Arsenic Mitigation: A Costly Delay

The people will invent more methods and survival strategies, if we really want to survive and refuse vested business interests of many western companies offering inadequate and expensive technologies... We do not want millions of rural poor to end up with slow, painful

by Dr. Jamal Anwar

Green and yellow my paddy sways its shoots tenderly

It calls me every day as I stand by the roadside.

It stalks touching and kissing and parting in the breeze.

O Blind Cloud, You are my Brother!

Give a little more rain so that we may eat good rice.

SO sing the villagers of Vashan Char (Floating Island), Faridpur, a sandy-silty island which evolved from the river Padma (Ganges). The fertile soil gave the villagers enough to live with laughter and tears for hundreds of years.

The poor villagers face many natural disasters such as severe flood, drought, and cyclone. Nothing has disrupted their life. Now, a poison named arsenic threatens to displace them forever from their home where they have lived for thousands of years.

On November 30th, 2001 I visited Vashan Char, where villagers informed me of several patients with skin disease, which would not heal in spite of antibiotics and hospital visits. I heard that Md. Salauddin, a farmer, and Sulekha Begum, 18, were suffering seriously from skin disease. I visited them and found Salauddin covered in infected skin, very weak to do anything, lying in bed most of the time. First I tested the tube well that was sunk at a depth of 95 feet for arsenic, to find that this had astonishingly high arsenic concentration at 1.45 mg/I (145 times more than WHO Standard). All wells at this depth (also from the same depth water for irrigation is collected) contained very high arsenic. But surprisingly, at depth 60 feet, wells contained arsenic within the range of Bangladesh Standard (0.05 mg/I).

I could not find Sulekha at Faridpur Hospital. It was like a bazaar. Doctors, nurses could not give any information. On 9th December I came again to Faridpur and Philip a French journalist accompanied me. In the early morning we went to Vashan Char. When we saw Salauddin, he greeted us with a smile. He said, "Since I am not drinking water from this poisonous well, I am feeling better"It will take time before he can recover. Arsenic poisoning can be mitigated, if it is discovered at an early stage. There is no medicine against arsenic poisoning but healthy food can improve the immune system. I was surprised to see the front page headline of a popular daily newspaper "Prothom Alo" on 7th December, 2000 that the algae tablet cures arsenic poisoning. There is no scientific evidence of this but it may be of commercial interest. I found that arsenic patients who take green Haldi (turmeric) juice every day, have improved skin. Ayurvedand cheap traditional methods can help more than imported medicine. Vitamin tablets are expensive and show several negative effects compared to vegetables and herbs.

We went to look for Sulekha at the 232-Bed Faridpur Hospital. It was a shock to see the dirty hospital, patients lying everywhere on the floor, while relatives were busy bringing water, food, medicine from outside. Sulekha, an eighteen-year old newly married girl was in a coma. She used to be a healthy beautiful girl, full of life, but now she was almost a discoloured skeleton lying on the bed. The family said that she had the same skin problems as Salauddin. She was being given blood transfusions and the family were thinking that she would be cured. It seems that she has liver cirrhosis. I touched her hand though she could hardly move to. We were very shocked and I saw Philip was stunned. Sulekha was fighting for her very young life. She did not know that she was drinking poisonous water. The doctors did not even ask for water analysis. Is this the beginning of a tragedy of a nation that was never known before? Millions of rural poor do not have any idea they are waiting for the worst to come.

We found an old woman in the same hospital ward with skin lesions. She could hardly walk, she told us there were several people in her village who were also suffering from the same disease. Her husband died with the same symptoms that she has now. We rushed to the village Purbo Gangabarti, Tambul Thana. To our surprise we found that all the tube wells in this village contained arsenic nearly 1.5 mg/I (WHO Standard 0.01mg/1). An extremely deadly poisonous water!

