

## ORIGINAL ARTICLE

# An Epidemiological Investigation of Cholera Outbreak in a Residential School for differently abled children and adolescents in Central India

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### ARTICLE CYCLE

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### ABSTRACT

**Background:** Migration, inadequate sanitation, congestion, and disease ignorance make cholera a major public health issue in emerging nations like India. The increase in diarrhea and dehydration cases at an NGO Residential School for differently abled children and adolescents in Indore, M.P., India, demanded quick investigation to avert future morbidity and mortality. **Objectives:** To investigate diarrhea and dehydration outbreak at an NGO Residential School for differently abled children and adolescents in urban Indore, M.P., India; determine the etiological agents, outbreak's severity and recommend control strategies. **Materials and Methods:** A cross-sectional study with pre-defined case definition, followed line-listing and collection of stool, food, and water samples. Symptomatic cases were referred and treated. A comprehensive epidemiological report with recommendations and inclusive action plan was submitted to the district health authorities. **Results:** Out of 94 suspected cases, 31 tested positive for cholera. Most affected individuals (72.34%) were aged 10–19 years, with an equal male-to-female ratio. The case fatality rate was 4.3%, while attack rate was 32.98%. Contaminated drinking water and poor hygiene were identified as the main causes of the outbreak. **Conclusion:** Contaminated water and poor hygiene were identified as key factors responsible for cholera outbreak. Water treatment and hygiene education helped control the outbreak. Periodic supervision suggested to prevent future outbreaks.

### KEYWORDS

Cholera; Diarrhea; Dehydration; Outbreak Investigation

### INTRODUCTION

Cholera is a severe diarrheal disease caused by ingesting food or water contaminated with *Vibrio cholerae* that often affects peri-urban slums and crowded camps. Humanitarian crises, which disrupt water and sanitation systems or force overcrowded living conditions, heighten cholera risk if the bacteria are introduced. Importantly, uninfected dead bodies have not been linked to epidemic outbreaks. (1) Cholera is a global public health threat, highlighting social inequities and underdevelopment. (2) Originating in the Ganges delta, cholera caused six global pandemics in the 19th century.(1) In 2022, cholera outbreaks were

reported in 30 countries across five WHO regions. The resurgence of the seventh cholera pandemic worsened into 2023. (3) Increased cholera surveillance is recommended for affected and at-risk nations. In 2023, WHO reported 535,321 cholera cases and 4,007 deaths from 45 countries.(4) The gap between reported figures and the actual disease burden is due to underreporting caused by weak surveillance systems and concerns over the impact on trade and tourism.(1) Most infections are mild and treatable with oral rehydration and antibiotics; untreated severe cases can lead to death within hours.(5) While diagnosis is usually confirmed with stool or rectal swabs, in

outbreaks, treatment is often started based on patient history and clinical signs before lab results.(6) The *V. cholerae* El Tor biotype is the primary causative agent of cholera, often leading to mild diarrhea without any symptoms.(7) Toxigenic strains of *V. cholerae* O1 and O139 cause severe diarrhea, where O1 being the most common in India. A surveillance in Kolkata found an incidence of 2.2 cases per 1000 person-years. (8)

Cholera remains a major threat despite being preventable and treatable. Between June 29 and July 9, 2024, cases of diarrhea, vomiting, and fever were reported at an NGO Residential School for differently abled children and adolescents of urban Indore, M.P., India. A multidisciplinary team from Government Medical College, Indore, investigated the outbreak to determine the etiological agents, evaluate the outbreak's severity, and recommend suitable control strategies.

#### **Aim & Objectives:**

1. To investigate an outbreak of Diarrhea and Dehydration cases at an NGO Residential School for differently abled children and adolescents of urban Indore, M.P., India.
2. To determine the etiological agents, assess the outbreak's severity, and recommend suitable control strategies.

## **MATERIAL & METHODS**

**Study design:** A cross-sectional study

**Study setting-**

- **An NGO Residential school of urban Indore, M.P., India** is a government-supported non-profit providing care for children with autism, cerebral palsy, and other intellectual & developmental disabilities. As of June 2024, it serves 204 children with the help of 50 staff members, offering residential services including meals, water, accommodation, and daily care.

