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The role of cultural practices that led to repeated anthrax outbreaks in Ikolomani Sub-County, Kakamega County, Kenya, June 2022

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Abstract

Introduction: *anthrax remains one of the important zoonotic diseases of public health concern in Kenya. Kakamega County has been experiencing recurrent outbreaks. In June 2022, anthrax outbreak was reported from Ikolomani sub-county where 4 people were affected after consumption of infected meat or participated in the handling of dead animals. We aimed at establishing the magnitude of the outbreak and assess health care workers understanding of the anthrax and collaboration with their counterparts in animal health.* ***Methods:*** *we conducted active case search and contact tracing to establish the magnitude of the outbreak. An online survey was administered to assess the health care worker´s knowledge on anthrax case detection, management and surveillance. We also collected skin lesion samples from suspected human cases for isolation of Bacillus anthracis. MS excel was used to clean and carry out descriptive statistics for continuous data and proportions for categorical variables. QGIS was used to construct spot maps for the distribution of probable/suspect cases.* ***Results:*** *a total of 24 persons who met the criteria for exposure definition, were traced and interviewed. Out of the 24 interviewed, eight were classified as suspect cases. From the eight suspect cases, five skin lesion samples were collected and one was confirmed positive by demonstrating B. anthracis spores from a pure colony. The overall attack rate was 33.3% (8/24). The males were 54.2% with an attack rate of 46.2%. The median age of the cases was 35 with an interquartile range (IQR) of 16 years. The most affected age group was 17-35 years (5/8) with an attack rate of 63%. Bushiangala village had the highest attack rate at 75%. The analysis of the occupation of those affected showed that farming was their main occupation at 46% (5/11). Fever was the common symptoms among all the suspected cases 24% (8/33) while 87.5% (7/33) had cutaneous lesions. Analysis of the route of exposure showed; multiple exposures 36% (15/42), consumption of infected meat 31% (31/42), participation in cooking 24% (10/42), and participation in burying of carcass 10% (4/42). The health care workers who responded to the online survey was 28 out of 54. Nurses were 46.43% (13/28), public health officers 25% (7/28), clinical officers 10.71% (3/28) and others 17.86% (5/28). Among the health care workers assessed 60.7% (17/28) knew the case definition for anthrax, 21.43% (6/28) did not know; 17.86% (5/28) were not sure.* ***Conclusion:*** *the main exposure was due to consumption of meat and handling of carcass suspected to have died of anthrax. There was low knowledge among the health care workers on anthrax detection and management.*

Introduction

Anthrax is one of the diseases of public health importance and is caused by gram-positive, rod-shaped, spore-forming bacteria (*Bacillus Anthracis*) [1,2]. Humans get affected when they consume or come into contact with infected meat or other animal products [3]. The *Bacillus* spores are also found naturally in contaminated soil, water, and pasture [2,4]. The spores get "activated" once they enter the body through ingestion, inhalation, or a cut on the skin [5]. Domestic and wildlife animals become infected when they inhale or ingest spores from contaminated soil, plants, or water [6,7] In animals, the disease is often associated with sudden death and may present as per-acute or acute infection. The common clinical signs observed are disorientation, ataxia, respiratory distress, and apoplectic seizures, followed by death. In most cases, the affected animals are in good body condition, and the carcass shows extensor rigidity of the limbs, bloating, and bleeding from the orifices [8].

Clinical disease in humans is classified into three forms depending on the route of entry, i.e., cutaneous, enteric, and inhalation, also known as the pulmonary form [9]. Cutaneous anthrax is characterised by an initially pruritic papule, which develops around vesicles. The arms, face, hand, and neck are the commonest parts of the body that are affected when the spores come into contact with cuts and abrasions, especially during slaughter and handling of a carcass of an animal suspected to have died of anthrax [10-13]. Even though it accounts for 95% of the cases, the cutaneous form is mild compared to the enteric and pulmonary forms. [1]. However, all three forms have the potential to progress to the septic form, which is fatal. Globally, the WHO estimates between 20,000 - 100,000 cases of human anthrax occur every year [3]. In the tropics where anthrax is endemic, animal outbreaks are characterised by sporadic cases occurring in irregular patterns [14,15]. Poorly drained soils with high moisture and low PH have also been documented as ecological drivers of outbreaks [16]. Outbreaks are less common in developed countries [10]. However, in the recent past, the anthrax organism has been propagated for biological warfare and bioterrorism, hence the potential for spread [2,17]. In Kenya, human and animal outbreaks have been reported in Nakuru, Meru, Muranga, Kisumu, and Narok counties [7,18]

