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Dear Reader,

We take great pleasure in welcoming you to Issue 1 Volume 9 of the Uganda Public Health Bulletin.

We aim to inform the district, national, and global stakeholders on disease outbreak investigations, public health surveillance, and interventions undertaken in detecting, preventing, and responding to public health events in Uganda.

In this issue, we present a variety of articles including; Food poisoning, Rotavirus outbreak, Role of illegal meat dealers in anthrax outbreaks in Western Uganda, Anthrax outbreak in Kyotera, Cholera outbreaks in Namayingo and Kayunga, Measles outbreaks in Kiryandongo and Bundibugyo, Rift Valley Fever outbreak in Nakaseke, Trends in uptake of tuberculosis preventive therapy in Uganda, Switching from Rotarix to Rotasiil rotavirus vaccine, Yellow fever preventive mass vaccination campaign-phase 2, and several upcoming world public health awareness events.

Should you have any questions or require additional information related to articles in this bulletin please contact us on:

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We hope you find this information valuable and we shall appreciate any feedback from you.

Thank you

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Food Poisoning Outbreak caused by *Bacillus Cereus* at a Secondary School in Mukono District, Uganda, July 2023

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Summary

Introduction: *Bacillus cereus* is a foodborne bacterial pathogen that causes abdominal pain and diarrhoea; incubation is typically 4-16 hours. On July 20, 2023, the Ministry of Health was notified of a suspected food poisoning outbreak at a secondary school in Mukono District, Uganda, following an alert about students with sudden-onset abdominal pain and diarrhoea. We investigated the incident and recommended control measures.

Methods: We defined a case as 'sudden onset of abdominal pain, diarrhoea or vomiting in a student or staff member at the school' from July 19–20, 2023. We found cases by reviewing school and health facility records and created a line-list. We subjected cases to a questionnaire and conducted descriptive epidemiology and environmental assessments. We tested our hypothesis in a cohort of all boarding students.

Findings: Among 267 cases (all students), 13% were commuters and 87% were boarders. The most common symptoms included abdominal pain (100%), diarrhoea (92%), and vomiting (16%). The epidemic curve indicated a point-source outbreak with onsets occurring 6-36 hours after eating school lunch or dinner. Posho and beans from the same bags were cooked and consumed on preceding days with no illness reported, suggesting that the food was contaminated during preparation on that day. Nearly all 299 cohort members ate the food for lunch and/or dinner on July 19. Zero (0%) of the 4 students who ate neither meal and 229 (78%) of 295 students who ate the school lunch and/or dinner and became ill (RR=0.13; 95% CI 0.01-1.8). Attack rates were 90% for those who ate only lunch, 77% only dinner and 78% who ate both. *Bacillus cereus* was isolated from leftover samples of the cooked food.

Conclusion: This was a point-source outbreak caused by *Bacillus cereus* in food cooked at school; mechanism of contamination was unknown. Proper food handling, preparation, and storage were emphasized to prevent repeat occurrences.

Background

Food poisoning is a common public health problem that can cause serious illness or even death. According to the World Health Organization, food poisoning affects an estimated 600 million people and kills 420,000 people every year (1).

Food poisoning can be caused by various biological, chemical, or physical agents that contaminate food during production, processing, distribution, or preparation. Some of the common symptoms of food poisoning include nausea, vomiting, diarrhea, abdominal cramps, fever, and headache(2).

In Africa, several outbreaks of food poisoning have been documented and it is estimated that 92 million people suffer from food poisoning after consuming contaminated foods resulting in 137 000 deaths each year.(3,4) The most common food poisoning causes are bacteria such as *Salmonella*, *Escherichia coli*, *Staphylococcus aureus* and *Bacillus cereus*(5). These bacteria can be found in foods such as meat, eggs, dairy products, and vegetables.

In Uganda, food poisoning is a major public health concern that affects many people every year. In 2019, deaths due to food poisoning by alkaloids and outbreaks of food poisoning by chemical agents were reported in Uganda (6,7) . Some of the risk factors for food poisoning in Uganda include poor hygiene practices, inadequate cooking methods, improper storage conditions, and lack of awareness among consumers (8).

On Thursday, July 20th, 2023, the Ministry of Health was notified of a suspected food poisoning outbreak at a secondary school in Mukono district, Uganda. The alert followed several students from the school complaining of a sudden onset of abdominal pain and diarrhoea. The school comprises of day and boarding sections with approximately 300 students in the boarding section many of whom developed symptoms suggestive of food poisoning and were evacuated to the nearby health facilities for treatment.

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We investigated to determine the scope, cause, risk factors for the outbreak and provide recommendations for remedial action.

Methods

Outbreak location

The investigation took place at the secondary school in Mukono District where the outbreak took place (Figure 1). The school is comprised of both boarding and day sections with a population of approximately 300 boarding students and 900 day scholars (commuters) respectively.

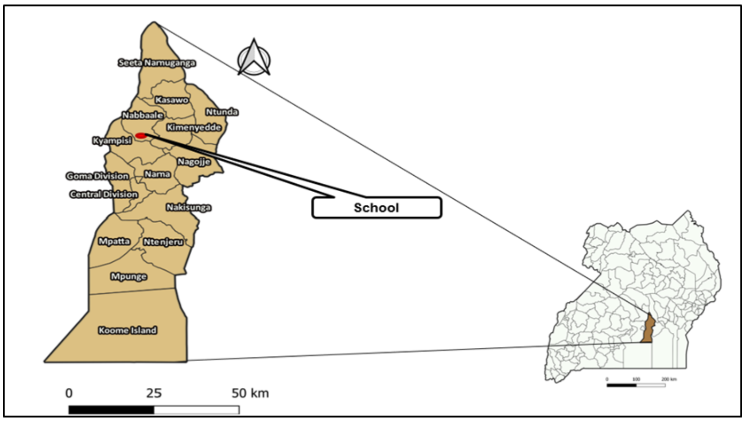

Figure 1: Location of the school at which the food poisoning outbreak occurred, Nabbale Sub-county, Mukono District, Uganda, July 2023

Case definition and finding

We defined a suspected case as *sudden onset of abdominal pain, diarrhoea or vomiting in a student or staff member at the school' from July 19–20, 2023.*

We found cases using records of sick children from both the school and the health facilities to which the students were evacuated and generated a line-list. A case investigation form was administered to case-patients on the line-list. The case investigation form included questions about demographic and clinical characteristics of the cases including age, sex, class, scholar type, date and time of symptom onset and gastrointestinal symptoms.

Descriptive analysis

We described case-patients by time using an epidemiologic curve and by person using attack rates by class, dormitory, and sex.

Laboratory Investigations

Samples both clinical (10 stool and 52 blood) and non-clinical (cooked beans and posho from the kitchen; flour, water, cooking oil, tomatoes from the food stores; and collard greens from the garden) were collected for laboratory testing. Clinical samples including stool and blood were taken from students while non-clinical samples were taken from the food stores, kitchen, and the vegetable garden.

Environmental assessment

We did this using both direct observation and interviews with the food handlers. We explored the food supply, storage facilities, preparation and the water source. We directly observed the process of food preparation, storage, and distribution at the school in order to identify possible sources of contamination. We inspected the reservoirs from which the students get their water in order to determine possible sources of contamination. We interviewed the food handlers about how, when, and from where they obtain the food, how it is prepared, how it is served, and stored also to assess for any possible risks for contamination

Hypothesis generation

Using a structured questionnaire, we interviewed 93 case-persons to generate a hypothesis. We asked questions about possible exposures such as food, snacks, and drink the cases had been exposed to on the day of the outbreak and quantified the exposure to each of these.

Retrospective cohort study

To test the hypotheses, a cohort consisting of all boarding school students was constructed. This was because the day scholars had been temporarily sent home pending investigation into the outbreak. A structured electronic questionnaire was administered to all members of the cohort in order to assess exposure and outcomes of interest which were symptoms of food poisoning constituting the case definition. Risk ratios were calculated.

Ethical considerations

We conducted this study in response to a public health emergency and as such was determined to be non-research. The MoH authorized this study and the office of the Center for Global Health, US Center for Disease Control and Prevention determined that this activity was not human subject research and with its primary intent being for public health practice or disease con-

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trol. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy. §

§See e.g., 45 C.F.R. part 46, 21 C.F.R. part 56; 42 U.S.C. §241(d); 5 U.S.C. §552a; 44 U.S.C. §3501 et seq.

We obtained permission to conduct the investigation from the Mukono District health authorities and the school administration in whose custody all the students were. We obtained verbal consent from all the respondents aged ≥18 years. For those aged <18 years, we obtained consent from the school administration and assent from the respondents. Participants were assured that their participation was voluntary and that there would be no negative consequences for declining to participate in the investigation. Data collected did not contain any individual personal identifiers and information was stored in password-protected computers, which were inaccessible by anyone outside the investigation team.

Results

Descriptive epidemiology

Of the 267 cases listed, 233(87%) were boarders and the rest were commuters. The most common symptom reported was abdominal pain among all (100%) of the cases followed by diarrhoea among 247 (92%) while vomiting was rare, among only 43(16%) of the cases

Females were more affected (Attack rate=85%) than males (Attack rate=64%).

The attack rates varied by class: with S4 having the highest (84%), S5(83%), S2(80%), S3(80%), S1(74%), and S6(53%). The attack rates also varied by dormitory with the three girls' dormitories having attack rates of 76%, 63%, and 56% while the two boys' dormitories had attack rates of 62% and 42%.

There was a rapid rise in the number of cases to a peak within twelve hours, and then a gradual fall over eighteen hours (Figure 2).

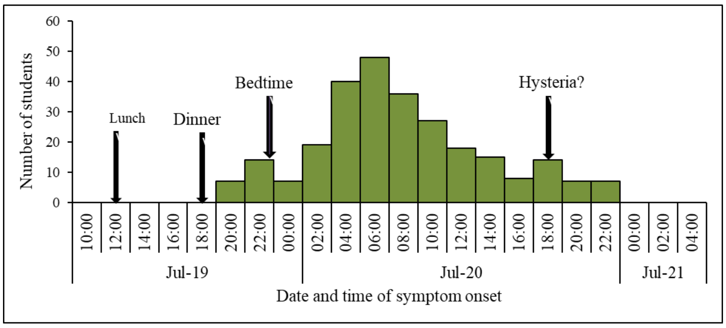

Figure 2: Distribution of case-patients by date of symptom onset during a food poisoning outbreak caused by Bacillus Cereus at a secondary school in Mukono District, Uganda, July 2023

Environmental assessment findings

Food supply: The school stocks food every two weeks from one supplier who also supplies the neighbouring school and community. Existing stock had been consumed for several days prior to the outbreak with no illness events occurring. Food cooked on the day of the outbreak was from same sacks as that cooked on previous days still with no illness events occurring on those days.

Food storage: The food store was a small dark room with no ceiling, no windows, and no ventilation system. The sacks of posho are kept on pallets on the floor while the sacks of beans sit directly on a cemented floor. The kitchen is more open with adequate ventilation but with mud floors and bare mud bricks comprising the walls. Trace-back for the flour was deemed unnecessary given that the same batch of flour had been used in the previous days with no incident. The fact that there were no similar incidents reported in the neighbouring school and surrounding community which use flour from the same supplier further negated the usefulness of a trace-back.

Food preparation: Posho and beans were cooked daily in one go and eaten at both lunch and dinner. Food preparation starts at 2.00am in the morning of each day with the preparation of posho. When the posho is ready, the beans are boiled by the same cooks until 5.00am. At 8.00am, the raw vegetables are added depending on what is available. The food is then left on low heat throughout the day until lunch time when the first portion is served. What remains is then left on low heat until dinner time when they are consumed. According to the cooks, the food eaten on the day of symptom onset was prepared in the same way that food is normally prepared. There was no deviation from the norm.

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Water source: Water is pumped from a protected deep well located about 1 kilometer away from the school. During pumping, it passes through a water purification system from which it is then distributed. The same water is used daily by three populations i.e. the secondary school, a neighbouring primary school and the community. There were no reports of related illness in the latter two.

Laboratory findings

Among the samples taken for lab testing: all stool samples were negative for parasites and bacteria. All blood samples were negative for pesticides, metals and aflatoxins. The tap water and vegetables tested negative for bacterial growth. Samples of left over posho and beans tested positive for ***Bacillus cereus***.

Hypothesis generation

We explored possible risk factors including all food and drink consumed by the cases on that day (Table 2).

Table 2: Proportion of cases exposed to possible risk factor during the food poisoning outbreak at a secondary school in Mukono District, July 2023

Exposure characteristic	Percentage exposed
Ate school food (posho &beans) -at least one meal on 19th July 2023	97%
Drank school water	100%
Took tea at either lunch or dinner	42%
Ate Snacks from canteen (cassava, donuts, etc.)	11%
Added flavoring ('appetizer') to their food	8%

Based on the table, the exposures of interest were food (posho & beans) eaten and water drunk. However, based on the environmental assessment, water was ruled out as the exposure since there were no reports of illness from the other consumers of the same water. We therefore hypothesized that food (posho and beans) consumed by the students on the 19th of July 2023 was responsible for the outbreak.

Retrospective Cohort Study

We constructed a cohort consisting of 299 boarding students. Among the cohort, 295(99%) had had at least one meal of posho and beans and of these, 229(78%) got sick. Among the 4(1%) that did not eat any meal, none got sick. We calculated the risk based on the exposure to food and stratified by number of meals eaten in order to assess for a dose response. The risk ratios did not vary significantly across strata likely due to the small numbers in some of the groups (Table 3).

Table 3: Level of risk among those who ate meals of posho and beans compared to those who did not prior to the food poisoning outbreak at a secondary school in Mukono District, July 2023

Exposure	Sick	Not sick	Total	RR	95%CI
Did not eat	0	4	4	0.13	0.01-1.8
Ate lunch only	4	1	5	1.03	0.67-1.6
Ate dinner only	51	15	66	0.99	0.86-1.2
Ate lunch + dinner	174	50	224	Ref	
Total	229	70	299		

Discussion

This was a point-source outbreak of food poisoning by *Bacillus cereus,* the source of which was undetermined. The outbreak presented as a diarrhoeal illness and there were no deaths. The food cooked on the day of the outbreak was from the same bags as that cooked on previous days where no illness events were reported, suggesting that contamination of the food occurred during preparation. Having at least one meal of posho and beans, either lunch or dinner, was the risk factor for developing illness.

Bacillus cereus is a gram-positive aerobic spore forming rod well known for causing food poisoning. It causes two syndrome types, the emetic and the diarrhoeal which present predominantly with vomiting or diarrhoea respectively and can occur independently(9,10). The emetic syndrome has a shorter incubation period(0 to 6 hours) while the diarrhoeal syndrome has a longer average incubation period of 8-16 hours(11,12). Based on our epi-curve, the timeline matched the

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diarrhoeal syndrome incubation period and given that diarrhoea was the main symptom, it makes sense that this was *Bacillus cereus* food poisoning with the diarrhoeal syndrome. Within 30 hours, there were no new cases or symptoms in keeping with reports that this illness is self-limiting and usually resolves within 48 hours (10). This bacteria has been identified as a major cause of food poisoning in various parts of the world including East Africa presenting as either the emetic syndrome or diarrhoeal or both(9,13–16).In one outbreak in Australia, whole genome sequencing was done and only genes encoding the diarrhoeal toxin were found(17) while in another, 90% had diarrhoea while only 10% had vomiting(18) Although rarely fatal, some outbreaks of *Bacillus cereus* have registered fatalities from food poisoning caused by this organism, although most fatal outbreaks are usually from the emetic type of food poisoning which normally has more severe consequences(19,20)There were no fatalities in this outbreak which was the diarrhoeal type, in keeping with what is documented about the severity of the different syndromes. In another outbreak, a 7-year-old girl died 13 hours after having a meal contaminated with these bacteria and subsequently developing the emetic syndrome. Four of her siblings developed illness with the emetic syndrome but recovered.(19)

These bacteria often exist as spores in the environment which are able to contaminate raw foods, vegetables and even cooked food during preparation as we suspect is what happened in this outbreak. Under favorable conditions such as warm food, inadequate refrigeration of cooked food , these spores germinate to produce viable bacteria which grow and produce the toxins responsible for most cases of *Bacillus cereus* food poisoning (14). Given the nature of food preparation at the school whereby food is cooked in the early hours of the morning and then left on low heat throughout the day, it is possible that the bacteria were given ideal conditions to grow.

Although this pathogen is more commonly found in cases of food poisoning with cooked rice or rice products(12,17,21), it has also been documented severally in other types of food such as cooked beans and green salads (22,23). However, food poisoning outbreaks with foods other than rice as the source of *Bacillus cereus* have not been widely documented. Studies have documented the growth of *Bacillus cereus* biofilms on green leafy vegetables (22,24), which is why it is plausible that the collard greens which were added to the cooked beans might have been the source of contamination. However, the sample of collard greens taken from what was left over in the same garden as those cooked on that day reportedly tested negative for bacteria. Flour, especially maize flour is known to be an unfavorable growth medium for bacterial organisms due to its low-water activity, although contamination of wheat flour by *Bacillus cereus* spores has been documented(25,26). This points out the interesting finding of *Bacillus cereus* in one out of the four samples of flour.

The symptoms, timelines of symptom onset, duration of illness, environmental findings as well as the laboratory findings are all consistent with *Bacillus cereus* food poisoning making it plausible as the cause of this outbreak.

For the cases who did not eat any of the suspect food but reported symptoms, we suspect that this may have been a result of mass hysteria influenced by fellow students falling ill, worsened by the anxiety of the community and the presence of the media and police at the school. Mass hysteria is a well-documented occurrence in schools especially affecting girls, and can even mimic food poisoning(27–30).

Study limitations

There were more boarders than commuters among the cases listed possibly due to the fact that the school had been closed temporarily and day scholars suspended to allow for the investigation to take place. Some scholars however were still at the school at the time of the investigation and were identified as cases. The school has approximately 900 day scholars compared to approximately 300 boarders and these share the same meals at lunch. It is possible that there were more cases among the day scholars but these were managed at home.

Given the likely apprehension brought about by the involvement of political, media, and security personnel in the response to this outbreak, it is possible that the key informant recounts of events pertinent to the incident including the food preparation specifics were less than accurate. The team was therefore unable to determine the source of contamination of the food on that day.

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Conclusion

Our investigation determined that there was an outbreak of *Bacillus cereus* food poisoning among students at the school on the 19th of July, 2023. This was probably as a result of contamination during handling and preparation of the food for that day but the source of contamination was not determined.

Recommendations and public health actions
Strict hygiene practices should be observed during handling and preparation of food. Vegetables must we washed thoroughly before cooking to remove any films of bacteria or toxins that may have formed on the leaves. Food must be kept hot or reheated adequately before serving in order to prevent germination of spores into viable organisms, or to destroy any viable organisms that may have grown while in storage at warm temperatures. The cooks were educated about food poisoning and best practices to prevent its occurrence.

Conflict of Interest

The authors declare that they had no conflict of interest.

Authors contribution

BGN: participated in the conception, design, analysis, interpretation of the investigation findings and wrote the draft bulletin.IS, AK, DA, AT, JML, VEN and BK reviewed the report. BK and ARA reviewed the bulletin to ensure intellectual content and scientific integrity.

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References

1. WHO's first ever global estimates of foodborne diseases find children under 5 account for almost one third of deaths [Internet]. [cited 2024 Jan 29]. Available from: https://www.who.int/news/item/03-12-2015-who-s-first-ever-global-estimates-of-foodborne-diseases-find-children-under-5-account-for-almost-one-third-of-deaths

2. CDC. Centers for Disease Control and Prevention. 2023 [cited 2024 Jan 29]. Food Poisoning Symptoms. Available from: https://www.cdc.gov/foodsafety/symptoms.html

3. World Health Organization: World Health Statistics... - Google Scholar [Internet]. [cited 2024 Mar 5]. Available from: https://scholar.google.com/scholar_lookup title=World+health+statistics+2015&publication_year=2015&

4. Idehen CN, Jiya MJ, Balogu VT. Food Poisoning in Africa: A Silent Epidemic in Recent Era of Global Food Traffic. DRJAFS. 2023 Feb 1;11 (2):25–30.

5. Malangu N. Risk Factors and Outcomes of Food Poisoning in Africa. In: Significance, Prevention and Control of Food Related Diseases [Internet]. IntechOpen; 2016 [cited 2024 Jan 29]. Available from: https://www.intechopen.com/chapters/49838

6. Mutebi RR, Ario AR, Nabatanzi M, Kyamwine IB, Wibabara Y, Muwereza P, et al. Large outbreak of Jimsonweed (Datura stramonium) poisoning due to consumption of contaminated humanitarian relief food: Uganda, March–April 2019. BMC Public Health. 2022 Mar 30;22(1):623.

7. Haughey SA, Chevallier OP, McVey C, Elliott CT. Laboratory investigations into the cause of multiple serious and fatal food poisoning incidents in Uganda during 2019. Food Control. 2021 Mar 1;121:107648.

8. UPDATE ON FOOD POISONING INVESTIGATIONS IN KARAMOJA REGION [Internet]. Ministry of Health | Government of Uganda. [cited 2024 Jan 28]. Available from: https://www.health.go.ug/document/update-on-food-poisoning-investigations-in-karamoja-region/

9. Granum PE, Lund T. Bacillus cereus and its food poisoning toxins. FEMS Microbiology Letters. 1997 Dec 1;157(2):223–8.

10. Bacillus cereus [Internet]. [cited 2024 Mar 5]. Available from: http://www.bccdc.ca/health-info/

Continues to page 8

diseases-conditions/bacillus-cereus

11. Canada PHA of. Pathogen Safety Data Sheets: Infectious Substances – Bacillus cereus [Internet]. 2012 [cited 2024 Mar 5]. Available from: https://www.canada.ca/en/public-health/services/laboratory-biosafety-biosecurity/pathogen-safety-data-sheets-risk-assessment/bacillus-cereus.html

12. Martinelli D, Fortunato F, Tafuri S, Cozza V, Chironna M, Germinario C, et al. Lessons learnt from a birthday party: a Bacillus cereus outbreak, Bari, Italy, January 2012. Ann Ist Super Sanità. 2013 Dec;49:391–4.

13. Thery M, Cousin VL, Tissieres P, Enault M, Morin L. Multi-organ failure caused by lasagnas: A case report of Bacillus cereus food poisoning. Front Pediatr. 2022 Sep 14;10:978250.

14. Midura T, Gerber M, Wood R, Leonard AR. Outbreak of food poisoning caused by Bacillus cereus. Public Health Rep (1896). 1970 Jan;85(1):45–8.

15. Tewari A, Abdullah S. Bacillus cereus food poisoning: international and Indian perspective. J Food Sci Technol. 2015 May;52(5):2500–11.

16. Lentz SAM, Rivas PM, Cardoso MR de I, Morales D de L, Centenaro FC, Martins AF. *Bacillus cereus* as the main casual agent of foodborne outbreaks in Southern Brazil: data from 11 years. Cad Saúde Pública. 2018 Mar 29;34:e00057417.

17. Thirkell CE, Sloan-Gardner TS, Kacmarek MC, Polkinghorne B. An outbreak of Bacillus cereus toxin-mediated emetic and diarrhoeal syndromes at a restaurant in Canberra, Australia 2018. Commun Dis Intell (2018). 2019 Sep 16;43.

18. Al-Abri SS, Al-Jardani AK, Al-Hosni MS, Kurup PJ, Al-Busaidi S, Beeching NJ. A hospital acquired outbreak of Bacillus cereus gastroenteritis, Oman. J Infect Public Health. 2011 Sep;4(4):180–6.

19. Dierick K, Coillie EV, Swiecicka I, Meyfroidt G, Devlieger H, Meulemans A, et al. Fatal Family Outbreak of Bacillus cereus-Associated Food Poisoning. Journal of Clinical Microbiology. 2005 Aug;43(8):4277.

20. Elise N, Cissé M, Souleymane B, Sindic M. A Review on Bacillus Cereus in Africa's Locally Produced Foods. European Scientific Journal ESJ. 2019 Mar 31;15.

21. Li T, Zou Q, Chen C, Li Q, Luo S, Li Z, et al. A foodborne outbreak linked to Bacillus cereus at two middle schools in a rural area of Chongqing, China, 2021. PLOS ONE [Internet]. 2023 [cited 2024 Mar 5];18(10). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10586640/

22. Antequera-Gómez ML, Díaz-Martínez L, Guadix JA, Sánchez-Tévar AM, Sopeña-Torres S, Hierrezuelo J, et al. Sporulation is dispensable for the vegetable-associated life cycle of the human pathogen Bacillus cereus. Microb Biotechnol. 2021 Jul;14(4):1550–65.

23. BLAKEY LJ, PRIEST FG. The Occurrence of Bacillus cereus in some Dried Foods Including Pulses and Cereals. Journal of Applied Bacteriology. 1980 Apr 1;48(2):297–302.

24. Majed R, Faille C, Kallassy M, Gohar M. Bacillus cereus Biofilms-Same, Only Different. Front Microbiol. 2016;7:1054.

25. Microbiology of Grains and Flours July 2021.pdf [Internet]. [cited 2024 Jan 29]. Available from: https://fri.wisc.edu/files/Briefs_File/Microbiology%20of%20Grains%20and%20Flours%20July%202021.pdf

26. Kindle P, Etter D, Stephan R, Johler S. Population structure and toxin gene profiles of Bacillus cereus sensu lato isolated from flour products. FEMS Microbiology Letters. 2019 Oct 1;366(20):fnz240.

27. Pfeiffer PH. MASS HYSTERIA MASQUERADING AS FOOD POISONING. J Maine Med Assoc. 1964 Feb;55:27.

28. Ebrahim GJ. Mass Hysteria in School Children: Notes on Three Outbreaks in East Africa. Clin Pediatr (Phila). 1968 Jul 1;7(7):437–8.

29. The Wandering Womb": Mass Hysteria in School Girls, 1968 [Internet]. [cited 2024 Jan 28]. Available from: https://journals.sagepub.com/doi/abs/10.1177/000992286800700701

30. Small GW, Borus JF. Outbreak of illness in a school chorus. Toxic poisoning or mass hysteria? N Engl J Med. 1983 Mar 17;308(11):632–5.

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Rotavirus outbreak linked to poor hygiene practices at a Babies' Home in Mpigi District, Uganda, July–August 2023

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Summary

Background: In Uganda, the rotavirus vaccine for children <5 years was introduced in 2018. By 2022, rotavirus as a cause of acute diarrhea among children had decreased by 40%. On August 10, 2023, the Uganda Ministry of Health was notified of a suspected rotavirus disease outbreak at a babies' home in Mpigi District. We investigated to determine the magnitude and identify possible exposures associated with the outbreak.
Methods: We described a suspected case as acute onset of diarrhea plus ≥1 of the following: vomiting, fever, lethargy or loss of appetite in a child or staff member at the babies' home from July 27— Aug 20, 2023 OR A positive rotavirus RDT result in an asymptomatic child or staff member. A confirmed case was a suspected case with a positive ELISA test for rotavirus A. We identified cases by reviewing health records and conducting mass RDT testing. We conducted descriptive epidemiology, staff interviews, and an environmental assessment to determine possible sources of exposure.
Results: Among the 44 children and 59 adults at the home, we line-listed 23 case-patients (21 children and 2 adults). Of these, 6 were confirmed and 13 were suspected (1 death). Symptom onsets ranged from August 3—17, 2023. Twenty (87%) case-patients were fully vaccinated against rotavirus. Attack rates were highest in children aged 13-18 months (86%) followed by the 7-12 months ages group (83%). No cases were reported in the children >2 years. The environmental assessment indicated poor hand hygiene practices among the caregivers. Of the caregivers interviewed, 9/23 used disposable gloves, 4/23 washed their hands after cleaning vomitus and fecal spills and 9/23 washed their hands after washing the childrens' potties.
Conclusion: The outbreak was caused by rotavirus, with spread likely facilitated by poor hygiene practices. We instituted infection prevention and control measures and decontaminated the babies' home.

Background

Rotaviruses are the leading cause of severe, diarrhea in children under the age of five years globally. They are spread through the fecal-oral route and during active infection high concentrations are shed in the stool and vomitus of infected individuals. Transmission may also occur through contaminated food, water, hands, and surfaces. Upon entry into a human body, rotavirus disrupts the function of the small intestinal epithelium, causing malabsorption of water and resulting in watery diarrhea. Once infected, it takes two to three days for a child to develop signs and symptoms. The World Health Organization (WHO) reports that 75% of children acquire their first episode of rotavirus infection before the age of one year, and severe infections occur in children aged 6 months-2 years (1,2).

Globally, rotavirus accounts for about 40% of acute diarrheal infections in children under the age of 5 years. In 2016, almost 258 million infections and 129,000 deaths were attributed to rotavirus infection, the biggest burden of which lay in low income countries. This could be because of limited access to health care, lack of available hydration therapy and a greater prevalence of comorbid conditions such as malnutrition in those countries (3–6).

In Uganda, diarrhea is still among the top ten causes of morbidity in children <5years. In 2019, rotavirus was the cause of almost half the acute diarrhea hospitalizations and an estimated 10,000 children died as a result (7). A recent study reported a prevalence of 16% among infants 3–24 months of age representing a reduction in prevalence(8).

After the global introduction of the rotavirus vaccine in 2006, rotavirus-associated mortality among children younger than 5 years decreased by 40% (3). Vaccinating infants further reduces rates of disease in older unvaccinated children and adults by reducing the circulating amount of rotavirus in the community.

On August 08th, 2023, four infants from a babies' home were hospitalized at a general hospital in Kampala. They presented with a history of acute watery diarrhea, vomiting, general body weakness and signs of dehydration for

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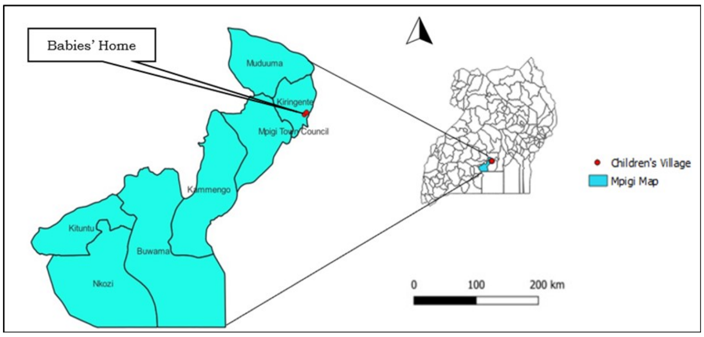
more than 24 hours. Shortly after admission, one infant succumbed to their symptoms. Admitting clinicians ordered for laboratory tests and the results were positive for Rotavirus. The Ministry of Health (MoH) was notified of the suspected outbreak by the babies' home administration. We determined the scope of the outbreak, confirmed the causative pathogen, identified possible exposures, and recommended evidence-based control and prevention measures.

Methods

Outbreak location

The outbreak took place at a babies' home in Mpigi District. Mpigi District is located in Central Uganda. It has 8 sub counties, 59 parishes, and 481 villages. The babies' home is located in Kiringente sub county and is nested in a children's village. The home caters for 44 abandoned children from birth to 5 years (Figure 1). Majority (40/44) of the children at the babies' home were



vaccinated against rotavirus.

Figure 1: **A map of Uganda showing the location of the babies' home in Mpigi District**

Case definition and finding

We defined a suspected case as acute onset of diarrhea plus ≥1 of the following: vomiting, fever, lethargy or loss of appetite in a child or staff member at the babies' home from July 27— Aug 20, 2023 **OR** A positive rotavirus RDT result in an asymptomatic child or staff member. A confirmed case was a suspected case with a positive Enzyme-linked immunoassay (ELISA) test for rotavirus A

To find cases we reviewed records of sick children from the babies' home clinic. For each child enumerated from these records, we also conducted follow-up interviews with the clinicians and caretakers on the presentation of the symptoms. We also carried out rotavirus testing for all asymptomatic persons at the babies' home using RDT kits. We then created a line-list of all cases who met the case definition capturing variables of dates of onset, demographic characteristics, symptoms, and vaccination status.

Descriptive epidemiology

We analyzed the line-list to characterize cases by their clinical presentation. We used attack rates to describe the distribution of cases by age group, vaccination status, and living area. We grouped the children in periods according to the time passed since they received the full 2-doses of vaccine. We defined three categories; <6 months since vaccination, 7-12, and >12 months since vaccination. We constructed an epi-curve to describe the cases by time.

Environmental assessment

We observed the layout of the babies' home and examined the living spaces, the kitchen, food stores, living, and play areas. We observed the food handling and preparation practices. We interviewed the staff at the Babies' Home on their hand hygiene as well as fecal matter handling and disposal practices.