- **Medical records department of Government Tertiary Care Hospital, Indore, M.P., India**

**a. Study duration:** June 29, 2024 to July 9, 2024

**Investigation team:** A multidisciplinary team comprising members from the Department of Community Medicine, Paediatrics, and Microbiology from Govt. medical college visited an NGO Residential School of urban Indore, M.P., India on 02/07/2024, to assess the recent surge in cases of diarrhoea and dehydration among children.

**Study Population:** All the cases of diarrhoea, vomiting, dehydration and fever reported among differently abled children and adolescents between June 29 and July 9, 2024; at the study sites.

**Outbreak Chronology:** The outbreak was monitored from June 29, 2024, to July 9, 2024, and

documented in daily increments based on the number of new cases and fatalities.

**Sample Size:** All the cases of diarrhoea, vomiting, dehydration and fever reported among differently abled children and adolescents between June 29 and July 9, 2024; at the study sites.

**Inclusion Criteria:** All the cases of diarrhea, vomiting, dehydration and fever reported among differently abled children and adolescents between June 29 and July 9, 2024; at the study sites.

**Exclusion Criteria:** All the asymptomatic differently abled children and adolescents after screening for signs and symptoms of dehydration during the outbreak at the study sites.

#### **Study Tools:**

##### *Primary Data-*

- Pre-designed Semi-structured questionnaire for interpersonal interview.
- Observation Checklist for Environmental assessment to evaluate water quality, sanitation, overcrowding, and hygiene practices etc. at the school.

##### *Secondary Data-*

- Clinical data from medical records section of Government Tertiary Care Hospital, Indore, M.P., India.

**Data Collection and Analysis:** Clinical data were collected through interviews with caregivers and reviews of medical records. Environmental assessments were conducted to evaluate water quality, sanitation, and hygiene practices at the facility. Microsoft Excel was used to enter and analyse all the data.

#### **Working Definitions:**

**Case Definition:** A case was defined as any resident of the school presenting with symptoms of diarrhea ( $\geq 3$  loose stools within 24 hours) or vomiting accompanied by signs of dehydration between June 29 and July 9, 2024.

**Acute watery diarrhea:** Acute watery diarrhea is an illness marked by the passage of three or more loose or watery (non-bloody) stools within a 24-hour period.(9)

**Suspected cholera case:** In regions where a cholera outbreak has not been confirmed, a suspected case includes anyone aged 2 years or older who presents with sudden onset of watery diarrhea accompanied by severe dehydration or dies from acute watery diarrhea. In areas with a declared cholera outbreak, any individual showing symptoms of or succumbing to acute watery diarrhea is considered a suspected case.(9)

**Confirmed cholera case:** A suspected case in which *Vibrio cholerae* O1 or O139 is confirmed through culture or polymerase chain reaction (PCR). In regions where cholera has either never been

present or has been eradicated, the *V. cholerae* O1 or O139 strain is shown to be toxigenic.(9)

**Cholera outbreak:** A cholera outbreak is identified when there is at least one confirmed cholera case with indications of local transmission. In areas where cholera transmission occurs consistently throughout the year, an outbreak is defined by an unexpected rise in suspected cases either in number or timing over a span of two consecutive weeks, with some cases confirmed through laboratory testing.(9)

**Ethical Approval:** The study received approval from institutional ethical committee and review board with letter no.- EC/MGM/Nov-24/243. Informed consent was taken from the head and caregivers of the study site as parents/guardians of the participants lived far away in various parts of India.

#### Microbiological Culture Methods:

**Isolation:** A common approach to isolate *Vibrio cholerae* involves first enriching the sample in Alkaline peptone water media, followed by culturing on TCBS agar for isolation.(9)

**TCBS Agar:** Thiosulfate-citrate-bile salts-sucrose (TCBS) agar is a specialized medium used in microbiological laboratories to selectively isolate *Vibrio* species, such as *Vibrio cholerae*.(9)

#### Laboratory Investigations:

**Microbiological and biochemical samples** were collected from affected individuals (admitted in

government tertiary care hospital) and environmental sources of the school. These included:

