

Cholera Outbreak in Al-Siferaia Village, White Nile State, Sudan 2024: A Cross Sectional Study

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Abstract

Background: Cholera is an acute diarrheal illness caused by infection with the bacterium *Vibrio cholerae*. Cholera remains a significant global health threat, particularly in regions with poor water, sanitation, and hygiene infrastructure & in areas affected by an arm conflict as is the case now in Sudan. It results in severe watery diarrhoea and can lead to high mortality if not promptly treated. Al-Siferaia village in White Nile State, Sudan, experienced a recent cholera outbreak in December 2023. This study aimed to assess the outbreak, identify causative factors, and recommend appropriate preventive measures.

Methods: A descriptive cross-sectional study was conducted at Al-Siferaia rural hospital from December 8 to December 26, 2023. Data were collected from medical records, including demographics, clinical symptoms, and outcomes. Stool samples were tested for *V. cholerae* using rapid diagnostic tests and culture. Data analysis was performed using SPSS version 22.

Results: A total of 205 cholera cases were recorded, with a higher prevalence among females (57.5%). The most affected age group was 10-20 years (22.3%). The majority of cases (86.8%) were from Al-Siferaia village, linked to contaminated irrigation canal water. Dehydration levels varied, with 38.6% experiencing mild, 3% moderate, and 22.8% severe dehydration. Treatment primarily involved Oral Rehydration Solution (68.7%), with a case fatality rate of 6.3%.

Conclusion: The outbreak in Al-Siferaia was primarily due to contaminated irrigation water. The high attack and case fatality rates highlight the need for improved water quality, sanitation, and healthcare infrastructure. Immediate measures, including comprehensive WASH programs (Water, Sanitation and hygiene for all initiative), enhanced public health surveillance, community education, vaccination, and strengthened healthcare facilities, are essential to prevent future outbreaks. It is important to implement comprehensive WASH programs, strengthen public health surveillance, enhance community education, introduce vaccination programs, improve healthcare infrastructure, and conduct further research to mitigate cholera risk factors.

Keywords: Cholera, **Vibrio cholerae**, outbreak, Al-Siferaia village, White Nile State, Sudan, waterborne diseases, public health, WASH program.

Introduction

Cholera, caused by the bacteria **Vibrio cholerae** O1 or O139, is characterized by sudden, severe, watery diarrhoea. The disease mechanism involves the colonization of the small intestine by *Vibrio cholerae*, which secretes cholera toxin (CT). This toxin induces a rapid outflow of electrolytes and water into the intestinal lumen, resulting in the characteristic watery diarrhoea known as "rice-water stools." Cholera diagnosis is typically confirmed through stool cultures, rapid diagnostic tests (RDTs), or PCR tests along with the characteristic clinical presentation during the outbreak. Treatment focuses on rapid rehydration using oral rehydration salts (ORS) and intravenous fluids in severe cases. Antibiotics such as doxycycline or azithromycin may be used to reduce the duration of diarrhoea and bacterial shedding. In 2024, there were approximately 708,200 cases and 4,300 deaths globally, primarily from 17 African countries, reported to the World Health Organization (WHO) [1]. This marked an alarming increase from 472,697 cases and 2,349 deaths in 2022 [1], [2]. The global cholera burden is likely underestimated, with the actual annual burden

exceeding 3 million episodes and over 100,000 fatalities [3]. In Sudan the last recorded cholera outbreak was at Al-Gedaref in September 2023, it spread to 46 areas across nine states by December. The Red Sea State reported the highest cases (2,240 cases and 77 related deaths), followed by Al Gedaref, Al Gezira, White Nile, Khartoum, South Kordofan, Sennar, Kassala, and Blue Nile, resulting in at least 8,267 suspected cases of cholera, including 224 deaths (case fatality rate of 2.7%) [4]. This represents an increase of roughly 104% compared to previous records. Cholera outbreaks typically afflict developing countries lacking access to safe drinking water and proper sanitation [5]. Control measures involve patient rehydration and preventing new cases through improved sanitation, hygiene, and safe water access [6]. To combat persistent cholera challenges, WHO now endorses vaccines alongside these measures [7]. WHO also advocates investment in Water, Sanitation, and Hygiene (WASH) infrastructure to prevent and manage outbreaks [8]. Sudan is home to Al-Siferaia village, located in the White Nile state. Following a cholera outbreak in Al-Siferaia village, an investigation was carried out to determine the scope of the

outbreak, identify the causative factors, and enforce appropriate medical and preventive actions to forestall future recurrence. This study aimed to assess the outbreak of cholera in Al-Siferaia village in White Nile State, Sudan.

