DRINKING WATER CONTAMINATION BY ARSENIC IN RURAL AREAS OF BANGLADESH POSSIBLE SOLUTION AND AWARENESS BUILDING

A Workshop Report

Edited by

HASAN SARWAR
A.K.M. ASHRAFUZZAMAN

Bangladesh Academy for Rural Development (BARD)
Kotbari, Comilla

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FOREWORD

More than ninety percent people in Bangladesh use tubewell water for drinking and domestic purposes. Only a few year ago, news praising Bangladesh, came in newspapers at home and abroad that Bangladesh had topped the list of countries in South Asia in supplying safe drinking water to its population. But the recent detection of arsenic in tubewell water beyond and allowable limit in some isolated areas has not only negated the excellent progress but also turned the progress upside down. People of isolated areas as stated are getting attacked by various incurable diseases. It is undoubtedly a great threat now looming over our health sector and the country has been facing a great danger.

Since 1959, Bangladesh Academy for Rural Development (BARD), Comilla, working in the field of rural development feels concerned about the arsenic problem in rural areas. For this BARD organised a day long workshop wherein scholars from Government, International Agencies and NGOs provided their concerted views, about the steps to be taken to mitigate the problem.

The workshop seems to be timely. The workshop report, no doubt, contains the thought, views and recommendations of the experts. It has given guidelines to the Government and to the public side by side. The authors and editors deserve thanks for identifying the issues involved in developing the strategies to solve the problem. I shall be happy if the policy maker, planner and scholars of the country can get the food for thought and inspiration in future by going through.

(Md. Akhtar Hussain Khan)
Director General

Editors' Note

Drinking water contamination by arsenic has been widely reported in Bangladesh since 1993. This has become a serious public health problem. Prolonged intake of arsenic contaminated water is well documented in having detrimental health effects. It is assumed that now one-third of the population are at risk of arsenic contamination. The affected districts are : Chapainababgonj, Lakhmipur, Kustia, Pabna, Faridpur, Barisal, Bagerhat, Gopalganj, Jessore, Rajbari, Rajshahi, Satkhira, Chandpur, Feni, Jhalokati, Magura, Madaripur, Manikganj, Munshiganj, Narail, Noakhali, Pirojpur, Sariatpur, Bogra and others.

Bangladesh Academy for Rural Development (BARD), Comilla has been working in the field of rural development following a unified approach of training, research and action research to address the problems of rural development and feels concerned about the arsenic problem in rural areas. To play a role in making the people aware of the problem through its village based organisations the Academy organised this workshop wherein scholars from Government, International Agencies and NGOs attended.

There were five papers in the workshop. These were (i) Key Note Paper on "Management of Ground Water Pollution" by Dr. A.V.S. Reddy, Director General, CIRDAP, (ii) "Arsenic in Drinking Water and Its Intervention" by S.A.K.M. Shafique, Chief Engg. DPHE, (iii) "Village Health Workers can Test Tubewell Water for Arsenic" by Dr. AMR Chowdhury, Director (Research) and Others, BRAC, (iv) "Arsenic Contamination in Drinking Water and its Effect on Human Health" by Hasan Sarwar, Joint Director, BARD and (v) "Health Hazards due to Arsenic Toxicity

in Bangladesh" by Professor A. Wadud Khan and Others from NIPSOM. A strategy with short term, medium term and long term approach was suggested to tackle the arsenic problem. Emphasis was given on collaboration between the Government and the NGOs to address the problem as well as to inform the public, specially the rural people, about the danger that come from consuming arsenic laced water on regular basis.

All tubewells in the affected areas has not yet been tested. Necessary steps should be undertaken to test the water of all the tubewells. If arsenic contaminated free tubewell is not available, people may be advised to use surface water, such as pond, river and lake water after boiling or after removing arsenic by adding Alum (which reduce arsenic about 70 per cent from water) or by using Arsenic Removal Chemical Powder. Arsenic patients may be treated by withdrawing of further intake of arsenic contaminated water and by intake of Protein and Vitamin A,C and E enriched foods. The villagers may be advised to increase intake of cheap available protein and vitamin enriched foods like peas, beans, pulses, tentils, wheat, soyabean, green and leafy vegetables.

The report has made an effort to address the arsenic problems and to create possible ways in mitigating arsenic problems in Bangladesh. The recommendations of the workshop and the findings of the papers will be very much helpful for the policy makers and planners in formulating policy and plan to combat arsenic problems in the country.

This report has been generously cooperated and blessed by Syed Marghub Morshed, former Secretary, Ministry of Local Government, Rural Development and Co-operatives, Mr. Md. Akhtar Hussain Khan, Director General, BARD and Dr. M.

Solaiman, Addl. Director General, BARD. Mr. S.M. Ilah, Director (Administration), BARD and Mr. M. Khairul Kabir, Director (Training), BARD. We express our acknowledgements to all of them. We also express our thanks to Dr. A.V.S. Reddy, Director General of CIRDAP to attend the workshop as Chief Guest and presented the key note paper. We extend our acknowledgements to the authors of the papers and the participants of the workshop for giving the valuable suggestions to combat arsenic problem. Our heartiest thanks are also to all faculty members and the employees of BARD for their inspiration and co-operation to make the workshop a success.

August 1998

Hasan Sarwar
A.K.M. Ashrafuzzaman
Editors

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PART I

1. Background

Adequate and accessible supply of safe water together with sanitation, has been recognised as the basic health need of the people. This also constitutes essential components of primary health care service. Water resources also form an important element in other areas of national development. The efforts of Bangladesh have brought about a commendable success in rural water supply sector. By now, nearly 96 per cent of the people even in rural areas have access to tubewell water[1]. The success has been achieved as a result of the National Rural Water Supply Programme of the Department of Public Health Engineering (DPHE), assisted by UNICEF, WHO and other supporting agencies. In spite of such commendable achievement the rural people and the dwellers in the urban slums, are affected by many water borne and water washed diseases. Along with this, high concentration of arsenic in tubewell water has been affecting a large number of population of the country.

Inorganic arsenic has been recognised as a poison since ancient times and large quantity, if ingested, can cause death. This is the fear that lies at the bottom of problem of arsenic contamination now facing Bangladesh. The danger is assuming serious dimension with arsenic in the soil and in underground water being of high levels than was at first apprehended. One of the main problems about ground water contamination is that it occurs out of sight. Therefore, the sources of pollution are as just as difficult to detect as are its effect until, of course, the damage begins to manifest.

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1. UNICEF, 1992. Towards Better Health, Department of Public Health and Engineering, Dhaka, P.4.

Contamination of ground water with arsenic, is no more an isolated case in the country, as reports of its presence in water in different regions are pouring in every day. The Atomic Energy Commission of Bangladesh has identified 17 districts where the level of arsenic in water is around 1.5 to 2.0 ppm, whereas according to WHO the acceptable level of arsenic in water is only 0.05 ppm. The affected districts are Bagerhat, Khulna, Satkhira, Jessore, Jhenaidah, Chuadanga, Meherepur, Kustia, Pubna, Rajshahi, Chapai Nowabganj, Faridpur, Rajbari, Narayangonj, Chandpur, Lakshmipur and Noakhali. Out of 17 districts, 13 are along with the Ganga Basin[2].

According to a survey conducted by the National Institute of Preventive and Social Medicine(NIPSOM), about 15 million people in 18 districts are living under the threat of arsenic poisoning form drinking water. Tubewells being the only source of drinking water in these districts, the population has no alternate source of portable water to minimise the possibilities of becoming unfortunate victims. It is doubly distressing that the local doctors and public health officials are neither aware of the situation nor can they identify arsenic cases for early treatment and this serious health hazard may spread eventually to the rest of the country. The local health officials have little previous experience and equipment support to help them in identifying arsenic cases at the primary stage[3].

Experts from Bangladesh Council of Scientific and Industrial Research (BCSIR) have found the highest level of contamination (14 mg/litre of shallow tubewell) in Pabna, and 220 mg/kg of soil in Sylhet. Analysis undertaken by the School of Environmental Studies (SOES), Jadavpur University, Calcutta,

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2. Sarwar, H.et al. 1997. Bangladesh Country Report. In : Rural Water Supply in Asia. Centre on Integrated Rural Development for Asia and the Pacific (CIRDAP), Dhaka.

3. The Independent, 1997. Spectre on Arsenic Pollution, 20 December 1997, Dhaka, P.6.

India, Dhaka Community Hospital (DCH) and the National Institute of Preventive and Social Medicine (NIPSOM) indicate that in the 28 districts studied, 58 per cent of the water samples from 27 of these districts are not suitable for drinking according to WHO recommended permissible level limit of 0.01mg/litre.

A preliminary field survey also found that 57 per cent people had arsenical lesions. Again, analysis of 700 hair, nail, skin and urine samples found that 91 per cent had arsenic above the maximum limit. This survey also showed 2,000 patients with arsenic affected in 28 districts. Arsenic related illness is resulting in social problems like divorce and ostracizing of people. More specially, arsenic poisoning is affecting the children. It is to be noted that children of Bangladesh are so undernourished that they can not combat it[4].

According to Dipankar Chakraborty, Director of SOES who has been studying the problem for a long time, "more than 2,20,000 people in Bangladesh is suffering from arsenic related diseases ranging from melanosis to skin cancer"[4]. Although official estimates give the number now at risk at 16 million but others put the figure near about 50 million.

Considering the above situation, it is reasonable to say that the country has been facing the great danger of arsenic poisoning. It is undoubtedly a great threat now looming over our health sector. The government has taken steps to resolve the problem by instituting surveys and studies and have asked international agencies for help. Several NGOs like BRAC, Disaster Forum of Bangladesh and others are also working on arsenic. Under such a

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4. Mortoza, S. 1997. The Prestine View : Resolving the Arsenic Problem. The Bangladesh Observer, 7 December, 1997, P.5.

situation, the public, specially the rural people, should be informed of the dangers that come from consuming arsenic laced water on a regular basis.

Bangladesh Academy for Rural Development (BARD), Comilla working in the field of rural development feels concerned about the arsenic problem in the rural areas. It wants to play a role in making the people aware about the problem through its village based organisations and steps for combating this. For this BARD organised a day-long workshop wherein scholars from Government, International Agencies and NGOs provided their concerted views about the steps to be taken by BARD to combat the problem. Programme of the workshop is enclosed in Annexure - I.

2. Objectives of the Workshop

The objectives of the workshop were to :

2.1 assess the trend of drinking water contamination by arsenic in different regions of the country and its impact on health of the rural people;

2.2 identify the ways and means for orienting the people how to avoid the problem; and

2.3 steps to be taken through action research, research and training to combat the problem.

3. Participants

Fourteen scholars from various government, non-government and international agencies participated in the workshop. A list of the participants is furnished in Annexure - II.

4. Inaugural Session

The inaugural session of the workshop was held on March 29, 1998 at 10:00 a.m. at Dr. Abdul Muyeed Conference Hall of BARD. The session was chaired by Mr. Md. Akhtar Hussain Khan, Director General, BARD while Dr. A.V.S. Reddy, Director General, CIRDAP was the Chief Guest.

Dr. M. Solaiman, Additional Director General, BARD, extended welcome to all the participants and guests of the inaugural session. He mentioned that other name of water is life and the contamination of drinking water by arsenic has been affecting this life, then society, locality and as a whole the nation. In many areas of Bangladesh, drinking water from tubewell is being contaminated by arsenic and it effects the human health. Different studies have already been conducted on arsenic and BARD has the responsibility to identify the extent of drinking water contamination by arsenic, its effect on rural society as well as to find out the ways and means to reduce the problem. He appealed that it is the responsibility of every body to make aware the rural people about the arsenic problem. He briefly discussed about the background and objectives of the workshop. He requested the participants to provide their valuable suggestions so that BARD can undertake the training, research and action research to combat the arsenic problems in rural areas of Bangladesh. With thanks he concluded his speech.

Mr. Hasan Sarwar, Workshop Director, at the initiation of his speech welcomed the guests and participants of the workshop. He briefly discussed about the aim, objectives and methodology of the workshop. He stated that five papers would be presented in the workshop. These were (i) Key Note Paper on Management of Ground Water Pollution by Dr. A.V.S. Reddy, DG, CIRDAP, (ii) Arsenic in Drinking Water and Its Intervention by S.A.K.M.

