

Cutaneous Anthrax Outbreak Associated with Handling Dead Animals, Rhino Camp Sub-county: Arua District, Uganda, January-May 2018

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Abstract

Background: On the 9 February 2018, Arua District notified Uganda Ministry of Health of a confirmed anthrax outbreak among humans in Rhino Camp sub-county. Many persons fell ill after reported contact with livestock that died suddenly. We investigated to determine the scope, mode of transmission and exposures associated with identified anthrax, to guide control and prevention measures.

Methods: We defined a suspected cutaneous anthrax case as onset of skin lesions (e.g., papule, vesicle, or eschar) in a person residing in Rhino Camp sub-county, Arua District from 25 December, 2017 to 31 May, 2018. A confirmed case was a suspected case with PCR-positivity for *Bacillus anthracis* from a clinical sample. We identified cases by reviewing medical records at Rhino Camp Health Centre. We also conducted additional case searches in the affected community with support from Community Health Workers. In a retrospective cohort study, we interviewed all members of households in which at least one person had contact with the carcasses of or meat from animals suspected to have died of anthrax. We collected and tested hides of implicated animals using an anthrax rapid diagnostic test.

Results: We identified 14 case-patients (1 confirmed, 13 suspected); none died. Only males were affected (AR: 12/10,000). Mean age of case-persons was 33years (SD: 22). The epidemic curve shows that the outbreak lasted for 5 months, from January 2018-May 2018, peaking in February. Skinning (RR=2.7, 95%CI=1.1-6.7), dissecting (RR=3.0, 95%CI=1.2-7.6), and carrying the dead animals (RR=2.7, 95%CI=1.1-6.7) were associated with increased risk of illness, as were carrying dissected parts of the animal (RR=2.9, 95%CI 1.3-6.5) and preparing and cooking the meat (RR=2.3, 95%CI 2.7-8.1). We found evidence of animal remains on pastureland.

Conclusion: Multiple exposures to the hides and meat of animals that died suddenly were associated with this cutaneous anthrax outbreak in Arua District. We recommended public education about safe disposal of carcasses of livestock that die suddenly.

Introduction

Anthrax is an acute infection caused by *Bacillus anthracis*, an aerobic, spore-forming Gram-positive bacteria that can infect both humans and animals[1]. The sporulation makes *B. anthracis* resistant to degradation in the environment, and spores can persist for extended periods of time, even under adverse conditions[2]. There are three main forms of human anthrax infection, depending on the route of exposure: cutaneous, gastrointestinal, and pulmonary (inhalational) anthrax [3]. The most common, cutaneous anthrax, accounts for approximately 95% of cases [4]. Between one and 12 days after exposure, clinical signs of cutaneous anthrax infection appear as one or more painless, itchy papules or vesicles on the skin, typically on exposed areas such as the face, neck, forearms, or hands. Within 7-10 days of the initial lesion, the papule forms an ulcer, which subsequently crusts over, forming a painless black eschar that is the hallmark of cutaneous anthrax. Localized swelling, painful swollen regional

lymph nodes, and systemic symptoms may also be present[5]. Without treatment, the case-fatality rate of cutaneous anthrax is 20% [6]; however, it can also self-resolve.

Anthrax is endemic in most sub-Saharan African countries[7]. Uganda has been reporting anthrax cases and deaths in humans and animals, including wildlife, since at least 1959 [8, 9]. Outbreaks have been reported from every region of Uganda, mostly among communities that rear cattle[10]. Surveillance data in Uganda in 2018 revealed 186 reported human cases and 721 reported livestock deaths due to anthrax[10].

On 3rd December, 2017, a 40 year old man presented with skin lesions at Rhino Camp Health Centre. A skin lesion swab was collected and confirmed on 31st December, 2017. On the 9 February 2018, Arua District notified Uganda Ministry of Health of a confirmed anthrax outbreak among humans in Rhino Camp sub-county. On 11th February, a multi-disciplinary team was sent on ground to investigate and respond to the outbreak. We investigated to determine the source and scope of the outbreak, identify exposures associated with transmission, and recommended evidence-based control and prevention measures.

