TEPHINET

Training Programs in Epidemiology and Public Health Interventions Network

FETP Field Epidemiology Training Program

Case Studies in Applied Epidemiology

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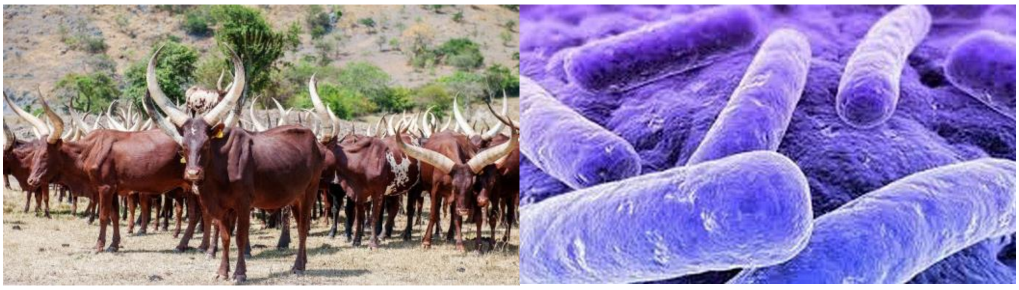

Anthrax in the cattle-keeping corridor of Uganda: a One Health case study

Participant Guide

Learning Objectives

After completing this case study, the fellow should be able to:

- Describe the usual sequence of steps of the outbreak investigation, and how they might differ when investigating a zoonotic disease outbreak.
- Define the One Health approach and its relevance to preventing and responding to zoonotic disease outbreaks.
- List the multi-disciplinary team members required to effectively investigate and respond to a zoonotic disease outbreak, and describe the roles of each.
- Calculate attack rates and risk ratios to identify associations between exposures and disease.
- Identify strategies for joint control of disease in animals and people in the context of a zoonotic disease outbreak.
- Describe challenges that can limit effective multisectoral coordination for outbreak investigation and control of zoonotic diseases.

This case study is based on investigations undertaken in 2018 by the Ugandan Public Health Fellowship Program. However, the case study is not a fully factual account of these investigations: aspects have been altered to assist in meeting the desired teaching objectives.

This case study was developed by Ausvet and the Australian National University in 2019, and edited by Richard Dicker, CDC, in 2019.

The authors would like to acknowledge the original outbreak investigation team, especially Kisaakye Esther and Bainomugisha Kenneth, the lead investigators and Kween District Rapid Response Team.

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Part 1: Background and Initial Investigation

Facilitator note: If Appendix 1 has not been distributed to and reviewed by participants in advance, direct participants to read Appendix 1 now (allow 5 minutes for reading and 5 minutes for discussion).

20th April 2018

On Friday 20th April 2018, seven people presented to a health centre in Kween District, Uganda with swollen skin blisters and lesions with black tissue in the centre. The attending clinician, Dr K, was concerned by the number of patients with the same clinical features. In response, Dr. K called the Kween District Health Officer.

Dr. K reported that all patients lived in the village of Kaplobotwo (subcounty Ngenge, Kween District, Uganda). Six patients were males between the ages of 14 and 62; one was a three-year-old female. All seven had been involved in skinning, butchering, carrying or eating a cow that had died suddenly on 11th April in Kaplobotwo.

<u>Question 1:</u> Would you call this an outbreak? Why or why not? (5 minutes).

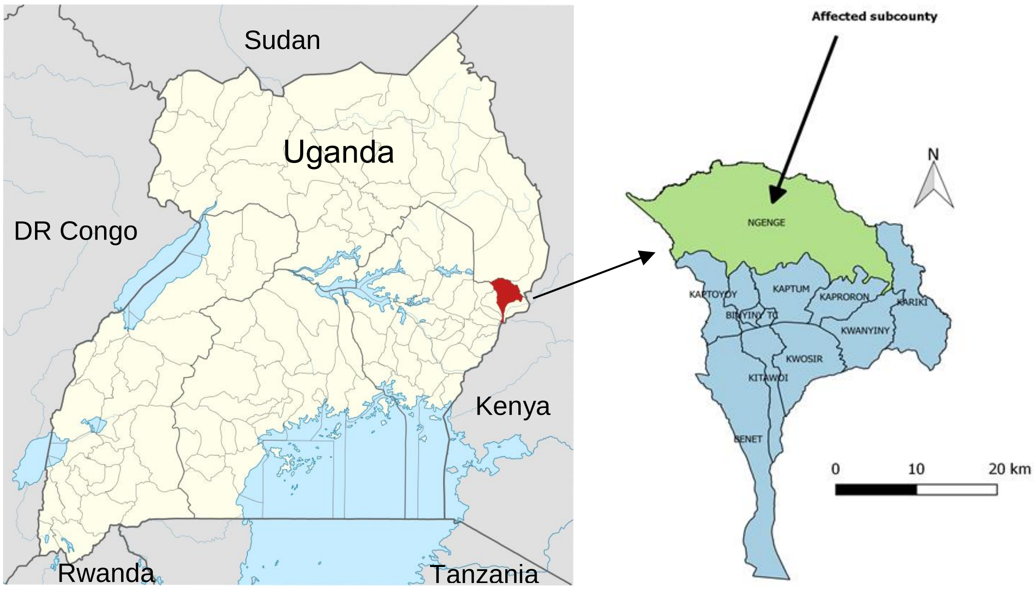
Setting

Kaplobotwo is located in Kween district, a mountainous area that is part of the ‘cattle-keeping corridor’ of Uganda. Kween shares a border with the Republic of Kenya to the south (Figure 1). Road access is limited to some areas of the district.

