

## Severe dehydration among cholera patients in Yemen: A cohort profile

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### Abstract

**Introduction** Cholera, an acute diarrheal illness caused by ingestion of food or water contaminated with *Vibrio cholerae*, is one of the major causes of morbidity and mortality globally. The occurrence of outbreaks of cholera are difficult to prevent in low and middle-income countries, especially those under armed conflicts.

**Methods** This study aimed to describe the characteristics of a cohort of inpatients with cholera in two main hospitals in Taiz and Sana'a, Yemen, between 3<sup>rd</sup> February 2017 and 8<sup>th</sup> December 2017. Patient data were entered into an excel database and analyzed using STATA 16.1. Descriptive summaries of patient's data were presented as frequencies and percentages. Patients' demographic and clinical characteristics were compared using the Chi-square test.

**Results** Preliminary findings from 172 hospitalizations for cholera during the study period include 163 that were severely dehydrated (94.8%). Age, education, hand hygiene, sanitation, water source, stool content and malnutrition were significantly associated with severe dehydration.

**Conclusions** This data contributes to a greater understanding of the associated risk factors for the occurrence of the infectious disease in the study region. Future study will analyze the risks for severe dehydration and diarrhea, and the associated healthcare costs.

**Keywords** Cholera, diarrhea, Yemen, war and conflicts, hand hygiene, sanitation, safe drinking water.

### Introduction

Known as well as emerging infectious diseases remain public health challenges with

potentially serious socio-economic and political consequences.<sup>1</sup> Cholera is a disease of the small intestine caused by the ingestion of toxigenic serogroups (O1 and less commonly O139) of the bacterium *Vibrio cholerae*. Humans are infected mainly by fecal contamination of water and food. This explains why cholera infection is linked to low living standards, poor infrastructure and sanitation as well as insufficient access to uncontaminated drinking water and food, especially among vulnerable groups such as women and children.<sup>2,6</sup> The disease has been practically eradicated in developed countries, and the few reported cases were traced back to exposure during foreign trips.<sup>6,7</sup> Depending on the severity, dehydration will be characterized by increased thirst, dry mouth, sunken eyes, depressed fontanelle (for children) and cold skin with decreased elasticity and wrinkling of hands and feet, rapid and feeble pulse, irritation, lethargy and unconsciousness.<sup>8</sup> Also, there will be significant weight loss among the severely dehydrated cholera patients.

Although cholera has been endemic in Yemen, the ongoing armed conflict has

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aggravated the disease to an unprecedented level.<sup>3</sup> The struggling healthcare system in Yemen has been stretched further, and severely damaged, with around half of its facilities being at least partially closed. Almost 20 million people are lacking access to healthcare facilities, with 24 million needing humanitarian support. About 18 million have no access to clean water, and sanitation and 1.3 million of potential cholera infection have been recorded.<sup>9</sup> In fact, the current outbreak is the largest ever documented outbreak in history.<sup>10</sup> The World Health Organization (WHO) declared the Yemen cholera outbreak a level three major emergency in May 2017. The cholera outbreak came in three waves with peaks in November 2016 followed by a much larger outbreak in May 2017 and the third one in late summer 2018.<sup>10,11</sup> The first small wave is attributed to the initial surge of the outbreak, which slowed down during winter but was strong enough to spread the bacteria nationwide. The start of the rainy season in April 2018 accelerated the epidemic and caused the second bigger wave.<sup>10,12</sup> Between October 2016 and December 2018, there were a total of 1,417,156 suspected cholera cases and 2,870 deaths (case fatality rate: 0.20%) in Yemen.<sup>12</sup>

Studies have shown that the isolates of *V. cholerae* collected during the first two epidemiological waves of the outbreak in Yemen originated in South Asia, and had caused epidemics in East Africa before appearing in Yemen.<sup>13</sup> Malnutrition is predominantly higher among the poor, and this could lead to low productivity, an increase in economic crisis and high cost of accessing healthcare. Malnutrition is widespread in children under the age of five, which makes them vulnerable to disease.<sup>14</sup> Globally, Yemen had “one of the highest-rates of childhood malnutrition.”<sup>15</sup> Outbreaks of cholera have been linked to both environmental and socioeconomic factors.<sup>16</sup> However, this is not limited by gender and age factors.

This study presents the profile description of a cohort of inpatients admitted and treated for cholera between February and December 2017 within two hospitals in Taiz and Sana’a, Yemen. We aimed to describe the characteristics of the cohort of patients with cholera.

