Geogenic Arsenic Contamination of Drinking Water and

Its Reproductive Health Related Complications

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# Abstract

Heavy metals and their salts are a vital nutrient for the nourishment of human body when taken in appropriate amount. However, they may pose a serious threat and add to the environmental pollution. Heavy metals accumulation in body to extreme levels has been documented as detrimental to human health. They have serious reproductive health related complications in both males and females. Here, arsenic has proven to be one of the toxic heavy metal that has the ability to affect reproductive health in both pregnant and non-pregnant women. Increased arsenic concentration in drinking water due to geogenic contamination can cause implications for fetus as well as mother. Such environmental concerns deter the overall public health outcomes. Water regulatory bodies have been implementing policies for providing safe and clean drinking water. This paper will discuss the effects of arsenic on human reproductive health and efforts to address the issue in terms of policy making and the efforts being made to curb it.

# Introduction

Heavy metals contain extreme high levels of highly concentrated metals that can prove to be toxic even in small concentrations. The most important and well-studied heavy metals with adverse effects on human reproductive health are arsenic, copper, lead and mercury. These metals primarily affect the fetus and the female reproductive system. The main reason for these complications is that these metals are directly accumulated in the fetal tissue via the transportation passage of placenta which is unable to filter these metals. Thus, an affected mother with arsenic toxicity can transfer these metals to her unborn child. Other implications of arsenic toxicity is infertility and imbalanced hormonal system (Neeti & Prakash, 2013).

The toxic effects from heavy metal infiltration in the drinking water cause brain fogging, chronic malaise, fatigue, illness, severe pain in muscles and tendons, chronic and gastrointestinal infections, allergies, depression, anxiety, visual and neurological problems and post menstrual stress and other hormonal disturbances (Neeti & Prakash, 2013).

Arsenic is a natural compound that is not toxic in its properties but increased levels of inorganic arsenic concentration in drinking water has been stated as a serious public health issue in many countries around the globe especially in the regions where people rely on the groundwater (Shih et al., 2017). According to World Health Organization recommendations, the maximum amount that can be ingested through drinking water is 0.01mg/L which is 10 parts per billion. Arsenic enters into the body via the routes of ingestion, inhalation or absorption. However, the primary route of entry of arsenic metalloids in the human body is through food and drinking water (Rahman et al., 2018). When this element enters inside the body, it promptly distributes in all the body organs but is mainly absorbed in intestines and stomach and the rest is released in the bloodstream.

Nevertheless, the symptoms of arsenic toxicity in the body are extremely vague and can easily be confused with chronic disorders like depression, autism, chronic fatigue syndrome etc. thus, it is of greater concern that pregnant women must look after themselves and understand the effect of arsenic toxicity. The medical examiners should also conduct important diagnostics and related therapies.

# Historical Context

Arsenic poisoning at chronic level converts the element into lesser toxic components by the liver and then they are excreted via urine. However, the higher levels of toxic arsenic concentration in body can lead into excessive accumulation into the body and ultimately can cause arsenicosis. In its early stages, it is difficult to diagnose its symptoms as they are highly non-specific in nature (Rahman et al., 2018). The extreme antagonistic effects of arsenic poisoning are dependent on the period of exposure and the dietary stuff of the population exposed to it. The chronic arsenic exposure due to drinking water causes multiple health related issues including cardiovascular, respiratory, reproductory, obstetric and neurological issues (Lennon, Whelton, O’Mullane, & Ekstrand, 2004). However, the main effects of arsenic poisoning are the complicated pregnancy outcomes. The risks of women expecting pregnancies had significant mortality rate due to cancer and the root cause was arsenic poisoning in tap water. The following table shows the data collected by National Academy of Sciences from 1999.

**Table: Arsenic concentration in tap water and its association with cancer risk among pregnant women**

|  |  |
| --- | --- |
| **Arsenic Concentration in Tap Water (parts per billion)** | **Approximate Cancer Risk Among pregnant women  (assuming 2 liters consumed/day)** |
| 0.5 ppb | 1 per 10,000 |
| 1 ppb | 1 per 5,000 |
| 5 ppb | 1 per 1,000 |
| 10 ppb | 1 per 500 |
| 50 ppb | 1 per 100 |

