Original Article

Acute Diarrheal Outbreak in 2022 Karachi, Pakistan: To Determine its Clinical Spectrum, Risk Factors and Complications

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ABSTRACT

OBJECTIVE: To identify the possible source of the outbreak and risk factors and suggest evidence-based recommendations for prevention and disease control in Pakistan.

METHODOLOGY: This cross-sectional study was conducted in Civil Hospital Karachi, Pakistan, from March to May 2022. A total of 90 patients with a history of more than one watery stool in 24 hours were included in the study. The data about demographics, hygienic practices, illness characteristics, treatment, and biochemical parameters, including serum electrolytes and creatinine levels, were recorded. IBM SPSS version 26 was used for data analysis.

RESULTS: The majority (83.3%) of symptoms were for less than one week. The mean family size was 6.7, SD 3.2, and 73.3% of patients had low income. Un-filtered municipal pipelines were the primary source of drinking water for 85.6% of patients, and 82.2% drank from tap water. Diarrhea (100%) and vomiting (81.1%), followed by abdominal discomfort (53.3%), were the most common symptoms, and 19 patients suffered acute kidney injury that resulted in the need for dialysis for a short time. Among 91 cases, only seven stool samples were positive for Vibrio cholera.

CONCLUSIONS: The study suggests the contaminated drinking water as a source of the outbreak, with independent risk factors such as large family size and low income. V. Cholera was indicated as the causative pathogen but with a low positivity rate; it may be due to the presence of uncommon serotype or a mutant variant of vibrio cholera for the outbreak.

KEYWORDS: Acute diarrheal illness, faecal oral route, borne diseases, water contamination, hand hygiene, pipeline contamination, acute kidney failure.

INTRODUCTION

Diarrheal illness is one of the leading causes of mortality in the developing world, especially in children under five Years. Studies showed that Sub- Saharan Africa and South Asia have around 50 to 150 deaths from diarrhea per 100,000. In contrast, the rest of the world has below five deaths per 100,000.[1] Poor sanitation, contaminated foods, and pipeline contamination are some known risk factors. The morbidity due to diarrhoea also remains essentially unchanged for ten years. Diarrhoea is caused by various pathogens usually transmitted by faecal-oral routes like salmonella paratyphi, shigella, campylobacter, E. coli, rotavirus, and Norwalk virus. Vibrio cholera alone is responsible for an annual 1.3-4.0 million morbidity and 21,000-143,000 mortality worldwide.[2]

The population who do not have access to safe drinking water across the globe is more than 884 million.[3] Provision of clean drinking water and adequate sanitation is imperative in preventing Cholera and other faecal-oral route-borne diseases. Safe hygiene practices like drinking pure water, proper handwashing before meals and after toilets, and avoiding uncooked unhygienic food from roadside vendors can prevent most cases. However, effective treatment lies in replacing lost fluid orally or via IV fluid with antibiotics in severe conditions.[4]

Karachi is the largest city in Pakistan; despite being the metropolitan hub of the country, water and sanitation remain the biggest challenge to date.[3] A rapid rise in acute diarrheal cases in Karachi was noted in March 2022. Our study is to investigate the outbreak to describe the epidemiology and identify the possible source of the outbreak and risk factors. Moreover, we characterize the manifestations of acute diarrheal illness and suggest recommendations for prevention and control that can impact the lives of the enormous population of this area.

METHODOLOGY

This cross-sectional study was conducted in Civil Hospital Karachi, Pakistan, from March to May 2022. This study was conducted on patients admitted to Civil Hospital Karachi, Pakistan, with suspected cases of infectious diarrheal illness. Patients with a history of three or more loose watery stools per day for less than

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two weeks were included. The 90 patients included were admitted from March to May 2022.

We have excluded people having an acute exacerbation of their chronic inflammatory bowel disease. (Bloody diarrhoea, severe abdominal pain, high-grade fever) and patients that had grossly bloody or non-watery diarrhoea. Along with patients with diarrheal episodes going on for more than two weeks.

A 41-item questionnaire was framed, and interviews were conducted with all the patients meeting our inclusion criteria. The questionnaire included information regarding demographic data and the water source in the patient's house. After providing detailed information about the purpose of the study, informed consent was obtained, and healthcare providers were in detail interviewed individual cases. Data was compiled from the questionnaires related to the history of loose motions during the previous week, public gatherings, exposure to local food vendors, source of water supply, eating habits, disposal of excreta and solid wastes, age, sex, occupation, signs and symptoms, illness onset and duration, and treatment given. We also collected data from the recorded lab values of patients with serum electrolytes and creatinine levels. All data of the patients were analyzed using IBM SPSS version 26.

