World Health Organization

Arsenic

15 February 2018

Key facts

- **Arsenic is naturally present at high levels in the groundwater of a number of countries.**
- **Arsenic is highly toxic in its inorganic form.**
- **Contaminated water used for drinking, food preparation and irrigation of food crops poses the greatest threat to public health from arsenic.**
- **Long-term exposure to arsenic from drinking-water and food can cause cancer and skin lesions. It has also been associated with cardiovascular disease and diabetes. In utero and early childhood exposure has been linked to negative impacts on cognitive development and increased deaths in young adults.**
- **The most important action in affected communities is the prevention of further exposure to arsenic by provision of a safe water supply.**

Sources of exposure

Arsenic is a natural component of the earth's crust and is widely distributed throughout the environment in the air, water and land. It is highly toxic in its inorganic form.

People are exposed to elevated levels of inorganic arsenic through drinking contaminated water, using contaminated water in food preparation and irrigation of food crops, industrial processes, eating contaminated food and smoking tobacco.

Long-term exposure to inorganic arsenic, mainly through drinking-water and food, can lead to chronic arsenic poisoning. Skin lesions and skin cancer are the most characteristic effects.

Drinking-water and food

The greatest threat to public health from arsenic originates from contaminated groundwater. Inorganic arsenic is naturally present at high levels in the groundwater of a number of countries, including Argentina, Bangladesh, Chile, China, India, Mexico, and the United States of America. Drinking-water, crops irrigated with contaminated water and food prepared with contaminated water are the sources of exposure.

Fish, shellfish, meat, poultry, dairy products and cereals can also be dietary sources of arsenic, although exposure from these foods is generally much lower compared to exposure through contaminated groundwater. In seafood, arsenic is mainly found in its less toxic organic form.

Industrial processes

Arsenic is used industrially as an alloying agent, as well as in the processing of glass, pigments, textiles, paper, metal adhesives, wood preservatives and ammunition. Arsenic is also used in the hide tanning process and, to a limited extent, in pesticides, feed additives and pharmaceuticals.

Tobacco

People who smoke tobacco can also be exposed to the natural inorganic arsenic content of tobacco because tobacco plants can take up arsenic naturally present in the soil. Also, in the past, the potential for elevated arsenic exposure was much greater when tobacco plants used to be treated with lead arsenate insecticide.

Health effects

Inorganic arsenic is a confirmed carcinogen and is the most significant chemical contaminant in drinking-water globally. Arsenic can also occur in an organic form. Inorganic arsenic compounds (such as those found in water) are highly toxic while organic arsenic compounds (such as those found in seafood) are less harmful to health.

Acute effects

The immediate symptoms of acute arsenic poisoning include vomiting, abdominal pain and diarrhoea. These are followed by numbness and tingling of the extremities, muscle cramping and death, in extreme cases.

Long-term effects

The first symptoms of long-term exposure to high levels of inorganic arsenic (for example, through drinking-water and food) are usually observed in the skin, and include pigmentation changes, skin lesions and hard patches on the palms and soles of the feet (hyperkeratosis). These occur after a minimum exposure of approximately five years and may be a precursor to skin cancer.

In addition to skin cancer, long-term exposure to arsenic may also cause cancers of the bladder and lungs. The International Agency for Research on Cancer (IARC) has classified arsenic and arsenic compounds as carcinogenic to humans, and has also stated that arsenic in drinking-water is carcinogenic to humans.

Other adverse health effects that may be associated with long-term ingestion of inorganic arsenic include developmental effects, diabetes, pulmonary disease, and cardiovascular disease. Arsenic-induced myocardial infarction, in particular, can be a significant cause of excess mortality. In China (Province of Taiwan), arsenic exposure has been linked to “Blackfoot disease”, which is a severe disease of blood vessels leading to gangrene. This disease has not been observed in other parts of the world however, and it is possible that malnutrition contributes to its development.

Arsenic is also associated with adverse pregnancy outcomes and infant mortality, with impacts on child health *(1)*, and exposure in utero and in early childhood has been linked to increases in mortality in young adults due to multiple cancers, lung disease, heart attacks, and kidney failure *(2)*. Numerous studies have demonstrated negative impacts of arsenic exposure on cognitive development, intelligence, and memory *(3)*.

Magnitude of the problem

Arsenic contamination of groundwater is widespread and there are a number of regions where arsenic contamination of drinking-water is significant. It is now recognized that at least 140 million people in 50 countries have been drinking water containing arsenic at levels above the WHO provisional guideline value of 10 µg/L *(4)*.

