

An Epidemiological Investigation of Chemical Spill Related Illness at District Shamli, Uttar Pradesh, India

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Abstract

Background: On October 10, 2017, children from a school of Uttar Pradesh reported sudden onset of bitter taste and breathlessness. The objective of the present field investigation was to describe the epidemiology, public health response and provide recommendations to limit the impact of such future incidents. **Methods:** We defined a case as “a resident of Dayanand colony, Shamli district who reported to have experienced sudden onset of bitter taste or breathlessness between October 9 and 15, 2017”. House-to-house survey, environmental assessments, laboratory investigation, record review, and interviews with key informants were undertaken as part of this present investigation. **Results:** We identified 383 cases, out of which 60% were female and 74% were being school children. The attack rate was calculated to be 4% (383/10,399). Median age was 13 years (range 3-63). Symptoms included bitter taste (94%), breathlessness (61%), vomiting (49%); 70% sought medical care and 3% were hospitalized. Most cases (90%) had onset of illness on October 10, between 8-11 am. We observed whitish powder scattered in the dumping yard of sugar mill and on the adjacent road. **Discussion:** The acute onset of illness, predominantly among children, was likely associated with a chemical spill from the local sugar mill prior to disposal at the dumping yard. In response, the state government mandated the closure of the mill and restricted access to the adjoining road. We also recommend stringent enforcement of industrial chemical safety protocols to prevent similar incidents in future.

Keywords: Chemical exposure- Epidemiological investigation- Industrial chemical- School children

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Introduction

Acute chemical incidents are defined as “uncontrolled or illegal release or threatened release of hazardous substances lasting <72 hours with mass casualties or extraordinary levels of damage or disruption severely affecting the population, infrastructure, environment, and economy” [1]. Several such accidents have been previously reported from various parts of the world [2-5]. This type of incidents is not new for a rapidly developing country like India. National Disaster Management Authority of India has reported 130 chemical accidents, 563 injuries and 259 deaths from 2001-2010 [6]. Frequent chemical accidents in the past had catastrophic consequences and resulted in high mortality and morbidity across the country [7-9].

A related incident of a suspected Acute Chemical accident, was reported on October 11, 2017, at Shamli

district, Uttar Pradesh, India, by media. Children of a school in close vicinity of a sugar mill complained of sudden onset of bitter taste in mouth, breathlessness, eye irritation, abdominal pain and headache during the school assembly between 8:30-9:00 am on October 11, 2017 [10]. Around 200 people including school going children were affected in the incident. On October 12, 2017, World Health Organization Country Office (WHO-CO) India requested NFP IHR India; National Centre for Disease Control (NCDC) for verification of this event. A team of two Epidemic Intelligence Services (EIS) officers from NCDC reached Shamli on Oct 13, 2017 to assist the local public health authorities, Shamli and investigated the event. Overall aim of the response activity was to describe the epidemiological characteristics of the incident, to

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assess the public health and emergency response activities and to provide recommendations to limit the impact of future incidents.

Materials and Methods

Epidemiological assessment

We collected the map of the affected area from the local administration to have a brief overview of the geographic location. After preliminary assessment, locality of Dayanand Nagar was selected for this investigation as it was located near the suspected source, a sugar mill. There were around 10,399 residents and 1947 households in the locality, based on the data from the local Primary Health Centre. We planned a house-to-house survey for further investigation. An operational case definition was framed, and thus a “case” was defined as “a resident of Dayanand colony, Shamli district who reported to have experienced sudden onset of bitter taste or breathlessness between October 9 and 15, 2017”. We adapted the Assessment of chemical exposures (ACE) survey questionnaire [11] to collect socio demographic data, symptoms and suspected exposures data were also collected through house-to-house survey. We also reviewed the medical records at government hospital as well as private hospitals in Shamli district.

Environmental assessment

To characterize the location and extent of the chemical accident, we inspected area of 0.5 km radius surrounding the sugar mill which included waste dumping yard and the distillery plant of the sugar mill.

Laboratory investigations

The samples of sand and ash collected from dumping

yard and the road adjacent to it were sent for chemical testing.

Key informant interviews

To understand the dynamics of disaster preparedness and response, we conducted key informant interviews with school authorities, hospital representatives (including the Chief Medical Officer, District Surveillance Officer, and Director of the private hospital), the sugar mill manager, and the doctor from the sugar mill clinic.

Data analysis

Data were entered in MS Excel and duplicate entries were removed during data cleaning. We analyzed the data in Epi Info version-7 and expressed the results in proportions. The qualitative data from key informant interviews were summarized as a narrative.