Methods

Study area

Arua District is located in Northwestern Uganda and is bordered by the Democratic Republic of the Congo (DRC) to the west. The district has a total population of about 782,000 persons [14]. The main economic activities in Arua district include cross-border trade with South Sudan and DRC, agriculture, and livestock farming, characterized by significant movement of livestock into and out of the district. Arua District has 18 sub-counties. Rhino Camp sub-county is one of the sub-counties occupied by both refugees (mostly from DRC) and Ugandan nationals and is named for its proximity to a Ugandan national park which contained white rhinos.

Case definition and case-finding

We defined a suspected cutaneous anthrax case as onset of skin lesions (e.g., papule, vesicle, or eschar) in a person residing in Rhino Camp sub-county, Arua District from 25 December 2017 to 31 May 2018. We defined a confirmed anthrax case as a suspected case with PCR-positivity for *Bacillus anthracis* from a clinical sample (swab from skin lesions/vesicles, or blood samples).

To identify cases, we reviewed medical records at Rhino Camp Health Centre III. We also conducted additional case searches in the affected community with support from Community Health Workers. We developed a line list of cutaneous anthrax case-persons with patient age, sex, residence, date of onset of signs and symptoms, laboratory investigations, specimens collected, and coordinates of the case-persons' households.

Descriptive epidemiology

We performed descriptive epidemiology on the line-listed case-persons. Using an epidemic curve, we described the case-persons by time of onset. Using population data obtained from the district population office, we computed attack rates by age-group, sex, and parish. We also drew a choropleth map using QGIS software version to describe case-persons by parish.

Hypothesis generation

We interviewed 14 suspected case-persons. The key exposures that we explored were those that occurred from 25 December 2017 onwards, including carrying a dead animal to a slaughter site, skinning of a dead animal, dissecting a dead animal, carrying already-dissected parts of dead animals, preparation and cooking of meat of dead animals, and having contact with soil through digging.

Retrospective cohort study

To identify specific animal-related exposures that increased risk for cutaneous anthrax among humans, we formed a cohort among all members of households in which at least one person had contact with the carcass of or meat from any animal suspected to have died of anthrax.

Laboratory investigations

In addition to collecting and testing swabs and blood samples from case-persons, we also tested hides from three implicated cows (hides from cows reported to have died suddenly) using an InBios Active Anthrax Detect™ (AAD) (Anthrax Rapid Test lateral flow immunoassay). The AAD is a point-of-care assay that is under investigational use for detecting *Bacillus anthracis* capsular polypeptide (polyglutamic acid) in suspect animal cases[11].

Environmental assessment

We observed the possible sites of animal infection, including grazing land and kraals. We mapped out all the kraals in Ombeniya village, identified communal grazing points, and observed both kraals and grazing points for evidence of remains of dead animals. We evaluated the carcass disposal methods on the grazing land. We also observed for the presence of human digging activities at points where sudden animal deaths had occurred.

Data analysis

We used Epi-info Version 7 for data analysis. Descriptive analysis was conducted by person, place and time and results were summarized using attack rates, an epidemic curve, and maps. To measure the associations between exposure variables and illness status, we estimated risk ratios (RR) and their 95% confidence intervals.

Ethical considerations

Approval to conduct this investigation was sought from the Ministry of Health of Uganda through the office of the Director General Health Services. The Division of Global Health Protection, Centers for Disease Control and Prevention determined that this investigation was not human subjects' research. Verbal consent was obtained from case-persons and other household members 18 years or older. For participants <18 years, we sought verbal assent after consent from their parents or guardians.

Results

Descriptive analysis

In total, 14 case-persons were identified by May 2018; none died. One case-person was confirmed by PCR. The mean age of the case-persons was 33 years (SD: 22). Persons aged ≥ 65 years were the most affected (AR: 27.8/10,000) followed by persons aged 14-64 years (AR: 7.4/10,000), and 5-13 years (AR: 2.8/10,000). The overall attack rate was 5.8 per 10,000. Only males were affected (AR: 11.9/10,000) (Table 1).