## Methods

### Settings

To gain a deeper understanding of cholera hospitalizations in Yemen, 10% of the patients admitted to two hospitals in the cities of Taiz and Sana’a (Al-Modafar Hospital, Taiz and University of Science and Technology Hospital, Sana’a) between 20<sup>th</sup> February 2017 and 8<sup>th</sup> December 2017 due to cholera were randomly selected (Figure 1). Patients were interviewed using a semi-structured questionnaire with questions on demographic, socioeconomic, household hygiene, food, water exposures and clinical outcomes. Arabic is the official language spoken in Yemen; therefore, the back-translation method was used first to translate the questionnaire to Arabic language and back-translated to English for internal consistency. The first author (MMA) reviewed and conducted the clinical examination of all patients presenting with acute watery diarrhea. Standard laboratory tests were requested and treatment provided as per protocol. Post-treatment and once a patient condition improved, the physician obtained informed consent and administered the questionnaire. Verbal informed consent was sought by the physician (first author) before administering the questionnaire.

### Cohort description

The following variables were collected: demographics (i.e., age, gender, place of residence, education), socioeconomic status (e.g., employment status, occupation, source of drinking water, sanitation), clinical presentations (e.g., dehydration and loss of fluid, stool description). Patients’ clinical presentations were analyzed by the first author. Tables 1-3 present the descriptive statistics of the variables used in this study. Following the WHO guidelines, the primary outcome of this study was the severity of diarrhea, dichotomized as severely dehydrated if a patient had lost at least 10% fluid, in shock or near shock while moderately dehydrated if a patient had lost within 6% to 9% fluid without shock.<sup>8</sup>

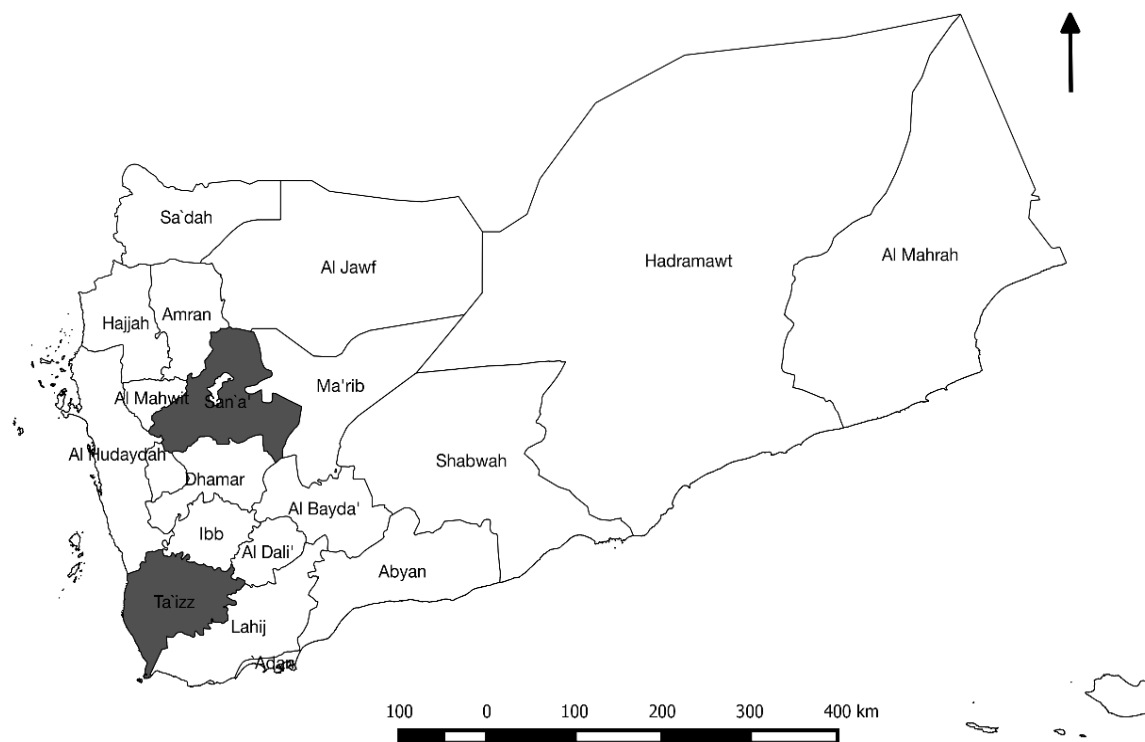


Figure 1. Cities where the two study hospitals are located, Taiz and Sana'a, Yemen

#### Data analysis

Patient data extracts were entered into an excel database and analyzed using Stata Statistical Software (Release 16.1, College Station, TX: StataCorp LLC). Descriptive summaries such as frequencies and percentages were computed for categorical variables. Chi-square test was used to compare patients' demographic and clinical characteristics.