Laboratory testing

We collected samples for laboratory testing from both clinical and non-clinical sources. We obtained samples of stool from the children and employees that were present during the outbreak period for testing using RDT kits. We tested 11 stool samples from symptomatic individuals using ELISA for rotavirus A (RVA) at the National Microbiology Reference Laboratory. We took non-clinical samples from the water sources at the babies' home for bacterial culture.

Ethical considerations

This investigation was in response to a public health emergency and was therefore determined to be non-research by the office of the Center for Global Health, US Center for Disease Control and Prevention. The Ministry of Health gave the directive to investigate this outbreak. Administrative clearance to conduct the investigation was also obtained from the Mpigi District administration and the babies' home administration.

Results

Descriptive epidemiology

We found 23 cases of rotavirus (6 confirmed; 17 suspected). Case fatality rate (CFR) for this outbreak was 4% with one death occurring. The average and median age of the child case-patients in

Continued from page 10

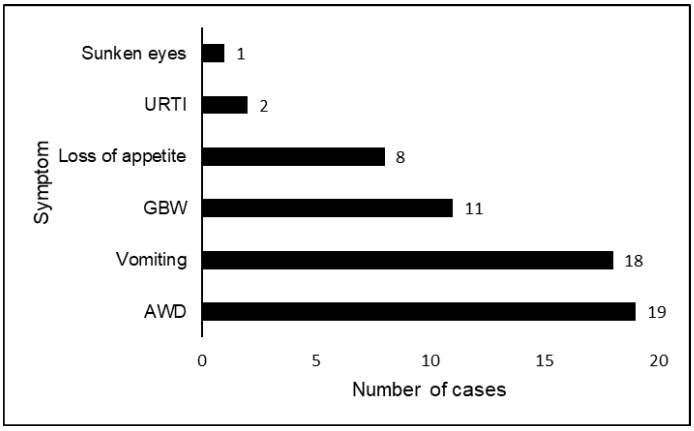
this outbreak was 14 months, modal age was 10 months.

Children in the 13-18 months age group were most affected with attack rates of 86% followed by the 7-12 months ages group (83%). No cases were reported in the children above 2 years (Table 1).

Age group	No. of Cases	Population	AR (%)
0-6 months	3	6	50
7-12 months	5	6	83
13-18 months	6	7	86
19-24 months	7	10	70
2-5 years	0	15	0
≥ 18 years	2	59	3.4

Table 1: Attack rates by age group during an outbreak of rotavirus at a babies' Home, Mpigi District, July—August 2023

Acute watery diarrhea was reported for 19/23 of case-patients, followed by vomiting (18/23), gen-



eral body weakness (GBW) (11/23), and loss of appetite (8/23). Thirteen percent of the cases did not experience any symptoms (Figure 2).

GBW- general body weakness, URTI-upper respiratory tract infections

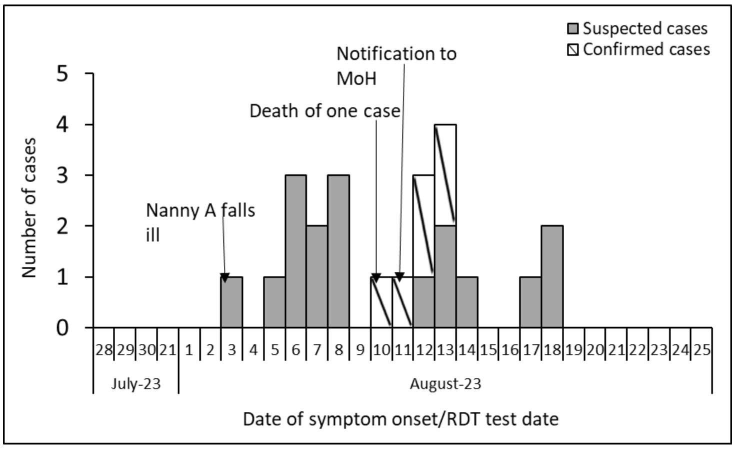
Figure 2: Frequency of rotavirus symptoms among affected children at a babies' home in Mpigi District, 2023

Ninety-five percent of the child case-patients were vaccinated. The only unvaccinated child was not yet eligible for vaccination on account of their age. Children that received the vaccine 7-12 months before the outbreak had highest attack rates compared to other categories (Table 2).

Time since vaccination (months)	Infected	Total	AR (%)	RR	CI limits
<6	4	7	57	Ref	
7-12	6	6	100	1.75	0.92-3.32
>12	10	26	38	0.67	0.78-3.91

Table 2: Time in months since vaccination vs Attack rates and Risk Ratios

The primary case fell ill on August 03rd, days after, multiple cases formed a first generation of cases (from August 5th-8th) (Figure 3). A second generation of cases were recorded from August 10-14.



The single case that died did so on August 10th, and this spurred the notification of MoH on August 11th. More cases that may have been the third generation of cases appeared on August 17-18th, 2023.

Figure 3: Epidemic curve for a rotavirus outbreak at the babies' home in Mpigi District

Laboratory findings

From the 103 babies' home residents and employees, 74 were tested for RV by RDT and 18 (24%) tested positive (Table 3). From the 11 stool samples collected from symptomatic persons, 6 (55%) tested positive on ELISA. No organism known to cause gastrointestinal infections was found by microbiology culture from both the water and stool samples.

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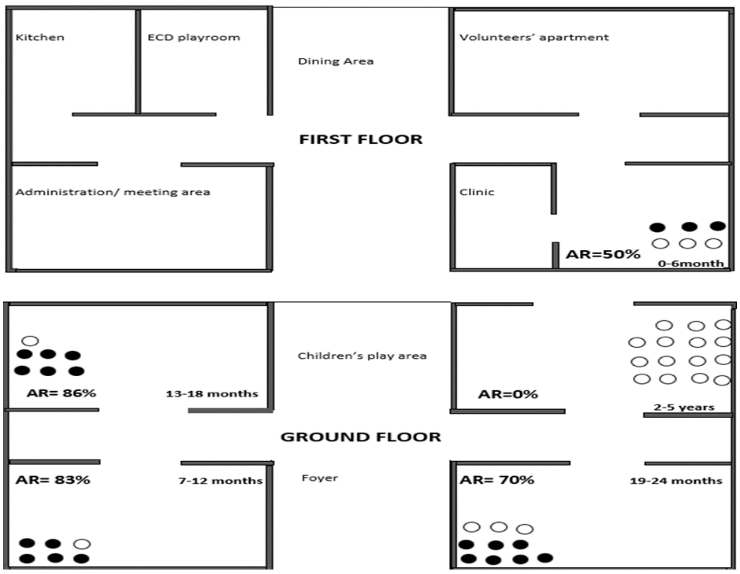
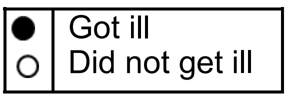
Test run	Samples collected	Positive n (%)	Negative n (%)
RDT	74	18 (24)	56 (76)
ELISA	11	6 (55)	5 (45)
Culture (stool)	11	0 (0)	11(100)
Culture (water)	7	0 (0)	7 (100)

Table 3: Laboratory results for the rotavirus outbreak at a babies' home in Mpigi District, July-August 2023

Environmental assessments

Babies' home layout: The babies' home is housed on two floors, most of the children live on the ground floor according to their age groups (Figure 4). Within age groups, they are separated into family units of four and are assigned to a specific caretaker. Mixing between children in the different age groups is not common. The children had different schedules based on their age and devel-





opmental needs. The common areas at the babies' home were the children's play area and the early childhood development playroom. There was minimal interaction between the older children (>2 years) and other age groups.

Figure 4: Attack rates by living area at the babies' home in Mpigi District

We however noted that the clinic was a high traffic area and that the cribs were the children were placed were not disinfected between case patients.

Food preparation and handling: The babies' home has two chefs who prepare food for both the children and the staff. Dry rations were purchased in bulk and stored in a pantry adjacent to the kitchen, fresh food was delivered on preset days according to the children's menu and also stored appropriately. The children had a separate menu from the adults, and menus varied for the different child age groups as well. Food prepared for the children was served into containers and placed on a counter for pick up. No food was left over for the next meal as menus between meals varied. The cooks reported that nothing changed in the food delivery and preparation process the week leading up to the outbreak. The same suppliers were used and food was prepared and served in the same way that food was normally prepared.

Water sources**:** Water used at the babies' home was pumped from a deep well located about 1.5 kilometers away and stored in plastic above ground water tanks. The same water was pumped and used at the children's village as well and there were no reports of related illness. There was no evidence of deviation from the norm.

Fecal matter and vomitus handling: Children in the 0-12 months age group were kept in diapers. Diaper changes were done at the start of each day, and whenever necessary thereafter and gloves were worn during each diaper change. Children in the 13-24 months age group were potty trained. Each child had their own potty, no sharing was reported or witnessed. Caretakers reported that when children were woken up, they had "potty-time" session, after which the child is cleaned and the contents of the potty taken to a toilet outside the living area for disposal. We observed one such potty disposal session and noted that while disposal happened outside the living area, the caretaker had to walk back to the living area to clean the potty. Potties were rinsed with soapy water in a sink within the living area.

Continued from page 12

We found that only 39% (9/23) used disposable gloves and washed the spill area with detergent after cleaning (Table 4). Only 17% (4/23) reported washing their hands after the spills cleaning pro-

Action	n	%
Put on disposable gloves	9	39
Wash the surface with a soap/ detergent	9	39
Keep other babies away from soiled area	4	17
Wash hands after the cleaning procedure	4	17
Self-reported handwashing times		
After feeding the babies	9	39
Before feeding the babies	9	39
Before touching utensils	6	26
Before changing baby's diapers	3	13
Before touching toys	9	39
After washing potties	9	39

cess and kept other children away from the spill area. Only 39% (9/23) washed their hands before and after feeding the children, before handling the children's toys and after washing the children's' potties.

Table 4: Procedure for cleaning of vomitus and diarrheal spills and handwashing

None of the staff reported washing their hands between feeding the children or when visibly soiled. At the time of the outbreak, staff reported a shortage of gloves.

Discussion

In this study, we carried out an epidemiological investigation on the outbreak of rotavirus in a babies' home in Mpigi District. We confirmed that Rotavirus A was the causative pathogen and both children and adult staff at the babies' home were affected. All the affected children were under 2 years but those aged between 13-18 months were most affected (AR=86%). One death occurred in an infant who died from rotavirus-induced dehydration (CFR= 4%). Majority (95%) of the child case patients affected by the outbreak were vaccinated. The outbreak was linked to poor hygiene practices among the care givers.

In this study, we confirmed that the outbreak at the babies' home was caused by Rotavirus A. Laboratory results showed that six out of eleven samples from symptomatic children tested positive for rotavirus A using ELISA. Similar to our findings, studies of rotavirus disease in children under the age of five years in central Uganda and Nigeria found that the most prevalent genotype of rotaviruses detected were group A rotaviruses (9,10).

In this study we found that children affected were under 2 years but those aged between 13-18 months had the highest attack rates. Similar to our findings, a study on children under the age of five years hospitalized with acute gastroenteritis reported that a majority were <24 months of age (11). This could be because older children are more resistant to rotavirus on account of their previous exposures to the pathogen which confers against reinfection and severe diarrhea. Two of the case patients in this outbreak were adults. Rotavirus infection in adults is not uncommon, as supported by research that found that nearly all adults have antibodies to rotavirus but also found that they were still susceptible to infection (12).

One death attributed to rotavirus-induced dehydration occurred during this outbreak. This is similar to the findings in an outbreak in subacute inpatient care facility where a case patient <2 years died due to rotavirus-induced dehydration (13). While the case patient in that outbreak was not vaccinated unlike the case patient in our outbreak, rotavirus diarrhea can quickly lead to serious dehydration without quick intervention.

We found that 95% of the child case patient affected by the outbreak were vaccinated, all having received the Rotarix ® vaccine at least six weeks prior to the outbreak. Rotarix (®) is a live attenuated vaccine and has been associated with causing acute gastroenteritis in vaccine recipients. This outbreak in a vaccinated closed population is contrary to other outbreaks in similar populations but largely unvaccinated (13,14). This could be because rotavirus is easily spread in settings where many children are together, such as day care, or other child care facilities.

In this study we found that 83% of the case-patients had symptoms ranging from acute watery diarrhea, vomiting, and general body weakness among others. Rotavirus is a known cause of severe dehydrating diarrhea. This could be possible reason for the single fatality in this study that reportedly occurred due to severe dehydration from loss of fluid and electrolytes in the wa-

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tery stool (15).

During the environmental assessments, we noted that the handwashing station at the home entrance was not utilized. Thus staff were likely to report and likely handle the children without washing their hands. We also evaluated the fecal matter handling processes for the children and noted that more than 20% of the caregivers were not knowledgeable on the proper procedure of cleaning up vomitus and diarrhea. And since RV is found in human feces and can be transmitted through the fecal-oral route, washing of hands with soap and water before handling a child halts its transmission (6). Several studies have shown that caregiver's handwashing with soap is linked with a low prevalence of diarrheal diseases among children (8,9). The same assessments revealed a possible source of exposure from the fecal management process. Children would defecate in potties and caregivers would dispose of the feces from the potty into the toilet, then clean the potty for the next use. The training given to staff prior to starting employment were lacking. Absence of essential IPC training increases the risk of exposure to infectious agents for the persons receiving care as the caregivers may not have proper knowledge and understanding of correct disease prevention processes and procedures.

Study limitations

Given that the key informants are staff at the babies' home, it is likely that the responses to the questions including the staff health prior to the outbreak were not truthful; making it impossible to ascertain the true source of infection. We were unable to perform genomic sequencing on the clinical samples we had taken hence unable to tell if the RVA was a wildtype or as a result of vaccination, something which would further facilitate in shaping the recommendations.

Public health actions taken

Immediately after the outbreak was detected, we started sensitization of the health workers and staff at the babies' home. With the help of the Mpigi district health team, we disinfected the babies' home distributing of hand washing facilities at entry points.

Conclusion

We concluded that the outbreak that occurred among children and staff at the babies' home was caused by Rotavirus A. The outbreak was linked to poor hygiene practices among the care givers.

Conflict of interest

The authors declare that they have no conflict of interest.

Authors' contribution

All authors contributed to the write-up and review of the bulletin. DA wrote the drafts of the bulletin and revised the bulletin for substantial intellectual content. DA, PA, BK, and BG participated in the investigation of rotavirus in Mpigi district and reviewed the bulletin for substantial intellectual content. SG and DNG were involved in the review of the bulletin for substantial intellectual content. BK and ARA participated in the supervision of field data collection and reviewed the draft manuscript for substantial intellectual content. All the authors read and approved the final version of the bulletin.

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References

1. Rotavirus [Internet]. [cited 2023 Aug 29]. Available from: https://www.who.int/teams/health-product-policy-and-standards/standards-and-specifications/vaccines-quality/rotavirus

2. Transmission of Rotavirus | CDC [Internet]. 2022 [cited 2023 Aug 30]. Available from: https://www.cdc.gov/rotavirus/about/transmission.html

3. Burnett E, Jonesteller CL, Tate JE, Yen C, Parashar UD. Global Impact of Rotavirus Vaccination on Childhood Hospitalizations and Mortality from Diarrhea. J Infect Dis. 2017 Jun 1;215(11):1666–72.

4. Du Y, Chen C, Zhang X, Yan D, Jiang D, Liu X, et al. Global burden and trends of rota-

Continued from page 14

virus infection-associated deaths from 1990 to 2019: an observational trend study. Virol J. 2022 Oct 20;19(1):166.
5. Ramig RF. Pathogenesis of Intestinal and Systemic Rotavirus Infection. J Virol. 2004 Oct;78 (19):10213–20.
6. Crawford SE, Ramani S, Tate JE, Parashar UD, Svensson L, Hagbom M, et al. Rotavirus infection. Nat Rev Dis Primer. 2017 Nov 9;3:17083.
7. Patrick L. Uganda rolls out rotavirus vaccine into the routine immunization schedule [Internet]. Ministry of Health | Government of Uganda. 2019 [cited 2024 Jan 29]. Available from: https://www.health.go.ug/2019/12/02/uganda-rolls-out-rotavirus-vaccine-into-the-routine-immunization-schedule/
8. Nakawesi JS, Wobudeya E, Ndeezi G, Mworozi EA, Tumwine JK. Prevalence and factors associated with rotavirus infection among children admitted with acute diarrhea in Uganda. BMC Pediatr. 2010 Sep 24;10:69.
9. Bwogi J, Malamba S, Kigozi B, Namuwulya P, Tushabe P, Kiguli S, et al. The epidemiology of rotavirus disease in under-five-year-old children hospitalized with acute diarrhea in central Uganda, 2012-2013. Arch Virol. 2016;161:999–1003.
10. Mado SM, Giwa FJ, Abdullahi SM, Alfa AM, Yaqub Y, Usman Y, et al. Prevalence and Characteristics of Rotavirus Acute Gastroenteritis among Under-five Children in Ahmadu Bello University Teaching Hospital, Zaria, Nigeria. Ann Afr Med. 2022;21(3):283–7.
11. Nguyen TV, Le Van P, Le Huy C, Weintraub A. Diarrhea Caused by Rotavirus in Children Less than 5 Years of Age in Hanoi, Vietnam. J Clin Microbiol. 2004 Dec;42(12):5745–50.
12.Anderson EJ, Weber SG. Rotavirus infection in adults. Lancet Infect Dis. 2004 Feb 1;4(2):91–9.
13. Burke RM, Tate JE, Barin N, Bock C, Bowen MD, Chang D, et al. Three Rotavirus Outbreaks in the Postvaccine Era — California, 2017. Morb Mortal Wkly Rep. 2018 Apr 27;67(16):470–2.
14. Burke RM, Tate JE, Han GS, Quenelle R, Gautam R, Wadford DA, et al. Rotavirus vaccination coverage during a rotavirus outbreak resulting in a fatality at a subacute care facility. J Pediatr Infect Dis Soc. 2020 Jul 13;9(3):287–92.
15. Rotavirus Infection in Children - Health Encyclopedia - University of Rochester Medical Center [Internet]. [cited 2023 Aug 20]. Available from: https://www.urmc.rochester.edu/encyclopedia/content.aspx? Contenttypeid=90&contentid=P02540

Anthrax outbreaks in western Uganda: The role of illegal meat dealers in spreading the infection, August 2022–April 2023

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Summary

Background: From 2017–2022, Uganda experienced nineteen human anthrax outbreaks, all associated with handling or eating meat from cows found dead. Dealers in such meat (illegal meat dealers) may facilitate the spread of anthrax outbreaks. We uncovered the network of illegal meat dealers in Ibanda District, described their effect on anthrax outbreaks, and explored the drivers of the illegal meat trade.
Methods: During an anthrax outbreak in Ibanda District in April 2023, we conducted 11 key informant interviews (KII) to learn about illegal meat trade. We used snowballing to identify illegal meat dealers. KII participants included the Ibanda District Surveillance Focal Person, security officers, farmers, and the dealers. We used open coding to generate themes and conducted thematic analysis.
Results: We found a well-organized network of illegal meat dealers in Kagongo Division, Ibanda District. They are well known to farm workers in and around the district. The dealers buy animals found dead or sick from farms and sell the meat at a reduced price to consumers in Ibanda and fellow dealers in neigh-

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boring Kitagwenda District. During the August 2022 and March-April 2023 outbreaks, illegal meat dealers butchered animals found dead and sold the meat in the affected areas; five of the six dealers also developed anthrax in the most recent outbreak. Key drivers of the illegal meat trade were delayed and non-reporting of animal deaths, non-compliance to mandatory disposal of animal carcasses, non-functional surveillance for animal deaths, weak meat market regulations and misperception of the risk of anthrax.

Conclusion: Illegal meat dealers operate well-organized networks in Ibanda District which likely facilitated the spread of anthrax infection and widened the scope of recent outbreaks. The practice also spreads and sustains anthrax spores in the grazing areas, which could explain the recurrent outbreaks. Deliberate measures should be taken to prohibit this trade to mitigate risks for future anthrax outbreaks.

Background

Anthrax is an acute zoonotic bacterial disease caused by spore-forming, *Bacillus anthracis*. The spores survive for approximately two decades in animal carcasses, slaughter and disposal sites of infected animals (1). The animals can acquire anthrax when they breathe in or ingest spores from contaminated soil, plants, or water. Transmission of Anthrax in humans always occurs through handling or eating meat from infected animals or their carcasses, contact with their products or by breathing in spores (2, 3). An estimated 20,000-100,000 cases of human anthrax are reported globally every year, with most occurring in rural areas without a routine vaccination program for anthrax (3) .

Uganda experiences recurrent human anthrax outbreaks mainly in the cattle corridors of western, eastern, and northern regions. These outbreaks are usually associated with handling or eating meat from cows found dead (2, 4-8) . During January 2017–April 2023, Uganda reported 19 anthrax outbreaks, seven of which occurred in the western region (9).

In March 2023, six months from a previous anthrax outbreak in August 2022, Ibanda District reported another outbreak in Kagongo Division. On April 16, 2023, Ministry of Health (MoH) dispatched a team to investigate the recent outbreak. During the investigation, rumors of a network of illegal meat dealers (persons involved in the trade of meat from animals (cattle, goats or sheep) that are found dead emerged. Animals that are found dead or die suddenly are suspected to have anthrax. Thus illegal meat dealers may facilitate the spread of anthrax infection and amplify outbreaks. We investigated to understand the network of illegal meat dealers in Ibanda District, describe their effect on the spread of anthrax, and explore the drivers of illegal meat trade to generate evidence-based recommendations.

Methods

Study setting

We conducted the study in April 2023 during an anthrax outbreak in Kagongo Division, Ibanda District in western Uganda. The district has 17 sub-counties and 600 villages, with a total population of approximately 277,300 people (10, 11). The main source of livelihood is subsistence agriculture in form of animal and crop farming which employs 78% of the population. Accordingly, sixty-four percent of the households in Ibanda District are involved in livestock farming (11). In addition, Ibanda is bordered by seven districts including Kazo, Kiruhura and Mbarara which lie in the western cattle corridor. During August 2022–April 2023, Ibanda District reported two human anthrax outbreaks in Kagongo Division (7) In both outbreaks, cattle found dead at farms in Kazo and Ibanda respectively were butchered and the meat sold in the affected areas.

Study design and participants

We conducted a qualitative study using Key Informant Interviews (KIIs). We used an interview guide with open-ended questions to understand the network of illegal meat dealers, effect of illegal meat trade on anthrax outbreaks and drivers of the trade. An illegal meat dealer was defined as anyone involved in the trade of meat from animals (cattle, goats or sheep) that are found dead, including butchers, slaughterers and restaurant owners. The Public Health Act of Uganda (2023), under statutory instrument 281-18 provides public health (meat) rules for cities, municipalities, and towns. The rules dictate that where a slaughterhouse exists, no animal shall be slaughtered elsewhere than in the slaughterhouse, except

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with the permission of the authority. Furthermore, the rules require that all animals be inspected for diseases before slaughter and forbid slaughter of animals with, or suspected to have disease.

We used purposive sampling to identify individuals who were most likely knowledgeable about the illegal meat trade in Kagongo Division, Ibanda District. In addition, we used snowballing to identify illegal meat dealers. The study participants included the Ibanda District Surveillance Focal Person (DSFP), security officers, farmers, Village Health Team (VHT), and illegal meat dealers in Kagongo Division, Ibanda District.

Data collection

We conducted KIIs using an interview guide with open-ended questions in the local language (Runyankole) to learn about the network of illegal meat dealers, effect of illegal meat trade on anthrax outbreaks, and drivers of the trade. We asked about demographic characteristics such as age, sex, occupation, sources of illegal meat, mode of transport of the meat, and marketing of the illegal meat. To describe the effect of illegal meat trade on anthrax outbreaks, we asked questions about villages of operation of individual dealers, and the possible role of dealers in spreading anthrax in the affected villages from August 2022 to April 2023. To explore the drivers of illegal meat trade, we asked questions on motivating factors for dealing in animals found dead, adherence to public meat rules, reasons why members of the community consume meat from animals found dead, movement of animals and their products, notification and reporting of animal deaths, and dealers' perceptions about anthrax.
We first interviewed a key informant at the district health department who informed us about a likely network of dealers in meat from animals found dead. He revealed one of the dealers in Kagongo Division and advised us to reach him through either the internal security officer or area councilor. The rest of the dealers were then reached with the help of security, village health teams (VHT), and area local leaders. We additionally disguised as restaurant customers to obtain more information. To reach some of the elusive dealers, we posed as farmers seeking buyers for our dead cattle.
We conducted and recorded all the interviews in privacy and used password protected smartphone recorders. We achieved saturation of information after 11 KIIs including seven with illegal meat dealers, the DSFP, security officer, farm manager and a VHT respectively. At that point, additional interviews were not generating any new information or ideas.

Data management and analysis

We transcribed and translated audio recorded data from the local language into English. This was done by two members of the study team who were proficient in both languages. We checked the transcribed data against the audio recordings to ensure accuracy. In addition, we conducted triangulation by comparing the transcribed data with field notes and seeking clarification from the respondents. We reviewed each individual interview several times to familiarize ourselves with data and identify words, phrases, sentences and paragraphs that described particular phenomena. These were summarized into codes manually using open coding. We reviewed and refined the initial codes and merged similar ones to generate three themes and fourteen subthemes.
We used the inductive thematic analysis approach to analyze the themes and subthemes. We presented the findings along the themes and also quoted representative statements by respondents verbatim.

Ethical considerations

This study was conducted as a response to public health emergency by the National Rapid Response Team. The Ministry of Health Uganda provided administrative clearance to conduct this investigation. In addition, we received a non-research determination clearance from the US Centers for Disease Prevention and Control (US CDC). This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.§ §See e.g., 45 C.F.R. part 46, 21 C.F.R. part 56; 42 U.S.C. §241(d); 5 U.S.C. §552a; 44 U.S.C. §3501 et seq. Furthermore, all the respondents were above the age of 18 years, and gave individual verbal consent for interviews. We conducted interviews in privacy to ensure confidentiality and the data kept under password protection by the study team.

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Results

We conducted eleven Key Informant Interviews. Of these, seven were among illegal meat dealers while the rest were a security officer, DSFP, VHT, and a farm manager. The manager was responsible for the farm where animals were found dead and butchered during a recent anthrax outbreak in March-April 2023. Of the seven illegal meat dealers, five were traders while two were restaurant owners. The mean age of the respondents was 38 years with a range of 28 to 60 years and majority (9/11) was male. The education level of the participants ranged from primary to tertiary education with the majority above primary. We generated three themes and fourteen subthemes (Table 1).

Illegal meat dealers in Ibanda District

We identified eleven illegal meat dealers operating in Kagongo Division. They included eight traders and three restaurant owners, and operated in Rwensuri, Bisheshe, Bugarama, Bufunda and Central Wards. The interviewed dealers revealed that they specialize in meat from animals that are found dead, sick or injured and were aware of the negative implications. The dealers were well known to the community and operate meat stalls in several parishes in Kagongo Division.

"I have been doing this for several years…I mainly buy animals that get damaged during transportation, run over by others and those that collapse and die."

53-year-old male meat dealer

"I had been into this business for several years but I abandoned it last year after I was arrested because some of my clients contracted anthrax from the meat I had supplied."

52-year-old male meat dealer

Network of illegal meat trade

The illegal meat dealers operate a wide network including agents and farm managers within and outside Ibanda District. We discovered that when animals become ill or die in Ibanda, Kazo or Kiruhura districts, farm managers or agents notify network leaders in Ibanda District. The network leaders buy and butcher the animals and supply meat to their fellow dealers in Ibanda and beyond who then sell the meat to the community.

"There are several dealers in meat from animals that are found dead in Ibanda District…They buy animals that die from farms in Ibanda, Kazo and Kiruhura districts through agents."

46-year-old male security officer

"We were called by the farm owner, who informed us that some of her cattle had collapsed and died, and wanted us to go and buy them."

-52-year-old male meat dealer

Sources of animals that are found dead

The dealers have well-known sources of animals found dead or their meat within and around Ibanda District. The main sources are farms in Ibanda and neighboring districts of Kazo and Kiruhura, and occasionally cattle markets. The dealers have agents/informers in the various areas that alert them about animal deaths and link them to the farm managers or owners. Occasionally, the dealers are directly contacted by the farm owners or managers.

"We buy most of the dead animals from farms in Ibanda and sometimes from Kazo and Kiruhura. We also occasionally buy sick or injured animals from cattle markets in Ibanda."

28-yr-old male meat dealer

Transportation of animals that are found dead or their meat

The network leaders transport the whole slaughtered animal carcasses or dissected meat from neighboring districts on Tricycles. The meat from animals slaughtered from farms in Ibanda District is transported on motorcycles (boda-boda taxi).

"We carry whole animal carcasses on tricycles… we use boda-boda taxis to transport the meat if the animal is already slaughtered"

-28-year-old male meat dealer

Market for meat for animals found dead

The meat is supplied mainly to co-traders, and restaurant owners in Ibanda District and the surplus to fellow dealers in Kitagwenda District, who then sell to the community in those areas.

"We also supply to some restaurants around Central Market and Bigulu Street…the surplus is sold to our colleagues in Kitagwenda."

55-year-old male meat dealer

"… Their market is big and goes as far as to Kitagwenda District."

46-year-old male security officer

Internal redistribution mechanism

The dealers also have an internal redistribution

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mechanism for replenishing each other's stock depending on their area of operation as illustrated in the schematic diagram.

"…We gave some of the meat to our colleague to sell in Rwampanga village. We usually communicate with our colleagues in case of excess stock or stock outs so that we redistribute and maintain constant supply of meat to our customers."

28-year-old male meat dealer

Effect of illegal meat trade on anthrax outbreaks

We found evidence suggesting that dealers had amplified outbreaks in all areas affected by the recent and previous anthrax outbreaks in Ibanda District. The meat dealers butchered animals found dead from within and beyond the district and sold meat in the villages that reported human anthrax cases. This practice led to importation of anthrax in previously unaffected areas, thus widening the scope the outbreaks.

Dealers operated in the affected villages in the recent anthrax outbreak in Ibanda

During the recent outbreak, dealers butchered and sold meat from cows found dead in the 5 affected villages. The investigation subsequently linked this dealer and his colleagues to the outbreak. In addition, the network leader and all his co-dealers, and colleagues that helped him in the slaughtering process except one were among the confirmed anthrax cases. In total, 5 of the 6 confirmed anthrax case-persons were dealers.

"I bought the first 3 cows that died... I sold all the meat in Kakijerere I and II, Kasambya, Kaberebere and Rwampanga villages…"

53-year-old male meat dealer

"I was supported by 6 colleagues during slaughter, and all of us except one, developed lesions on the hands and arms and we were told that we contracted anthrax …."

53-year-old male meat dealer

The dealers also butchered cows linked to a previous anthrax outbreak in Ibanda

Dealers also butchered cows linked to a previous anthrax outbreak in August 2022, and are aware of the negative implications of the practice. Dealers butchered cows that had died at a farm in Kazo District and sold the meat sold in the affected villages in Ibanda District. This led to the importation of the anthrax outbreak from the neighboring Kazo District into Ibanda District which had not reported any animal anthrax cases at the time.

"I had dealt in that meat for several years, until last year…people contracted anthrax from the meat I had supplied…..I was arrested and made to compensate the family of the deceased and pay medical bills of the sick"

52-year-old male meat dealer

Drivers of trade of the illegal meat trade

Our findings revealed several drivers of the trade in meat obtained from animals found dead in Kagongo Division, Ibanda District. The drivers included individual level, veterinary health system, societal and structural factors. At individual level, people in the affected communities were generally complacent to the illegal meat trade thus sustaining it. Furthermore, the meat dealers were driven by the need to make quick profits with minimal regard of the negative health and legal consequences of their business. In addition, failure to promptly detect and control animal anthrax outbreaks by the district veterinary health system provided dealers an opportunity to conduct their business. At societal and structural level, inadequate regulation of meat trade and movement of animal and their products also propagated the illegal meat trade.

Public willingness to buy meat from animals found dead

Members of the public in Kagongo Division willingly and knowingly buy meat from animals found. This ensures a ready market for the illegal meat trade thus driving the practice. The community had even come up with a local name for the meat for ease of identification. Locally, meat from animals found dead was referred to as "kyakorwa mukama", loosely translated as "God has done it for us."

"Our people buy the meat knowingly and willingly because it is cheap. They even nicknamed it 'Kyakorwa mukama' loosely translated as "God has done it for us."