Assuming 0.250 mg/litter as the mean content of arsenic, a person who consumes 1500 ml of this water each day for 10 years will consume about 6 gm of arsenic only from drinking water. It is reported in the literature that 3 to 25 grams of arsenic when consumed over 1 to 22 years produces hepatic damage in the form of cirrhosis and non-cirrhotic hypertension (Morris, et al., 1974). Considering the poor health situation of the majority of population in Bangladesh it is very likely dose-response effects will be more severe and devastating.

I could not find anything of any arsenic mitigation project of the World Bank/UNICEF/DEPHE/NGOs progrms for identifying wells, giving alternative choice. These projects have been presenting their agenda at international conferences and have informed us about their programmes, highlighted with boldly decorated words on the Internet. But the villagers who are suffering do not know anything about these people. If they bring water samples to DPHE for analysis, they are turned away because DPME says they do not have chemicals. Shahidul of Wireless Para, Faridpur said, "They give me the wrong results, I compared with Calcutta analysis. After drilling a new well at Wireless Para, they say this water is good but I found that

While water of many a tubewell has 0.50mg arsenic, this traditional well (Alipur, Faridpur) is just unaffected.

this water is as bad as the water from the well which made me sick"Arsenic contamination is known since 1993 in the country. Bangladesh, one of the poorest and most densely populated countries of the world, is beset by flood, tidal storm, famine and disease and now is confronting with the accidental poisoning of as many as 85 million of its 125 million people with arsenic contaminated drinking water (The Independent, UK, October 11, 2000). The scale of disaster in Bangladesh is beyond the accident in Bhopal and Chernobyl (WHO, 2000). The epidemic of arsenic related cancer has just begun. The arsenic mitigation programme financed by the World Bank/donors is hopelessly subject to inefficiency, bureaucracy, corruption, lack of capacity, lack of capabilities, lack of professionalism, etc (Hoorens and Koender, Deltf University, Netherlands, 1999). The Bangladesh Observer in an editorial writes on Dec 5, 2000, "Does Bangladesh have a future? Unless we can assure people of a regular supply of pure drinking water, out future as a nation is in doubt"So far no programme or aid has reached the people. Most money is spent in organising seminars, international experts and on counting tube wells on the basis of standard of 1942. On travelling to the remote villages of Bangladesh, you can hardly find green safe or red (unsafe) coloured tube wells. To carry out tests in some places, NGOs demand Tk 20-3 which many poor cannot afford. About 35 million dollars has been approved for arsenic mitigation based on an outdated 1940s standard. Now we hear they need more money, as the tube wells are more than they expected to find 5 million!

Health Hazard Information (US, EPA, 1998)

Acute Effects:

Acute (short-term) inorganic arsenic exposure, via inhalation, in humans, may result in gastronintestinal effects (nausea, diarrhoea, and abdominal pain), haemolysis, and central and peripheral nervous system disorders.

Acute oral exposure to inorganic arsenic, at doses of approximately 600 ug.kg/d or higher in humans has resulted in death. Oral expsoure to lower levels of inorganic arsenic has resulted in effects on the gastrointestinal tract (nausea, vomiting), central nervous system (CNS) (headaches, weakness, delirium), cardiovascular system (hypertension, shock), liver, kidney, and blood (anaemia, leucopoenia).

The major effects from acute arsine expsoure in humans include haemolytic anaemia, hemoglobinuria, and jaundice; these effects can lead to kidney failure.

Acute animal tests, such as the LD50 test in rats and mice, have shown inorganic arsenic to have moderate to high acute toxicity, while arsine has extreme acute toxicity.

Chronic Effects (Noncancer):

Chronic, inhalation exposure to inorganic arsenic in humans is associated with irritation of the skin and mucous membranes (dermatitis, conjunctivitis, pharyngitis, and rhinitis).

Chronic, oral exposure to inorganic arsenic in humans has resulted in gastrointestinal effects, anaemia, peripheral neuropathy, skin lesions, hyper pigmentation, gangrene of the extremities, vascular lesions, and liver or kidney damage.