Methodology

This study used a descriptive cross-sectional approach of cholera cases at Al-Siferaia rural hospital in White Nile State which is situated in the southern part of Sudan. It borders South Kordofan, North Kordofan, Khartoum, Gezira and Sennar states and shares an international border with South Sudan.

Alsiferaia village has a total number of population of about 3500 persons. They use water from a contaminated canal.

Data were collected from the medical records between 8/12/2023 and 26/12/2023, including age, sex, residence, locality, date of onset and admission, symptoms, and outcome of the disease. Data were uploaded to an Excel database processed and analyzed by the suitable statistical methods for quantitative and qualitative data and analyzed using SPSS version 22.

Inclusion criteria: Any person who fit the case definition of cholera and sought treatment at Al-Siferaia_rural hospital and whose records were found in patient records.

Exclusion criterion: Anyone who did not match the inclusion criteria.

Cholera case definition: A suspected case was identified as a patient experiencing acute watery diarrhoea (minimum three episodes in the past 24 hours) and dehydration with or without vomiting. Confirmation required isolation of *Vibrio cholerae** from faecal samples. Dehydration criteria were determined according to the WHO's cholera outbreak response framework [9].

Laboratory testing: Random stool samples were collected from patients using rectal swabs. Rapid diagnostic tests were run on-site and resulted positive. Samples were taken by the State's Ministry of Health to laboratories for stool culture confirmation.

Ethical considerations:

Ethical approval was obtained from Ministry of health White Nile State and Al-Siferaia rural hospital ethical committee and informed verbal consent from the medical director of Al-Siferaia rural hospital.

Results

In this study, 205 participants were included. The majority were females 118, (57.5%) and 87 (42.4%) were males. The age distribution of participants was as follows:10-20 years: 47 (22.3%), 21-30 years: 46 (22.4%), 31-40 years: 41 (20%), 41-50 years: 20 (9.7%), 51-60 years: 18 (8.7%), 80 years: 24 (11.7%), 81+ years: 9 (4.3%). The majority were young adults and adolescents.

The geographical distribution of cholera cases in White Nile state showed that Al-Siferaia village had the highest number of cases: 171, (86.8%) with an attack rate of 205/3,500 population (8.91%), followed by Al-Hila Al-Gadida and Al-Gmoaia village with 10 cases each.

An initial case from Al-Siferaia village in the White Nile area, residing in Al-Duaim at the time of infection, likely brought the infection from there. The final case was reported on 26/12/2023. All identified cases were linked to irrigation canal water exposure. The descriptive epidemiology suggested that drinking contaminated water from the irrigation canal caused this outbreak.

See figure 1, 2 and 3 showing Dehydration Level, Medications, and Outcome of Cholera-Affected Patients respectively.

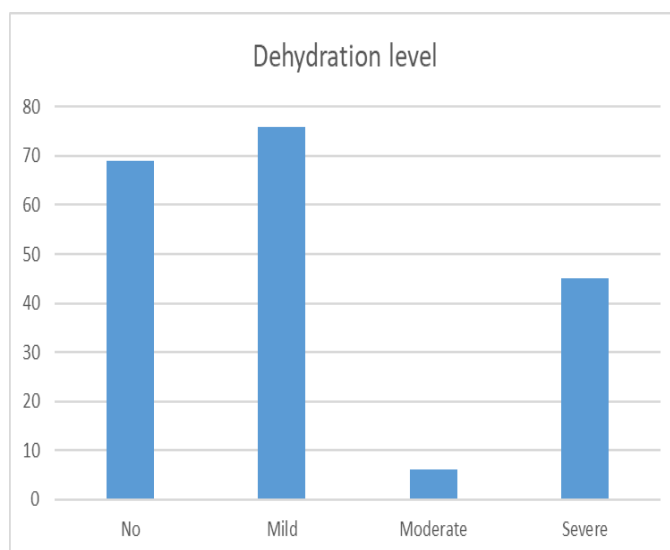


Figure 1: Dehydration levels.

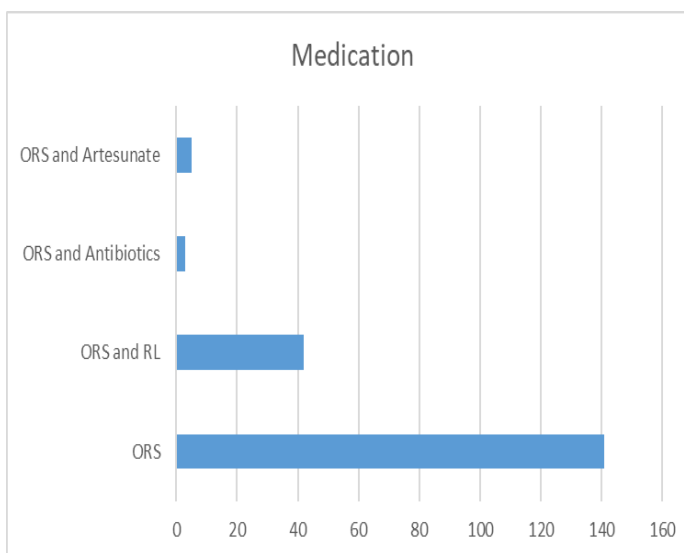


Figure 2: Types of medications.

