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ADVERSE EFFECT OF ARSENIC ON HEALTH: A SYSTEMATIC REVIEW

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ABSTRACT

Recently heavy metal pollution becomes a severe problem whole over the world, and these toxic metals enter into the environment either by natural phenomena or due to extensive industrialization. The discharged effluents containing toxic heavy metals mixed with soil or water and change their natural composition. These heavy metals have adverse effects on living beings and cause damage to the vital body organs of animals as well as humans. The heavy metal pollution also inhibits the biodegradation of the chlorinated organic compounds by interacting with metabolizing enzymes and inhibits their functioning. Earlier studies described that heavy metals cannot be fully removed from the environment, but they can be effectively neutralized or transformed into less toxic form so that their harmful effect on the environment can be reduced. The distinctive enzymatic apparatus within microbial system plays a major role in the transformation of heavy metals in the environment. A considerable advancement has been made during recent years to transform the heavy metals by utilizing the bioremediation potential of genetically engineered microorganisms. In the present review article, the detailed description of the adverse effects of arsenic and its adverse effect on our environment and human beings is discussed. Furthermore, the use of micro-organisms, organisms for the bioremediation of arsenic from the environment is also discussed along with detailed bioremediation mechanism.

Keywords: *Adverse - Effect - Arsenic – Health.*

1. Introduction: Arsenic is a naturally occurring element that is widely distributed in the Earth's crust. It is found in water, air, food, and soil. There are two general forms of arsenic: Organic and Inorganic. Sci-

entists, pediatricians, and public health advocates are increasingly concerned about the more subtle and long-range health effects of low-level exposures to humans, especially for infants and children exposed to arsenic in water and some foods, such as rice-based products, during sensitive windows of development. Arsenic is found just about everywhere. It can leach into groundwater through rocks and soil, and is used in pesticides, wood preservatives, and tobacco. It is also released into the environment by volcanoes and mining processes. Arsenic in groundwater is a widespread problem. Arsenic levels tend to be higher in drinking water that comes from ground sources, such as wells, than from water from surface sources, such as lakes or reservoirs. Most arsenic gets into the body through ingestion of food or water. Arsenic in drinking water is a problem in many countries around the world, including Bangladesh, Chile, China, Vietnam, Taiwan, India, and the United States. Arsenic may also be found in foods, including rice and some fish, where it is present due to uptake from soil and water. It can also enter the body by breathing dust containing arsenic, or through the skin, though this is not a major route of exposure. Arsenic affects a broad range of organs and systems including: Skin, Nervous system, Respiratory system, Cardiovascular system, Liver, kidney, bladder and prostate, Immune system, Endocrine system and Developmental processes. Arsenic contamination of groundwater is a pressing health issue throughout the world. For example, elevated arsenic concentrations pose a threat to over 40 million people in Bangladesh and eastern India alone, particular those living in Bangladesh. Meanwhile in the US, a recent study revealed that 20 of 37 principal aquifers contained arsenic concentrations above the maximum contaminant level of 10 $\mu g\ L^{-1}$, affecting approximately 2.1 million. Arsenic can occur in a range of redox states (-3, 0, +3, and +5), with mobile arsenite (As^{3+}) and arsenate (As^{5+}) the most common in groundwater systems. In this context, arsenite is more soluble and affected by sorption than arsenate and presents a greater risk for human consumption. The mobility of arsenic in these aquifer systems is at least partly mediated by microbial metabolism, via both direct and indirect mechanisms. Bacteria from diverse phylogenetic lineages feature resistance mechanisms that reduce and transport arsenic, such as the one encoded by the *ars* operon, where *arsB* is a membrane bound efflux pump and *arsC* is a cytoplasmic arsenate reductas. Alternatively, a narrower phylogenetic distribution of microorganisms can participate in dissimilatory arsenic reduction via the *arr* system, utilizing arsenate as a terminal electron acceptor and converting it to arsenite. Bacteria can also immobilize arsenic using arsenite oxidation mechanisms, such as the anaerobic (*arx*) and aerobic (*aio*) oxidase systems. Arsenic is further affected by the biogeochemical cycles of other inorganic groundwater constituents. The reductive dissolution of iron oxides through either direct microbial activity or indirect biogenic sulfide production can lead to release of adsorbed arsenic species. Although some previous studies have suggested that microbial sulfate reduction could immobilize arsenic through co-precipitation of sulfide-arsenic-iron species, other research has indicated increased arsenic mobilization associated with the formation of thioarsenic species that are more soluble and less likely to adsorb to iron minerals.