60-year-old male VHT

Weak beef market regulations in peri-urban and rural areas

Most of the meat stalls and restaurants dealing in illegal meat trade were in peri-urban areas and not licensed. Hence, animals butchered at such stalls are not usually inspected by the veterinary and medical health teams as observed by one of the key

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informants.
"…meat from there never bears any stamp as opposed to the one sold in the butcheries in Central Market."
32-year-old female restaurant owner

Delayed or non-reporting of animal deaths by farmers
The farmers in Ibanda District and beyond were not reporting or delaying reports of animal deaths to veterinary health authorities. Thus animal disease anthrax control measures like appropriate disposal of animal carcasses were always delayed, allowing the illegal meat dealers enough time to transact their business. This is contrary to the Uganda animal diseases act which requires all farmers to notify veterinary health authorities about sudden animal deaths.
"…It's me who notified the district authorities about the animal deaths and human death, almost 2 weeks after the first animal death. This was the same case during last year's anthrax outbreak…"
-46-year-old male security officer

Non-compliance of farmers to appropriate disposal of dead animals
The farmers were also non-compliant when it came to appropriate disposal animal carcasses, and instead opted to sell them to the illegal meat dealers to avoid total losses. This complacency ensures the dealers have constant source of meat from animals found dead thus propagating the practice. "… *I was called by the farm owner to go and buy some cows that had died"…They sell them to us to avoid total losses."*
-52-year-old male meat dealer

High profitability of the illegal meat trade
The illegal meat trade requires very low capital in terms of investment and yet has very high returns. This is because the sick animals and animal carcasses are sold very cheaply as noted by one of the key informants. This makes illegal meat trade a very attractive business for persons with limited working capital and those looking for quick profits.
"…These animals are cheap and fetch a lot of profits. We buy a cow at UGX 200,000 (54USD) and earn a profit of over UGX 710,000 (189USD)…"
32-year-old female restaurant owner

Community preference for cheap meat
The community members generally preferred cheap meat and thus facilitated the illegal meat trade by ensuring a readily available market. Key informants noted that people in the peri-urban and rural areas preferred cheap meat since most can't afford the price of normal meat.
"I buy a kilogram of meat at UGX 3,000-6,000 (≈1USD-2USD)…my customers and I can't afford the normal meat whose price is UGX 12,000 (4USD)…"
48-year-old female restaurant owner

Misperception of risk of anthrax transmission among dealers
The illegal meat dealers misperceived their risk of acquiring anthrax from handling animals found dead or their meat. They did not perceive that butchering or handling meat from animals found dead posed a risk of acquiring anthrax to them. Even those that developed anthrax were dismissive of the diagnosis and instead attributed their symptoms to witchcraft.
"…I don't think it is dangerous to butcher those animals. We were told that we acquired anthrax from the dead animals that we slaughtered but…this was witchcraft…"
53-year-old male meat dealer

Discussion

We found a well-organized network of dealers in meat from animals found dead, operating in Ibanda District and beyond. They buy animals found dead from the local farms in Ibanda and neighboring districts of Kazo and Kiruhura districts, and sell the meat to local consumers in Ibanda and fellow dealers in neighboring Kitagwenda District. By butchering and selling meat from infected cows in several villages, the dealers likely facilitated spread of anthrax infection and widened the scope of recent outbreaks. Reported drivers of illegal meat trade included delayed or non-reporting of animal deaths, non-compliance to mandatory disposal of animal carcasses and high profitability of the illegal meat trade. In addition, there was poor enforcement of meat market regulations, non-functional surveil-

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lance for animal deaths and misperception of risk of acquiring anthrax among dealers.

Our study revealed that illegal meat dealers were linked to the March-April, 2023 anthrax outbreak in Kagongo Division, Ibanda District when they butchered cattle that were found dead at a local farm. Subsequently, all the human anthrax cases were reported from five villages where the above meat was sold. In August 2022, dealers had also facilitated the human anthrax outbreak by butchering cattle that had died on a farm from the neighboring district of Kitagwenda (7). Furthermore, butchering animals that have died of anthrax also spreads and sustains anthrax spores in the grazing areas, which could explain the recurrent outbreaks.

The discovery of well-organized networks of illegal meat dealers adds a new dimension to the investigations of anthrax and other zoonotic disease outbreaks in humans. We did not find previous studies that had found such organized illegal meat trade in the context of anthrax or zoonotic disease outbreaks. However, a previous study in France that had highlighted the role of the meat production chain in amplification of infectious diseases. It found that meat production industry had likely amplified zoonotic infectious disease epidemics in France (12)

The role of butcheries in spreading anthrax infection was also highlighted during an anthrax outbreak investigation in Isingiro District. It was found that case-patients had bought and eaten meat from a particular butcher who had slaughtered a diseased cow from a local farm (2).

In addition, such uninterrupted networks of illegal meat dealers discourage farmers from complying with the mandatory reporting and appropriate disposal of carcasses. They opt to selling them to the dealers to avoid total losses in absence of a functional animal death surveillance system. By butchering diseased animals, the dealers sustain spores in the environment including grazing areas which could explain the recurrent anthrax outbreaks in these areas. This assertion is supported by findings of the environmental studies during the outbreak investigation in Ibanda District. Soil samples from three different sites in the affected farm returned positive results for *Bacillus anthracis*. In addition, a study in Uganda found that disposing or butchering livestock with suspected anthrax within <50m from kraals or near grazing areas were associated with recurrent anthrax outbreaks (4)

Many of the drivers of illegal meat trade were also consistent with findings of previous studies in Uganda about factors associated with anthrax outbreaks (2, 4-6, 8).

The delay in reporting animal deaths by farmers as they buy time to sell them to the dealers, delays outbreak response subsequently delays the response. This contributes to further spread of anthrax in animals and humans as they continue to handle and/or eat meat from the slaughtered infected animals.

In Ibanda District, the above situation was made worse by lack of a functional animal anthrax disease surveillance system. Animal deaths were only occasionally notified by concerned citizens and security officer and such notifications often reached the District veterinary officer late. This gap in detection of anthrax outbreaks if not addressed, would make it difficult for Uganda to attain the targets of the global '7-1-7' goal for early outbreak detection and control at source (13).

Study limitations

The perspectives of farm managers in Kazo and Kiruhura districts, the dealers' agents and co-dealers in Kitagwenda District were not sought. However, we were able to achieve saturation after 11 interviews which meant that any additional interviews wouldn't have generated valuable new information.

We relied on self-reports from the dealers for most of the data on the illegal meat trade which might have led to social desirability bias. Nevertheless, it was minimized during the consenting process during which dealers were assured of confidentiality and no risks arising out their participation. We also endeavored to create enough rapport with the participants and conducted all the interviews in privacy to encourage disclosure.

Conclusion

Illegal meat dealers operate well-organized networks in Ibanda District. By butchering and selling meat from infected cows in several villages, they likely facilitated spread of anthrax infection and widened the scope of recent outbreaks. The practice is also known to spread and sustain anthrax spores in the environment including grazing areas and could explain the recurrent outbreaks. The reported drivers included delayed or non-reporting of

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animal deaths, non-compliance to mandatory disposal of animal carcasses, non-functional surveillance for animal deaths, public willingness to buy meat from animals found dead or ill, inadequate enforcement of meat market regulations and misperception of risk of acquiring anthrax among dealers.

Recommendations

To mitigate the risk of future outbreaks, we recommended the following:

The district veterinary and production, and health departments and law enforcement agencies should strengthen enforcement of laws that prohibit trade in animals that are found dead or diseased through multisectoral collaboration. Such laws include the public health (meat) rules, UNBS hygienic requirements for butcheries, and animal diseases act.

The district health, and veterinary and production departments working together should also sensitize the community members, meat traders and farmers on anthrax.
The messages should include information on the cause, transmission, prevention, presentation and management of anthrax in both animals and humans.

The district veterinary and production department working with the law enforcement agencies should strengthen regulation of animal movements and their products within and between districts, and lower local governments. This can be achieved through strict enforcement of the animal diseases act and other relevant laws on animal trade, and through enacting appropriate byelaws.

The district veterinary and production department should ensure that all animals are inspected before slaughter in all areas including rural, urban and peri-urban settings. More emphasis needs to be put on peri-urban and rural areas where the meat market is poorly regulated.

The district veterinary department should enhance surveillance for animal deaths to enable timely detection and reporting of anthrax and other zoonotic diseases. This will facilitate prompt control of any future outbreaks at source thus limiting the scope in both animals and humans.

The government of Uganda should consider compensating farmers for reported and verified animal deaths to incentivize reporting, and appropriate disposal of animal carcasses. This will dissuade farmers from selling or slaughtering the animal carcasses for human consumption.

The ministry of agriculture, animal industries and fisheries working with the ministry of health should consider conducting further investigations into illegal meat trade in other anthrax prone districts in Uganda to inform targeted interventions. This is necessary for the broader prevention of anthrax outbreaks attributable to the practices of illegal meat traders in the entire country.

Conflict of interest
The authors declare no conflict of interest.

Authors' contributions
YN, DK, DA, AK, IS, SW, BK, RM and DK designed the study, contributed to data collection and analysis. YN led the writing of the bulletin. YN, DK, DA, IS, SW, LB, BK, RM, FM, and ARA participated in bulletin writing and review to ensure scientific integrity and intellectual content. All authors contributed to the final draft of the bulletin. All authors read and approved the final bulletin.

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References
1. Dragon DC, Rennie RP. The ecology of an-

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thrax spores: tough but not invincible. The Canadian Veterinary Journal. 1995;36(5):295.
2. Nakanwagi M, Ario AR, Kwagonza L, Aceng FL, Mwesigye J, Bulage L, et al. Outbreak of gastrointestinal anthrax following eating beef of suspicious origin: Isingiro District, Uganda, 2017. PLoS Neglected Tropical Diseases. 2020;14(2):e0008026.
3. Elelu N, Aiyedun JO, Mohammed IG, Oludairo OO, Odetokun IA, Mohammed KM, et al. Neglected zoonotic diseases in Nigeria: Role of the public health veterinarian. Pan African Medical Journal. 2019;32(1).
4. Coffin JL, Monje F, Asiimwe-Karimu G, Amuguni HJ, Odoch T. A One Health, participatory epidemiology assessment of anthrax (Bacillus anthracis) management in Western Uganda. Social Science & Medicine. 2015;129:44-50.
5. Senyange S, Nsubuga EJ, Kadobera D, Kwesiga B, Bulage L, Ario AR. Knowledge, Attitudes and Practices regarding Anthrax among affected communities in Kazo District, South-western Uganda, May 2022.
6. Kisaakye E, Ario AR, Bainomugisha K, Cossaboom CM, Lowe D, Bulage L, et al. Outbreak of anthrax associated with handling and eating meat from a cow, Uganda, 2018. Emerging Infectious Diseases. 2020;26(12):2799.
7. Monitor D. Anthrax outbreak in Ibanda leaves one dead, 20 admitted. 2022; Available from: https://www.monitor.co.ug/uganda/news/national/anthrax-outbreak-in-ibanda-leaves-one-dead-20-admitted-3940898.
8. Musewa A, Mirembe BB, Monje F, Birungi D, Nanziri C, Aceng FL, et al. Outbreak of cutaneous anthrax associated with handling meat of dead cows in Southwestern Uganda, May 2018. Tropical Medicine and Health. 2022;50(1):1-8.
9. Health UNIoP. Anthrax outbreaks in Uganda, 2017- 2023. 2023; Available from: https://uniph.go.ug/.
10. Statistics UBo. Population & Censuses. 2023; Available from: https://www.ubos.org/explore-statistics/20/.
11. UBOS. National Population and Housing Census 2014, Area Specific Profiles. 2014.
12. Espinosa R, Tago D, Treich N. Infectious diseases and meat production. Environmental and Resource Economics. 2020;76(4):1019-44.
13. Frieden TR, Lee CT, Bochner AF, Buissonnière M, McClelland A. 7-1-7: an organising principle, target, and accountability metric to make the world safer from pandemics. The Lancet. 2021;398(10300):638-40.

Anthrax outbreak associated with consumption and handling of meat from suddenly dead cattle, Kabira Sub-County, Kyotera District, Uganda, June–December 2023

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Summary

Background: In November 2023, a strange illness was reported in Kabira Sub-County Kyotera District, characterized by itching, rash, swelling, and skin lesions. Subsequent investigation confirmed the illness as anthrax. We investigated to assess its magnitude, identify potential exposures, and propose evidence-based control measures.

Methods: A suspected cutaneous anthrax case was acute onset of skin itching or swelling plus ≥2 of skin reddening, lymphadenopathy, headache, fever, general body weakness in a resident of Kabira sub-county, June–December, 2023. A suspected gastrointestinal anthrax case was acute onset of ≥2 of abdominal pain, vomiting, diarrhea, mouth lesions, neck swelling, in a resident of Kabira sub-county, June–December, 2023. A confirmed anthrax case was a suspected case with *Bacillus anthracis* PCR-positive results. We reviewed medical records and community active case-finding. In a case-control study, we compared exposures between 50 case-patients and 200 neighborhood controls.

Results: We identified 63 cases (46 suspected and 17 confirmed); most (n=48; 76%) were male. Of these, 55 cases (87%) were cutaneous and 8 (13%) were gastrointestinal, with a mean age of 42 years. Overall attack rate was 3.1/1,000; males were more affected (4.5/1,000) than females (AR=1.5/1,000). Case

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-fatality rate was 19% (n=12). Only 29% (n=18) of the cases sought care from health facilities with majority (52%, n=33) being managed from shrines by traditional healers. 74% (37/50) case-patients and 21% (41/200) control-persons consumed meat from cattle that died suddenly (aOR = 6.19; 95% CI: 2.76–13.9). 62% (31/50) case-patients and 18% (36/200) control-persons had contact with meat or other products from animals that died suddenly (aOR = 2.52; 95% CI: 1.08–5.91).

Conclusion: The anthrax outbreak in Kyotera District was primarily attributed to the consumption and handling of meat from suddenly deceased cattle. To prevent future outbreaks, we recommended implementing inspection protocols for cattle before slaughter, instituting widespread vaccination campaigns against *Bacillus anthracis* in livestock and community sensitization on healthcare seeking. These proactive measures could reduce the risk of anthrax transmission to humans and mitigate the impact of outbreaks on public health and agricultural livelihoods in the region.

Background

Anthrax is a serious infectious zoonotic disease caused by gram-positive, rod-shaped, and spore forming bacteria known as *Bacillus anthracis*(1). The bacteria naturally present in soil and causes severe illness in both animals and humans. Domestic and wild animals become infected when they breathe in or ingest spores in contaminated soil, plants or water(2). The age, sex and condition of animals may all influence the incidence of the disease at any one site(3). There are no reports of person to person transmission of anthrax, people get sick with anthrax through contact with infected animals or occupational exposure to infected or contaminated animal products (e.g. hair, wool, hides, bones)(4). When anthrax spores get inside the body, they are activated, multiply, spread out in the body, produce toxins, and cause severe illness(5). The incidence of the disease depends on the level of exposure to the affected animals. In contrast to animals, age- or sex-related bias is generally not apparent in humans, though males generally have higher occupational risk rates in many countries(6).

Human anthrax infection is classified into four forms depending on the route of exposure, with varying degree of severity and incubational period; cutaneous (1–12 days), inhalational (1–60 days), gastrointestinal (1–6 days), injectional (1–10 days)(7).

Cutaneous anthrax is the most common form, accounting for >95% of human cases, and results from direct contact with or exposure to infected animals or contaminated animal products (8). It is typically a localized skin infection, often occurring on the face, neck, arms, or hands.

Approximately 2,000 to 20,000 cases of human anthrax are reported globally annually, with 75% occurring in African countries with low livestock vaccination rates(9). Uganda has reported sporadic anthrax outbreaks in different sub regions of the country(10). The outbreaks mainly occurs in areas where people commonly keep livestock primarily within western, eastern, and northern Uganda(11).

On November 21, 2023, a strange illness was reported in Kabira Sub-County, Kyotera District, characterized by itching, rash, swelling, and skin lesions. Subsequent investigation confirmed the illness as anthrax. We investigated to assess its magnitude, identify potential exposures, and propose evidence-based control measures.

Methods

Outbreak area

This outbreak occurred in Kabira Sub-County, Kyotera District which is located in the South Western part of Uganda (Figure 1). The district has a total area of 1,722 (sq. km), with a population of approximately 261,000 (12). Agriculture forms the backbone of the economy of the district although most of the agriculture is at subsistence level.

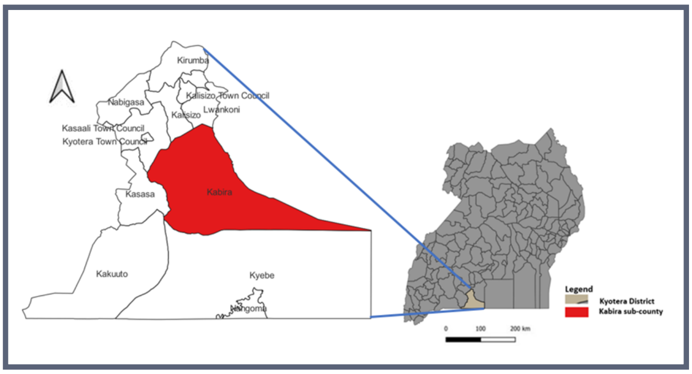

Figure 1: Location of Kyotera District in Uganda

Case definition and case finding

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We defined a suspected case as follows:Cutaneous anthrax: Acute onset of skin itching or swelling plus ≥2 of; skin reddening, lymphadenopathy, headache, fever, general body weakness in a resident of Kabira sub-county from June–December 2023 OR Gastrointestinal anthrax: An acute onset of ≥2 of the following symptoms; abdominal pain, vomiting, diarrhea, mouth lesions, neck swelling, in a resident of Kabira sub-county from June–December 2023. A Confirmed anthrax case: A suspected case patient with PCR-positive results for *Bacillus anthracis.*

We conducted house to house and health facility active case search using our case definition to identify case-patients in the affected areas since June 1, 2023. We also asking already identified case-patients to lead us to people with similar signs and symptoms in the community. We interviewed identified case-patients to identify possible exposures for contracting Anthrax.

Descriptive epidemiology

We calculated proportions to describe the distribution of case-persons by age, sex, and symptoms. We also described case-persons by time of onset of symptoms using an epidemiological curve and calculated attack rates to describe the distribution of cases by age, sex, and parish.

Laboratory Investigations

In humans, 57 samples (30 whole blood and 27 swabs) were collected from anthrax-suspected cases and available fluids from lesions. In cattle, 24 samples (18 swabs and 6 body tissue (ear lobe) were collected from carcasses and cattle already butchered. All samples were packaged using a triple package technique and transported using the hub system to the Uganda Virus Research Institute (UVRI) in Arua and the National Animal Disease Diagnostics and Epidemiology Centre (NADDEC) laboratory in Entebbe Uganda for anthrax testing in humans and animals respectively.

Environmental investigations

We inspected animal farms in the affected villages using snowballing and house-to-house visits to identify farms that had reported sudden death of cattle, goats or sheep within Kabira Sub County between June 1, 2023 and December 15, 2023. We interviewed the farm owner and herdsman to gather information on the farm management practices and how the meat and other animal products were distributed. We visited the affected farms and observed the pasture in the grazing area, and also areas where the cattle were slaughtered or buried. We interviewed the identified dealers of meat from cattle that had died suddenly and slaughtered for distribution.

Hypothesis generation interviews

We conducted interviews with the 63 suspected cases to identify possible sources and factors associated with contracting anthrax. We explored for meat consumption from cattle that died suddenly, contact with livestock that suddenly died, presence of skins and hides, animal ownership, and occupation.

Case-control study

To test the hypotheses, we conducted a case-control study in the in Kabira sub-county, Kyotera District. We recruited and interviewed the first 50 case-patients on the line list in the case-control study. For each case-patients, we selected 4 control persons. A control person was an individual who never had any signs of cutaneous or gastrointestinal anthrax from June 1, 2023 to the time of the investigation, resident in the same village as the case-patient. To randomly select control persons, we obtained the locations of case patients' households and spun a bottle while at these households to obtain the first control-person household. The bottle was spun after every interview until the four different households were got. All members present in the households at the time of data collection were listed and one was chosen randomly as a control-person.

For each case and control, we obtained information on their meat consumption history, contact with dead livestock (slaughtering, dissecting, carrying), eating meat of an animal that had died suddenly, the clinical characteristics, as well as demographic variables.

We used logistic regression to identify factors associated with anthrax. Variables that had a p-value <0.2 at bivariate level were included in the final model for multivariable analysis and corresponding adjusted odds ratios (aOR's) and 95% confidence intervals were reported.

Ethical considerations

This investigation was a response to a public health emergency. The Ministry of Health (MOH) gave permission to investigate the deaths and the

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Centre for Global Health, US Center for Disease Control and Prevention determined the activity as non-human research but rather aimed at improving public health practices or disease control. We sought permission to conduct this investigation from Kyotera District health authorities. We also sought verbal informed consent from the respondents who were caretakers of the deceased, family members and suspect cases. The respondents were informed that their participation was voluntary and were free to continue or opt out with no negative consequences. The data collected was coded with no individual personal identifiers so as to maintain confidentiality.

Results

Descriptive epidemiology

We line listed 63 Anthrax case-patients, with 17 confirmed and 46 suspected as of December 31, 2023. Seventy-six percent (n=48) were males, 12 case-patients died, with an overall attack rate of 3.1/1,000 population and case fatality rate of 19%. Of the 63 case-patients, 55 were cutaneous and 8 gastrointestinal, with a mean age of 42 years (interquartile range: 13-75 years). Males were more affected (AR: 4.5/1,000) than females (AR: 1.5/1,000), age-group 50-69 was most affected (AR = 14/1,000). Swelling of the skin (81%), itching of the skin (81%) and general body weakness (57%) were the most common sign and symptom of illness among case-persons (figure 2). Only 29% of the case-patients sought care from Health facilities.

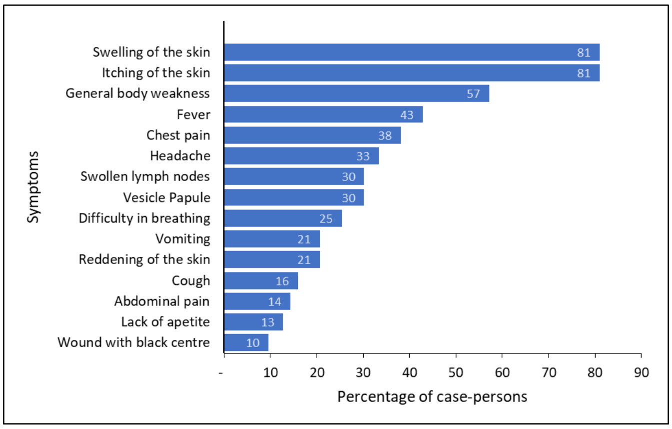

Figure 2: Distribution of symptoms among anthrax case-persons during an anthrax outbreak: Kyotera District, Uganda, June-December, 2023.

As of December 31, 2023, a total of three parishes of Bwamijja, Ndolo and Kyanika were affected. Bwamijja parish was the most affected (AR: 5.3/1,000), followed by Ndolo (AR: 2.6/1,000) while Kyanika was the least affected (AR: 1.4/1,000) (Figure 3).

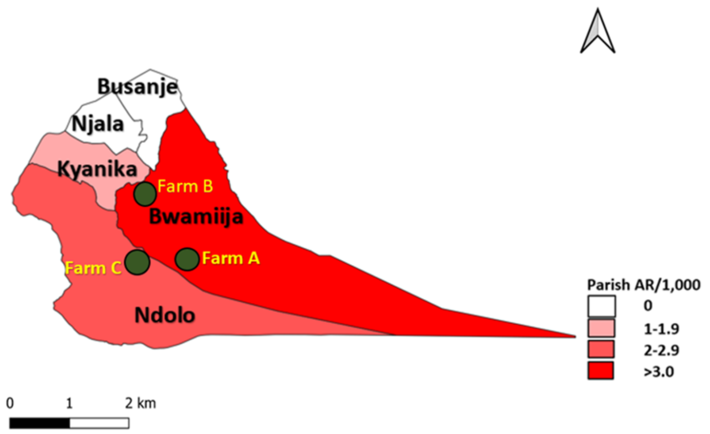

Figure 3: Location of the affected parishes and farms during an anthrax outbreak in Kyotera District, June–December, 2023

Following the sudden death and slaughtering of an animal on Farm B on June 10, 2023, case-persons started to appear from June 15, 2023 (Figure 8). There was no case-person recorded from July 27, 2023 up to September 13, 2023. This coincided with no animal deaths reported following a massive treatment of cattle on Farm B with penicillin therapy. Case-persons reappeared starting September 16, 2023 just 1 week after cattle had resumed dying on farm B and two other farms. The number of case-persons rapidly increased and peaked in November, 2023. This epidemic curve suggests a multiple-source outbreak.

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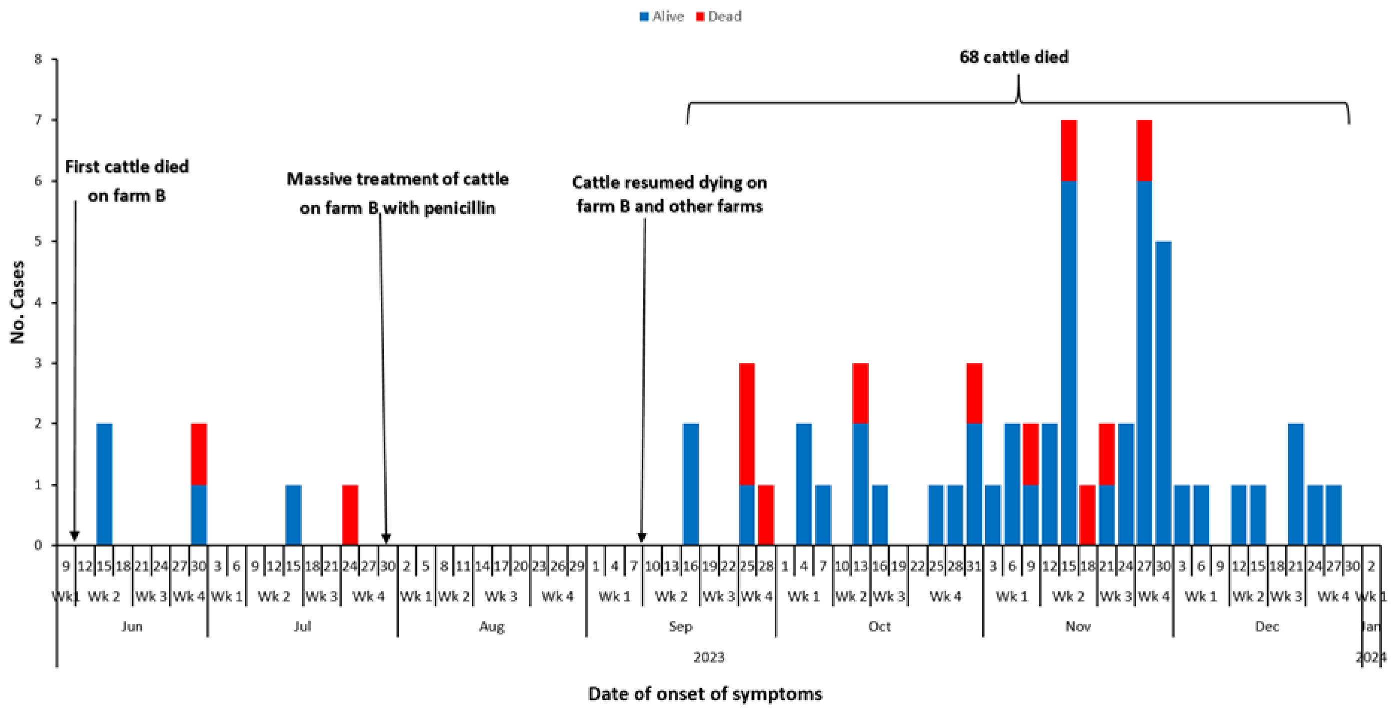

Figure 4: Distribution of anthrax cases by date of symptom onset: Kyotera District, Uganda, June–December, 2023

Laboratory investigation findings

A total of 81 (57 human and 24 cattle) samples were collected and tested for Bacillus anthracis. Seventeen of the human samples returned PCR positive (positivity rate of 30%) while we were not able to obtain results of the 24 animal results.

Environmental assessment findings

There were 68 suspected cases of animal anthrax that died on three different farms (A, B & C) located in Kidda, Kyamayembe, and Kifambi villages in Bwamiija and Ndolo parishes respectively in Kabira sub-county. These three farms share one stream of drinking water with two of them (Farm A and C) having a common point of drinking water. The first animal died on farm B on June 10, 2023, and the dead animal was slaughtered by meat dealers who sold it to the surrounding community at the trading centers of Kyanika, Kyamayembe, and Kifambi at an average price of $1.28 per Kilogram. Farm B subsequently lost 22 cattle, and all of them were sold to the local community by the meat dealers. According to the farm manager, the deaths of cattle on farm coincided with the heavy rains. An organized network of people dealing in cheap meat from cattle that died suddenly was discovered in Kabira Sub-county, Kyotera District. We also identified an area next to dead meat stall where meat was prepared very fast for the slaughtering teams and people drinking in the next bar. Boiled meat termed ‘Huta Huta ko’ was sold cheaply to people such that it’s affordable for everyone.

Hypothesis generation

Based on the 63 hypothesis generating interviews, 79% of the respondents indicated they had consumed meat from cattle that had died suddenly, 63% had contact with dead livestock, wildlife or their body fluids, while 33% had participated in slaughtering or handling of animal products. We hypothesized that consuming and handling meat from cattle that died suddenly were associated with the December 2023 anthrax outbreak in Kyotera District.

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Case-control study findings

Following adjustment for age and sex in the case-control investigation, 74% (37/50) of case-patients compared to 21% (41/200) of control-persons consumed meat from an animal that had died suddenly (aOR = 6.19; 95% CI: 2.76–13.9). In addition, 62% (31/50) of case-patients compared to 18% (36/200) had contact with meat or other products from cattle that had died suddenly (aOR = 2.52; 95% CI: 1.08–5.91).

Table 1: Distribution of exposure status among cases and controls during an anthrax outbreak: Kyotera District, Uganda, June–December, 2023

Variables	Cases, n=50 (%)	Controls, n=200(%)	Crude ORs (95% CI)	Adjusted ORs (95% CI)
Consumed dead cattle meat	37(74.0)	41(20.5)	11.0 (5.38, 22.7)	6.19 (2.76, 13.9)
Contact with meat or other products from dead cattle	31(62.0)	36(18.0)	7.43 (3.78, 14.6)	2.52 (1.08, 5.91)
Butcher man	8(16.0)	3(1.5)	2.52 (1.15, 3.89)	2.77 (1.04, 4.51)
Presence of hides in the household	6(12.0)	7(3.5)	1.32 (0.19, 2.46)	0.77 (-0.65, 2.19)
Owned animals	27(54)	83(41.5)	0.5 (-0.12, 0.13)	0.34 (-0.36, 1.04)
Meat trader	4(8.0)	1(0.5)	2.85 (0.63, 5.06)	2.93 (0.23, 5.64)
Cattle keeper	2(4.0)	14(7.0)	-0.6 (-2.11, 0.92)	-1.4 (-3.56, 0.76)

Discussion

This investigation confirmed an anthrax outbreak among humans in Kabira sub-county, Kyotera District with both cutaneous and gastrointestinal clinical signs and symptoms observed. The study found that male were more affected than women, with the majority case-patients being managed by traditional healers. There was evidence that the outbreak was caused by *Bacilius anthracis* and was spread through handling and consuming meat from cattle that died suddenly on local farms.

Cutaneous cases were more than the gastrointestinal, these findings were consistent with other studies(13)(14). Since hands are used for handling meat, they are at higher risk of developing abrasions, bruises, and cuts, thereby creating a route of entry for the anthrax spores. The findings also agree with a study by Chakraborty A. et al (2012) on anthrax outbreaks in Bangladesh which indicated that fewer gastrointestinal cases were due to cooking meat for a long period (15). The process of cooking destroys the *Bacillius anthracis* thus reducing the virulence and chances of causing the disease.

The study found that males were more affected than females, the findings were in agreement with a study that revealed males are most likely to be engaged in exposures to animal carcasses such as slaughter, skinning, transportation, and selling of meat from cattle that have died of anthrax(6).

The case fatality rate of 19% was high, this finding was contrary to other studies that had recorded low fatality cases in anthrax outbreaks(16)(17). This was probably due to failure or delay to seek appropriate care especially during the initial stage of the outbreak as many people believed that witchcraft was the cause of the disease and thought care from traditional healers in shrines

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(18).

The onset of symptoms in case-patients in the 11 villages coincided with the slaughtering and selling of the meat from the affected farms, this indicates that persons who ate or had contact with the dead cattle had an increased risk of cutaneous and Gastrointestinal Anthrax. Previous studies of anthrax outbreaks in Uganda also found an association of anthrax to handling and eating of meat from cattle that died suddenly before slaughter(19)(20)(21). This investigation demonstrated that consumption and contact with meat from the cattle that died suddenly resulted in the Anthrax outbreak. This information was utilized by Kyotera District to implement immediate interventions to limit the spread of infection and stop the outbreak.