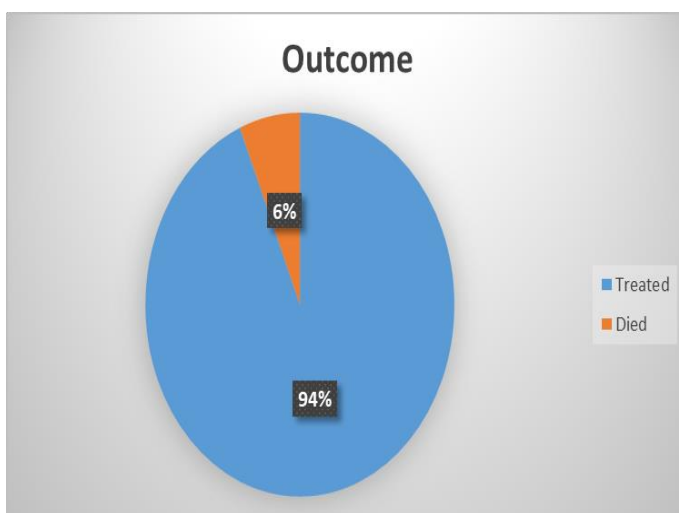


Figure 3: Outcome.

Discussion

The present study investigated the cholera outbreak in Al-Siferaia village, White Nile State, Sudan, with a particular focus on the demographics, geographical distribution, dehydration levels, treatment modalities, and outcomes of affected patients. The findings of this study provide valuable insights into the epidemiological characteristics of cholera in this region and offer a basis for comparison with similar outbreaks in Sudan and other countries.

The majority of participants in this study were females (57.5%), which is consistent with some previous studies indicating a higher incidence of cholera among females due to their roles in water collection and food preparation, thus increasing their exposure to contaminated water [10]. The age group most affected was 10-20 years (22.3%), followed closely by the 21-30 years' age group (22.4%). This age distribution is similar to other cholera outbreaks, where young adults and adolescents are often disproportionately affected due to higher mobility and social interaction, which increases exposure risk [11]. The geographical distribution indicated that Al-Siferaia village had the highest number of cases compared to other areas in White Nile Province (86.8%), which could be attributed to the contamination of the irrigation canal water, a primary water source for the village. This finding aligns with previous studies where contaminated water sources were identified as the primary transmission route for cholera [12], [13]. The attack rate in Al-Siferaia village was 8.91%, which is significantly higher compared to other villages, suggesting a localized outbreak likely due to specific environmental and sanitary conditions.

The level of dehydration among patients varied, with 38.6% experiencing mild dehydration, 3% moderate, and 22.8% severe. These findings are consistent with the WHO's classification of dehydration severity in cholera patients [14]. Oral Rehydration Solution (ORS) was the most commonly used treatment (68.7%), reflecting the standard treatment protocol for cholera, which emphasizes rehydration therapy to replace lost fluids and electrolytes [15]. The use of ORS and Ringer's Lactate (RL) was also significant (20.4%), indicating cases requiring more intensive rehydration efforts.

The case fatality rate in this outbreak was 6.3%, higher than the global average of less than 1% for treated cholera cases but comparable to other severe outbreaks in resource-limited settings [16]. This elevated fatality rate underscores the challenges faced in managing cholera outbreaks in rural areas with limited healthcare infrastructure and resources & in some cases due to late presentation to health facilities.

Comparing these results with other outbreaks, the attack rate and case fatality rate in Al-Siferaia are higher than those reported in previous Sudanese outbreaks. For instance, the 2023 outbreak in Al-Gedaref had a lower-case fatality rate of 2.7% [4]. This difference may be attributed to variations in healthcare accessibility, public health interventions, and environmental factors.

