

## A Series Case Reports of Four Accidental Sewer Gas Poisoning

Pandit J.N.\*, Chandran V.\*\*, Dhaka S.\*\*, Millo T.\*\*\*

**Authors Affiliation:** \*Junior Resident \*\*Senior Resident \*\*\*Professor, Department of Forensic Medicine and Toxicology, All India Institute of Medical Sciences, New Delhi 110029, India.

**Reprints Requests:** Millo Tabin, Professor, Faculty Incharge: Forensic Toxicology and DNA Lab, Department of Forensic Medicine and Toxicology, All India Institute of Medical Sciences, New Delhi 110029, India.

E-mail: [tabinmillo2003@rediffmail.com](mailto:tabinmillo2003@rediffmail.com)

Received on 09.11.2018, Accepted on 03.12.2018

### Abstract

Sewer gas ( $H_2S$ ) is a toxic gas generally produced naturally by decaying organic matter. Death in sewer gas poisoning is due to respiratory arrest. Acute exposure of Hydrogen sulphide causes cytochrome oxidase enzyme inhibition causing disruption of oxidative metabolism and affecting nervous system and cardiac tissue immediately. It affects almost all system like, CNS, respiratory, cardiovascular, renal, gastrointestinal, dermal and ocular system. The powerful effect of hydrogen sulphide over olfactory inhibition makes the people unaware to its characteristic rotten egg odour. Rarely hydrogen sulphide poisoning occurs by intention but most of the case is accidental. Hydrogen sulphide is highly toxic and flammable gas, and, because of heavier than air it is accumulated at the bottom of poorly ventilated and closed space. In India it is observed that most of the sewer cleaning is done manually and the workers are not aware to its harmful effect because of lack of knowledge, so they unfortunately comes under its silent dangerous effect. There are standards and guidelines for exposure of hydrogen sulphide at work place; if it is followed and proper safety measures are taken then incidence will be reduced. Here we are reporting a series of four cases of accidental sewer gas poisoning, the autopsy of which were done in our mortuary, AIIMS, New Delhi.

**Keyword:** Sewer Gas; Hydrogen Sulphide; Flammable Gas etc.

### Introduction

Hydrogen sulphide is a major constituent of sewer gas, along with this it also contains carbon mono-oxide and methane. Death in sewer gas poisoning is mainly due to  $H_2S$  which cause asphyxia as a result of respiratory paralysis.  $H_2S$  is a colourless, flammable, heavier than air, moderately water soluble and highly toxic gas. It has a characteristic "rotten egg" odour and sweat in test [1,2,3]. However, odour is not a reliable indicator of presence of hydrogen sulphide and may not give adequate alarm of hazardous concentration because of its powerful effect over olfactory inhibition [2,4].

Hydrogen sulphide occurs naturally in the environment in sewer and volcanic gas, coal pits, swamps, marshes and in several industries, it is

generated as a by-product of organic decomposition by anaerobic bacteria like sulphate reducing bacteria (such as salmonella), but the gut enzymes exist in the body capable of detoxifying it by oxidation to harmless sulphate [1,3,5].

OSHA (Occupational Safety and Health Administration) recorded 13 work-related asphyxiation deaths, mostly death occurs accidentally but a case report in Japan reported 17 autopsy case of fatal hydrogen sulphide poisoning due to inhalation of intentionally generated hydrogen sulphide gas. This may be generated by mixing sulphur based bath powder or pesticides and acidic detergents [2,6,7]. In India most of the sewer cleaning is done manually by entering inside the sewage and the workers are not aware to its harmful effect because of lack of knowledge so they unfortunately comes under its silent dangerous effect.

### Case Report One A

As per inquest by the police of Lajpat Nagar police station, New Delhi, on 07/08/2017 morning, there were four persons carrying out the cleaning work of the sewer line who were directed by the contractor to clean 25 sewer holes from Jal Sadan to Ring Road, near Jal Vihar, Lajpat Nagar, New Delhi. On 06/08/2017 at about 10:30 am they were involved in the cleaning job without proper safety dress, equipments like mask, cylinder etc. because the safety gadgets were costly and they were not available with the contractor. After cleaning 3 to 4 holes in front of MCD Office Jal Vihar Road, three of them went to clean the next hole at opposite to Sant Kabir Ram Mandir, Lajpat Nagar at around 12:00 pm and the fourth person went for another work.

