Knowledge on arsenicosis among primary school children

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Preface

A thesis- Knowledge on arsenicosis among primary school children was done in 2007 on the occasion to complete the MPH course at the University of New Castle, USA.

The study focused on the importance of social awareness program in arsenic contaminated area. Moreover, arsenicosis has been considered as an important public health problem in Bangladesh. Out of 64 districts, 61 districts were found as an arsenic contaminated area. Many people were found suffering from arsenicosis and important number of people was found suffering from cancer originated from arsenicosis. Few people even died from arsenicosis. Still, there is no specific treatment for arsenicosis. It can only be preventable by avoiding drinking of arsenic contaminated water.

In addition, as most of the people in rural area are illiterate and living under the line of poverty, they still do not know the deleterious effect of arsenicosis. At this stage, more media campaign and health education programs are necessary in arsenic contaminated areas.

The study area 'Faridpur Sadar' was selected as an arsenic contaminated area. About 255 people suffering from arsenicosis in Faridpur Sadar. One patient was recently died from arsenicosis. From the study, it was found that the knowledge level about arsenicosis among the primary school children was not high. It was also found that the media coverage in that area was low. Media coverage as well as more health education campaign is necessary to grow social awareness about arsenicosis.

I would like to thank all the teachers of University of New Castle, USA relevant to this thesis. This research I have dedicated to my dearest Mom and the University of New Castle, USA. Thank you.

Dr Tariqul Islam

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About the author in short

All praises belong to the Almighty.

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Academic schooling:
Class 1-5: Saint Mary's School.
Class 6: Chittagong Collegiate School.
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a. 'A Thesis: Knowledge on arsenicosis among primary school children'.

b. 'My Public Health Research: Year 2004-2009'

c. 'My 45 Drawings': Volume 1, 2, 3.

Abstract

A three month study was conducted in three primary schools of Faridpur Sadar district. The study type was descriptive, cross-sectional study. At first among 30 primary schools of Faridpur Sadar upazilla, three primary schools were selected for the study. Selected schools were: Alipur Government Primary School,

Kamalapur Government Primary School, and Bhati Lakshmipur Government Primary School.

Only the students of class four and five were selected for the study. The total sample was taken purposively and it was 150. A prepared structured questionnaire was used to conduct the study. The questions in the questionnaire were both open and close end type.

The variables taken for the study were age, sex, economic condition, media exposure and finally, the knowledge level of arsenicosis.

The age range among the study were 9-12 years, mean= 10.57, mode=45, and median= 10.5. Among the study sample, male was 60% and female was 40%.

Only 38% among the study sample were not considered from poor socio-economic status, the rest 62% were considered as poor.

Media access or media exposure became an important part of the study. Only 28% of the study sample was considered as having active media exposure. The rest of study group (72%) was found as not having an active media exposure.

Based on mainly five selected questions, the knowledge level of arsenicosis was judged or scored. Only 34% got the satisfactory score, the rest 66% got the unsatisfactory score.

Through a hypothesis testing, it was proved that there was a relationship between media exposure and knowledge level of arsenicosis. Here, Odds Ratio is 11.67 and 95% Confidence Interval is from 0.5067 to 0.7732. The children, who had active media access at their home or family, got better scores in knowledge level of arsenicosis exam. We can hope most of the students will improve their

knowledge level through active health promotion and media coverage on arsenicosis in their community by different health organizations.

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Introduction

Arsenicosis is now has been considered as a major public health problem in Bangladesh. Sixty one districts were found as arsenic contaminated areas out of 64 districts.

A 3 month study was conducted on 150 primary school children in Faridpur Sadar Upazilla. Faridpur Sadar was selected as it was a highly arsenic contaminated area. The study topic was: Knowledge on arsenicosis among primary school children.

The study type was descriptive, cross-sectional study. The variables were age, sex, economic condition, media exposure and knowledge level on arsenicosis.

The study was done due to following reasons:
a. Primary school children especially from class four and class five can contribute to the society for social awareness.
b. They can aware their family as well as their community.
c. Health promotion programs can actively involve primary school children.

Background information of arsenicosis in Bangladesh

In the face of heavily polluted surface water, Bangladeshi governments and foreign aid agencies took action in the 1970s and '80s in order to provide the masses with safe water. These governments and agencies dug over a million public tube wells to shallow aquifers, providing the population with water that was believed to be clean and safe. The majority of the wells were sunk by the UNICEF. Ironically these wells led to the largest arsenic contamination crisis in the world. In later years, privately sunk wells became more prominent, eventually outnumbering public wells. Currently, more than 90% of the drinking water in Bangladesh drives from aquifers less than 300m deep, with most aquifers less than 100 meters deep.