Historical background on the recurrent outbreak: Kakamega County has been experiencing recurrent outbreaks over the past years. According to records at the County Disease Surveillance Unit, there was an outbreak which was reported from Khwisero in 2014, but the number affected was not confirmed. In 2019, an outbreak was reported in Ikolomani, where 23 human cases were recorded with two (2) confirmed deaths. The most recent outbreak was in March 2021 in Shinyalu sub-county, in which sixteen (16) human cases, including six deaths and sixteen (16) animal cases, were reported.

Recent outbreak that we investigated: on 7th June 2022, the first case of human infection was reported by a local administrator from Bushiangala village, Mukhongolo administrative unit, Idakho central ward in Ikolomani sub-county. The sick people were reported to have eaten meat from animals that died in the village. They all presented with blisters on the left hand, which later burst, forming wounds. The first four (4) cases participated in the slaughtering of an animal that had died and shown typical signs of anthrax, i.e., bloating and blood oozing out from all the natural body orifices. By Wednesday, 22nd June, 2022, a total of eight cases have been isolated, and the sub-county team also identified 43 persons who were exposed. The exposed either ate meat from the carcass or participated in slaughtering, skinning, or butchering of the dead animals. According to the acting director for public health, the local community believes that no meat should be thrown away, regardless of the cause of death of the animal. They also believed that even if meat from a dead animal is not eaten, the animal should not be thrown away with the hide or skin. Shibwe sub-county hospital was the health facility where all the cases were reported and treated. At first, the health care workers at the sub-county felt or thought they could not handle the cases, and they referred the first case to Kakamega County Referral hospital, but the patient was referred back to Shibwe, and they were advised to treat all the cases at the sub-county hospital. There was a rumour that one person had died of anthrax in Bushiangala village, but upon further investigation, it was found that the gentleman had been sick for quite a long time before he died, as he was suffering from cancer. However, it was not possible to establish whether he ate meat from the dead animals, even though his brother, who lived two homesteads away, lost two of his cattle to anthrax, which was later eaten by the villagers

The animal component of the outbreak investigation: the first case of animal death due to suspected anthrax was from Shinyalu sub-county in April, 2022. The vet in charge of the sub-county

collected samples from the dead animal (a sheep), which was later confirmed to be anthrax. On 27th May 2022, animal deaths were reported from Khwisero sub-county, and upon laboratory investigation, it was confirmed that the deaths were due to anthrax. The reports were made from Mushiangubu location, Kisa ward in Khwisero sub-county. The outbreak in Khwisero subsided after a week. On Tuesday 7th June, 2022, the sub-county veterinary office reported that they received a report of public panic and mass sale of livestock at Musoli livestock market in Ikolomani sub-county. On 8th June 2022, they received a report from the local administrator of livestock deaths. Upon visiting the area, they found 4 people who were sick and they had consumed meat from the dead animal some two weeks ago. In total six animals died since the onset of the outbreak. On 11th June 2022, the sub-county veterinary officer imposed a quarantine, which was still in force by the time of investigation. This investigation aimed to establish the magnitude of the outbreak and factors associated with the recurrent occurrences. In addition, health care workers understanding of the anthrax detection, case management and surveillance as well as collaboration with their counterparts in animal health was assessed.

Methods

Study area: we conducted the study in the rural villages of Mukhongolo administrative unit in Idakho Central Ward, Ikolomani sub-county in Kakamega County. Kakamega County is located in the Western part of Kenya and borders Vihiga County to the South, Siaya County to the West, Bungoma and Trans Nzoia Counties to the North and Nandi and Uasin Gishu Counties to the East. The County covers an area of 3,051.3 Km^2 and is the second populous county after Nairobi, with the largest rural population. Kakamega County had a total population of 1,867,579 people, of which 897,133 are males, 970,406 are females, and 40 are intersex persons. There are 433,207 households with an average size of 4.3 persons per household and a population density of 618 people per square kilometre. Ikolomani sub-county has an approximate area of 143.6 sq.km and a total population of 104,669. It has four wards Idakho East, Idakho Central, Idakho North and Idakho South (Figure 1). The major economic activity is small-scale farming. Residents produce tea, sugarcane, maize, and milk. The main challenge is poor infrastructure especially the rural roads, and poverty among the residents. The Kenya National Bureau of Statistics Report ranks Kakamega County among the poorest counties in the country. The poverty incidence for the county stands at 49.2%, and it contributes 4.8% of the national poverty [19]. It has a high potential for gold mining. Other activities are bull fighting, which is the main sport the area is known for.

