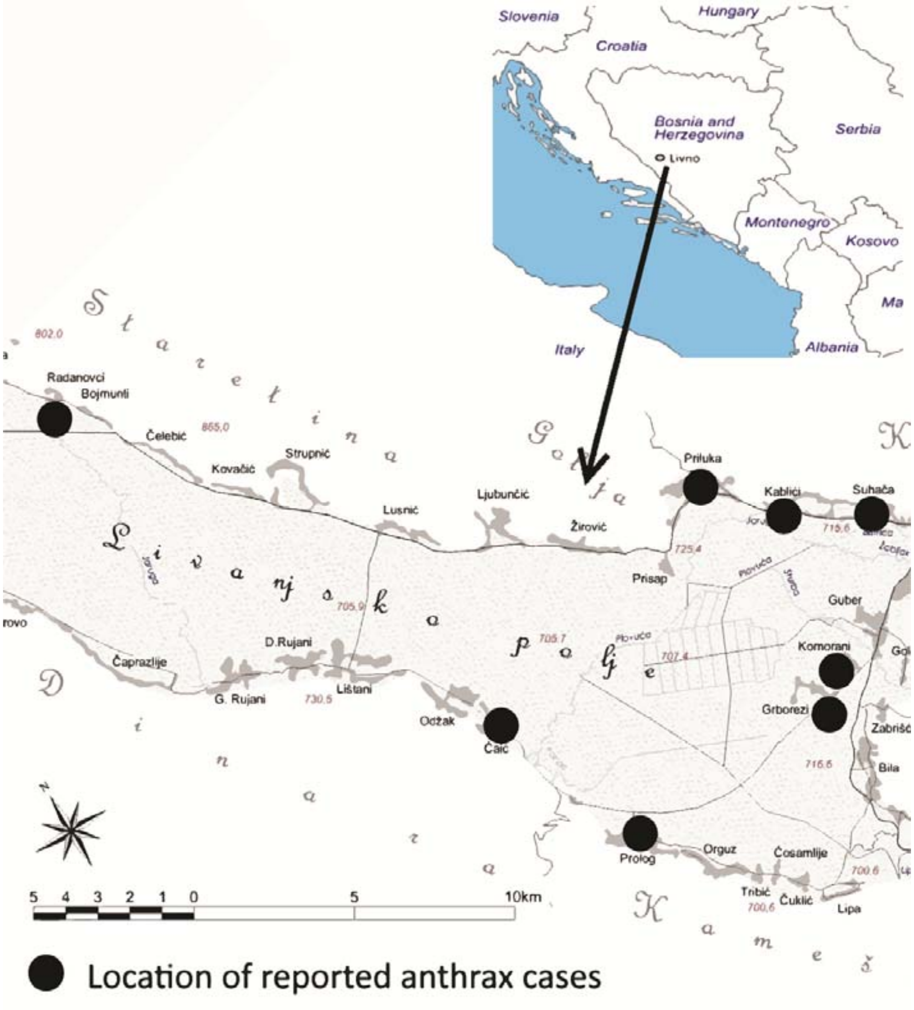

Fig. 1

Map of Livanjsko field with locations of reported anthrax cases