Original Article

An Outbreak Investigation of Acute Diarrheal Disease, Nagpur District, Maharashtra, India

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Abstract

Background: Acute diarrheal disease (ADD) accounts for 12 million cases and 1216 deaths annually in India. On July 13, 2016, an ADD outbreak was reported from Sawargaon village from Nagpur district, Maharashtra. **Objective:** The outbreak was investigated to describe the epidemiology and suggest control and preventive measures. **Methods:** A case was defined as a person experiencing at least one loose stool in Sawargaon village between July 9, 2016, and July 31, 2016. We searched for cases by enhanced passive surveillance. We collected stool samples for bacterial culture and tested water from multiple water sources for fecal coliforms. We also reviewed sanitary practices and rainfall data. **Results:** A total of 889 cases were identified, with 51% female, 280 hospitalizations (31%), and two deaths. The median age was 27 years (range 6 months to 90 years). Cases started on July 9, a week after heavy rains. District authorities started chlorination of water sources on July 13 and cases declined soon after. Two of nine stool samples tested positive for *Vibrio cholera* O1 serogroup. Of the 18 water samples collected, 16 (88%) samples from multiple sources, including wells, hand pumps, and taps, were positive for fecal coliforms. Of 1,885 households in the village, 450 (24%) households had no toilets and open defecation was commonly observed in the nearby river bed. **Conclusions:** This ADD outbreak was likely associated with drinking contaminated groundwater, which probably occurred after heavy rainfall in an area of open defecation. We recommended providing chlorinated drinking water, promoting safe sanitation practices, including building more public and private toilets, and enhancing diagnostic laboratory capacity.

Key words: Defecation, diarrhea, drinking water, *Vibrio cholerae* O1, water wells

Introduction

Diarrheal diseases, one of the leading causes of death in children <5 years, are both preventable and treatable. The World Health Organization (WHO) estimates that there are globally 1.7 billion cases of diarrhea every year.[1] Lack of clean drinking water and sanitary practices combined with poor hygiene are responsible for about 90% of deaths from diarrheal diseases, mostly in children.[2]

In India, acute diarrheal disease (ADD) accounts for 12 million illnesses and 1216 deaths annually.[3] There were 450 ADD outbreaks reported in 2015 to the Integrated Disease Surveillance Programme (IDSP), accounting for 26% of all outbreaks reported.[3] However, because of limited capacity at local levels, many of these outbreaks were not fully investigated.

In July 2016, an outbreak of ADD at Sawargaon village of Narkhed taluka, Nagpur District, Maharashtra, was reported to IDSP at the National Centre for Disease Control (NCDC). District Nagpur consists of 14 taluks with a population of 2,405,665. Sawargaon village, located 72 km from Nagpur City, has a population of 8795. NCDC joined the local investigation to describe the epidemiology of the outbreak and propose recommendations for control and prevention.

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Materials and Methods

Case finding

We defined a case as a person experiencing at least one loose stool in Sawargaon Primary Health Centre (PHC) catering area between July 9, 2016, and July 31, 2016. We searched for cases from the outpatient and inpatient department records of Sawargaon PHC and collected data regarding age, sex, and residence.

Human laboratory investigation

We collected stool samples from cases presenting with dehydration at Sawargaon PHC outpatient department on July 12, 2016, and sent them for stool culture in Cary-Blair transport medium to the Government Medical College and Regional Public Health Laboratory (RPHL), Nagpur. For confirmation, positive samples were transported to the enteric laboratory, NCDC, New Delhi, for biotype and antibiotic sensitivity profile.

Environmental investigation

We collected water samples from the village per convenient sampling on July 12, 2016, and sent to RPHL, Nagpur. RPHL performed microbiological testing of water using multiple-tube method for thermos-tolerant (fecal) coliforms. In addition, we observed and assessed the water treatment plant, public wells, overhead tanks, and the river bed in Sawargaon village. We also interviewed the village panchayat worker, also known as gram sevak and water treatment plant workers using semi-structured open-ended questionnaires regarding the water supply system in the village and techniques used for chlorination.