Of the 14 case-persons, 10 (73%) presented with itching of skin areas, eight (64%) had swelling or reddening of some areas of the skin, and eight (64%) had eschar formation (Figure 1). The outbreak lasted for 5 months, from January-May 2018. Cases peaked in February, stagnated in March and April, and sharply declined in May (Figure 3). There was at least one animal death every month except for February. One cow died in December 2017, 12 cows died in January 2018, one cow died in March, one goat died in April, and three cows died in May. Awuvu parish was more affected (AR: 31/10,000) compared to Eranva parish (AR: 2/10,000) (Figure 2). Thirteen cases were from one parish in Ombeniva village, while one case was from another parish, but had come to visit in Ombeniva village on 1 April, 2018 and fell ill on 25 April, 2018. Therefore, we decided to form the cohort from persons in Ombeniva village.

Retrospective cohort study findings

The cohort included all members of households in Ombeniva village in which at least one household member had contact with the carcass of or meat from an animal suspected to have died of anthrax (n=31). Skinning a dead animal (RR: 2.6, 95%CI 1.1-6.7), dissecting a dead animal (RR: 3.0, 95% CI 1.2-7.6), carrying a dead animal to a site for skinning and dissection (RR: 2.7, 95% CI 1.1-6.7), carrying already-dissected parts of a dead animal (RR: 2.9, 95%CI 1.3-6.5), and preparing and cooking meat from a dead animal (RR: 2.3, 95%CI 2.7-8.1) were all associated with infection (Table 2). All cohort members reported contact with soil.

Environmental assessment findings

Animal remains were found in the communal grazing land, which indicated possible death or slaughtering of animals within communal grazing areas. Animals were also reported to have died suddenly within the kraals and the communal grazing land. Digging activities are carried out near and

within the grazing land; however, this was not identified as a risk factor for cutaneous anthrax in this outbreak.

Laboratory findings

Among nine human skin lesion swabs collected, one (11%) tested positive for *B. anthracis* DNA by PCR at UVRI. All twelve blood samples were negative for *B. anthracis* by PCR at UVRI. All three hides from the implicated cows tested positive by the rapid diagnostic test for anthrax.

Discussion

Our epidemiological, environmental, and laboratory investigations revealed a cutaneous anthrax outbreak in Arua District, Uganda, associated with handling dead animals. Uganda has reported 14 anthrax outbreaks among humans previously in Western, Eastern, and West Nile regions where animal husbandry is a major source of income[10]; the most recent outbreak in West Nile Region occurred in Arua in 2017[10]. All documented anthrax outbreaks in humans in Uganda have occurred within areas with nomadic pastoralism and cattle-rearing (“the cattle corridor”), and have been mainly triggered by physical contact with sick animals through slaughtering, handling, and consumption of dead animals[10]. Since January 2016, an increase in animal movements from other districts within the cattle corridor into Arua District has occurred as ‘Balaalo’ herdsman have been evicted from their home areas and have brought their animals to graze and drink along the Albert Nile in Arua District [12]. It is believed that these herdsman have been moving from other areas known to be at high risk for anthrax, such as western Uganda and Karamoja regions where anthrax cases have been reported previously[10]. It is possible that there this movement led to an introduction or re-introduction of spores to Arua District through influx of infected animals into the area.

This outbreak was associated with a variety of exposures to dead animals or meat from animals suspected to have been infected with anthrax. Such exposures have frequently been associated with cutaneous anthrax, both in Uganda and elsewhere [13-15]. Although at least some in the community are aware of the dangers of handling or consuming animals that die ‘naturally’, poverty in the community may override decisions to forego meat after the financial loss of an animal [16]. Similar anthrax outbreak investigations in China and Bhutan have also suggested that persons in impoverished areas may be reluctant to discard dead animals, even if they have not been slaughtered in a way considered safe[17, 18].