Approximately 85% of households in Kween district are dependent on subsistence farming as a main source of livelihood, with over 80% engaged in raising livestock. Cattle and goats are particularly common, along with sheep, pigs and poultry. Of the approximately 100 000 people residing in Kween district, over half are under 18 years of age, and approximately 35% are illiterate. Fewer than 2% of households own a television but about half of households own a radio, which serves as the main source of information in the area.

At the time of this cluster, the village of Kaplobotwo had 234 residents, of whom 127 were males and 138 were less than 18 years old.

Figure 1 Map of Districts of Uganda, with Kween District highlighted in red (left); map of Kween District, with the affected subcounty, Ngenge, highlighted in green (right).



The field investigation

The Kween District Health Officer immediately called a meeting with the District Rapid Response Team (RRT), which included a fellow in Uganda's Field Epidemiology Training Programme (FETP).

Question 2:	Keeping in mind that all seven index cases were involved in butchering or eating a cow, which government agencies might be interested in participating in an investigation? What types of staff might be part of a field investigation team? (5 minutes)

21st April 2018

The RRT consisted of the FETP fellow, a health promotion officer, a laboratory technician, the district veterinary officer, two environmental health officers and the District Administrator.

On the 21st April, the RRT met with the District Health Officer, then travelled to Ngenge to start the field investigation.

The team met with the village leader to discuss possible exposures, including exposure to the dead cow linked to the seven clinic patients. The village leader reported that the cow had died suddenly, and was butchered shortly afterwards. In total, 15 Kaplobotwo residents were involved in butchering the cow and carrying its meat. Additional Kaplobotwo village residents reportedly ate some of the meat. Some meat was also sold to neighbouring villages.

The RRT visited the Ngenge health centre and met with Dr K, who provided clinical case notes for review. The presumptive diagnosis was anthrax, given the patients' characteristic skin lesions, reported contact with a cow that had died suddenly, and a history of anthrax outbreaks in the region. Before proceeding, the team refreshed their knowledge of anthrax (see Appendix 2 for more information about anthrax).

Question 3: (5 minutes)	a. What was the likely source of infection for the human cases? b. What was the likely source of infection for the cow?

At this stage, the RRT reviewed the steps of an outbreak investigation.

Table 1. Steps of an Outbreak Investigation

1. *Identify your team/prepare for field work (Done)*
2. *Establish the existence of an outbreak (in progress)*
3. *Verify the diagnosis*
4. *Construct a working case definition*
5. *Find cases and develop line listing*
6. *Perform descriptive epidemiology*
7. ______________________________
8. *Evaluate hypotheses through analytical studies*
9. *As necessary, reconsider, refine and re-evaluate hypotheses*
10. *Compare and reconcile with laboratory and/or environmental studies*
11. *Implement control and prevention measures (as early as possible)*
12. *Initiate or maintain surveillance*
13. *Communicate findings*

Question 4:	Which step is missing? (5 minutes)

Question 5:	From a public health perspective, which steps might be approached differently in a zoonotic disease investigation? (5 minutes)

To verify the suspected diagnosis, the laboratory technician recommended collecting samples from the skin lesions and testing them for anthrax, with the patients' consent. Specimens from all seven patients were collected, packaged and sent to the National Reference Laboratory in Kampala, with PCR testing for anthrax to be run as an urgent priority.

The RRT's next steps were to develop a case definition, develop a standard case investigation form for this outbreak, and conduct active case finding.

Question 6:	How does an outbreak case definition differ from a standard surveillance case definition? (5 minutes)

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Given the high index of suspicion for anthrax, the FETP fellow developed the following case definitions for humans:

Case definitions for human anthrax

Clinical

- **Suspected cutaneous anthrax case**: onset of itching, reddening or swelling of skin areas and any of the following: skin lesions (e.g. papule, vesicle or eschar) or lymphadenopathy
- **Suspected gastrointestinal anthrax case**: onset of abdominal pain and any of the following: diarrhea, vomiting, lymphadenopathy, pharyngitis, or oropharyngeal lesions
- **Confirmed anthrax case**: A suspected case with PCR-positivity for *Bacillus anthracis* from a clinical sample (swab from skin lesions or vesicles, and/or blood sample)

Time: with onset from 6th April onwards
Place, Person: in a person residing in Kaplobotwo village, Kween District

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Question 7: What are some ways you might look for additional cases (active case finding) among humans? (5 minutes)

Question 8: What are the advantages of using a disease-specific standard case investigation form as part of active case finding? (5 minutes)

The FETP fellow identified five additional possible cases through speaking with community leaders. Members of the RRT interviewed the 12 suspected case-persons using the case investigation form. Meanwhile, the health promotion officer met with Kaplobotwo community health workers to commence community engagement and mobilization. The initial focus was on learning about community practices related to the management of animals that have died suddenly, their beliefs and understanding of why villagers had fallen sick, and the most effective means of village communication. In addition, the health promotions officer trained community health workers to use visual aids to educate villagers about anthrax prevention.

Meanwhile, the district veterinary officer, his team, and the village leader visited the owner of the cow that was linked to the initial cases. Given the high suspicion of anthrax, the district veterinary officer and his team decontaminated the cow's death site and butchering site using formalin (10% concentration). They vaccinated all livestock that had access to these sites and advised the owner on managing anthrax risk in livestock. The team reported the suspicions of anthrax to neighbouring livestock owners, and vaccinated all livestock deemed at risk of infection. Owners were asked to monitor their animals and report sudden deaths.