Shafique, Chief. Engg. DPHE, (iii) Village Health Workers can Test Tubewell Water for Arsenic by Dr. AMR Chowdhury, Director (Research) and Others, BRAC, (iv) Arsenic Contamination in Drinking Water and Its Effect on Human Health by Hasan Sarwar, Joint Director, BARD and (v) Health Hazards due to Arsenic Toxicity in Bangladesh by Professor A. Wadud Khan and Others from NIPSQM. He pointed out that after the presentation and discussion on the papers the participants would provide their valuable suggestions by which BARD could undertake the training, research and action research on solving the arsenic problems in rural areas. Finally, he expressed his gratitude to Syed Marghub Morshed, Secretary, Rural Development and Cooperatives Division, Ministry of Local Government, Rural Development and Cooperatives, Chief Guest, Dr. A.V.S. Reddy, DG, CIRDAP, Mr. Md. Akhtar Hussain Khan, DG, BARD, Dr.M. Solaiman, ADG, BARD and Mr. M. Khairul Kabir, Director (Training) for their continuous inspiration given to him to conduct the workshop. He also expressed his grateful thanks to the authors of the papers and the participants for their kind participation in the workshop. Wishing the success of the workshop he concluded his speech.

Dr. A.V.S. Reddy, Director General of CIRDAP expressed his pleasure to attend the inaugural session of the workshop as Chief Guest. He pointed out that arsenic in drinking water is dangerous and it may be the cause of a person's death. Arsenic problem may be treated as disaster. There are two types of disaster, one is rapid like cyclone, flood and the other is slow type like famine. Arsenic in drinking water is slow type disaster and it effects the whole society. Rapid disaster like cyclone and flood damage properties, infrastructures, and a large scale of human lives. It act as rapid disaster and upset the socio-economic and political life, whereas arsenic in a long period of time affect a large

scale of human lives. It provides enough time to rectify the disaster. In relation to this, he explained his past experience about Anantapur District of Andhra Pradesh, India. He told that Anantapur was a drought prone district. As drought was a slow disaster, the policy maker rarely made a prior arrangement for this slow disaster. Though arsenic is a slow disaster but it effects human health. People should be aware about the toxicity of arsenic. He suggested for an Action Research Plan to aware the people about arsenic. He advised to select a District or a Thana to carry out a survey and accordingly draw the action plan as well as to identify the arsenic affected people. He emphasised on effective extension management and to make a coordination committee to coordinate the actions taken or to be taken by GOs and NGOs. Finally, he hoped that arsenic problem would be reduced by taken proper action. With thanks he concluded his speech.

Mr. Md. Akhtar Hussain Khan, Director General, BARD and Chairperson of the session began his speech with warm welcome to the distinguished guests and participants of the workshop. He briefly discussed about the arsenic problem of Bangladesh. He pointed out that arsenic in drinking water has ben affecting a large number of rural population in Bangladesh. Inorganic arsenic has been recognised as a poison since ancient times and large amount, if ingested, could cause a person's death. The danger was assuming serious dimension with arsenic in the soil and in under ground water being of higher levels than was at first apprehended. One of the main problems about ground water contamination was that it occurred out of sight.

He mentioned that contamination of ground water with arsenic, was no more an isolated case in the country. Study revealed that more than 2,20,000 people in Bangladesh were suffering from arsenic related diseases ranging from melanosis to

skin cancer. Official estimates a number of the persons now at risk was about 16 million, the other estimated that the figure was at about 50 million.

The country has been facing the great danger of arsenic poisoning and it is a great threat in looming over our health sector. He also warned that government has been taken steps to resolve the problem by instituting surveys and studies and have asked international agencies for help. Several NGOs and International agencies like ICDDR,B, BRAC, DCH, Disaster Forum of Bangladesh and others had been working on arsenic. Under such a situation, the public, specially the rural people, should be informed of the danger of arsenic laced water on a regular basis.

He mentioned that Bangladesh Academy for Rural Development (BARD), Comilla had been working in the field of rural development and concerned about the arsenic problem in rural areas. For this BARD had organised this workshop wherein scholars form Government, International Agencies and NGOs would provide their concerted views about the steps should be taken by BARD to combat the problem.

Finally, Mr. Khan, the chairperson of the session hoped that the workshop would able to identify the ways and means for orienting people. With this few words he concluded his speech and declared the workshop open.

5. Working Sessions of the Workshop

Including the inaugural and concluding sessions there were also two sessions in the workshop where five papers were presented. The papers were circulated among all the participants before presentation. Two faculty members from BARD acted as rapporteurs for each session. Since the papers have been included

in part II, of this proceeding, only the issues raised and discussed are furnished below :

Working Session - I

Two papers were presented in this session. At first, Dr. A.V.S. Reddy, Director General, CIRDAP, presented the keynote papers on "Management of Ground Water Pollution" with the Chairmanship of Mr. Md. Akhtar Hussain Khan, Director General, BARD. Mr. Shafiqul Islam, Deputy Director and Mr. Kamrul Hasan, Asstt. Director, BARD acted as rapporteurs of the session. The rapporteurs report on the keynote paper is as follows :

1.1 Different committees/projects have been working with the problem of drinking water contamination by arsenic. As for example National Emergency Arsenic Mitigation Project under the Ministry of Health and Family Welfare. Other committees like National Steering Committee, Technical Committee etc. have also been working on this problem. Therefore, coordination should be strengthen among all these committees.

1.2 Experiences regarding arsenic problems in West Bengal, Andra Pradesh and Panchayat Raj of India should be shared with the experiences of Bangladesh and accordingly measures should be taken to solve the problem.

1.3 There need to be involved politicians, policy makers, peoples representative to combat the arsenic problem.

1.4 Over exploitation of ground water should be reduced to combat the contamination of drinking water by arsenic.

1.5 To minimise the arsenic contamination problem biological treatment like changing cropping pattern should be introduced. Food habits should also be changed.

1.6 Appropriate domestic filter system should be developed to remove arsenic from drinking water and side by side motivational activities should be strengthen.

1.7 Immediate short-term measures should be taken so that the people who are been affected by arsenic may get relieve.

1.8 Quick and easy method for measuring arsenic in drinking water should be developed.

1.9 Action programme for combating arsenic problem should be taken immediately.

1.10 Extension management training should be conducted regarding arsenic contamination in drinking water.

1.11 Short-term, Medium-term and Long-term approaches may run paralally.

1.12 Technical assistance/support services should be provided to the community so that they can handle the problem efficiently.

1.13 People's participation and involvement of local government should be ensured to combat the arsenic related problems.

1.14 GO, NGO and Community triangle collaboration should be ensured for policy/strategy formulation regarding arsenic contamination problem.

1.15 Awareness of the mass people should also be developed regarding fluoride and other contamination of water which may reduce the health hazard of the people.

Second paper of this session entitled "Arsenic in Drinking Water in Bangladesh and Its Intervention" was presented by

Mr. Md. Asadul Hoque, Executive Engineer, DPHE, Dhaka on behalf of Mr. S.A.K.M. Shafiquel, Chief Engineer, DPHE. The session was presided over by Mr. M. Ghulam Sattar, Manager, Research and Evaluation Division, BRAC, Dhaka. Mr. Abul Kalam Azad, Deputy Director, BARD and Mr. Newaz Ahmed Chowdhury, Asstt. Director, BARD, acted as rapporteurs of the session. The rapporteurs report in this session is as follows:

2.1 The provisional guide line value of arsenic tolerance for human being is recommended by WHO is 0.01 mg/litre, whereas in Bangladesh context it is recommended as 0.05 mg/litre by DPHE. WHO accepts maximum tolerance limit 0.05 mg/litre.

2.2 Permissions are not given by DPHE to install new STW/DTW for drinking purpose in the arsenic affected areas.

2.3 As an alternate water supply option, sanitary ring well was found effective in Sylhet regions, whereas rain water harvesting system existed in Chittagong Hill Tracts. Besides, pond water with slow sand filtration (PSF) was found dominant in Barisal, Khulna and Patuakhali region.

2.4 Researches are being conducted to find out the arsenic free aquifer (i.e. water containing tolerance level of arsenic) for installation of STW/DTW in future.

2.5 In order to eliminate air pollutants, birds droppings and others in case of rain water harvesting, appropriate measures should be explored and adopted.

Working Session - II

Three papers were presented in the second working session of the workshop which was chaired by Mr. Mohammad Mofazzal Hoque, National Field Programme Officer, WHO, Dhaka. Mr. M. Ghulam Sattar, Manager, Research and Evaluation Division, BRAC, Dhaka on behalf of Dr. AMR Chowdhury, Director (Research), BRAC, presented the paper entitled "Village Health Workers can Test Tubewell Water for Arsenic". Mr. Swapan Kumar Dasgupta, Deputy Director and Mr. Abdus Samad Miah, Deputy Director, BARD, acted as rapporters of the paper. The rapporteurs report is as follows:

3.1 In testing the drinking water contamination by arsenic Village Health Workers (VHWs) may be used.
3.2 Ninety two per cent sample diagnosed by VHW are confirmed by spectrophotometer of DPHE.
3.3 NGOs can help in testing drinking water contamination by arsenic and they may work as helping hand of the government.
3.4 NGOs and government collaborations are to be encouraged.
3.4 Testing of drinking water by VHWs whose education level is very low is appreciated.
3.5 Arsenic content in drinking water of any region is not constant. It may change with season.
3.7 Treatment of arsenic affected people is to be initiated.
3.8 Specific gravity of arsenic is more than water so it can pass and deposited in deeper region of the earth.
3.9 Ways and means for removal of arsenic from water is to be more emphasised.
3.10 Remedial measures by BRAC yet not started.

3.11 Cost effective treatment and remedial system is to be explored.

3.12 Deep tubewells are being installed in the arsenic free region by DPHE.

3.13 Coordinated effort under the World Bank is being made.

3.14 World Bank has taken projects for 15 years with an allocation of about 40 million dollars.

3.15 National Arsenic Mitigation Centre is to be implemented at different regions of the country under the sponsorship of World Bank.

3.16 Orientation programme for the VHWs are to be initiated.

3.17 Local people have tremendous potential to do all necessary thing for arsenic identification and mitigation.

3.18 Water of all tubewells of Bangladesh should be tested. Because, it has observed that some of the tubewells are free from arsenic adjacent to the affected tubewells.

3.19 Lowering of ground water level is one of the main causes of arsenic contamination.

3.20 The mitigation process of arsenic evolved by DPHE is to be adopted by the villagers and it needs extension.

3.21 BRAC will undertake mitigating measures for arsenic contaminations soon.

3.22 BRAC did not identified the arsenic affected people in its experimental areas. In future they will identify the same.

3.23 Community based water supply project may be initiated by the World Bank in collaboration with GOs and NGOs.

Mr. Hasan Sarwar, Joint Director (Community Health and Nutrition), BARD and the Workshop Director presented the paper on "Arsenic Contamination in Drinking Water and Its Effect on Human Health". Afterwords, Dr. Sk. Akhtar Ahmad, Associate Professor, Dept. of Occupational and Environmental Health,

NIPSOM, Dhaka presented the paper entitled "Health Hazards Due to Arsenic Toxicity in Bangladesh". Mr. Tapash Ranjan Bose, Joint Director and Mr. Abdul Karim, Asstt. Director, BARD acted as a rapporteurs of the papers. The rapporteurs report is as follows:

4.1 Arsenic presence in a body can be identified by testing hair, nail and skin which is a very costly method. In Bangladesh it is usually done by Atomic Energy Commission, Dhaka.

4.2 Effect of arsenic may be observed on body surface (skin) of a person within 2 to 10 years of contamination. This completely depends upon the genetic character, health condition, resistance power etc. of the person.

4.3 Arsenic effect is an cumulative effect. Excess intake of arsenic accumulate in the body. Some extent of arsenic is necessary for stimulant and growth of the body.

4.4 Through arsenic contaminated irrigation water crops may be affected and it can enter into the food chain but this type of effect may be observed in the mineral mining areas. But strong evidence are not yet available, and

4.5 Possibility of arsenic contamination of livestock is minimum as livestock has more capability of making arsenic into non-toxic form.

6. Open Discussion and Recommendations for Action

The session was chaired by Dr. M. Solaiman, Additional Director General of BARD. The Chairperson, at the start, said that BARD was willing to initiate some follow-up activities of the workshop in the fields of research, training and action research through which BARD could contribute to the solution of arsenic problem in the country. He requested the participants to propose some actions to be undertaken by BARD in the fields of training, research and action research. He also requested them to propose

the possible ways and means for implementation of these actions. After detailed discussions, the following decisions were taken. It was also decided that the Academy would take necessary actions in the following order.

6.1 Research

6.1.1 Research will be undertaken in two stages in Comilla Sadar Thana. The status of water contamination by arsenic will be measured in the first stage while arsenic patients will be identified in the second stage.

6.1.2 Both surface and ground water will be tested. Water of hand tubewells, samples of deep and shallow tubewells, and surface water will be tested to determine the level of arsenic in different water sources. Ground water in the municipality area of Comilla will also be tested.