Laboratory investigations

Stool samples were collected as part of the initial workup from symptomatic cases and sent for culture and sensitivity for common pathogens such as salmonella sp., shigella sp., vibrio cholera, escherichia coli, and campylobacter sp. Other lab works, including complete blood count, serum creatinine and BUN, and serum electrolytes, were obtained for each patient. We did not conduct a polymerase chain reaction or viral serology of the samples, and our investigations mainly focused on sensitivity to common bacterial pathogens.

RESULTS

Out of the 91 patients included in the study, 90 responded to the questionnaire with a successful response rate of 99%. The admitted patients' ages ranged from 13-86 years old, with a mean of 43 and SD = 18.9 and a median of 42 years. The gender preponderance was equivocal, as 51% of patients were females, and the rest were males. The most affected age groups were patients 50-60 years old. The mean family size was 6.7, and SD was 3.2. Around 73.3% of the population had a monthly income of less than 20,000 Pakistani rupees (RPK). **Table I** summarizes the demographics of all patients.

A section of the questionnaire confided our patients on their drinking water source. Based on the responses from the questionnaire, 71 (78.9%) of respondents did not reside near freshwater bodies. 77 (85.6%) of respondents indicated that their primary source of drinking water came from pipelines, with 12 (13.3%) obtaining filtered water and 1 (1.1%) drinking from wells. Most patients, 74 (82.2%), drank directly from tap water, whereas 13 (14.4%) drank water previously stored in a covered container, and 3 (3.3%) consumed uncovered to water. When asked if patients boil their drinking water, 11 (12.2%) indicated "yes," and 78 (86.7%) indicated "no". Most of them have a proper sanitation system, 89 (98.2%), but only 55 (61.1%) of patients wash their hands with soap before eating, whereas 4(4.4%) do not wash their hands at all.

Table I:
Social demographics of admitted patients (n = 90)

Variable	No. (%)
Age (years)	
Mean (SD)	42.80 (18.971)
Median	43
Minimum – Maximum	13 – 86
Gender	
Male	44 (48.9)
Female	46 (51.1)
Family Size	
Mean (SD)	6.69 (3.203)
Median	6
Minimum – Maximum	3 – 20
Monthly income (PKR)	
More than or equal to 20k	24 (26.7)
Less than 20k	66 (73.3)

Disease characteristics

Most patients, 85(94.4%), were afebrile, and the duration of symptoms was less than a week in 75 (83%) of the total cases. Dehydration was assessed, and almost all patients, 88 (97.8%), reported no signs of severe water loss. When evaluating the reported symptoms of all patients, the majority, 73 (81.1%), reported vomiting within the first 24 hours of presentation. Of these, 22 (24%) patients had 12 or more episodes, 11 (12.2%) had 5 to 8 episodes of vomiting, and 36 (40%) of the cases had at least 1 to 4 vomiting episodes at the time of presentation. Meanwhile, 17 (18.9%) subjects had no history of vomiting. Diarrhea was a common symptomatic presentation of all patients in the study, with only 3 (3%) cases associated with blood in the stool. In 50 (55.6%) cases, patients had had ten or more loose stool episodes within 24 hours, and 48(53%) complained of abdominal pain. A summary of disease characterizations is provided in **Table II**.

We assessed the serum levels of all patients included in the study. The mean values of serum sodium (Na), chloride (Cl), and potassium (K) levels were within normal ranges, following the values provided by the International Federation of Clinical Chemistry and the National Committee for Clinical Laboratory Standards (**Table III**). 40 (44%) had Na levels below 135, around 25 (28%) had hypokalemia, and 3 (3%) presented with

hyperkalemia. The mean creatinine (Cr) level at the presentation was 2.5mg/dL with an SD of 0.84, elevated compared to normal values, and 19 patients suffered acute kidney injury that resulted in the need for dialysis for a short time. However, the mean creatinine levels came down to 0.99 mg/dL after the resolution of symptoms. Amongst 90 cases, only seven stool samples were positive for Vibrio cholera. Treatment with antibiotics, including (ciprofloxacin, metronidazole, ceftriaxone, and azithromycin) and IV hydration were given, which resulted in fast recovery and resolution of acute kidney injury (AKI).