Study limitations

Some cases may not have been line-listed during case finding given that many people were managed in secret shrines by traditional healers and we could not be allowed to access them. This likely lead to an under estimation of the magnitude of the outbreak. The presentation of gastrointestinal anthrax is similar to other diseases such as ulcero glandular tularemia and bubonic plague. Additionally, some anthrax cases only develop mild symptoms and may not know that they have anthrax, so the likelihood of missing them out during case finding is high hence the possible under estimation of the magnitude of this outbreak.

Conclusion

Eating and handling meat from cattle that died suddenly was the cause of the Anthrax outbreak in Kabira Sub County, Kyotera District. We recommended the inspection of all cattle before slaughter and vaccination of livestock against *B. anthracis.* We also recommended continued risk communication and community engagement sessions regarding Anthrax throughout the District.

Public health actions

Following our recommendations, the task force immediately announced an animal quarantine for 14 days. Additionally, the affected communities were sensitized to create Anthrax awareness. Farm managers were also supported to properly dispose off animal carcass whenever an animal died on the farm.

Conflict of interest

The authors declare no conflict of interest

Author contribution

LT, DK, BK, RM, DK, ARA conceived and designed the study. LT, DK, AK, BK, RM, DK, ARA contributed to data collection, cleaning and analysis. AK, EN, AB, participated in coordination of laboratory work. LT, DK, AK, EN, BK, RM, DK, ARA took lead in developing the bulletin. All authors contributed to the final draft of the bulletin. All the authors read and approved the final bulletin.

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References

1. Kamal SM, Rashid AKMM, Bakar MA, Ahad MA. Anthrax: an update. Asian Pac J Trop Biomed. 2011;1(6):496–501.
2. Sweeney DA, Hicks CW, Cui X, Li Y, Eichacker PQ. Anthrax infection. Am J Respir Crit Care Med. 2011;184(12):1333–41.
3. Range RWH. Anthrax in free-ranging wildlife. Fowler's Zoo Wild Anim Med Curr Ther (Miller, RE Fowler, ME eds), Elsevier Heal Sci St Louis. 2011;98.
4. Doganay M, Demiraslan H. Human anthrax as a re-emerging disease. Recent Pat Anti-infect Drug Discov. 2015;10(1):10–29.
5. Moayeri M, Leppla SH, Vrentas C, Pomerantsev AP, Liu S. Anthrax pathogenesis. Annu Rev Microbiol. 2015;69:185–208.

Continues to page 30

6. Organization WH, Epizootics IO of. Anthrax in humans and animals. World Health Organization; 2008.
7. Cieslak TJ, Eitzen Jr EM. Clinical and epidemiologic principles of anthrax. Emerg Infect Dis. 1999;5(4):552.
8. Doganay M, Metan G, Alp E. A review of cutaneous anthrax and its outcome. J Infect Public Health. 2010;3(3):98–105.
9. Gachohi J, Bett B, Otieno F, Mogoa E, Njoki P, Muturi M, et al. Anthrax hotspot mapping in Kenya support establishing a sustainable two-phase elimination program targeting less than 6% of the country landmass. Sci Rep. 2022;12(1):21670.
10. Coffin JL, Monje F, Asiimwe-Karimu G, Amuguni HJ, Odoch T. A One Health, participatory epidemiology assessment of anthrax (Bacillus anthracis) management in Western Uganda. Soc Sci Med. 2015;129:44–50.
11. Musewa A, Mirembe BB, Monje F, Birungi D, Nanziri C, Aceng FL, et al. Outbreak of cutaneous anthrax associated with handling meat of dead cows in Southwestern Uganda, May 2018. Trop Med Health. 2022;50 (1):1–8.
12. Statistics UBO. The national population and housing census 2014-main report. Kampala Uganda Bur Stat. 2016;
13. Gombe NT, Nkomo BMM, Chadambuka A, Shambira G, Tshimanga M. Risk factors for contracting anthrax in Kuwirirana ward, Gokwe North, Zimbabwe. Afr Health Sci. 2010;10(2):159–64.
14. Patassi AA, Saka B, Landoh DE, Agbenoko K, Tamekloe T, Salmon-Ceron D. Detection and management of the first human anthrax outbreak in Togo. Trop Doct. 2016;46 (3):129–34.
15. Chakraborty A, Khan SU, Hasnat MA, Parveen S, Islam MS, Mikolon A, et al. Anthrax outbreaks in Bangladesh, 2009–2010. Am J Trop Med Hyg. 2012;86(4):703.
16. Opare C, Nsiire A, Awumbilla B, Akanmori BD. Human behavioural factors implicated in outbreaks of human anthrax in the Tamale municipality of northern Ghana. Acta Trop. 2000;76(1):49–52.
17. Takawira E, Charimari L, Tshimanga M. An outbreak investigation of Anthrax in Rushinga District of Mashonaland Central Province in Zimbabwe. Harare: ZimFETP. 2004;
18. Kracalik I, Malania L, Tsertsvadze N, Manvelyan J, Bakanidze L, Imnadze P, et al. Human cutaneous anthrax, Georgia 2010–2012. Emerg Infect Dis. 2014;20(2):261.
19. Monje F, Kisaakye E, Ario AR, Eurien D, Ntono V, Kadobera D, et al. Anthrax Outbreaks among Domestic Ruminants Associated with Butchering Infected Livestock and Improper Carcass Disposal in Three Districts of Uganda, 2016-2018. 2020;
20. Aceng FL, Ario AR, Alitubeera PH, Neckyon MM, Kadobera D, Sekamatte M, et al. Cutaneous anthrax associated with handling carcasses of animals that died suddenly of unknown cause: Arua District, Uganda, January 2015–August 2017. PLoS Negl Trop Dis. 2021;15 (8):e0009645.
21. Kibwika B, Namulondo E, Aanyu D, Nuwamanya Y, Rek J, Kiza D, et al. Anthrax outbreak associated with handling and consuming meat from animals that died suddenly, Ibanda District, Uganda, May 2023.

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Cholera outbreak associated with drinking contaminated lakeshore water, Namayingo District, Uganda, July–August 2023

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Summary

Background: On July 24, 2023 Uganda's Ministry of Health confirmed a cholera outbreak on Sigulu Island, Namayingo District. We investigated to determine its magnitude, identify possible exposures and recommend evidence-based control interventions.
Methods: We defined a suspected case as acute onset of watery diarrhea in a resident of Sigulu and Bukana Sub-counties in Namayingo District from July 1–August 15, 2023, and a confirmed case as a suspected case with positive *Vibrio cholerae* serotype 01 and 0139 stool culture. Cases were identified by active case search and records review at the health centers. We conducted descriptive epidemiology, environmental assessment at the lakeshore water collection points, and generated hypotheses. We additionally collected water samples from lakeshore water collection points and Jericans used for household water storage for cholera testing. We conducted an unmatched individual case-control study to compare exposures among case-patients and asymptomatic controls residing in Sigulu and Bukana sub-counties.
Results: We identified 24 cases of which 4 were confirmed to have *V.cholerae* serotype 01 and 0139 ogawa. Fifteen (62%) cases were female and the median age of cases was 27 years (range:2-68 years). Nine (37%) received the oral cholera vaccine (OCV) in 2020/2021. The epi curve showed a propagated outbreak after the contamination of a communal water collection point on July 8, 2023 by the primary case who had recently traveled back from a neighboring country with a cholera outbreak. Eighteen (75%) were resident of Secho village in Sigulu sub county. All case-patients drunk lakewater but no water samples tested positive for *Vibrio cholerae.* Compared to other water collection points, drinking water from water point A in Secho, Sigulu sub-county increased odds of getting cholera (aOR=4.3, 95% CI: 1.3–15). Treatment of drinking water by any means (aOR=0.085, 95% CI: 0.097–0.74) and receiving OCV (aOR=0.16, 95% CI: 0.051–0.56) were both protective. We observed residents directly drawing lakeshore water for laundry, bathing, and drinking.
Conclusion: This cholera outbreak in an island community was associated with the introduction of *Vibrio cholerae* by a traveller, followed by community consumption of untreated lakeshore water. We recommended mass distribution of water treatment tablets, repeated OCV, and community mass sensitization about risks associated with drinking untreated lake water.

Introduction

Cholera is characterized by profuse rice water diarrhea and is caused by the bacterium *Vibro cholerae*. It is transmitted through the consumption of *Vibrio cholerae* fecally contaminated food and water (1). It has an incubation period of hours to 5 days, with most infected persons being asymptomatic carriers capable of transmitting infection (2). Most of the global burden of cholera is seen in developing countries and areas with poor sanitation (ref). Globally, there are about 1.3 to 4 million cases and 22,000 to 143,000 deaths annually (3). Clusters of cholera are common due to either person to person spread or through spread from contamination of the environment by a case (4). Strategies for prevention of cholera include; vaccination in hotspots, and improving water, sanitation and hygiene. The global targets are a reduction of deaths by 90% and elimination of transmission in 20 countries by 2030 (5).

Uganda is one of the cholera endemic countries targeted for cholera elimination by the global task force for cholera. Between 2015 and 2021, Uganda had reported 63 outbreaks from 61 districts with a total of 8,498 cases(6). There are several hotspots in the country including border and refugee hosting districts and, lakeshore communities. Urban slums are also at high risk of cholera(7,8). While progress has been made in the fight against Cholera, over 15 districts remain endemic for Cholera in Uganda including Namayingo (6,9). Between 2018 and 2021, the country rolled out the Oral Cholera Vaccination

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(OCV) campaign in several districts, including Namayingo in a bid to eliminate Cholera from these districts. The vaccine is given in 2 doses, 14 days apart to people aged ≥2 years and provides protection upto 80% for 3 years (10). Despite this, the country still grapples with cholera outbreaks from time to time (6).

On July 24, 2023, the Ministry of Health was notified of a confirmed outbreak of Cholera in Sigulu Island. This followed an alert on July 15, 2023 of four residents from Secho village, Sigulu Island in Namayingo District presenting with acute profuse watery diarrhea and vomiting. Stool samples from 4 of the suspected cases were sent to the Central Public Health Laboratory (CPHL) for testing and three of the four were confirmed culture positive for *Vibro cholerae 01 ogawa.* We investigated the outbreak to determine its magnitude, identify possible associated exposures and recommend evidence-based control and prevention interventions.

Methods

Outbreak area

The outbreak occurred in Namayingo District, Busoga Region, in South Eastern Uganda. The district has nine subcounties and 193 villages with an estimated population of 247,400 people (11). Three of the district sub counties (Bukana, Sigulu and Lolwe) are Island sub counties, with an estimated population of 42,900 people. Safe water coverage in the district is 62% (12), and latrine coverage is 20% (13).

Case definition and finding

We defined a suspected case as any resident of Sigulu and Bukana Subcounties in Namayingo District aged ≥2 years with acute onset of watery diarrhea between July 1 – August 15 2023. A confirmed case was a suspected case with *Vibrio cholerae* O1 or O139 confirmed by stool culture. Cases were identified through records review at the health centres and active case search in the community.

Descriptive epidemiology

We conducted descriptive analysis of the cases identified during July 1 to August 15, 2023 by age, sex, clinical presentation, place of residence, possible exposures, and vaccination status. We calculated attack rates by age, sex, and place of residence using population estimates from Namayingo district biostatistician and Uganda Bureau of statistics, of persons aged ≥2 years. An epicurve was used to describe the distribution of cases by dates of symptom (diarrheal) onset.

Laboratory investigations

We collected both stool (ten samples) and water (six samples) and shipped to the Central Public Health Laboratories in triple packaging bags for testing.

Environmental assessment

We inspected six water collection sources identified by the case-patients in the villages of Secho, Bukana, Buhere, Buhone, and Bulagaye to observe for open defecation, water collection practices, and activities at the water collection sites like washing clothes and bathing.

Hypothesis generation

We used a case investigation form to collect information on potential exposures including sources of household water, water treatment practices, consumption of commercial foods and drinks, food preparation, contact with an individual with profuse watery diarrhea, and travel form an area with known cholera. We also assessed vaccination status of case-patients by looking at vaccination cards and for those with no cards, a vivid recall of the vaccination exercise, dose schedule, and vaccine administration. One was considered fully vaccinated if they had received 2 doses of the OCV.

Case control study

We conducted a 1:4 individual unmatched case control study in Sigulu and Bukana sub counties where the case-patients resided. Control persons were residents of the same village as the case patients but never had an episode of acute watery diarrhea from July 1, 2023 to the time of the investigation. They were selected randomly using the case patient household as the starting point and spinning a bottle to obtain direction of the next household. This was continued until all the 4 controls were selected.

Ethical considerations

The Ministry of Health (MoH) gave permission to investigate this outbreak. We additionally sought permission and support to conduct the investigation from district health authorities of Namayingo District. In addition, the office of the Center for Global Health, US Center for Disease Control and Prevention determined that this activity was not human subject research and with its primary intent being for public health practice or disease

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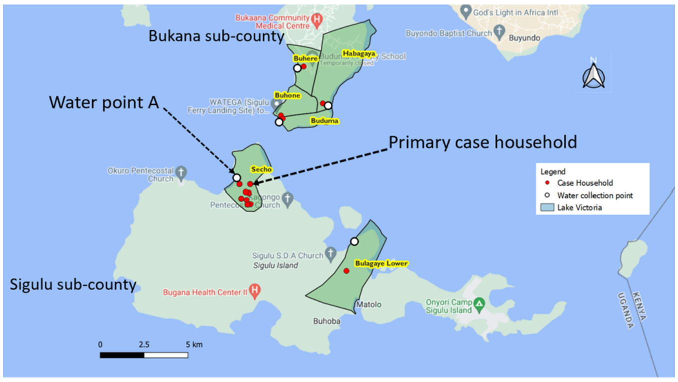
control. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy. § § See e.g., 45 C.F.R. part 46, 21 C.F.R. part 56; 42 U.S.C. §241(d); 5 U.S.C. §552a; 44 U.S.C. §3501 et seq.
We sought verbal informed consent from the respondents who were either sick at the time or survivors of cholera. All respondents were informed that their participation was voluntary and their refusal would not attract any negative consequences. To ensure confidentiality, personal identifying information collected was only accessed by the investigators.

Results

Descriptive epidemiology

We identified 24 cases of which four were confirmed cases of *Vibro cholerae,* serotype *01 and 0139 ogawa.* There was no death reported. The median age of the case-patients was 27 years (range: 1-68) and those above 15 years (79% (19) Attack rate (AR) 7/1000) were most affected. Both sexes were affected. However,females (63% (15), AR: 12/100,000) were more affected than males. Cases were clustered around water collection points, and the most affected were residents of Secho village in Sigulu sub county (79% (19), attack rate: 13/1000 (Figure). The epi curve showed a propagated outbreak following the washing of fecally soiled clothes by the primary case on



July 8, 2023 (Figure 2). The majority of case patients 92% (22) drank untreated lake water and 38% (9) received the OCV.

Figure 1: Location of affected villages and households affected by cholera and, the lake shore water collection points in the affected villages in Sigulu and Bukana sub county, Namayingo District, July 1 – August 15, 2023

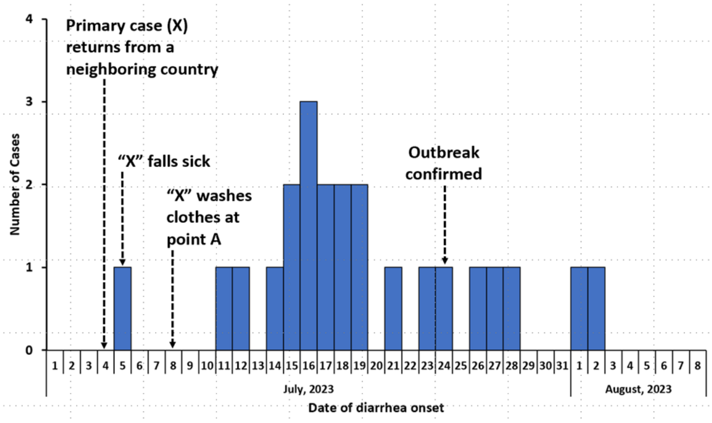


Figure 2: Distribution of symptom onset of cholera cases, Sigulu and Bukana sub-counties, Namayingo District, Uganda, July 1 – August 15, 2023

Environmental assessment findings

We found that residents drew lake water for all domestic use, but also bath and washed clothes at the lake shore water collection points. Residents were also seen drinking water directly drawn from the lake. The available boreholes had salty unpalatable hard water.

Exposures associated with cholera in Sigulu and Bukana subcounties, Namayingo District, Uganda, July 1 – August 15, 2023

From the case-control study, compared to other water collection points, drinking water from water point A in Secho, Sigulu sub-county increased odds of getting cholera (aOR=4.3, 95% CI: 1.3–15). The odds of getting cholera were reduced by treatment of drinking water by any means (aOR=0.085, 95% CI: 0.097–0.74) and receiving OCV (aOR=0.16, 95% CI: 0.051–0.56).

Discussion

This was a cholera outbreak following possible importation of *Vibrio cholerae* into Secho Village, Sigulu Island in Namayingo District. Six villages in 2 sub-counties were affected. We also show evidence that drinking untreated lake water was a risk factor, while the cholera vaccine remained protective after 2 years of administration.

Namayingo District borders Kenya to the east and

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is a cholera epidemic prone district. In the past, the district has had several cholera outbreaks, mainly affecting the island subcounties. There have also been cases of the outbreak spreading to the mainland for example in 2018, where 90% of mainland cases were reported to have originated from the Islands(14). Being a border district, cross border movements between Uganda and Kenya provide an efficient channel for spread of epidemic diseases like cholera (15) . During this outbreak, it is reported that Busia Kenya had a protracted cholera outbreak. The primary case travelled back to Sigulu after possible exposure at a hospital in Busia Kenya where she shared a ward with suspected cholera patients between June 27 and July 4 2023.

All age groups were affected. However, adults ≥15 years and females were more affected in this outbreak. Cholera is a water borne disease, and all age groups and gender can be affected by the infection, though some age groups and genders may be more affected than the others. Outbreaks in other settings have indeed shown different age groups being affected by cholera, for example in the cholera outbreak in the democratic republic of Congo, December 2022(16), Bagdad, Iraq in 2015(17) and Kampala, Uganda in 2018(18). Females especially those above 15 years play a more central role in water collection, food preparation and washing of clothes, either as wives or older siblings in the household (19,20). They therefore have more exposure to the water sources than male counterparts. In this investigation, we found that indeed females above 15 years were more affected.

The index case was suspected on July 16, ten days after the primary case developed symptoms of cholera. The 7-1-7 protocol requires that an infectious disease outbreak is detected within 7 days, notified within a day and response measures mounted within 7 days after notification. This outbreak was detected10 days after the primary case developed symptoms. An outbreak of cholera is detected when two or more suspected cholera cases are reported from the same unit within a week of each other or if there is a death in a person 2 years and older due to acute watery diarrhea with no other known cause(21). This presented a missed opportunity to curb the outbreak. If the primary case had been detected, she would not have washed clothes at the lakeshore water collection point as usual, thus stopping spread of the outbreak.

Drinking of untreated water from unsafe water collection points is a major risk for cholera. The lakeshore communities affected by this outbreak drink untreated water from the lakeshores. Like in many other outbreaks in lake shore communities, this has been found to be a risk factor for outbreaks (22–25). Fresh water access at Sigulu and Bukana Sub counties are 59% and 30% respectively (12). However, the borehole water was heavily salty and unpalatable, and the piped lake water was only available in Bukana subcounty at a fee of 0.08 USD per 20 liter Jerican. This cost is prohibitive to the community members who find it expensive. Provision of safe drinking water is a major preventive strategy for the control of cholera, in addition to improved hygiene and sanitation(26,27).

The oral cholera vaccine was deployed in Namayingo in October 2020 as a strategy to control outbreaks especially in the outbreak prone lakeshore communities of the district (6). This investigation confirms that several residents received the vaccine and either had a vaccination card or could recall the vaccination process. The vaccine is given in 2 doses, 14 days apart and targeting individuals over 2 years and It provides protection upto 80% for 3 years (10) . We found that the vaccine given in the 2020/2021 campaign was 84% protective of cholera in the individuals who received it 2 years post vaccination. This is consistent with other studies in Zambia and Malawi that report vaccine protection upto 80% when 2 doses are administered (28,29).

Study limitations

This investigation had some limitations including. First, some patients with cholera experience mild or nonspecific symptoms or asymptomatic and may not have been picked up during case-finding. This likely led to an under estimation of the magnitude of the outbreak. Secondly, although drinking untreated and contaminated lake water was found to be significantly associated with cholera, *Vibro cholerae* was not isolated from any of the water samples tested. This is likely because of late collection of samples, which was over three weeks since contamination with soiled clothes by the primary case. Additionally, being an open lake shore collection point, any residual reservoirs could have been washed away by lake shore waves or the concentration of biofilms harboring *vibro cholerae* was low(30).

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Conclusion

This outbreak was associated with drinking contaminated and untreated lake shore water. However, receiving the OCV was protective against cholera. We recommended emergency distribution of water treatment tablets, sensitisation of the community about cholera and treatment of all drinking water and deployment of periodic OCV to the high-risk island residents. The public health actions implemented included, distribution of water treatment tablets, mass sensitisation of the communities in the affected sub counties about cholera and refresher training of health workers about cholera and its management.

Conflict of Interest

The authors declare that they had no conflict of interest.

Authors contribution

JR, SW, DO, BK, and LB designed the study and contributed to data collection and analysis. JR led the writing of the bulletin. SW, DO, RM, BK, LB, and ARA participated in bulletin writing and review to ensure scientific integrity and intellectual content. All authors contributed to the final draft of the bulletin.

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References

1. WHO 2022. Cholera Fact sheet [Internet]. Available from: https://www.who.int/news-room/fact-sheets/detail/cholera
2. Azman AS, Rudolph KE, Cummings DAT, Lessler J. The incubation period of cholera: A systematic review. J Infect. 2013 May;66(5):432–8.
3. World Health Organization. Global Task Force on Cholera Control: Ending Cholera. A global road map to 2030 [Internet]. Available from: https://www.gtfcc.org/wp-content/uploads/2019/10/gtfcc-ending-cholera-a-global-roadmap-to-2030.pdf
4. Deen J, Mengel MA, Clemens JD. Epidemiology of cholera. Vaccine. 2020 Feb 29;38:A31–40.
5. Kanungo S, Azman AS, Ramamurthy T, Deen J, Dutta S. Cholera. The Lancet. 2022 Apr;399 (10333):1429–40.
6. Bwire G, Sack DA, Lunkuse SM, Ongole F, Ngwa MC, Namanya DB, et al. Development of a Scorecard to Monitor Progress toward National Cholera Elimination: Its Application in Uganda. The American Journal of Tropical Medicine and Hygiene. 2023 May 3;108(5):954–62.
7. Bwire G, Ali M, Sack DA, Nakinsige A, Naigaga M, Debes AK, et al. Identifying cholera "hotspots" in Uganda: An analysis of cholera surveillance data from 2011 to 2016. PLoS Negl Trop Dis. 2017 Dec;11(12):e0006118.
8. Bwire G, Orach CG, Aceng FL, Arianitwe SE, Matseketse D, Tumusherure E, et al. Refugee Settlements and Cholera Risks in Uganda, 2016–2019. Am J Trop Med Hyg. 2021 Apr;104 (4):1225–31.
9. Atuhairwe J. Spreading like a wild fire: a tale of three cholera outbreaks, Namayingo District, Uganda, March 2016. Pan Afr Med J. 2018 Jan;
10. Bi Q, Ferreras E, Pezzoli L, Legros D, Ivers LC, Date K, et al. Protection against cholera from killed whole-cell oral cholera vaccines: a systematic review and meta-analysis. Lancet Infect Dis. 2017 Oct;17(10):1080–8.
11. Uganda Bureau of Statistics. Statistical Abstract, 2022 [Internet]. 2022. Available from: https://www.ubos.org
12. Uganda Water Supply Atlas [Internet]. [cited 2024 Jan 17]. Available from: http://wsdb.mwe.go.ug/index.php/reports/district/104
13. Bwire G, Kisakye A, Amulen E, Bwanika JB, Badebye J, Aanyu C, et al. Cholera and COVID-

Continues to page 36

19 pandemic prevention in multiple hotspot districts of Uganda: vaccine coverage, adverse events following immunization and WASH conditions survey. BMC Infectious Diseases. 2023 Jul 21;23(1):487.
14. The Independent. Few people turn up for cholera vaccination in Namayingo [Internet]. The Independent Uganda: 2020. Available from: https://www.independent.co.ug/fewer-people-turn-up-for-cholera-vaccination-in-namayingo/
15. Bwire G, Mwesawina M, Baluku Y, Kanyanda SSE, Orach CG. Cross-Border Cholera Outbreaks in Sub-Saharan Africa, the Mystery behind the Silent Illness: What Needs to Be Done? PLoS One. 2016 Jun 3;11(6):e0156674.
16. World Health Organization. Disease Outbreak News; Cholera - Democratic Republic of Congo [Internet]. 2023. Available from: https://www.who.int/emergencies/disease-outbreak-news/item/2023-DON441
17. Jameel SK, Shafek MA, Abdulmohsen AM, Mohamed NS, Naji SR, Mohammed TT. The Isolation of Vibrio cholera and Other Enteric Bacteria with Molecular Characterization of Vibrio cholera during the Outbreak of Baghdad/Iraq in 2015. Advances in Microbiology. 2016 Aug 2;6(9):699–715.
18. Eurien D, Mirembe BB, Musewa A, Kisaakye E, Kwesiga B, Ogole F, et al. Cholera outbreak caused by drinking unprotected well water contaminated with faeces from an open storm water drainage: Kampala City, Uganda, January 2019. BMC Infect Dis. 2021 Dec;21(1):1–9.
19. UNICEF. Brief notes on gender and cholera [Internet]. 2010 [cited 2024 Jan 16]. Available from: https://gbvguidelines.org/wp/wp-content/uploads/2020/03/29_Haiti_UNICEF_Briefing_Note_Gender_Cholera.pdf
20. Rancourt N. Oxfam Policy & Practice. 2013. Gender and Vulnerability to Cholera in Sierra Leone: Gender analysis of the 2012 cholera outbreak and an assessment of Oxfam's response. Available from: https://policy-practice.oxfam.org/resources/gender-and-vulnerability-to-cholera-in-sierra-leone-gender-analysis-of-the-2012-293965/
21. Cholera Outbreak Toolbox [Internet]. . Available from: https://www.who.int/emergencies/outbreak-toolkit/disease-outbreak-toolboxes/cholera-outbreak-toolbox
22. Challa JM, Getachew T, Debella A, Merid M, Atnafe G, Eyeberu A, et al. Inadequate Hand Washing, Lack of Clean Drinking Water and Latrines as Major Determinants of Cholera Outbreak in Somali Region, Ethiopia in 2019. Frontiers in Public Health [Internet]. 2022 [cited 2024 Jan 16];10. Available from: https://www.frontiersin.org/articles/10.3389/fpubh.2022.845057
23. Oguttu DW, Okullo A, Bwire G, Nsubuga P, Ario AR. Cholera outbreak caused by drinking lake water contaminated with human faeces in Kaiso Village, Hoima District, Western Uganda, October 2015. Infectious Diseases of Poverty. 2017 Oct 10;6(1):146.
24. Pande G, Kwesiga B, Bwire G, Kalyebi P, Riolexus A, Matovu JKB, et al. Cholera outbreak caused by drinking contaminated water from a lakeshore water-collection site, Kasese District, south-western Uganda, June-July 2015. PLoS One. 2018;13(6):e0198431.
25. Birmingham ME, Lee LA, Ndayimirije N, Nkurikiye S, Hersh BS, Wells JG, et al. Epidemic cholera in Burundi: patterns of transmission in the Great Rift Valley Lake region. The Lancet. 1997 Apr 5;349(9057):981–5.
26. Buliva E, Elnossery S, Okwarah P, Tayyab M, Brennan R, Abubakar A. Cholera prevention, control strategies, challenges and World Health Organization initiatives in the Eastern Mediterranean Region: A narrative review. Heliyon. 2023 May 1;9(5):e15598.
27. Wolfe M, Kaur M, Yates T, Woodin M, Lantagne D. A Systematic Review and Meta-Analysis of the Association between Water, Sanitation, and Hygiene Exposures and Cholera in Case–Control Studies. The American Journal of Tropical Medicine and Hygiene. 2018 Jul 2;99(2):534–

Continued from page 36

45.
28. Grandesso F, Kasambara W, Page AL, Debes AK, M'bang'ombe M, Palomares A, et al. Effectiveness of oral cholera vaccine in preventing cholera among fishermen in Lake Chilwa, Malawi: A case-control study. Vaccine. 2019 Jun 19;37(28):3668–76.
29. Sialubanje C, Kapina M, Chewe O, Matapo BB, Ngomah AM, Gianetti B, et al. Effectiveness of two doses of Euvichol-plus oral cholera vaccine in response to the 2017/2018 outbreak: a matched case–control study in Lusaka, Zambia. BMJ Open. 2022 Nov;12(11):e066945.
30. Conner JG, Teschler JK, Jones CJ, Yildiz FH. Staying alive: Vibrio cholerae's cycle of environmental survival, transmission, and dissemination. Microbiol Spectr. 2016 Apr;4(2):10.1128/microbiolspec.VMBF-0015–2015.

Cholera outbreak associated with drinking contaminated river water in Kayunga District, Uganda, June–August 2023

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Summary

Background: Cholera is endemic in Uganda with cases reported annually. On July 19, 2023, the Uganda Ministry of Health declared a cholera outbreak in Kayunga District following death of four family members within eight days and confirmation of *Vibrio cholerae* by culture. We investigated the outbreak to determine the magnitude, factors associated with cholera infection, and recommend control and prevention measures.

Methods: We defined a suspected case as onset of acute watery diarrhea during June 24–August 29, 2023 in a resident of Kayunga District aged ≥2 years. A confirmed case was a suspected case with *Vibrio cholerae* cultured from stool. We described cases and conducted an environmental assessment and an un-matched case-control study in Lusenke Village which was the epicenter of the outbreak. We analyzed data using logistic regression to identify factors associated with cholera infection.

Results: We identified 78 case-patients (34 suspected and 44 confirmed); 10 (13%) died. Males were more affected than females (attack rate (AR)=2.4 vs 1.6/1,000). Lusenke Village was most affected (AR=41/1,000). The outbreak began following the funeral of the primary case in Kayonjo, an inland village on July 1, 2024. Eleven days later, cases were reported in the distant Lusenke Village. We observed that some village residents defecated in the open, bathed, and washed clothes along the river banks where they collected water for drinking and domestic use. Drinking and using unboiled/untreated river water domestically significantly increased the likelihood of cholera infection (AOR=17, CI=3.8-78).

Conclusion: This outbreak was likely a propagated outbreak initiated at a funeral of a suspected case whose source of infection was unknown and amplified through contamination of river water used and drank by village members. The outbreak ended within one week after prohibiting use of River Nile water and activities that contaminate river water among other control measures.

Background

Cholera is an acute diarrheal disease caused by the bacterium *Vibrio cholerae*. It *presents with sudden onset of profuse watery diarrhea with or without abdominal discomfort, vomiting or dehydration.* The disease affects both children and adults and can kill within hours if untreated. The case fatality rate in untreated cases may be as high as 30–50%; however, if well treated with rapid and sufficient rehydration, the case fatality rate can be reduced to as low as below 1% (1).

Vibrio cholerae occurs and persists in various aquatic systems such as lakes and rivers, and is transmitted via ingestion of contaminated water or food (2). The incubation period is between

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hours and 5 days (3). Inadequate clean water and poor sanitary conditions have been identified as the driving forces for the cholera epidemic (4,5).

The annual cholera burden is estimated to be between 1.3-4.0 million cases and 21,000-143,000 deaths globally with about 30% of the cases and 80% of the deaths occurring in Africa (6–8). Africa saw the highest burden of cholera outbreaks on record in 2021, with 19 countries reporting over 137,000 cases and 4,062 deaths (9). In Uganda, cholera outbreaks have continued to occur since 1971 when the disease was first reported (10). From 1997, cholera cases have been reported annually in Uganda, including a major epidemic that occurred in 1998, with nearly 50,000 reported cases (11,12). Border districts along the Democratic Republic of Congo, South Sudan, and Kenya borders are at high risk because of cross boarder transmission (13). In addition, areas lying along water bodies are prone to cholera outbreaks especially during rainy seasons when the water bodies get contaminated with fecal matter due to runoffs and flooding (14). Over 50% of the cholera cases in Uganda occur in the fishing villages (15). Majority of these communities live under high levels of poverty, poor hygiene conditions, and have poor access to safe water (15).