6.1.3 Technical assistance of the Department of Public Health and Engineering (DPHE) will be sought for the study on water contamination by arsenic. Experiences of BRAC will also be shared for this purpose, particularly for testing the water at low costs.

6.1.4 Equal samples of male and female will be taken for patient identification.

6.1.5 Data collection will be done by the field workers of BARD-projects in its project villages. In non-project villages, local people will be used for this purpose. Both categories of people will be trained on water test and patient identification before data collection.

6.2 Training

6.2.1 On completion of the research studies, the Academy will design and implement training courses to raise people's awareness about arsenic.

6.2.2 If the intensity of arsenic in water is found low in Comilla Sadar Thana, training will be limited to conveyance of basic information on the hazards of arsenic and their available remedies.

6.2.3 In case of high and critical presence of arsenic in water, comprehensive training curriculum will be developed to impart both general knowledge and technical know-how to the people so that they may become able to remain safe from arsenic toxicity.

6.2.4 In designing the module concerned agencies like NIPSOM, BRAC, DPHE and DCH will be consulted. The curriculum will be developed upon the opinions of relevant experts of the country.

6.2.5 Training of Trainers (TOT) courses will be organised for the trainers of field workers, and knowledge on arsenic will be disseminated through the field workers. There will also be follow - up actions to assess the impact of the TOT.

6.2.6 Efforts will be made to involve the Thana and Union level health officers in educating people on the adverse consequences of arsenic and their available solutions. Field workers will be linked with the health officers in order that the former can obtain necessary advice and services from the latter.

6.2.7 The Academy will seek collaboration of NGOs and private organisation to solve arsenic problems in its laboratory area.

6.2.8 Whether arsenic contamination is severe or not in Comilla Sadar Thana, the Academy will organise training programmes for the interest of the nation and keep itself ready in every possible way to help the nation in this regard.

6.2.9 From now, at least one topic on arsenic will be included in every training courses of BARD.

6.2.10 There will be a cell on arsenic at BARD under the Health and Nutrition Discipline. This Discipline will be in constant touch with concerned agencies and collect necessary information and materials including AV materials on arsenic. The discipline will also develop expertise to address the arsenic issue.

6.2.11 All the female UP members of Comilla Sadar Thana will be oriented on arsenic and efforts will be made to ensure their participation in making the community aware about the threats of arsenic. The arsenic issue will also be included in the forthcoming Asia Foundation sponsored courses at BARD for the UP members.

6.2.12 Videos and publications on arsenic of the Dhaka Community Hospital (DCH) will be collected shortly.

6.3 Action Research

Instead of undertaking a separate action research on arsenic, BARD will experiment on how to tackle the arsenic problems through its on-going projects. Efforts will be made for transfer and adoptation of technologies for arsenic-free water in the project areas.

7. Concluding Session

The session was chaired by Dr. M. Solaiman, Additional Director General, BARD.

Mr. M. Ghulam Sattar, Manager, Research and Evaluation Division of BRAC and Mr. Mohammad Mofazzal Hoque, National Field Programme Officer, WHO,Dhaka spoke on behalf of the participants. Mr. Sattar said that the workshop came to a successful end because it succeeded in working out some concrete actions to be undertaken by BARD for addressing the arsenic issue. He expressed his satisfaction because the workshop was not only for sharing experiences but also for enabling BARD to take certain actions to tackle arsenic problems in the country.

Mr. Mohammad Mofazzal Hoque of WHO appreciated the Academy for its willingness to address the arsenic issue. He hoped that with the collaboration of concerned agencies, the Academy would make significant contributions to solve this national hazard. He expressed his happiness because the Academy decided to introduce the arsenic issue in its all training courses.

Mr. M. Khairul Kabir, Director (Training), BARD delivered the vote of thanks. He acknowledged the guidance of the Director General and Addl. Director General of BARD for organising the workshop. He expressed his gratitude to the presenters of papers, the participants and their nominating organisations and the rapporteurs of the workshop. He thanked the Workshop Director and Assistant Workshop Director for organising the workshop successfully. He gratefully mentioned the presence of Dr. A.V.S. Reddy, Director General of CIRDAP in the opening sessions as Chief Guest. Finally, he acknowledged the supports and services of different divisions and sections of the Academy.

Dr. M. Solaiman, Chairperson of this session said, the proposal and inspiration for organising this workshop and initiating follow-up actions on the arsenic problem came to BARD from Syed Marghub Morshed, Honourable Secretary, Rural Development and Cooperatives Division, Ministry of Local Government, Rural Development and Cooperatives. The Academy would remain grateful to him for his valuable advice and inspiration. The Chairperson expressed his gratitude to Dr. A.V.S. Reddy, Director General, CIRDAP for his kind presence as Chief Guest in the inaugural session and presenting a Key Note Paper on arsenic in the subsequent session. He also gratefully mentioned that the Director General of CIRDAP gave assurance of some financial assistance of his organisation to BARD to conduct studies on the arsenic issue.

The Chairperson thanked the participants for sharing their knowledge and helping BARD with valuable suggestions for undertaking actions to save people from arsenic. He hoped that the participants and their respective organisations would continue their cooperation to BARD to find some effective solutions to the arsenic problems.

Annexure-I

Bangladesh Academy for Rural Development
Kotbari, Comilla
Workshop on "Drinking Water Contamination by Arsenic in Rural Areas of Bangladesh, Possible Solution and Awareness Building"

Sponsor : Bangladesh Academy for Rural Development
Venue : Conference Hall No. 1, Date : 29 March 1998

PROGRAMME

Date & Day	Time	Event(s)	Chairperson/ Resource Person	Rapporteur
28.03.98 Saturday	05:00-07:00	Arrival at BARD Hostel		
29.03.98 Sunday	09:00-09:30	Registration		
	09:30-10:00	Introduction to BARD (Video show)	Addl. Director General Director (Training) Workshop Director	
	10:00-11:00	Inaugural Session	Director General Addl. Director General Participants, Guest and BARD Faculty	Tahamin Banu Nasima Akhtar
	11:00-11:30	Tea Break		
		WORKING SESSION – I		
	11:30-11:50	Key Note Paper : Management of Ground Water Pollution by Dr. A.V.S. Reddy, DG, CIRDAP	Chairperson : Md. Akhtar Hussain Khan, DG, BARD	Md. Shafiqul Islam 2 Kamrul Hasan
	11:50-12:05	Discussion		
	12:05-12:25	Arsenic in Drinking Water in Bangladesh and its Interventions by S.A.K.M. Shafique, Chief Engr. DPHE	Chairperson : M. Ghulam Sattar, BRAC,Dhaka	Abul Kalam Azad Newaz Ahmed Chowdhury
	12:25-12:40	Discussion		
	12:40-14:00	Prayer and Lunch		

WORKING SESSION – II

14:00-14:20	Village Health Workers Can Test Tubewell Water for Arsenic by Dr. AMR Chowdhury Director (Research) and others, BRAC	Chairperson : Mohammad Mofazzal Hoque WHO, Dhaka	Swapan Kr. Dasgupta Abdus Samad Miah
14:20-14:35	Discussion		
14:35-14:55	Arsenic Contamination in Drinking Water and Its Effect on Human Health		Tapash Ranjan Bose Abdul Karim

	Nutrition), BARD		
14:55-15:10	Discussion		
15:10-15:30	Health Hazards Due to Arsenic Toxicity in Bangladesh by Dr.SK. Akhtar Ahmed, Associate Professor, Dept.of Occupational and Environmental Health, NIPSOM, Dhaka		Tapash Ranjan Bose Abdul Karim
15:30-15:45	Discussion		

CONCLUDING SESSION

15:45-16:45	Open Discussion : Regarding Action Research, Research and Training related to Combat the Arsenic Problem	Chairperson : Dr. M. Solaiman, ADG, BARD	Milan Kanti Bhattacharjee Ranjan Kr. Guha
16:45-16:55	Chairperson's Concluding Speech		
16:55-17:00	Vote of Thanks		

Md. Mir Kashem
Workshop Co-ordinator

A.K.M. Ashrafuzzaman
Asstt. Workshop Director

Hasan Sarwar
Workshop Director

Annexure - II

LIST OF PARTICIPANTS

Sl. No.	Name of the Participants	Address
1.	Mr. Mohammad Mofazzal Hoque	National Field Programme Officer, WHO, Dhaka
2.	Mr. Md. Asadul Hoque	Executive Engineer, DPHE, Dhaka
3.	Dr. SK. Akhtar Ahmad	Associate Professor Dept. of Occupational and Environmental Health, NIPSOM, Dhaka
4.	Dr. M.H. Salim Ullah Sayed	Assistant Professor Dept. of Occupational and Environmental Health, NIPSOM, Dhaka
5.	Mr. M. Ghulam Sattar	Manager Research and Evaluation Division, BRAC, Dhaka
6.	Mr. Samul Amin	Consultant World Bank, Dhaka
7.	Dr. Mohammad Abdul Hasnat (Milton)	Coordinator CME and Research Division Dhaka Community Hospital Dhaka
8.	Mr. Md. Khairul Amin	Hydro Geologist 2-H/9-20 Mirpur Dhaka
9.	Dr. Golam Shah Jahan	Medical Officer (CS) Civil Surgeon Office Comilla

Sl. No.	Name of the Participants	Address
10.	Mr. Iqbal Azad	Regional Officer NGO Forum, Comilla
11.	Begum Nurun Nahar Kabir	Project Director WEINI, BARD
12.	Mr. Md. Abdul Quasem	Project Coordinator CEP, BARD
13.	Mr. Md. Mostafa Kamal	Deputy Project Director CVDP, BARD
14.	Begum Jannatun Ara Begum	Assistant Project Director SFDP, BARD

PART II

KEYNOTE PAPER ON

MANAGEMENT OF GROUND WATER POLLUTION

Dr. A.V.S. Reddy*

1. Introduction

The problem of ground water pollution is assuming increasingly serious proportions, because the extent of contamination is much more than what was originally apprehended. In fact, it has assumed the dimension of a disaster - a slow on-set disaster. Among the ground water pollutants, arsenic and fluoride contaminants are a widespread phenomenon in the region, affecting millions of people in Bangladesh, India and China. Between the two, the arsenic contamination is more dreadful not only because it causes physical deformities among the people but also due to the stigma attached to it.

In India, especially in Andhra Pradesh, significant amount of work has been done to solve the fluorosis problem by adopting measures such as, identification of safe drinking aquifers, safe and potable surface drinking water sources, creation of awareness, designing and using domestic filters and community filter systems, and provision of comprehensive protected water supply from far off sources which at times run into hundreds of kilometers. In the case of arsenic pollution, though some research has been done to combat the problems, yet a lot is required to be done.

In Bangladesh, it is reported that the arsenic contamination is detected in 34 out of the total 64 districts. Though the ground water contamination of arsenic is now widely recorded in a vast

* Director General, Centre on Integrated Rural Development forAsia and the Pacific (CIRDAP), Dhaka

tract of Indo Gangetic deltaic region, it is only recently that it has been given due importance. It is predicted that the younger deltaic deposition which stretches from West Bengal to Bangladesh is responsible for the arsenic contamination (Dhar, et al.,1997). The effect is more pronounced in Bangladesh than elsewhere in the region because 95 per cent of the population use tubewell water for drinking and cooking purposes, especially in the rural areas (The Bhoreer Kagaj, 17 January, 1997). Indiscriminate drilling of tubewells for ground water irrigation adds to the problem (DAE, 1993). Further, the depletion of the water table also causes desertification, salinity and compounds chemical and biological pollution. While various hypotheses in this regard have been propounded and the information gathered appear to be in a rudimentary stage, one thing is clear that arsenic is a carcinogen and the prolonged consumption of arsenic contaminated water is leading to ailments from maleness to skin cancer which is manifest in hair, nails, urine and skin lesions of the affected persons. The ingestion of arsenic-contaminated water is emerging as one of the prominent environmental causes of cancer mortality in the world today(Smith et al.).

In the case of fluoride contamination, experience has shown that because of the water table going down owing to indiscriminate drilling of borewells, the contamination has surfaced in more areas compared to that in 1960s. A salient feature in the case of fluoirde affected areas is that it is not only the water drawn from tubewells and borewells but also from areas where water is passing through fluoride contained geo-strata or rock formation, that the water is found to be contaminated.

2. Arsenic Contamination and Its Effect on Health

It is a well established that arsenic is a terrestrial element and is naturally distributed in air, water, soil and edible material. The element is transported in the environment mainly through volatisation of contaminated water(Mohammad, et al.). Arsenic enters the environment as a result of both natural and anthropogenic activities. Soluble forms of arsenic are readily absorbed by the body, whereas the less soluble forms are poorly absorbed and largely excreted by the faeces. Both anthropogenic activities and natural soil processes have contributed to the contamination of many sites throughout the world (Naidu, R). Mobilization of arsenic in ground water is governed by the geochemical processes involving continental rocks as well as sediments. The origin of arsenic in ground water is geogenic, while soil contamination is anthropogenic from contaminated irrigation water. Though the reason why arsenic is coming out with ground water is not completely clear, one hypothesis suggested is the over exploitation of ground water. From these contaminated soils, arsenic enters into the food chain through crop uptake. Entry of this element into human body is through inhalation and ingestion of food and drinks.