The district veterinary officer and his team formulated the following cattle case definitions for use in this outbreak:

- **Suspected anthrax cattle case**: sudden death, or death within 24 hours of illness onset, with or without blood-stained discharges from external orifices, in cattle in Kaplobotwo village from 6th April onwards.
- **Confirmed anthrax cattle case**: a suspected cattle case with *Bacillus anthracis* identified in clinical sample (blood, oedematous fluid or exudate) by bacterial culture, PCR or microscopic examination of blood smears.

The district veterinary officer also reviewed district veterinary anthrax records for anthrax occurrence in livestock in the area during the previous 4 months.

<u>Question 9:</u> How might information from the animal investigation help the human investigation (and vice versa)? (5 minutes)

Table 2 is a timeline of key events from 11th April to 30th April.

Table 2. Timeline: 11th – 30th April

11th April	Cow dies suddenly, is butchered and eaten in Kaplobotwo village
…	
20th April	Seven people present sick to the Ngenge III health centre, Dr K calls district health officer
21st April	Rapid response team starts field investigation, learns about history of exposure of cases to dead cow. Anthrax suspected.
22nd April	
23rd April	
…	
29th April	
30th April	

22nd April 2018

In a meeting of the RRT, the district veterinary officer reported that another cow died suddenly in the same area where the first cow died. A blood sample was taken and sent to the National Reference Laboratory for PCR testing. Under the supervision of the district veterinary officer, the carcass was buried to minimise the potential for infection of humans and environmental contamination with anthrax spores. The death site was decontaminated. Given the frequency of movement and trade of meat and movement of live animals between villages, the FETP fellow worked with neighbouring village leaders to arrange training for community health workers in active case finding in humans, who may have been exposed to infected animals or meat that were moved from Kaplobotwo to neighbouring villages.

Meanwhile, the environmental health officers advised the investigation team on environmental routes of anthrax transmission, including soil conditions favourable to persistence of anthrax spores, the potential for spread by local waterways, and the possibility of wildlife being affected.

Question 10a: What key information from 22nd April would you add to the Table 2 timeline? (2 minutes)

23rd – 29th April 2018

On the 23rd April, seven additional cows were found dead in an area neighbouring that of the previous cow cases — one carcass was found on a pasture, and six were found in the nearby water stream and surrounding bushes. On 29th April 2018, another cow was found dead in Kaplobotwo. The district veterinary officer was notified, and samples were collected from these cows, with appropriate management of the carcasses. Further interviews were conducted with local livestock owners about their livestock management practices.

On receiving positive laboratory test results for *B. anthracis* from the cattle samples, the district veterinary officer reported the confirmed cases to the RRT, as well as the Ministry of Agriculture, Animal Industry and Fisheries.

Question 10b: What key information from 23rd –29th April would you add to the Table 2 timeline? (2 minutes)

30th April 2018

By the 30th April, 26 suspected human cases had been identified and interviewed using the case investigation form. All of these 26 suspected cases reported onset of symptoms after contact with the cow that died on 11th April. Reported contact included skinning, butchering, carrying and eating meat from the dead cow. Only 10 of the 26 cases had sought care at the health centre. It was suggested that the low rate of care-seeking may have been related to a recent outbreak of Marburg virus (October 2017), after which some members of the community had begun to fear going to the health centre. These fears included dying at the health centre, being sprayed with disinfectant, having their home quarantined, and being stigmatised as a suspected Marburg case.

Question 10c: What key information from 30th April would you add to the Table 2 timeline? (2 minutes)

Part 2: Describing the data

Based on the information collected to date, the obvious hypothesis was that the outbreak resulted from exposure to the cow that had died on the 11th of April. The team decided to conduct an epidemiologic study to obtain more information on risk factors for this anthrax outbreak.

<u>Question 11:</u> What type of epidemiologic study would you undertake? Why? (5 minutes)

The team decided to conduct a cohort study. They developed a study questionnaire and visited all 57 households in the village. A total of 141 people from the 57 households (out of the 234 Kaplobotwo residents) responded to the questionnaire. The primary reason for non-response was absence from the village when the cohort study team visited, including children who were away at boarding school and adults who had travelled to neighbouring villages for trade, cattle rearing and farming. Data were collected on demographics, clinical symptoms, and exposures that may be related to the outbreak occurrence.

During the cohort study, an additional 22 cases (for a total of 48 cases from Kaplobotwo) were identified. Forty-five cases met the suspected case definition and three met the confirmed case definition.

The team sketched out an analysis plan for the data they collected through surveillance, case finding, and the study.

<u>Question 12</u>: How would you analyse the available data? (5 minutes)