From 2015–2021, 63 cholera outbreaks were reported in Uganda, affecting 43 districts, Kayunga District inclusive. In 2018–2019, Kayunga District was reported as one of the cholera endemic districts in Uganda (13,16). On July 19, 2023, the Uganda Ministry of Health (MoH) declared a cholera outbreak in Kayunga District following death of four family members within eight days. *Vibrio cholerae* was cultured from two stool samples collected from the last two people who died. We investigated the outbreak to determine the magnitude, factors associated with cholera infection, and recommend control and prevention measures.

Methods

Outbreak area

The outbreak occurred in Kayunga District, located in the North-central Region of Uganda (Figure 1). The district neighbors Lake Kyoga in the North and River Nile in the East, where there are fishing activities (17). Kayunga District has a population of approximately 427,100 people living in nine sub-counties (17,18). Sixty four percent of the population has access to safe drinking water (piped water, water from protected springs, and water from deep boreholes) and the district latrine coverage is 73% (19).

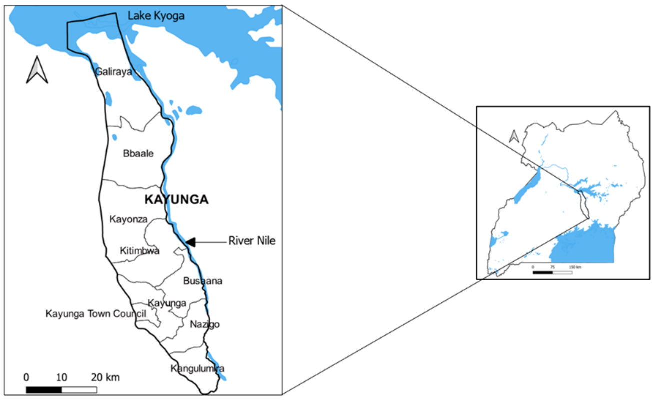

Figure 1: Location of Kayunga District in Uganda

Case definition and finding

We defined a suspected case as onset of acute watery diarrhea during June 24–August 29, 2023 in a resident of Kayunga District aged ≥2 years. A confirmed case was a suspected case in which *V. cholerae* was isolated in stool by culture (20,21).

We interviewed health workers and reviewed records at Kayunga Regional Referral Hospital, Busaana heath center III, Namusaala heath center II, and five purposively-selected private health facilities to identify confirmed and suspected cases. The selected private health facilities were those in the epicenter subcounty or those with high volume of patients. In the community, we interviewed leaders and village health team (VHT) members and already identified case-patients, their caretakers and family members to direct us to other persons who had experienced diarrhea, vomiting or abdominal pain in the community. We then line listed the case-patients.

Descriptive epidemiology

We calculated attack rates by place (district, subcounty, and village), age (grouped age into categories of 2-4, 5-14, 15-29, 30-59 and ≥60 years) and sex using the 2023 population estimates of persons aged two and above years obtained from Kayunga district biostatistician and Uganda Bureau of Statistics (UBOS).

Environmental assessment

We assessed the disposal of human excreta in

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communities and inspected the sources of water for drinking and domestic use in the most affected villages. We inspected for any possible sources of water contamination.

Laboratory investigations

We collected 107 stool samples from all suspected case-patients and rectal swabs from those who died from acute watery diarrhea. The samples were tested for *V. cholerae* by culture at Kayunga Regional Referral Hospital and Central Public Health Laboratory in Kampala. We collected water samples for bacteriological culture for *V. cholerae: four samples from River Nile,* two from boreholes, and two from solar pumped taps.

Eight water samples (*four from River Nile,* two from boreholes, two from solar pumped taps) were collected aseptically. Water samples from River Nile were collected along the shores where the community regularly fetched water. The samples were transported under cold chain conditions to the laboratory for testing.

Hypothesis generation

We interviewed the first 40 case-patients (identified by active case search), their family members, caretakers, community leaders and village health team (VHT) members. The interviews included questions about foods consumed, drinking water, history of recent travel, and funeral practices.

Case-control study

Because of logistical limitations, we conducted a case-control study using 25 cases (14 confirmed and 11 suspected) and 99 controls from Lusenke Village which was the most affected village in the most affected subcounty of Busaana (Figures 2&3). All case-patients identified in Lusenke Village by the time of the study were included in the case-control study. We defined a control as a resident of Lusenke Village, aged ≥2 years with no history of acute watery diarrhea during June 24–August 29, 2023. We listed all households that did not have any case in the village as control households. We systematically sampled control-households. One control-person was randomly selected from each sampled control-household using lottery method. We administered a standard questionnaire to both case and control-persons to obtain information on their demographics (age, sex), clinical characteristics (date of onset, signs and symptoms, seeking health care) and exposures (water sources, history of travel, attending funerals and preparation of drinking water). We analyzed data using logistic regression to generate odds ratios and 95% confidence intervals (CI) for factors associated with cholera infection. We stopped at bivariate analysis since most of the variables had counts less than five. However, we further conducted common reference group analysis for factors that were significant at bivariate level to assess the differences in the odds of infection based on combinations of the factors associated with cholera infection.

Ethics approval and consent to participate

This outbreak investigation was in response to a public health emergency and was instituted by the Uganda Ministry of Health. This investigation was also reviewed by the US CDC and was conducted consistent with applicable federal law and the US CDC policy. §§See e.g., 45 C.F.R. part 46, 21 C.F.R. part 56; 42 U.S.C. §241(d); 5 U.S.C. §552a; 44 U.S.C. §3501 et seq.

We got permission to enter the district and do the investigation from the Kayunga District health authorities. We obtained verbal informed consent and assent from the adult and minor respondents accordingly. We ensured confidentiality by conducting interviews in privacy ensuring that no one could follow proceedings of the interview. Unique identifiers were used and raw data were kept in a password protected computer and shared only among the investigation team.

Results

Descriptive epidemiology

There were 78 case-patients in Kayunga District (AR=20/100,000); 44 confirmed (*V.cholerae 01 Ogawa*) and 34 suspected. Ten case-patients died; case fatality rate (CFR)=13%. The median age was 24 years (IQR:15-37 years). Males were more affected (AR =24/100,000) compared to females (AR = 16/100,000). Persons aged ≥15 years were most affected (Table 1).

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Table 1: Attack rates of case-patients by sex and age during a cholera outbreak in Kayunga District, Uganda, June–August, 2023

Characteristic	Frequency (n=78)	Population	AR / 100,000
Sex			
Male	46	194,407	24
Female	32	194,681	16
Age (years)			
2-4	5	50,825	10
5-14	14	141,370	10
15-29	34	102,077	33
30-59	20	77,305	26
≥60	5	17,511	29

Of the nine sub-counties in Kayunga District, five were affected. Three of the affected sub-counties lie along the River Nile; Busaana Sub-county was the most affected (AR=109/100,000) (Figure 2).

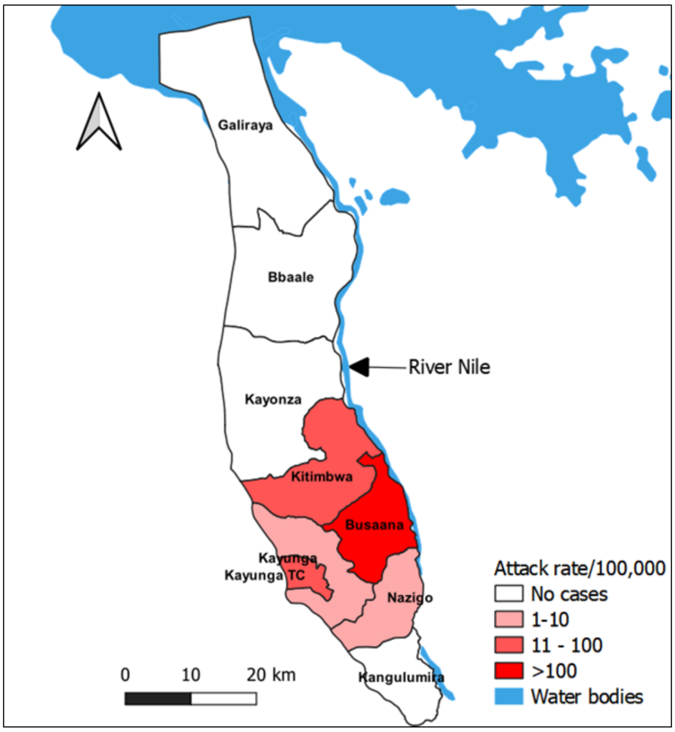

Figure 2: Attack rate by sub-county during a cholera outbreak in Kayunga District, Uganda, June–August, 2023

In Busaana Sub-county, Lusenke Village (lies upstream along River Nile) was the most affected (AR=4.0%). It registered cases before the downstream villages of Bukomba, Kakooge and Bujwaya. In these villages, cases were clustered around water collection points along the River Nile (Figure 3).

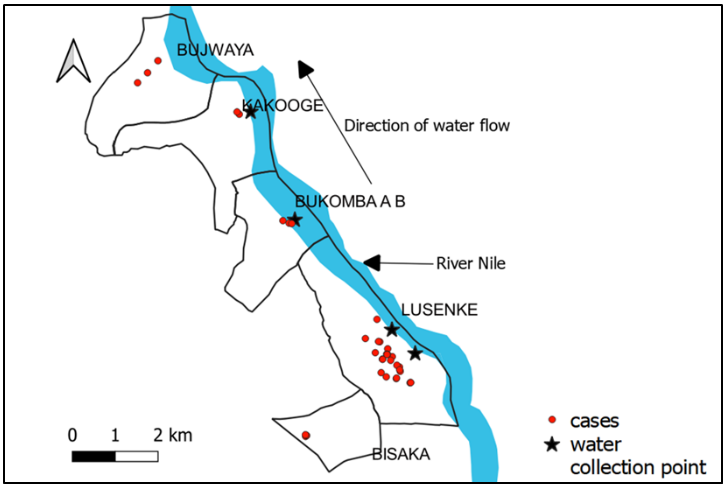

Figure 3: Clustering of cases around water collection points along River Nile during a cholera outbreak in Kayunga District, Uganda, June–August, 2023

The "primary" case-patient presented with acute watery diarrhea on June 29, 2023 and the diarrhea was described as colorless (not rice-water) by caretakers. She was admitted in hospital six hours later and treated with intravenous rehydration. She died on June 30, 2023 about 10 hours following admission. The cause of death was described as respiratory failure in hospital. Her body was washed according to her culture and religious beliefs before being buried on July 1, 2023 in Kayonjo Village. Two days after the funeral, the deceased's two brothers and a neighbor who had all attended the funeral developed acute watery diarrhea. They were admitted and treated in hospital and they both recovered. Three days after the funeral, another brother and a cousin to the "primary" case-patient who had also attended the funeral developed acute watery diarrhea. The brother died and the cousin recovered. Five days after the first funeral, the "primary" case's father and another cousin who had also attended the funeral developed acute watery diarrhea and both died on July 7, 2023 at home. Following these two deaths, cholera was suspect-

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ed; two rectal swabs were picked on July 7 from the deceased. Twelve days later, V. cholerae 01 Ogawa was confirmed by culture.

On July 19, cases started occurring in distant villages mainly Lusenke Village. During active case search, we found that two case-patients in Lusenke Village (a mother and her child) had their dates of onset on July 4, 2023, but we did not find them to have any link with Kayonjo Village (Figure 4). The mother and the child reported to have defecated along River Nile shore when they developed acute watery diarrhea. They also reported to have washed their clothes soiled with fecal matter along River shores before crossing to the neighboring district by boat to seek treatment. None of the case-patients in Lusenke Village admitted to have attended the funerals in Kayonjo Village, and neither of the cases in Kayonjo Village was reported/ reported to have travelled or come in contact with anyone in Lusenke Village.

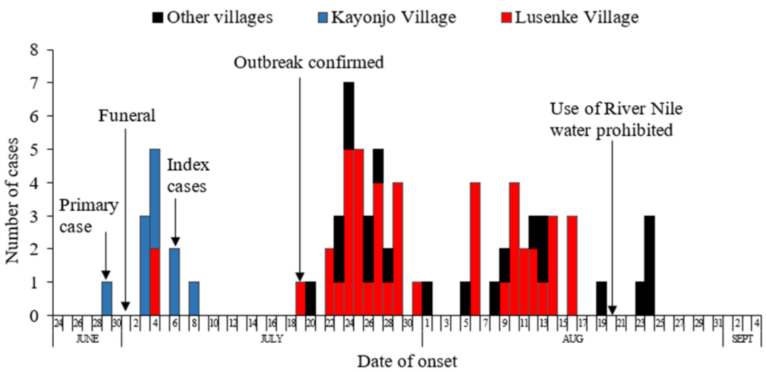

Figure 4: Distribution of cases over time during the cholera outbreak in Kayunga District, Uganda, June –August, 2023

Hypothesis generation findings

Sixty eight percent of the case-patients had used water from River Nile and 23% had attended a funeral within 5 days prior to onset of symptoms. We hypothesized that, using contaminated water from River Nile while or attending a funeral was associated with cholera transmission.

Environmental findings

Lusenke Village is a low-lying village and had experienced episodes of flooding during the June–August 2023. According to VHT reports, latrine coverage in Lusenke Village was 38%. We found feces along the river banks in Lusenke Village; some case-patients and caretakers reported defecating in the river while fishing. We also found villagers washing clothes along the river banks where they also fetch water. Some of the case-patients and their care takers reported to have washed clothes soiled with fecal matter at the river banks.

Laboratory findings

No *V. cholerae* or coliforms were isolated from the water samples tested.

Case-control study findings

Eighty eight percent (22/25) of case-patients compared to 53% (52/98) of controls used water from River Nile for domestic purposes (COR=6.5, CI 1.8-23). In addition, 36% (9/25) of case-patients compared to 9% (9/99) of controls drank water from River Nile (COR=5.6, 95%CI 1.9-16). All case-patients who drank River Nile water also used it for domestic purposes (Table 2). All persons who drunk or used water from River Nile did not boil or treat it.

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Table 2: Risk factors associated with cholera transmission in Lusenke Village during the cholera outbreak in Kayunga District, Uganda, June–August, 2023

Exposure	Cases (n)	(%)	Controls (n)	(%)	COR	95%CI
Used River Nile water for domestic purpose						
No	3	(12)	46	(47)	Ref	
Yes	22	(88)	52	(53)	6.5	1.8-23
Drank water from River Nile						
No	16	(64)	90	(91)	Ref	
Yes	9	(36)	9	(9)	5.6	1.9-16
Used borehole water for domestic purposes						
No	17	(68)	48	(48)	Ref	
Yes	8	(32)	51	(52)	0.4	0.2-1.1
Drank borehole water						
No	4	(16)	16	(16)	Ref	
Yes	21	(84)	83	(84)	1.0	0.3-3.3
Attended a funeral						
No	12	(48)	53	(46)	Ref	
Yes	13	(52)	46	(54)	0.9	0.4-2.3
Ate something at the funeral						
No	6	(46)	27	(51)	Ref	
Yes	7	(54)	26	(49)	1.2	0.4-4.1
Drank anything at the funeral						
No	7	(54)	36	(68)	Ref	
Yes	6	(46)	17	(32)	1.8	0.5-6.2
Touched the dead body						
No	9	(69)	44	(85)	Ref	
Yes	4	(31)	8	(15)	2.4	0.6-9.9

Upon using common reference group analysis, 36% (9/25) of case-persons and 8% (8/99) of controls drank and used River Nile water for domestic purposes (AOR=17, CI 3.8-77) compared to those who never drank or used River Nile water (Table 3).

Table 3: Adjusted odds ratios for domestic use or drinking of water from River Nile in Lusenke Village during the cholera outbreak in Kayunga District, Uganda, June–August, 2023

Drank water from River Nile	Domestic use of water from River Nile	Cases (n)	(%)	Controls (n)	(%)	AOR	95% CI
No	No	3	(12)	46	(46)	Ref	
Yes	No	0	(0)	1	(1)	NA	NA
No	Yes	13	(52)	44	(44)	4.5	1.2-17
Yes	Yes	9	(36)	8	(8)	17	3.8-78

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Discussion

The cholera outbreak in Kayunga District started in June and lasted two months. It was a propagated outbreak, caused by *V. cholerae* serotype 01 Ogawa, the major causative agent of previous cholera outbreaks in Uganda (22). The outbreak was initiated at a funeral of a suspected case whose source of infection was unknown, and amplified through contamination of river water used and drank by community members. Cases first occurred in the upstream villages before sequentially occurring in the downstream villages following the direction of flow of River Nile water. Lusenke Village which was most affected had low latrine coverage (38%) compared to the district average latrine coverage (about 70%) (17). In addition, there was defecation along River Nile banks.

The outbreak started in Kayonjo Village (an inland village) following a funeral of the "primary" case-patient. Relatives and neighbors developed symptoms of cholera days later. We were unable to ascertain how the primary case got cholera and how it spread among the relatives and neighbors. However, funerals have previously been found to be points of clusters of cholera transmission especially where individuals who wash the corpse also participate in food preparation without thoroughly washing hands (23–25). This might have been the source of infection among the funeral attendees.

From Kayonjo Village, the outbreak spread to other villages along the River Nile including: Lusenke, Bukomba, Kakooge and Bujwaya villages with some spillovers to other inland villages. The village being low-lying, makes it prone to flooding and river water contamination during heavy rains. Heavy rains, flooding and proximity to lakes and rivers have been identified by as the risk factors for cholera outbreaks in Uganda and Africa (13,14). These findings suggest that contaminated river water could have propagated the outbreak from Lusenke Village to downstream villages. Cases had 17 times odds of drinking and using unboiled/untreated river water for domestic purposes compared to controls. These findings further corroborate reports that *V. cholerae* is known to persist and thrive in river water for almost two years and can later enter the human body through consumption of contaminated water (2,26,27) (14). Prohibiting practices like washing and swimming in the river, enforcing latrine construction and discouraging people from drinking unboiled/ untreated river water could have largely contributed to the end of this outbreak.

The high CFR (13%) registered in this outbreak compared to the average of 2-4% reported from other outbreaks in Uganda (28) could be explained by poor health seeking behavior among case-patients as evidenced by the case-patients who died at home. With timely rehydration, the cholera CFR can be less than 1% (29). In addition, there was delay in suspicion and detection of cholera. Initial case-patients were reported to have presented with normal color diarrhea contrary to the usually expected whitish (rice-water) diarrhea. This could have led to the clinicians not suspecting cholera quickly. The outbreak was not suspected until four cases-patients had died. Further, it took 12 days to receive the stool culture results and confirm the outbreak. This delay in suspicion and confirmation could have led to delay in instituting timely and appropriate treatment and control measures.

Study limitations

We were not able to identify how the "primary" case acquired the infection to prevent similar future outbreaks and specifically how the infection reached Lusenke Village from Kayonjo Village which is far apart. However, it is likely that the outbreak might have been spread through population movement, open defecation, and flooding.

Conclusion

This outbreak started as a point source following a funeral in Kayonjo Village. It later spread to other villages where it was propagated and amplified by domestic use and drinking contaminated River Nile water. The water was likely contaminated by introduction of feces into the river by practices like open defecation and washing soiled clothes along the river. The outbreak lasted for two months and ended within one week following temporary prohibition of use of River Nile water and activities that contaminate river water. To prevent future similar outbreaks, community sensitization against drinking and domestically using untreated/ unboiled river water and enforcement of latrine construction should be sustained by the Kayunga District health department.

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Public health actions

We instituted control measures for the outbreak, including: community and health worker sensitization, setting up a cholera treatment unit near the epicenter, distribution of hand washing facilities, water chlorinating tablets, and prophylactic antibiotics to affected communities.

Acknowledgements

We appreciate the support of the Kayunga District health team, Kayunga Regional Referral Hospital administration and personnel, and community members who participated in this study.

Conflict of interest

The authors declare that they have no conflict of interest.

Authors' contributions

AK, EN, YN, LNB, BK designed the study, contributed to data collection and analysis. AK led the writing of the bulletin. EN, YN, LNB, BK, IK, HTN, LB, and ARA participated in manuscript writing and review to ensure scientific integrity and intellectual content. All authors contributed to the final draft of the bulletin.

References

1.Cholera | Cholera Outbreak Response Field Manual [Internet]. [cited 2023 Nov 5]. Available from: https://choleraoutbreak.org/book-page/cholera

2. Almagro-Moreno S, Taylor RK. Cholera: Environmental Reservoirs and Impact on Disease Transmission. Microbiol Spectr. 2013 Dec;1(2): OH-0003-2012.

3. Azman AS, Rudolph KE, Cummings DAT, Lessler J. The incubation period of cholera: a systematic review. J Infect. 2013 May;66(5):432–8.

4. Paye NG, Miller RHB, Zhou C, Weamie SJY, Davies TA. Systematic Study and Meta-Analysis of Risk Factors Associated with Cholera Outbreaks in Africa: A Review. Advances in Infectious Diseases. 2021 Apr 2;11(2):240–60.

5. Cholera [Internet]. [cited 2023 Oct 4]. Available from: https://www.who.int/news-room/fact-sheets/detail/cholera

6. Cholera – Global situation [Internet]. [cited 2023 Oct 4]. Available from: https://www.who.int/emergencies/disease-outbreak-news/item/2022-DON426

7. WHO reports exponential rise in cholera cases in Africa | UN News [Internet]. 2023 [cited 2023 Oct 4]. Available from: https://news.un.org/en/story/2023/02/1133337

8. Zheng Q, Luquero FJ, Ciglenecki I, Wamala JF, Abubakar A, Welo P, et al. Cholera outbreaks in sub-Saharan Africa during 2010-2019: a descriptive analysis. Int J Infect Dis. 2022 Sep;122:215–21.

9. WHO and Partners revamp war against cholera in Africa - World | ReliefWeb [Internet]. 2022 [cited 2024 Jan 24]. Available from: https://reliefweb.int/report/world/who-and-partners-revamp-war-against-cholera-africa

10. Bwire G, Malimbo M, Makumbi I, Kagirita A, Wamala JF, Kalyebi P, et al. Cholera surveillance in Uganda: an analysis of notifications for the years 2007-2011. J Infect Dis. 2013 Nov 1;208 Suppl 1: S78-85.

11. WHO_CDS_CSR_ISR_2000.1.pdf [Internet]. [cited 2024 Jan 24]. Available from: https://iris.who.int/bitstream/handle/10665/66485/WHO_CDS_CSR_ISR_2000.1.pdf?sequence=1

12. Bwire G, Malimbo M, Maskery B, Kim YE, Mogasale V, Levin A. The Burden of Cholera in Uganda. PLOS Neglected Tropical Diseases. 2013 Dec 5;7(12): e2545.

13. Bwire G, Ali M, Sack DA, Nakinsige A, Naigaga M, Debes AK, et al. Identifying cholera "hotspots" in Uganda: An analysis of cholera surveillance data from 2011 to 2016. PLOS Neglected Tropical Diseases. 2017 Dec 28;11(12): e0006118.

Continued from page 44

14.WHO | Regional Office for Africa [Internet]. 2023 [cited 2024 Jan 19]. Floods raise cholera risk even as cases decline in Africa. Available from: https://www.afro.who.int/countries/madagascar/news/floods-raise-cholera-risk-even-cases-decline-africa

15. Bwire G, Munier A, Ouedraogo I, Heyerdahl L, Komakech H, Kagirita A, et al. Epidemiology of cholera outbreaks and socio-economic characteristics of the communities in the fishing villages of Uganda: 2011-2015. PLOS Neglected Tropical Diseases. 2017 Mar 13;11(3): e0005407.

16. Bwire G, Sack DA, Lunkuse SM, Ongole F, Ngwa MC, Namanya DB, et al. Development of a Scorecard to Monitor Progress towards National Cholera Elimination: Its Application in Uganda. Am J Trop Med Hyg. 2023 May 3;108(5):954–62.

17. Kayunga District Profile | KAYUNGA DISTRICT [Internet]. [cited 2023 Oct 24]. Available from: https://kayunga.go.ug/about-us/district-profile

18. Explore Statistics - Uganda Bureau of Statistics [Internet]. [cited 2024 Feb 6]. Available from: https://www.ubos.org/explore-statistics/20/

19. Water | KAYUNGA DISTRICT [Internet]. [cited 2024 Jan 24]. Available from: https://kayunga.go.ug/services/water

20. IDSR.pdf.

21. Cholera Outbreak Toolbox [Internet]. [cited 2023 Oct 24]. Available from: https://www.who.int/emergencies/outbreak-toolkit/disease-outbreak-toolboxes/cholera-outbreak-toolbox

22. Legros D, McCormick M, Mugero C, Skinnider M, Bek'Obita DD, Okware SI. Epidemiology of cholera outbreak in Kampala, Uganda. East Afr Med J. 2000 Jul;77(7):347–9.

23. Ngwa MC, Young A, Liang S, Blackburn J, Mouhaman A, Morris JG. Cultural influences behind cholera transmission in the Far North Region, Republic of Cameroon: a field experience and implications for operational level planning of interventions. Pan Afr Med J. 2017; 28:311.

24. McAteer JB, Danda S, Nhende T, Manamike P, Parayiwa T, Tarupihwa A, et al. Notes from the Field: Outbreak of Vibrio cholerae Associated with Attending a Funeral — Chegutu District, Zimbabwe, 2018. MMWR Morb Mortal Wkly Rep. 2018 May 18;67(19):560–1.

25. Sack RB, Siddique AK. Corpses and the spread of cholera. The Lancet. 1998 Nov 14;352 (9140):1570.

26. Opare J, Ohuabunwo C, Afari E, Wurapa F, Sackey S, Der J, et al. Outbreak of Cholera in the East Akim Municipality of Ghana Following Unhygienic Practices by Small-Scale Gold Miners, November 2010. Ghana Med J. 2012 Sep;46(3):116–23.

27. Jubair M, Atanasova KR, Rahman M, Klose KE, Yasmin M, Yilmaz Ö, et al. Vibrio cholerae Persisted in Microcosm for 700 Days Inhibits Motility but Promotes Biofilm Formation in Nutrient-Poor Lake Water Microcosms. PLOS ONE. 2014 Mar 25;9(3): e92883.

28. Uganda Cholera case fatality ratio, 1923-2023 [Internet]. [cited 2024 Jan 29]. Available from: https://knoema.com/atlas/Uganda/topics/Health/Communicable-Diseases/Cholera-case-fatality-ratio?mode=amp

29. Cholera Outbreak Response field manual | Cholera Outbreak Response Field Manual [Internet]. [cited 2024 Jan 29]. Available from: https://choleraoutbreak.org/

Measles outbreak at a refugee settlement, Kiryandongo District, Uganda, July–October 2023

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Summary

Introduction: Measles is a highly infectious viral disease that mostly affects children. On 28 August 2023, the Ministry of Health was notified of an outbreak of measles in Kiryandongo, a refugee hosting district located in Western Uganda. We investigated to determine the scope of the out-

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break, factors associated with transmission, vaccine effectiveness and coverage, and recommend evidence-based interventions.

Method: We defined a suspected case as onset of fever (lasting ≥3 days) and maculopapular rash with ≥1 of: cough, coryza or conjunctivitis in a resident of Kiryandongo District from July 1 –October 25, 2023. A confirmed case was a suspected case with positive measles-specific IgM not explained by vaccination in the past 8 weeks. Cases were identified through medical records review and active case search. We conducted a descriptive analysis and an unmatched case-control study (1:2) to evaluate risk factors for transmission during the case-person's exposure period (7–21 days prior to rash onset). We estimated vaccine effectiveness (VE) as VE≈100 (1-$OR_{protective}$), using the odds ratio associated with having received ≥1 dose of measles vaccine. We calculated vaccination coverage using the percent of eligible controls vaccinated. We also carried out interviews with key settlement staff.

Results: We identified 74 case-patients (14 confirmed), 54% were females and non-died. The overall attack rate (AR) was 16/100,000 population and was higher among refugees than among nationals (49 vs 11/100,000). Children <12 months (AR=108/100,000) were the most affected age group. Being vaccinated (AOR=0.13, 95%CI: 0.06-0.31) and playing around a water collection point (AOR=3.2, 95% CI: 1.4-6.9) were associated with infection. Vaccination coverage was 87% among refugees and 85% among nationals; VE was 87% (95% CI=69-94) for both groups. Interviews with key staff revealed unrestricted movement of unregistered refugees visiting their relatives in and out of the settlement.

Conclusion: The measles outbreak was associated with suboptimal vaccination coverage and unrestricted movement of persons into and out of the settlement. Increased screening of persons entering the settlement and strengthened immunization programs could avert a similar situation in the future.

Introduction

Measles is a highly infectious viral disease that can cause severe complications and death, especially among children under five years of age. It's transmitted through respiratory droplets from infected persons and can spread rapidly in susceptible populations [1]. Measles can be prevented by vaccination, which is safe and effective [1, 2]. However, measles remains a major public health problem in many parts of the world, particularly in resource-limited settings where vaccination coverage is low, and outbreaks are frequent[3].

Globally, epidemics of measles cause an estimated 2.6 million deaths each year. Measles and rubella remain a major cause of worldwide morbidity and mortality with an estimated 7.5 million measles cases and more than 60,700 measles-related deaths in 2020[4]. According to the World health organization (WHO) and the US Centers for Disease Control and Prevention (CDC), the estimated coverage of the first dose of measles-containing vaccine, meaning that more than 22 million children did not receive their first dose in 2020. Global coverage of the second dose also declined in 2020 to 70%, from 71% in 2019[5]. WHO and CDC reported that due to ongoing declines in measles vaccination, cases in 2022 rose by 18%, and deaths were up 43% globally compared to 2021. Thirty-seven countries reported large or disruptive outbreaks in 2022, up from 22 in 2021 and African region was hit hardest, with 28 outbreaks 6 in the Eastern Mediterranean, 2 in Southeast Asia, and 1 in the European Region[6].

Uganda is one of the countries in the African region that has experienced recurrent measles outbreaks in recent years [7, 8]. According to the World Health Organization (WHO), Uganda reported 1,039 confirmed measles cases and 12 deaths in 2021, with a case fatality rate of 1.2%. Most of the cases occurred among children under five years of age, who accounted for 72% of the total cases and 83% of the deaths [9]. The outbreaks were attributed to low routine immunization coverage, inadequate surveillance, and delayed outbreak response.

In 2023, Uganda launched a nationwide measles-rubella vaccination campaign, targeting 18.1 million children aged 9 months to 15 years, with the aim of achieving at least 95% coverage in each district. The campaign was conducted in two phases, from 12–16 September and from 19–23 September, using a fixed-post and out-

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reach strategy [10]. The campaign also included vitamin A supplementation and deworming for children under five years of age.
On 28 September 2023, the Ministry of Health (MoH) declared a measles outbreak in Kiryandongo District, Western Uganda following a 6 cases laboratory confirmed by the Uganda Virus Research Institute (UVRI). We investigated the outbreak to determine its scope, Identify the risk factors for transmission, and recommendations evidence-based control and prevention measures.

Methods

Outbreak area

We conducted the investigation in Kiryandongo District in Bunyoro sub-region, which is located in the western part of Uganda (Figure 1). The district has seven sub-counties (three town councils and four sub-counties). Mutunda subcounty and Bweyale Town Council (in green) host the refugee population (Figure 1). Mutunda subcounty has 2 health facilities: Mutunda Health Centre III and Panyadoli Health Centre III, while Bweyale Town Council has 3 health facilities: Kichwabugingo Health Centre II, Nyakadoti Health Centre III and Panyadoli Health Centre IV which is the referral facility for the settlement. All these 5 facilities offer immunization services at static and outreach levels. The estimated population is 171,095 for Bweyale TC and 86732 for Mutunda SC out of which 59,200 are refugees.

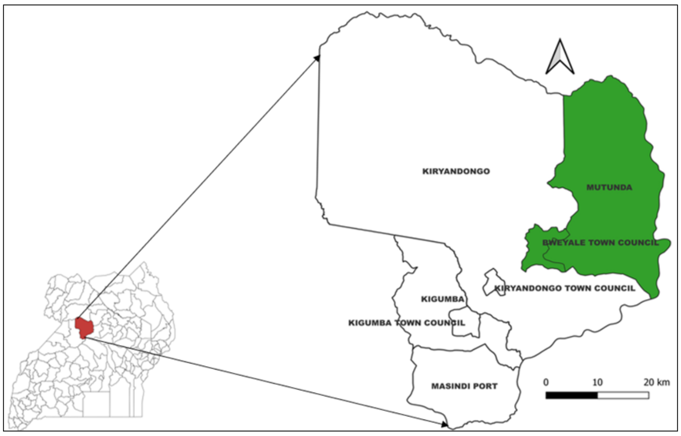

Figure 1: Location of Kiryandongo refugee settlement where the measles outbreak occurred, Kiryandongo District, Uganda, July–October 2023

Case definition and finding

We defined a suspected case as onset of fever lasting ≥3 days and maculopapular rash with ≥1 of: cough, coryza or conjunctivitis in a resident of Kiryandongo District from July 1–October 25, 2023. A confirmed case was a suspected case with positive measles-specific IgM test.
We line-listed suspected measles cases by reviewing medical records in all the 5 health facilities serving the refugee settlement population. We searched for additional cases in the community by asking members of households with suspected cases to direct us to other households with children of similar measles-like symptoms. We used a standardized case investigation form to collect data on case-patients' demographics, clinical information, vaccination status and exposure history.