#### Ethical approval

The study was approved by the institutional review board of Taiz University, Faculty of Medicine and Health Sciences (TU-IRB-IA/3). The data used in this study were fully anonymized before the authors had access to them.

#### Results

During the study period, a total of 172 patients were treated for cholera in two hospitals in Sana'a and Taiz, Yemen, mostly in the second wave of the epidemic (Figure 2). Table 1 presents the descriptive demographic characteristics of the

data. Of the 172 patients, the majority were males (69.2%), and more than two-thirds (73.3%) were in the age group (15-49) years. Almost all (94.7%) patients reported they were educated with at least a primary education. More than half of the patients reported to be employed in their last 12 months before the study, and 34.9% had professional, technical or managerial positions. Age group [ $\chi^2(3)=8.56$ ,  $p=0.036$ ] and education level [ $\chi^2(3)=12.23$ ,  $p=0.007$ ] of the patients were found to have a significant association with the severity of diarrhea (Table 1).

Table 2 presents the description of patient's household characteristics. About two-thirds of the patients had more than six household members. The number of household members ranged from three to ten, with a median of six household members. Most (93.0%) of the patients reported place of usual residence as urban. It would take less than an hour to get access to the hospital from more than three quarters of the patient's place of residence. Only a small proportion (2.9%) of patients reported living in a mud housing. The percentage of those

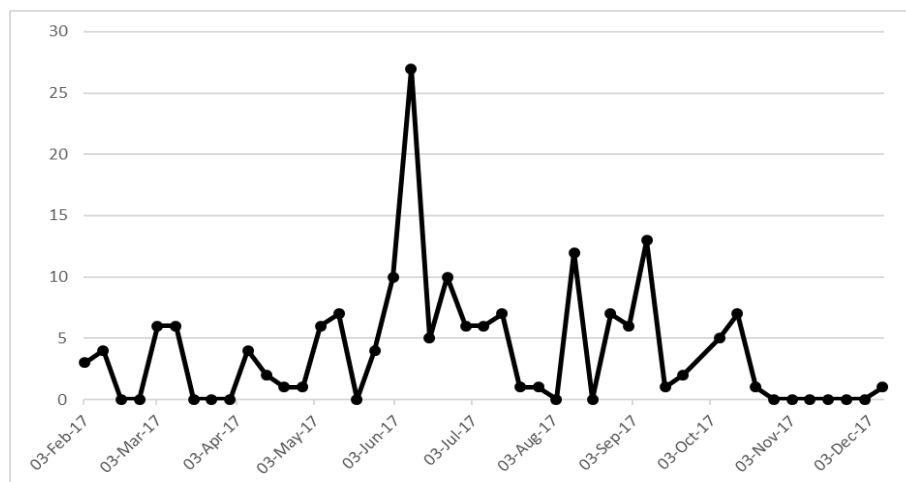


Figure 2. Weekly number of cholera infections (based on the date of hospitalization) in the study site, 3<sup>rd</sup> February 2017 and 8<sup>th</sup> December 2017

Table 1. Demographic summaries of cholera patients in the study area in 2017

Demographic characteristics	N (%)	Severity of diarrhea		p-value*
		Mild	Severe	
Gender				
Male	119 (69.2)	6 (66.7)	113 (69.3)	0.866
Female	53 (30.8)	3 (33.3)	50 (30.7)	
Age group				
<15 years	33 (19.2)	3 (33.3)	30 (18.4)	0.036
15-49 years	126 (73.3)	6 (66.7)	120 (73.6)	
>49 years	13 (7.6)	0 (0.0)	13 (8.0)	
Employment status				
Employed in the last 12 months	89 (59.7)	4 (57.1)	85 (59.9)	0.886
Not employed in the last 12 months	60 (40.3)	3 (42.9)	57 (40.1)	
Occupation				
Professional/ technical/ managerial	60 (34.9)	1 (11.1)	59 (36.2)	0.223
Clerical	29 (16.9)	1 (11.1)	28 (17.2)	
Sales and services	16 (9.3)	3 (33.3)	13 (8.0)	
Skilled manual	6 (3.5)	0 (0.0)	6 (3.7)	
Unskilled manual	8 (4.7)	0 (0.0)	8 (4.9)	
Agriculture	3 (1.7)	0 (0.0)	3 (1.8)	
Unknown	10 (5.8)	1 (11.1)	9 (5.5)	
Student (<18 years)	40 (23.3)	3 (33.3)	37 (22.7)	
Education				
No education	7 (5.3)	0 (0.0)	7 (5.6)	0.007
Primary education	2 (1.5)	0 (0.0)	2 (1.6)	
Secondary education	6 (4.6)	2 (33.3)	4 (3.2)	
Tertiary education	117 (88.6)	4 (66.7)	113 (89.7)	

