



Impact of Cholera on Children with Malnutrition under 5 Years in Hodeidah , Yemen

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Abstract

Background: Cholera and malnutrition synergistically increase mortality in children under five years. This case report evaluates clinical outcomes and management challenges in malnourished children hospitalized during cholera outbreak.

Objective: To assess the clinical outcomes in malnourished children with cholera, identify the barriers to care, and evaluate the rehydration and nutritional interventions. **Methodology:** A retrospective study (a case series) of 25 children (1–5 years, median age: 3 years) , confirmed with cholera infection and diagnosed with moderate acute malnutrition (MAM) and severe acute malnutrition (SAM). The data included demographics, symptoms, dehydration severity, admission timing, and treatment outcomes. **Results:** 25 children, 76% presented with severe dehydration, 100 % with acute watery diarrhea (AWD) and vomiting, and 100% of patients were malnutrition (68% of SAM and 32% of MAM). Delayed admission (>72 hours) occurred in 56% of cases. All cases received the recommended rehydration (32% IV fluids) of world health organization (WHO) guideline and nutritional support (F75 therapeutic milk, RUTF). Full recovery was achieved in 92%, with 8 % requiring intensive care unit (ICU) care for hypovolemic shock. **Conclusion:** Malnutrition exacerbated the severity of cholera, but adherence to WHO-integrated hydration and nutrition protocols had significantly improved survival rates. Early intervention and addressing systemic delays in care are critical to reducing mortality in cholera-endemic settings.

Keywords: Cholera, Children under five years , Malnutrition, Hodeidah, Yemen

1. Introduction

Malnourished children are more vulnerable to infectious diseases, including severe diarrhea, than well-nourished children. However, data are scarce on differences in the presentation in such children [1]. On the other hand, the cholera can aggravate or precipitate malnutrition, and children with severe acute malnutrition (SAM) have a higher incidence and longer duration of diarrhea [2]. Previous study in Hodeidah, Yemen was reported that the patients infected by cholera were under 5 years of age with the mean age was 2.1 years (± 1.2) with a great variation, the median age of patients was 5 years [3]. Cholera and malnutrition are significant public health problems worldwide. Malnutrition and cholera are strongly interconnected such that malnourished people are more likely to develop cholera infections. The common practice of constraining food during recovery from acute diarrhea is incorrect during and after cholera infection, and it has been shown that early oral feeding during infantile diarrhea leads to better recovery. It has also been shown that early oral feeding throughout infantile diarrhea leads to better recovery. For a long time, malnutrition has been a problem in Africa and is now complicated by several factors, such as the impact of infectious diseases, limited food availability, poor food intake, loss of appetite, metabolic disorders, and restriction of food during recovery from cholera [4]. Children under five years are particularly vulnerable due to underdeveloped immune systems, malnutrition, and higher susceptibility to dehydration. This age group accounts for a disproportionate number of cholera cases globally [5, 6]. Diarrhea illnesses such as cholera can aggravate or precipitate malnutrition, and converse children with SAM have a higher incidence and longer duration of diarrhea. The pathophysiological explanation for these interactions is mainly electrolyte imbalance, which affects the treatment of dehydration, especially in severity malnourished individuals [7, 8]. This study aimed to assess clinical outcomes in malnourished children under 5 years with cholera in Hodeidah,

and to describe the epidemiological and clinical features of cholera-infected children with malnutrition .

2. Methodology

2.1. Study setting and design

A retrospective study (case series) , 25 children was conducted in the triage unit of the isolation department, Center of Tropical Medicine and Infectious Diseases (CTMID), AL-Thawrah Public Hospital Authority, Hodeidah, Yemen.

2.2. Sample size and population

The study sample consisted of 1271 malnourished children under five years of age in Hodeidah, Yemen, 2024. A sub - samples of 25 children were selected as laboratory-confirmed cholera cases using convenience sampling.