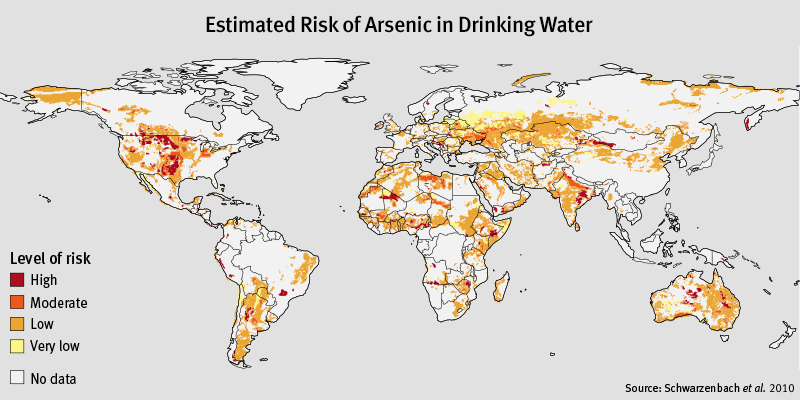


Figure 1: Estimated Risk of Arsenic in Drinking Water Globally (Schwarzenbach et al., 2010).

Several studies have conducted the assessment of the concentration of arsenic in drinking water and its adversarial effects on pregnant women. The main risks that women face due to chronic arsenic exposure are unplanned abortions, stillbirths and preterm births. Children born to women who have been exposed to arsenic toxicity while their pregnancy have a significantly higher incidence rate of congenital malformations (Sankhla, Kumari, Nandan, Kumar, & Agrawal, 2016). Their average weight at the time of birth is also less than normal babies. Several literature studies have proposed after conducting studies on the women who had been working in the semiconductor industries. Their industrial wastes have large concentrations of arsine which have led to cause an increased number of miscarriages. There is also a strong association between neonatal death and exposure to arsenic just like it is in case of other adverse pregnancy outcomes (Amitai & Koren, 2018).

The prolonged exposure to arsenic from drinking water can be detrimental and cause to increase the risk of both fetal as well as infant deaths among pregnant women. These children can also suffer from developmental disability and mental retardation in new born babies (Maji, Pal, & Pal, 2007). Furthermore, it was also reported that the men working in arsenic-contaminated community, especially those that work in a smelter or live in close vicinity of the area had a much lower sperm count. They also suffered from a change in sperm head, affects the sperm motility, semen value as well as the production of luteinizing hormones (Milton et al., 2005).

Metals like arsenic can have a deleterious impact on fetus as a result of direct deposition of metals into the fetus. Thus, if the mother continues to have a proper diet, she can certainly save her child from abnormalities. Additionally, it also reduces pregnancy related complications among the newly born adults. By proper diet, a mother can save her child which are most probably caused by inhalation or ingestion of these metals. If consumption of heavy metals is prohibited, we can save lives of mother and her child by avoiding complications in pregnancy and abnormalities of newly borne infants.

# Current Policies and Role of Regulatory Bodies

In United States, the federal law that includes Safe Drinking Water Act (SDWA) guarantees the best quality of Americans' drinking water. In the supervision of SDWA, EPA has set specific standards for maintaining quality of drinking and overseeing the states, regulatory bodies, and water suppliers that are involved in implementing those standards. It identifies the contaminants in the drinking water and regulates them in an effort to protect public health and wellbeing. The agency aims to set regulatory limits with regard to the amount of contaminants being consumed by the public water systems (Kallis & Butler, 2001).

A National Primary Drinking Water Regulations has been established by the EPA for legally enforcing the standards that are applicable to the public water systems at present. The prime purpose of these standards is to ensure that the quality of water is maintained to a standard and protected by keeping the number of contaminants that can adversely impact public health standards and frequently occur in water bodies. Additionally, EPA has also put into place the National Secondary Drinking Water Regulations (NSDWRs), that operates as the non-mandatory standard testing water quality against 15 different contaminants (EPA, 2002). These guidelines have been put into place to support the public water system in an effort to manage drinking water for aesthetic contemplations. These considerations included a debate on the taste, the odor, and the color of the contaminant at hand and can be considered a threat to the general public health.

The exposure to arsenic from drinking water has greatly reduced in the fresh water bodies through the regulations imposed by the EPA. These regulations have led to an almost 17% decline in the level of urinary arsenic and has provided us with an estimated 200 cases of lung and bladder cancer annually. However, the levels of arsenic in private wells used by individuals did not change in any respect. This shows that at the end of the day, it is important that the role played by regulations be brought to the forefront and how this could result in protecting human health by reducing any form of exposure. Considering that arsenic is a carcinogen, these measures are rather important (The Lancet, 2017).