After 10 minutes the three became unconscious and fell down inside the sewer hole while cleaning the lid of the hole. When this incidence came in knowledge of fourth one, he tried to go inside the holes for taking out his co-workers but he got some uneasiness and came out. The police came immediately and removed the workers with the help of Fire Brigade team and brought him to AIIMS Hospital, New Delhi as early as possible, where they were declared brought dead at 3:19 pm to 3:25 pm. All three deceased were brought to AIIMS mortuary for preservation in cold chamber (4°C) till conducting autopsy on next day.

On examination, the first case was 24 year old male having average built wearing wet cloths with mud stained. "Rotten egg" smell was coming out from the body. Nail beds were bluish in colour, post-mortem hypostasis was present over back and dependent parts of body except pressure areas in supine position and was fixed, rigor mortis were well developed all over the body including distal interphalangeal joint of fingers and toes. The cornea and conjunctiva were clear.

The teeth, gums and lips including mucosa were intact. There were multiple reddish brown colour abrasions noted over body at places. The pleural cavity, diaphragm, peritoneal cavity, inner abdominal walls and urinary bladder and all internal organs were intact and present in its normal anatomical position. Trachea was congested, and bilateral lungs were congested, oedematous and having multiple ecchymosis over their surface of lower lobes. All other visceral organ and brain were congested. Stomach contains about 100 ml of greenish colour fluid and having congested mucosa.



Fig. 1: Sewage hole



Fig. 2: Cyanosis of finger nails

### Case Report One B

The second case was a 33 years old male having same built as first, wearing mud stained cloths. No any smell was detected over body. Post mortem hypostasis, rigor mortis, nail beds, eye, lips, teeth, gums, cavities and visceral organ finding were same as the first case. No any external ante mortem injury was noted over body. The lungs were congested and oedematous along with Petechiae present over the surface. About 50 ml greenish colour fluid was present in stomach and mucosa of stomach was congested.



Fig. 1: Congestion of stomach mucosa

### Case Report One C

Third case was a 27 years old male also having average built wearing mud stained cloths and musty odour coming from the body. Rigor mortis and hypostasis as well as other external findings were as first case. Multiple old healed transverse scar marks were present over anterior aspect of left forearm. There was no external ante mortem injury found over body. Internal organ were congested and lungs were oedematous having Petechiae diffusely over the lung surfaces. Stomach contains 100 ml of greenish colour fluid with congested mucosa.

In all three cases viscera were preserved, along with blood sample in EDTA vial preserved under liquid paraffin to detect presence of sewer gases ( $H_2S$ , methane, ethane,  $CO_2$  etc.)



Fig. 1: Petechial haemorrhage in lung pleura

### Case Report Two

A request made by police from Neb Sarai police station with a history of deceased falling down in to septic tank while cleaning of same on 18/02/18 at about 11:30 am, and then he was taken to AIIMS casualty, New Delhi where he was declared brought dead on 4:35 pm on same day. Then he was brought to AIIMS Mortuary for autopsy at 5:25 pm but body was preserved for next day in cold chamber. On next day autopsy was done. On external examination the cloths of deceased was smeared with some blackish brown material. The rigor mortis was established and retained; Post mortem lividity was present over back and was fixed. Cornea was hazy and conjunctiva was congested, nail beds were bluish in colour. Teeth,

gums, frenulum and lips including mucosa were intact. No any external ante mortem injury was present over body. Internal examination shows congested brain, lungs and all other visceral organs along with the mucosa of stomach. The stomach contains about 30 ml mucoïd fluid. The heart was normal in size and their walls, valves and chambers were intact, the coronaries were patent. The cavities, diaphragm and urinary bladder were intact. Cause of death in this case was given as death due to asphyxia due to suffocation consequent upon inhalation of sewage gas. However viscera along with blood sample in EDTA vial under liquid paraffin were preserved to rule out any concomitant poisoning and detection of presence of sewer gas.

### Toxicological Analysis

Toxicological analysis of viscera of case one A, B and C showed the evidence of presence of Hydrogen sulphide and ethyl alcohol (having blood concentration of 24.4 mg, 6.8 mg and 14.4 mg per 100 ml of blood respectively).

Causes of death in all first three cases were given as death due to hydrogen sulphide poisoning due to sewer gas exposure. The cause of death in the fourth case was given however viscera and blood sample reports were still waiting.