No chronic inhalation expsoure studies have been performed in animals for any inorganic arsenic compound or for arsine.

Some studies have suggested that inorganic arsenic is an essential nutrient in goats, chicks, mini pigs, and rats. However, no comparable data are available for humans.

The RfD (Reference Dose) for inorganic arsenic is 0.0003 mg/kg/d based on hyper pigmentation, keratosis, and possible vascular complications in humans.

Reproductive /Developmental Effects:

Several studies suggest that women who work in, or live near, metal smelters may have higher and exposure to other chemicals in addition to arsine.

Inorganic arsenic can cross the placenta in humans, exposing the fetus to the chemical.

Oral animal studies have reported inorganic arsenic at very high doses to be fetotoxic and to cause birth defects.

Cancer Risk:

Ingestion of inorganic arsenic in humans has been associated with an increased risk of nonmelanoma skin cancer and also to an increased risk of bladder, liver, and lung cancer.

Animal studies have not associated inorganic arsenic exposure via the oral route with cancer, and no cancer inhalation studies have been performed for inorganic arsenic or for arsine.

EPA has classified inorganic arsenic as a Group A, human carcinogen.

How and to what extent an individual reacts to a particular exposure to an environmental pollutant is determined by the interaction of the substance with the endogenous characteristics of the individual and the other exogenous factors affecting the individual. As a result, there is great variation in response to exposure to the environmental pollution.

Detection of biochemical response to pollutants has provided much insight into the mechanisms of toxic action and has received considerable attention in the assessment of stress effects in contaminated ecosystems (Sastry and Miller, 1981).

Acute arsenic poisoning in humans is characterised by central nervous system effects, leading to coma and eventual death (Moore, 1991). Chronic exposure results in fatigue and loss of energy, Inflammation of the stomach and intestines, kidney degeneration, cirrhosis of the liver, bone-marrow degeneration, nervous-system damage, and severe dermatitis can result from exposure to higher concentration. Arsenic has been shown to the toxic to both vertebrate and invertebrate freshwater aquatic organisms. It is presumed to be a suspected carcinogen. Arsenic affects tissues that are rich in oxidative systems primarily the alimentary tract, kidneys, liver, lungs and epidermis. It is very damaging to capillaries and this results in haemorrhage into the gastrointestinal tract. The major characteristics of acute arsenic poisoning in humans are profound gastrointestinal damage and cardiac abnormalities. Sub-acute exposure results in vomiting, diarrhoea, conjunctivitis, rhitinis, laryngitis, bronchitis, skin eruption, neuralgic signs and symptoms, muscle tenderness, and transverse white ridge on the finger nail.

Arsenic exposure leads to hyperkeratosis of the palms and soles of the feet, together with hyper pigmentation and these symptoms are commonly observed among arsenic poisoned population in Bangladesh. A survey by Dhaka Community Hospital and Jadevpur University, India reported that the available data shows that Bangladesh's arsenic calamity appears to be more severe than in India. They identified people having arsenical skin lesions such as melanosis, leucomelanosis, keratosis, hyperkeratosis, dorsum, non-petting oedema, gangrene and skin cancer (Dhar et al., 1997).

Dhaka Community Hospital Trust, which first identified severe arsenic poisoning in the country, from October 1996 to February 1997, examined about 1344 people, among whom 67.7 per cent male, 58.4 per cent female and 25.3 per cent children were identified as acute arsenic affected. 71.66 per cent of tube well contains arsenic more than recommended level (0.01-1.625 mg/1).

Chronic exposure to a toxic substance can damage the body in a variety of ways. A distinction is made in medicine between acute and chronic heavy metal poisoning, as well as the production of genetic defects. Only about 30 substances are known human carcinogens, but strong evidence of human carcinogen exists for more than 200 materials. Most known suspected carcinogens are also mutagen (changes in cells genetic material) and teratogen (damage in developing embryo and fetus). A toxic material can cause a variety of other damaging chronic effects once inside the body, including sterility, chromosomal damages, miscarriage, damage to immune systems, and disorder to the heart and circulatory system.