The consumption of arsenic contaminated water leads to skin lesions such as malanosis, leuco melanosis, keratosis, hyperkeratosis, dorsum gangrene and skin cancer. It is also reported that people with poor nutrition are at higher health risks than those with better nutrition(Das, et al. 1995). It is suspected that a high frequency of spontaneous abortion, still birth, prenatal mortality (Csanady, et al.) and risks of liver, lung, kidney and bladder cancer could be related to the high level of arsenic in the drinking water. A significant dose-response relationship between the total arsenic ingested and the mortality rate from lung cancer is

reported as well as that between urinary cancer and arsenic content (Feu, et al.). Though arsenic borne diseases are not contagious, various literature report the possibility of mother to fetus transmission. If authenticated, this bodes serious implication for the future generation.

3. Social Inhabitants an Impediment for Detection of Arsenic Cases

In fact, the problem is deep rooted than what is perceived because there are certain social factors which are inhibiting the detection of affected persons :

3.1 A majority of the affected persons do not turn up for medical check up, because people wrongly believe that arsenic borne disease are contagious and if their ailment is known to others they may be isolated.

3.2 The young girls do not show up because they consider that it would negatively affect their marriage prospects.

3.3 Women do not show up because they consider that if the disease is detected in them, their marital relations could become strained and may even lead to divorce.

3.4 As the ill affects are dormant in the initial stages, the people neglect it without knowing the fact that it takes several years for the symptoms to surface.

3.5 As medical facilities are unavailable or inadequate within the vicinity of the village, they consider it a wastage of time and expense to go in for proper medical check up or treatment.

3.6 The medical teams visit the villages during working hours when young people are away at work.

3.7 Lack of lady doctors inhibits females from seeking medical consultation.

4. The Present Scenario

No doubt, the Government is keen to ensure that relief is extended as expeditiously as possible and is taking prompt action wherever the arsenic contamination is reported through measures such as sealing the contaminated shallow tubewells and advising people against using water of those tubewells for drinking and cooking purposes. The support given by the World Bank and other agencies in this worth mentioning. However, without adequate awareness the news of arsenic contamination and sealing of tubewells is creating panic with people in some places shifting to other water sources, some of which are not safe. The problem is further aggravated by the communication materials produced to educate people which is being circulated without a proper study of the social behaviour. Along with the officials in the field and media coverage other sources who sometimes propagate exaggerated information to communities on the potential health risks deter efforts at combating the arsenic problem.

Currently, there is a multiplicity of agencies who deal with the problem without adequate coordination. At present, several departments of the Government with assistance from various international donor agencies, some NGOs, University departments and private organisations are working on the arsenic problem without standardisation of their work and exchange of information among themselves. Conscious efforts at coordination and information exchange between implementing agencies would not only increase efficiency but also limit resource wastage by avoiding duplication of work.

5. Approach to the Problem and Areas of Intervention

Rather than wasting valuable time and resources on quantitative information (i.e. level of arsenic poisoning), a quick

solution to combat the problem should be on the basis of qualitative information. As a comprehensive solution is yet to be found to this problem, effective awareness creation from authorised sources remains the best hope which could be organised through extension service duly supplemented with supply of arsenic free drinking water in the first instance.

6. Need for an Effective Extension Service

Communication handled with sensitivity using the right extension channels can play a significant role in infusing confidence among the people. As such, anyone visiting the field and interacting with the people is required to be made completely aware of the issues involved with arsenic and also trained in the use of correct interpersonal communication techniques. This effort of training the field workers should also be supplemented by other forms of various media channels such as posters and pictures to disseminate proper knowledge of the dangers as well as suggest solutions. A baseline survey must be done initially keeping in view the existing situation, i.e., the knowledge of the people about the arsenic contamination, their level of understanding, the effect on their health, their water habits as well as the gender concerns.

Another salient issue is the cumulative effect of the other factors such as intake of arsenic through edible herbs grown in contaminated water, food materials contaminated through washing which perpetuate the problem despite people having safe water for drinking and cooking. Therefore, while implementing solutions, the Government should follow a holistic approach. An awareness campaign among the communities only through some authorised agencies should be conducted to let them realise the problem and minimise undue panic.

7. Making Alternate Arrangement

Making available arsenic free water for cooking and other prime requirements remains the top priority in the Government agenda. This could be supplemented with certain other actions such as, change in food habits and use of alternate fertilizers and pesticides. In Bangladesh, the conventional rice cultivation which needs huge amount of ground water should be replaced by the crops which need less water, particularly during the dry season. This envisages a change in the cropping pattern. While the green revolution has doubled the food production, it has been accomplished through usage of abundant water tapped from the ground. Thus, a change in the water use pattern would first require the identification of an alternate water source for irrigation purposes. Further, it is reported that biological treatment processes are more economical and environmental friendly as compared to physico-chemical treatment process(Bluestone, 1986:34-40). Therefore, the solutions to the problem could be addressed in this direction.

There is need for the basic infrastructure of testing to be made available in all the villages to test the water source regularly. One can go to the extent of supplying kits to all the communities or a group of households. Simultaneously, various alternatives for safe drinking water, such as deep tubewells, pond, sand filters and effective rain water harvesting could be immediate solutions for this problem. It is in fact expedient to attach arsenic removal units to all tubewells irrespective of the fact that the ground water is less contaminated with arsenic. The filter system is cost effective, durable and could be used on a daily basis. This system has been tried in arsenic affected areas with excellent results.

An effective solution to this problem could be to formulate projects, initially on pilot project basis with objectives of solving the shortage of safe drinking water, preventing soil erosion, greening of the area, promoting organic farming, educating people and enlisting their participation in all stages. The long term objectives are to improve ground water potential by perculation, improve soil fertility, prevent frequent land slides and floods and motivate farmers to take ecological farming(Mathew and Francina).

8. Use of Bioflocculant

It is reported that from the seeds of `Stychnos Potatorum tree' a proteinaceous substance could be isolated. This substance which is termed as Bio-flocculant has a unique capability of binding with a wide range of metals which include uranium, arsenic, zinc, lead, cadmium, copper, mercury, iron etc.(Prasad, D.). It is also certified that the Bio-flocculant by virtue of its binding capability removes arsenic from the ground water. It is, therefore, suggested that the Bio-flocculant could be effectively used to isolate and remove arsenic from the contaminated ground water in Bangladesh.

As is already mentioned, another problem which is more or less akin to arsenic problem is that relating to flouride which is equally deleterious to health if consumed in quantities greater than the permitted limit. It is also surfacing due to exploitation of ground water and its affects are more pronounced in coastal areas. The similarity existing between these two problems indicates that there could be identified solutions.

In this regard, it is emphasised that a considerably greater work has gone into ways and means to combat fluoride problem and convincingly positive results have been obtained. An example in this regard is the Netherlands Assistance Project (NAP) in

Andhra Pradesh, India. This project has been proposed with both short-term and long-term solutions. This comprehensive scheme was implemented and is being maintained by the Panchayat Raj and Rural Development Department. Also, a comprehensive protected water supply scheme has been implemented under the aegis of Sri Satya Sai Trust, Ananthapur, wherein 737 habitations have been connected with protected water supply through pipelines. This massive scheme has been completed in a record time of one year by the Panchayat Raj and Rural Development, Government of Andhra Pradesh. The author was the Head of the Panchayat Raj and Rural Development Department, when the above two schemes were implemented.

9. Strategies for Management of Ground Water Pollution

A three pronged simultaneous approach to combat arsenic problem is suggested, viz., short-term, medium term and long-term. The components under each approach are as follows :

9.1 Short-term approach

i) Heighten awareness among the people in the arsenic affected areas about the ill affects of arsenic by developing a standard set of communication material.
ii) Sealing off of the contaminated tubewells.
iii) Supply of arsenic free drinking water almost on a day to day basis from an outside source if the same is not available in the vicinity of the village.
iv) Medical treatment of all those who are affected by the arsenic, if necessary, by having medical camps.

9.2 Medium-term approach

i) Educate people who are prone to arsenic contamination on the ill affects of arsenic and how to avoid the same.
ii) Supply arsenic free water from a protected water supply scheme for both drinking and also for household purposes.

iii) A thorough check-up of all the persons who live in the vicinity of arsenic contamination areas with a simultaneous treatment.
iv) Improve water table by effective water management and developing suitable watersheds. This will ensure less intake of arsenic by the crops and animals.
v) Appointment of lady doctors in rural areas for check-up and treatment of women patients.
vi) Arrange training for the health workers and field workers.
vii) Arrange training of local villagers with regard to use of arsenic kits.

9.3 Long-Term Approach

i) Formulate a national strategy to resolve arsenic problem.
ii) Identify arsenic free sources by integrating various technologies viz., RS & GIS chemical analysis, geological data etc. and tap water only from arsenic free sources for P.W.S. and other household purposes.
iii) Construction of reservoirs to act as a permanent water source. This ensures supply of arsenic free water for crops on a permanent basis.
iv) Change in water habit, i.e., shift from use of ground water to use of reservoir water for cropping purposes.
v) Change in cropping pattern by developing such of those crops which consume less water and less arsenic.
vi) Change in food habits, i.e., adoptability to consume changed crops and improving the nutrition value of food.
vii) Periodic health check-up of all those who live in the vicinity of arsenic contamination.
viii) Education with regard to arsenic problem to become a part of regular curriculum for all the students.
ix) Rehabilitation of arsenic affected persons.
x) Establishing arsenic testing labs in all unions and capacity building for water testing.
xi) Establishing Primary Health Centres (PHCs) in all unions

10. Creation of a Separate Agency to deal with the Arsenic Problem

As the departments now dealing with the arsenic issue are not specialised departments which consider the arsenic issue as one of their many responsibilities, inadequate importance is given to resolving the problem. Also, there is a multiplicity of agencies which are handling this issue. As such, it is expedient to create a separate Board/Agency to deal with this problem, and to manage and monitor funds and resources in a consolidated and systematic manner for making effective use. It is quite likely that certain committees could be existing in this regard, but as of date they are not vibrant.

In view of the above it is suggested that a special officer of the rank of Cabinet Secretary may be appointed to head this Agency. In order to ensure political commitment, it is further suggested that there could be a Governing Body with the following composition to take policy decisions :

1.	Prime Minister	: Chairperson
2.	Minister for Local Government. Rural Development and Cooperatives	: Member
3.	Minister for Health and Family Welfare	: Member
4.	Minister for Information and Communication	Member
5.	Minister for Water Resources	: Member
6.	Minister for Finance	: Member
7.	Representatives from donors/regional institutions	: Members

The Governing Body could meet once in three months to review the progress made.

Apart form the Governing Body, there could be an Executive Body to advise the special officer on a regular basis. The composition of the Executive Body could be :

1.	Cabinet Secretary	: Chairperson
2.	Secretary, Finance, Planning Commission	: Member
3.	Secretary, Rural Development and Cooperatives	: Member
4.	Secretary, Health and Family Welfare	: Member
5.	Secretary, Information & Communication	: Member
6.	Secretary, Irrigation	: Member
7.	Persons nominated by the funding Agencies	: Member
8.	Special Officer	: Member Secretary

The Executive Body could meet once in a month or as often as required.

Also, there could be one Technical Committee/Body consisting of the following members to advise the special officer on technical matters :

1.	Special Officer	: Chairperson
2.	Chief Engineer, Public Health and Engineering Department	: Member
3.	Director, Public Health	: Member
4.	Director, Institute of Post Graduate Medicine and Research	: Member

5. Director General, Geological Survey of Bangladesh : Member
6. Director,National Institute of Preventive, Social and Occupational Medicine : Member

The Special Officer may be provided with sufficient exclusive staff support both technical and non-technical which could include a Chief Engineer, Medical and Health Officer, Public Health Officer, Information & Communication Officer and a Finance Officer. All these officers could be on deputation from the respective departments. Also, necessary secretarial support could be provided to this agency so that it could function independently.

11. Conclusions

The problem of ground water pollution has assumed the proportion of a slow onset disaster. Among the ground water pollutions, arsenic and fluoride contaminations are affecting millions of people in Bangladesh, India and China. In Bangladesh, the arsenic contamination is detected in almost 34 out of the total 64 districts, that is to say, about half of the population is affected. Contaminated ground water is considered to be the prime cause of arsenic poisoning. The arsenic effect is more pronounced in Bangladesh than elsewhere because of water use habits especially the dependence on ground water.