Laboratory investigations

Samples were collected from suspected case-patients and sent to UVRI for testing.

Descriptive epidemiology

We constructed an epidemic curve to assess the time distribution of measles cases. We computed the attack rates by person and place using the Uganda Bureau of statistics projected populations of children [11] as the denominator and presented results using graphs and tables.

Hypothesis generation

We collected information from a random sample of 20 suspected case-patients using a measles case investigation form. We asked case-patients' caretakers about potential risk factors for measles transmission occurring between 7 and 21 days prior to symptom onset. The risk factors included: not being vaccinated, attending a place of worship, visiting a health facility, visiting a water collection point and visiting or receiving a visitor from outside the district. Evidence of vaccination included child health cards or, if missing, caretakers' recall, which we attempted to confirm by asking the site and age at which the child received the measles vaccine.
We generated hypotheses about exposures based on findings from the descriptive epidemiology analysis and hypothesis-generation interviews. To further support our hypothesis, we carried out interviews with key informants from the refugee settlement.

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Case control investigation

We conducted an unmatched case control investigation in the refugee settlement to test our hypotheses. We defined a control as a resident of Kiryandongo refugee settlement aged 6 months–6 years (all cases were in the same range) with no history of fever or rash from 1st July–25th October 2023. Cases and controls were selected in the ratio of 1:2, with one additional control identified. The controls were selected using simple random sampling from non-case households in the same neighborhood as cases. All eligible children from the selected household were listed down and a random number selected. Data was analyzed using Epi Info 7.1.5 version. To assess factors associated with measles infection, we obtained adjusted Mantel-Haenszel odds ratios (OR_{MH}) and their corresponding 95% confidence intervals (CIs)

Vaccination coverage (VC)

We estimated the one dose VC using the percent of eligible controls vaccinated.

Vaccination effectiveness (VE)

We calculated VE using the formula: VE≈100 (1-$OR_{protective}$), using the odds ratio associated with having received one dose of measles vaccine.

Ethical consideration

We conducted this study in response to a public health emergency and as such was determined to be non-research. The MoH authorized this study and the office of the Center for Global Health, US Center for Diseases Control and Prevention determined that this activity was not human subject research and with its primary intent being for public health practice or disease control. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy. We obtained permission to conduct the investigation from the district health authorities of Kiryandongo. We obtained written informed consent from all the respondents. Participants were assured that their participation was voluntary and that there would be no negative consequences for declining or withdrawing from the study (none declined or withdrew). Data collected did not contain any individual personal identifiers and information was stored in password-protected computers, which were inaccessible by anyone outside the investigation team.

Results

Descriptive epidemiology

We identified 74 case-patients (60 suspected and 14 confirmed) with an overall attack rate [AR] of 16/100,000. There were no deaths and Females were 40 (54%). The AR was higher among the refugees than among nationals (49 vs 11/100,000). The most affected subcounty was Mutunda (AR=102/1000,000), followed by Bweyale Town Council (AR=65/100,000), Kiryandongo town council (AR=11/100,000), and Kiryandongo subcounty (AR=10/100,000). The age range of the case-patients was 4 months to 6 years. The most affected age group was 7-11 months (AR=183/100,000), followed by 1-4 years (AR=59/100,000), 0-6 months (AR=47/100,000) (Table 1). The attack rate was similar among females (17/100,000) and males (16/100,000). All (100%) cases presented with fever and generalized rash; 42 (84%) had cold, 41(82%) had cough, and 29(58%) had conjunctivitis.

Table 1: Measles attack rates by the subcounty of residence, age group, and sex during a measles outbreak in the refugee settlement, Kiryandongo District, Uganda, July–October 2022

Variable	Category	Frequency	Population	Attack rate/ 100,000
Sub-county	Mutunda	31	30,356	102
	Bweyale TC	39	59,883	65
	Kiryandongo TC	2	17,527	11
	Kiryandongo	2	20,906	10
Age-group	0-6 months	5	10,745	47
	7-11 months	16	8,750	183
	1-4 years	43	73,445	59
	5-14 years	10	150,064	7
	>15 years	0	210,362	0
Sex	Male	34	217,615	16
	Female	40	235,750	17

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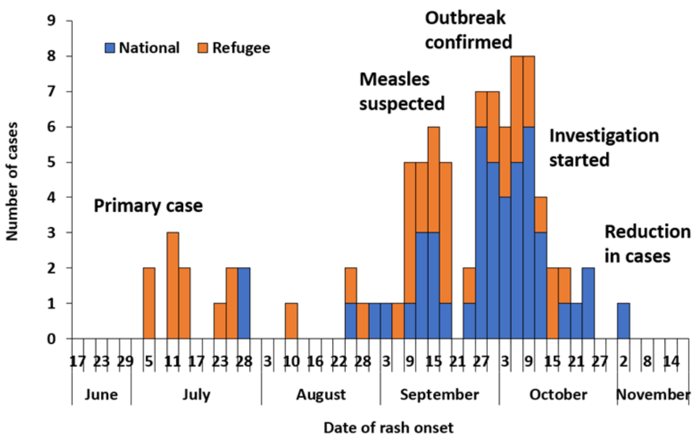

Figure 2: Distribution of measles cases by date of earliest rash onset, Kiryandongo District, July–October, 2023

The epidemic curve (Figure 2) showed a propagated measles outbreak lasting approximately 150 days. The primary case was identified on 3 July 2023, a refugee child with no history of measles vaccination from Bweyale town council. The outbreak was not suspected until 11 September 2023, when health workers in Panyadoli HC IV (serving the refugee settlement population) started seeing children presenting with measles like symptoms. The outbreak was confirmed on 28 August 2023 and Investigations started on 11 October 2023.

Hypothesis generation findings

Of the 20 case-patients interviewed, 15 (75%) had visited a place of worship, 13(65%) were not vaccinated, 11 (55%) had played round a water collection point during the exposure period, 6 (30%) visited a health facility, 3 (15%) had gone to school, and 1 (5%) had received a visitor from outside the district. No other exposures were reported. We considered all exposures that were reported by at least 2 case-patients as potential exposures to include in the case-control study. We therefore considered going to a place of worship, not being vaccinated and playing around a water collection point as possible factors associated with the outbreak.

Interviews with key informants from the refugee settlement revealed that: Incoming refugees were not screened to assess vaccination status, the unregistered refugees feared taking children for immunization and there was unrestricted movement of refugees into and out of the settlement and it was worth noting that most refugees were from South Sudan that had suffered from measles outbreak for the past one year.

Case control investigation findings

Twenty-nine (58%) case-patients and 27 (26%) control-persons played around at a water collection point (OR_{MH}=3.2, 95% CI: 1.4-6.9). Thirty-eight (76%) case-patients and 60 (59%) control-persons visited a place of worship (OR_{MH}=1.0, 95% CI: 0.43-2.4) (Table 2).

Table 2: Factors associated with measles transmission during the measles outbreak in the refugee settlement, Kiryandongo District, Uganda, July–October 2022

Measles vaccine coverage and vaccine effectiveness

Risk factor	Cases N	(%)	Controls n	(%)	OR_{MH}	(95% CI)
Received measles vaccination	17	(34)	81	(80)	0.13	(0.06-0.31)
Playing around a water collection point	29	(58)	27	(26)	3.2	(1.4-6.9)
Visiting a place of worship	38	(76)	60	(59)	1.0	(0.43-2.4)

Among control-persons aged ≥6 months to 6 years, we estimated the overall vaccination coverage to be 86% (95% CI: 76-94%). It was similar among refugees 87% (95% CI: 73-94%) and nationals 85% (95% CI: 76-91%). Seventeen (34%) case-patients and 81 (80%) control-persons had received a dose of measles vaccination (OR_{MH}=0.13, 95% CI: 0.06-0.31), giving an estimated VE of 87% (95% CI: 69–93%).

Discussion

This outbreak in the refugee settlement area (Mutunda Subcounty and Bweyale Town-council) represented the second measles outbreak in the same year, 2023. Vaccination was associated with reduced odds of infection. The estimated vaccine effectiveness for a single dose lies in the expected range of 89-95% [9]. Overall, the estimated measles vaccination coverage was below 95% and was similar when

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stratified by nationality and refugees. The outbreak was propagated by children congregating at community water collection points. The sub-optimal vaccination coverage of a single measles vaccine dose increased community susceptibility to infection since it doesn't build herd immunity to the community.
A history of measles vaccination was protective in this outbreak. However, attack rates were three times as high in children aged 7-11 months as children aged 1-4 years. This may be due to sub-optimal vaccination coverage of children in the settlement area. While school going children may also have more opportunities for exposure, this outbreak affected children of age group 4months -6 years of which only 18% were attending school and thus this was not a factor in this outbreak. The comparatively lower protection offered by a single dose of the measles vaccine led to the recommendation by WHO to add a second dose of measles vaccine into the routine vaccination schedule [9].
Socializing of children at water collection points was associated with increased odds of infection. Other studies have also identified socialization as a factor that facilitates measles transmission [11]. In rural Uganda, water collection points are typically areas where young children play with each other while they wait for their mothers or older siblings to collect water for domestic use. If a child at a water collection point is ill, other children can be put at risk of contracting infection.
The lack of severe illness or deaths among patients in this study may also be reflected in the relatively high vaccination rates; studies have shown that when measles occurs in immunized individuals, the illness is less severe [11].

Study limitations
In this investigation, we assumed that the controls were representative of the general population and used the proportion of controls vaccinated to estimate vaccination coverage instead of the standard WHO community survey method. Vaccination status was in some cases based on caretakers' recall, which might have led to recall bias leading to an overestimation or underestimation of vaccine effectiveness and vaccination coverage. This might have overestimated the vaccination coverage. Finally, we also could not triangulate the administrative measles vaccination coverage with the estimated measles vaccination coverage (proportion of controls vaccinated) used to calculate vaccination coverage in this study since vaccination records in some of the health facilities were not up to date. This likely resulted in a low records-based administrative coverage of 79% compared to the calculated vaccination coverage of 86%.

Conclusion
Socializing at water collection points was associated with this measles outbreak. Measles vaccination was protective against measles infection. We recommended that the Kiryandongo District Health team conduct a mass community measles vaccination (or re-vaccination) campaign for all children in the refugee settlement to capture unvaccinated children in the area and provide a second dose for those who might have received one dose. Children who had not received the measles vaccines were referred to the nearby health facilities, where they received their vaccines.

Conflict of Interest
The authors declare that they had no conflict of interest.

Authors contribution
EN: participated in the conception, design, analysis, interpretation of the study and wrote the draft bulletin; IS, MK, YN, BK, EJN, SW, JK, RA reviewed the report, reviewed the drafts of the bulletin for intellectual content and made multiple edits to the draft bulletin; BK, RM, DK, and ARA reviewed the bulletin to ensure intellectual content and scientific integrity.

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References
1. WHO. *Measles*. 2022; Available from: https://www.who.int/news-room/fact-sheets/detail/measles?gclid=Cj0KCQiAo7KqBhDhARIsAKhZ

Continued from page 50

4uhRRwlWUgqRtkuu57MCaddsDyDK8TOAY9CDhgxa-usoiffyVR_CXOsaAv34EALw_wcB.
2. Sbarra, A.N., et al., *Estimating national-level measles case–fatality ratios in low-income and middle-income countries: an updated systematic review and modelling study.* The Lancet Global Health, 2023. **11**(4): p. e516-e524.
3. Tariku, M.K., et al., *Attack rate, case fatality rate and determinants of measles infection during a measles outbreak in Ethiopia: systematic review and meta-analysis.* BMC Infectious Diseases, 2023. **23**(1): p. 756.
4. Dixon, M.G., et al., *Progress toward regional measles elimination—worldwide, 2000–2020.* Morbidity and Mortality Weekly Report, 2021. **70**(45): p. 1563.
5. *Muhoza P, Danovaro-Holliday MC, Diallo MS, Murphy P, Sodha SV, Requejo JH, Wallace AS. Routine Vaccination Coverage - Worldwide, 2020. MMWR Morb Mortal Wkly Rep. 2021 Oct 29;70(43):1495-1500. doi: 10.15585/mmwr.mm7043a1. Erratum in: MMWR Morb Mortal Wkly Rep. 2021 Nov 19;70(46):1620. PMID: 34710074; PMCID: PMC8553029.*
6. *Measles cases and deaths are increasing worldwide, say WHO and CDC BMJ 2023; 383 doi: https://doi.org/10.1136/bmj.p2733 (Published 20 November 2023) Cite this as: BMJ 2023;383:p2733.*
7. Namugga, B., et al., *The immediate treatment outcomes and cost estimate for managing clinical measles in children admitted at Mulago Hospital: a retrospective cohort study.* medRxiv, 2023: p. 2023.01.04.23284186.
8. Flavia, A., B. Fred, and T. Eleanor, *Gaps in vaccine management practices during Vaccination outreach sessions in rural settings in southwestern Uganda.* BMC Infectious Diseases, 2023. **23**(1): p. 758.
9. Kizito, S.N. 2023; Available from: https://uniph.go.ug/measles-outbreak-propagated-by-visiting-a-health-facility-in-a-refugee-hosting-community-kiryandongo-district-western-uganda-august-2022-may-2023/#:~:text=In%202019%2C%20Uganda%20reported%209%2C774,cases%20occurring%20in%20refugee%20settlements.&text=At%20the%20end%20of%20December,from%20January%20to%20February%202023.
10. WHO. *Statement from Uganda's Minister of Health on the National Measles-Rubella and Polio Immunisation Campaign 2019.* 2019; Available from: https://www.afro.who.int/news/statement-ugandas-minister-health-national-measles-rubella-and-polio-immunisation-campaign.
11. UBOS, *https://www.ubos.org/explore-statistics/20/.* 2022.

Measles Outbreak in Bundibugyo District, Western Uganda, February–June 2023

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Summary

Background: Measles is the most common cause of vaccine preventable disease outbreaks in Uganda. On April 28, 2023, the Ministry of Health was notified of a measles outbreak in Bundibugyo District, Western Uganda. We investigated to determine the scope of the outbreak, assess risk factors for transmission, evaluate vaccine effectiveness (VE), and recommend control measures.
Methods: A suspected measles case was onset of fever and maculopapular rash, plus ≥1 of: cough, runny nose, or conjunctivitis in a Bundibugyo District resident from February 1 to June 8, 2023. A confirmed case was a suspected case with positive measles-specific IgM. We reviewed medical records and conducted active case-finding in communities to identify case-patients. We conducted a matched case-control study (by age and village of residence) to identify risk factors for transmission. We estimated vaccine coverage using the percentage of vaccinated persons among eligible controls. We identified risk factors using conditional logistic regression, and calculated VE as VE= 1-OR_{MH}, where OR_{MH} is the Mantel-Haenszel odds ratios associated with having received ≥1 dose of measles vaccine.
Results: We identified 234 case-patients; 14 (6%) were confirmed and 4 (2%) died. Children aged 7-11 months were the most affected (attack rate [AR]=134/10,000), followed by 0-6 months

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(AR=44/10,000). Tokwe (AR=18/10,000) and Bundibugyo (AR=19/10,000) were the most affected sub-counties. Being unvaccinated for measles (aOR=6.1, 95%CI: 2.5–15) and visiting a health facility with symptomatic case-patients 7-21 days before rash onset (aOR=3.7, 95%CI: 1.0–13) increased odds of infection. Overall, measles vaccination coverage was 86% (95%CI 79-92); VE was 87% (95%CI: 69–94%).
Conclusion: The measles outbreak was facilitated by suboptimal vaccine coverage. A mass measles vaccination campaign targeting children <5 years in affected sub-counties, and proper triaging and isolation of patients with signs and symptoms of measles could help prevent future outbreaks in this area.

Background

Measles virus causes systemic illness (1, 2). Transmission of measles is dependent on person to person spread through respiration droplets or direct contact (2).Measles is highly contagious disease which was responsible for high infant mortality before the advent of an effective vaccine in 1963 (3). Furthermore measles virus infection diminishes preexisting antibodies that offer protection from other pathogens (4). Despite the availability of an effective and safe vaccine for almost half a century, measles is re-emerging in several developed countries because of the insufficient vaccination coverage among specific subpopulations, the emerging anti-vaccination movement, and the increasing movement of humans across borders. (5). The same applies to developing countries. Most strategies for reducing global measles morbidity and mortality and eliminating measles are based on the ability to enhance immune response to the measles virus(6). In 2023, Uganda launched a nationwide measles-rubella vaccination campaign, targeting 18.1 million children aged 9 months to 15 years, with the aim of achieving at least 95% coverage in each district. The campaign was conducted in two phases, from 12–16 September and from 19–23 September, using a fixed-post and outreach strategy (7). The campaign also included vitamin A supplementation and deworming for children under five years of age. Despite the measures, Uganda has been experiencing measles outbreaks.

On April 28, 2023, Ministry of Health (MoH)
On April 28, 2023, Ministry of Health (MoH)
received a notification of a measles outbreak in Bundibugyo District, Uganda. This was after four out of five samples tested positive for measles specific IgM antibodies at the Uganda Virus Research Institute (UVRI). A total of 78 case-patients had been line listed at that time. We determined the scope of the outbreak, assessed risk factors for transmission, assessed vaccine effectiveness and vaccine coverage, and recommended evidence-based control measures.

Methods

Outbreak area

This outbreak occurred in Bundibugyo District, Western Uganda between March and June 2023. The district is bordered by Ntoroko District to the north, Kabarole District to the east and southeast and the Democratic Republic of Congo to the west. The outbreak affected 18 sub counties and town councils of Bundibugyo District namely: Tokwe, Bundibugyo town council, Nyahuka town council, Buganikire town council, Busaru, Bubandi, Kisubba, Mirambi, Bubukwanga, Butama-Mitunda town council, Kirumya, Ntotoro, Bundingoma, Busunga town council, Bukonzo, Nduguto, Ntandi town council and Sindila. The district has a population of approximately 277,900 people. The district has 27 sub-counties and town councils and covers an area of 848.2 km^2 with an average population density of approximately 328/km^2.

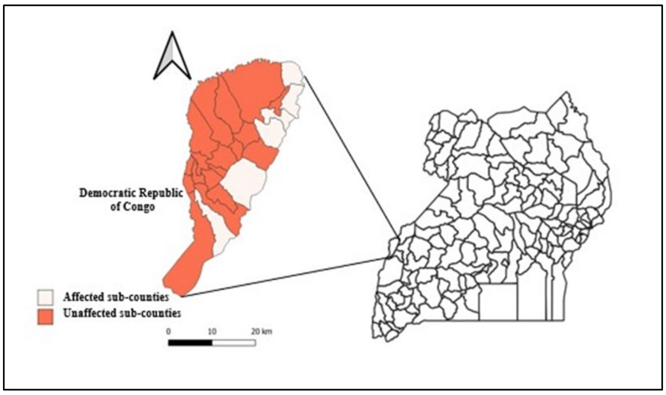

Figure 1: Location of Bundibugyo District, Western Uganda.

Case definition and finding

We defined a suspected case as onset of fe-

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ver and maculopapular rash, with at least

one of the following: cough, runny nose (Coryza) or conjunctivitis (red eyes) in a resident of Bundibugyo District from 1st February, 2023 to 08th June 2023. A confirmed case was defined as a suspected case that has been confirmed positive for IgM measles-specific antibody test(2).

We reviewed patient records to identify measles case-patients that visited health facilities in Bundibugyo District since February, 2023. We updated the line-list by reviewing patients' clinical records and registers.

Additional case-patients were identified through active case search at both health facilities and communities, with the help of the Health Assistants (HAs) and Village Health Teams (VHTs). We trained 15 HAs from the 18 affected sub-counties on the case definition, and these subsequently cascaded the training to their respective VHTs. The VHTs then conducted house to house community active case-search, and notified the HA who then verified whether the person met the case definition. For those that met the case definition, a standard Case Investigation Form (CIF) would then be administered by the HA.

Descriptive epidemiology

We described the case-patients by calculating attack rates by person and place, using the Uganda Bureau of Statistics 2021 population projection of children in Bundibugyo District sub counties as the denominator (8). We further described the case-patients by time of rash onset using an epidemic curve.

Hypothesis generation interviews

We conducted fifty-six (56) hypothesis-generating interviews using a standardized measles case investigation form. We interviewed parents/guardians of case-patients about potential risk factors for measles transmission occurring within 3 weeks before onset of signs and symptoms.

These included visiting a health facility, attending social gatherings, school or places of worship, receiving a visitor and travelling outside Bundibugyo district. We asked parents/guardians about the case-patients' immunization status before symptom onset. Vaccination status was verified through review of health cards and where the card was missing, a recall approach was employed. Additional risk factors we assessed included playing away from home and visiting water collection points.

Laboratory Investigations

We collected whole blood, oral and pharyngeal swabs from suspected case-patients for measles IgM antibody testing and molecular testing to ascertain the strain.

Environmental investigations

We conducted an environmental assessment at the different border crossings between DRC and Bundibugyo district, as well the isolation facilities at the two major measles treatment units i.e. Bundibugyo Hospital and Nyahuka HCIV. This was with the aim of evaluating any potential factors that may have led to the outbreak.

Case control study

We conducted a matched case control study in the 18 affected sub-counties and town councils to evaluate exposures that emerged during hypothesis generation. We defined a control as any person residing in Bundibugyo District with no history of fever or rash from 1st Feb 2023 to 8th June 2023.

We matched cases to controls by age, the following groups: 0<9 months, 9-24 months, 25-59 months, 5-14 years and >14 years to align with the national routine and mass immunization schedules for measles and by village of residence to ensure both case and control had comparable exposures. The controls were randomly selected from the neighborhood and from only households that didn't report any measles case from February 2023 to 8th June 2023. We defined effective exposure period to be the time window during 7-21 days prior to case patient's onset of rash. Vaccination history was assessed by vaccination card availability and recall of the parent with demonstration of knowledge on site of vaccination.

We collected data using Epi Data and exported it to MS Excel for cleaning. We conducted data analysis using Epi Info 7.1.5. We conducted a

Continues to page 54

conditional logistic regression to analyze matched case control data.

We estimated vaccine effectiveness for measles vaccine using the formula VE= (1-$OR_{Protective}$) where $OR_{Protective}$ were the protective odds from the case control study. We excluded subjects with ages between 1 to 9 months based on Uganda's measles immunization schedule.

Measles vaccine effectiveness

We identified risk factors using conditional logistic regression, and calculated VE as VE= 1-OR_{MH}, where OR_{MH} is the Mantel-Haenszel odds ratios associated with having received ≥1 dose of measles vaccine.

Measles vaccine coverage

We estimated vaccine coverage using the percentage of vaccinated persons among eligible controls.

Ethical considerations

This outbreak investigation was in response to a public health emergency and was therefore determined to be non-research. The Ministry of Health (MoH) gave permission to investigate this outbreak. The investigation was also approved by US CDC and conducted in accordance to the applicable US federal laws.
We sought permission to conduct the investigation from District health authorities of Bundibugyo District. We also sought verbal informed consent from the respondents who were survivors, and next of kin of the deceased. We ensured privacy during all interviews and case-patients information was kept confidential throughout the investigation period and beyond.

Results

Descriptive epidemiology

Overall, 234 measles cases were identified (220 suspected and 14 confirmed cases), with a case-fatality rate of 2%. The age range of the identified cases was 2 months–60 years with age group 7–11 months being the most affected (AR 134/10,000 persons), followed by 0–6 months (AR 44/10,000 persons). Males and females were similarly affected (Attack rate [AR]: 9/10,000) vs. 8/10,000) (Table 1). Tokwe (AR 19/10,000 persons) and Bundibugyo TC (AR 18/10,000 persons) were the most affected sub counties (Table 1).

Table 1: Measles attack rate by sex and age group of case-patients and sub counties, Bundibugyo District, Western Uganda, March-June, 2023

Variable	Frequency	Population	AR/ 10,000
Age			
0-6 Months	29	6,586	44
7-11 Months	72	5,363	134
12-59 Months	105	45,020	23
5-14 Years	21	91,985	2
15 Years and above	7	128,946	1
Sex			
Male	116	136,300	9
Female	118	141,600	8
Sub-county			
Tokwe	23	11,886	19
Bundibugyo TC	43	23,711	18
Nyahuka	34	20,883	16
Buganikere TC	9	6,344	14
Busaru	24	18,568	13
Bubandi	9	9,425	10
Kisubba	19	21,112	9
Mirambi	9	10,115	9
Bubukwanga	12	14,184	9
Butuma-Mitunda TC	5	7,019	7
Kirumya	8	13,971	6
Ntotoro	5	13,130	4
Bundigoma	2	5,733	4
Busunga tc	4	11,915	3
Bukonzo	2	8,382	2
Ndugoto	1	7,257	1
Ntandi TC	1	9,478	1
Sindila	1	9,705	1
Mabere	2	5,857	3

The epidemic curve revealed a propagated measles outbreak, with the primary case having rash

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onset on March 10th, 2023. The primary case-person had arrived from DRC on February 27th, 2023, and developed fever on March 4th,2023 followed by a generalized maculopapular rash on March 10th, 2023. This implies that he was infectious from about March 6th, 2023 since measles case-patients are known to be infectious 4 days before and after the onset of rash. The first secondary case was a 2-year-old son to the primary case and had onset of rash on 14th March 2023. The index case was identified on 1st April 2023, at Bundibugyo hospital. More cases appeared after 31st March 2023 and there have been no reported cases since 15th June 2023 (Figure 2).

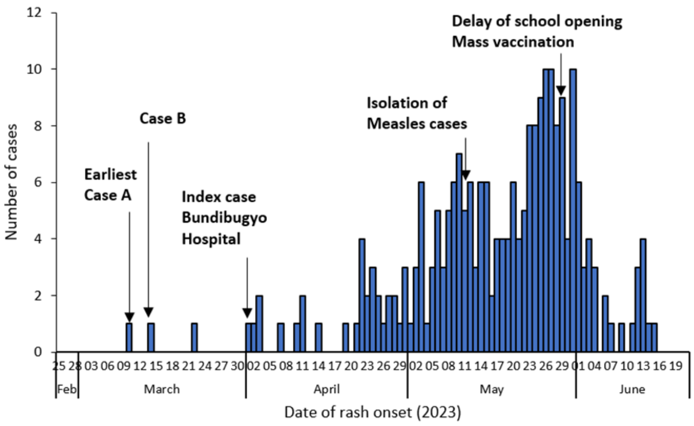

Figure 2: Date of onset of illness of case-patients during Measles outbreak, Bundibugyo District, Western Uganda, March-June, 2023

Laboratory investigation

The measles strain responsible for the outbreak was the B_3 measles virus following molecular gene sequencing.

Environmental assessment

We found that there was generally unregulated movement of persons to and from either side of the border, and no screening of incoming persons from DRC. We got reports from members of the border community about a similar illness that had been in DRC since February 2023.

We also found out that there was mixing up of measles case-patients and other patients on the pediatric ward of Bundibugyo hospital in the early weeks of outbreak. The isolation facility was established after about 2 weeks from when the first confirmed case visited the facility. The nursing staff on the ward informed us that they started seeing suspicious cases as early as March 2023 but their reports were ignored by the medical officers. There was also lack of functional triage at all health facilities, even after the outbreak was confirmed.

Hypothesis-generating interview findings

The hypothesis generation findings suggested that the potential risk factors for measles transmission were: attending school, not being vaccinated, visiting a water collection point, attending a health facility and attending any place of worship before falling sick before falling sick within 3 weeks before falling sick (Table 2).

Table 2: Hypothesis generation interview findings

Risk factors	Percentage (%)
Attending school within 3 weeks before falling sick	89
Not vaccinated against measles	71
Visiting a water collection point	57
Attending a health facility	55
Attending a place of worship	54
Playing away from home	45
Attending a social gathering	29
Travel outside Bundibugyo district	18
Receiving a visitor	14

Case-control study findings

Being unvaccinated against measles increased the odds of measles infection 6 times (aOR 6.13 (2.5, 15.0)) (Table 3). In addition, meeting a symptomatic person during a health facility visit was associated with a 3-fold increase in the odds of measles infection, compared to those who never visited a health facility (aOR 3.7(1.01, 13) (Table 3).

Measles vaccine effectiveness

We estimated vaccine effectiveness at 87% (CI 69,94) among respondents above 9 months of age (Table 4).

Measles vaccination coverage

Approximately eighty-six percent (101/117) of the controls above the age of 9 months had received at least one dose of measles vaccine. Thus, the estimated vaccine coverage was 86%.

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Table 3: Multivariate analysis of risk factors for Measles transmission in Bundibugyo District, February-June 2023

Risk factor	Number (%) Exposed		aOR (95% CI)
	Cases (%)	Controls (%)	
Vaccinated	Ref		
Not vaccinated	35(57)	16 (14)	6.1 (2.5,15)
Did not visit health facility	Ref		
Visited health facility and saw symptomatic persons	30(36)	28 (17)	3.7 (1.01,13)
No health facility admission	Ref		
Health facility admission	8(10)	9(5)	0.74 (0.13,4.9)

Table 4: Measles vaccine effectiveness by age, Bundibugyo District, May-June 2023

Age	Vaccination status	Frequency (%)		OR_{MH} (95% CI)	Vaccine effectiveness
		Cases (n=62)	Controls (n=117)		
Overall (9 months-60 years)	Vaccinated	27 (44)	101 (86)	0.13 (0.14,0.31)	87 (69,94)
	Not vaccinated	35 (56)	16 (14)	Ref	

Discussion

Our investigation revealed that being unvaccinated against measles, and meeting someone with a rash during a health facility visit increased the odds of measles infection during the measles outbreak in Bundibugyo District. Molecular laboratory findings showed that the outbreak was due to the measles B_3 strain. The most affected sub-counties were Bundibugyo town council and Tokwe sub-county.

The vaccination coverage of 86% was way below the recommended minimum target of 95%, required for herd immunity (9). This lack of herd immunity facilitated the outbreak and spread of the measles, following its introduction by the earliest identified case who had recently returned from an affected village in DRC.

The estimated coverage also grossly contrasts the administrative district coverage, and is much lower than the reported coverage of 114% (10), suggesting data quality gaps.

Poor triage at health facilities, particularly Bundibugyo hospital facilitated the transmission and amplified the measles outbreak. During the first three weeks of the outbreak, measles case-patients admitted to the pediatric ward were mixed with other patients, who would days later, be readmitted with measles infection.

The most affected sub-county of Tokwe and Bundibugyo town council are closely linked to DRC by the physical border and trade activities respectively. The porous border entry points with unregulated entry and exit of persons along with lack of routine screening of persons likely introduced the measles virus into a population. The primary case-patient returned to Uganda from DRC via one of the s border points at Butogho village, Kisubba subcounty and proceeded to Nyahuka subcounty.

Study limitations

Recall bias from parents who had lost their vaccination cards and children whose caretakers who did not have clear vaccination and exposure information which might have led to over estimation or under estimation of vaccination status. We relied on knowledge of site of vaccination at 9 months to establish vaccination status. Most cases were identified through active case search at health facilities and this could have introduced selection bias. We used proportion of vaccinated controls in the affected sub counties to estimate vac-

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cine coverage which may not have been representative of the coverage in the entire district.

Conclusion

The outbreak was facilitated by the low measles vaccination coverage and suboptimal vaccine effectiveness in the affected sub counties. We recommended mass vaccination campaign and scale up of routine immunization activities while observing good cold chain practices. We further recommended the following measures to mitigate the risk of future outbreaks in Bundibugyo District: routine measles vaccination through sustained daily static clinics and outreaches, proper triaging of all patients at care-entry points in all departments by health facility managers, improvement on health education on immunization, and ensuring that at least one isolation room is established and maintained at all high-volume health facilities to prevent mix-up of patients with contagious diseases.

Public Health Actions

Following the investigation, we conducted a mass measles immunization campaign targeting all children aged 6-59 months regardless of prior immunization for measles at health facilities of all affected sub counties. The District task force supported mass measles vaccination by delaying school opening for one week. The District Health Officer redistributed key drugs and supplies for measles case management to support the established isolation units. We intensified case-finding through active search at health facilities and communities and emphasized set up of triage and temporary holding areas at all outpatient departments

Conflict of interest

The authors declare that they have no conflict of interest.