The retrospective cohort analysis estimated that about 4 people with skin lesions were not exposed. An explanation to this would be in the retrospective cohort unexposed cutaneous anthrax cases serve as the comparison group. The unexposed cases with lesions provided an estimate of the baseline or expected amount of Cutaneous Anthrax occurrence in the community assuming the exposure was not there. From our findings the disease rate is substantively higher in the exposed group compared to the unexposed group, therefore contact with the carcasses of or meat from animals suspected to have died of anthrax was associated with Cutaneous Anthrax.

In our outbreak, only males were affected. Men are typically the primary persons involved in slaughtering, skinning, and carrying dissected parts of an animal in Uganda, as well as sometimes roasting meat, and are often more affected than women in similar outbreaks[19]. Children were least affected, likely due to their lack of a role in animal processing or cooking.

Although one patient had a positive PCR result from a skin lesion, blood samples from all 13 patients were negative for *B. anthracis* by PCR. The reason for this is unknown but is likely related to the fact that all patients had already undergone antibiotic treatment at the time of blood sample collection. In contrast, the skin lesion was the first sample sent for testing by the district health office to confirm the outbreak and came from a patient who had not yet initiated antibiotic treatment. A point-of-care test for anthrax could facilitate rapid diagnosis in the field; however, such a test is not yet commercially available.

Environmental assessment revealed that there were sudden animal deaths every month except February 2018, both within the kraals and on the grazing land. These deaths coincided with the outbreak among humans. It seems likely that slaughtering of these animals within the grazing land and the kraals, combined with failure to dispose of their carcasses, might have led to contamination of the grazing land and kraals with anthrax spores. This in turn might have facilitated further transmission as animals subsequently grazed the land during this period. This is a well-known mode of transmission [20][2].

Conclusions And Recommendations

Handling the carcasses of animals that died suddenly was associated with cutaneous anthrax outbreak. We recommended public education about safe disposal of carcasses of animals that die suddenly and consideration of vaccination of healthy animals against anthrax.

Abbreviations

AAD: Active Anthrax Detect AR: Attack Rate, CI: Confidence Interval, CHW: Community Health Worker, DRC: Democratic Republic of Congo, RR: Risk Ratio, PCR: Polymerase Chain Reaction, QGIS: Quantum Geographical Information System, SD: Standard Deviation

Declarations

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Competing interest

The authors declare that they have no competing interests.

Authors' contribution

VN took lead in the outbreak investigation, data collection, data analysis, report writing and manuscript writing. DE, participated in the outbreak investigation, data collection, analysis and manuscript writing under the supervision of ARA. The manuscript was reviewed for intellectual content and scientific integrity under the technical guidance and supervision of LB, DK, ARA and JH. All the co-authors have read and approved the final version of this manuscript.

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Tables

Table 1: Distribution of cutaneous anthrax case-persons by age and sex in Rhino-camp Sub-County, Arua District, and January-May 2018

Characteristic	N	Population	Attack rates/ 10,000
Sex			
Male	14	11,756	12
Female	0	12,235	0
Age (years)			
5-13	3	11,036	3
14-64	9	12,235	7
≥ 65	2	720	27

Table 2: Exposures associated with cutaneous anthrax presentation

Exposure	Exposed			Not Exposed			Risk Ratio	95% CI
	Cases	Total	AR (%)	Cases	Total	AR (%)		
Skinning dead animal	10	15	67%	4	16	25%	2.6	1.1-6.7
Dissecting dead animal	10	14	71%	4	17	23%	3.0	1.2-7.6
Carrying dead cow to site for skinning & dissection	10	15	67%	4	16	25%	2.7	1.1-6.7
Carried already dissected parts of dead animal	9	12	67%	5	19	25%	2.9	1.3-6.5
Preparation and cooking of dead meat	10	16	62%	4	15	27%	2.3	2.7-8.1