In 1980s, health problems associated with arsenic poisoning were discovered in West Bengal. Despite these clues, the arsenic problem was remained unknown till a 1993 examination of tube well water in Nawabganj district led to the discovery of high arsenic concentrations. The number of drinking water wells contaminated by arsenic has been rising day by day. According to a survey, 27% of shallow pipe wells have concentrations of arsenic exceeding the Bangladeshi standards of 50μg/L, which is 5 times the WHO's standard of 10μg/L. It is estimated that up to 30-35 million people became affected by arsenic in Bangladesh and about 57 million people are exposed to high level of arsenic (10μg/L or more).

The crisis in Bangladesh highlights the health problems associated with arsenic poisoning. Skin problems such as keratosis, pigmentation and de-pigmentation, and skin cancer became widespread. Patients who have been exposed for a longer period of time have developed internal organ problems and carcinoma and may even die.

Latest survey result has shown that around 70 million people are at risk of arsenic poisoning from drinking water, 38500 are arsenic affected, 36 died in last 3 years (The Daily Ittefaq, 18th May 2006). Till date, nearly 13000 cases of arsenicosis patients have been identified (August 2002 BBS). The prevalence of symptomatic patients is about 3 in 1000, for a population of 140 millions. There are nearly 11 million tube wells in Bangladesh. Different survey results have indicated that about 35% of the water well is affected, where 9000 villages are seriously affected.

Statement of the problem

Arsenicosis has been considered as a major public health problem in Bangladesh. Day by day, the problem has been increasing due to lack of strong technical support for arsenic mitigation. Unofficially, the number of arsenicosis patients is 40,000 whereas officially it is only about 16,000.

Still there is shortage of government support for the treatment of arsenicosis patients and to support for establishing alternative water options in the arsenic contaminated areas. Out of 64 districts, 61 districts are arsenic contaminated. Many organizations in Bangladesh are now working on arsenic issues. The people of arsenic contaminated areas are getting support from them.

In 1996, arsenicosis patient was first identified in Bangladesh. Now, it is the year of 2007. Through these years, many policies about arsenic were proposed and changed. In 2005, the WHO published a guideline for the physicians to identify and manage the arsenicosis patients effectively.

Details about arsenic and arsenicosis

A. About arsenic

Arsenic- a metalloid element- is a natural part of the earth's crust in some parts of the World and may be found in water that has flowed through arsenic-rich rocks. Arsenic is also emitted into the atmosphere by high temperature processes, i.e. coal-fired power generation plants, burning vegetation, and volcanic action. High concentrations of arsenic in drinking water were found in various parts of the World including Argentina, Bangladesh, Chile, China, Hungary, India, Mexico, Nepal, Pakistan, Thailand, USA, and Viet Nam. A variety of instrumental techniques are available for the determination of arsenic in water and air. (WHO Environmental Health Criteria, No. 224: Arsenic). Arsenic content of natural water may be up to 1-2 μg/L.
The acceptance level of arsenic in drinking water has been agreed to be 0.05 μg/L for Bangladesh.
Most fruits, vegetables, meats, and fishes contain arsenic; but arsenic levels in sea water and sea fishes are higher. Sea fish may contain 5 mg arsenic/kg weight.
Living with nature means human beings take a little amount of arsenic every day through breaths, food, or drinks. But, as they are negligible in quantity and organic in nature, they do no harm.
An intake of 150 μg arsenic per day should not cause any harm to humans, but very sensitive or allergic person may fell sick even with low concentrations.

Table 1 in appendix shows the chemical nature of arsenic.

B. Use of arsenic

Arsenic compounds are mainly used in agriculture, forestry, and industrial processes:

a. In farming and forestry to kill weeds, ants, termites, insects, rats.

b. To protect wood from decay as wood preservatives.

c. In copper melting and industrial manufacturing of glasses, pigments, pesticides, electronic components.

d. Small amount of arsenic compounds are also used in some herbal and traditional medicine.

C. Exposure pathways of arsenic:

Exposure to environment arsenic can occur through one or more of three pathways:

a. Inhalation

b. Ingestion

c. Dermal absorption

Available information suggests that non-occupational exposure occurs primarily through the ingestion of water, with the inhalation pathway playing only a minor role. In Bangladesh, drinking water is the most important source of arsenic intake.

D. Absorption of arsenic:

Both organic and inorganic arsenic are absorbed from the gastrointestinal tract. Following ingestion of trivalent and pentavalent form of inorganic arsenic in solution, arsenic is almost completely absorbed from the gut and a small proportion passes through the faeces. When arsenic is absorbed into the body, the major portion is excreted through urine. After ingestion, arsenic appears in urine within 2-8 hours, about 25% being excreted in 24 hours and 75% within 7 days of exposure.

After absorption, two types of biotransformation- reduction and methylation occur in liver.