- Stool (66 cases) and rectal swab (19 cases) samples from symptomatic children.
- Gastric aspirate (4 cases) samples from symptomatic children
- Postmortem tissue samples (3 cases) from deceased children.
- Water samples from borewell and RO systems.
- Food samples from the facility's kitchen.
- Blood samples from symptomatic children

#### Laboratory investigations included:

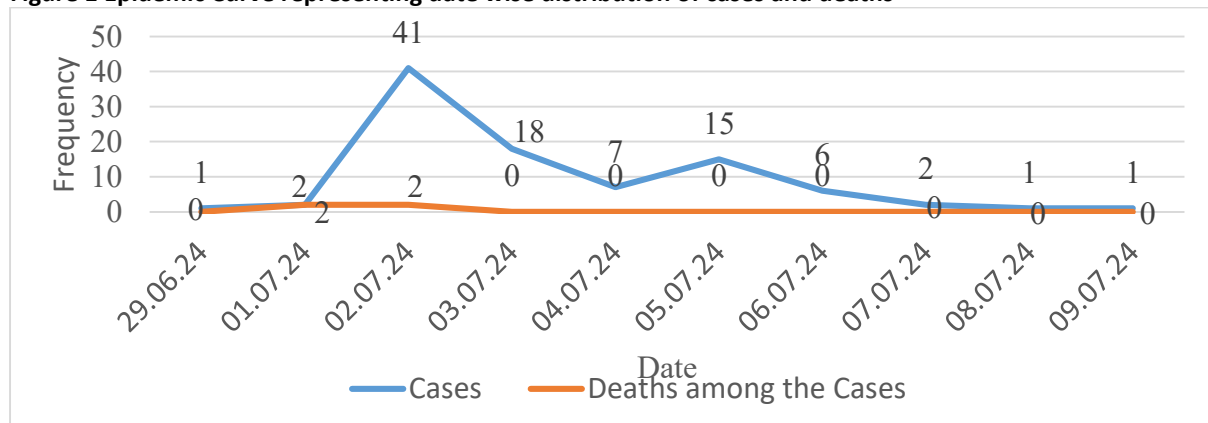
- Hanging drop preparations for detection of motile organisms.
- Culture studies for identification of bacterial pathogens.
- Biochemical tests to assess the impact of dehydration on organ function.

## RESULTS

A total of 94 cases including 4 deaths occurred during June 29 and July 9, 2024 were line listed. The case fatality rate was found to be 4.3%, while the attack rate was 32.98%.

#### Epidemiological Findings

**Figure 1 Epidemic Curve representing date wise distribution of cases and deaths**



The epidemic curve illustrated the first case appearance on 29<sup>th</sup> June 2024 and showed sudden peak of cases on 2<sup>nd</sup> July 2024; thereafter depicted declining trend in the frequency of cases on 3<sup>rd</sup> and 4<sup>th</sup> July 2024; followed by an upsurge on 5<sup>th</sup> July 2024 and a final gradual descent of the occurrence of new cases of loose stool.

#### Chronology of Cases and Fatalities:

- **Day 1 (29/06/2024):** The index case, an 8-year-old boy, was admitted with diarrhoea and vomiting in government tertiary care hospital.

- **Day 2 (01/07/2024):** Two more cases were reported. A 10-year-old boy died at 9:30 am in hospital, and a 7-year-old with Cerebral Palsy died later at 11:30 pm at the school.
- **Day 3 (02/07/2024):** 23 children were admitted with diarrhoea and dehydration in govt. hospital. Among them, a 5-year-old boy, a known case of Cerebral Palsy, was brought in already deceased. Additionally, 16 other children who had experienced 1-2 episodes of diarrhea and vomiting were referred to government tertiary care hospital for further

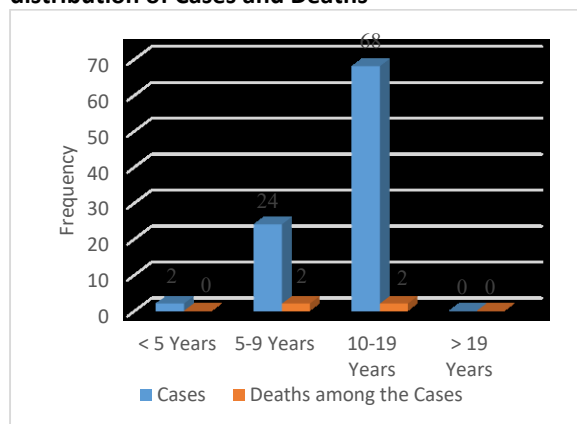
observation. Tragically, another death occurred on this day—a 11-year-old girl, a known case of Cerebral Palsy, passed away at the school. By the end of the day, total 41 cases including 2 deaths, were reported.