Study design: we conducted an active case search, contact tracing, and retrospective review of records in health facilities with suspected anthrax cases within the sub-county to update the available line list. We assessed the health care workers' understanding of anthrax case detection, case management, surveillance, and reporting through a cross-sectional study.

Data collection

Active case search: we obtained an initial line list of suspected cases as well as their contacts, mainly the family members, from the sub-county surveillance officer. We also visited the health facilities at the sub-county level and updated the line list using the developed case definition. We used Kobocollect to collect data on suspect cases in the line list and their contacts. We began the active case search by identifying the home from which the index case was reported. We then interviewed the family members. Through snowballing, the family members informed the investigation team of other people in the village who came into contact with the infected carcass either by handling while cooking of meat, consumption of meat, slaughtering, touching blood and other fluids, and disposal of waste. We collected information on demographics, clinical and exposure as well as treatment outcome.

A human suspected case definition: was defined as an acute illness with a painless skin lesion developing over 1 to 7 days with or without oedema, fever, malaise and lymphadenopathy in a person of any age residing in Mukhongolo administrative unit following contact with infected meat or fluids, consumption of meat or participating in slaughter of a dead cow since 1st May 2022.

Probable case definition: any person who meets the suspect case definition and has an epidemiological link with a confirmed case. Epidemiological link in this case was the slaughter of an animal that is suspected to have died of anthrax, similar to the one slaughtered by a confirmed case.

Confirmed case: a suspected case with a positive gram stain for *B. anthracis* from a clinical sample (swabs from skin lesion).

Case definition for animals: a suspected case was defined as: report of a sudden death of animals (cattle, sheep, and goats) with or without tarry coloured and unclotted blood oozing from body orifices in Ikolomani sub-county since 1st May 2022.

Exposure definition: we defined contacts as persons who have a history of coming into contact with a suspected anthrax animal since 1st May 2022. Type of contact included the following: slaughtering, skinning, cutting into small pieces (butchering), cooking, consumption, burying, sleeping on the skin, being close to where the animal is being killed or any other contact with suspected anthrax animal or its products.

Laboratory investigation: we collected 5 samples, swabs from skin lesions from suspected human anthrax cases, and transported the samples to the University of Nairobi Institute of Tropical and Infectious Diseases (UNITID) in Nairobi for laboratory analysis. The samples were inoculated onto both blood and nutrient agar. Bacteria were then cultured on anthrax blood agar. Then from pure colonies, gram staining was done for all five samples.

Assessment of healthcare workers´ knowledge on anthrax and collaboration with animal health: we used an online survey, which was administered to selected healthcare workers (clinicians) who worked at the outpatient department in various health facilities within Ikolomani sub-county. The information that was collected included a cadre of health care workers, knowledge on anthrax case definition, testing and treatment, knowledge on the different forms of human anthrax, and collaboration with animal health officers in surveillance.

Data analysis

Active case search and contact tracing: we used Microsoft Excel to construct an epidemic curve showing date of exposure, date of onset of the illness, and the counts of cases (probable and suspected). The X-axis had the dates of onset and the Y-axis had the counts of cases. The total number of those exposed was determined, and we calculated the attack rate where the numerator was the number of cases and the denominator was the total exposed (number at risk). Measures of central tendency (median age), and dispersion (range) was calculated for continuous variables and proportions were calculated for categorical data. Quantum geographic information system (QGIS) was used to construct spot maps for the distribution of suspected cases.

Assessment of health care workers´ knowledge on anthrax: we used MS Excel to calculate the proportions of health care workers´ cadre (the numerator is the number of various cadres, and the denominator is the total number of HCWs interviewed). Those who came across the anthrax case in the last 6 months and those who had an understanding of the anthrax case definition (the numerator is the number the HCWs who responded affirmatively to the question, and the denominator is the total number who were interviewed).