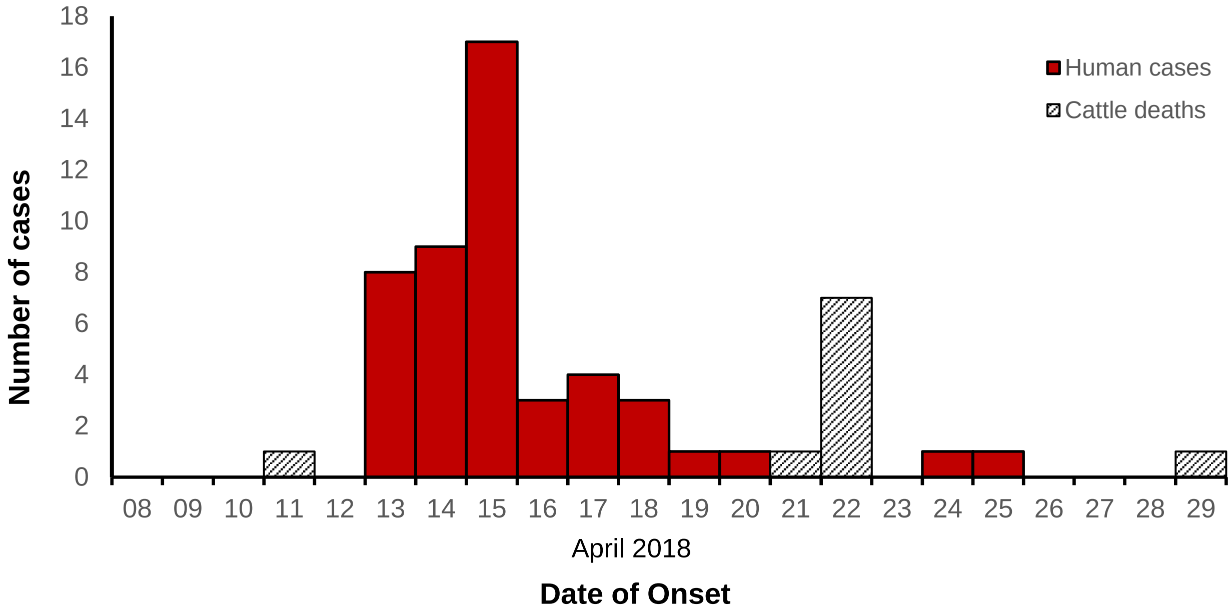
The FETP fellow reviewed the clinical features (signs and symptoms) among the 48 cases and classified them according to the outbreak case definitions for humans. Some cases had symptoms consistent with cutaneous anthrax, some had symptoms consistent with gastrointestinal anthrax, and some had both (see Table 3).

The FETP fellow also characterized the outbreak by time, using an epidemic curve (see Figure 2).

Table 3. Distribution of suspected and confirmed human cases of anthrax by clinical presentation, Kaplobotwo, April 2018.

Type of anthrax presentation	Number of cases	Percentage of anthrax cases (%)
Cutaneous only	14	29
Gastrointestinal only	14	29
Cutaneous and gastrointestinal	20	42
Total cases	48	100

Figure 2 Suspected and confirmed human cases of anthrax (n=48), and sudden deaths of local cattle (n=10), by date of onset / occurrence, Kaplobotwo, April 2018



Question 13: *Add arrows to the epidemic curve to indicate the first three events from the Table 2 timeline. (5 minutes)*

Question 14: *Interpret the epidemic curve (Figure 2) (10 minutes)*

Table 4a. Attack rates of suspected and confirmed human cases of anthrax by sex, Kaplobotwo, April 2018.

Sex	No. Cases	Population	Attack Rate (%)
Males		127	
Females		107	

Table 4b. Attack rates of suspected and confirmed human cases of anthrax by age group, Kaplobotwo, April 2018.

Age Group (years)	No. Cases	Population	Attack Rate (%)
0–4		41	
5–10		41	
11–17		56	
18–34		45	
35–54		39	
≥55		12	
Total			

Question 15: Using the line list data in Appendix 3, calculate attack rates and complete Tables 4a and 4b. (10 minutes)

The team entered the data from the cohort study (n=141) into a database, then analysed the data to identify possible risk factors for anthrax in humans.

Question 16: Using the data in Appendix 4, draw 2-by-2 tables, calculate attack rates (risks), and calculate risk ratios for exposures possibly associated with cutaneous anthrax (n=34) amongst people from Kaplobotwo. Include as cases those with cutaneous anthrax, whether or not they had concurrent gastrointestinal anthrax. (10 minutes).

The district veterinary officer and his team traced meat from the implicated cow to buyers in two nearby villages, Tukumo and Rikwo. The RRT then followed up with the buyers and found:

- in Tukumo village, approximately 23 people ate the meat (cooked) in a bar, but there were no reports of anyone becoming sick.
- in Rikwo village, 28 people ate the meat (cooked) in a bar and none became sick, whilst two people who bought meat directly from the seller became sick.

The bar owners in Tukumo and Rikwo villages told the RRT that they boiled the meat for a long time. This may have destroyed any anthrax spores present, and diminished the risk of infection by eating the meat. In contrast, the people who bought the meat directly from the seller ate the meat roasted, which may not have been sufficient to reduce the risk of infection, given that anthrax spores are resistant to dry heat. From additional analyses of the Kaplobotwo cohort study data, the FETP fellow determined that boiling meat for more than 60 minutes was protective against anthrax (RR=0.49 for persons who boiled for 60 minutes or longer compared with those who boiled for less than 60 minutes).

Meanwhile, accumulating information from the district veterinary officer’s investigation indicated that over 150 suspected anthrax animal cases had occurred since 1st January 2018 in Ngenge subcounty. However, none of the interviewed livestock owners had vaccinated their animals against anthrax. The government did not subsidise vaccination, and many owners reported that vaccines were too expensive to purchase. Additionally, some animals were owned by groups or large extended families, which complicated decision-making on payment for vaccinations.

<u>Question 17:</u> Why might some livestock owners with sick animals not come forward during an outbreak? How can reporting and compliance be improved? (5 minutes)

Response

Although control measures were initiated throughout the investigation (as soon as appropriate), the public health and animal health investigation teams met on 30th April to discuss findings so far and to formulate a concerted plan of action. The findings included:

- Human cases started on 13th April 2018 and were from Kaplobotwo village in Kween district.
- Twenty six cases in humans were identified either as index cases or through active case finding; a further 22 human cases were identified through the cohort study.
- The most likely cause was anthrax, based on signs and symptoms in affected humans and cattle, history of association between affected humans and cattle, and laboratory findings.
- The first suspected cattle case (linked to the index human cases) occurred on 11th April 2018. Ten cattle were suspected or confirmed to have died of anthrax in Kaplobotwo during the investigation period.
- Retrospective investigation identified over 150 suspected anthrax cases in cattle from 1st January to 30th April 2018 in Ngenge subcounty.
- Livestock in the affected area were not routinely vaccinated.