It is difficult to measure the chronic situation because of a number of reasons; for instance.

The body reaches some type of balanced state where there is no longer any change in response to continued exposure. The effects may persist even after exposure has ceased, and the current levels may not reflect initial exposure. Basic understanding of what happens to chemicals in human body is lacking for many pollutants.

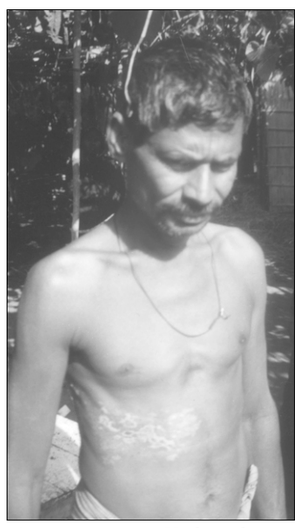
Most involve chronic toxicity and some fall between acute and chronic. Those in between, fall on a continuum of difficulty where the longer the latent period, the more poorly the available measurements reflects the actual exposure situation. It is likely that those who are drinking low-dose contaminated arsenic water in Bangladesh are exposed to chronic arsenic poisoning.

Toxic effects result not only from the absorption in a short space of time of relatively large doses, but also, very often, a much more insidious form of poisoning that generally occurs without warning. The absorption of small doses of so-called cumulative toxins in the target organ or tissue causes disorders in which the symptoms are highly variable.

Response to a toxic substance can be categorised according to the dose rate and according to the severity of damage (Miller, 1984):

Acute toxicity causing mortality:

Chronically accumulating damage ultimately causing death.



Arsenic victim, Vashanchar.

Affected limb of a victim.

Subleathal impairment of various aspects of physiology and morphology.

Subleathal behavioural effects.

Measurable biochemical changes.

We know of arsenic patients with mainly skin effects in Bangladesh, but organs such as the lungs, liver, cardiovascular system, nervous system, haematopoietic system, reproductive systems have probably been damaged by arsenic but these cases still remain unreported.

Mitigation Activities

At Dhakin Tepakhola, Faridpur, within a cluster of houses arsenic concentration as high as 1.76 mg/1 (more than 30 times than Bangladesh standard). 10 tube wells still in use were tested for arsenic concentration. The wells varied from 1.6 to 0.5 mg/1 arsenic concentrations. Seven deaths have been reported as follows: Shahidul Islam, Usha Rani Sudhor, Sirin Begum, Halima Khatun, Amina Khatun, Sukur Jahn, Mumta Begum.

Many international experts, and NGO workers visited this area collected hair, nail, skin, photographed the villagers and promised to help them by providing arsenic free water but the villagers have never seen them again. Surprisingly, two new wells were drilled under an arsenic mitigation project. Both of them are highly arsenic contaminated. One, along the street, contains 1.76 mg/l (WHO standard 0.010 mg/l) but now this tube well has been removed. I intended to begin an arsenic removal project that would prepared by the villagers with traditional wisdom that can produce and maintain arsenic removal filters. But having never received a reply from UNESCO, and now I have learnt the Department of Environment has postponed all projects. The NGO Forum reported that they are engaged in these areas but along Kumar River or Char (island) areas no arsenic mitigation activities can be seen. Deep tube wells are drilled in Faridpur by conventional methods in spite of warning (Anwar, Arsenic Poisoning in Bangladesh, 2000) and now these wells are also arsenic contaminated, as it has happened in India. The deeper, uncontaminated water horizon will soon be contaminated as it happened in W Bengal, India. (Mandal et al. 1996): "During 1990, the Public Health Engineering Department (PHED), India, to deeper depths (450 ft) in a village in Nadia (Ghatugachi) where the shallow tube wells (850-200 ft) is arsenic contaminated. At the beginning, arsenic was not found in these tube wells but in course of time all these tube wells got contaminated. After our analysis of more than 26,000 water samples (April 1996) we may state that no tube well at any depth is safe is arsenic affected villages. We have many examples where arsenic was not present at the beginning but contaminated in course of time."