Arsenic is a human carcinogen and the consumption of arsenic contaminated water leads to aliments such as skin cancer, maleness and the risk of liver, kidney and bladder cancer. There is also the possibility that arsenic borne diseases are transmitted from mother to the fetus.

Due to social factors and the stigma attached, the arsenic problem is more deep rooted and insidious than what is reported. Inadequate knowledge regarding the problem has perpetuated the belief that arsenic diseases are contagious and affected person would be isolated if it is known to others. Lack of medical facilities is also hampering its detection.

The Government is trying its best to tackle the problem by sealing the arsenic affected tubewells and propagating the ill-affects of arsenic. However, without a properly developed and locally sensitive educational mode, the campaign at times is causing undue panic among tubewell water users. Also, multiplicity of agencies who are dealing with arsenic problem is creating confusion. Successful strategies followed by neighbouring countries such as India in combating the problem may be explored and locally adopted. The use of Bio-flocculants may also be attempted. A strategy with short-term,, medium-term and long-term approach is suggested to tackle the arsenic problem. An agency under an independent officer be created to monitor the entire arsenic problem.

ARSENIC IN DRINKING WATER IN BANGLADESH AND ITS INTERVENTION

S.A.K.M. Shafique*

1. Background

The report of Arsenic poisoning in West Bengal, India adjacent to western border of Bangladesh created a sensation throughout the country. Department of Public Health Engineering (DPHE) initiated monitoring and water testing activities in the adjacent border district in 1993. In Bangladesh the contamination of arsenic in groundwater was first detected in 1993 at Barogharia Union of Chapainawabganj District by DPHE. The arsenic contamination problem in groundwater had then been reported from different parts of the country. Appreciating the gravity of the problem water samples from hand pump tubewells were tested in 1995 in some more areas. From then the identification of arsenic in groundwater in Bangladesh were started and has been continuing.

2. Magnitude of the Problem

DPHE under a Technical Assistance Project procured 500 arsenic test field kits and distributed to District and Thana level. Till January 1998 a total of 19167 samples from hand pump tubewells have been field tested by field test kits covering almost the whole country where 3731 samples have shown positive results which is more than 0.05mg/liter (The maximum permissible limit of arsenic in drinking water is considered 0.05 mg/liter in Bangladesh). The positive result is 19.46 per cent of the total sample tested all over the country.

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* Chief Engineer, Department of Public Health Engineering (DPHE), Dhaka

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The Bhoreer Kagaj, Dhaka, Bangladesh dated 17 January, 1997, p.1

Water sample was tested from 368 Thanas of 60 Districts where 155 Thanas were found affected resulting total number of arsenic affected Districts in Bangladesh as 45.

On the other hand 2983 samples have been tested in laboratories and 2385 data were analyzed. The remaining data could not be identified due to confusion of its exact location. The sampled analysis of the data indicated that 63 per cent (1505) tubewells have arsenic content within 0.01 mg/litre, 14 per cent (330) tubewells water have arsenic 0.01 to 0.05 mg/litre which is maximum allowable limit considered for Bangladesh and 23 per cent tubewells have arsenic content more than 0.05 mg/litre i.e. above the maximum acceptable limit. The maximum arsenic in groundwater was found 2.50 mg/litre in Pabna and 2.43 mg/litre in Kushtia. The laboratory tests were done mostly from affected areas.

3. Situation Analysis

As the source of arsenic in groundwater is considered to be geological, the concentration of arsenic in water varies from place to place within the same district and also differ in zonal basis.

In Chapainawabganj District 187 laboratory tests result indicted 43 per cent water sample had arsenic concentration more than 0.05 mg/litre. Whereas in Faridpur District 205 laboratory tests result indicated only 21 per cent water sample had arsenic concentration more than 0.05 mg/litre.

A different scenario was found in a severe problem area. A very recent laboratory test result of 110 tubewell water samples at Haziganj Thana of District Chandpur indicated the following results.

up to 0.01	mg/litre	5 Samples
> 0.01	to 0.05	7
> 0.05	to 0.10	8
> 0.10	to 0.20	23
> 0.20	to 0.40	36
> 0.40	to 0.60	24
> 0.60		7

Out of 110 tested samples 89 per cent (98) samples have arsenic concentration more than 0.05 mg/litre.

The concentration of arsenic in groundwater also varies widely in a small difference of depths in a village. Generally the concentration of arsenic in groundwater decreases with increases of depths.

3.1 At villagae Alhera Nagar of Thana Bera of District Pabna the depths of the tubewells varies from 50 to 70 feet. The concentration of arsenic in tubewll water were found from 0.01 mg/litre to 0.70 mg/litre.

3.2 At village Chandpur of Thana Faridganj of District Chandpur, the depths of the tubewells are normally within 50-65 feet. The arsenic concentration were found from 0.10 to 1.20 mg/litre. However, the tubeweil having depth 750 feet had shown arsenic concentration of 0.03 mg/litre.

3.3 A different situation prevails in the deep tubewell areas. In those areas arsenic were found in shallow tubewells but not in the deep tubewell.

4. Alternate Water Supply Option

To intervene the problem DPHE is first identifying the arsenic affected areas and affected and unaffected tubewells and motivating the people not to use arsenic contamination water for

drinking and cooking purposes. DPHE is providing various alternate options of safe drinking water supply to the peoples of arsenic affected areas and also doing various research and development activities to mitigate the problem.

4.1 Alternate Water Supply Options in Arsenic Problem Areas

4.1.1 Deep Tubewell (Hand pump)
4.1.2 Pond water with slow sand filtration (PSF)
4.1.3 Sanitary ring well
4.1.4 Rain water harvesting
4.1.5 Infiltration galleries
4.1.6 In case of semi urban areas small scale piped water supply from safe source
4.1.7 Surface water treatment for urban towns
4.1.7 Where no alternate option exist arsenic treatment plant (large and community type).

At present the tubewells affected by arsenic are mostly hand pumps of shallow depths. The areas fall from northern part to southern coastal areas of Bangladesh. Till now no deep tubewells have been found with arsenic contaminated. The most probable alternate option of water supply is the deep aquifer. DPHE undertook several exploratory drilling in different parts of the arsenic problem areas of the country. The outcome of the exploratory drilling are promising. Most of the cases (with few exception) good quality water have been found in deeper aquifer. Where good aquifer will not be found available Pond Sand Filter (PSF) and Rain Water Harvesting would be used as alternatives.

5. Conclusion

The present problem of arsenic in groundwater in Bangladesh is a great challenge for providing safe drinking water when 97 per cent of the population have access to tubewell water sources in the country. As such short term, medium term and long term strategies shall have to be formulated to mitigate the problem. In this regard potential of safe surface water sources shall have to be studied for a long term solution.

VILLAGE HEALTH WORKERS CAN TEST TUBEWELL WATER FOR ARSENIC

Dr. A M R Chowdhury*
Md. Jakariya*
Md. Ashiqul H. Tareq*
Jalaluddin Ahmed*

1. Introduction

Arsenic is an element with metalloid property and is historically known for its toxicity. Arsenic is relatively soluble in water. It occurs naturally in all environmental media and is usually present in the form of compounds with sulphur and with many metals (iron, copper, cobalt, lead, zinc, etc.). It is widely distributed throughout the earth's crust.

The issue of arsenic poisoning in groundwater in Bangladesh has received considerable attention from the press and from various government and non-government organizations and international agencies. BRAC has been working closely with the poor in improving their health, education and economic conditions. In water and sanitation program, BRAC encouraged the use of sanitary latrine and drinking of water from hand tubewells. The recent discovery of arsenic in groundwater indicate that drinking tubewell water is no longer safe particularly in areas where arsenic contamination is severe.

Recently BRAC has initiated a program on arsenic. As alluded earlier, the nature, extent and magnitude of the problem is still not clearly known due to lack of adequate research and information. As a first step, BRAC initiated two testing programs. The intensive one tested all the tubewells of one thana for arsenic

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where, according to previous information, the problem was said to be worse. The extensive one tested tubewells of all of BRAC's 802 field offices. The testing program was implemented in collaboration with the Department of Public Health and Engineering (DPHE) of this Government of Bangladesh through a Memorandum of Understanding. This paper presents two studies conducted by BRAC on the level of arsenic contamination in tubewell water. The suitability of village based health worker's capacities in large scale testing campaign is highlighted.

2. Objectives

The broad objective of the testing program was to determine the level of arsenic concentration in hand tubewells of all BRAC field offices in different parts of Bangladesh and all tubewells of Hajiganj Thana and thereby develop a simple, inexpensive and rapid arsenic testing methodology.

2.1 Specific objectives

The specific objectives of the testing program were to :

2.1.1 assess the capability of village health workers trained by BRAC in testing the tubewells in their own villages for arsenic contamination ;

2.2.2 test the reliability of the field kits in testing water for arsenic, and

2.2.3 assess the capacity of BRAC in undertaking a large scale testing program through its countrywide network.

3. Materials and Methods

3.1 Testing in BRAC Field Offices

Field kits promoted by National Institute of Preventive and Social Medicine (NIPSOM) in Dhaka were used for testing tubewell water[1]. Water which found contaminated with arsenic, on sample basis, were sent to four field laboratories (Comilla, Rajshahi, Mymensisngh, Khulna) of the Department of Public Health and Engineering (DHPE) for further testing by spectro-photometer. All the water samples collected from the field for laboratory analysis were properly stored and acidified before sending on to the laboratory.

3.2 Testing in Hajiganj Thana

In Hajiganj Thana all tubewells were tested. To ensure mobilization and participation of the local community in the process, BRAC involved the *Shasthya Shebikas* (village health workers or VHWs) in the task. VHWs were illiterate women who had earlier been trained by BRAC to treat selected common

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1 In ground water arsenic usually occurs as arsenite (As-III) and arsenate (As-V). To determine the existence of arsenic in water, arsenate is reduced to arsenite by the reducing agents Potassium Iodide (KI) and Stannous Chloride ($SnCl_2$). The As-III is then reacted with Zinc and hydrochloric Acid (HCl) to produce arsenic gas. A color change between light yellow to reddish brown (produced by the reaction of arsenic gas with mercury bromide paper) indicates the presence of arsenic in water. The absence of arsenic in the water is indicated by no colour change on the bromide paper).

illnesses in the village (Chowdhury et al. 1997). *The Shasthya Shebikas* carried out the testing program using field kits. All the 156 villages of Hajiganj Thana were distributed among the 40 *Shasthya Shebikas* who identified with the help of community people, tested all tubewells in her area. The VHWs were given a two-day training by the Environment Group of BRAC on use of the kits. They were also trained on what to advise the villagers if they tested any contaminated tubewells[2]. In addition the village health workers collected information about the depth, location and year of sinking of each tubewell.

A total of 11,954 tubewells were identified and tested with field kits. Of this, 193 water samples were selected randomly for further testing using spectrophotometer at DPHE, Comilla. Unique identification labels were used to identify the samples, and the results from two tests were subsequently matched.

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2 The following advice were given to the villagers if their tubewells tested arsenic contaminated :

* Arsenic cannot be removed from water by boiling and also by using normal filter.
* Arsenic cannot produce an infectious, contagious, or hereditary disease.
* Manifestation of arsenicosis can be reversed by drinking arsenic free water and by eating nutritious and vitamin rich food.
* Increased used of surface water from rivers, ponds, canals, lakes, and rain water for all daily needs including those for agriculture should be encouraged.
* In areas where arsenic-free tubewell water is not available, river/pond/lake/dagwell water can be used for drinking after proper boiling. Or alternately, seventy percent of the arsenic can be removed by keeping the arsenic contaminated water in a pot for at least twelve hours and stirring the water three or four times with a piece of alum and then taking the upper 2/3 portions of the water (Khan & Ahamad, 1997).

4. Results

4.1 The Tubewells of BRAC Field Offices

Out of the 802 field offices of BRAC, tubewell water of 94 offices (12%) were found to be contaminated with arsenic content of more than 0.05 mg/litre. Status of arsenic in tubewells of BRAC offices by region is given in Table 1 which shows that proportion of tubwells found contaminated was more in the Southern part of the country. Figure 1 shows the districts in which at least one tubewell was found contaminated. Out of 61 districts from which data was available, arsenic was found in 34 districts.