Figures

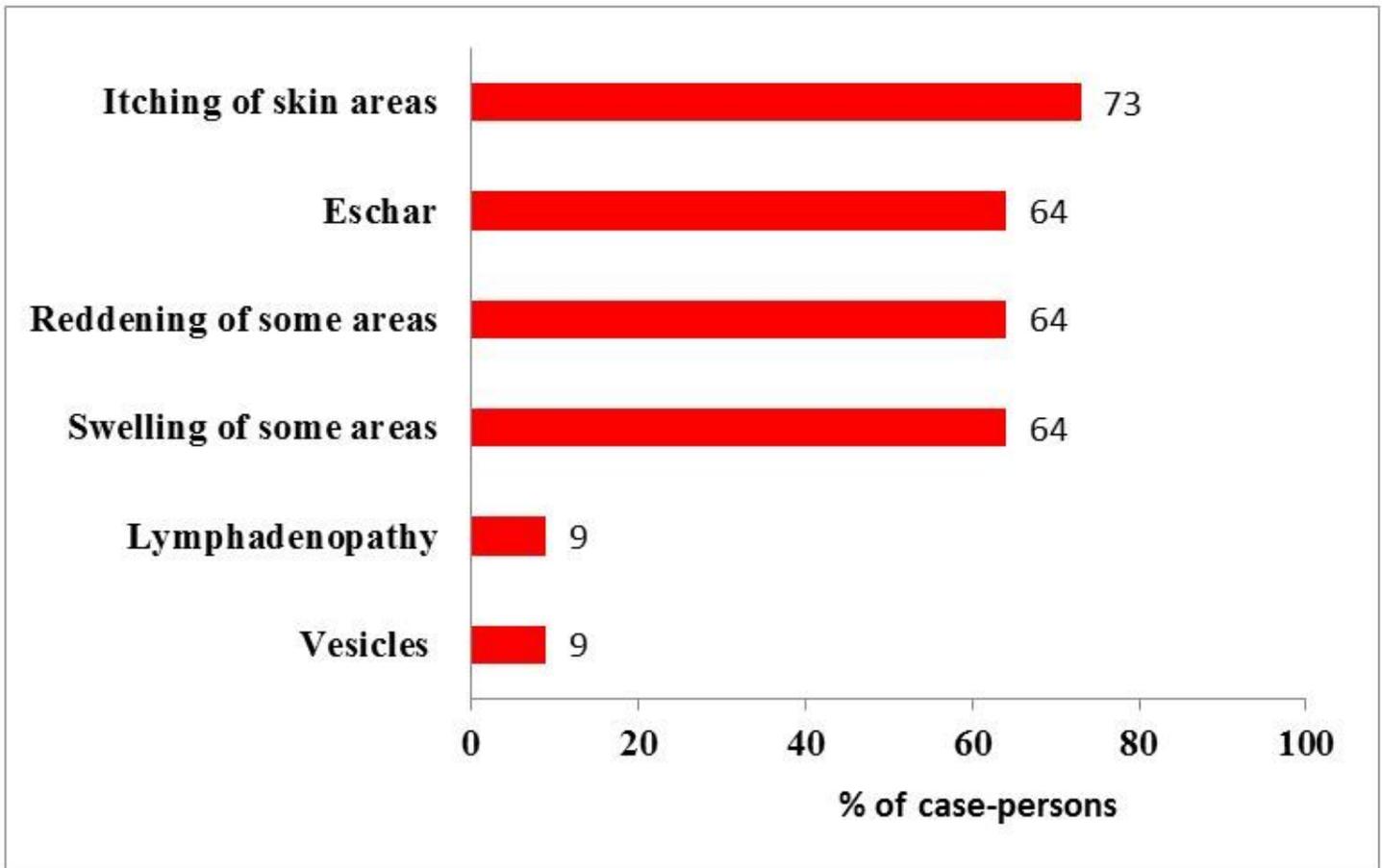


Figure 1

Distribution of signs and symptoms among 14 case-persons in Rhino Camp Sub-county, Arua District, Uganda, January-May, 2018.