2.3. Data Collection

2.3.1. Demographics data

The study included 11 children males and 14 female, 6 children in rural and 19 in urban. The range of age from 1to 5 years old,

2.3.2. Clinical data

The common symptoms were acute watery diarrhea (AWD) , severe vomiting, severe dehydration, sunken eyes, and fatigue. Cholera diagnosis was confirmed through stool cultures and rapid diagnostic tests. The dehydration severity was assessed based on World Health Organization (WHO) (e.g., severe dehydration: $\geq 10\%$ weight loss, lethargy, sunken eyes, delayed skin turgor). The admission timing was documented from symptom onset to hospital presentation (e.g., “median 24 hours”).

2.3.2. Rehydration therapy

Cholera is a medical emergency requiring immediate action. The first treatment facility must be operational within 24 hours, and patients must be isolated promptly due to the disease’s high contagiousness-without waiting for laboratory confirmation.

2.3.3. Special considerations for malnourished children

- Rehydration adjustments: Avoid rapid IV fluids; use slower rates to prevent cardiac overload.
- Prioritize nasogastric tube (NG) tube ORS for mild/moderate dehydration.
- Antibiotics: single-dose azithromycin reduces complications in SAM.
- Nutrition: F75 milk addresses electrolyte imbalances during rehydration. RUTF post-rehydration restores nutrients and prevents relapse [9].

Table 1. SAM with cholera according to updated WHO guideline

Treatment	SAM patient
Shows no signs of dehydration	Replace fluid losses with standard WHO ORS or (low osmolality) (NOT ReSoMal): ≤2 years old: 30-50 ml per loose stool >2 years old: 100 per loose stool. - As soon as possible, initiate F-75 feeding. Follow WHO SAM management guidelines.
Shows signs of dehydration but conscious and able to drink	Step 1: Rehydrate slowly with standard WHO ORS or low osmolality (NOT ReSoMal), orally or by Nasogastric tube (only if the child is unable to drink): 5 ml/kg every 30 min for the first 2 hours. - Step 2: If dehydration persists, administer 5 -10 ml/kg WHO ORS until child is fully rehydrated (up to a maximum of 10 hours); alternate with F75 . Adjust ORS volumes to compensate for ongoing fluid losses (<2 years 30-50 ml after each loose or watery stool, 2 years and older 100 ml after each loose or watery stool.
Shows signs of dehydration and shock: Lethargic or unconscious, Cold hand Slow capillary refill (> 3 seconds) Weak/fast pulse	Administer IV fluids, 15ml/kg over 1 hour using either Ringer's lactate solution with 5% glucose or half-strength Darrow's solution with 5% glucose. If neither is available, use 0.45% saline + 5% glucose. Note: monitor every 10 min for signs of over hydration and signs of congestive heart failure. Stop IV therapy immediately if these develop. If child does not improve after 1 hr of rehydration, assume septic shock and treat accordingly. - If child improves, repeat same amount of IV fluids for a second hour and start administration of 5 -10 ml/kg standard ORS until child is fully rehydrated (up to a maximum of 10 hours); alternate ORS with F75 . Adjust ORS volumes to compensate for ongoing fluid loss (<2 years 30-50 ml after each loose or watery stool, 2 years and older 100 ml after each loose or watery stool). - Initiate antibiotics as soon as Possible. - Once patient is successfully rehydrated, re-screen for SAM and follow treatment plan either for SAM or non-SAM children depending on nutritional status. If the patient is SAM after successful rehydration, observe the patient and continue treatment as per WHO inpatient management of SAM until he/she diarrhea stops

3.4. Ethical considerations

The study adhered to ethical guidelines, ensuring patient confidentiality and privacy. Ethical approval was obtained from the relevant institutional review board or ethics committee of Center for Tropical Medicine and Epidemiology Studies, Hodeidah University (CTMES – HU) that is academic, research and applied center before conducting the research.

3. Results

3.1. Clinical presentation

A total of 25 children aged 1 to 5 years from 1271 children were affected by cholera during the 2024 outbreak in Hodeidah, Yemen. Among these, 11 children (44%) were males, and 14 children (56%) were females. The age distribution revealed that 20 children (80%) were aged over 2 years, while 5 children (20%) were aged 1-2 years. 19 children (76%) from urban while 6 children (24%) from rural. Acute watery diarrhea was reported in 100% of children, 80 % of vomiting, the average of heart rate (HR) was 55 bpm, blood pressure (BP) was <70/40 mmHg (severe cases),

oxygen saturation (SpO₂) was 96%. 76 % of severe dehydration: , 20 % of moderate dehydration, and 4 % of mild dehydration.

