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REPORT AND ACTION PLAN FOR ARSENIC IN DRINKING WATER FOCUSING ON HEALTH, BANGLADESH

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CONTENTS

1. INTRODUCTION

This report follows a two-week consultancy in Bangladesh concerning the problems of inorganic arsenic in drinking water. Potential arsenic problems in the country have recently become apparent, with most of the information resulting from investigations during 1995 and 1996, including identification of patients by the National Institute of Preventive and Social Medicine (NIPSOM) and measurements of arsenic in water undertaken by the Department of Public Health Engineering (DPHE) and the Bangladesh Atomic Energy Commission. Additional information came from the School of Environmental Studies, Jadavpur University, Calcutta, India, which released a report in November, 1996, of the work conducted jointly with NIPSOM, Rajshahi University and the Dhaka Community Hospital.

The present report focuses on a human health-oriented action plan. It is intended to complement and expand on some of the recommendations made by Professor J.M. Dave, WHO/STC. In addition, the work was undertaken in collaboration with Prof Dave, who will later submit a report based on his second consultancy which will be focused on short-term and long-term methods for providing arsenic-free water.

2. TERMS OF REFERENCE

The terms of reference of this consultancy are listed below. (It should be noted that the work was conducted in collaboration with Professor Dave. The recommendations made in this report are consistent with and are an elaboration of some of those given in his first report of 18 February 1997.)

(1) Based on field visits and known epidemiological findings, to develop an action programme to take remedial measures as well as formulate an appropriate method/technique to evaluate arsenic problems in Bangladesh.

(2) To develop risk-assessment profile for exposed populations, including the consideration of associated factors such as age, gender and nutritional status.

(3) Based on item 2, above to determine an appropriate action level (cut-off point) for arsenic in groundwater in Bangladesh.

(4) To Advise on specific epidemiological research projects to enable further elucidation of the problem with emphasis on risk assessment and field diagnostic methods.

(5) To formulate a strategy to prevent further exposure of the detected cases to arsenic.

(6) To develop a nationwide programme for the elimination or reduction of the risk of exposure to arsenic in Bangladesh.

(7) To identify the need(s) for training/development of concerned units of the Directorate-General of Health Services (DGHS), including the department of Occupational and Environmental Health, of the National Institute of Preventive and Social Medicine (NIPSOM) and assist in meeting those needs for appropriate functioning of arsenic-related activities in Bangladesh.

(8) To Identify suitable field diagnostic methods, i.e. clinical diagnosis without the use of expensive laboratory tests.

(9) To advise on strengthening the NIPSOM laboratory for diagnosis, including the detection of arsenic in human tissue samples.

(10) To develop plans for an out-patient facility at NIPSOM and intervention of affected cases.

(11) To advise on appropriate method(s) for follow-up following intervention of affected cases.

(12) Develop an intersectoral collaborative mechanism (to be prepared in a format which could be easily converted into project proposal(s) to be presented to interested donors) and agencies outside the country, with particular emphasis on the role of NIPSOM to establish a comprehensive national programme for tackling the arsenic problem in Bangladesh.

3. EXISTING SITUATION AND THE MAIN PROBLEMS

3.1 Information Concerning Current Population Exposure to Arsenic in Drinking Water in Bangladesh

Contamination of tubewell water with arsenic was first identified in Bangladesh by the Department of Public Health Engineering (DPHE) in wells in the Nawabgong district in 1993. A committee for reviewing the arsenic situation was formed in 1994 (currently called the Arsenic Technical Committee) and further investigations were conducted by the Department of Occupational and Environmental Health of NIPSOM, along with continuing measurements made by DPHE.

A DPHE laboratory is located in the city of Khulna and serves the Khulna circle which consists of 10 districts with a population which was said to be around 12 million people. A compilation of arsenic measurements up to 28 February 1997 was made available to the consultants. The earliest measurements were made in 1993 with results compiled for six wells. Arsenic was not detected in these samples. The next reports were for the sampling taken in 1995. Measurements were recorded for 35 samples. The highest value was 0.126 mg/L for a well in Meherpur town. During the consultants' visit to the laboratory in March 1997, a summary analysis of measurements made in 1996 was made available. Of the 617 tests made, 282 reported arsenic levels less than 0.01 mg/L. Of the remaining 335 wells tested, 164 of the wells (or about 25% of the total tests) reported more than 0.1 mg/L of arsenic. The samples came form the 10 regions of the Khulna circle which is served by the Khulna laboratory.