Table 1 : Field Test Results of Tubewells in BRAC Field Offices by Region, 1997

Zone	No. arsenic free (<0.05 mg/L)	No. contaminated (>0.05 mg/L)	Total
North East	43 (100)	00	43
North West	207 (97)	06 (3)	213
North Central	234 (94)	14 (6)	248
South East	44 (69)	20 (31)	64
South West	180 (77)	54 (23)	234
Total	**708 (88)**	**94 (12)**	**802**(100)

Note : Figures within parentheses indicate percentage

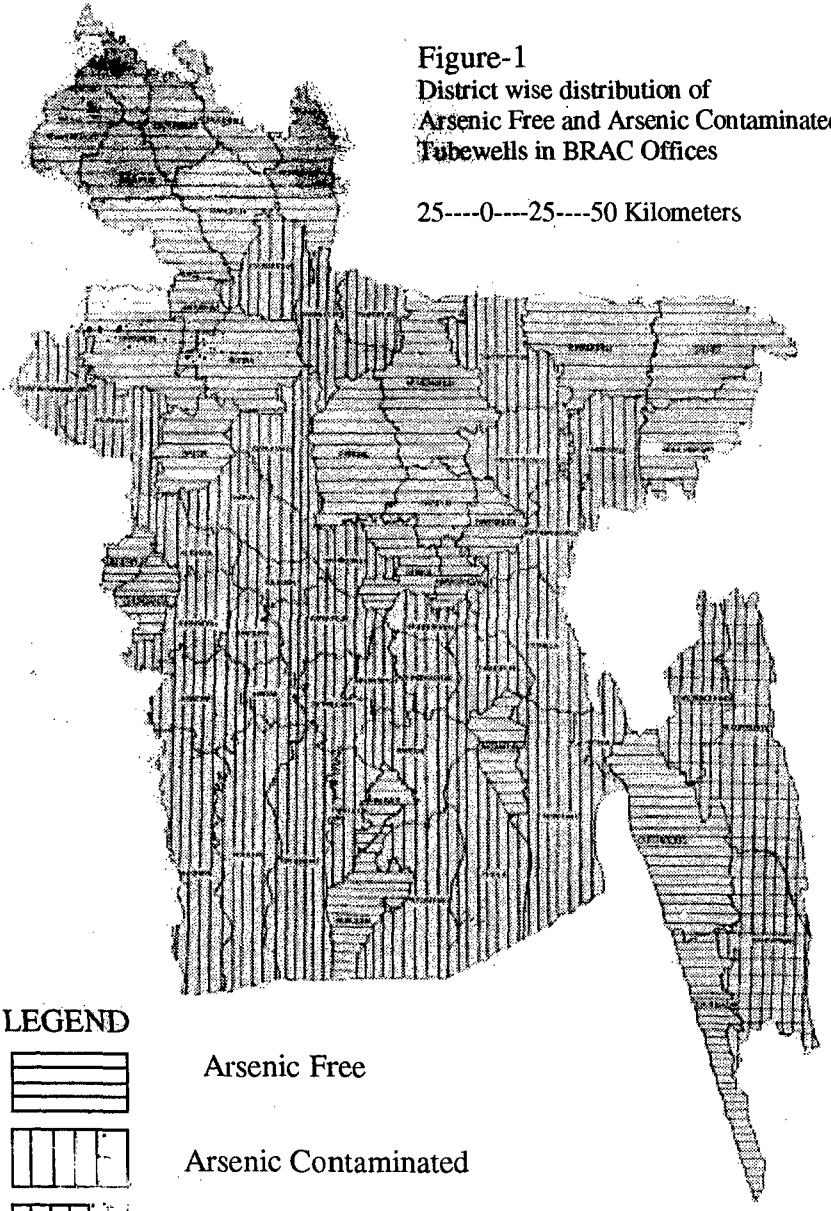


Figure-1
District wise distribution of
Arsenic Free and Arsenic Contaminated
Tubewells in BRAC Offices

25----0----25----50 Kilometers

4.2 Tubewells of Hajiganj

Table 2 gives major results from the testing programme at Hajiganj Thana.

Table 2 : Survey Report on Hajiganj Tubewells at a Glance, 1997

Total population of the Thana	254,057
Number of unions	11
Number of villages	156
Number of tubewells tested by field kit	11,954
Number of tubewells contaminated with arsenic	11,095 (93%)
Number of villages with all tubewells contaminated	83 (53%)
Number of samples tested by spectrophotometer field test results confirmed by spectrophotometer (% cases)	193 92

Out of the total of 11,954 tubewells at Hajiganj Thana, arsenic concentration in 859 tubewells were found to be 0.05 mg/litre or less which falls within the acceptable limit set by WHO. The remaining 11,096 or 93 per cent tubewells were found to be contaminated with arsenic concentration higher than the acceptable limit. Table 3 shows the distribution of the field test results by Union indicating that there are some variation among the Unions. In two of the 11 Unions, over 99 per cent of the

tubewells are contaminated. When the test results were examined by village, the percentage of village where all tubewells were contaminated was 53.

Table 3 : Arsenic Test Results by Union, 1997

Name of Union	Number of Tubewells	
	Total	Arsenic Contaminated
Hajiganj	2717	2646 (97)
Barakul (E)	1039	967 (93)
Barakul (W)	1043	786 (75)
Rajargaon (N)	797	773 (97)
Rajargaon (S)	819	813 (99)
Kalchow (N)	1040	999 (96)
Kalchow (S)	1166	1137 (98)
Hatia	1076	970 (90)
Gondhorbopur (N)	375	334 (89)
Gondhorbopur (S)	1273	1064 (84)
Pauroshobha	609	606 (99)
Total	11954	11095 (93)

Note : Figures within parentheses indicate percentage

The findings indicated that arsenic free tubewells were found more in the south eastern part of Hajiganj Thana adjoining the river Dakatia than in the upper portion of the Thana, which negates any relationship between river borne sediment and arsenic contamination.

An attempt was made to discover whether there was any relationship between depth of the tubewell and arsenic contamination. Table 4 shows that there was a strong relationship between the depth of the tubewells and arsenic contamination (as determined by field kits). Tubewells with high (100 feet or more) and low depth (less than 50 feet) were less likely to be contaminated.

Table 4 : Number of Tubewells by Depth, 1997

Arsenic Status	Depth(feet)				Total
	<50	51-74	75-99	100+	
Arsenic free	31 (11.8)	446 (7.8)	332 (6.0)	29 (13)	837 (7.1)
Arsenic contaminated	231 (88.2)	5280 (92.2)	5216 (94)	195 (87)	10922 (93)
Total	262 (2.2)	5726 (84.7)	5548 (47)	224 (1.9)	11760

Note : Figures within parentheses indicate percentage
P value 34.96791 significance 0.000

An attempt was also made to discover whether there was any relationship between the installation year of the tubewlls and

the amount of arsenic contamination in the ground water. Table 5 shows, there was no pattern found in the distribution of arsenic contaminated tubewells in respect of their age.

Table 5 : Number of Tubewells by Depth, 1997

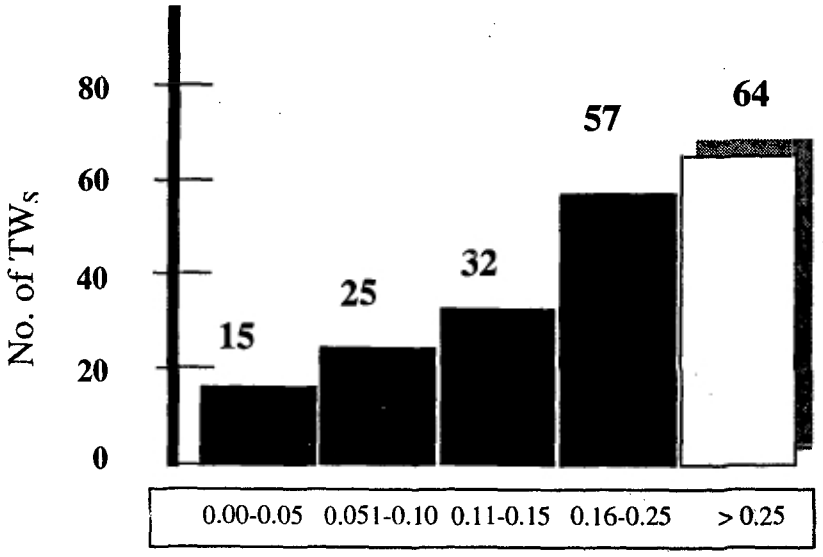
Arsenic Status	Years of Sinking				Total
	1-5	6-10	11-15	>15	
Arsenic free	474 (7.2)	197 (6.9)	60 (6.4)	104 (7.9)	835 (7.1)
Arsenic contami-nated	6129 (92.8)	2673 (93.1)	876 (93.6)	1205 (92.1)	10883 (92.9)
Total	6603 (56.3)	2870 (24.5)	936 (8.0)	1309 (11.2)	11718

Note : Figures within parentheses indicate percentage
P value 2.37624, significance 0.49807

5. Analysis by Spectrophotometer

A total of 193 randomly selected water samples from Hajiganj were analyzed by spectrophotometer to determine the validity of the field kit results. Field kit analysis of 178 or 92 per cent water samples were done simultaneously and matched with the spectrophotometer results. Results of arsenic testing by spectrophotometer indicated the presence of high level of arsenic concentration in the hand tubewells of Hajiganj Thana. The spectrophotometer analysis allowed exact specification of arsenic content in the water sample. As Figure 2 shows, only 8 per cent had arsenic content which is considered safe (<0.05 mg/litre). Sixty four tubewells (33%) had contamination of over 0.25 mg/litre which is alarmingly high.

Figure 2 : Distribution of Arsenic in Groundwater of Hajigonj Thana



6. Time Taken in Testing all Tubewells of Hajiganj

The fieldwork in Hajiganj was undertaken between 23 November and 23 December 1997. It means that the whole operation including testing took about 35 days. A total of 45 VHWs and volunteers took part in the operation, each testing 20-25 tubewells per day.

7. Cost for Testing

An important objective of this program was to accomplish the testing at a low cost. On an average Tk. 18 was spent to test each tubewell for arsenic contamination. VHWs and volunteers were paid Tk. 50 per work day. A detailed breakdown of the cost of carrying out the testing in Hajiganj Thana is given in Table 6.

Table 6 : Breakdown of Costs for Testing Tubewells in Hajiganj Thana

Items	Amount (Tk.)
Salaries and Allowances	
1. Main investigators	30,000
2. VHWs and volunteers : 45 persons	33,500
Arsenic Testing	
1. Cost of field Kit reagent	62,460
2. Cost of using spectrophotometer(193 samples)	25,090
Training	
Training cost for VHWs and volunteers (45 persons)	9,000
Questionnaire & others (including computer use etc.)	15,000
Transport	30,000
Report and Dissemination	5,000
Total (Taka)	2,10,050

8. Discussion

The source of arsenic contamination is considered to be geological, and is a result of high withdrawal of underground water. In Bangladesh most of the drinking water is tapped from ground water by deep and shallow tubewells. There are more than 2.5 million hand-pump tubewells in the rural areas, covering 95 per cent of the total population (Quadiruzzaman, 1997). The indiscriminate use of groundwater for irrigation, lack of proper water management, and inadequate recharge of the aquifer is believed to have led to the progressive decline of ground water all over the country. As a result, the arsenic problem in Bangladesh is growing very rapidly and appears to be a threat to public health. This study also strongly confirmed the existence of the problem. It is a matter of grave concern particularly for specific affected areas such as Hajiganj. To mitigate this problem in Bangladesh, rapid detection of arsenic contaminated tubewells, provision of safe water, treatment of affected persons and health awareness in the community is essential. There is no user friendly, low cost and simple method available for arsenic removal. The detection of arsenic contaminated tubewells and provision of arsenic related information appear to be critical in the present situation.

The number of tubewells to be tested is very large, necessitating development of a simple, low cost, low key and community acceptable system of tubewell testing. BRAC has developed such a system with community members involved in the testing. It has been shown in the present study the rural illiterate women can effectively be trained to carry out testing of tubewells in their own villages at a reasonably low cost and at short time. It took just over a month to test nearly 12,000 tubewells. Compared to what is charged in Dhaka for testing of water for arsenic, Tk. 18, which was found to cost in the BRAC project per tubewell, is considerably low.

The other advantage of involving the community in this task is the creation of awareness about the problem. This comes almost as a by-product of the testing program. It is expected that a mitigation program if implemented following such testing will have a much higher chances of success.

Several field kits for arsenic testing are available in Bangladesh. The field kit used for BRAC's program was cheap, easy to handle and gave reasonably accurate results. Continuous monitoring of the kit itself and the reagent used in this process must be ensured.

NGOs are working closely with community people, meeting and interacting on a regular basis to implement various programs and disseminate related messages. Part of these messages could easily be related to arsenic and arsenic hazards. Such networks also offer the potential for effective implementation of any mitigation program. BRAC has worked with the Department of Public Health and Engineering (DPHE) of the government in this testing experiment which shows that effective collaboration between the Government and NGOs can be forged to address a gigantic problem such as the arsenic contamination in tubewell water.