# Comparison of Current Policies

According to EPA, every single water body contains these contaminants to some extent. If these contaminants are present in any water body, the water appears cloudy, colored and even smells and tastes weird. While EPA has been key to improving the system as a whole at present, in 1972, the federal government in United States ratified the modern arrangement of the Federal Water Pollution Control Act. About three decades later, the European Union implemented the directive 2000/60/EC of the European Parliament and of the Council inaugurating a charter for the Community actions in water policies, which is famous as EU Water Framework Directive (WFD) (Kaika, 2003). This present framework replaced the earlier practices and replaced the former and much inadequate policies that concentrated on protecting the various drinking water sources.

The laws of both EU WFD and Clean Water Act (CWA) seek to enhance the water management strategies and the condition of waterbodies but they have three differences in their laws. The WFD is much more inclusive in its methodology for water management as compared to CWA. CWA considers the federalism system of United States worthy and leaves several branches of water regulation up to respective states. Moreover, both laws have different focal of regulations. The CWA seeks to reduce the surface water pollution that comes from various sources while WFD concentrates on improving the general status of waterbodies. Furthermore, CWA laws are comparatively easier to enforce (Kallis & Butler, 2001).

The water framework directive of EU is much comprehensive in contrast to CWA’s water management system and governmental activities. It includes the distribution of surface and ground water and reduction laws, control of surface and ground water pollution, preservation of aquatic habitat, development of waterbodies and demolition of wetlands and mangroves. Many countries divide the different aspects of managing the water bodies among several organizations and public regulatory bodies. This distribution of authorities sometimes results in hampering the development of extensive and general water policies with distinctive priorities regarding to a specific water resource (Kaika, 2003).

US legislations on water management divide the water allocation which is governed by state laws from the water quality laws that are implemented by CWA. Thus, CWA unequivocally stresses twice on the management process, once at the initial stages and then once at the end and it is does not interfere in the water allocation matters of the state and water rights.

The applications of CWA on the groundwater contamination are much more tenuous as compared to WFD. CWA implements directly on the navigable waters that include two federal agencies for implementing the Act, US Environmental Protection Agency (USEPA) and US Army Corps of Engineers (USACE) that only address the issues of surface water. Industrial, commercial or household activities that contaminate the ground water do not generally violate the Act though current litigation has shed light on the issue and led it to the US Courts of Appeals. It addressed the matter of CWA implementation on facilities when they discharge contaminants in to the groundwater which is hydrologically connected with the sources of surface water.

However, both WFD and CWA laws provide additional protective measures to the coastal waters. In the preamble of WFD, it has been noted the certain susceptibilities of coastal waters and seas and though its primary goal is to look over the concern of pollution in freshwaters and removing the hazardous contaminants, it also focuses on the marine waters and its concentrations of naturally occurring substances. Thus, CWA is applied on both ocean waters to implement special criteria for ocean discharge activities as well as efforts to regulate the facilities that discharge contaminants in coastal waters.

# Recommended Policy

In a number of developed countries, such as the United States, the average volume of arsenic in drinking water is 22.3 μg/l. These reported levels are drastically higher in ratio and can become one of the primary reasons for ischemic stroke and related hospitalization (Lisabeth et al., 2010). A huge number of individuals exposed to these high concentrations of arsenic globally make this issue a public health consequence, especially with regard to drinking water.

The emerging international data in the field establishes that the chronic arsenic exposure to arsenic at any level below 10 μg/l found in drinking water can prove to be harmful for health. The studies carried out on the subject have shown an increase in the risk associated with these increased levels of arsenic in drinking water, which in turn has increased the risk associated with coronary heart disease as well as stroke in the country. Thus, the country must commit to improving the translation of scientific research and turn the data collected and the recommendations made into those policies in an effort to strengthen the conversation among the policy-makers and scientific community as a whole. Together, both segments are essential for the policy making process.

Despite considerable advances in the field, both locally and otherwise, the scientific evidence obtained in terms of chronic arsenic exposure has not been translated into policy. Therefore, it is vital that policy makers are made aware of the present data available, so they devise a good program in order to deal with the issue at hand. One such means is to look into the abundance of private wells in the country and estimate the levels of arsenic in those wells and compare it to the level of arsenic that can be found in public wells. This provides the masses with a source for cleaner water while the government works towards reducing the level of arsenic in the water system (Greco, Belova, Haskell, & Backer, n.d.).

# Conclusion

At the end of the day, USA is in dire need of better risk communication, as well as public education. Here, the various mistaken perceptions with regard to the belief that the situation is not as grave as the science behind it makes it out to be, shows that the population still has enough to demand for better quality of water or accept personal risks in efforts to reduce the amount of arsenic in water. The authorities can do a lot to increase the public awareness in an effort to not only reduce institutional barriers that limit the public access to information while also making an effort to improve scientific knowledge in the area by supporting information. For instance, the government has to go through a long, unnecessary and tiresome process when someone seeks any access to information.

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