Ethical consideration and consent to participate: the outbreak investigation, being part of an urgent public health response to an epidemic, the Kenya Ministry of Health approved the study as a non-research study not requiring approval by any institutional review board or ethical committee. However, verbal informed consent was sought from all participants, including parents/legal guardians for those aged less than 18 years. The interview tool was mobile-based, and the first question, after the introduction and consent process, was whether the participant gave consent to proceed. If the answer to the question was "no" the interview ended there.

Results

Demographic and clinical characteristics of cases: a total of 24 persons who met the criteria for exposure definition; they either handled or ate meat from an animal that died from suspected anthrax, were traced and interviewed. Out of the 24 interviewed, eight were classified as suspect cases (they had at least one clinical symptom for suspected anthrax). From the eight suspect cases, five skin lesion samples were collected, and one sample was confirmed by demonstrating *B. anthracis* spores from a pure colony. The overall attack rate was 33.3% (8/24). The males were 54.2% with an attack rate of 46.2%. The median age of the cases was 35 with an interquartile range (IQR) of 16 years. The most affected age group was 17-35 years (5/8) with an attack rate of 63%. Bushiangala village had the highest attack rate at 75%. The analysis of the occupation of those affected showed that farming was their main occupation at 46% (5/11) (Table 1). Fever was the common symptom among all the suspected cases, 24% (8/33), while 87.5% (7/33) had cutaneous lesions (Figure 2). The first animal death was reported on May 21, 2022, the second on May 24, and the third on 1st June 2022, while the first human case was on May 30, 2022, and the last human case was on 20th June 2022 (Figure 3).

Exposure factors: analysis of route of exposure showed that 36% was through multiple routes of exposure (skinning, gutting, butchering, transportation and handling of carcasses), 31% was through consumption of meat from a suspected anthrax animal, 24% was due participation in cooking of meat from suspected animal and 10% due to participation in burying of an animal that died as a result of suspected anthrax (Table 2).

Health care workers´ assessment of knowledge of anthrax and community sensitization: the proportion of HCWs who responded to the online survey was 51.85% (28/54). Of the total who responded, nurses were 46.43% (13/28), public health officers 25% (7/28), clinical officers 10.71% (3/28), and others 17.86% (5/28) (Table 3). Among the health care workers assessed, 60.7% (17/28) knew the case definition for anthrax, 21.43% (6/28) did not know the case definition, while 17.86% (5/28) were not sure (Figure 4).

Discussion

We report an outbreak of a suspected anthrax in rural villages of Mukhongolo administrative unit in Idakho central ward of Ikolomani sub-county of Kakamega county where a total of eight suspected cases were isolated, who met the suspect case definition from 24 who were traced and interviewed, with an attack rate of 33.3%. This finding is contrary to a similar study in Kisumu by Mugo and others, which reported an attack rate of 43.4% [20]. The majority of those exposed, 67% came from Ibundabu village, but Bushiangala village had the highest attack rate of 75%. Bushiangala is also the same place where the first case of animal death was reported from, and it is the epicentre of the outbreak. The index human case was also from the same village. Three animals were reported to have died within a span of two weeks in neighbouring homesteads in Bushiangala village. From the epi-curve, the first animal death was on May 21, 2022 while the second was on May 25, 2022 and the third on June 1, 2022. The

outbreak in animals seems to have started and ended in slightly less than two weeks. The first human case was reported on June 1, 2022. The period from the time of exposure to the development of symptoms for the first human case was 11 days from the date of death of the first animal and 7 days from the date of death of the second animal. Given the average incubation period of 3-7 days for anthrax, the second animal could have been the source of exposure for the index case [21]. The human outbreak took three weeks from May 30th, 2022 to June 20, 2022.

This study also revealed that the cutaneous form of human anthrax was the most common, since 87.5% of the suspected cases had cutaneous lesions. This could be because almost all the cases participated in the slaughter, skinning, or butchering of the suspected animal, and they either had wounds or scratches on their hands prior to handling the carcass, or they got injured in the process of slaughter. Mostly a prick from bone splinters. Of importance to note is that all 7 cases that had cutaneous lesions on their forelimbs had them on the left hand. This may be explained by the fact that all the cases where may be right-handed, and therefore they were holding the knife or whichever tool that they were using during skinning or slaughter by their right hand leaving the left hand to hold the bone, skin or pieces of meat as they were working on the carcass. Thus, we hypothesise that the injuries or breaks to the skin may have occurred during slaughter. The break in the skin barrier facilitated the entry of anthrax spores into the body, and the resulting pathogenesis led to the cutaneous lesions. This finding is consistent with the study by Bengis *et al*. and Doganay *et al*. [1,10].