- **Day 4 (03/07/2024):** 18 more children admitted with similar symptoms.
- **Day 5 (04/07/2024):** 7 new cases were reported.
- **Day 6 (05/07/2024):** 15 additional cases were admitted.
- **Day 7 (06/07/2024):** 6 new cases were reported.
- **Day 8 (07/07/2024):** 2 more cases were admitted.
- **Day 9 (08/07/2024):** 1 new case was reported.
- **Day 10 (09/07/2024):** 1 final case was admitted.

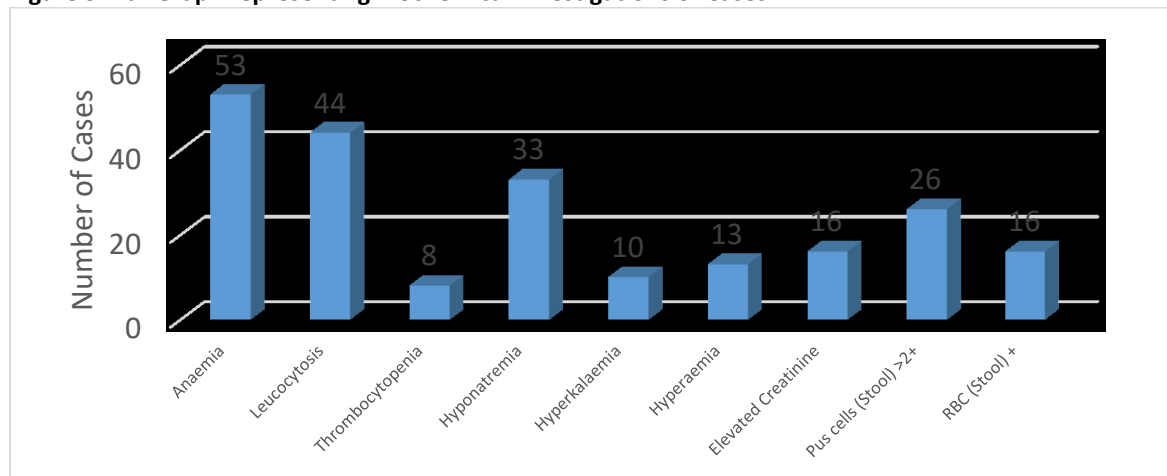
#### Age and Gender Distribution:

Of the 94 cholera cases, 72.34% (68) were in children aged 10-19 years, with an equal distribution between males and females (47 each). Four deaths occurred, including two male children aged 5-9 years, and one male and one female child aged 10-19 years.

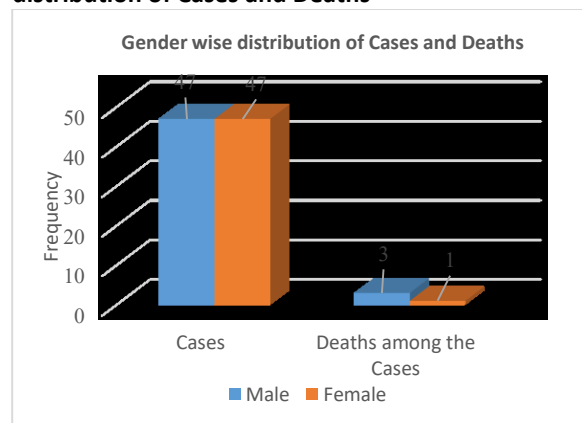
**Figure 2: Bar diagram depicting age wise distribution of Cases and Deaths**



**Figure 5: Bar Graph representing Biochemical Investigations of Cases**



**Figure 3: Bar diagram depicting Gender wise distribution of Cases and Deaths**



**Table 1: Gender and age wise distribution of Deaths**

Age Group	Deaths among the Cases		Total
	Male	Female	
5-9 Years	2	0	2
10-19 Years	1	1	2
<b>Total</b>	<b>3</b>	<b>1</b>	<b>4</b>

#### 1. Environmental Assessment:

##### a. Water Supply:

The facility used borewell water for general use and RO-filtered water for drinking, but maintenance records for the RO system were missing, raising concerns. Overcrowded living conditions, poor ventilation and hygiene practices were observed during the site visit.