Results

Descriptive epidemiology

We identified 383 cases with overall attack rate of 4% (383/10,399). Of all the cases, 60% (228/383) were females. The median age of cases was 13 years (range: 3-63 years); 55% (213/338) were in the age group of 11-20 years with 74% (284/383) being school children having middle school education 42% (119/228). The school specific attack rate was 18.3% (284/1550). Initial cases reported experiencing bitter taste and breathlessness on the evening of October 9, 2017 between 5-10 pm but most of them (73%) had illness onset on October 10, 2017 between 8-10 am. All the cases recovered from illness and no deaths were reported. Health seeking behavior, clinical symptoms and place of appearance are described in Table 1. One seventy-nine cases were seen in the

Table 1. Distribution of Cases Regarding Exposure, Symptoms and Health Seeking Behavior, District Shamli, Uttar Pradesh, Oct, 2017 (n=383)

Characteristics	Number of cases (383)	Proportion (%)
Clinical features	Bitter taste in mouth	362
	Breathlessness	236
	Irritation of eyes	92
	Abdominal pain	99
	Headache	108
	Vomiting	189
Place of appearance of symptoms	At school	171
	At home	81
	En route school	122
	En route home	9
	Yes	270
	No	97
Seeking medical care	Took self-medication	16
	District hospital, Shamli	179
	Private hospital	62
Place of seeking medical care (n=270)	Local traditional doctor	21
	Medical college	9

Table 2. Summary of Key Informant Interviews and Observations of Investigation Team Highlighting Institutional Preparedness and Response to the Chemical Spill Incident in Shamli District, Uttar Pradesh, India

Place of assessment	Category of people interviewed	Key information provided by the Interviewers	Key observations of the Investigation team
School	Principal and Teachers	· The school was established as an all-girls school in early nineties. · Majority of the school children reported symptoms like bitter taste in mouth, breathlessness, eye irritation on early morning after reaching school. · As a first aid, the teachers advised the children to wash their eyes and rinse their mouth. · Incident reported to district administration by the school authority · The students were shifted to nearby district hospital with the help of police and ambulances. · Majority of the school children were using the road adjacent to the dumping yard of the sugar mill for commuting to school. · The school was closed for 3 days following the incident.	· School has not participated in any chemical hazard mitigation measures like disaster mock drill conducted by the district authorities in the recent past. · The first responders did not use any special personal protective equipment. · There was no emergency evacuation plan displayed in the school, · There was no first aid unit available at school. · Emergency contact numbers were available but were not displayed. · After the incident, the district authorities sealed the road adjacent to the sugar mill dumping yard for 14 days and a boundary wall was built around the dumping yard.
District Hospital	Chief Medical Officer, Doctors, Paramedics	· All the area hospitals were informed about the accident with an advisory to attend and handle victims of chemical spill · Doctors, paramedics were mobilized from peripheral health centers to district hospital. · No decontamination was done. · The most common presenting symptoms were bitter taste in mouth and breathlessness. · Cases were immediately given symptomatic treatment, oxygen and emergency care and kept under observation. · The treating physicians decided that there was no requirement of further investigations for milder cases. · Nine cases were referred to tertiary Healthcare Centre and the rest were discharged. · The health personnel both from government and private sector informed that they have not been part of any capacity building exercise related to chemical emergencies during last one year. Therefore, they were also not aware of SOPs for handling chemical emergencies. · According to the district surveillance officer, capacity building on prevention and management of chemical emergencies should be included in the trainings conducted for the rapid response team of the district.	· There were 20 beds in the district hospital wards with 4 beds in Emergency Department. · The district hospital did not have a contingency plan to deal with emergencies, and health personnel were not aware of any hazard mapping for chemicals carried out for the area. · Due to shortage of space and manpower in district hospital, three medical officers, two pharmacists, two health workers were mobilized from nearby primary health centers to meet the surge in demand. · A case list was posted in the emergency department, but hospital staff did not communicate risks to reassure concerned parents.
Sugar Mill	Operational Manager, Medical Officer	· Factory compliant with Factories act 1948. · Factory had a fully equipped medical clinic and a trained doctor to deal with emergencies. · The distillery plant has been abandoned by the mill since June 2017. · Chemical disposal handled by untrained staff. Clinic lacked awareness of chemicals and had no protocol for neutralization. Medical officer untrained in chemical emergencies and clinic lacked emergency drugs	· The staff who disposed of the chemical in the dumping yard was not acquainted with the procedure. · The medical clinic at sugar mill was not equipped with emergency drugs required to deal with chemical accidents. · The doctor posted in the medical clinic was not aware of the hazardous chemicals being handled by sugar mill, poison reference centre or the chemical neutralization protocol. · The doctor was also not trained to handle medical management of any chemical emergencies.

Emergency Department (ED) of district hospital and were discharged on the day of the incident. The median duration of hospital stay was two hours with a range from 25 minutes to approximately 10 hours. The cases admitted to the private hospitals were also discharged on the same day. Nine cases were admitted in the medical college for detailed evaluation and cases with similar complaints were not reported to the hospital after 12th October, 2017.