Results from various laboratories had been collated in a WHO country situation report titled *Arsenic in Drinking Water in Bangladesh, 1996.* The sources included the Bangladesh Atomic Energy Commission, Jadavpur University in Calcutta, the DPHE laboratories in Khulna and Rajshahi, and NIPSOM. Altogether 400 measurements were presented although there was an overlap between the wells measured in the various laboratories, as well as with the Khulna laboratory results described above. About half of the measurements were above 0.05mg/L. Ten per cent of these anged between 0.05 and 0.1 mg/L, eight per cent between 0.1-0.2mg/L, 26 per cent between 0.2-1.0 mg/L while 5 per cent were over 1.0 mg/L, the highest being 2.87 mg/L for a well in Bangdubupara. About 26 per cent of the measurements were above 0.2mg/L, which can be characterized as a very high level of arsenic contamination.

A larger collection of measurements made by NIPSOM using field kits, including those in the WHO compilation and many more, involved 1328 analyses. two hundred and forty samples contained more then 0.05mg/L.

It is not possible to extrapolate from these findings about the situation in other areas of Bangladesh with any validity. No systematic sampling surveys have been conducted. The report of Jadavpur University

(November 27, 1996) noted that the population living in the 16 districts where there was a high content of arsenic in wells and where some patients were known to exixt was 23 million, and that 50 million lived in the total triangular land area which incorporates the districts involved. However, the report was careful to point out that these figures did not mean that 23 million people were drinking arsenic-contaminated water; it stated that the percentage of people also were suspected to be drinking arsenic- contaminated water could only be mentioned after a detailed survey had been conducted. Since the areas tested were predominently as a result of the reported cases of arseniasis, it was likely that the *average* arsenic levels in drinking water in other areas not so far tested would be lower than the average levels of arsenic in water measured to date. However, it was clear, just from the wells so far tested, that arsenic in drinking water was a major problem,with high concentrations of arsenic having been found in hundreds of wells in a large area of the country involving, now 21 district out of the total 64 districts.

3.2 Information Concerning Current Arsenic Health Effects in Bangladesh

The first signs of chronic arsenic poisoning usually involve the skin with areas of hyperpigmentation appearing on the upper chest and arms. Keratoses later appear on the palms of hands and the soles of feet, ranging from initially small raised lesions difficult to identify to large keratotic patches which are obvious even from a distance.

With the available data on arsenic water concentrations, it is difficult to estimate the number of patients who might be affected. NIPSOM has been compiling and continually adding to a list of cases, mainly identified in 1995 and 1996, by their own team and by the Jadavpur University survey in which NIPSOM also participated, and by the Dhaka Community Hospital. A total of about 850 cases with skin lesions are so far on this important register. They live in villages scattered throughout the arsenic-affected area. However, since the list results from the patients found so far, rather than a systematic sampling and examination of the population, the list does not reveal the full extent of the arsenic problem in Bangladesh. That this was so was evident during the consultant's field trip to the Khulna and Jessore areas. These were areas where there had been several previous visits and where the arsenic problem was well known. Patients were sought using names and addresses appearing on the register. Yet, even while they were examined, other villagers appeared, some with obvious skin manifestations, and were added to the register. This is not to minimize the value of the register, which is the result of diligent work with limited resources. Rather it serves to indicate that ascertainment of cases was not complete even in the well-known arsenic areas.

Further surveys had been conducted by the Dhaka Community Hospital (Disaster Forum,Arsenic Fact Sheet). During a survey from December 1996 to January 1997, 17 districts were visited, with 1066 adults and 278 children being examined in 44 villages. 673 adults and 278 children were reported to be affected. The extent of overlap between those identified and those already appearing on the NIPSOM register was not yet known.

Based on the information available to date, it was difficult to derive estimates of the total number of cases who *currently* had arsenic-caused health effects in Bangladesh. Many villages in the arsenic region of the country had not yet been visited. On the other hand, there had been repeated visits to some areas by several different groups. One question remained: whether it was the tip of the iceberg of arsenic-caused skin disease now present in the region which had been identified, or whether the majority of the most seriously affected villages were already evident. In the latter case, it would be expected that many more arsenic-contaminated wells might be found but at somewhat lower arsenic-concentration levels than so far reported.

Based on what was already known, a rough estimate might put the current member of chronic arsenic poisoning cases with skin disease atleast 2,000 cases. However, the true figure could be many times higher

than this. So far there had been only scattered reports of skin cancer. For example, pictures of two cases were included in the report of Jadavpur University (November 27, 1996). The occurrence of internal cancers in the arsenic-exposed population was unknown.

4. ACTIVITIES UNDERTAKEN

All activities were undertaken following briefing in the WHO office in Dhaka. Staff of the Ministry of Health were closely involved in the organization of the programme of work of this Consultant, particularly the staff of NIPSOM under the leadership of Prof Wadud.

5. FINDINGS AND CONCLUSIONS

Findings

(1) Arsenic exposure is widespread in a large area of Bangladesh and has already been found to affect hundreds of wells.