Acknowledgements

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References

1. Griffin DE, Ward BJ, Esolen LM. Pathogenesis Of Measles Virus Infection: An Hypothesis For Altered Immune Responses. The Journal of Infectious Diseases. 1994;170(Supplement_1):S24-S31.
2. Bester JC. Measles and Measles Vaccination: A Review. JAMA Pediatrics. 2016;170(12):1209-15.
3. Naniche D. Human immunology of measles virus infection. Measles: Pathogenesis and Control. 2009:151-71.
4. Mina MJ, Kula T, Leng Y, Li M, de Vries RD, Knip M, et al. Measles virus infection diminishes preexisting antibodies that offer protection from other pathogens. Science. 2019;366(6465):599-606.
5. Rota JS, Hickman CJ, Sowers SB, Rota PA, Mercader S, Bellini WJ. Two Case Studies of Modified Measles in Vaccinated Physicians Exposed to Primary Measles Cases: High Risk of Infection But Low Risk of Transmission. The Journal of Infectious Diseases. 2011;204(suppl_1):S559-S63.
6. Moss WJ, Polack FP. Immune responses to measles and measles vaccine: challenges for measles control. Viral immunology. 2001;14(4):297-309.
7. WHO. Statement from Uganda's Minister of Health on the National Measles-Rubella and Polio Immunisation Campaign 2019 2019 [Available from: https://www.afro.who.int/news/statement-ugandas-minister-health-national-measles-rubella-and-polio-immunisation-campaign.
8. Statistics UE. Uganda Bureau of Statistics. Energy. 2022;95(13.6):14.5.
9. Immunization WHODo. Immunization in practice: a practical guide for health staff: World Health Organization; 2015.

Continues to page 58

10. Health Mo. 2023 [updated 15-6-2023. Available from: https://hmis.health.go.ug/dhis-web-data-visualizer/index.html#/.

Application of genomic sequencing in a disease outbreak investigation; A case of cholera in Kayunga and Namayingo, 2023

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Summary

Background: On 19 July 2023, Uganda declared a Cholera outbreak in districts of Kayunga and Namayingo. We describe how we used genomic sequencing to ascertain the causative agents and drug resistance profile in this outbreak investigation.

Methods: The national rapid response team worked with the district laboratory focal persons and hub coordinators to collect and refer samples through the hub system for testing. Staff from the National Microbiology Reference Laboratory (NMRL) and National Genomic Sequencing Laboratory tested samples for Vibrio cholerae and antibiotic resistance.

Results: *Vibrio cholerae* serotype 01 Ogawa isolate belonging to ST69 Multiple Locus Sequence Type (MLST) was identified. Isolates carried the IncC plasmid, known for harboring antibiotic-resistance genes. Identical drug resistance gene markers indicating resistance to multiple drugs included streptomycin, ampicillin, ceftriaxone, chloramphenicol, trimethoprim, erythromycin, azithromycin, sulfisoxazole, and co-trimoxazole.

Conclusion: Genomic sequencing did not establish a definitive transmission link between cases in the two districts, indicating potential diverse sources.

Background

Genomic sequencing provides an innovative approach in identifying and characterizing strains in disease outbreak investigations (1),(2). This approach has successfully been applied in ebola virus disease, COVID-19 pandemic, seasonal influenza, and zika virus outbreak investigations (3). Although it's been recommended for Cholera surveillance and investigation (4), genomic sequencing has hardly been used for this purpose in Uganda. We describe how we used genomic sequencing to ascertain the causative agents and drug resistance profile in this outbreak investigation.

Methods

We analyzed culture and antibiotic and genomic testing data for samples collected from suspected cases during the cholera outbreak in Kayunga and Namayingo in July 2023. A total of 144 stool samples were collected, 118 samples from Kayunga and 26 samples from Namayingo. The samples were collected in sterile stool containers and transported to the reference laboratories using the national sample transport system (hub system) in Cary- Blair transport media under cold chain (2-8OC) following triple packaging principles. The samples were accompanied with cholera case investigation forms that captured data variables which included age, sex, district, health facility, sample type and date of sample collection. The laboratory generated data of whole genome sequencing (WGS) WGS, culture results as well as antimicrobial susceptibility test results of which was then merged with the metadata for the downstream analysis

Culture and sensitivity were performed by the national microbiology reference laboratory (NMRL) using conventional biochemical methods for identification and disk diffusion for antimicrobial susceptibility testing. The resultant isolates were then subjected to whole genome sequencing at national genomic sequencing labor-

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atory. For whole genome sequencing, DNA extraction was done using the Qiagen extraction kit followed by DNA quantification using quibit. Library preparation was done using Illumina DNA preparation kit and sequenced using the Miseq platform. WGS data was analyzed using the back-page pipeline.

Ethical considerations

This was in response to the cholera outbreak in Kayunga and Namayingo. The office of the Center for Global Health, US Center for Disease Control and Prevention determined that this activity was not human subject research and its primary intent was for disease control. We sought permission and administrative clearance from the National Health Laboratory and Diagnostic Services (NHLDS), Kayunga Regional Referral Hospital and the district health authorities to conduct the investigation.

Results

Of the 144 samples referred, 59 samples tested positive by culture and sensitivity. Genomic sequencing revealed *Vibrio cholerae* serotype 01 Ogawa of ST69 Multiple Locus Sequence Type (MLST), a predominantly local endemic sequence, among isolates from both districts. All the isolates carried the IncC plasmid, a harboring antibiotic-resistance gene and forty-nine virulence factor- genes, contributing to the pathogenicity of *vibrio cholerae*. Identical drug resistance gene markers indicating resistance to multiple drugs included; streptomycin, ampicillin, ceftriaxone, chloramphenicol, trimethoprim, erythromycin, azithromycin, sulfisoxazole and co-trimoxazole. From the phenotypic results, doxycycline, the recommended first-line treatment, showed no signs of resistance. Ciprofloxacin, an alternative treatment, exhibited a 2% resistance rate. However, erythromycin, azithromycin, and trimethoprim/sulfamethoxazole demonstrated a resistance rate exceeding 96.5%, emphasizing the significance of associated gene markers.

Discussion

Whole genome sequencing revealed the persistence of a local endemic strain in the country. The presence of common antibiotic resistance markers among all isolates raises concerns about the potential for widespread resistance as these genes harbor integrating conjugative elements, plasmids, superintegron, transposable elements, and insertion sequences which are the key carriers of genetic traits encoding AMR function(5). The resistance to erythromycin, azithromycin, and trimethoprim/sulfamethoxazole highlights the importance of understanding the genetic basis for resistance, factors underlying the expansion of these resistant phenotypes as observed in other countries (6), (7) and the need for alternative treatment options. The absence of resistance to doxycycline aligns with current treatment guidelines, while the 2% resistance to ciprofloxacin suggests cautious consideration when selecting alternative treatments. The lack of resistance to chloramphenicol raises questions about the potential impact of the dfrA1 gene marker. Further investigation is required to determine the relationship between this marker and chloramphenicol resistance (5).

Study limitations

We did not sample all cases due to logistical challenges and there were no environmental samples sequenced to enable us have detailed transmission linkages for the two districts.

Conclusion

Genomic sequencing played a pivotal role in understanding the Cholera outbreak in Kayunga and Namayingo. Genomic sequencing did not establish a definitive transmission link between cases in the two districts, indicating potential diverse sources. However, shared characteristics among the Vibrio cholerae isolates, such as MLST results, plasmid presence, resistance markers, and virulence factors, strongly indicated a common origin. We recommend utilization of this technology in subsequent disease outbreak investigation including outbreaks of bacterial origin in nature.

Conflict of interest: The authors declare no conflict of interest.

Authors contribution: RN: participated in the conception, design, analysis, interpretation of the study and wrote the draft bulletin; SG, LNB,MP, AA, and GN reviewed the report, reviewed the drafts of the bulletin for intellectual content and

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made multiple edits to the draft bulletin; SG, RN, and ARA reviewed the final bulletin to ensure intellectual content and scientific integrity. All authors read and approved the final bulletin.

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Reference

1. Robinson ER, Walker TM, Pallen MJ. Genomics and outbreak investigation: From sequence to consequence. Genome Med. 2013;5(4).
2. World Health Organization (WHO). Interim Guidance Document on Cholera Surveillance Global Task Force on Cholera Control (GTFCC) Surveillance Working Group. 2017.
3. The National Academies Press Washington. Genomic Epidemiology Data Infrastructure Needs for SARS-CoV-2: MODERNIZING PANDEMIC RESPONSE STRATEGIES. Genomic Epidemiology Data Infrastructure Needs for SARS-CoV-2: Modernizing Pandemic Response Strategies. 2020.
4. WHO. Public Health Surveillance for Cholera : Interim Guidance. Who [Internet]. 2020;2019(16 December 2020):1–11. Available from: https://www.who.int/publications/i/item/who-2019-nCoV-surveillanceguidance-2020.8
5. Das B, Verma J, Kumar P, Ghosh A, Ramamurthy T. Antibiotic resistance in Vibrio cholerae: Understanding the ecology of resistance genes and mechanisms. Vaccine [Internet]. 2020;38:A83–92. Available from: https://doi.org/10.1016/j.vaccine.2019.06.031
6. Berthe M, Sandra M, Muyembe JJ, George NT, Ickel Kakongo K, Daniel Yassa N. Antimicrobial Drug Resistance of Vibrio cholerae, Democratic Republic of the Congo. Emerg Infect Dis [Internet]. 2015;21(5):2015. Available from: https://www.britannica.com/place/Democratic-Republic-of-the-Congo
7. Aligholi M, Emaneini M, Jabalameli F, Shahsavan S, Dabiri H, Sedaght H. Emergence of high-level vancomycin-resistant Staphylococcus aureus in the Imam Khomeini hospital in Tehran. Med Princ Pract. 2008;17(5):432–4.

Outbreak of Rift Valley Fever among herdsmen linked to contact with body fluids of infected animals in Nakaseke District, Central Uganda, June–July, 2023

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Summary

Background: Rift Valley fever (RVF) is a viral zoonosis which occurs sporadically in Uganda**.** On July 24, 2023, a 24-year-old male paraveterinarian from Kimotozi village, Nakaseke District presented to Mengo Hospital with a 5-day history of intermittent nosebleeds, fever, abdominal, and joint pain; Polymerase Chain Reaction (PCR) from a blood sample was positive for RVF. We investigated to identify the source, estimate the magnitude, and drivers of the outbreak to inform control and prevention measures.
Methods: We defined a suspected case as a sudden onset of fever (≥38°C), and at least 2 of the following signs and symptoms: headache, skin rash, muscle/joint pain, intense fatigue, dizziness, coughing, abdominal pain, or bleeding in a resident of Nakaseke District from June 1–July

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30, 2023. A confirmed case was a suspected case with positive PCR results. We actively searched for case-patients and interviewed them about demographics, symptoms, and animal-related activities. Blood samples from seven case-patients were tested by PCR at Uganda Virus Research Institute (UVRI). We conducted environmental assessments and interviewed farmers and herdsmen to identify risk factors.
Results: Eight case-patients (2 confirmed), all males, were identified in Kimotozi Village; one (12.5%) died. Median age was 25 years (range 19-28). Symptoms included fever (100%), headache (100%), and bleeding (25%). All case-patients (one para-veterinarian and seven herdsmen) resided and worked on three RVF-affected farms with reports of multiple recent animal abortions and young animal deaths. All had frequent contact with the livestock, including placentas, and drank raw cow milk. Before presenting to Mengo Hospital, the index case visited three health facilities without any suspicion or clinical testing for viral hemorrhagic fevers.
Conclusion: This RVF outbreak likely resulted from contact with infected animals' fluids. We educated farmers and herdsmen, and restricted animal movement from RVF affected farms. Training clinicians to increase their suspicion index for RVF could reduce delays to diagnosis in the future.

Introduction

Rift Valley fever (RVF) is an acute viral hemorrhagic fever caused by Rift Valley Fever Virus (RVFV), a member of the genus *Phlebovirus* belonging to the family *Bunyaviridae*. The virus can be transmitted from infected animals to humans through contact with blood, body fluids, or animal tissues during slaughtering or butchering, assisting with birth in animals, conducting veterinary procedures, or from the disposal of carcasses or fetuses. Transmission can also occur through bites from infected mosquitoes, but person to person transmission has not been documented. Persons who are always in close contact with the animals and animal products such as herders, farmers, and animal health practitioners are at higher risk of infection (1). In animals, RVFV is mainly transmitted by mosquitoes.
The disease has an incubation period of 2–6 days in humans, and those infected may remain asymptomatic, while others might develop mild or severe symptoms. People with mild form may experience signs and symptoms such as fever, sudden onset of flu like signs, body weakness, joint pain, muscle pain, headache, loss of appetite, vomiting, confusion, neck stiffness, sensitivity to light and dizziness. The symptoms of RVF usually last from 4 to 7 days, after which the antibodies can be detected and the virus disappears from the blood. People with severe form of RVF may experience clinical signs and symptoms such as vomiting blood, passing blood in the faeces, a purpuric rash, bleeding from the nose or gums and bleeding from venipuncture sites (2). The overall case fatality rate is <1%. However, in patients with hemorrhagic form, the case-fatality rate is up to 50%.
Rift Valley Fever Virus infects domestic ruminants such as cattle, sheep, and goats in an age-dependent manner, where young animals are more susceptible than adults. In livestock, the disease can cause increased abortions and stillbirths, and high mortality in neonates and young animals leading to significant economic losses (3). There is no specific treatment for RVF in humans and animals, but supportive care may prevent complications and decrease mortality.
Rift Valley Fever Virus was first isolated during an epidemic among sheep in the Rift Valley in Kenya in 1931. Between 2000–2016, wide spread outbreaks have occurred in various countries such as Kenya, Tanzania, Somalia, Sudan, Niger, Madagascar, South Africa, Saudi Arabia and Yemen. In Uganda, the first RVF human case was identified in 1968 followed by an outbreak of RVF that occurred in Kabale district in 2016 (4). Uganda has continued to experience an increase in sporadic outbreaks of RVF. From 2016 to 2018, 10 independent outbreaks occurred in 10 districts (5). The disease is endemic in several regions of the country; a recent study reported a seroprevalence of 11% in animals (6). From 2017 to 2023, RVF was confirmed in 21 districts.
On July 24, 2023, the Uganda National Public Health Emergency Operations Center (PHEOC) was notified of a suspected Viral Hemorrhagic Fever (VHF) by Mengo Hospital through the Event Based Surveillance (EBS) unit. On the same day, the case-patient tested positive for RVF using Polymerase Chain Reaction (PCR) at the Central Public Health Laboratory (CPHL). We investigated to identify the source, estimate the magnitude, and drivers of the outbreak to inform control and prevention measures.

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Methods

Outbreak area

This outbreak occurred in Kinyogoga Subcounty, Nakaseke District (Figure 1). The district is located in Central Uganda; has an estimated population of 254,900 living in 8 sub-counties (7). Rearing of cattle and goats is the main economic activity in the district. Nakaseke District is located in the cattle corridor. The cattle corridor stretches from South-Western through central to north-eastern Uganda, and covers 35% of the country's land. Livestock production in Uganda is highly concentrated in the cattle corridor.

Figure 1: Map of Uganda showing the location of Nakaseke District in the cattle corridor

Case definition and finding

We defined a suspected case as sudden onset of fever (38°C), no clear alternative diagnosis, and at least two of the following signs and symptoms: headache, skin rash, muscle/joint pain, intense fatigue, dizziness, coughing, abdominal pain, or unexplained, bleeding from any site from June 01, 2023 to July 30, 2023 in a resident of Nakaseke District. A confirmed case was defined as a suspected case with Rift Valley Fever Virus identified by PCR.

To identify additional cases, the team visited several health facilities where the index case-patient sought care; reviewed records and interviewed health workers. We interviewed the index case household members and herdsmen on the RVF affected farms (farms which reported high abortions and high mortality rate of young animals). We also used snow-balling to identify additional cases who presented with similar signs and symptoms in the community. We subsequently interviewed case-patients on the date of symptom onset, signs and symptoms, demographics, and exposure history. We line-listed all case-persons identified in the community.

Descriptive epidemiology

During the investigation, we conducted a descriptive epidemiologic analysis of the case-patients by time, person, and place.

Environmental assessment

We conducted assessments at three (3) RVF affected farms where case-patients resided or worked. We assessed for the presence of livestock that had aborted and died suddenly during June –July 2023. We interviewed 9 herd's men, 3 farmers and 4 animal health practitioners to understand more about the RVF affected farms with high abortions and animal deaths, and risk practices that exposed case-patients to RVFV.

Laboratory investigations

We collected 5 ml of blood from 7 case-patients. The samples were transported to the Uganda Virus Research Institute (UVRI) laboratory, Entebbe, Uganda for laboratory testing using Polymerase Chain Reaction (PCR).

Ethical considerations

This investigation was in response to a public health emergency (RVF outbreak) and was therefore determined by the US Centers for Disease Control to be non-research and that its primary intent was public health practice or a, epidemic or endemic disease control activity. The Ugandan Ministry of Health through the office of the Director General of Health Services gave the directive and approval to investigate this outbreak. We obtained verbal informed consent from case-patients during this investigation and other interviewed community members that were above 18 years. We ensured confidentiality by conducting interviews in privacy ensuring that no one could follow proceedings of the interview. The questionnaires were kept under lock and key to avoid disclosure of personal information of the respondents to members who were not part of the investigation.

Continued from page 62

Results

Descriptive epidemiology

We identified 8 RVF case patients, including 2 confirmed cases and 6 suspected cases. Of the 8 case-patients, one died (case-fatality rate =12.5%). The time to death from symptom onset was 16 days. Among the 8 case-patients with symptom data, common symptoms included fever (100%), headache (100%), and abdominal pain (63%) (Figure 2). The case-patients ranged in age from 19 to 28 years. All (100%) of the case-patients were males. All case patients were residents of Kimotozi village, Kinyogoga subcounty in Nakaseke District. Seven (88%) case-patients were herders (88%) and one (12%) was a para-veterinarian. The index case sought care at four (4) different health facilities where he was managed for gastritis, typhoid, and brucellosis before RVF was suspected and confirmed.

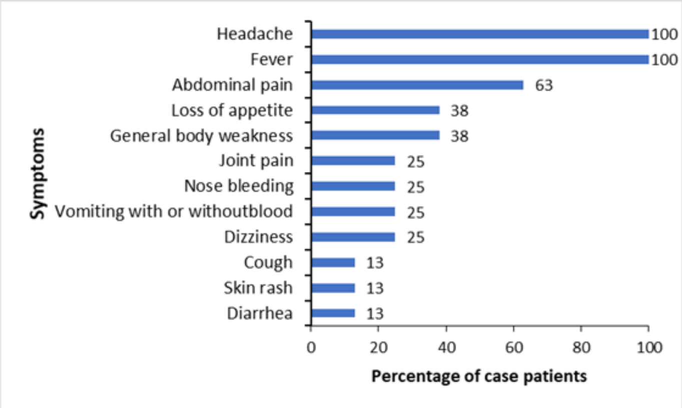

Figure 2: Symptoms presented by eight Rift Valley Fever case-patients during an outbreak in Nakaseke District, Uganda, June–July 2023

The case-patients resided and worked on the 3 RVF affected farms with multiple abortions and young animal deaths in particular calves, lamb, and kids (Figure 3). The 3 RVF affected farms were neighboring each other, in a single village known as Kimotozi village located in Kinyogoga subcounty, Nakaseke District.

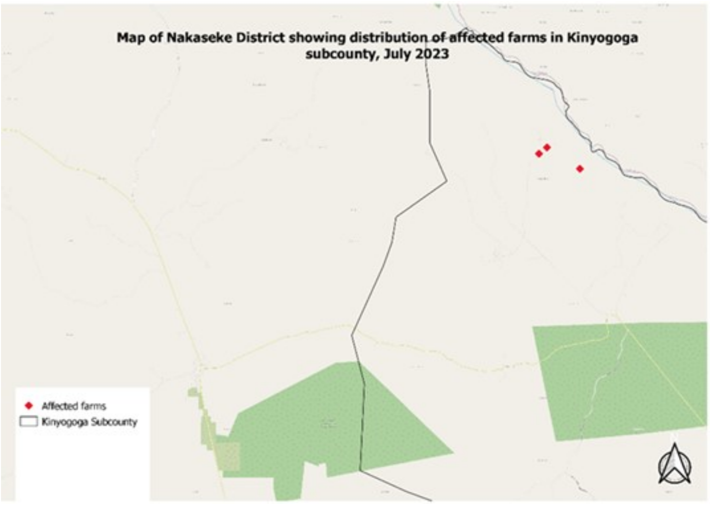

Figure 3: Distribution of Rift Valley Fever affected farms in Kimotozi village, Kinyogoga subcounty, Nakaseke District during June–July, 2023

Following high abortion rates among cattle, sheep, and goats, and death of neonates and young animals (goats, sheep and cattle) aged less than 1 year which started in early June throughout the month of July, 2023; human cases started to appear on June 17, 2023. On July 12, the index case of the outbreak appeared in Kinyogoga Subcounty. The case-patients rapidly increased and peaked on July 15, 2023. This epidemic curve suggests a multiple-source outbreak (Figure 4). The onset of cases declined, the last case onset symptom occurred on July 26.

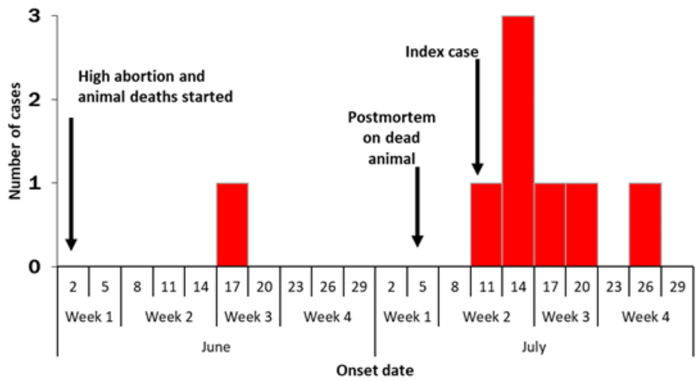

Figure 4: Epidemic curve showing distribution of RVF case-patients by date of symptom onset, Nakaseke District, Uganda, June-July, 2023

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Laboratory investigations
A total of eight (8) human samples were collected. Two of the returned human sample results were PCR positive (positivity rate of 25%). During the outbreak investigation, the team was unable to collect animal samples because of logistical limitations.

Environmental assessment findings
The animals on the three (3) affected farms shared a grazing area and a watering point. Unusual increase in abortion rates and death of young domestic animals (goats, sheep, and calves aged less than one year) were reported on the three affected farms. From June 1 to July 30, 42 young animals died, 36 animals aborted and 8 adult animals died. During this period, the case-patients engaged in assisted animal birth, handling of retained placenta, handling of aborted fetus, and slaughtering of dead animals on the affected farms without using personal protective equipment. There was restricted movement of animals from the three affected farms.

Exposure history
The RVF case-patients had a history of contact with the animals and animal products from RVF affected farms. The case- patients participated in the slaughter and butchering of sick animals, assisting animal birth, handling aborted animal fetus, and retained placenta without wearing personal protective equipment. In addition, they consumed dead animal meat, milked and drank raw milk which increased exposure to RVFV. The RVF index case collected blood samples from sick animals and also conducted post-mortem on sick animals prior to illness.

Discussion

The RVF outbreak occurred in Kimitozi village, Nakaseke District, which resulted in 8 cases and 1 death during June to July, 2023. The outbreak likely resulted from contact with infected animal fluids.

The RVF index case sought care at 4 health facilities where he was diagnosed with gastric ulcer, brucellosis, and typhoid before a VHF was suspected by the clinicians after 12 days of seeking health care. The delay in detection could have been worse with other VHFs such as Crimean-Congo hemorrhagic fever which is endemic to Nakaseke District with a higher case fatality rate and capable of person-to-person transmission (8). Early suspicion and laboratory diagnosis can help in the early detection of the disease, early supportive treatment and recovery of the infected persons. Our findings highlight the need to improve access to diagnostic services, educating the clinicians about VHFs in humans, creating awareness among clinicians on the possibility of co-infections with other highly infectious pathogens such as RVF, and also enhancing surveillance of VHFs in humans and animals in Uganda.

The outbreak was linked to contact with infected animals' fluids during slaughtering, butchering, assisted animal birth, handling of aborted fetus, and milking of sick animals without using personal protective equipment. Case-patients also consumed raw milk and dead animal meat which increased the risk of acquiring RVF disease. This is consistent with the study conducted in South Africa (9). Livestock in particular cattle, sheep, and goat act as reservoirs for RVFV, and play a vital role in the transmission of zoonotic diseases such as RVF to humans (10, 11).

Herders and a para-veterinarian were affected by the outbreak. According to the World Health Organisation (WHO), occupational groups such as herders, and veterinarians are at higher risk of acquiring zoonotic diseases such as RVF disease (12) because of frequent contact with live animals and their products. There is a possibility that the human cases, in particular herdsmen got exposed to RVFV through bites from infected mosquitoes, most commonly Aedes and Culex mosquitoes, since they herd in busy areas. There is need for targeted interventions such as creating awareness on the transmission and prevention of zoonotic diseases among the high-risk. This could reduce the chances of exposure to highly infectious zoonotic diseases such as RVF. Hence, preventing future RVF outbreaks, and also minimizing the effect of RVF outbreaks.

The investigation found that the outbreak affected only males and young adults aged 19-28 years. In cattle keeping communities; males play gender roles such as grazing and slaughtering of animals which increases the risk of zoonotic disease transmission from animals to males compared to females (13). The young adults have frequent participation in livestock-related activities such as grazing, slaughtering and butchering of animals.

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A study conducted in Kabale District, Western Uganda, in 2016, found no antibodies against RVFV among individuals younger than 19 years (4). Exposure prevention strategies for RVF should target towards males and young adults.

The study found a higher case-fatality rate of 12.5% compared to previous outbreaks (14, 15). Additionally, less than 1% of humans infected with RVF die of the disease according to the World Health Organization(1). The higher CFR in this study could have resulted from under-detection of RVF cases because majority of the RVF cases maybe asymptomatic.

We found out that there was no One health collaboration between the human health and veterinary teams at district level which affected information sharing and timely detection of RVF outbreak. There is need to strengthen collaboration among the human health, veterinary and environmental officials through establishment of a District One Health team (DOHT) in Nakaseke District to enable effective response to zoonotic diseases in particular RVF at district level.

Limitations

We may have underestimated the magnitude of the outbreak because majority of the RVF cases may exhibit mild or no symptoms of RVF(16, 17). We were unable to collect animal samples because of logistical limitations. Therefore, unable to confirm and also determine the magnitude of RVF in animals. However, we based on the fact that RVF causes high abortion and death of young animals to identify the RVF affected farms. All case-patients worked and resided on the RVF affected farms.

Conclusion

The investigation revealed that there was Rift Valley Fever outbreak in Nakaseke, Uganda. The outbreak was linked to contact with infected animals and their body fluids. The outbreak revealed that the suspicion index for VHFs is still low among clinicians, and the animal disease surveillance system is still weak to enable timely detection of zoonotic diseases in animals before they cross over to humans. We educated communities with focus on high risk groups such as herds men, veterinary practitioners and farm owners in Nakaseke district on the signs and symptoms, transmission and preventive measures for RVF; were we encouraged use of PPE such as gloves during handling of animal products and consumption of boiled milk.

Conflict of interest

The authors declare that they have no conflict of interest.

Authors' contribution

All authors contributed to the write-up and review of the bulletin. MK wrote the drafts of the bulletin and revised the paper for substantial intellectual content. MK, BK, JK, and LN participated in the investigation of RVF in Nakaseke District and reviewed the paper for substantial intellectual content. LN, SL, and DM were involved in the review of the bulletin for substantial intellectual content. BK, RM, and ARA participated in the supervision of field data collection and reviewed the draft bulletin for substantial intellectual content. All the authors read and approved the final version of the bulletin.

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References

1. World Health Organization. Rift Valley Fever 2018 [23/August/2023:[
2. Hartman A. Rift Valley Fever. Clinics in laboratory medicine. 2017;37(2):285-301.
3. Wright D, Kortekaas J, Bowden TA, Warimwe GM. Rift Valley fever: biology and epidemiology. The Journal of general virology. 2019;100 (8):1187-99.
4. Nyakarahuka L, de St Maurice A, Purpura L, Ervin E, Balinandi S, Tumusiime A, et al. Preva-

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lence and risk factors of Rift Valley fever in humans and animals from Kabale district in Southwestern Uganda, 2016. PLoS Negl Trop Dis. 2018;12(5):e0006412.
5. Luke N, Balinandi S, Mulei S, Kyondo J, Tumusiime A, Klena J, et al. Ten outbreaks of rift valley fever in Uganda 2016-2018: epidemiological and laboratory findings. International Journal of Infectious Diseases. 2019;79:4.
6. Tumusiime D, Isingoma E, Tashoroora OB, Ndumu DB, Bahati M, Nantima N, et al. Mapping the risk of Rift Valley fever in Uganda using national seroprevalence data from cattle, sheep and goats. PLoS Negl Trop Dis. 2023;17(5):e0010482.
7. Uganda Bureau of Statistics. Population and Censuses, population by sex for 146 districts 2022 [Available from: https://www.ubos.org/explore-statistics/20/.
8. Mirembe BB, Musewa A, Kadobera D, Kisaakye E, Birungi D, Eurien D, et al. Sporadic outbreaks of crimean-congo haemorrhagic fever in Uganda, July 2018-January 2019. PLoS Negl Trop Dis. 2021;15(3):e0009213.
9. Msimang V, Thompson PN, Jansen van Vuren P, Tempia S, Cordel C, Kgaladi J, et al. Rift Valley Fever Virus Exposure amongst Farmers, Farm Workers, and Veterinary Professionals in Central South Africa. Viruses. 2019;11(2).
10. Rahman MT, Sobur MA, Islam MS, Ievy S, Hossain MJ, El Zowalaty ME, et al. Zoonotic Diseases: Etiology, Impact, and Control. Microorganisms. 2020;8(9).
11. Samad M. Public health threat caused by zoonotic diseases in Bangladesh. Bangladesh Journal of Veterinary Medicine. 2011;9(2):95-120.
12. Adam-Poupart A, Drapeau LM, Bekal S, Germain G, Irace-Cima A, Sassine MP, et al. Occupations at risk of contracting zoonoses of public health significance in Québec. Canada communicable disease report = Releve des maladies transmissibles au Canada. 2021;47(1):47-58.
13. Whitehouse ER, Bonwitt J, Hughes CM, Lushima RS, Likafi T, Nguete B, et al. Clinical and epidemiological findings from enhanced monkeypox surveillance in Tshuapa province, Democratic Republic of the Congo during 2011–2015. The Journal of infectious diseases. 2021;223(11):1870-8.
14. Laughlin LW, Meegan JM, Strausbaugh LJ, Morens DM, Watten RH. Epidemic Rift Valley fever in Egypt: observations of the spectrum of human illness. Transactions of the Royal Society of Tropical Medicine and Hygiene. 1979;73(6):630-3.
15. Ramadan OPC, Berta KK, Wamala JF, Maleghemi S, Rumunu J, Ryan C, et al. Analysis of the 2017-2018 Rift valley fever outbreak in Yirol East County, South Sudan: a one health perspective. The Pan African medical journal. 2022;42(Suppl 1):5.
16. Centers for Disease Control and Prevention. Rift Valley Fever 2023 [Available from: https://www.cdc.gov/vhf/rvf/index.html.
17. Birungi D, Aceng FL, Bulage L, Nkonwa IH, Mirembe BB, Biribawa C, et al. Sporadic Rift Valley Fever Outbreaks in Humans and Animals in Uganda, October 2017–January 2018. Journal of Environmental and Public Health. 2021;2021:8881191.

Uptake and completion of tuberculosis preventive therapy among people living with HIV on antiretroviral therapy, Uganda, 2020–2023

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Summary

Background: In 2015, Uganda adopted the World Health Organization (WHO) guidelines for Tuberculosis (TB) prevention among PLHIV. Accordingly, the country has implemented several initiatives to scale up TB preventive therapy including the integration of TB Preventive Therapy (TPT) into HIV care services. The WHO target for both initiation and completion among PLHIV in care is 90%. We described the trends and spatial distribution of TPT uptake and completion, and reasons for non-completion among PLHIV, Uganda, 2020-2023 to track progress towards meeting the targets.
Methods: We extracted and analyzed national and subnational aggregated data on TPT among PLHIV on ART as reported through DHIS2 from January 2020 to December 2023. We calculated rates of TPT eligibility, initiation, and completion. Reasons for failure to complete TPT were categorized

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as a loss to follow-up, TB diagnosis, and death while on TPT. We analyzed trends using Mann Kendall test and described spatial distribution by region.