\*P value based on Chi-square test for comparing categorical variables (mild vs. severe).

that did not know someone who had travelled to a cholera affected area was 83.7%. There was a suggestion of food poisoning, with 73.3% of the patients reporting that they ate uncooked vegetables; 16.9% consumed raw vegetables and

fruits, while 9.9% consumed fruits. Almost all (98%) of the patients had access to water in their home, while for around 2% of the patients it would take more than 10 minutes to get access to water and 10.5% of the patients drank from a

**Table 2. Household characteristics of the study participants in 2017**

Socio-economic characteristics	N (%)	Severity of diarrhea		p-value*
		Mild	Severe	
<b>Travelled to a cholera affected area</b>				
Yes	28 (16.3)	0 (0.0)	28 (17.2)	0.174
No	144 (83.7)	9 (100.0)	135 (82.8)	
<b>Place of usual residence</b>				
Urban	160 (93.0)	8 (88.9)	152 (93.3)	0.617
Rural	12 (7.0)	1 (11.1)	12 (7.0)	
<b>Hand hygiene</b>				
Soap (or cleansing agent) and water	114 (66.3)	9 (100.0)	105 (64.5)	0.038
Water only	58 (33.7)	0 (0.0)	58 (35.6)	
<b>Sanitation</b>				
Improved facility	117 (68.0)	9 (100.0)	108 (66.3)	0.035
Shared facility	55 (32.0)	0 (0.0)	55 (33.7)	
<b>Water exposure</b>				
In the home	169 (98.3)	9 (100.0)	160 (98.2)	0.681
More than 10 minutes to water source	3 (1.7)	0 (0.0)	3 (1.8)	
<b>Access to safe drinking water</b>				
Yes (protected, piped water, treated borehole)	18 (10.5)	3 (33.3)	15 (9.2)	0.021
No (open, untreated borehole)	154 (89.5)	6 (66.7)	148 (90.8)	
<b>Type of housing</b>				
Mud housing	5 (2.9)	1 (11.1)	4 (2.5)	0.279
Non-iron sheet roof	6 (3.5)	0 (0.0)	6 (3.7)	
Metal roofs and brick or concrete walls	161 (93.6)	8 (88.9)	153 (93.9)	
<b>Distance to hospital</b>				
<1 hour	132 (76.7)	9 (100.0)	123 (75.5)	0.090
>1 hour	40 (23.3)	0 (0.0)	40 (24.5)	
<b>Food</b>				
Uncooked vegetables	126 (73.2)	0 (0.0)	126 (77.3)	< 0.001
Fruits	17 (9.9)	9 (100.0)	8 (4.9)	
Uncooked vegetables and fruits	29 (16.9)	0 (0.0)	29 (17.8)	

\*P value based on Chi-square test for comparing categorical variables (mild vs. severe).

protected water source, piped water, or treated borehole. Of all the patients, slightly more than two-thirds had access to improved toilet facilities. One-third of the patients washed their hands with soap (or any cleansing agent) and water, while 33.7% used only water. There was a significant association between severity of diarrhea and the following household characteristics; hand hygiene, sanitation (toilet type), source of drinking; distance to the hospital and food (Table 2).

Table 3 presents the descriptive summaries of the clinical presentation of patients. One hundred and sixty-three patients (94.8%) were severely dehydrated while the rest were moderately dehydrated. Stool was characterized as watery for 61% of the patients, with the majority

reporting continuous stooling (60.5%) and 96.5% reported to be under-fed. The reported range of diarrhea duration prior to arrival at the hospital was between one to three days; on arrival, almost all patients were hospitalized for more than 48 hours. Stool contents and malnutrition were significantly associated with the severity of diarrhea (Table 3).