(2) It is estimated that at least 2,000 cases of skin lesions caused by arsenic had already occurred, and there may be many times more cases than this.

(3) Cases of arsenic-caused skin lesions will continue to occur in the future if the exposure continues.

(4) Arsenic skin lesions are extremely unpleasant for patients, and may be very debilitating.

(5) Cases of arsenic-caused skin lesions were occurring in children as young as 10 years of age.

(6) While few cases of cancer had yet been reported, large numbers can be predicted in the future including those of highly fatal internal cancers.

Conclusions

(1) The most common effects of chronic ingestion of arsenic from drinking water are characteristic skin lesions which can be diagnosed by simple examination of a patient in the field without requiring medical training.

(2) There are many other non-specific effects of arsenic, but at this point in time there are no special diagnostic tests that differentiate them from the same conditions due to causes other than arsenic.

(3) The technology of greatest value for diagnosing the disease caused by chronic ingestion of arsenic involves rapid field measurement of drinking-water arsenic concentrations to confirm exposure. These measurements need to be approximations only.

(4) The first priority in treating a patient suffering from an effect of chronic arsenic exposure is to provide him/her with drinking water free of arsenic. Indeed, in the absence as yet of good evidence for the effectiveness of other treatment, it can be said that the treatment is of the second priority to continuation of providing arsenic-free water, and that the third priority is to monitor that the patient remains unexposed to arsenic. The reason for this is that it is clear that

providing arsenic-free water will reduce the risk of further complications and further arsenic-caused disease.

(5) Unlike many other major health problems experienced in Bangladesh and other developing nations, arsenic-caused diseases can be eradicated at a relatively low cost.

(6) Studies in Taiwan have shown that there is an increased occurrence of diabetes in the population exposed to arsenic via drinking water. While further research is needed concerning this association, diabetes can be readily diagnosed and treated. A simple dipstick test on a spot urine sample can be used to detect urinary glucose. If positive, the patient could be referred to the nearest health clinic for confirmatory tests and treatment.

6. RECOMMENDATIONS

(1) Classification of arsenic in drinking water as a public health emergency

Consideration should be given to classifying arsenic contamination as a public health emergency in Bangladesh as this would facilitate the rapid allocation of funding and prompt expansion of interventions which have been introduced in the field.

The situation calls for *immediate* expansion of activities in two priority areas.

(a) ON the water side: Prompt implementation of long-term water solutions

The DPHE has already commenced implementation of some long-term solutions.

Plans for Action concerning water will be presented separately by Prof Dave, WHO-STC.

(b) ON the health side: Rapid case ascertainment and interim intervention

In view of their knowledge and experience in the field concerning arsenic-caused effects, their diagnosis and management, it would seem that NIPSOM is ideally suited to undertake this task, although a major inflow of resources and additional personnel will be needed.

Emergency plan of action: HEALTH

The core activity in the emergency plan of action concerning human health involves rapid case ascertainment with immediate provision of arsenic-free water.

(2) Rapid case ascertainment with immediate provision of arsenic-free water

Objectives

(1) To identify all cases of arseniasis in Bangladesh (i.e. patients manifesting skin lesions due to arsenic) in Bangladesh (summary plan in Annex).

(2) To immediately identify an interim source of arsenic-free water and to commence implementation of the long-term solution, usually provision of alternative water supply by DPHE (see separate plan of action).

(3) To monitor progress of patients and compliance with interim water treatment until a long-term water source had been identified and run into operation.

(4) To provide patient care, including starting vitamin supplementation, and providing lotions for patients with keratoses including treatment of infections. The physician should also be equipped to commence treatment of common diseases in the population, making referral for follow-up to health clinics or health complexes.

(5) If symptoms suggest, urinary glucose should be measured. In the course of arsenic research projects, the Consultant discovered undiagnosed cases of diabetes by using routine glucose dipstick testing who have rapidly benefited from treatment. Since testing is inexpensive and easy to do in the field, and since there is evidence that arsenic ingestion may cause diabetes, it is recommended that the rapid case ascertainment teams routinely test for urinary glucose

Once around 90 per cent of the patients had been provided with a long-term source of arsenic-free water in their areas, the rapid case ascertainment teams should be disbanded.

Annex

SUMMARY PLAN FOR OBJECTIVE 1

1. Formation of rapid case-ascertainment teams:

Under the overall direction of the Department of Occupational and Environmental Health of NIPSOM, six rapid case-ascertainment teams should be formed.

The case-ascertainment teams might be based at Khulna, Rajshahi, Lakshmipur, Kushtia, Faridpur and Dhaka. Each of these centres has been chosen on the basis that the large majority of villages can be reached in one-day field trips from there. However, the first and only necessary decision to get started would be to identify the location for the first team which should be selected to be an area with already known major arsenic problems.