### Discussion

Sewer gas is a generic name of mixture of gases and airborne agents that often accompany sewage and the natural processes and reactions associated with sewage processing and the decomposition of organic materials. The major compositions of sewer gas include: hydrogen sulphide ( $H_2S$ ), carbon dioxide ( $CO_2$ ), methane ( $CH_4$ ), ammonia ( $NH_3$ ), biological organisms, water vapour, and other chemicals. The presence and concentration of any of these components can vary with time, composition of the sewage, temperature and Ph [8].

The major adverse health effects and hazards from exposure to sewer gases are due to poisoning from  $H_2S$ , Asphyxiation from displaced or consumed oxygen. Decreased vigilance or fatigue due to reduced oxygen levels (from  $CO_2$  and  $CH_4$ ). Hydrogen sulphide is highly toxic and flammable gas, and, because of heavier than air it is accumulated at the bottom of poorly ventilated and closed space. Despite of its bad (characteristic "rotten egg") odour it is not easily detected by

workers because of its inhibitory action on olfactory nerve ending at high concentration and people become faint without any aware [9]. The odour threshold (0.5 ppb) is much lower than the OSHA (Occupational Safety and Health Administration) permissible limit of ceiling (20 ppm). The standards and guidelines for exposure of hydrogen sulphide at work place are as follows, OSHA ceiling is 20ppm, OSHA maximum peak is 50 ppm (10 minute, once during an 8 hour shift, no other exposure), and NIOSH IDLH (National Institute of Occupational Safety and Health Immediately Dangerous to Life or Health) is 100 ppm [4]. The route of exposure may be inhalational, through surface contact (skin/eye) or ingestion. Hydrogen sulphide is quickly absorbed through lungs and gastrointestinal tracts. The elimination of this poison is through the lungs and faeces, and their metabolites are passes through urine as thiosulfate.

On acute exposure, H<sub>2</sub>S causes inhibition of the cytochrome oxidase enzyme system causing lack of oxygen in the cell which leads to anaerobic metabolism and accumulation of lactic acid which further causes acid-base imbalance. It also affects CNS, Respiratory, Cardiovascular, Renal, Gastrointestinal, Dermal and ocular system. CNS symptoms are immediate and lead to loss of consciousness, inhibition of respiratory centre, seizure depression and death. It is a mucous membrane and respiratory tract irritant which may lead to breathlessness, cough, pulmonary oedema and bronchial or lung haemorrhage.

### Safety Precautions

Education of the workers regarding the potential lethal effects of the job they are involved and the early symptoms of accidental poisoning will be helpful to avoid these types of mishaps.

*Proper safety measures should be taken at work place.*

1. The manholes should be opened and ventilated at least one hour before entering the workers inside, and the area around the workplace, if it is at road side, should be cordoned off with railing and warning signal should be put to avoid RTA.
2. Before entering, the presence of toxic gases should be tested by wet lead acetate paper test (colour changes from white to grey to black depending upon concentration of Hydrogen sulphide).

3. Pressure of oxygen should be measured by lowering detector lamp. If there is less or no oxygen, personnel should go with oxygen kit.
4. The personnel should tie safety belt with rope with two men standing outside the hole to pull out in emergency.
5. Air blower should be available at the site of working place to flow fresh air.

Besides these safety measure we can use Vacuumed system to minimise the accident, which works on the basis of differential pressure between atmosphere and vacuum creating negative pressure in machine which propels the sewage towards the vacuum station. It is cost effective, require single source power, operator and environment friendly as the operator never comes in contact with sewage. So confined space would not be an issue, and the system is entirely closed and air proof.

*Relevant laws in India dealing with sewage cleaning [10,11].* In India, an act was passed called: The prohibition of employment as manual scavengers and their rehabilitation act 2013. As per this act the "Hazardous cleaning" by an employee, in relation to a sewer or septic tank, means its manual cleaning by such employee without the employer fulfilling his obligations to provide protective gear and other cleaning devices and ensuring observance of safety precautions, as may be prescribed or provided in any other law, for the time being in force or rule made there under. The "insanitary latrine" means a latrine which require human excreta to be cleaned or otherwise handled manually, either in situ, or in an open drain or pit into which the excreta is discharged or flushed out, before the excreta fully decomposes in such manner as may be prescribed. The "sanitary latrine" means a latrine which is not an 'insanitary latrine'. A "septic tank" means a water-tight settling tank or chamber, normally located underground, which is used to receive and hold human excreta, allowing it to decompose through bacterial activity. The "Sewer" means an underground conduit or pipe for carrying off human excreta, besides other waste matter and drainage wastes.