Table 2. Distribution of sex, age, residency (n=25)

Variables	Number (n)	Percentage %
Sex		
• Males	11	44
• Females	14	56
Age (years)		
• < 2 years	5	20
• > 2 - <5	20	80
Residency		
• Urban	19	76
• Rural	6	24

3.2. Malnutrition prevalence

The study included 1,271 children under five years of age in Hodeidah, Yemen, 2024. 25 children were reported with malnutrition, 25/1271 (1.96 %). The malnutrition patients were diagnosed into 17/25 (68 %) patient of SAM and 8/25 (32 %) of MAM (Figure 1).

3.3. Admission timing

The children with malnutrition were admitted from 24 hours to 96 hours in the center. 24% of patients were admitted ≤24 hours; 60 % were admitted 24–72 hours; and 16 % were admitted 96 hours (Table 3).

Table 3. Clinical presentation, time of admission, and case severity (n=25)

variables	Number (n)	Percentage (%)
Time of Admission		
24 H	6	24
48 H	5	20
72 H	10	40
96 H	4	16
Watery Diarrhea with Vomiting		
Yes	20	80
No	5	20
Dehydration Severity		
Mild	1	4
Moderate	5	20
Severe	19	76

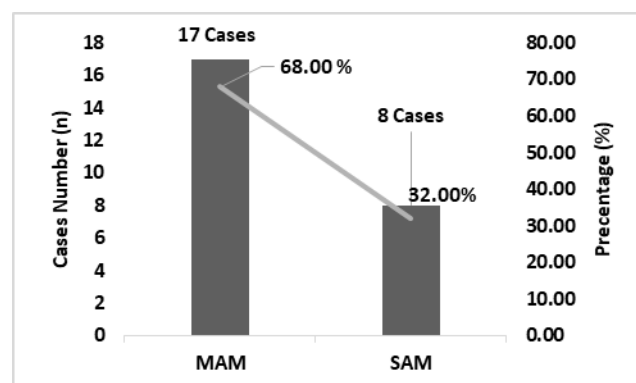


Figure 1. MAM and SAM in cholera patients

3.4. Treatment outcomes

All patients recovered successfully, reflecting the effectiveness of the treatment protocols. The majority of children were admitted within 72 hours after the onset of symptoms, with 40% being admitted at the 72-hour mark and 24% admitted within 24 hours. The delay in admission (16% admitted after 96 hours) suggested

that some children may have experienced a delay in seeking medical help or there were challenges in early detection. Early admission (within 24 hours) is crucial for preventing complications associated with severe dehydration and cholera infection. 80% of children are presented with watery diarrhea and vomiting, which are classic symptoms of cholera. The high percentage of children presenting with these symptoms reflects the typical nature of cholera infections, which can rapidly lead to dehydration and electrolyte imbalances. The remaining 20% had watery diarrhea without vomiting, which still indicates cholera but may suggest a less severe form or early stages of the infection. 76% of children are presented with severe dehydration, which is concerning and highlights the critical need for early rehydration therapy. The remaining children (20%) had moderate dehydration, and only 4% showed mild dehydration.

