

Contamination of drinking-water by arsenic in Bangladesh: a public health emergency

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IN Bangladesh, arsenic contamination of water in tubewells was confirmed in 1993 in the Nawabganj district. Further testing was done in the following years; this included investigations by the Department of Occupational and Environmental Health of the National Institute of Preventive and Social Medicine. Results from various Laboratories were collated in a WHO country situation report in 1996. The institutions that provided results included the Jadavpur University in Calcutta, India, the Bangladesh Atomic Energy Commission, the Department of Public Health Engineering's laboratories in the Khulna and Rajshahi districts, and the National Institute of Preventive and Social Medicine in Dhaka. Altogether, 400 measurements were presented in the report, although contamination in some wells was measured by more than one laboratory. In about half of the measurements concentrations were above 50g/1, which is clearly in excess of the maximum level recommended by WHO of 10µg/1 and greater than the maximum level of 50µg/1 permitted in Bangladesh.

To raise awareness of the seriousness of the arsenic problem in West Bengal and to draw attention to the need for studies in Bangladesh, a conference was convened in 1995 by D Chakraborti and the School of Environmental Studies of Jadavpur University in Calcutta. In the years after the conference, the extent of the problem in Bangladesh has become clearer through additional surveys of the water and population, many of which were led by Chakraborti

A study conducted in the Rajarampur village of the Nawabganj district, by the National Institute of Preventive and Social Medicine and the School of Environmental Studies, found that 29% of the 294 tube-wells tested had arsenic concentrations greater than 50g/1. Between September 1996 and June 1997, a survey was jointly conducted by Dhaka Community Hospital and the School of Environmental Studies. An examination of 265 wells in Samta village in the Jessore district found that about 91% of the wells had arsenic concentrations higher than 50g/1 (13). In 1998, a British Geological Survey of 41 districts collected 2022 water samples 35% were found to have arsenic concentrations above 50g/1 (Table 1) and 8.4% were above 300g/1 was about 21 million. This number would be approximately doubled if WHO's standard of 10 g/1 were adopted. Further studies conducted by the School of Environmental Studies and the Dhaka Community Hospital found that 59% of the 7800 groundwater samples had arsenic concentrations greater than 50µg/1.

Surveys of the effects on the population's health have occurred concurrently with the previous studies of groundwater contamination. From December 1996 to January 1997, a three-week survey was conducted by the Dhaka Community Hospital and the School of Environmental Studies. The survey team visited 18 affected districts. Of the 1630 adults and children examined, 57.5% of them had skin lesions due to arsenic poisoning. In another study, approximately one-third of the 7364 patients examined had skin lesions due to arsenic.

The population of the 42 affected districts was 76.9 million. These studies do not imply that the entire population is drinking contaminated water. A recent report from



the World Bank has estimated that 20 million inhabitants of Bangladesh may be drinking arsenic-contaminated water.

The actual extent of the contamination and the number of people with skin diseases caused by arsenic might be many times higher than is currently estimated. For comparison, it has been estimated that in West Bengal the number of people exposed to arsenic is 1.5 million, and one estimate of the number of patients with arsenicosis exceeds 200 000. Since the estimate of those who may be drinking arsenic-contaminated water in Bangladesh is in the tens of millions, it is reasonable to expect the unless exposure ends the number of people with arsenicosis will eventually far exceed the number observed in West Bengal.

Although all wells and all villagers have not been systematically tested and examined, this should not delay action. The evidence that has accumulated since 1997 has only confirmed that this is a public health threat of great magnitude.

Long-term health effects of exposure

The health effects of ingesting arsenic-contaminated drinking-water appear slowly. For this reason, a more important issue than the number of patients who currently have arsenic-caused diseases is the number who will develop these diseases in the future as a result of past and continuing exposure to arsenic. Large numbers of tubewells were installed in Bangladesh approximately 5 to 20 years ago. If the population continues to drink arsenic-contaminated water, then a major increase in the number of cases of diseases caused by arsenic may be predicted.

Skin lesions

The latency for arsenic-caused skin lesions (i.e., the time from first exposure to manifestation of disease), in particular keratoses, is typically about 10 years. In the 1997 consultancy, it was found that the youngest individuals with skin lesions caused by arsenic were about 10 years old. Other studies have shown that skin lesions also occur in children younger than 10 years. It was also found that in adults, exposures commenced approximately 10 years before they stated the skin lesions began to appear. In some instances, the apparent latency for the appearance of skin lesions from the time of first exposure to contaminated water from the tubewell currently in use was much shorter, but as no measurements were available for water from previously used tubewells, a short latency from first exposure could not be inferred. However, latency that is shorter or longer than 10 years may occur, and the rapidity of the appearance of skin lesions appears to be dose dependent. Further studies of the latency and patterns of occurrence of skin lesions are needed and these will require careful interviewing of participants about their current and past exposures.

Cancer

Skin cancer. Small numbers of cases of skin cancer have started to appear. Since the typical latency is more than 20 years after the beginning of exposure, the fact that only a small number have been found provides little reassurance about the future incidence of skin cancer. A study of a large population in Taiwan found a clear dose-response relationship between arsenic concentrations in drinking-water and the prevalence of skin cancer. In this study, the average concentration of arsenic in water was about 500 µg/l, and by age 60 more than 1 in 10 had developed skin cancer.