This act prohibits the employment of manual scavengers or manual cleaning of sewers and septic tanks without protective equipment.

As per the rules issued after the act came into force, 40 items are prescribed as protective gear for sewer workers such as airline breathing apparatus, Artificial respiration/reticulate,

Blower, Breath mask, Emergency medical oxygen resuscitator kit, First Aid box, gas monitor, Hand gloves, Helmet, Life guard pad, Safety body clothing, safety goggles etc. and a specialised unit.

The act prescribes the first aid measures to be available in the work place. The following first aid facility should be provided and maintained, so as to be easily accessible during working hours. There should be not less than one first-aid box for 150 employees [1].

*For less than 50 workers, each first aid box should contain:*

- a. 6 small, 3 medium and 3 large size sterilised dressings,
- b. 3 large sterilised burn dressings,
- c. 30 ml (1 bottle) 2% alcohol solution iodine,
- d. 30 ml of salvolatile labelled with dose and mode of administration,
- e. 1 snakebite lancet,
- f. 30 gm (bottle) of potassium permanganate crystals,
- g. One pair scissor,
- h. 100 tablets of Aspirin (5 gm),
- i. Ointment for burn,
- j. A bottle of suitable surgical antiseptic solution
- k. A copy of the first aid leaflet issued by Director General, Factory advice service, and Labour Institute Government of India [2].

For more than 50 workers, the number of dresses should be doubled and amount of 2% alcohol solution, iodine and salvolatile should be 60 ml along with one roll of adhesive plaster. Other materials are as above. The first-aid box should be distinctly marked with a Red cross on white back ground.

The law enforcement authorities should be able to define this hazardous work atmosphere present in most of the cities in India. Need of strict implementation of rules and protocols are needed. The compliance from the part of contractors must be evaluated. This act also has guide line for "Prohibition of insanitary latrine and employment and engagement as manual scavenger" (sec. 5), "Contract agreement" (sec.6), "Prohibition of persons from engagement and employment for hazardous cleaning of sewer and septic tanks" (sec. 7) in Chapter III of the act. If any contravention has occurred of section 5 or 6, the culprit is

punishable with an imprisonment for a term which may be extended to one year or with fine which may be extended to fifty thousand rupees or with both for first contravention, and for subsequent offence it will be two years or one lakh rupees or with both. For violation of section 7 it will be two years or two lakh rupees or with both for first offence and five years or five lakh rupees or both for second offence respectively.

The death due to sewer gas poisoning at work may also be charged under U/S 304/177/218/417/468/471 of IPC.

The limitation of prosecution is "No court shall take cognizance of any offence punishable under this act except upon a complaint thereof is made by a person in this behalf within three months from the date of the occurrence of the alleged commission of the offence.

As per chapter VI of this act, these offences should be tried by Executive Magistrate, and is a cognizable and non-bailable offence.

#### **Manual Scavenging and Social Issues**

In India manual scavenging has existed since long. In recent survey it showed that it still exists in most of the states in India even after the passing of this act. As per the survey of the Govt. of Delhi Social welfare Department, it showed 32 manual scavengers in the city. These scavengers mainly belong to the lower castes of Hindu like Valmiki and muslims. The Delhi Govt. has taken initiatives to provide training to these workers in various skills for jobs and rehabilitate them.

#### **Role of Treating Doctor and Autopsy Surgeon**

Every case of mishaps due to sewage gas should be treated immediately in the emergency and a medicolegal report has to be prepared. It needs to be reported to the appropriate authority as it affects the public.

Proper history of the incidence from investigating officer, co-workers, relatives, eye witness and employer is essential. If possible visit the scene of occurrence by taking protective measures. During autopsy, observe the "rotten egg smell" from body (if possible) and note any injury over body. Conduct complete autopsy and look for signs of asphyxia externally and internally. Preserve the viscera and blood with preservatives to test for sewer gas poisons.

## Conclusion

Sewage gas poisoning deaths are not uncommon in India. It is generally seen in cities where manual scavengers are employed to clean the sewage pipe or holes or sewage treatment plant tanks. The deaths are generally accidental due to lack of knowledge about toxicity of sewage gas and not taking adequate scientific precautions in the work place. It is also due to lack of scientific safety equipments in the work place. The victims are generally poor labourers of lower caste, who are hired to do this job. The Government needs to make the society aware about the toxicity of sewage gas and also implement strict guidelines of safety measure and employ safety scientific scavenging equipments to be used, instead of manual scavengers.

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