### Discussion

Despite recent successes in eliminating cholera worldwide, Yemen has been plagued by the largest ever-recorded cholera outbreak which started in 2016 and has been fueled by the ongoing civil war.<sup>2,3</sup> As of late 2018 and out of a population of 27 million Yemenis, 3.3 million remain displaced, around 70,000 have been

**Table 3. Descriptive summaries of clinical presentation of patients in this study**

Clinical characteristics	N (%)	Severity of diarrhea		P-value*
		Mild	Severe	
<b>Stool content</b>				
Rice-water	67 (39.0)	0 (0.0)	67 (41.1)	0.014
Watery	105 (61.0)	9 (100.0)	96 (58.9)	
<b>Number of stools</b>				
Continuous	104 (60.5)	5 (55.6)	99 (60.7)	0.757
Many	68 (39.5)	4 (44.4)	64 (39.3)	
<b>Malnutrition</b>				
No	6 (3.5)	6 (66.7)	0 (0.0)	<0.001
Yes	166 (96.5)	3 (33.3)	163 (100.0)	
<b>Duration of hospitalization</b>				
24-48 hours	7 (4.1)	0 (0.0)	7 (4.3)	0.526
>48 hours	165 (95.9)	9 (100.0)	256 (95.7)	
<b>Patient referred from other hospital</b>				
Yes	149 (86.6)	9 (100.0)	140 (85.9)	0.226
No	23 (13.4)	0 (0.0)	23 (14.1)	

\*P value based on Chi-square test for comparing categorical variables (mild vs. severe).

killed or wounded, 14.3 million are in acute need of humanitarian assistance or protection, 20.1 million face food insecurity and acute malnutrition.<sup>17</sup> Preceding the first reported cholera cases by only one year, the civil war in Yemen started in 2015 with no foreseeable prospects for a peaceful resolution to date and has devastated the country, including the infrastructure and government service. This study described the characteristics and severity of cholera patients in two major Yemeni hospitals.

The results suggest that having access to safe drinking water and adequate sanitation could significantly reduce the severity of diarrhea. The long-term solution for cholera lies in access to safe drinking water, adequate sanitation and hygiene (WaSH).<sup>18</sup> Water is considered safe for drinking if stored in a covered container with a narrow tap neck dedicated for extracting the water or when effective water treatment is practiced, such as boiling up to the rolling boil, or treating with the use of proven filters or appropriate chlorine dosing.<sup>19</sup> However, due to the ongoing war in Yemen, naval and air blockades through bombing have destroyed water and sanitation amenities, resulting in an increase in water shortages.<sup>20</sup> Moreover, the constant bombing in the cities have created debris from

damaged buildings that contaminate water containers, which are not correctly stored. To this end, the newly invented easy-to-use oral cholera vaccines (OCVs) also play a vital role in this situation.<sup>18</sup> The first OCV campaign was put into operation in Yemen in 2018; they are socially acceptable, safe, and useful for preventing cholera for three or more years after administration.<sup>21</sup>

People in the age group less than 15 years and 15-49 years are more likely to experience a severe form of cholera. Previous studies have reported different age groups for severe cholera.<sup>5,22</sup> In their study, Tamang et al.<sup>23</sup> found that younger people below 30 years were the most affected during the 2004 cholera outbreak in Nepal. In Nigeria, the 2005/2006 cholera outbreak was predominantly fatal in young children aged 15 years and below.<sup>5,24</sup> Cholera morbidity and mortality are avoidable and often significantly related to poor household conditions, such as sanitation and water supply, and poor access to healthcare facilities.<sup>25</sup> In the last decade, there have been large outbreaks of cholera with the most prominent being those in Yemen and Haiti. New methods to combat cholera outbreaks have been developed with a target to reduce cholera deaths by 90% globally

and eliminate the disease at least in 20 countries by 2030.<sup>22</sup>

### Conclusions

Using hospital data, this cohort of patient data will be valuable in understanding the environmental, behavioral and socio-economic factors associated with the danger of cholera.

**Authors' contributions statement:** MMA and OAA conceived and designed the study. OAA and TIE analyzed the data. MMA, OAA, TIE, LOM, KMR and FAME contributed to the writing of the manuscript. All authors read and approved the final version of the manuscript.

**Conflicts of interest:** All authors – none to declare.

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