

REVIEW ARTICLE

A Review on Arsenic Contamination in Ground Water: Its Occurrence and Health Effects

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ABSTRACT

Arsenic contamination of ground water used for human consumption has taken the dimension of epidemiological problem. Arsenic is extremely toxic; hence some remedial measures should be taken to create awareness among people. In this review article, its occurrence and health effects on human being have been discussed. Further studies are also required in this regard.

Key words: Arsenic contamination, health effects, prevention, water pollution.

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INTRODUCTION

A considerable part of the global population is exposed to arsenic-contaminated drinking water which is the main source of inorganic arsenic (As) exposure in humans [1-2]. Arsenic pollution in groundwater, used for drinking purposes, has been envisaged as a problem of global concern. It has been reported from many countries like Taiwan, China, Argentina, Mexico, Thailand, Myanmar, Nepal and USA but the severity of the contamination in India and Bangladesh is unprecedented [1]. It was first reported in West Bengal in 1983 [4, 5] and over the years, other states like Bihar, Jharkhand, Chhattisgarh, Uttar Pradesh, Assam and Manipur were also found to have been chronically exposed to Arsenic contaminated water from tube wells.

Arsenic (As) contamination is a major public health concern affecting a large number of people around the world. Its consequences have been reported as the world's biggest natural groundwater calamities. Arsenic is a naturally occurring element and the 20th most abundant in the earth's crust. It is a component of more than 245 minerals.

What is Arsenic?

Arsenic is an odourless & tasteless metalloid widely distributed in the earth's crust, which is brittle in nature and grey or tin white in colour. Arsenic is a ubiquitous element in the nature and widely distributed in the air, water, soils, rocks, plants and animals in variable concentrations. But it is usually found combined with one or more other elements such as Oxygen, Chlorine and Sulphur with the highest mineral concentration occurring as arsenides of Gold, Silver, Copper, Iron and Lead. Major Arsenic containing minerals are arsenopyrites (FeAsS), realgar (As₄S₄). Its position in periodic table is in the VA column. It has an atomic number of 33 and an atomic mass of 74.51. Its electronic configuration is 3d¹⁰s²p³ with three electrons in the outer shell. This configuration allows a wide variety of oxidation states -3, 0, +3 and +5. It is available in both organic and inorganic forms ⁶. Arsenite [As (III)] is most toxic form of arsenic and caused acute toxicity. Forms of As (III) & As (V) lead to chronic toxicity. It is insoluble in HCl and dil. H₂SO₄, but soluble in Conc. HNO₃. Arsenic is not an essential element for human body, although it is found in very small quantities in tissues. Elemental Arsenic is not absorbed in human body but their salts are readily absorbed through the food and water.

SOURCES OF ARSENIC CONTAMINATION

According to the officials from the ministry of water resources, river development and Ganga rejuvenation, the elevated level of arsenic in ground water is caused largely by natural process and partly due to anthropogenic activities, like application of fertilizers, burning coal, leaching from coal ash and

from mining. The most common sources of elevated Arsenic is a) weathering of arsenic bearing minerals and ores b) infiltration or runoff from locations of past mining activities.

HEALTH EFFECTS

Excessive arsenic taking causes various diseases. Symptoms of arsenic pollution in a body should be identified and measure for treatment should be taken. For prevention, first of all arsenic taking should be always below the danger level (0.05 mg/lit) and if required, arsenic free water should be supplied [7]. Adverse health effects of arsenic depend strongly on the dose and duration of exposure. Chronic exposure to arsenic leads to skin ailments, like keratosis and skin cancer, internal cancers such as that of lungs and bladder and disease of vascular systems. Other health problems such as diabetes, organ dysfunction and adverse reproductive outcomes have also been observed [8].