Environmental assessment

The suspected chemical spill occurred in the sugar mill's dumping yard and on the adjacent road which was frequently used by the school children. The dumping yard lacked boundary walls, and whitish crystalline material was observed both within the yard and along the road (Figure 1). The deposits were irregular in shape, hard in consistency, and emitted a pungent, irritating odor, with sizes ranging from 0.5 to 2 feet in diameter. The school was situated 800 meters from the mill and 400 meters from the dumping yard.

Laboratory investigation

The Uttar Pradesh Pollution Control Board Pollution collected ash and sand samples from the sugar mill's dumping yard and adjacent road, which were sent to the Central Chemical Testing Laboratory. Analysis confirmed the presence of Denatonium Saccharide.

Key informant interviews

The summary of the interviews and key observation by the investigation team are described in Table 2.

Discussion

Laboratory investigation confirmed the accident was due to Denatonium Saccharide, which is among the most bitter (threshold of 0.01 ppm) known compound and is used in sugar mill distilleries to denature ethanol. It is typically colorless and odorless, traded as a solution. Acute exposure can cause oropharyngeal irritation, respiratory distress, conjunctival and dermal irritation, and

gastrointestinal discomfort. No long-term health effects have been documented [12]. Although there are no studies reported on Acute toxicity of Denatonium Saccharide, experimental studies have conclusively depicted high aversiveness and deterrent action of the chemical under various concentrations, indicating the potential of acute toxicity effects in high concentrations [13]. However, there are case reports of a similar chemical Denatonium benzoate resulting in aggravating the Asthma symptoms as a result of acute exposure to it through inhalation [14]. Similar to Denatonium, there could be numerous potentially hazardous chemicals which are being used in various industries whose acute toxic incidents are rarely reported.

The sugar mill was established in 1932, is now surrounded by residential areas and a school due to urban expansion. Following the incident, the open dumping yard was enclosed and the road to the school sealed as part of the public health response and our recommendation. However, proper "land use planning" is critical to prevent hazardous facilities from being located near populated or sensitive areas. As per the Factories Act of 1948, industrial waste must be treated and disposed of safely [15]. Denatonium saccharide, which requires landfill disposal, was improperly discarded and inadequately neutralized, leading to this incident.

As we found high morbidity of Acute respiratory attack among school children, capacity building among school children, teachers, and school personnel on preparedness for natural and manmade disasters are also endorsed. We also observed the public health care facilities are burdened with unmanageable patient load and the doctors at the district hospital as well as in the medical clinic of the factory reported to be unaware about the chemicals being used in the vicinity of their hospital which could lead to accidents. In India, there are several examples in past that point towards the inability of system to handle such emergencies. During Bhopal gas tragedy in 1984, weak infrastructure and nonexistence of mass casualty emergency response system was reported. The IHR (2005) and the Disaster Risk Reduction emphasize on all hazard approach i.e. to build capacity for preparedness and response to all hazards including biological, chemical, radio nuclear (CBRN) [16, 17].

We also explored that no risk communication efforts were targeted at the community residing around the sugar mill regarding chemical accidents. According to a report of the New York's Attorney General's office on preventing crisis due to toxic chemical accidents, the population of an area should be made aware about the potential chemical accidents that can happen in their vicinity [18]. Capacity building, risk categorization, hazard mapping, regular risk communication campaigns, and community awareness on various hazards to the local context are highly recommended to prevent such accidents in future.

The present investigation had some limitations. As we began the investigation three days after the incident, recall bias with respect to the time onset of illness may have affected the results. We could not assess the duration of exposure of the cases and were unable to ascertain

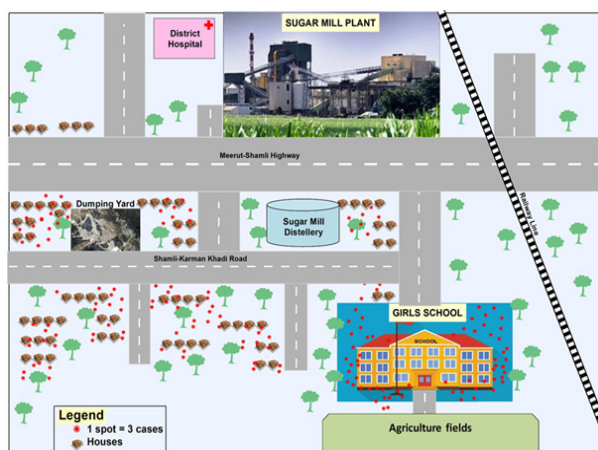


Figure 1. Distribution of Chemical Spill Affected Cases by Area, District Shamli, Uttar Pradesh, Oct, 2017 (n=383)

a dose response relationship. We could not collect any blood samples from the affected school children. Due to paucity of time, few representatives were interviewed from hospital and school. Our study provides a most likely hypothesis that Denatonium Saccharide as the cause of this incident, however conducting Case control study additionally would have confirmed it.

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