The distribution of males and females amongst those exposed were 54% and 45% respectively. This study shows that more males are exposed that females and that is also reflected in the attack rates, where the attack rate for males is higher 46.2% as compared to that of females 18.2%. This shows that the attack rate for males are 2.5 times higher than that of females. This is explained by the fact that in most cases males are the one involved in the activity of slaughtering and handling or burying of carcasses among the Idakho community, which exposes them to risk of contracting anthrax. This finding has been documented in similar investigations [11]. This study found that farmers were most affected because of their closeness to and handling of animals and their products, and this finding is also consistent with the study by Savransky [20].

The majority of those exposed, 36% had mixed routes of transmission; they either skinned, slaughtered/butchered, transported, or handled meat from an infected animal and 31% ate meat from a carcass of an animal suspected to have died of anthrax. The mixed route of exposure seems to be the main route. It is the cultural practice among the Idakho and Isukha people who are the inhabitants of the Mukhongolo administrative unit, to slaughter and eat meat from a dead animal regardless of the cause of death. They also believed that if one buried a dead animal without skinning, he or she will never keep an animal in the future. Such beliefs and practices may be the main drivers for recurrent outbreaks in the area, since the environment remains contaminated with anthrax spores. The act of skinning and handling of carcass of an animal that is already infected with anthrax increases the chances of one contracting anthrax, especially the cutaneous form. In addition, the chances of contaminating the environment in the process are very high. In the absence of proper decontamination, the environment remains contaminated with *Bacillus anthracis* spores for a long period of time, leading to recurrent outbreaks among the livestock population in the same area.

This finding is in agreement with three studies done in Uganda and another in eastern china that linked cutaneous anthrax with eating of meat or handling of carcasses from a suspected anthrax animal [11,22-24]. This study also found that health care worker´s knowledge on case detection was low. Only 60.7% of those who responded to

the online survey knew the case definition for anthrax. This leads to a low suspicion index and poor management of clinical cases. From the health facility records, most cases were diagnosed as cellulitis, and this is a potential risk to the health care workers themselves, as they could expose themselves to anthrax without knowing. This is in agreement with a study on knowledge among health care workers on zoonotic diseases in Western Uganda, particularly on anthrax and Ebola [25]. Nurses formed the majority, 46.43% of those interviewed. This is maybe because most of those peripheral health facilities are manned by nurses who act as clinicians attending to patients at the outpatient departments. There was very little collaboration between the human and animal health officers in the surveillance and reporting of anthrax. This affected the management of the outbreak of anthrax because of the delay in reporting, and thus the enforcement of control and prevention measures.

Conclusion

The cutaneous form of anthrax was the most common among the human cases. The main exposure was due to the consumption of meat and handling of carcasses suspected of having died of anthrax. A cultural practice associated with the repeated anthrax outbreaks. There was low knowledge among the healthcare workers on anthrax detection and management. Their understanding of the case definition for anthrax was limited.

What is known about this topic

- *Anthrax is a zoonotic disease that is a priority disease in Kenya;*
- *In most cases it occurs as outbreaks and humans get infected by eating contaminated meat from animals that have died of suspected anthrax;*
- *The Bacillus anthracis spores remain in the environment for years in the absence of proper decontamination.*

What this study adds

- *The role of cultural practices among the local community that contributed to recurrent outbreak has not been documented and the fact that the outbreak was never reported in time due to poor knowledge among the health care workers and their collaboration with animal health counterparts (One Health approach) in disease detection and reporting is what the study is highlighting.*

Competing interests

The authors declare no competing interests.

Authors' contributions

Conceptualization and design: Boku Bodha. Formal analysis: Boku Bodha, Nassoro Mwanyalu. Investigation: Boku Bodha, Nasoro Mwanyalu, Zephania Irura, Benjamin Kandie. Methodology: Boku Bodha, Mathew Mutiiria, Athman Mwatondo. Supervision: Maurice Owiny. Validation: Maurice Owiny. Writing original draft: Boku Bodha. All the authors have read and agreed to the final version of this manuscript.