a) Effects on skin

Skin problem is the most common and initial sign of chronic Arsenic exposure. It may cause diffuse melanosis (hyperpigmentation), spotted melanosis (spotted pigmentation) non melanosis (depigmentataion) and leucomelanosis, in which white and black spots side by side present on the skin ⁹. Chronic exposure of Arsenic may cause Keratosis [10]. Depigmentation causes the increased risk of low grade basal cell carcinoma [11] and Bowen's disease. It is precancerous lesion and predisposed to an increased incidence of other malignant lesions ^{12, 13}. The long term ingestion of Arsenic leads to accumulate in keratin rich areas of body and appears as white lines in the fingernails and toenails, called Mee's lines [14].

b) Effects on respiratory system

The two usual routes of absorption of arsenic are by ingestion and/or inhalation. If the inhalation is the route of initial contact, then respiratory irritation will be a major determinant of early symptoms. Humans exposed to arsenic dust or fume inhalation are more opt to be encountered in mining and milling of ores, in industrial processing, such as smelting industry which often produces irritation of the mucous membrane, resulting in laryngitis, bronchitis, rhinitis, lesions of mucous membrane, irritation of nasal mucosa, and perforation of nasal septum [15]. However, once the arsenic is absorbed, the vascular circulation will ensue contact with a wide variety of potential symptoms reflecting the diversity of possible organ damages. A new study confirms that exposure to low to moderate amounts of arsenic in drinking water can impair lung function.

c) Effects on Cardiovascular System

Several studies suggested that chronic inhalation of arsenic trioxide can increase the risk of death in humans from cardiovascular disease [16, 17]. Long term inhalation of inorganic arsenic could injure the blood vessels or the heart. In several cases myocardial infarction and arterial thickening in children who consumed water containing about 0.6 mg/l arsenic has been reported [18].

d) Carcinogenic Effects

The most serious effects of prolonged exposure to arsenic in water are cancer. Arsenic exposure has been linked with cancer in the skin, lungs and kidney. The risk of cancer increases with the amount of arsenic that has been ingested, and also where drinking water has an arsenic contamination of 50µg/litre. Inhaling arsenic is a major risk factor for lung cancer, a significant risk increase was found for developing cancer at the level of 750 µg/m³ per year and above.

e) Arsenic induced diseases affecting eyes

It was discovered that exposed individuals suffered from watering, irritation and redness in the eyes. Few were reported conjunctivitis due to chronic arsenic ingestion [19]. Others symptoms due to arsenic exposure incorporated the pigmentation in the sclera, pinguecula, pterygium and conjunctival congestion [20].

f) Mental health problems

As health is defined by the World Health Organization as "a state of complete physical, mental and social wellbeing" [21], therefore the psychical and social dimensions have a large impact on individual's mental health. Some studies have shown that mental health problems (e.g. depression) are more common among the people affected by arsenic contamination [22].

Treatment for Arsenic poisoning

Recent studies have shown that the toxicity of arsenic is dependent on the exposure amount, length and frequency. The best way to treat is to eliminate arsenic exposure. Vitamin E and Selenium supplements have been used to limit the effects of arsenic exposure. It is thought that these substances cancel each other. Still more human studies are needed to support Vitamin E and Selenium as viable treatment methods.

CONCLUSION

At present the most promising possibility seems to be the extraction of water from the Arsenic free deep aquifer, which would offer an effective and speedy solution. It is therefore an urgent need to make arrangements for the availability of safe water source among the arsenic affected people. Measures should be taken to reduce arsenic exposure in the general population in order to minimise the risk of adverse health effects with drinking of arsenic free water. Awareness generation programme and motivation of the people for testing their drinking water sources for arsenic are also important to prevent further exposure of arsenic to the people.

Arsenic and other heavy metal testing facilities should be available at an affordable cost.