The lifetime risk of developing skin cancer from the intake of 1 µg. kg body weight-1 day-1 (roughly equivalent to 1 litre per day at concentrations of 50 µg/l) of arsenic in water ranges from 1 per 1000 to 2 per 1000. Though large numbers of skin cancers have been reported in Taiwan, the future burden of arsenic-caused skin cancer in Bangladesh is uncertain. Differences in susceptibility between the populations of Taiwan and Bangladesh may exist that only time and further study will identify. However, as yet there is no evidence to indicate that the long-term risks of skin cancer would be any lower in Bangladesh than in Taiwan.

Mortality from internal cancers

In other countries, the main causes of death associated with chronic ingestion of arsenic in drinking-water are internal cancers; skin cancers are not usually fatal if treated appropriately. Dramatic increases in mortality from internal concerns have been reported in Taiwan and Chile. In Taiwan, populations exposed to high concentrations of arsenic in their drinking-water, containing an average of 800 µg/l of arsenic, had estimates of their relative risk of bladder cancer in the order of 30-60. In Region II of northern Chile, 5-10% of all deaths occurring among those over the age of 30 were attributable to arsenic caused internal cancers, in particular bladder cancer and lung cancer. Average exposures were in the order of 500 µg/l (0.5 mg/l) over 10-20 years; exposure decreased in subsequent years after remediation efforts were introduced. Long latency was apparent, and increase in mortality continued for 40 years after the highest exposures began

In Argentina, a mortality study in the arsenic-exposed region of Cordoba found increased risks of bladder and lung cancer among men and women from 1986 to 1991, although concentration were lower (average 178 µg/l) than in Taiwan and Chile.

Although specific estimates of the current and future health effects of arsenic exposure are uncertain, in the case of Bangladesh it can be inferred that since there are many people who currently have skin lesions caused by ingesting arsenic, many more cases will occur if exposure continues; based on what is known about the relationship between ingestion and the development of internal cancers, it is reasonable to expect marked increases in mortality from internal cancers once sufficient latency has been reached.

Treatment

The basic treatment is to supply the patient with drinking-water that is free from arsenic. This is the first priority. Indeed, in the absence of good evidence for the effectiveness of other treatments, the second priority is to continue providing arsenic-free water, and the third priority is to monitor patients to ensure that they remain unexposed to arsenic. Providing arsenic-free water reduces the risk of further complications and disease caused by arsenic. There are no well-designed studies to show whether cessation of exposure leads to improvement in skin keratoses. Thus far, anecdotal interviews of patients suggests that mild to moderate keratoses do improve with cessation of exposure.

Chelation.

Some physicians have been giving chelation therapy to arsenic patients in West Bengal and Bangladesh. The objective of chelation therapy is provide the patient with a chemical to which arsenic binds strongly, and is then excreted in urine. Providing such treatment could remove large stores of arsenic from the body in a matter of hours.

There are several problems with chelation therapy in cases of chronic arsenic exposure. The **first** is related to the observation that arsenic is excreted rapidly even without chelation therapy. Most of the readily available arsenic in the body will be excreted in the urine within 1 week. The question is whether chelation might remove arsenic which is, for example, bound in the skin and which might without chelation only be removed slowly. This is possible but exposure to arsenic generally occurs over many years, and chelation may make little difference to the cumulative dose of arsenic that patients have received. Thus, chelation therapy is unlikely to reduce the future risk of cancer. Whether it might improve keratoses more rapidly than simply stopping exposure is unknown. This idea has some plausibility but its effectiveness has not been established.

The **second problem** with chelation therapy is the lack of any clinical trials that found evidence of its effectiveness. When exposure to arsenic ceases, improvement in skin lesions might occur. Thus, if a patient improves after chelation therapy it could be due to the cessation of exposure alone or to both cessation and chelation therapy. (Finding that patients improve after chelation therapy does not provide evidence that the therapy) itself is effective.

The **third problem** with chelation therapy is that it is of no benefit if the patient continues to drink contaminated water after treatment, and it may give the false impression that effects can be treated despite continued exposure. Thus, chelation therapy should not be used routinely, although careful controlled studies of chelation therapy in patients with keratoses and other arsenic effects should perhaps be undertaken

Nutrition

Since evidence from Taiwan suggests that some nutritional factors may modify cancer risks associated with arsenic, it has been proposed that providing vitamins and improving nutrition may be of benefit to patients. In particular, vitamin A is known to be beneficial in the differentiation of various tissues, particularly the skin. If the doses given are not excessive, there are other nutritional benefits to providing vitamins, particularly in populations that may have inadequate levels of micronutrients. For these reasons, it is recommended that all patients with skin lesions be provided multivitamin tablets and that research projects be undertaken to establish whether or not they are effective for patients with arsenicosis

Other considerations

Advanced keratoses on the palms of the hands and soles of the feet are extremely debilitating, and **superimposed infections**, such as fungal infections, may cause serious problems. Providing moisturizing lotions and treatment for infections may be beneficial and should be part of routine care in advanced cases. These topics should be systematically studied. Arsenic is a probable contributor to causation of **diabetes**

mellitus. For this reason, urinary glucose should be tested in all patients with arsenicosis, and appropriate treatment and monitoring should be started if necessary. Patients' **blood pressure** should also be monitored since arsenic exposure may induce hypertension.

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