Table II: Disease characterization (n = 90)

Variables	No. (%)
Duration of illness	
>1 week	15 (16.7)
= or <1 week	75 (83.3)
Fever	
Afebrile	85 (94.4)
High	1 (1.1)
Low grade (100-102)	4 (4.4)
Dehydration grade	
Grade 1	1 (1.1)
Grade 2	1 (1.1)
None	88 (97.8)
Number of vomiting per day	
1-4	36 (40.1)
5-8	11 (12.2)
9-12	4 (4.4)
12+ (Continuous)	22 (24.4)
No vomiting	17 (18.9)
Number of loose stools within 24 hours	
>10	50 (55.6)
<10	40 (44.4)
Color of stool	
Brown	12 (13.3)
Green	10 (11.1)
Transparent	39 (43.3)
Yellow	29 (32.2)

Table III:
Laboratory results in admitted patients (n = 90)

Variables	Mean (SD)	Range	Normal*
Sodium (mEq/L)	134.7 (5.27)	120-148	135 - 145
Chloride (mEq/L)	101.1 (7.13)	76-127	96 - 109
Potassium (mEq/L)	3.9 (0.92)	1-7	3.5 - 5.0
Creatinine at time of presentation (mg/dL)	2.6 (0.84)	1.3-4.5	0.6 - 1.2
Creatinine after resolution of symptoms (mg/dL)	1.0 (0.44)	0.0-2.2	

** Standardized values based on the International Federation of Clinical Chemistry (IFCC) and the National Committee for Clinical Laboratory Standards (NCCLS) consensus[23].*

DISCUSSION

In developing countries, safe access to drinking water, hand and personal hygiene, and proper sanitation are vital to preventing outbreaks of illnesses[5]. As the hospital serves a large and diverse city population from various areas, the outbreak is likely to be a multiple-point source epidemic, suggesting that the burden of the ongoing epidemic can be significant. An outbreak of acute gastroenteritis in a developing country like Pakistan is typical due to unfavourable circumstances and accounts for substantial mortalities in this part of the world[6]. To our best knowledge, this cross-sectional study is one of the first in Karachi to extensively discuss the multifactorial nature of this acute diarrheal outbreak of 2022.

In a densely populated metropolitan city like Karachi, it is not uncommon to see an improper drainage system running parallel to the domestic water pipelines. In the literature, water source contamination has been reported as the primary source of diarrhoea outbreaks in various parts of Pakistan[7]. Our study found that most of the population drank tap water directly from pipelines without using any filtering technology or boiling the water before drinking. Pipelines are highly susceptible to faecal contamination from domestic sewage or industrial waste and can harbor a favorable environment for pathogens if drinking water is not safely decontaminated before use. These findings were consistent with an original study in Tamil Nadu that reported the leading cause of an acute diarrheal outbreak due to damaged pipelines causing faecal contamination[8]. These results are similar to Gupta G 2021[9] reporting an outbreak in India caused by the consumption of contaminated well water, lack of water covering, poor hand hygiene, and lack of toilet access. Interestingly, our results show that most patients practiced proper sanitation techniques, such as washing their hands with soap before eating. Lack of hygiene has been reported previously in the literature as a significant risk factor in acute diarrheal illness and was not deemed to have influenced the outbreak in our case[10].

There was no information regarding any typical public gathering amongst the patients, but our results suggest that risk factors pertained to diarrheal outbreaks include large family sizes of over six; this may be due to the effect of multiple family members sharing household facilities such as bathrooms, making the spread of pathogens more probable in cases wherein one individual is affected. However, our findings regarding family size were consistent with a study in Sierra Leone, wherein a household size of 5 was associated with diarrheal disease[11]. Monthly income levels were also implicated in the diarrheal outbreaks, with most patients only earning a total monthly income of less than 20,000 PKR ($101 US dollars). Several studies have analyzed the

association of household income to drinking water use and found that lower-income families cannot afford safer and better drinking water in rural communities[12]. Income was one of the most critical determinants in individuals selecting their method of filtering water, which reinforces that less purchasing power of consumers results in drinking directly from the tap without filtering it and being unable to relocate to communities with safer access to water[13].

When analyzing the clinical manifestations of the diarrheal outbreak, symptoms were generally mild abdominal discomfort followed by vomiting and loose stools, consistent with Cholera's clinical picture. Diarrhoea is a common clinical condition with a multifactorial aetiology and can be divided into acute and chronic forms. In this study, acute diarrhoea was the most likely condition affecting these patients and is defined as an episode of loose, watery stool lasting less than two weeks[3]. The duration of the illness, fever status (the majority were afebrile), and low-grade dehydration reinforced the diagnosis of acute diarrheal illness. Acute kidney injury was a common complication of diarrheal illness in hospitalized patients, but treatment can typically resolve increased creatinine levels when admitted, as seen in our study[14].