<u>Question 18</u>:	Based on the findings of the outbreak investigation, what short-term and longer-term actions and control measures might you undertake? (5 minutes)

Control measures are a vital part of outbreak response and should be implemented as soon as possible. However, it is also important to understand the context when planning, implementing and evaluating control measures. As the investigation progressed, the team learned more about the social and economic context of the outbreak, and how that may impact disease control measures.

Question 19: What are some possible cultural and contextual challenges associated with the proposed control measures, and other factors that are important to consider? (5 minutes)

Question 20: Considering a One Health approach to outbreak investigation and disease control, what challenges can limit effective multisectoral collaboration? (5 minutes)

Conclusion

This outbreak of anthrax in animals and people in the ‘cattle-keeping corridor’ of Uganda highlights the need for coordinated investigations and response by public and animal health authorities for suspected zoonotic disease outbreaks. This case study highlights how a One Health approach can improve the effectiveness of the response. In this outbreak, all human cases were linked to exposure to a single cow death. Community health education campaigns and appropriate management of infected carcasses subsequent to the index cow death may have contributed to preventing further human anthrax cases, as no human cases were linked to these subsequent cow deaths. Vaccination of susceptible animals in the area is likely to have also helped prevent cases in cattle.

Based on what they learned from working together in a multidisciplinary team, the outbreak team decided to form a Kween District One Heath taskforce to focus on improving information sharing between animal and human health to support the prevention of, detection of and response to zoonotic disease outbreaks in Kween district in the future.

END

Appendix 1: Introduction to One Health (for background reading)

What is One Health?

One Health is about recognising the close relationship between people, animals and the environment, and the impact that poor health in one of these areas can have on the others.

The U.S. Centers for Disease Control and Prevention (CDC) defines One Health as ‘a collaborative, multisectoral, and transdisciplinary approach — working at the local, regional, national, and global levels — with the goal of achieving optimal health outcomes recognizing the interconnection between people, animals, plants, and their shared environment’[1]. Though this approach is particularly relevant to control of diseases that can be transmitted from animals to humans (‘zoonoses’), a One Health approach is also important for understanding other health challenges, such as antimicrobial resistance, food safety and security, and community and mental health issues arising from relationships with the environment in the face of environmental degradation and climate change.

One Health approaches are important for the prevention, investigation and control of zoonotic diseases. Early detection of zoonoses in animal populations can prevent transmission to humans (including by preventing introduction of these pathogens into the food chain, or mitigating the risk of the pathogens if introduced). For some zoonoses, control of infection in animal populations can be the most effective way to prevent disease in humans (e.g. anthrax, brucellosis, rabies, zoonotic Influenza A viruses). Given that approximately 60% of infectious diseases in humans are zoonotic, and approximately 70% of emerging infectious diseases are zoonotic, a ‘One Health’ approach to disease investigation and management is appropriate in many cases.

Investigating and controlling diseases at the human–animal–environment interface requires coordination and collaboration between different disciplines and agencies, at different levels.

Which professions are involved in a One Health approach to zoonotic disease investigation and control?

Relevant professions include:

- Public health epidemiologists
- Veterinary epidemiologists
- Clinicians, pathologists, nurses and community health workers
- Veterinarians, animal health workers and quarantine officers
- Laboratory technicians
- Environmental scientists, ecologists and wildlife biologists

Several other professions have key roles in implementing One Health. For example, politicians have a role in developing policies that provide legislative support for disease investigation and control, including compensation schemes; economists have a role in evaluation of the economics of disease intervention strategies; sociologists have a role in understanding the drivers of human behaviour and social conditions that influence the occurrence of and response to outbreaks; and security personnel may have a role in supporting disease investigation and control measures.

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[1] Centers for Disease Control and Prevention, 2018. *One Health Basics* (online). Available https://www.cdc.gov/onehealth/basics/index.html

Appendix 2: Anthrax Fact Sheet

Anthrax epidemiology: a brief overview

Anthrax is an illness caused by the bacteria *Bacillus anthracis*. The bacteria are endemic in the soil in certain areas of the world, where they persist as environmentally-resistant spores. Sporadically, the bacteria can cause outbreaks of illness in domestic and wild animals, and humans. Outbreaks in humans typically occur associated with outbreaks in animals.

Anthrax is exceptional in that it not contagious (spread between live animals or humans is insignificant). Herbivorous animals tend to acquire infection from eating soil-borne spores whilst grazing; this is a particular risk in areas where there is a previous history of anthrax occurrence, where infected carcasses are not managed appropriately, and after soil disturbance such as flooding, deep ploughing and excavation. Omnivorous and carnivorous animals tend to acquire the infection by eating infected animals, and humans may also acquire infection by handling infected animals and contaminated animal products. Milk is not an important mode of spread of infection.

The vegetative form of *B. anthracis* found in infected animals is fragile; however on exposure to air, it can form highly resistant spores, which remain viable for many years in some soil types. Appropriate management of infected carcasses is therefore important to minimise environmental contamination with spores, and thus the potential for future infections. Spores and vegetative bacteria are destroyed by moist heat at 100-105°C for 20 minutes.