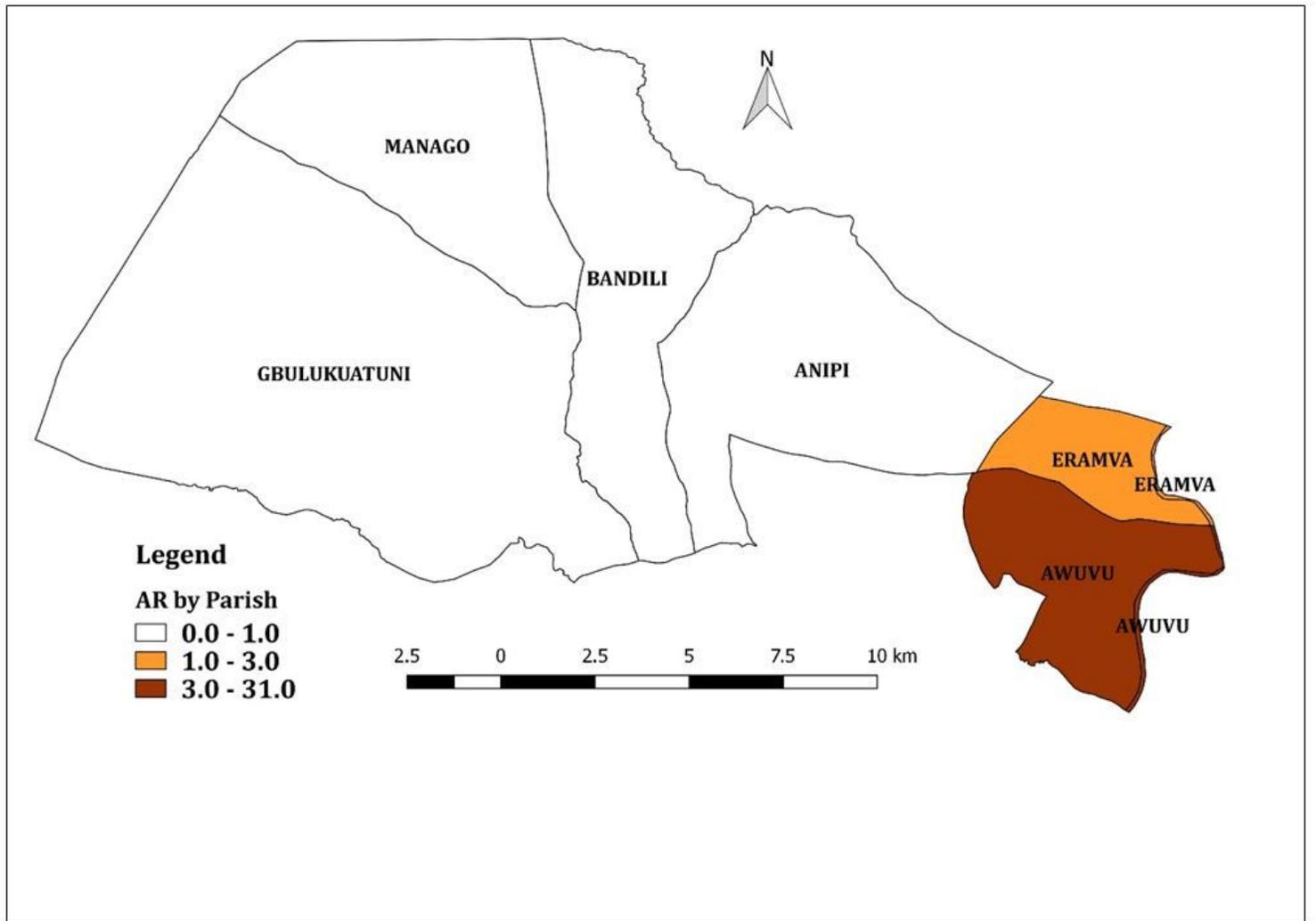


Figure 2

Parish attack rates per 100,000 persons in Rhino Camp, Arua District, Uganda, 2018.