Analysis

We calculated measures of central tendency, proportions, and attack rates (ARs) using Epi Info version 7 software tool from US Centre for Disease Control and Prevention, Atlanta, Georgia, USA. An epidemic curve was also prepared.

Ethical considerations

The investigation was a public health response to an outbreak as part of the India Epidemic Intelligence Service Program, undertaken with the purpose to identify the source of contamination for immediate control of outbreak and intended for benefit of the community at large. Ethical approval is not applicable as part of public health response. The investigation did not involve any human laboratory sample collection for research purpose and there were no invasive investigations or medical interventions/experiments. All Government of India ethical principles and guidelines were adopted during the outbreak response: the investigation was aimed at achieving public good (beneficence) and collective welfare (solidarity); no harm was done to any individual (nonmaleficence); fair, honest, and transparent (accountability and transparency); and participants' data were de-identified prior to analysis (confidentiality).

Results

Descriptive epidemiology

We identified 1078 cases (51% females) that reported to Sawargaon PHC. The median age was 21 years (range: 1–80 years). Most cases (889, 82%) were from Sawargaon village. The AR in the village was 10% (889/8795). Mhasora village situated 7 km from Sawargaon had 58 cases with an AR of 4% (58/1637); all other villages had less than 20 cases each [Table 1].

The first case was reported to Sawargaon PHC on July 9, 2016. The maximum number (193, 22%) of cases was reported on July 13, 2016. Chlorine solution for drinking water was distributed within 24 h of outbreak detection to households for chlorination at the household level. The outbreak diminished soon after. Cases then decreased until the last case was reported on July 31, 2016 [Figure 1].

Among 1078 cases, 285 (27%) cases were treated as inpatients at PHC: the most commonly reported symptoms were watery stool (89%), followed by vomiting (26%), nausea (19%), abdominal pain (16%), bloody stool (12%), and fever (6%). There were two deaths (case fatality rate <1%) reported on July 12, 2016.

Human laboratory investigation

Of the nine stool samples tested, *Vibrio cholera* O1 serogroup was isolated and cultured in two stool specimens. Among the

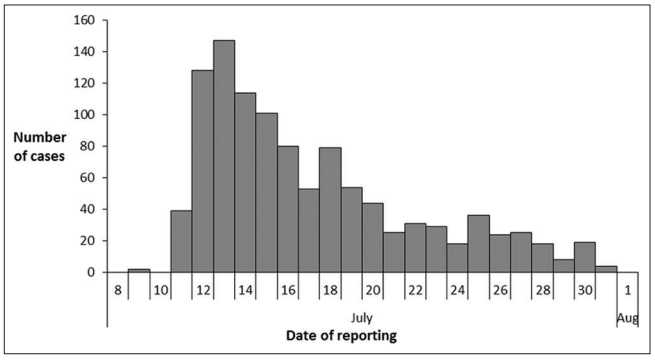

Figure 1: Acute diarrheal disease cases by date of reporting, Sawargaon Primary Health Center, Swargaon village, Nagpur district, Maharashtra, India, 2016 (n = 1078).

Table 1: Population, cases of acute diarrheal disease and attack rate, Sawargaon village, Nagpur district, Maharashtra, India, 2016 (n=1078)

Village	Population	Number of cases	Attack rate (%)
Sawargaon	8795	889	10
Ward 1	605	39	7
Ward 2	1385	82	6
Ward 3	1605	137	9
Ward 4	1630	191	12
Ward 5	1895	111	6
Ward 6	1850	63	3
Unspecified	NA	266	NA
Mhasora	1637	58	4
Malapur	784	19	2
Sindi	1642	18	1
Mannathkhedi	NA	15	-
Junona	502	11	2
Others	NA	68	-

NA: Not available

positive samples, one isolate was retested at NCDC. The tested isolate was confirmed positive for *V.cholera* O1 serogroup. In addition sample was found to be biotype El-tor and sensitive to azithromycin, ceftriaxone, cefixime, ciprofloxacin, doxycycline, norfloxacin, ofloxacin, tetracycline, meropenam and ofloxacin but resistant for cotrimoxazole.