Anthrax in animals

Anthrax affects many domestic and wild animal species. Of livestock, anthrax generally causes sudden death in cattle, sheep, goats and camelids; blood may be present around the nose, mouth and anus of carcasses. These species have high levels of septicaemia at death and the carcasses can contaminate the environment with spores. Appropriate management of carcasses of these species includes isolating the carcass from other animals, not opening the carcass (as exposure to oxygen allows spore formation), decontaminating the death site, and incineration or deep burial of the carcass.

In contrast, pigs have some degree of natural resistance to anthrax, and may recover from the disease. Clinical signs may include bloody faeces, haemorrhage from the nose and respiratory distress, or can be relatively mild with fever, enlarged lymph nodes and localised swelling.

Anthrax does not form a carrier state in animals (except possibly in recovered pigs, though the role they play in the epidemiology of anthrax is uncertain). Infection is primarily spread by movement of live animals in the incubation period, with death and release of bacteria from the carcass at the new site.

Anthrax in humans

The three typical forms of clinical anthrax in humans are

- **cutaneous anthrax**, which can occur after penetration of spores through skin lesions, usually while handling contaminated animal products such as meat from an infected animal. The incubation period is typically 1–7 days, though it can be longer. Clinical signs may include a group of blisters with associated itching and swelling, progressing to a painless sore with a necrotic black scab (anthrax eschar). These lesions typically occur on hands, arms, face or neck. Given the lack of pain associated with the sores, people with cutaneous anthrax may not seek medical care.
- **gastrointestinal anthrax**, which can occur after eating raw or undercooked meat from infected animals. The incubation period is typically 3–7 days, though it can be longer. Clinical signs may include fever, swelling of glands in the neck, a sore throat, headache, nausea and vomiting (which may include blood), diarrhoea (which may include blood), abdominal swelling and fainting.
- **inhalational (pulmonary) anthrax**, which can occur if a person inhales *B. anthracis* spores, is typically associated with processing of contaminated animal hides, wool, etc., where spores may become aerosolised. The incubation period is typically 1–7 days, though it can be longer. Clinical signs may include fever, fatigue, aches, nausea and vomiting, chest discomfort, a cough and difficulty breathing.

Occasionally, other forms of anthrax can occur, including meningeal anthrax (often secondary to one of the above forms of anthrax) and injection anthrax (associated with use of contaminated needles).

Appendix 3: Line list data for anthrax outbreak

Cases arranged by age, to facilitate calculating attack rates by age group

Case no.	District	Subcounty	Village	Sex	Age	Anthrax category[1]	Date of sickness onset	Laboratory investigation?	Lab result
10	Kween	Ngenge	Kaplobotwo	F	1	Cutan-GI	15/4/18	0	
91	Kween	Ngenge	Kaplobotwo	F	1	Cutan-Only	20/4/18	0	
125	Kween	Ngenge	Kaplobotwo	M	2	GI-Only	16/4/18	0	
23	Kween	Ngenge	Kaplobotwo	F	3	Cutan-GI	14/4/18	0	
57	Kween	Ngenge	Kaplobotwo	M	3	Cutan-GI	17/4/18	0	
94	Kween	Ngenge	Kaplobotwo	M	3	GI-Only	19/4/18	0	
74	Kween	Ngenge	Kaplobotwo	M	3	GI-Only	13/4/18	0	
11	Kween	Ngenge	Kaplobotwo	M	4	Cutan-GI	15/4/18	0	
73	Kween	Ngenge	Kaplobotwo	M	4	GI-Only	13/4/18	0	
123	Kween	Ngenge	Kaplobotwo	M	5	Cutan-GI	14/4/18	0	
58	Kween	Ngenge	Kaplobotwo	M	5	Cutan-GI	15/4/18	0	
34	Kween	Ngenge	Kaplobotwo	M	5	GI-Only	13/4/18	0	
12	Kween	Ngenge	Kaplobotwo	M	6	Cutan-GI	15/4/18	0	
59	Kween	Ngenge	Kaplobotwo	M	7	Cutan-GI	15/4/18	0	
8	Kween	Ngenge	Kaplobotwo	M	8	Cutan-GI	15/4/18	0	
121	Kween	Ngenge	Kaplobotwo	M	11	GI-Only	15/4/18	0	
82	Kween	Ngenge	Kaplobotwo	M	14	Cutan-Only	14/4/18	1	
87	Kween	Ngenge	Kaplobotwo	M	16	Cutan-GI	13/4/18	1	
122	Kween	Ngenge	Kaplobotwo	F	21	GI-Only	14/4/18	1	
13	Kween	Ngenge	Kaplobotwo	F	22	Cutan-GI	15/4/18	0	
103	Kween	Ngenge	Kaplobotwo	M	25	Cutan-GI	14/4/18	1	
60	Kween	Ngenge	Kaplobotwo	F	26	Cutan-GI	15/4/18	0	
70	Kween	Ngenge	Kaplobotwo	F	26	Cutan-Only	18/4/18	0	
56	Kween	Ngenge	Kaplobotwo	F	27	Cutan-Only	17/4/18	0	
72	Kween	Ngenge	Kaplobotwo	F	28	Cutan-Only	16/4/18	0	
9	Kween	Ngenge	Kaplobotwo	M	30	Cutan-GI	15/4/18	0	
71	Kween	Ngenge	Kaplobotwo	M	30	GI-Only	13/4/18	0	
96	Kween	Ngenge	Kaplobotwo	M	34	Cutan-Only	17/4/18	0	
15	Kween	Ngenge	Kaplobotwo	M	35	Cutan-GI	15/4/18	1	Positive
98	Kween	Ngenge	Kaplobotwo	M	35	GI-Only	15/4/18	0	
97	Kween	Ngenge	Kaplobotwo	M	38	Cutan-GI	13/4/18	1	Positive
55	Kween	Ngenge	Kaplobotwo	M	44	Cutan-GI	25/4/18	1	Positive
64	Kween	Ngenge	Kaplobotwo	M	45	Cutan-GI	18/4/18	0	
33	Kween	Ngenge	Kaplobotwo	F	45	Cutan-Only	15/4/18	0	
93	Kween	Ngenge	Kaplobotwo	M	47	Cutan-Only	13/4/18	1	
31	Kween	Ngenge	Kaplobotwo	F	48	Cutan-Only	17/4/18	0	
92	Kween	Ngenge	Kaplobotwo	M	53	Cutan-Only	24/4/18	1	
119	Kween	Ngenge	Kaplobotwo	M	53	GI-Only	16/4/18	1	
26	Kween	Ngenge	Kaplobotwo	F	55	Cutan-Only	14/4/18	0	
99	Kween	Ngenge	Kaplobotwo	M	57	GI-Only	15/4/18	0	
21	Kween	Ngenge	Kaplobotwo	M	58	GI-Only	18/4/18	0	
105	Kween	Ngenge	Kaplobotwo	F	60	Cutan-GI	15/4/18	0	
76	Kween	Ngenge	Kaplobotwo	M	61	Cutan-Only	14/4/18	0	
1	Kween	Ngenge	Kaplobotwo	M	62	Cutan-GI	14/4/18	0	
75	Kween	Ngenge	Kaplobotwo	F	65	Cutan-Only	14/4/18	0	
104	Kween	Ngenge	Kaplobotwo	M	65	Cutan-Only	15/4/18	0	
29	Kween	Ngenge	Kaplobotwo	F	75	GI-Only	15/4/18	0	
30	Kween	Ngenge	Kaplobotwo	M	84	GI-Only	13/4/18	0	