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ARSENIC CONTAMINATION IN DRINKING WATER AND ITS EFFECT ON HUMAN HEALTH

Hasan Sarwar*

1. Introduction

Adequate and accessible supply of safe water together with sanitation, are recognised as basic health needs of the people. These also constitute essential components of primary health care services and rural development. Water resources also form an important element in other areas of national development. The efforts of Bangladesh have brought about a commendable success in rural water supply sector. By now, nearly 96.0 per cent of the people even in rural areas have access to tubewell water (UNICEF, 1992:142). The success has been achieved as a result of the National Rural Water Supply Programme of the Department of Public Health Engineering (DPHE), assisted by UNICEF, WHO and other supporting agencies. Inspite of such commendable development the rural people and the dwellers in the urban slums are affected by many water borne and water washed diseases. Along with this recently identified high concentration of arsenic in tubewell water has been affecting a large number of population of the country. Its toxic effect on human health is creating a new public health problem in the country. Arsenic related illness is resulting in social problems like divorce and ostracizing of women. This paper focuses on the trend of drinking water contamination by arsenic and its effect on human health.

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2. Trend of Drinking Water Contamination by Arsenic

2.1 Sources of Arsenic Contamination

There are several hypotheses regarding ground water arsenic contamination in Bangladesh. Some experts think that rural wooden poles used for supply of electricity which are treated with arsenic may be the source of arsenic pollution in ground water. The proximity of the wooden poles may be contaminated from this source but a widespread arsenic contamination throughout the country by wooden poles may not be the source. Findings of a study carried out by the International Centre for Diarrhoeal Disease Research, Bangladesh(ICDDR,B) indicated that within 100 yards of such poles no arsenic was found in drinking water above the daily maximum tolerable limit of 0.05 mg/liter.

Some think that pesticides and chemical fertilizers may be the source of contamination. If this hypothesis would be true, then the surface water must be contaminated by arsenic. But laboratory analysis shows that surface water both soft and hard is free from arsenic contamination. Only exception was found in Narayangonj District where industrial arsenic wastes were dumped. From this point of view, it is clear that pesticides and chemical fertilizers may not be the major source of arsenic contamination in ground water (BCAS, 1997 : 1-4).

Seafood contains a large amount of organic arsenic which is less toxic compared to inorganic form. No report is yet available in Bangladesh that arsenic pollution occurred from food (BCAS, 1997: 1-4).

Arsenic patients have been identified in those areas where tubewell water are found to be contaminated. This observation clearly indicates that tubewell water may be the source of arsenic contamination. Arsenic contamination is found greater in between the depth of 30 to 100 feet.

There are several hypotheses about the sources of arsenic contamination in ground water of the Ganges delta region. According to published documentation of various scientists the following hypotheses have been put forward on arsenic contamination in the Ganges delta :

a) Oxidation of pyrite and arsenopyrite due to excessive withdrawal and lowering of ground water is responsible for arsenic contamination in ground water ;
b) Reduction of oxyhdroxides is the cause of arsenic contamination in ground water; and
c) Unconfined aquifers subjected to oxidation and reduction, and underlain by peaty clay and/or clay layer is responsible for arsenic contamination. Mine waste, specially carbonaceous shale, dumped to the surface from coal mining in the Rajmahal basins are transported and deposited along with the river and flood-born sediments may be responsible for the formation of peaty clay layer in the deltaic domain. The continued abstraction of water from unconfined aquifers release pentavalent arsenic and transformed into trivalent arsenic on reduction to become soluble and mobile in water. However, all these three hypotheses may be operative in the Ganges delta region and responsible for arsenic contamination (BCAS 1997 : 1-4).

Major source of arsenic is in the sediments of Ganges delta from Rajmahal coal basin and hydrothermal veins of Rajmahal volcanoes of India. Erosion and denudation of rock materials from this region have resulted arsenic contaminated sediments to be carried down and deposited with quarternary sediments precipitation of iron hydroxides and sulfides. Down the streams in the delta plain iron from Acid Mine Drainage (AMD) of Rajmahal basin has also precipitated via hydrolysis, contributing new suspended sediments enriched with arsenic (BCAS, 1997 : 1-4).

2.2 Arsenic Concentration in Drinking Water in Different Districts of Bangladesh

Contamination of ground water with arsenic is no more an isolated case in the country, as reports of its presence in water in different regions are pouring in every day. Ground water arsenic contamination was detected only in seven districts in 1996, in the middle of 1997 it is extended upto 48 districts. It is assumed that now one-third of the population are at risk of arsenic contamination. It was reported that out of 64 districts arsenic concentration of 25 is below the WHO recommended daily maximum tolerable level of 0.05 mg./litre. The arsenic concentration of most affected districts are briefly described below:

Chapainababgonj : Arsenic contamination was first detected in 1993 by the Department of Public Health Engineering and present concentration in tubewell water varies from 0.00 to 1.00 mg./litre and 70 percent of the tubewells are unsafe.

Lakshmipur : Arsenic concentration ranged from 0.00 to 1.11 mg/litre and 90 percent of the tubewell water is in risk.

Kushtia : Fifty six percent of the tubewell water is unsafe for drinking. Arsenic concentration ranged from safe level to above 1.51 mg/litre.

Pabna : Arsenic concentration ranged from 0.00 to 1.3 mg/litre and 48 percent of the tubewells are above the safe level.

Faridpur : Arsenic concentration in tubewell water varies from 0.00 to 1.53 mg/litre and seventy five percent of the tubewells are above the tolerable level.

Seventy nine per cent of the tubewells in Barisal, eighty seven per cent in Bagerhat, seventy two per cent in Gopalganj, seventy eight per cent is Jessore, seventy four per cent in Rajbari, twenty one per cent in Rajshahi and seventy per cent in Satkhira are above the safe level. Besides these, Comilla, Manikgonj, Munshiganj, Narail, Noakhali, Pirojpur, Sariatpur etc. are arsenic affected districts (BCAS, 1997 : 1).

3. Drinking Water Arsenic Pollution in Bangladesh and West Bengal, India

Dr. Dipanker Chakraborty, a renowed scientist and Director of School of Environmental Studies (SOES), Jadavpur University, Calcutta, India, who has been studying the problem for a long time and played a vital role in addressing the extent and magnitude of the issue. According to him "more than 2,20,000 people in Bangladesh is suffering from arsenic related diseases ranging from melanosis to skin cancer" (Quated by Mortoza, 1997 : 5). According to newspaper information the arsenic problem in Bangladesh is much higher compared to West Bengal, India. The quality of ground water withdrawn by different sources is two times higher in Bangladesh compared to West Bengal.

The following tables present the situation in detail :

Table 1 : Tubewell in Bangladesh and West Bengal, India, 1997

Tubewell	Bangladesh	West Bengal
Deep tubewell (thousand)	27	8
Shallow tubewll (lac)	6	4
Hand tubewell (lac)	25	15

Source : Ranajit Das, 1998, Arsenic Bangladesh a Nuton Ghatak. In: The Khabarer Kagaj, p-12.

Table 2 : Arsenic Concentration in Drinking Water in Bangladesh and West Bengal, India, 1997

	Bangladesh	West Bengal
1. No. of TW water examined	6000	38000
2. TW water contaminated by arsenic to the extent of 1.0 mgm./litre	75 (1.3)	35 (0.9)
3. No of TW water contaminated by Arsenic near to 1.0 mgm./litre	225	N.A.

Data within parentheses indicate percentage

Source : Ranjit Das, 1998. Arsenic Bangladesh a Nuton Ghatok. In : Khabarer Kagaj, p-12.

Table 3 : People Drinking the Arsenic Polluted Water in Bangladesh and West Bengal, India, 1997

	Bangladesh	West Bengal
1. Average percentage of arsenic contaminated TW water	40-60	20-25
2. Percentage of people drinking tubewell water containing 0.3 mg./litre or near	15-25	10-15

Source : Ibid

Table 4 : Children Affected and Skin Diseases Due to Arsenic in Bangladesh and West Bengal, India, 1997

	Bangladesh	West Bengal, India
1. Percentage of children affected	25	2-3
2. Percentage of skin diseases	63*	15-20**

Source : Ibid.

* 1066 skin diseased patients examined in 45 villages in Bangladesh

** Selected skin diseased patients examined in West Bengal

4. Arsenic Toxicity

Any form of arsenic compounds is toxic to human. Its toxicity is more than four times higher than that of the toxic trace element mercury. The toxic effect of arsenic species depends mainly on their chemical form, route of entry, age, sex, doses and duration of exposure. The excessive arsenic intake results in arsenic toxicity which can occur through intake of contaminated food or drinking water. The FAO/WHO recommended maximum tolerable daily intake of ingested inorganic arsenic is 2mg/kg of body mass, and the output in urine is about 5-40 mg/day, and for water it is 0.05 mg/litre. In general, uncontaminated water, both hard and soft, contains arsenic from the undetectable level to a very few microgramme per litre. Dietary intake of arsenic is greatly influenced by the amount of sea food in the diet, and most of the arsenic species in food are in organic forms which are about ten-fold less poisonous than inorganic form. Tow forms - Arsenite (As III) and Arsenate (As V) of inorganic compounds are present in contaminated water and arsenite is more poisonous than arsenate when arsenic is absorbed into the human body, the major portion is excreted in the urine (approximately 50%), a small portion via faeces and through the skin, hair and nail and possibly a trace through lungs. Even if a small amount of arsenic is absorbed it is deposited in the skin, hair and nails where it is firmly bound to keratin. Storage in these metabolically `dead' tissues is responsible for the slow elimination rate of arsenic from the body (BCAS, 1997 : 7).

Arsenic toxicity is normally considered on the basis of intake of arsenic compounds and their excretion from the body. It was reported in literature that 40-60 percent of the arsenic is retained in the body and, therefore, of more arsenic containing water is taken, the greater will be the body burden. In a tropical

country, such as India and Bangladesh, the water consumption is higher because most of the affected areas are villages where manual labour in the fields is necessary. A survey undertaken in West Bengal shows that the average normal water consumption of an adult villager is 5 litre per day. Moreover, the villagers consume plenty of rice-water in the morning and all foods are prepared using arsenic contaminated water which is also be used for bathing, washing and other domestic uses. Thus, considering their intake of water it appears that villagers are ingesting more arsenite than expected. Moreover, since arsenic is more toxic than arsenate and the average concentration of arsenite is 50 per cent of the total arsenic in the ground water of the affected villages, the toxic effect was also found greater than anticipated (BCAS, 1997 : 1-7).

5. Clinical Manifestation of Arsenic Toxicity

The clinical manifestations due to chronic arsenic toxicity develop very insidiously after six months to two years or more depending on the amount of arsenic intake. The symptoms of acute toxicity include severe vomiting and diarrhoea, muscular cramps, facial oedema and cardiac abnormalities. Arsenic affects all the organs and systems - the skin, nervous system, liver, cardiovascular system, endocrine and respiratory system. Signs and symptoms of chronic arsenicosis show different manifestations in different countries (Hotta, 1989 : 49-70)

The skin manifestations are predominant in Bangladesh as well as in West Bengal. Among the patients identified in Bangladesh the most common skin manifestations are shown in the following table :

Table 5 : Skin and Other Manifestations of Arsenic Toxicity in Bangladesh, 1997

Skin Manifestations	Percentage
1. Melanosis	87.4
2. Keratosis	67.7
3. Leukomelanosis	35.5
4. Hyperkeratosis	38.7
Other manifestation	
1. Conjunctivities	6.3
2. Bronchitis	10.5
3. Hepatomegaly	2.2
4. Non-pitting Odema	1.6
5. Bowen's disease	1.4
6. Skin cancer	0.7

Source : A. Wadud Khan, et al. 1997. "Arsenic Contaminated in Ground Water and Its Effect on Human Health with Particular Reference to Bangladesh", in JOPSOM Journal of Preventive and Social Medicine, 1997 : 16 (1) : 65-73.

Long term exposure to inorganic arsenic compounds from drinking water may lead to conjunctivity, hyperkeratosis, hyper pigmentation, cardiovascular disease, peripheral vascular disturbance and nervous systems, cancer of the skin and gangrene

in the limbs. These chronic effects which are different from those of acute arsenic toxicity, may look similar to those resulting from long term environmental exposure of the general population of certain parts of the world to naturally raised inorganic concentration in drinking water (BCAS, 1997 : 7).

Chronic exposure to arsenic has been reported to produce reversible liver enlargement and has been associated with cirrhosis of the liver and also nonchirrhotic portal hypertension. In early stages of arsenic intoxication respiratory infection is found associated with other clinical manifestations. Diabetic Mellitus and Anaemia have also been reported in chronic arsenic intoxication. Available epidemiological and toxicological data indicate that arsenic is a toxin and carcinogen in man.