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Tables and figures

Table 1: distribution of cases, social demographics: village, age, occupation, gender - specific attack rates for anthrax in Ikolomani sub-county, Kakamega County, June 2022

Table 2: routes of exposure for the suspected cases in Ikolomani sub-county, Kakamega County, June 2022 (N=42)

Table 3: cadre of health care workers interviewed in Ikolomani sub-county, Kakamega County, June 2022 (N=28)

Figure 1: Idakho Central Ward in Ikolomani sub-county, where cases were reported from

Figure 2: signs and symptoms for the suspected human cases in Ikolomani sub-county, Kakmega County, June 2022 (N=33)

Figure 3: epi curve showing date of exposure and onset of symptoms against the number of human cases, Ikolomani sub-county, Kakamega County, June 2022

Figure 4: assessment of HCWs understanding of anthrax case definition in Ikolomani sub-county, Kakamega County, June 2022 (N=28)

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Table 1: distribution of cases, social demographics: village, age, occupation, gender - specific attack rates for anthrax in Ikolomani sub-county, Kakamega County, June 2022 N=24

Key variables	Frequency of at-risk	Proportion (%)	Frequency of cases	Attack rates (%)
Age group				
5-12	5	20.8	0	0
13-16	2	8.3	0	0
17-35	8	33.3	5	63
36-64	8	33.3	3	37.5
>64	1	4.2	0	0
Gender				
Female	11	45.8	2	18.2
Male	13	54.2	6	46.2
Residence				
Ibundabu	16	66.7	2	12.5
Bukhabili	3	12.5	2	66.7
Bushiangala	4	16.7	3	75
Shikanganya	1	4.2	1	100
Occupation				
Farmer	11	45.8	5	45.5
Herder	1	4.2	0	0
Mineworker	2	8.3	1	50
Student	5	20.8	0	0
Self-employed	4	16.7	1	25
Welder	1	4.2	1	100

Table 2: routes of exposure for the suspected cases in Ikolomani sub-county, Kakamega County, June 2022 (N=42)		
Route of exposure	**Frequency**	**Proportion**
Multiple exposures: slaughter, transportation, handling	15	36
Consumption of meat from a dead animal	13	31
Cooked meat from a suspected anthrax animal	10	24
Participated in burying a dead animal	4	10
Total	42	100

Table 3: cadre of health care workers interviewed in Ikolomani Sub-County, Kakamega County, June 2022 (N=28)		
Cadre	Frequency	Proportion (%)
Nurse	13	46.43
Clinical officer	3	10.71
Public health officer	7	25.00
Others	5	17.86
Total	28	100

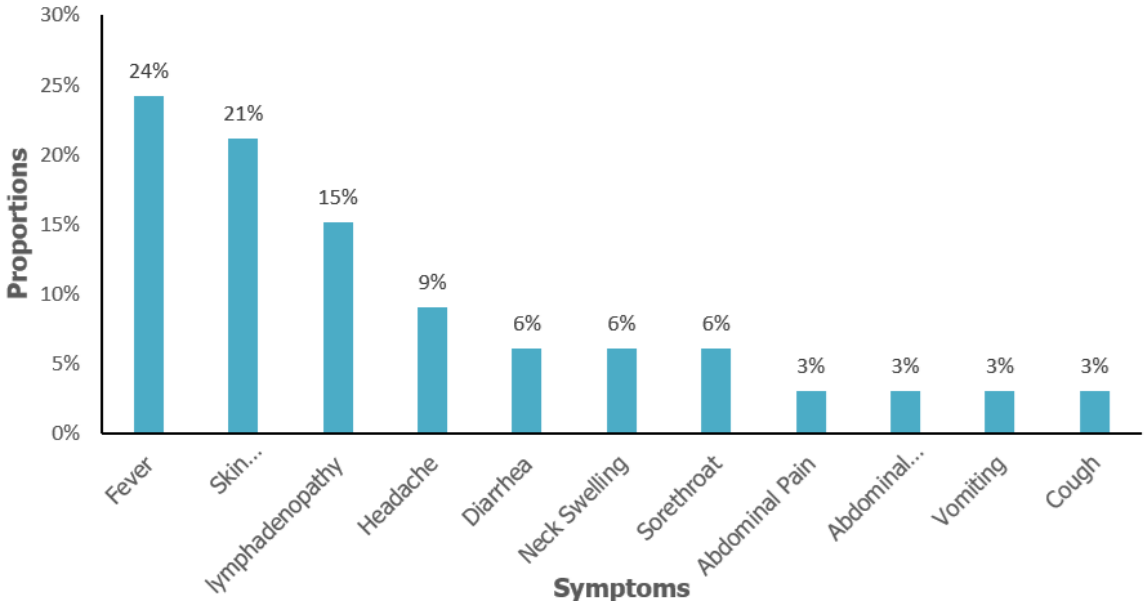

Figure 2: signs and symptoms for the suspected human cases in Ikolomani sub-county, Kakmega County, June 2022 (N=33)