[1] Cutan-Only = cutaneous anthrax only; GI-Only = gastrointestinal anthrax only; Cutan-GI = concurrent cutaneous and gastrointestinal anthrax

Appendix 4: Cohort study data for anthrax outbreak (page 1 of 3)

Cases arranged by anthrax category, to facilitate calculating relative risks for cutaneous anthrax

ID no.	Anthrax category[1]	Cutaneous form present?	Carried cow &/or butchered parts?	Skinned cow?	Carried skin from dead animal?	Cut/ butchered cow?	Cleaned waste from butchering site?	Removed internal organs?	Prepared meat for cooking?
10	Cutan-GI	1	0	0	0	0	0	0	0
23	Cutan-GI	1	0	0	0	0	1	0	0
57	Cutan-GI	1	0	0	0	0	0	0	0
11	Cutan-GI	1	0	0	0	0	0	0	0
123	Cutan-GI	1	0	0	0	0	0	0	0
58	Cutan-GI	1	0	0	0	0	0	0	0
12	Cutan-GI	1	0	0	0	0	1	0	0
59	Cutan-GI	1	0	0	0	0	0	0	0
8	Cutan-GI	1	0	0	0	0	0	0	0
87	Cutan-GI	1	1	1	1	1	1	1	0
13	Cutan-GI	1	0	0	0	0	0	0	1
103	Cutan-GI	1	1	1	1	1	1	1	1
60	Cutan-GI	1	0	0	0	0	0	0	1
9	Cutan-GI	1	1	0	0	0	0	0	0
15	Cutan-GI	1	1	1	1	1	1	1	0
97	Cutan-GI	1	1	1	1	1	1	1	0
55	Cutan-GI	1	1	0	0	1	0	0	0
64	Cutan-GI	1	1	1	0	1	1	1	0
105	Cutan-GI	1	1	0	0	0	0	0	1
1	Cutan-GI	1	1	1	0	1	1	1	1
91	Cutan-Only	1	1	0	0	0	0	0	0
82	Cutan-Only	1	1	0	1	0	0	0	1
70	Cutan-Only	1	1	0	0	0	0	0	1
56	Cutan-Only	1	1	0	0	0	0	0	1
72	Cutan-Only	1	1	0	0	0	0	0	1
96	Cutan-Only	1	1	1	0	0	0	1	0
33	Cutan-Only	1	1	0	0	0	0	0	0
93	Cutan-Only	1	1	0	0	1	0	0	1
31	Cutan-Only	1	1	0	0	0	0	0	0
92	Cutan-Only	1	1	1	1	1	0	0	0
26	Cutan-Only	1	0	0	0	0	0	0	1
76	Cutan-Only	1	1	0	1	0	0	0	0
75	Cutan-Only	1	1	0	0	0	0	0	1
104	Cutan-Only	1	0	0	0	0	0	0	0
125	GI-Only	0	0	0	0	0	0	0	0
94	GI-Only	0	0	0	0	0	0	0	0
74	GI-Only	0	0	0	0	0	0	0	0
73	GI-Only	0	0	0	0	0	0	0	0
34	GI-Only	0	0	0	0	0	0	0	0
121	GI-Only	0	0	0	0	0	0	0	0
122	GI-Only	0	0	0	0	0	0	0	1
71	GI-Only	0	1	1	0	0	0	0	0
98	GI-Only	0	0	0	0	0	0	0	1
119	GI-Only	0	0	0	0	0	0	0	0
99	GI-Only	0	1	1	1	1	1	1	1

[1] Cutan-Only = cutaneous anthrax only; GI-Only = gastrointestinal anthrax only; Cutan-GI = concurrent cutaneous and gastrointestinal anthrax