Arsenic in Bangladesh has attracted much attention since recognition in the 1990s of its wide occurrence in well-water in that country. Since this time, significant progress has since been made and the number of people exposed to arsenic exceeding the Bangladesh drinking-water quality standard has decreased by approximately 40%. Despite these efforts, it was estimated that in 2012 about 19 million and 39 million people in Bangladesh were still exposed to arsenic concentrations above the national standard of 50 µg/L and the WHO provisional guideline value of 10 µg/L respectively *(5)*. In a highly affected area of Bangladesh, 21.4% of all deaths in the area were attributed to arsenic levels above 10 µg/L in drinking-water *(6)*. A similar dose-response function has been found in other parts of Bangladesh, and these these results have been combined with national survey data to estimate an annual death toll of nearly 43 000 *(7)*. The US National Research Council has noted that as many as 1 in 100 additional cancer deaths could be expected from a lifetime exposure to drinking-water containing 50 µg/L *(8)*.

The symptoms and signs caused by long-term elevated exposure to inorganic arsenic differ between individuals, population groups and geographical areas. Thus, there is no universal definition of the disease caused by arsenic. This complicates the assessment of the burden on health of arsenic.

Similarly, there is no method to distinguish cases of cancer caused by arsenic from cancers induced by other factors. As a result, there is no reliable estimate of the magnitude of the problem worldwide.

In 2010, the Joint FAO/WHO Expert Committee on Food Additives (JECFA) re-evaluated the effects of arsenic on human health, taking new data into account. JECFA concluded that for certain regions of the world where concentrations of inorganic arsenic in drinking-water exceed 50–100 µg/L, there is some evidence of adverse effects. In other areas, where arsenic concentrations in water are elevated (10–50 µg/L), JECFA concluded that while there is a possibility of adverse effects, these would be at a low incidence that would be difficult to detect in epidemiological studies.

Prevention and control

The most important action in affected communities is the prevention of further exposure to arsenic by the provision of a safe water supply for drinking, food preparation and irrigation of food crops. There are a number of options to reduce levels of arsenic in drinking-water.

- **Substitute high-arsenic sources, such as groundwater, with low-arsenic, microbiologically safe sources such as rain water and treated surface water. Low-arsenic water can be used for drinking, cooking and irrigation purposes, whereas high-arsenic water can be used for other purposes such as bathing and washing clothes.**
- **Discriminate between high-arsenic and low-arsenic sources. For example, test water for arsenic levels and paint tube wells or hand pumps different colours. This can be an effective and low-cost means to rapidly reduce exposure to arsenic when accompanied by effective education.**
- **Blend low-arsenic water with higher-arsenic water to achieve an acceptable arsenic concentration level.**
- **Install arsenic removal systems – either centralized or domestic – and ensure the appropriate disposal of the removed arsenic. Technologies for arsenic removal include oxidation, coagulation-precipitation, absorption, ion exchange, and membrane techniques. There is an increasing number of effective and low-cost options for removing arsenic from small or household supplies, though there is still limited evidence about the extent to which such systems are used effectively over sustained periods of time.**

Long-term actions are also required to reduce occupational exposure from industrial processes.

Education and community engagement are key factors for ensuring successful interventions. There is a need for community members to understand the risks of high arsenic exposure and the sources of arsenic exposure, including the intake of arsenic by crops (e.g. rice) from irrigation water and the intake of arsenic into food from cooking water.

High-risk populations should also be monitored for early signs of arsenic poisoning – usually skin problems.

WHO response

Arsenic is one of WHO's 10 chemicals of major public health concern. WHO's work to reduce arsenic exposure includes setting guideline values, reviewing evidence, and providing risk management recommendations. WHO publishes a guideline value for arsenic in its *Guidelines for drinking-water quality*. The Guidelines are intended for use as the basis for regulation and standard setting worldwide.

The current recommended limit of arsenic in drinking-water is 10 µg/L, although this guideline value is designated as provisional because of practical difficulties in removing arsenic from drinking-water. Every effort should therefore be made to keep concentrations as low as reasonably possible and below the guideline value when resources are available.

However, millions of people around the world are exposed to arsenic at concentrations much higher than the guideline value (100 µg/L or greater), and therefore the public health priority should be to reduce exposure for these people. Where it is difficult to achieve the guideline value, Member States may set higher limits or interim values as part of an overall strategy to progressively reduce risks, while taking into account local circumstances, available resources, and risks from low arsenic sources that are contaminated microbiologically.

The WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene monitors progress towards global targets on drinking water. Under the new 2030 Agenda for Sustainable Development, the indicator of "safely managed drinking water services" calls for tracking the population accessing drinking water which is free of faecal contamination and priority chemical contaminants, including arsenic.

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