Results: By June 2023, a cumulative total of 1,330,693 antiretroviral therapy (ART) clients had been eligible for TPT of which, 1,157,703 (87%) had been initiated on TPT and 92% completed their treatment. Both uptake and completion rates significantly increased from 2020 to 2023 at 87% and 96%, respectively. Of the 79,106 ART clients who did not complete their TPT regimen, 29,435 (37%) were lost to follow-up, 2,356 (3%) died, and 1,589 (2%) were diagnosed with TB while on TPT.

Conclusion: Uganda achieved high levels of TPT uptake and high completion rates among PLHIV considering the WHO targets. The Ministry of Health should however explore factors associated with TPT loss to follow-up in this subpopulation for better program performance.

Background

Tuberculosis (TB) remains the leading cause of illness and death among people living with HIV (PLHIV) globally [1]. People living with HIV are at high risk of developing active TB due to their weakened immune response and equal risk of exposure to TB infection in their communities just as the HIV-negative population [2, 3]. In 2022, 0.89 million TB cases were attributed to HIV, and 167,000 TB deaths were among HIV-positive people [4, 5]. Tuberculosis remains the world's leading infectious disease killer in low- and middle-income countries [4].

The World Health Organization's End TB strategy calls for a reduction in TB cases and TB deaths by 90% and 95% respectively, by 2035 [6]. The organization has a goal of eliminating TB as a public health problem by 2050 and one of its main strategies is TB preventive treatment (TPT), which is the administration of anti-TB drugs to people who do not have symptoms or signs of active TB disease (regardless of their tuberculin skin test or interferon-gamma release assay status) [1, 7, 8]. This is an effective intervention to reduce the incidence and mortality of TB among PLHIV [7]. It has been reported to reduce the risk of developing active TB disease by up to 60% and the risk of dying from TB by up to 37% among PLHIV[8]. The World Health Organization (WHO) recommends TPT for all PLHIV as part of a comprehensive package of HIV care, along with antiretroviral therapy (ART), cotrimoxazole prophylaxis, and regular screening for TB symptoms [9]. The WHO End TB Strategy calls for 90% TPT coverage among PLHIV and close contacts of infectious TB patients by 2035 [10, 11].

Uganda adopted the WHO recommendations and guidelines for TPT and has implemented several initiatives to scale up TPT among PLHIV since 2015 [12]. These include integrating TPT into HIV care services, introducing new TPT regimens such as rifapentine-based 3HP, conducting mass campaigns to increase awareness and demand for TPT, and using digital technologies to monitor and support TPT adherence and completion [13, 14]. As a result, the country has achieved remarkable progress in increasing TPT coverage among PLHIV from 0.6% in 2016 to 88.8% in 2022 [15]. However, data on the trends and distribution of TPT uptake and completion among PLHIV in Uganda at the national and sub-national levels remains suboptimal. To inform programming, we described the TPT cascade, assessed the trends of TPT uptake, completion, and the temporal distribution of loss to follow-up among PLHIV on ART in Uganda,2020-2023

Methods

We conducted a descriptive analysis study using TPT surveillance data from all the health facilities across the country that report through the District Health Information System version 2 (DHIS2). DHIS2 is a web-based platform that collects routine health service data from all public and private health facilities in Uganda, including information on HIV testing, care, and treatment services, as well as TB screening, diagnosis, treatment, and prevention [16]. Health facilities report this data to the district health offices through the HMIS report 106a, which is then aggregated and submitted to the Ministry of Health. Uganda's health facilities are classified into seven levels based on the services they provide and the catchment area they are intended [17]. The classification starts at a Health center II up to the National Referral Hospital. Of the seven, TB and HIV care is provided at six levels, starting from Health center III. Therefore, the data included in this study came from these facilities.

The study population included all records for PLHIV who were enrolled in HIV care services and eligible for TPT according to the national guidelines [18]. We collected data on TPT uptake rates, com-

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pletion, and loss to follow-up rates. As per the guidelines, TPT uptake was defined as starting any TPT regimen whereas completion was defined as receiving a full course of the prescribed TPT regimen. Therefore, we calculated TPT uptake rate by dividing the number of eligible ART clients initiated on TPT by the number of all eligible ART clients, and TPT completion rate was calculated by dividing the number of all ART clients on TPT expected to complete and completed in each semi-annual period by the number of ART clients on TPT expected to complete, and loss to follow-up rate was defined as the number of ART clients expected to complete in each period but were lost to follow-up divided by the *total number of ART clients expected to complete in that period.* We also determined the national reporting rates during the study period. For the TPT cascade, we determined the proportion of PLHIV on ART who were eligible for TPT from the total number of PLHIV on ART. From those who were eligible, we determined the proportion of those who had initiated TPT and from those who had initiated; we further determined the proportion of those who completed their TPT regimen.

We used line graphs to determine trends of uptake, completion, and loss to follow-up of TPT clients. Data was exported to STATA for analysis and used the Mann-Kendal test to determine the significance of trends at a level of 0.05.

We used the Quantum Geographic Information System (QGIS) for spatial analysis to visualize and measure the spatial patterns and variations of TPT loss to follow up among PLHIV across regions in Uganda.

We used secondary data from the DHIS2 that are routinely collected and reported by health facilities as part of the national health information system. The data are anonymized and do not contain any personal identifiers of the patients or health workers. The study did pose minimal risk to the privacy or confidentiality of the data subjects. The protocol was approved as non-research by the Centers for Disease Control and Prevention.

Results

Tuberculosis preventive therapy cascade among HIV patients on ante-retro viral therapy, Uganda, 2020–2023

A total of 5,316,668 patient DHIS2 entries from January 2020 to December 2023 from over 1,990 facilities, were examined and used for the study. During the study period, we found that by the beginning of 2022, 1,441,254 PLHIV had been enrolled on antiretroviral therapy of which, a cumulative total of 1,330,693 (92%) were eligible for TB preventive therapy (TPT). Of these who were eligible, 87% (1,157,703) were initiated on TPT and 92% (1,065,086) of those who initiated were able to complete their full dose of TPT (Figure 1).

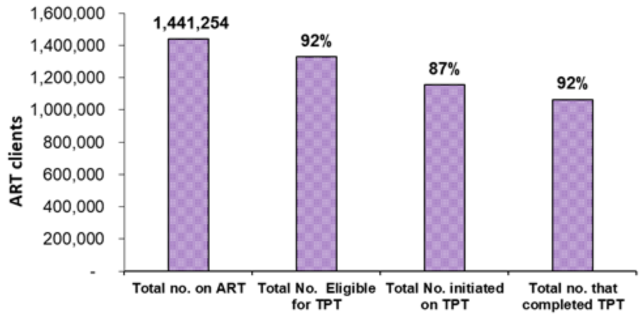

Figure 1: Tuberculosis preventive therapy cascade among HIV patients on ante-retro viral therapy, Uganda, 2020–2023

Trends in tuberculosis preventive therapy uptake and completion among HIV patients on ante-retro viral therapy, Uganda, 2020–2023

During the study period we found that the average national reporting rate was 93.8. Overall, the rates of uptake and completion of TPT in Uganda increased by 58% and 5% respectively over the 4-year period. We performed a Mann-Kendall test to examine the trend of both uptake and completion rates. The results showed that there was a significant improvement uptake ($p=0.004$) and completion ($p = 0.02$) respectively. The greatest increase for both was between July 2020 and June 2021 (Figure 2).

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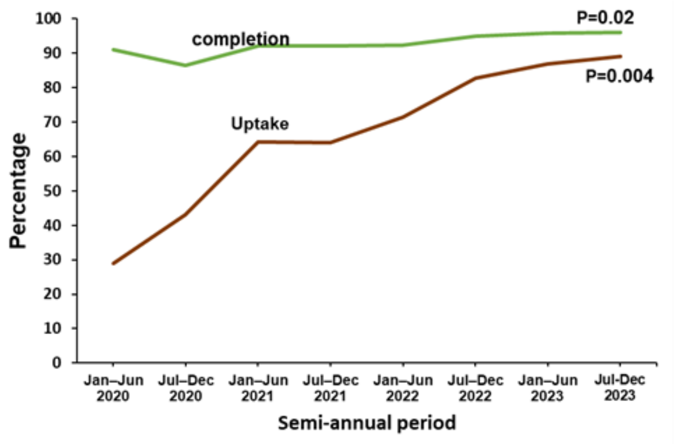

Figure 2: Trends in tuberculosis preventive therapy uptake and completion among HIV patients on ante-retro viral therapy, Uganda, 2020–2023

Regional distribution of tuberculosis preventive therapy uptake among HIV patients on ante-retro viral therapy, Uganda, 2020–2023

Uptake of TPT varied across regions in Uganda, ranging from 68% to 94%. The upper west (Bunyoro), Lower North (Lango), and Northeast (Karamoja) had the highest uptake and Midwest (Tooro) had the lowest uptake (Figure 3).

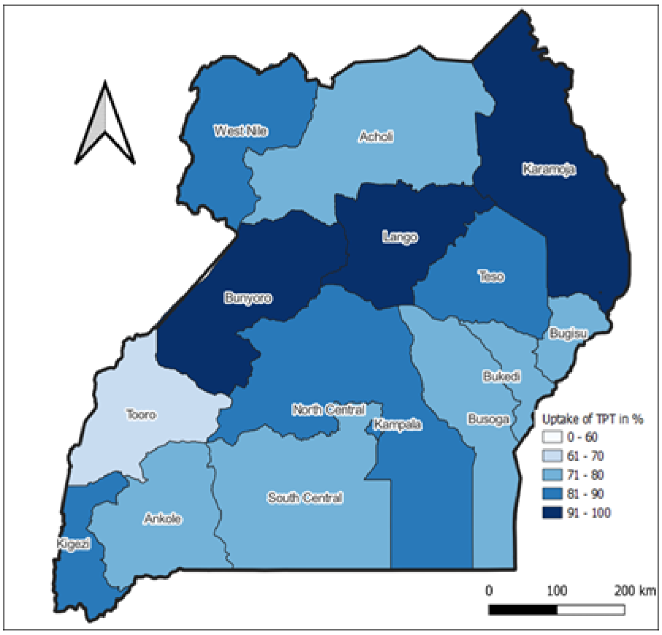

Figure 3: Regional distribution of tuberculosis preventive therapy uptake among HIV patients on ante-retro viral therapy, Uganda, 2020–2023

Loss to follow up, death, and discontinuation of Tuberculosis Preventive Therapy among HIV patients on Ante-Retro Viral Therapy who did not complete their regimen, Uganda, 2022–2023

During this study period, a total of 92,617 (8%) ART clients on TPT did not complete their course of TPT. We found that of those who did not complete, one third did not have documented reasons.

However, of those who had documented reasons, majority (60%) were lost to follow-up and 31% stopped due to side effects. Whereas 5% died, and 3% developed TB before completion (Figure 4).

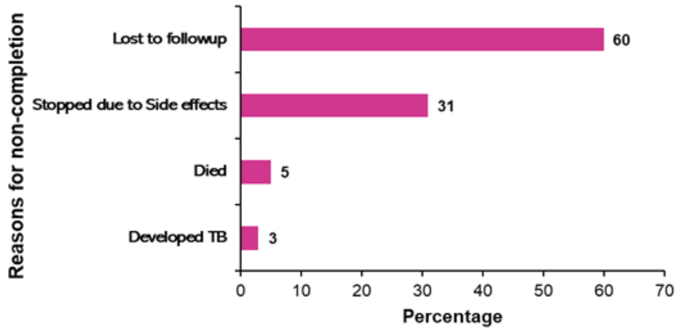

Figure 4: Loss to follow up, death, and discontinuation of tuberculosis preventive therapy among HIV patients on ante-retro viral therapy who did not complete their regimen, Uganda, 2022–2023

Temporal distribution of loss to follow-up among HIV patients on Ante-Retro viral Therapy who did not complete their Tuberculosis Preventive Therapy regimen by region, Uganda, 2020–2023

The proportion of regions with a loss to follow-up greater than 40 TPT patients per 1,000 reduced from 53% in period January to June 2020 to 13% by December 2023. Loss to follow-up remained highest in Mid-Eastern sub region (Figure 5).

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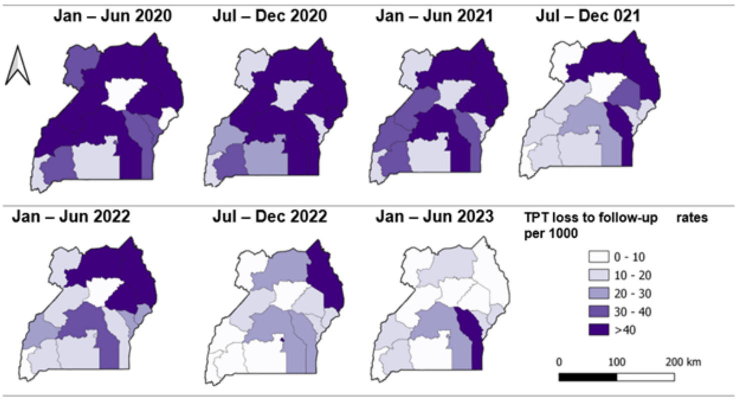

Figure 5: Temporal distribution of loss to follow-up among HIV patients on ante-retro viral therapy who did not complete their tuberculosis preventive therapy regimen by region, Uganda, 2020 –2023

Discussion

In this study, we describe the trends, spatial and temporal distribution of TPT uptake and completion among PLHIV in Uganda from 2020 to 2023. Tuberculosis Preventive Therapy uptake was at 87% among all eligible patients on ART, and among those who initiated, 92% completed. Considering the targeted 90% for both uptake and completion both indicators improved significantly between 2020 and 2023. Over one-third of persons who did not complete were lost to follow-up, throughout the study period highest in Mideastern region.

Tuberculosis Preventive Therapy completion surpassed the national and global target of 90%. This was consistent with a 2022 study done in Uganda on TPT, which showed a national TPT completion of 94% [15, 19]. This achievement could be attributed to enhanced integration of HIV and TB management among PLHIV by the Ministry of Health made possible by commodity availability, while implementing partners supported TPT demand creation among the beneficiaries [12, 20]. Although TPT uptake improved during the same period, this fell short of the national and global target of 90%. Other studies have suggested that challenges with uptake may be related to clinician's fears and beliefs and lack of sufficient information on TPT [21]. Additional studies may be needed to understand the causes of low TPT uptake in poorly performing regions.

We did not find significant differences in the proportion of patients lost to follow-up over the three and half years of the study. A 2022 study on factors contributing to TB treatment LTFU in developing countries demonstrated that treatment illiteracy and insufficient pre-treatment counselling were the most important factors associated with LTFU [22]. This study suggested that enhancing pre-screening and pre-treatment counselling could help reduce LTFU. We recommend such a study on specific factors in our setting to inform program implementation.

A 2023 study conducted in Uganda on outcomes of treatment among patients with drug-resistant TB found that a high frequency of adverse events, led to persisting discontinuation of treatment. In our study, 19% of those patients who did not complete treatment was a result of TPT side effects [23]. To address the persistent issue of anti-TB drug side effects, several measures have been proposed elsewhere and one such is nanomedicine, which is an emerging research area that offers the potential of effective drug delivery using nanoparticles and a reduction in drug doses. A study done in 2023 explored the progress of this research and found that this technology offers a slow, sustained, and controlled release of anti-TB drugs and provides advantages of low doses, reduced side-effects and improved patient compliance [24].

Our findings have implications for TB prevention and control programs in Uganda and other similar settings. First, the study demonstrates that initiation and completion of TPT can improve over time, implying that 100% coverage of TPT is feasible. Secondly, for the programs to achieve 100% completion rates, they should address issues leading to loss to follow-up of PLHIV initiated on TPT.

Study limitations

The study has some limitations that should be considered when interpreting the results. First, the study used secondary data from the DHIS2, which may have issues of completeness and accuracy likely leading to either over or under estimation of the study outcomes. Secondly, it was not possible to

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do age and sex disaggregation's because this detail missed in DHIS2 our source of data. This may lead to a bias, as vulnerable populations may be underrepresented, or their contributions underestimated.

Conclusion

In conclusion, TPT uptake and completion among PLHIV improved markedly over the three years. However, some PLHIV initiated on treatment discontinue before completion which may affect the impact of TPT among PLHIV in the long term and delay achievement of end TB strategy targets. Although we registered major improvements in completion rates, the number of eligible ART clients initiated on TPT remained lower than the national target. Additionally, Loss to follow-up occurred as a documented reason. However, it is worth noting that loss to follow-up, even when documented, does not provide an actual reason for stopping treatment. It is possible that these patients followed up at another clinic or died or had side effects and chose not to complete. This demonstrates a major challenge with documentation for non-completion. To implement effective interventions, it is necessary to understand the reasons people do not return to the clinic. Our findings add to the available pool of data on TPT implementation among PLHIV in the country to further improve programing towards ending TB in Uganda and similar settings through prevention.

Conflict of interest

The authors declare that they had no conflict of interest.

Authors' contributions

IS: participated in the conception, design, analysis, interpretation of the study and wrote the draft bulletin; SW, MN, and BK reviewed the report, reviewed the drafts of the bulletin for intellectual content and made multiple edits to the draft bulletin; BK, LB, and ARA reviewed the final bulletin to ensure intellectual content and scientific integrity. All authors read and approved the final bulletin.

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References

1. WHO. *HIV and Tuberculosis*. 2023; Available from: https://www.who.int/westernpacific/health-topics/hiv-aids/hiv-and-tuberculosis.
2. Komrower, D. and M. Thillai, *Tuberculosis and HIV co-infection.* Clinical Tuberculosis: A Practical Handbook, 2015. **157**.
3. Mebratu, W., et al., *Prevalence and associated factors of tuberculosis among isoniazid users and non-users of HIV patients in Dessie, Ethiopia.* Scientific Reports, 2022. **12**(1): p. 13500.
4. USAID. *TB/HIV*. 2021; Available from: https://www.usaid.gov/global-health/health-areas/tuberculosis/tbhiv.
5. WHO. *Tuberculosis*. 2023; Available from: https://www.who.int/news-room/fact-sheets/detail/tuberculosis.
6. WHO. *WHO consolidated guidelines on tuberculosis: tuberculosis preventive treatment*. 2023; Available from: https://iris.who.int/bitstream/handle/10665/372738/9789240078154-eng.pdf?sequence=1.
7. Mbonde, A., et al., *A comprehensive analysis of stroke risk factors by HIV serostatus in Uganda: Implications for stroke prevention in sub-Saharan Africa (P1-1.Virtual).* Neurology, 2022. **98**(18 Supplement): p. 3846.
8. Lee, M.C., et al., *Isoniazid level and flu-like symptoms during rifapentine-based tuberculosis preventive therapy: A population pharmacokinetic analysis.* British journal of clinical pharmacology, 2023. **89**(2): p. 714-726.
9. WHO. *Consolidated guidelines on TB preventive therapy*. 2020; Available from: https://www.who.int/docs/default-source/

Continues to page 72

campaigns-and-initiatives/world-tb-day-2020/5-faqs-tb-preventive-treatment.pdf?sfvrsn=d633097e_2.
10. CDC. *Living with HIV - dying of TB*. 2023; Available from: https://www.cdc.gov/globalhivtb/who-we-are/features/tbpreventivetherapy.html.
11. Den Boon, S., et al., *WHO target product profiles for TB preventive treatment.* Int J Tuberc Lung Dis, 2022. **26**(4): p. 302-309.
12. Ministry of Health, U. 2020; Available from: http://library.health.go.ug/sites/default/files/resources/Final%20TB%20Infection%20Control%20Guidelines%202011.pdf.
13. Ministry of Health, U. *Consolidated-HIV-and-AIDS-Guidelines*. 2023; Available from: https://dsduganda.com/wp-content/uploads/2023/05/Consolidated-HIV-and-AIDS-Guidelines-20230516.pdf.
14. USAID. *Uganda Tuberculosis Roadmap*. 2021; Available from: https://www.usaid.gov/sites/default/files/2022-05Ugada_TBRM21_TB_DIAH_Version_Final.pdf
15. Lukoye, D., et al., *Tuberculosis Preventive Therapy among Persons Living with HIV, Uganda, 2016–2022.* Emerging Infectious Diseases, 2023. **29**(3): p. 609.
16. ministry of Health, U.a.C.P.H.L. *DHIS2 User Manual, Uganda*. 2022.
17. Minsitry of Health, U. *Health Facility inventory*. 2018; Available from: https://health.go.ug/sites/default/files/Signed%20n%20final%20mfl.pdf.
18. Ministry of Health, U. *Consolidated HIV and AIDS gudilines 2023*. 2022; Available from: https://dsduganda.com/wp-content/uploads/2023/05/Consolidated-HIV-and-AIDS-Guidelines-20230516.pdf.
19. Musaazi, J., et al., *Increased uptake of tuberculosis preventive therapy (TPT) among people living with HIV following the 100-days accelerated campaign: A retrospective review of routinely collected data at six urban public health facilities in Uganda.* PloS one, 2023. **18**(2): p. e0268935.
20. Minsitry of Health, U. 2020; Available from: https://www.health.go.ug/cause/100-day-accelerated-isoniazid-preventive-therapy-scale-up-plan/.
21. Baluku, J.B., et al., *One dollar incentive improves tuberculosis treatment outcomes in programmatic settings in rural Uganda.* Scientific Reports, 2021. **11**(1): p. 19346.
22. Opperman, M. and I. Du Preez, *Factors contributing to pulmonary TB treatment lost to follow-up in developing countries: an overview.* African Journal of Infectious Diseases, 2023. **17**(1): p. 60-73.
23. Kintu, T., et al., *Unfavorable treatment outcomes among patients with drug-resistant TB in Uganda.* The International Journal of Tuberculosis and Lung Disease, 2023. **27**(4): p. 291-297.
24. Borah Slater, K., et al., *A Current Perspective on the Potential of Nanomedicine for Anti-Tuberculosis Therapy.* Tropical Medicine and Infectious Disease, 2023. **8**(2): p. 100.

Uganda switches from Rotarix rotavirus vaccine to Rotasiil: Introducing a 3-dose Rotavirus vaccine schedule into the routine immunization program, March 2024

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Background

Uganda introduced the Rota Virus Vaccine (Rotarix) a 2 dose schedule into the RI schedule in June 2018 and the prevalence of Rota virus diarrhoea in children < 5 years has since greatly reduced (1). However, global supply challenges with the Rota virus vaccine in 2022 through to 2023 have necessitated the switch to a new formulation to ensure that children continue to be protected from Rotavirus disease (2).

Uganda made a decision to switch to Rotasiil type

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of rotavirus vaccine in March 2024. This is in a bid to reduce missed opportunities and ensure that infants continue to be protected from rotavirus disease. This vaccine follows a three-dose schedule administered at 6, 10, and 14 weeks of life.

Rationale for the revised scheduling and administration of the rotavirus vaccine

The World Health Organization recommends that the rotavirus vaccine series for each child be completed with the same product (brand of the vaccine) whenever possible. However, vaccination should not be deferred or restarted because the product used for a previous dose is not available. In these situations, the series should be completed with any available licensed product (3).

Key instructions for health service providers

Accordingly, the ministry of health wishes to guide health providers as follows:

If any dose in the series includes Rotasiil-Liquid, a total of 3 doses of rotavirus vaccine should be given to ensure the infant is fully immunized. A child who has received two doses of Rotarix vaccine is not supposed to receive a 3rd dose of Rotasiil (Table 1).

Table 1: Illustration on how to complete the rotavirus vaccine infant series when switching from Rotarix to Rotasiil-Liquid

Dose 1	Dose 2	Dose 3	Complete series
Rotarix	Rotarix	Not applicable	2 doses total
Rotarix	Rotasiil-Liquid	Rotasiil-Liquid	3 doses total
Rotasiil-Liquid	Rotasiil-Liquid	Rotasiil-Liquid	3 doses total

References

1. Ministry of Health UNEPoI. IMMUNIZATION GUIDELINES BY UNEPI. 2018; Available from: https://www.health.go.ug/wp-content/uploads/2019/11/UNEPI-Immunization-guidelines.pdf.
2. Fund UNCs. Rotavirus Vaccine: Supply and Demand Update. 2022; Available from: https://www.unicef.org/supply/media/10841/file/Rotavirus-Vaccine-Supply-Demand-Update-January-2022.pdf.
3. Organization WH. Summary of the WHO position paper on Rotavirus vaccines WHO position paper- 16 July 2021. 2021; Available from: https://cdn.who.int/media/docs/default-source/immunization/position_paper_documents/rotavirus/rotavirus-summary-23july-2021.pdf?sfvrsn=8c06e9d8_7.

Uganda yellow fever preventive mass vaccination campaign phase 2, April 2-8, 2024

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Introduction

Uganda is a yellow fever endemic country with high-risk of transmission. The country introduced Yellow Fever vaccine into routine immunization schedule in October 2022, during the integrated child health days (ICHDs). The yellow fever vaccine is safe and effective, and a single dose provides life-long protection against yellow fever. It provides effective immunity within 10 days for 80–100% of people vaccinated, and within 30 days for more than 99% of people vaccinated. All children aged 9 months and above, and adults are eligible for vaccination. A booster dose is not needed!

Despite the introduction of the yellow fever vaccine in the routine immunization schedule, the national coverage has remained low at 29%. This low level of population immunity poses a high risk of yellow fever outbreaks. To rapidly raise the population immunity against yellow fever, the country planned to conduct phased implementation of Yellow Fever Preventive Mass Vaccination Campaigns (PMVC) in 2023, and 2024.

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Goal of yellow fever preventive mass vaccination campaigns

- To eliminate yellow fever epidemics in Uganda by 2026

Specific objectives

- To vaccinate at least 90% of eligible population aged 1 to 60 years against yellow fever
- To effectively engage all stakeholders and mobilize all communities for yellow fever vaccination
- To effectively communicate and engage communities on risk of YF, how to reduce risk and strengthen surveillance for yellow fever
- To strengthen routine immunization by improving uptake and reporting for new vaccines with emphasis to the life course approach

Target population

Vaccination will target 14,437,098 (90% of the eligible population) persons aged 12 months up to 60 years, including the refugee population.

Planned implementation dates

The Yellow Fever (YF) PMVC will take place between **2nd - 8th April 2024.** In the first four days, vaccination teams will be in schools and then move to the community in the remaining three days.

Implementation strategy

Ministry of Health will use a combination of fixed and mobile post vaccination strategies at health facilities, schools, and selected villages to vaccinate all eligible people during the campaign.

Phase 1 was conducted in June, 2023 in 51 districts in 6 regions of Kabale (Kigezi), Kabarole (Tooro), Lira (Lango), Arua (Westnile), Gulu (Acholi), and Hoima (Bunyoro).

Ministry of Health (MOH) with support from Global Alliance for Vaccines and Immunization (GAVI), World Health Organization (WHO), United Nations Children's Fund (UNICEF), Clinton Health Access Initiative (CHAI), and other partners has planned to conduct phase 2 of the Yellow Fever PMVC. Phase 2 will be conducted in 53 districts and cities in 5 regions of Moroto (Karamoja), Mbarara (Ankole), Kampala, Masaka (South central), and Soroti (Teso) in April 2024.

World health awareness days, and international health days, April-June 2024

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Introduction

Global public health awareness days are intended to raise awareness, publicity, and profile of particular diseases or disease conditions among the general population. Every year, different organizations and communities actively promote and support World Health Days globally.

1st to 30th April – International Cesarean Awareness Month

The entire month of April, every year is globally recognized and celebrated as the International Cesarean Awareness Month. It is intended to promote maternal-child health by raising awareness about the dangers of unnecessary cesarean sections, and encouraging vaginal birth after cesarean section for those assessed and found fit by a professional birth attendant. The World Health Organization estimates that 1 in 5 deliveries globally are by cesarean section and the trend has been continuously rising. It is further estimated that one in every three deliveries will be through cesarean section by 2030. Although, cesarean section is a lifesaving surgery, it puts the lives and health of both the mother and child at risk if performed when there is no medical indication.

17th April - World Hemophilia Day

Every year on April 17, the world commemorates the World Hemophilia Day. The theme of the event this year is "Equitable access for all: recognizing all bleeding disorders". Hemophilia is usually an inherited bleeding disorder in which the blood does not clot properly and mostly affects males. It is estimated to occur in about 1 of every 5,000 male births. People with hemophilia have low levels of proteins called clotting factors that help to stop bleeding. The disease can result in spontaneous bleeding within joints leading to chronic joint disease and pain, bleeding in the skin, head and brain which can cause seizures and paralysis. It can also lead to excessive bleeding following injuries or surgery. Death can occur if the bleeding cannot be stopped or if it occurs in

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a vital organ such as the brain. Patients with hemophilia are encouraged to get annual comprehensive checkups, vaccination against hepatitis A and B, treat bleeds early and adequately, and exercise and maintain a healthy weight to protect joints.

25th April - World Malaria Day
On 25th April, every year was designated by World Health Organization Member States during the World Health Assembly of 2007. The commemoration is intended to raise community awareness and highlight the need for continued investment and sustained political commitment for malaria prevention and control. Malaria is a preventable disease caused by parasites transmitted through bites by female anopheles mosquitoes. In 2022, there were an estimated 249 million malaria cases and 608,000 deaths globally mainly in Africa, Uganda inclusive. Eight in every 10 malaria deaths occur in children under the age of 5 years. Malaria can be prevented by avoiding mosquito bites and by taking medicines. The ministry of health thus encourages people to sleep under insecticide mosquito nets, and always visit the nearest health facility for malaria testing and treatment services within 24 hours of developing fever among other measures.

24th to 30th April – World Immunization week
The World Health Organization designated 24th to 30th April, every year as the World Immunization week. The goal is for more children, adults, and their communities to be protected from vaccine-preventable diseases, thus living healthier and happier lives. In Uganda, the entire month of April every year, is designated for Integrated Child Health Days during which Ministry of Health heightens interventions for improving child health and survival. This year, the World will celebrate 50 years of the essential programme on immunization.

7th May – World Asthma Day
Every year, 1st Tuesday of May, countries commemorate the World Asthma to raise awareness of Asthma in their communities. The theme of this year's World Asthma Day celebration is "Asthma Education Empowers". Emphasis will be put on the need to empower people with asthma with the appropriate education to manage their disease, and recognize when to seek medical help. Asthma is a disease that affects lungs and causes repeated episodes of wheezing, breathlessness, chest tightness, and coughing. It is a leading chronic non-communicable disease globally, affecting about 260 million people and causing over 450000 deaths each year. Health care professionals are also called upon to increase their awareness of the continuing avoidable morbidity and mortality from asthma, and effective management of asthma, to provide reliable information and optimal treatment for their patients.

17th May – World Hypertension Day
On 17th May, countries celebrate the World Hypertension Day. It is intended to highlight the importance of monitoring blood pressure and raising awareness about hypertension. Hypertension, also known as high blood pressure, is defined as a systolic blood pressure consistently above 140 mm Hg and/or diastolic blood pressure consistently above 90 mm Hg. It is the number one risk factor for heart disease, stroke, renal complications, and premature death. Usually, high blood pressure alone does not cause any symptoms. Fortunately, hypertension can be prevented and managed, by checking your blood pressure regularly, and through treatment. Raising public awareness is key to prevention, along with access to early detection and management.

22nd May – World Preeclampsia Day
On 22nd May, is World Preeclampsia Day and its commemoration is intended to raise awareness about this severe and dangerous pregnancy complication, to facilitate its timely detection and management. Preeclampsia is dangerous and potentially fatal pregnancy complication characterized by high blood pressure. It usually begins after 20 weeks of pregnancy in a woman whose blood pressure had been normal, and may not cause any symptoms in early stages. Timely diagnosis and treatment improves outcomes for both the mother and unborn child. This can be achieved by attending antenatal care clinics early during the pregnancy and undergoing regular blood pressure checkups by a health professional.

9th June – World Blood Donor Day
The commemoration of the World Blood Donor Day is meant to raise awareness about patients requiring lifelong transfusion support and emphasize the role every single person can play by donating blood. The objectives are to celebrate and appreciate blood donors, encourage more people

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to donate, transform the quality of life for transfusion dependent patients, highlight the critical roles of voluntary blood donations in achieving universal access to safe blood products, and mobilize support at national, regional, and global levels among governments and development partners to invest in, strengthen, and sustain national blood programmes.

19th June – World Sickle Cell Day

On 19th June every year marks the commemoration of the World Sickle Cell Awareness Day. The goal to increase public knowledge and an understanding of sickle cell disease, and the challenges experienced by patients and their families and caregivers. Globally, 5% of the population carries trait genes for sickle-cell disease and over 300 000 children are born with the disease each year. A child acquires the disease only if they inherit two sickle cell genes, one from each parent. The effect of the disease on the population can be effectively reduced through effective treatment disease management and prevention programmes. Screening and counseling before marriage or pregnancy is the key to preventing of sickle cell disease.

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