2. **Methodology:** Review done on more than 100 papers which were published in the pubmed from 2000. On the basis of key factors related to level of arsenic and human health a gist was produced to show the adverse effect of arsenic on human health.

3. **Discussion:** Oral exposure to As is associated with gastrointestinal symptoms including cramps, nausea, vomiting, and diarrhea and with cardiovascular and respiratory symptoms such as hypotension, shock, pulmonary edema, and heart failure. In acute As poisoning, death is usually due to cardiovascu-

lar collapse and hypovolemic shock. The fatal human dose for ingested As trioxide is 70–300 mg. After the ingestion of a lethal dose, death occurs after 12–24 h. Acute As exposure also includes neurological symptoms such as light-headedness, delirium, encephalopathy, muscle weakness or cramping, and peripheral neuropathy. Peripheral neuropathy occurs as symmetrical sensory-motor polyneuropathy one or more weeks after the initial toxic exposure, which usually shows axonal degeneration but sometimes shows demyelinating polyradiculoneuropathy-like Guillain–Barré syndrome. Unfortunately, As contamination in groundwater is now a common phenomenon being reported from various countries, including Bangladesh, India, Myanmar, Argentina, Chile, China, Hungary, Mexico, Nepal, Taiwan, the United States, and others. At least 140 million people from 50 countries are exposed to As through low-dose As-contaminated groundwater at levels above 10 ppb. Several studies have shown that As exposure induces peripheral neuropathy or neuritis. The type of neuropathy caused by such extremely long exposure to low As concentrations in water has gradually become clear over the last decade. For neurological impairments, it has been suggested that mild peripheral neuropathy may occur by drinking As-contaminated water at the level of 10 ppb. On the other hand, there is no study showing that CNS impairments occur due to drinking As-contaminated groundwater in adults except the DPAA exposure of the Kamisu city incident. In a study in Cambodia, neurobehavioral function was found to be affected in the group of children that consumed more than 50 ppb of As-contaminated drinking water compared to those in the normal control groups. The long-term prognosis for the above impairments is unknown. There are no conclusions as to whether the intake of low concentration As-contaminated drinking water adversely affects the brain of children. An epidemiological study indicated that CNS impairments such as cognitive or intellectual deficits were associated with As exposure in children. However, a study in West Bengal showed no association between long-term As exposure in water and intellectual functions in children. To discuss the effect of As exposure on children, we will contrast a few differences between adults and children. First, exposure durations in children are shorter than those in adults. If toxic effects are cumulative, adults would be affected more severely than children. Second, children may have a higher As methylation capacity than adults, resulting in more efficient detoxification and a lower incidence of neuropathy. In fact, in the case of the Wakayama curry-poisoning cases, the majority of the children were in the process of recovery approximately 1 week to 10 days after the high dose As-contaminated curry intake, whereas the poisoning symptoms in adults were exacerbated. Third, compared with adults, children have an immature defense system of the blood–brain–barrier against toxic substances. Therefore, CNS damage due to As may occur easily in children. Therefore, when determining the reference value of drinking water, it is necessary to carefully consider whether the value for children is the same as that for adults.

4. **Conclusion:** Arsenic-contaminated drinking water has long been a global problem, especially in South Asia. The emerging symptoms are often nonspecific and the diagnoses require a different public health approach than the conventional clinical approach. To determine whether health problems in certain people caused by As, a multifaceted approach is needed, including not only clinicians but also specialists from multiple fields.

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