Arsenic has also been found to cause cancer of the skin, liver, lung, urinary bladder prostate, and possibly of haempoietic and lymphatic tissue. Inorganic arsenic has indicated an association with lung cancer (Hotta, 1989 : 49-70, Mandal, et al. 1996 : 976-986, Landrigan, 1981 : 5-14, Saha, 1995 : 1-12).

The clinical manifestation in Bangladesh are categorised as :

Status	Clinical Manifestations	
Initial stage	Melanosis (spotted, diffuse), Keratosis (diffuse, spotted), Conjunctivities, Bronchitis, Gastroenterities	Reversible
Second stage	Depigmentation (leukomelanosis), Hyperkeratosis, Non-pitting oedema of legs, peripheral neuropathy, Nephropathy (early stage), Hepatopathy (early stage)	Reversible
Third stage	Nephropathy (late stage) Hepatopathy (late stage), Gangrene and Cancer	Irreversible

Source : Khan, et al. "Arsenic contamination" in JOPSOM Journal of Preventive and Social Medicine, 1997 : 16 (1): 65-75.

6. Curative and Preventive Management

6.1 Curative Management

Till-date no effective medicine for arsenic toxicity is available. Withdrawing of further intake of arsenic contaminated water improve the cases. Keratosis can be treated by local application of an ointment containing urea (20%) and salicyic acid

(10-20%). Recently the chelating agents : Penicilamine, DMCA (dimercapto succinic acid : 10 mg/kg body weight for first 7 days followed by 10mg/kg thrice daily for 14 days) and DMPS (dimercaptopropane sulphonate : 100 mg 3 to 4 times a day for every alternate week upto 3 courses) are being used for the treatment of arsenic toxicity. The chelating agent relief clinical manifestations of toxicity and reduce arsenic stores in the body (Khan, et al 1997 : 47, Mazumder, 1996 : 41-42).

Arsenic poisoning is affecting the children as the children of Bangladesh are so under nourished that they cannot combat it. The following table presents the nutrition status of children in detail:

Table 6 : Trend of Nutritional Status of Children in Rural Bangladesh, 1995

Nutritional status	Distribution of Children by Year (%)		
	1975-76	1981-82	1991-92
Normal	3.5	10.0	6.2
Mild (Ist deg. mal.)	17.7	28.8	39.8
Moderate (2nd deg. mal.)	53.0	46.1	47.2
Severe (3rd deg. mal.)	25.8	15.1	6.8

Source : Dr. H.K. Yusuf, 1995. Department of Bio-chemistry, Dhaka University, Dhaka.

Symptoms are improved by intake of nutrious food and vitamins. High protein diet and the antioxidant vitamins A, C & E play important role in management of cases. These vitamins may be given to the arsenicosis patient in the following doses for 3 months.

Vitamin A = 50,000 iu daily for adult
Vitamin E = 200mg daily
Vitamin C = 500mg both daily
In children reduced doses should be given (Khan, et al, 1997 : 3).

6.2 Preventive Management

The preventive measures of arsenic toxicity basically depend on early diagnosis and case management, detection of arsenic in water and supply of arsenic free water. People are to be encouraged to use the tubewells which are not contaminated with arsenic. To identify arsenic contamination-free tubewells, it is necessary to test all the tubewells in affected areas. For supply of safe drinking water as an immediate measure, hand, deep and shallow tubewells may be installed in safe layer. If arsenic contamination - free tubewell is not available, people can be advised to use surface water, such as pond, river and lake water after proper boiling, or to remove arsenic from contaminated water by adding alum which reduce arsenic by about 70 percent or recently developed arsenic removal chemical powder (on the basis of Iron coagulation method) for household use which can remove 95-99 per cent arsenic from the contaminated water (Khan, 1997 : 47).

7. Conclusion

The country has been facing a great danger of arsenic poisoning. It is undoubtedly a great threat now looming over our health sector. The government has taken steps to resolve the problem by instituting surveys and studies and have asked international agencies for help. Several NGOs like DCH, BRAC, ICDDR,B, NGO Forum for Drinking Water amd Sanitation and others are also working on arsenic. Under such a situation, the public, specially the rural people, should be informed of the danger that come from consuming arsenic laced water on a regular basis. Bangladesh Academy for Rural Development

(BARD), Comilla working in the field of rural development feels concerned about the arsenic problem in the rural areas. BARD can play a role in making the people aware about the problem through its village based organisations and steps for combating this.

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HEALTH HAZARDS DUE TO ARSENIC TOXICITY IN BANGLADESH

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1. Introduction

Arsenic is an element, naturally present in all environmental media (air, soil and water)(Claylon, 1981 : 1517-1531 : ILO, 1983 : 1179-1531). The arsenic hazards in Bangladesh is due to only the ground water contamination with high concentration of arsenic.

WHO drinking water quality guide line for arsenic is 0.01 mg/litre and the maximum permissible limit for drinking water is 0.05 mg/litre (WHO, 1981 : 17). In Bangladesh the accepted value for arsenic in drinking water is 0.05 mg/litre.

Previously it was thought that arsenic contamination of ground water occurred mainly in the gangetic plains of Bangladesh. This survey observed that ground water in most of the areas of Bangladesh are contaminated with arsenic except in Barind and Hilly areas where there is no contamination of ground water was detected.

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2. Situation in Bangladesh

In Bangladesh the contamination of arsenic in ground water was first detected in respect of water and its toxicity on human health by two government agencies namely Department of Public Health Engineering (DPHE) under the Ministry of Local Government, Rural Development and Co-operatives (LGRD & C) and National Institute of Preventive and Social Medicine (NIPSOM) under the Ministry of Health and Family Welfare. In the year 1993 in Baroghoria Union of Nawabganj District DPHE detected contamination of water by arsenic. However, Arsenicosis patients were identified for the first time through the survey conducted by Department of Occupational and Environmental Health (DOEH), NIPSOM in the same area during 1994 and 8 patients were detected.

DOEH was the first initiator in the field of study on arsenic contamination in ground water. In the late 1993 the department had taken this issue for research as a part of their academic interest. Through their facts finding survey it was possible to give a primary information on arsenical contamination in ground water and its effect on human health in Bangladesh to the concern people. Although arsenic contamination in ground water is detected in 46 districts, the arsenicosis cases were identified in 33 districts with a distribution in 155 villages of 64 thanas.

So far, 3500 arsenicosis patients were identified upto April 1998. Among them 54 per cent were male and 46 per cent female. The age of arsenicosis patients varied from 5 to 70 years and the most common age group is 10-40 years. All the three stages of chronic arsenic toxicity were observed and most of the patients were in initial and second stage. Only 25 patients were detected in third stage, among them 7 patients were suffering from cancer.

Upto April 1998, 5000 tubewells water samples were analysed by DOEH. Out of these 1405 (28%) had arsenic concentration above maximum permissible limit of 0.05 mg/litre and 1046 (21%) had concentration between 0.01-0.05 mg/litre. The maximum concentration of arsenic detected by DOEH was 2.97 mg/litre (by Atomic Absorption Spectro photometry method) in Nawabganj District. The depth of contaminated tubewells ranged from 35-475 feet and the average range was 50-110 feet.

It has been reported that there exists about 5 million handpump shallow tubewells throughout Bangladesh installed by government and non government agencies and individuals. So far only about 30 thousand of such tubewells have been tested by different agencies for arsenic contamination. Out of these tubewells 20 per cent have been identified to be contaminated with arsenic above the maximum permissible limit (0.05 mg/litre).

The affected districts are : Nawabganj, Rajshahi, Meherpur, Kustia, Khulna, Bagerthat, Jessore, Satkhira, Narail, Chuadanga, Jenaidah, Pabna, Magura, Rajbari, Gopalganj, Faridpur, Madaripur, Laxmipur, Noakhali, Feni, Comilla, Chandpur, Brahmanbaria, Narayanganj, Dhaka, Munshiganj, Narshingdhi, Gajipur, Kishoreganj, Manikganj, Jamalpur, Tangail, Barisal, Natore, Shariatpur, pirojpur, Jhalkathi, Patuakhali, Barguna, Bhola, Netrokona, Shunamganj, Habiganj, Sylhet, Moulavibazar and Kurigram (Arsenicosis patients have been identified in underlined districts).

DOEH developed a Field Kit to detect arsenic in water with the co-operation of Asia Arsenic Network, which is simple, cheap, effective, easy to carry and gives result within few minutes on the spot.

To provide arsenic free water to the arsenic affected people, DOHE have also developed arsenic removal chemical powder on the basis of formula provided by World Health Organisation in collaboration with Atomic Energy Commission for household use which can remove 95-99 per cent arsenic from 18-20 litres of contaminated water within 12 hours. With respect to residual chlorine trial for further modification is under way (Khan, et al. 1997a : 65-73).

3. Clinical Manifestation

In Bangladesh skin manifestation is prime and common manifestation of arsenicosis.

The clinical manifestations are categorised as :

INITIAL STAGE	:	Melanosis (spotted, diffuse)
		Keratosis (spotted, diffuse)
		Conjunctivitis
		Bronchitis
		Gastro-enteritis
SECOND STAGE	:	Depigmentation (leukomelanosis)
		Hyperkeratosis
		Oedema of legs (non piting)
		Peripheral neurophathy
		Nephrophathy (early stage)
		Hepatopathy (early stage)
LAST STAGE:		Nephrophathy (late stage)
		Hepatopathy (late stage)
		Gangrene
		Cancer (skin, bladder and lung)

(Khan, et al. 1997 b : 47)

Among the patients identified, the most common skin manifestations were melanosis (87.4%), Keratosis (67.7%), Leukomelanosis (35.5%) and Hyperkeratosis (38.7%). Other manifestations were conjunctivitis (6.3%), bronchitis (10.5%), hepatomegally (2.2%), and non-pitting oedema (1.6%), Bowen's disease (1.4%) and skin cancer (0.7%).

The cardinal features for diagnosing the arsenicosis cases are :

* Melanosis of palm/trunk/gum/tongue, with or without
* Symmetric Keratosis of sole/palm
* History of drinking arsenic contaminated water

4. Management

So far is no known specific treatment for chronic arsenicosis. Withdrawing of further intake of arsenic contaminated water improve the cases. Symptoms are improved by good diet and vitamins. High protein diet helps in the clearance of inorganic arsenic by increased methylation and protects against toxic effect of arsenic. The antioxidant vitamins, A,E, & C play an important role for management of cases. Vitamin C reduce the toxicity of Arsenic and Vitamin A deficiency in the body increases sensivity to arsenic and Vitamin E protect the Vitamin A and acts as well as antioxidant. These vitamins may be given to the arsenicosis patients for three months in the following doses - Vitamin A - 50,000 i,u daily, Vitamin E - 200 mg daily and Vitamin C - 500mg daily (in case of chidren dose should be adjusted). The affected villagers may be advised to increase intake of cheap available vegetable protein and vitamin rich foods such as : peas, beans, pulses, lentils, wheat, soyabeans, green and leafy vegetables. Keratosis can be treated by local application of an ointment containing urea (20%) and salicylic acid (10-20%). Mechanical scraping of water soaked keratotic soles and palms give encoraging

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results. Chelating agent d Penicillamine can be used in some selected cases under close medical supervision in the doses of 250 mg four times daily for 14 days (Khan, et al. 1997b : 47, Majumder, 1996 : 41-42, Saha, 1995 : 40).

5. Preventive

The preventive measures of arsenic toxicity basically depend on early diagnosis and case management, detection of arsenic in water and provision of arsenic free water. People are to be encouraged to use the tubewells which are not contaminated with arsenic. To identify arsenic contamination free tubewells, it is necessary to test all the tubewells in affected areas. The test can be done by using Arsenic Test Kit. For supply of safe drinking water as an immediate measure, deep and shallow tubewells may be installed in safe layer. If arsenic contamination free tubewell is not available, people can be advised to use surface water, such as pond, river and lake water after boiling or to remove arsenic from contaminated water by adding alum (which reduce arsenic about 70 per cent from water) or Arsenic Removal Chemical Powder for household use(Khan, et al. 1997a : 65-73).

6. Conclusion

It is urgently necessary to test all the tubewells of deltaic and alluvial plain of Bangladesh and to identify the arsenicosis patients in early stages. Comprehensive study is also necessary to find out the exact magnitude and trend of the problem. As there is indication that heavy extraction of ground water and marked fluctuations of the ground water and marked fluctuations of the water level is leading to arsenic contamination in ground water, people should be encouraged reliance on ground water and to increase use of surface water specially for irrigation purpose; for this, proper water shed management policy needs to be adopted.