4. Discussion

The 2024 cholera outbreak in Hodeidah, Yemen, highlights critical interactions between malnutrition, delayed care, and disease severity in pediatric cholera cases. Below is a structured analysis of the findings, contextualized with prior research: Severe Acute Malnutrition and Cholera in Children Under Five years Correlation and Challenges in Yemen. Severe acute malnutrition (SAM) is one of the most serious health threats facing children under five years, affecting approximately 19 million children worldwide and contributing to around 400,000 child deaths annually. SAM is diagnosed based on severely low weight-for-height, the presence of bilateral pitting edema, or a very low mid-upper arm circumference in children aged 6–59 months. Yemen is one of the countries most affected by malnutrition, with an estimated 2.3 million children under five suffering from acute malnutrition in 2021. Among them, 400,000 were at risk of death without urgent treatment. The ongoing conflict, food insecurity, and the collapse of the healthcare system have exacerbated this crisis, making children more vulnerable to infectious diseases, including cholera.[10]. The Link Between Cholera and Malnutrition in Yemen. Data show a strong correlation between malnutrition and the spread of infectious diseases such as cholera. Since 2018, over 280,198 suspected cholera cases have been reported in Yemen, with children under five accounting for 32% of total cases [11]. During the 2024 cholera outbreak in Hodeidah, 25 children aged 1–5 years were affected. The geographic distribution showed that 76% of cases were from urban areas, while 24% were from rural areas. Among these children, 76% suffered from severe dehydration, highlighting the impact of malnutrition in worsening health complications. Fluid Management in Children with SAM and Cholera Managing dehydration in children suffering from both SAM and cholera is a medical challenge. According to WHO, the recommended treatment includes the use of low-osmolarity oral rehydration salts (ORS) or cautious intravenous fluid administration to prevent complications. In severe cases reported in Yemen, affected children showed low blood pressure (<70/40 mmHg) and an increased heart rate (155 bpm), indicating hypovolemic shock. This requires a carefully balanced fluid replacement strategy to avoid complications such as fluid overload or heart failure.[12]. The study revealed a high prevalence (68%) of Severe Acute Malnutrition (SAM) among cholera-affected children, aligning with prior evidence that malnutrition exacerbates cholera outcomes. SAM is known to delay recovery (54% longer in exposed children, as per earlier data) and heighten mortality risk, particularly in fluid-refractory septic shock (69% fatality rate in similar settings).[13] The high rate of severe dehydration (76%) in this report synergy: malnourished children lose fluids more rapidly and struggle to compensate, escalating dehydration severity. [14] This aligns with the observed 76% severe dehydration rate, far exceeding the 40/1000 person-week recovery rates reported in non-malnourished populations [15] The concentration of SAM in urban areas (76% of cases) may reflect compounded vulnerabilities, such as overcrowding and poor sanitation, which exacerbate both malnutrition and cholera exposure. Delayed admission (16% after 96 hours) likely contributed to severe dehydration and poor outcomes. Early rehydration is criti-

cal, yet barriers such as healthcare access, caregiver awareness, or logistical challenges in conflict-affected Yemen delayed care. This aligns with prior studies linking delayed treatment to higher mortality in cholera-endemic settings [16]. The 60% admission rate at 72 hours suggests a missed window for early intervention, particularly for malnourished children, who require urgent rehydration and nutritional support to prevent shock [17]. Despite a high cure rate (99.7%), emphasizing the challenges in managing critically ill, malnourished children. SAM complicates fluid resuscitation due to risks of refeeding syndrome and cardiac compromise [18]. The study's adherence to updated WHO guidelines likely improved outcomes, but resource limitations in Yemen's healthcare system (e.g., shortages of trained staff, therapeutic foods) may have hindered optimal care. The 11 abandoned cases (0.06%) reflect broader systemic issues, though this was minimally impactful. Urban predominance (76%) aligns with cholera's association with overcrowding and inadequate sanitation, typical of endemic settings [19]. The age distribution (80% aged >2 years) mirrors prior findings that older children in endemic regions, due to increased mobility and exposure, bear higher cholera burdens [20]. The absence of cases in children <1 year may stem from maternal antibody protection or reduced exposure, as noted in earlier studies [21].

5. Conclusion

This study underscores the compounding impact of malnutrition on cholera severity in children under five in Hodeidah, Yemen. These findings emphasized that integrated protocols addressing both dehydration and malnutrition are essential to mitigating mortality. However, delayed care and resource limitations in war-affected regions like Yemen remain critical obstacles. Strengthening community awareness, improving access to early treatment, and ensuring uninterrupted supplies of therapeutic foods and rehydration solutions are imperative. Future efforts should focus on preventive strategies targeting malnutrition and cholera transmission to break this deadly cycle in vulnerable populations.

Data Availability

No data were used to support this study.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

This work was conducted during our work at CTMID – Al Thawara Public Hospital Authority, Hodeidah, Yemen

Ethical Approval

The studies involving human participants were reviewed and approved by Ethics Committee of Tropical Medicine and Epidemiology Studies of Hodeidah University (CTMES-HU) Hodeidah, Yemen.

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