BGR, German Geological Survey (1999) comments on deep well drilling in Bangladesh, that an unknown risk is the possibility of arsenic migration from the upper aquifer to the lower one by percolation of water, if the hydraulic conditions are changed by abstraction, as the conditions in the separating layer (aquitard) are widely unknown. Under the current arsenic mitigation programme in Bangladesh deep drilling will further contaminate the uncontaminated mater. In the USA, section 265.91 of the Code of Federal Regulations (CFR) dealing with hazardous waste regulations, requires some design criteria for the use of filter packing around screen intakes and annual space be sealed with a suitable material to prevent ground-water contamination. It is advisable to get special casing design and materials, for example clay, around the outside of the deepest casing while sinking wells in a contaminated region.

Arsenic Standard

The latest toxicological studies reveal that even a low amount of arsenic is harmful to human consumption. The US EPA proposes a drastic reduction of permissible level from 0.05 mg/l to 0.002mg/l. No international standards have been set as low as 5 [micrograms] ug/L, the water supply source said. Both the European Union and World Health Organisation have set standards at 10 [micrograms] ug/L, and Canada's standard is 25 [micro grams] ug/L.

The current 50 [micrograms] ug/L standard for arsenic in drinking water in the USA was set by EPA in 1975, and was based on a 1942 Public Health Service standard before the substance was known to be a human carcinogen. Since 1975, it has been found that high exposure levels of arsenic in drinking water can cause skin cancer and vascular disease. At lower levels, the substance is linked, but less certainly, to bladder, liver, kidney, and colon cancers. EPA's expected low limit for arsenic is probably based on statistics for bladder cancer referenced in a March 1999 National Academy of Sciences report that the water supply sources said. In that report, NAS said a 50 [micro grams] ug/L standard for arsenic was not sufficiently protective of human health and that existing data can be used to internal cancer risks (56 DEN A-6, 3/24/99). Until recently, data were available only on the risks for skin cancer, which is considered to be less serious than internal cancers. NAS, USA also recommended that EPA toughen the standard as soon as possible.

The permissible level of arsenic in Bangladesh is 0.05 mg/l (50ug/L) which is too high and based on water consumption 2/litres/person/day. But people in Bangladesh drink twice the amount, are malnourished and in very poor health conditions. Arsenic in drinking water should be below the detecting level (2 ug/L).

Painting the tube wells

Under the arsenic mitigation programme, tube wells are identified red (not allowable) or green (allowable) marks. I visited more than 300 villages, but I could not find any panted tube well (red or green) even where deaths were reported. Those who are drinking and absorbing arsenic through food chain even below Bangladesh standard (50 micro mg/L) are in danger. Almost all wells in Bangladesh are contaminated. The arsenic tragedy calls for declaring a state of emergency. The New York Times wrote in November 1998 "If this were the United States, they'd call out the National Guard and get everyone bottled water."

Easiest Alternative

There are several arsenic separators in the market. All these filter or separators have disadvantages to expensive, difficult to operate, stop flowing water after a few runs, one poison is replaced by others, no disposal programme etc. Proshikha intends to make brick from arsenic sludge (Baral, PHA Conference 7.12.2000). The National Occupational Commission Australia (1999) reports arsenic trioxide filings will explode on heating and besides bricks are used for road construction in Bangladesh and will further contaminate surface and ground water. It is likely recycle to nature and wall, with dangerous substances posing potential health hazard.