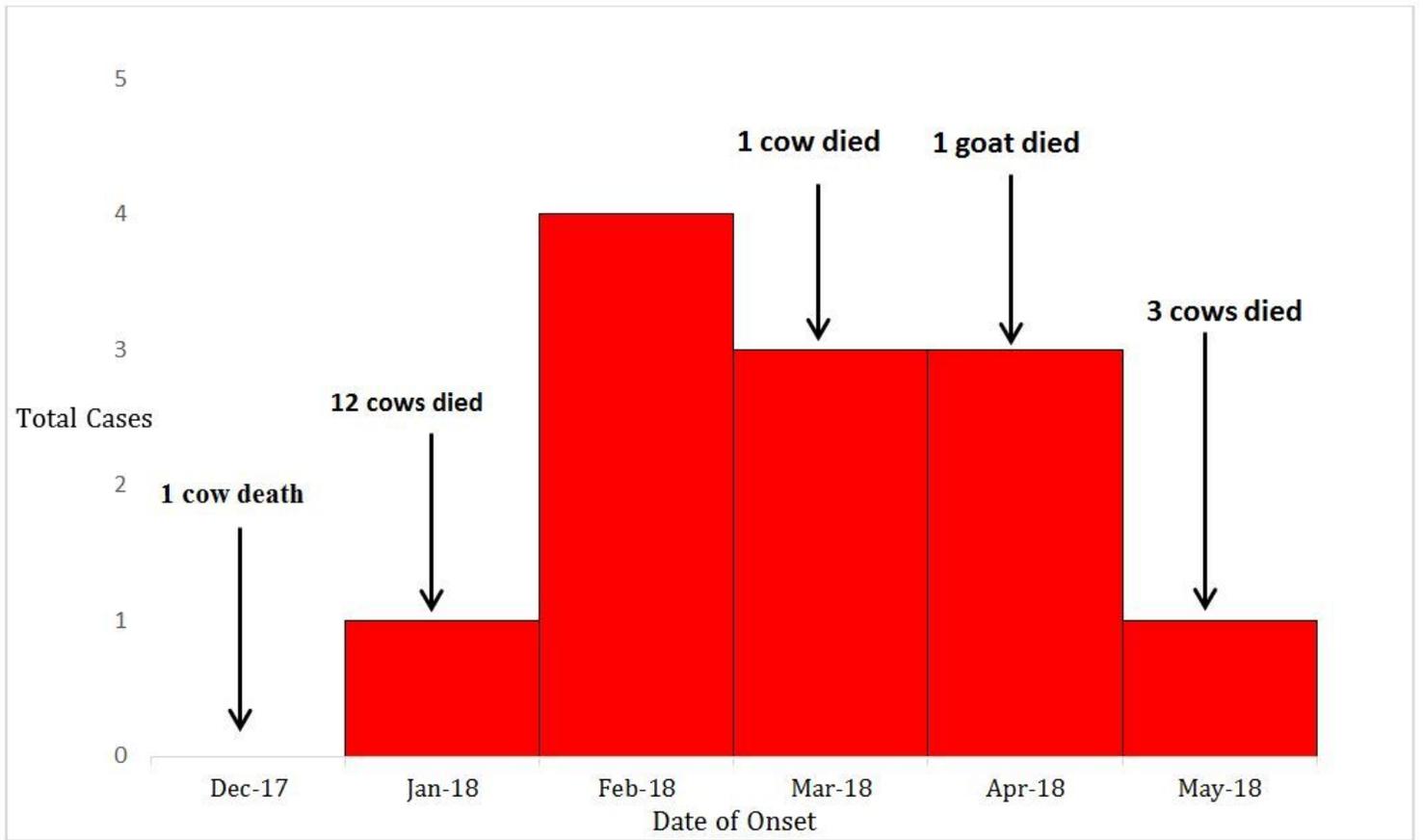


Figure 3

Epidemic curve of case-persons with cutaneous anthrax in Rhino Camp, Arua District, Uganda, 2018.