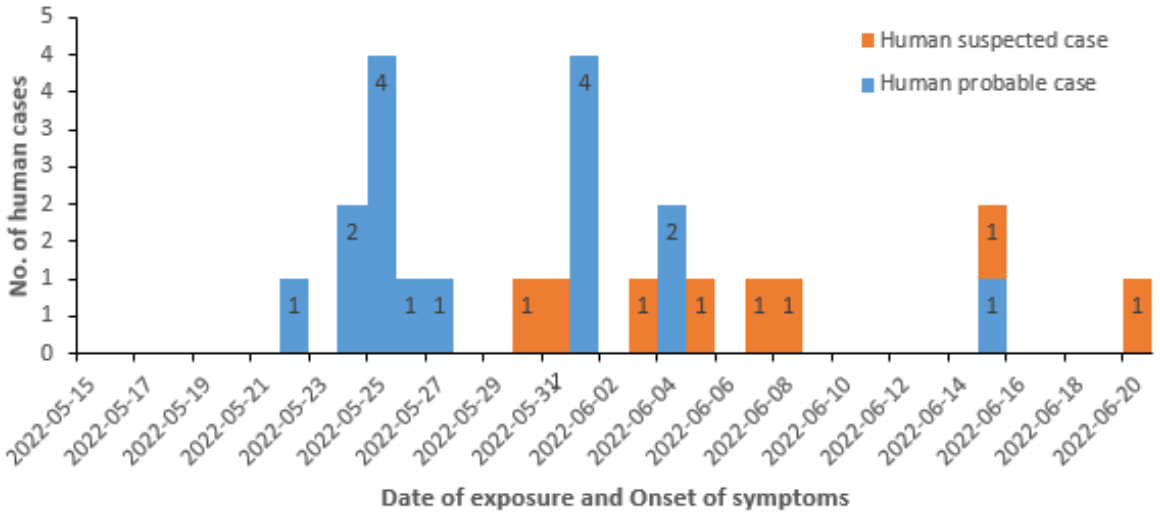

Figure 3: epi curve showing date of exposure and onset of symptoms against the number of human cases, Ikolomani sub-county, Kakamega County, June 2022

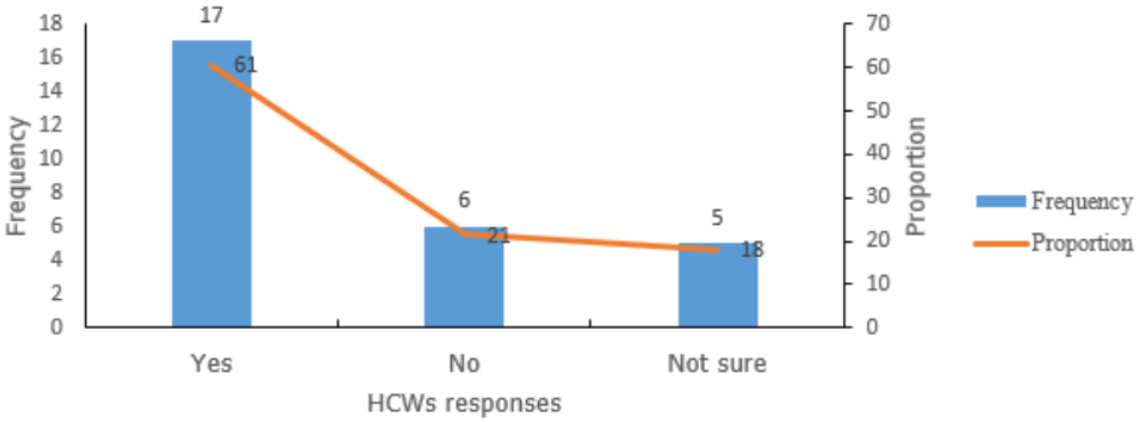

Figure 4: assessment of HCWs understanding of anthrax case definition in Ikolomani sub-county, Kakamega County, June 2022 (N=28)