**b. Sanitation and Hygiene:** Bathrooms and communal areas were poorly cleaned, and both caregivers and children neglected proper hand hygiene, raising the risk of faeco-oral transmission.

#### 2. Biochemical investigations:

Hyperaemia and Elevated Creatinine were S/O Acute Kidney Injury (AKI) due to Severe Dehydration.



3. **Microbiological Investigations** (Done at government tertiary care hospital):

a. **Stool Samples:**

- **Hanging Drop Preparation:** *Vibrio cholerae*-like organisms exhibiting darting motility were observed in 4 cases.
- **Culture (TCBS agar) Results:** *Vibrio cholerae* was isolated from the stool cultures of 19 cases.

b. **Stool Samples:**

- **Hanging Drop Preparation:** Darting motility indicative of *Vibrio cholerae* was seen in 3 cases.
- **Culture (TCBS agar) Results:** *Vibrio cholerae* was grown in the stool cultures of 5 cases.

c. **Stool Samples:**

- Mixed intestinal parasitic infestations were detected, including:
  - *Giardia* (4 cases)
  - *Entamoeba histolytica* (1 case)
  - *Trichuris trichiura* (3 cases)
  - *Blastocystis hominis* (2 cases)
  - *Ascaris lumbricoides* (17 cases)
  - *Hymenolepis nana* (4 cases)

d. **Post-mortem Cultures:** Intestinal tissue and swab cultures from three deceased children tested positive for *Vibrio cholerae*.

e. **Water Culture:** *Vibrio cholerae* isolated from water samples collected at the site.

f. **Food Samples (Dal & Rice):** No pathogenic organisms were isolated from the cultured food samples.

4. **Gastric Aspirates Culture:** No pathogenic organisms were grown in gastric aspirate cultures from 4 cases.

5. **Rectal Swab Culture in Alkaline Peptone Water:** *Vibrio cholerae* was isolated from the rectal swab cultures of 10 cases.

6. **Serotyping:** Serotyping of positive culture samples could not be performed due to the unavailability of serotyping facilities.

7. One blood sample found positive for **malaria (*P. vivax*)**.

## DISCUSSION

In the current outbreak investigation, microbiological analysis of stool samples identified *Vibrio cholerae* as the causative agent. Similar investigations conducted in various regions of India over different periods have consistently found the same organism to be responsible for cholera.(10,11,12)

In the current study, the majority of suspected cases (72.34%, or 68 cases) were in the 10-19 years age group. This contrasts with a study by Goswami *et al.*, which reported that 57% of suspected cases were in the 0–10 years age group, based on a sample of 28 cases.(13) A comparable study done by Panda *et al.* also found that majority cases reported were below 18 years of age, while another study by Mahanta *et al.* reported that all cases ranged from 0 to 70 years.(14,15)The present study reported the male-to-female ratio of 1:1. This is consistent with the findings of Panda *et al.*, who reported a ratio of 1:1.214. Contrarily, Masthi *et al.* observed a higher male to female ratio of 1:1.55, while Goswami *et al.* found a more pronounced male dominance with a ratio of 1.8:1.(13)

The Global Positioning System (GPS) was utilized for mapping the affected study site in the present study. Similarly, Masthi *et al.* and Goswami *et al.* incorporated GPS in their investigations of cholera outbreaks, using it not only for mapping but also for tracking cases to monitor recovery and any complications. The current investigation discovered that none of the probable cases had traveled within the previous 15 days, which is in line with results from earlier studies.(16,13)