Studies from other countries also reveal similar patterns. For example, a study in Haiti reported a significant association between water source contamination and cholera incidence, similar to the findings in Al-Siferaia [17]. Additionally, a study in Bangladesh highlighted the importance of rapid diagnostic tests and stool cultures in confirming cholera cases, as implemented in this study [18]. Another study conducted in

India concluded that outbreak of cholera in 2013 in Medipally village affected nearly 11% of the village population and was due to contamination of the main water supply of the village and case fatality ratio was 0.72/100(19). The following outbreaks of cholera in the following countries: Yemen (2016-2021): One of the largest cholera outbreaks in recent history, Yemen faced over 2 million suspected cases and thousands of deaths. The war-torn country struggled with a collapsed health system, poor sanitation, and a lack of clean water, which exacerbated the spread of the disease [20] [21]. Democratic Republic of the Congo (DRC) (2017-2020): The DRC has faced recurring cholera outbreaks, with tens of thousands of cases annually. Contributing factors include displacement, inadequate water supply, and poor sanitation. The international community has been actively involved in response efforts, including vaccination campaigns and the provision of clean water [22] [23]. Mozambique (2015-2019): Following Cyclone Idai in 2019, Mozambique experienced a significant cholera outbreak, with thousands of cases reported. The destruction of infrastructure and contamination of water sources were major contributing factors. International aid and rapid response teams helped contain the outbreak through vaccination and improved water and sanitation facilities [24] [25] and South Sudan (2016-2017): Amidst ongoing conflict and humanitarian crisis, South Sudan faced several cholera outbreaks. The lack of access to clean water and poor living conditions in displacement camps were key factors. Efforts to combat the outbreaks included extensive vaccination campaigns and the establishment of cholera treatment centres [26] [27].

The linkage of all identified cases to irrigation canal water exposure suggests a focal point for intervention. Implementing comprehensive WASH (Water, Sanitation, and Hygiene) programs and ensuring safe drinking water sources could significantly reduce cholera transmission in similar settings [8].

Conclusion

The cholera outbreak in Al-Siferaia village, White Nile State, Sudan, highlights significant public health challenges in managing and preventing waterborne diseases in rural settings. The study identified contaminated irrigation canal water as the primary source of the outbreak, affecting predominantly young adults and adolescents, with a higher incidence among females. The attack rate was notably high, and the case fatality rate exceeded global averages, emphasizing the need for improved healthcare infrastructure and timely interventions as well as health education programs of villagers. The findings underscore the importance of effective water, sanitation, and hygiene (WASH) interventions, rapid diagnostic testing, and appropriate rehydration therapy in controlling cholera outbreaks.

Recommendations

- **Improve Water Quality and Sanitation:** Implement Comprehensive WASH programs to ensure access to safe drinking water and adequate sanitation facilities in Al-Siferaia village and surrounding areas and regularly monitoring and treating irrigation canal water and other potential water sources to prevent contamination with *Vibrio cholerae*.*
- **Enhance Public Health Surveillance:** Strengthen surveillance systems for early detection and rapid response to cholera cases. Implement community-based monitoring to quickly identify and report outbreaks. Train healthcare

workers in rapid diagnostic testing and management of cholera cases to ensure timely and effective treatment.

- **Community Education and Engagement:** Conduct health education campaigns to raise awareness about cholera transmission, symptoms, and preventive measures, targeting both urban and rural populations. Encourage community involvement in maintaining clean water sources and practicing good hygiene to reduce the risk of cholera transmission.
- **Strengthen healthcare infrastructure and conduct of further researches** to identify and mitigate risk factors for cholera outbreaks in Sudan. This includes studying environmental, social, and cultural determinants of cholera transmission.

By addressing these recommendations, it is possible to reduce the incidence and impact of cholera outbreaks in Al-Siferaia village and similar settings, thereby improving public health outcomes and enhancing community resilience to waterborne diseases.

Limitations

Retrospective data collection: The study relied on medical records for data collection, which may have resulted in incomplete or inaccurate data due to inconsistencies in record-keeping and potential recall bias from healthcare providers.

Limited scope: The study focused on patients who sought treatment at Al-Siferaia rural hospital, potentially excluding individuals who did not seek medical care or visited other healthcare facilities, thus not capturing the full extent of the outbreak.

Laboratory testing: While rapid diagnostic tests and stool cultures were used to confirm cases, the sensitivity and specificity of these tests could affect the accuracy of case confirmation, potentially leading to underreporting or overreporting of cholera cases.

Environmental factors: The study did not extensively investigate environmental factors such as water source contamination levels, seasonal variations, or specific hygiene practices, which could provide deeper insights into the outbreak's causes and preventive measures.

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Disclosure of conflict of interest.

All authors have no conflict of interest.

Ethical approval

Ethical approval was obtained from Ministry of health White Nile State and Al-Siferaia rural hospital ethical committee and informed verbal consent from the medical director of Al-Siferaia rural hospital.

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