In early 1998, I published my finding and the sunlight-air-clay pot method found to separate arsenic from drinking water. After travelling in several villages in Bangladesh I found the "open dug hole" or Bangla Kua or Indira does not contain arsenic. At Alipur, Faridpur I found an open dug hole "Kua" and a tube well; the water from the tube well contained 0.50 mg/L arsenic (WHO standard 0.01 mg/l) and water from "Kua" did not contain any arsenic. But this open dug hole has vanished from Bangladesh.

Open dug hole or "Kua" can be dug only during February, March and April at low water level and costs about Tk 5000. It should be monitored properly. If agencies, organisations want to stop arsenic poisoning now, there is handly any time lift.

UNICEF and other involved agencies should rebuild the open dug hole and send all tube wells to their head quarters, since their consultants (British Geological Survey and Mott MacDoland Ltd UK) have reported that arsenic was always present in Bangladesh.

Water from the open dug hole can be improved through protection (keep it clean) and bacteria can be removed through solar radiation (without cost) or through boiling. A simple filter produced and maintained by the villagers cannot cost more than 100 Taka.

The Faridpur Water Supply was built during British period and it contains two open basins first an oxidation chamber and the second sedimentation chamber. The water pumped from the ground water contains a high arsenic concentration but after oxidation, sedimentation and filteration, water has shown arsenic below Bangladesh standard. This process can be further improved. Such systems can be easily introduced on small and large scale in the most affected areas on community basis and do not require outside know how or import of high technology.

Unfortunately, every day the arsenic sludge is disposed of nearby in a pond. The arsenic sludge can be disposed of under cheap biological disintegration method.

The people will invent more methods and survival strategies, if we really want to survive and refuse vested business interests of many western companies offering inadequate and expensive technologies. These methods are not practised in their own countries.

We do not want millions of rural poor to end up with slow, painful suffering. I still cannot forget the face of Sulekha and the helpless family. The helpless rural population sings:

We who bring out food
From the depth of the earth,
We who provide food for the whole world
Why can't we get pure water can any one tells us?
We shall plough no more the earth for rice
But to see how far it is to the graves.

(modified from Jasim Uddin)

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Health effects due to arsenic
(WHO, 1981, Pershgen, 1983)

Organ affected	Effects
Skin	Hyperpigmentation Hyperkeratosis Skin tumours
Lungs	Lung cancer
Liver	Liver dysfunction Haemangioendothelioma
Cardiovascular system	Peripheral vascular disturbances leading to gangrene
Nervous system	Peripheral neuropathy or hearing defects
Haematopoietic system	Disturbed erythropoiesis with anaemia
Reproductive system	Increased frequency of spontaneous

All health information to keep you up to date

Before the doctor comes

How to apply a bandage

Select the width of bandage appropriate to the area to be covered e.g. a narrow bandage for a wrist and a wide bandage for a knee.

What to do

support the injured limb while bandaging.

start below theinjury site, and wrap the bandage around the limb, using a spiral action, overlapping two thirds each time.

bandage injured joints by wrapping the bandage round the joint in a figure 8 (eight) pattern, over-lapping two thirds each time.

secure with a safety pin or adhsive tape.

check to make sure the bandage isn't restricting blood circulation.

Never

bandage too tightly as this can restrict the circulation and cause swelling. If the fingers or toes of the bandaged limb become darker or bluish in colour, the bandage is too tight and should be removed and reapplied more loosely.

ignore an injury to a limb. You should seek medical help if the limb is too painful to take your weight, or the sweling hasn't gone down after 72 hours.

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Beware!

Don't mislead doctors

Some people consider themselves to be very intelligent and come out with their own diagnosis. Instead of explaining the symptoms they would say, "Doctor, I have got gas trouble," "I have acidity," "I have low blood pressure" and "I have a sluggish liver," etc. Such an attitude is very misguiding for a doctor, especially if the doctor happens to be very friendly and he may believe you. As a result he may miss the real diagnosis and may give his prescription even without examining the patient. Never force your own diagnosis upon the doctor. You should always tell your symptoms and let the doctor come to his own conclusion.

Tomorrow: Aged first and other tips.