Environmental investigation

Drinking water to Sawargaon village was supplied through three overhead tanks. The overhead water tanks received water from the Chikhali Dam reservoir or two public wells located in the village. As villagers had complained of muddy water supply from the Chikhali Dam, water supply was temporarily stopped on June 30, 2016. In the interim, villagers consumed shallow groundwater from two public wells, 40 private wells, and five hand pumps located in Sawargaon village. Continuous and heavy rainfall (184 mm) was reported from July 6, 2016, to July 12, 2016, at Sawargaon village.

Of 18 water samples collected, 16 (88%) were positive for fecal coliforms and were found unfit for drinking. These samples had been collected from five wells, five hand pumps, and six taps. Water samples from the two public wells located in Sawargaon village were negative for fecal coliforms, but these wells and water storage tanks had just been chlorinated by the district rapid response Team just before sampling. The gram sevak is normally responsible for chlorination of wells in the Sawargaon village but was not aware of the technique to chlorinate the wells.

Among 1885 households in Sawargaon, 450 (24%) lacked toilets. Open defecation practices were observed around public wells and the river bed located within the village area. Damage to the protective walls was noted in one of the two public wells. Leakage of supply pipes was noted at four places near one of the public wells in the Sawargaon village.

Discussion

This outbreak of ADD, possibly due to cholera, was likely due to consumption of contaminated drinking water from alternate sources during a break in the regular water supply. Contamination may have occurred because of open defecation practices in the area followed by heavy rainfall, leading to contamination of shallow water sources. Timely intervention within 24 h by district authorities ensured quick control of the outbreak.

Lack of safe drinking water availability is a major public health concern in India.[4] Ineffective water treatment at water sources and at the household level exposes residents to contaminated water and commonly leads to outbreaks. Similar results showing contamination of water sources due to open defecation practices have been shown in previous outbreaks.[5-7]

Open defecation practices are highly prevalent in India with 48% of its population practising open defecation as per the 2012 estimates.[8] The Government of India is in the process of building more public and private toilets in rural areas through the Rural India Clean Campaign also known as "Swatch Bharat Abhiyan –Gramin" and is promoting the use of toilets through publicity campaigns. Future evaluations are required to determine if this program has an impact on defecation practices in rural communities, and more importantly on health impact, such as with diarrheal diseases.

Although the large scale of the outbreak was consistent with a cholera outbreak, we could not conclusively determine this to be a cholera outbreak with only two positive stool samples. Cholera diagnostic kits and culture capacity were not available at the Sawargaon PHC. Similarly, community hospitals in other regions of India fail to timely detect cholera outbreaks due to lack of laboratory capacity. This influences the distribution and reporting pattern of cholera cases in the country[9] and likely leads to underestimation of the burden. There is a need to strengthen laboratory capacity at local levels in India; appropriate laboratory capacity is the key to improving surveillance and response in resource-challenged settings.[10]

There were limitations to our investigation. Our sensitive case definition may have yielded an increased number of false positives. We could not retrieve addresses of all patients from incomplete hospital records, and stool samples were not tested for other pathogens due to limited laboratory capacity; thus, other etiological agents could not be excluded.

Conclusions

Improved epidemiological and laboratory capacity in the future will lead to improved detection of, and response to, ADD outbreaks. To prevent similar outbreaks of waterborne diseases in future, provision of an adequate supply of potable water and improved sanitation and promotion of good hygienic practices should remain the mainstay for prevention efforts.

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Conflicts of interest

There are no conflicts of interest.

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