After absorption, arsenic is cleared rapidly from the blood and during its 'first-pass' phase, it reaches the liver where it is detoxified by conversion into MMA and DMA.

E. Metabolism of arsenic:

Arsenic metabolism is characterized by two sequential reactions:
a. First, the reduction of pentavalent arsenic to trivalent arsenic in the presence of glutathione,
b. The second is, oxidative methylation reaction in which the trivalent forms of arsenic are sequentially methylated to form mono, di and tri-methylated products using s-adenosyl methionine (SAM) as methyl donor and GSH as an essential co-factor. Arsenic methylation occurs primarily in the liver. Urine is the primary route for elimination of both pentavalent and trivalent inorganic arsenicals, 45-75% of the administered dose being excreted in the urine within a few days to a week.

Arsenate can uncouple oxidative phosphorylation in mitochondria by substituting for inorganic phosphate in the synthesis of ATP, the main energy source of cellular metabolism.
Arsenite reacts readily with vicinal sulfhydryl groups of many essential enzymes and proteins within the cell. It is the affinity of arsenic for the sulfhydryl group that accounts for its accumulation in keratin rich tissues such as, skin, hair and nails. Chronic arsenic toxicity produces various dermal and systemic manifestations including cancer. Trivalent arsenic is believed to be a carcinogen that induces chromosomal abnormalities including changes in the structure and number of chromosomes and sister chromatid changes. The exact molecular mechanism of arsenic induced carcinogenesis is less understood.

F. Acceptable arsenic concentration in human being:

Nail: <1mg/kg
Hair: <1mg/kg
Urine: <.01-.05 mg/L (in absence of seafood)

G. Source of arsenic:

The source of arsenic in soil water is still a controversial issue and yet to be resolved.

Scientists say that sedimentation with arsenic laden soils began in this region about 25000-80000 years back in the Quaternary era which was most popularly known as the Younger Deltaic Deposition or YDD. Sedimentation continued years after years and pockets and rocks of arsenic have been created in specific zones of the country.

Bangladesh is situated at the lower end of the three great river systems: the Ganges, the Brahmaputra and the Meghna and their total catchment area is around 1.5 million square kilometres comprising the Himalayan Mountain System, the Indian Shield, the Shilong Plateau, and the great Gangetic Plains. The area produces huge amount of sediments each year due to geologic reason. An estimate says that the three great rivers carry over 2.4 billion tons of sediments each year through Bangladesh. Frequent floods in Bangladesh have a link with this process. Holocene and recent sediments mostly cover Bangladesh and almost all sediments contain arsenic compounds. Both national and expatriate experts assume that irrational over utilization of soil water for irrigation purpose have caused dissociation of arsenic from the compounds with consequent water contamination.

H. Definition of arsenicosis

Arsenicosis may be defined as a chronic condition due to prolonged exposure of arsenic (for more than 6 months) above the safe level (0.05 mg/L) usually manifested by characteristic skin lesions with or without involvement of internal organ and malignancies.

Drinking of arsenic rich water over a prolonged period leads to chronic arsenic poisoning or arsenicosis. The health effect is delayed and the most effective preventive measure is to drink arsenic free water.

I. Arsenicosis case classification

a. Suspected case: A suspected case is a subject who shows characteristic skin lesions or pigmentary changes or keratosis on first presentation and who has not undergone in-depth medical examination or laboratory testing.

b. Probable case: A case that has undergone further clinical examination and belongs to one of the following categories:

- A suspected case showing melanosis and bilateral keratosis involving palms and soles.
- A suspected case showing unilateral melanosis or keratosis after excluding other skin lesions mimicking arsenicosis.

c. Clinically confirmed case: A case where the presence of arsenic simulating skin lesions has been confirmed by a trained dermatologist or arsenic expert.
The case can be confirmed if laboratory testing was not performed because either a predominant amount of clinical and non-specific laboratory evidence of arsenic was present or a 100% certainty of aetiology was known.

d. Laboratory confirmed case: A case classified on the basis of differential skin diagnosis but in whom subsequent laboratory test for arsenic was positive.

e. Clinically and laboratory confirmed case: A 'clinically and laboratory confirmed case' is a 'clinically confirmed case' in whom laboratory test for arsenic was positive.

f. Non-arsenic case: It is a suspected or probable case where the medical expert finds that the patient's skin lesion is due to the cause other than arsenic exposure.

g. Sensitivity and specificity of case definition:

The rigor and complexity of a case definition and its sensitivity and specificity vary depending on the purpose for which the definition will be applied. In clinical settings, it is appropriate to use a broader and simpler case definition that will apply to capture all possible spectrums of clinical presentations. The present case definition algorithm for non-cancerous skin lesions shows acceptable sensitivity (>80%) and specificity (>80%) for the prevalent arsenic associated skin lesions. It must be remembered that all arsenicosis cases may not necessarily show dermal manifestations at the onset. Those cases will not be captured by present algorithm. However, clinical evaluation for management of suspected cases will pick up such cases that will have to be appropriately followed up medically.