**Figure 6: Mapping of the affected study site**



In our study, 91 out of 94 cases were admitted to a government hospital where they received comprehensive treatment. Four fatalities were reported up to the survey date, including two deaths at school, one brought in dead, and one death at the government tertiary care hospital. In a study by Goswami *et al.*, all but one of the 28 suspected cases sought medical care at hospitals or clinics and received complete treatment, with no fatalities stated.(13) Similarly, a study by Masthi *et al.* found that 5 out of the 27 suspected cases received no medical treatment.(16)

During cholera outbreaks in India, contaminated water sources have often been found to be the main source of infection.(17,18) In present study, the presumptive coliform count indicated satisfactory results for all water samples, with isolation of *Vibrio cholerae* confirming faecal contamination of the borewell water source. Similarly, 8 out of 12 tap water samples collected from the affected area tested positive for faecal contamination with coliform bacteria, according to study by Bhunia *et al.*(19) The consistency across regional studies highlights a pressing need for robust sanitation practices, timely interventions, and standardized protocols in cholera outbreak management across India

## CONCLUSION

The cholera outbreak at an NGO Residential School for differently abled children and adolescents of urban Indore, M.P., India caused significant illness and death among a highly vulnerable population. Contaminated water and poor hygiene were identified as key factors for the outbreak. Immediate actions, including water treatment and hygiene education, helped control the outbreak. Periodic supervision by the concerned authorities was suggested to prevent future outbreaks.

### Interventions:

#### Immediate Control Measures:

- 1. Water Treatment:** Chlorination of the facility's water supply was initiated immediately after the outbreak was identified.
- 2. Hygiene Promotion:** Caregivers and children were educated on the importance of hand hygiene and proper sanitation practices.
- 3. Health Surveillance:** All residents and staff were placed under daily health surveillance for early detection of new cases.
- 4. Community awareness and health education** was also given by the investigation team on hygiene and sanitation in the adjoining areas.

## RECOMMENDATION

### Long-Term Recommendations:

- 1. Water Quality Monitoring:** Regular testing of the facility's water supply should be conducted to ensure that it remains free from contamination.
- 2. Infrastructure Improvements:** Upgrades to the facility's sanitation and living conditions are necessary to reduce the risk of future outbreaks.
- 3. Nutritional and Health Education:** Caregivers should receive ongoing training in hygiene and food safety practices.
- 4. Periodic supervision:** The concerned authorities were suggested to prevent future outbreaks.

**Further Research:** The impact of mixed parasitic infestations on the clinical outcomes of cholera cases warrants further investigation. Additionally, a detailed study into the effectiveness of long-term public health interventions at the facility could provide valuable insights for managing similar outbreaks in other institutional settings.

### Public health surveillance for cholera:

1. Early detection and reporting of suspected cholera cases through event-based systems, community-based surveillance, and healthcare facilities.
2. Prompt reporting of essential, standardized case-based information.
3. Systematic testing of individuals with suspected cholera routinely.
4. In-depth analysis and interpretation of surveillance data at local level.
5. Consistent communication of surveillance results to guide multisectoral initiatives.
6. Prompt national, regional, and international reporting. (20)

### Ending Cholera - Global Roadmap to 2030:

Targeted multisectoral actions may halt the spread of cholera and significantly decrease the number of cholera deaths. These include-

1. Effective community involvement
2. Improved water, sanitation, and hygiene (WASH) practices
3. Oral cholera vaccines use
4. Strengthening early warning systems, surveillance and laboratory capacities
5. Readiness of healthcare systems and supplies for prompt, effective care
6. Establishment of rapid response teams.( 21)

### LIMITATION OF THE STUDY

The investigation was limited to one specific location on a single outbreak event. Hence, the results of the study cannot be generalized.

### RELEVANCE OF THE STUDY

The study's detailed investigation of a cholera outbreak in Indore underscores the crucial need for hygiene education, water treatment, and continuous health monitoring in vulnerable settings.

### AUTHORS CONTRIBUTION

All authors have contributed equally.

### FINANCIAL SUPPORT AND SPONSORSHIP

Nil

### CONFLICT OF INTEREST

There are no conflicts of interest.

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### DECLARATION OF GENERATIVE AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

The authors haven't used any generative AI/AI assisted technologies in the writing process.

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