REFERENCES

1. Rihmer Z, Hal M, Kapitany B, Gonda X, Vargha M, Dome P (2015). Preliminary investigation of the possible association between arsenic levels in drinking water and suicide mortality. *J Affect Disord* 182:23-5.
2. Stefania Milione IM, Gianmarco T, Paola M, Veronica A, Nicola N, Mauro B (2016) Drugs and psychoactive substances in the Tiber River. *Aust. J Forensic Sci.*
3. IARC, World Health Organization (2004), Some drinking water disinfectants and contaminants, including Arsenic, IARC monograph on the evaluation of Carcinogenic risks to humans. 84:271-441.
4. Garai R, Chakraborti A K, Dey S B, Saha KC (1984). Chronic arsenic poisoning from tubewell water. *J Indian Med Assoc*; 82: 34-5.
5. Chakraborti D, Rahman MM, Paul K, Chowdhury UK, Sengupta MK, Lord D et al. (2002) Arsenic calamity in the Indian subcontinent. What lessons have been learned? *Talanta*; 58: 3-22.
6. Rashid, M R & Mridha, M A K (1998). Arsenic contamination in ground water in Bangladesh, 24th WEDC conference on sanitation and water for all, Islamabad, Pakistan.
7. Sk. Rezaul Hoque (2013). Arsenic Pollution in Rural West Bengal – Exploring Some Challenges. *IOSR Journal of Environmental Science, Toxicology And Food Technology (IOSR-JESTFT)* e-ISSN: 2319-2402, p- ISSN: 2319-2399. Volume 2, Issue 6 (Jan. - Feb. 2013), PP 13-17.
8. National Research Council (1999). Arsenic in drinking water. Washington, DC: National Academy Press, 330 pp.
9. Guha Mazumdar, D.N., A.K. Chakraborti and A. Ghose (1988). Chronic arsenic toxicity from drinking tubewell water in rural West Bengal. *Bull. World Hlth. Organ.*, 66, 499-506.
10. Mazumdar, D.N., J. Das-Gupta and A. Santra (1998). Chronic arsenic toxicity in West Bengal - the worse calamity in the world. *J. Indian Med. Assoc.*, 96, 4-7, 18.
11. Abernathy, C.O., Y.P. Liu and D. Longfellow (1999). Arsenic: Health effects, mechanisms of actions and research issues. *Environ. Hlth. Perspect.*, 107, 593-597.
12. Graham, J.H. and E.B. Helwig (1959). Bowen's disease and its relationship to systemic cancer. *Arch. Dermatol.*, 80, 133.
13. Graham, J.H. and E.B. Helwig (1966). Cutaneous pre-malignant lesions. In *Advance in Biology of Skin. Vol. VII - Carcinogenesis.* Oxford and New York, Pergamon Press. pp. 277-327.
14. Fincher, R.M. and R.M. Koerker (1987). Long term survival in acute arsenic encephalopathy. Follow-up using newer measures of electro physiologic parameters. *Am. J. Med.*, 82, 549-552.
15. Hine, C.H., S.S. Pinto and K.W. Nelson (1977). Medical problems associated with arsenic exposure. *J. Occup. Med.*, 19, 391-396.
16. Wall, S. (1980). Survival and mortality pattern among Swedish smelter workers. *Int. J. Epidemiol.* 9, pp 73-87.
17. Axelson, O., Dahlgren, E., Jansson, C. D., and Rehnlund, S. O. (1978). Arsenic exposure and mortality. A Case reference study from a Swedish copper smelter. *Br. J. Ind. Med.* 35, pp 8-15.
18. Zaldivar, R. (1974). Arsenic contamination of drinking water and foodstuffs causing endemic chronic arsenic poisoning. *Beitr. Pathol.* 151, pp 384-400.
19. Baidya K, Raj A Mondal L, Bhanduri G, Todani A (2006) Persistent conjunctivitis associated with drinking arsenic contaminated water. *J Ocul Pharmacol Therw* 22:208-211.
20. Tantry B A, Shrivastava D, Taher I, Tantry MN (2015) Arsenic Exposure: Mechanisms of action and related health effects. *J Environ Anal Toxicol* 5:537.
21. WHO (2001). Arsenic and Arsenic compounds. International programme on chemical safety; World Health Organization: Geneva, Switzerland.
22. Brinkel J, Khan MH, Kraemer A (2009). A systematic review of arsenic exposure and its social and mental health effects with special reference to Bangladesh. *Int J Environ Res Public Health* 6(5):1609-19.

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