Though the condition is well studied in the literature, it can be difficult to trace the source of diarrheal outbreaks. During our investigation, we could not confirm the causative pathogen of the outbreak. Studies have implicated rotaviruses as one of the significant causes of disease burden related to gastrointestinal infections in Pakistan[15]. However, recent studies have observed a rise in Vibrio cholerae associated with diarrheal illnesses[16]. Previous outbreaks of diarrheal diseases, including Cholera, are associated with contamination of drinking water sources[17]. The stool samples showed growth of vibrio cholerae from 7 out of 90 patients. Cary-Blair media was not used to transport stool samples, and vibrio cholera was identified in the thiosulfate-citrate-bile salts agar. Our study's growth positivity for V. Cholerae was lower (7.7%) compared to similar outbreaks from other parts of South Asia[18]. The possible explanation for low positivity for V. Cholerae includes patients taking antibiotics before hospital visits, or vibrio cholera destroyed during intestinal transit by low pH, delays in transferring the sample to the lab and unavailability of Cary-Blair media, which provides high pH (8.4) necessary for the viability of Vibrio Cholera for a longer duration of time. It could also be because of a mutant variant, rare serotype, or virus not detected on a regular growth medium. Although various public health guidelines have established that even a single lab-identified case of V. cholera is significant enough to alert an epidemic, we acknowledge that PCR testing for viruses or other organisms from stool samples would have helped arrive at concrete conclusions[19].

World Health Organization (WHO) has introduced several household water treatment and safe storage (HWTS), including solar disinfection, bleach addition, boiling, and low-cost ceramic or sand filters[20]. However, it is not uncommon for policymakers of developing countries to overlook the importance of expanding and preserving the infrastructure required for sanitation and improved drinking water and hygiene services. Because of several challenges, the supply of reliably safe drinking water throughout the country has not been possible in Pakistan, and the drinking water across various parts of the country has been reported to be contaminated with potentially pathogenic microbes[21]. This paper highlights the importance of introducing various water filtering and purifying techniques like sand-filtered drinking water, which has been shown to reduce the number of diarrheal disease cases[22]. To avoid future epidemics, a proper surveillance system for early case detection, ensuring the availability of safe drinking water, and ongoing health education are required to establish and execute quick control strategies. Combined efforts from the water authority, local government, and public health department are required to pinpoint the actual source of the outbreak. Increasing awareness at the community level regarding measures that can be taken to prevent the infection from spreading is also equally important as ensuring the availability and education of the oral cholera vaccine. Moreover, the study warrants establishing a good water quality surveillance system and efficient planning and execution of water supply, drainage system, and sewage disposal. Behavior change communication to address the practice of dumping sewage into water sources is the need of the hour.

The limitations of this study include no case follow-up and no PCR testing in culture-negative stool samples for viral causes of diarrhoea. Nonculturable Vibrio produced in an acidic environment during intestinal transit or prior antibiotic use or a mutant variant, unavailability of Cary Blair media, inability to detect uncommon serotypes and lack of community-level survey. Community-level surveys directed at testing for pathogens in the water bodies and storage tanks would add value to future studies.

CONCLUSION

The investigation suggests the common possible sources of the outbreak are contamination of water sources, and socioeconomic factors have been emphasized as risk factors in the literature. Our findings show that the diarrheal outbreak in Karachi symptomatically mimicked vibrio cholera infection; however, only seven stool samples were positive for the pathogen that has potentially spread through contaminated drinking water sources. Further studies are needed to determine the cause of low positivity for vibrio cholera and investigate other possible causes, such as enteric viruses. This outbreak presented mild acute kidney failure, which could have led to life-

threatening dehydration. We suggest the government should provide mass education about using such water purification techniques along with surveillance of water supply pipelines, sewage and water pipelines should be appropriately separated and explore future recommendations that could prevent the recurrence of acute diarrheal outbreaks in Pakistan.

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AUTHOR CONTRIBUTIONS

Abbasi A: Analyzed data, reviewed the final manuscript
Tahir SA: Editing and reviewing the manuscript, organizing research conduction, and proofreading for clinical accuracy.
Asghar SA: Analyzed data, written introduction, methodology, and results.
Huang H: Thorough reviewing and editing of the manuscript, written abstract, production of tables.
Rahim K: Proofreading of the manuscript with final editing and organizing data collection
Upadhyaya A: Written discussion

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