Appendix 4: Cohort study data for anthrax outbreak (page 2 of 3)

ID no.	Anthrax category	Cutaneous form present?	Carried cow &/or butchered parts?	Skinned cow?	Carried skin from dead animal?	Cut/ butchered cow?	Cleaned waste from butchering site?	Removed internal organs?	Prepared meat for cooking?
21	GI-Only	0	0	0	0	0	0	0	0
29	GI-Only	0	0	0	0	0	0	0	1
30	GI-Only	0	0	0	0	0	0	0	0
116	None	0	0	0	0	0	0	0	0
19	None	0	0	0	0	0	0	0	0
78	None	0	0	0	0	0	0	0	0
109	None	0	0	0	0	0	0	0	0
112	None	0	0	0	0	0	0	0	0
131	None	0	0	0	0	0	0	0	0
84	None	0	0	0	0	0	0	0	0
115	None	0	0	0	0	0	0	0	0
107	None	0	0	0	0	0	0	0	0
114	None	0	0	0	0	0	0	0	0
18	None	0	0	0	0	0	0	0	0
108	None	0	0	0	0	0	0	0	0
113	None	0	0	0	0	0	0	0	0
130	None	0	0	0	0	0	0	0	0
25	None	0	1	0	0	0	0	1	0
4	None	0	0	0	0	0	0	0	0
17	None	0	0	0	0	0	0	0	0
79	None	0	0	0	0	0	0	0	0
28	None	0	0	0	0	0	0	0	0
36	None	0	0	0	0	0	0	0	0
40	None	0	0	0	0	0	0	0	0
54	None	0	0	0	0	0	0	0	0
5	None	0	0	0	0	0	0	0	0
129	None	0	0	0	0	0	0	0	0
3	None	0	0	0	0	0	0	0	0
24	None	0	0	0	0	0	0	0	0
39	None	0	0	0	0	0	0	0	0
102	None	0	0	0	0	0	0	0	0
128	None	0	0	0	0	0	0	0	0
118	None	0	1	0	0	0	1	1	0
7	None	0	0	0	0	0	0	0	0
27	None	0	0	0	0	0	0	0	0
127	None	0	0	0	0	0	0	0	0
136	None	0	0	0	0	0	0	0	0
51	None	0	0	0	0	0	0	0	0
63	None	0	0	0	0	0	0	0	0
32	None	0	0	0	0	0	0	0	0
67	None	0	0	0	0	0	0	0	0
124	None	0	0	0	0	0	0	0	0
44	None	0	0	0	0	0	0	0	0
89	None	0	1	0	0	0	0	0	1
41	None	0	0	0	0	0	0	0	0
43	None	0	0	0	0	0	0	0	0
47	None	0	0	0	0	0	0	0	0
37	None	0	0	0	0	0	0	0	0

Appendix 4: Cohort study data for anthrax outbreak (page 3 of 3)

ID no.	Anthrax category	Cutaneous form present?	Carried cow &/or butchered parts?	Skinned cow?	Carried skin from dead animal?	Cut/ butchered cow?	Cleaned waste from butchering site?	Removed internal organs?	Prepared meat for cooking?
106	None	0	0	0	0	0	0	0	1
68	None	0	1	0	0	0	0	0	1
95	None	0	1	0	0	0	0	0	1
2	None	0	0	0	0	0	0	0	0
111	None	0	0	0	0	0	0	0	0
83	None	0	1	0	0	0	0	0	0
16	None	0	0	0	0	0	0	0	1
117	None	0	1	0	0	0	0	0	1
42	None	0	0	0	0	0	0	0	1
48	None	0	0	0	0	0	0	0	0
6	None	0	0	0	0	0	0	0	1
22	None	0	0	0	0	0	0	0	1
61	None	0	0	0	0	0	0	0	0
62	None	0	0	0	0	0	0	0	0
85	None	0	1	0	0	0	0	0	0
50	None	0	0	0	0	0	0	0	0
139	None	0	0	0	0	0	0	0	0
14	None	0	0	0	0	0	0	0	0
53	None	0	0	0	0	0	0	0	0
126	None	0	1	0	0	0	0	0	0
81	None	0	1	0	0	0	0	0	1
20	None	0	1	0	0	0	0	0	0
110	None	0	0	0	0	0	0	0	0
77	None	0	0	0	0	0	0	0	0
80	None	0	0	0	0	0	0	0	1
88	None	0	0	0	0	0	0	0	1
65	None	0	0	0	0	0	0	0	1
138	None	0	1	0	0	0	0	0	1
49	None	0	0	0	0	0	0	0	0
52	None	0	0	0	0	0	0	0	1
120	None	0	0	0	0	0	0	0	0
134	None	0	0	0	0	0	0	0	0
38	None	0	0	0	0	0	0	0	0
101	None	0	1	0	0	0	0	0	0
66	None	0	0	0	0	0	0	0	0
138	None	0	0	0	0	0	0	0	0
133	None	0	1	0	0	0	0	0	1
35	None	0	0	0	0	0	0	0	0
90	None	0	0	0	0	0	0	0	1
137	None	0	0	0	0	0	0	0	0
137	None	0	0	0	0	0	0	0	0
86	None	0	1	0	0	0	0	0	1
69	None	0	1	0	0	0	0	0	1
45	None	0	0	0	0	0	0	0	0
132	None	0	1	0	0	0	0	0	1
100	None	0	0	0	0	0	0	0	0
46	None	0	0	0	0	0	0	0	0
135	None	0	0	0	0	0	0	0	0