Members of the case-ascertainment teams would be recruited from persons resident in those centres, or who would be prepared to live in those centres for one year.

Personnel:

Physician Team Leader - These might be graduates from NIPSOM.

Two Interviewers - health educators, social workers or nurses

Field laboratory technician

Driver

Consideration should be given to including a patient with arsenic skin lesions in the teams.

Office and equipment:

Each team would need a base office with telephone, basic office equipment and supplies, and a typist/ clerk.

Equipment would include:

Four-wheel drive vehicle.
Field kit for water measurement of arsenic.
Equipment and supplies for immediate interim water treatment.
Dip sticks to test urinary sugar.
Lotions for patients skin.
Multivitamin tablets including A, E and C.
Anti-fungal creams
Basic medical kit for unrelated conditions.

2. Advisory committees

NIPSOM Internal Advisory Commitee. It is recommended that an internal advisory committee for rapid case ascertainment and intervention be formed which should include faculty members from the departments of health education, epidemiology, statistics and nutrition.

External Advisory Committee. It is recommended that there be an External Advisory Committee which should include a representative each from DPHE, the Ministry of Health and Family Welfare, the

Directorate General of Health Services, WHO, UNICEF and relevant non- governmental organizations (NGOs).

3. Timetable

It would be advisable to establish one team first, and as soon as it starts functioning, establish teams in other centres one by one, until each of the six centres has a functioning team.

Weeks 1-4:

- Declaration of a public health emergency.
- Identification of emergency sources of funding.
- Identification of NIPSOM staff in Dhaka to work on the project, in particular a full-time project director.
- Select an office to be known as the 'Emergency Programme Dhaka Arsenic Centre'.
- Select a full-time secretary and record-keeper.

Weeks 5-8:

- Selection of a team leader for the pilot field team.
- Selection of office space.
- Preliminary training of team leader.
- Commence recruiting other team members.
- Train team members.
- Obtain a vehicle.

Weeks 9-12:

- Commence operations of first team.
- Evaluate and refine programme.

Week 13 onwards:

- Commence additional field teams.

Although it is difficult to make projections the with existing knowledge of the arsenic problem, it is anticipated that each team would need to be in operation for one year after which they would be disbanded or will focus on arsenic-related research projects.

4. Specific task description: *Health*

Task 1: Rapid case ascertainment, including field kit measurement of arsenic in drinking water

A register has been prepared by NIPSOM involving over 800 cases. The first step would be to establish a priority area for commencement of activities of Team 1 in one centre using the existing register. Cases would be identified by multiple methods, including information from health clinics, examination of villagers living near known patients, questioning of villagers who might have knowledge of other villages, etc. Water would be tested for current and past wells used by patients following interview of patients to identify water sources and volumes consumed.

Task 2: Interim provision of arsenic-free water; commencement of patient therapy; notification of priority sites to DPHE for long-term remedial measures

The most appropriate source for arsenic-free water would be identified starting with the testing of nearby wells by the laboratory technician. Failing that, temporary remedial steps would be commenced using either arsenic filtration, treatment with packets of chemicals, or suitable treatment of surface-water sources. The interviewers would explain the procedures to patients. Where a cluster of perhaps five or more patients was identified, DPHE would be notified that this was a priority site for long-term intervention such as drilling deep tube wells.

Task 3: Patient-monitoring until long-term water solution is implemented near their homes

The monitoring would depend upon the short-term solution chosen. Monitoring and continuing education would be most needed for use of home treatment packets. Patients would be notified to the nearest health clinic and informed that they should go to the clinic if they have any particular health needs or questions. The rapid case ascertainment would periodically check a sub-sample of patients to ensure that the short-term intervention was functioning satisfactorily. Once urine assays for total arsenic were established, sub-samples of patients should have their urine checked to determine compliance and to investigate the possibility that they might continue to ingest significant amounts of arsenic from food sources.

Task 4: Programme completion and evaluation

Once the large majority, say 95 per cent of the patients in the team area, were determined to be in the programme and were receiving the long-term water solution, the teams would be disbanded, moved to another area, or would participate in the research programme.

5. Budget

No specific amounts could be determined, but a budget can be derived by identifying salaries for the personnel to be involved, equipment costs, office costs, transport, etc.

Personnel costs will include a full-time project director, director's office costs, chemist to set up the headquarter laboratory, and an administrator/accountant

Headquarter laboratory costs should include modern equipment to measure arsenic in water and in biological samples, particularly urine.

Costs for each team would include salaries for one year for one physician, two interviewers, one laboratory technician and one driver. Main equipment costs would be a four-wheel drive vehicle for each team.