Sensitivity: Percentages of suspected cases reported timely and properly from the community. If the percentage of sensitivity is more, system will be stronger.

Specificity: Percentages of suspected or reported cases are genuine case according to case definition, i.e. probable or confirmed cases. Quality of a system can be strong in this way.

J. Characteristic skin lesions of arsenicosis:

According to National Policy for Arsenic Mitigation 2004 (APSU, 2004) the characteristic skin lesions are as follows:

a. Pigmentary changes in skin &/ mucous membrane:

It can occur anywhere in the human body, especially at non-exposed parts of the body. Presentation can be as follows:

- Fine, freckled or spotted hyperpigmentation pattern on trunk and extremities.
- Diffuse or generalized pigmentation.
- Rounded hypo pigmented or depigment macules on a normal or hyper pigmented background (leucomelanosis or rain drop pigmentation).

- Localized or patchy pigmentation, especially at palms or sole (less common).
- Pigmentation of mucous membrane (oral mucosa), usually in combination with other changes (less common).

b. Keratosis: Thickening of skin and appearance of papule or nodule and that can be categorized as:

- **Mild keratosis:** Slight thickening or minute papules (less than 2 mm) on the palms or soles often associated with girt like texture that may be primarily detectable by palpation.
- **Moderate keratosis:** Multiple, raised keratosis (>2-5mm) appearing mainly or exclusively in a symmetric distribution on palms and soles.
- **Severe keratosis:** Large, discrete or confluent elevations (>5mm) on the palms and soles with nodular, wart like or horny appearance. Less commonly may also appear on the dorsum of the extremities and trunk.
- Diffuse thickening of palms and soles alone, or in combination with the keratotic nodules.

c. Bowen's Disease:

It appears as multiple macules, papule or plaque (1 mm to many cm) in unexposed areas. Usually a scaly, crusted erythematous plaque. Usually, sharply demarcated and seldom indurate in shape. When the crust is removed the underlying surface may be red and oozing.

d. Squamous and basal cell carcinoma: They have highly variable clinical appearances, depending in part on the stage of the malignancy. SCC is characterized by ulcerated or fungating growth. BCC is initially characterized by purely translucent nodules leading to ulcerations.

Hyper and hypopigmentation and hyperkeratosis are the hallmark of high arsenic exposure. The latency period for these skin lesions range from 5-10 years.

Table 2 in appendix shows the arsenic toxicity in different organs in our body.

K. Steps of diagnosis of arsenicosis:

a. History of exposure: History of consumption of arsenic contaminated water (>0.05 mg/L) for a period exceeding 6 months.

- **Either testing water:** The arsenic concentration should be determined by using a validated method performed by trained personnel in a laboratory meeting national standards and practicing operating procedures.
- **Or, Testing Biomarker:** If data on the arsenic concentration of previously consumed water is unavailable, an elevated concentration of arsenic in hair (0.8 mg/kg), in nail clipping (> 1.3 mg/kg) may serve as presumptive evidence of arsenic exposure.

b. Clinical examination:

i. Characteristic skin manifestations:

- Place the patient in direct sunlight (melanosis may not be visible)
- For melanosis, inspect mainly non exposed part of the body, i.e. front and back of the trunk and palms.
- For leucomelanosis, examine the trunk and especially thighs.
- For hyperkeratosis, inspect both palms and soles for the corn like elevation. If corn or wart is not visible, palpate the same for thickening or unevenness in the central parts and edges of the palms and soles.

ii. Non dermatological manifestations

iii. Presence of complications

L. Differential dermal diagnosis of arsenicosis:

The classic pattern of rain-drop pigmentation is relatively specific for arsenic, and its occurrence together with palmar-planter hyperkeratosis is pathognomonic for arsenicosis.

Some of the skin changes associated with arsenic may appear the same or similar to those encountered in other medical conditions. Table 2 lists at least five categories of dermal manifestations those mimicking arsenical dermatosis and include diffused melanosis, spotted melanosis, leucomelanosis, diffused keratosis, and nodular keratosis. Clinicians and paramedical personnel practising in primary care settings can be trained to screen patients for the possible presence of characteristic arsenic-related skin lesions, but a differential diagnosis examination using the criteria by an experienced dermatologist or other physicians with relevant expertise is recommended for confirmation of the diagnosis.

Table 3 in appendix shows the common conditions those to be considered for differential diagnosis of benign skin lesions.

Table 4 in appendix shows the WHO protocol for diagnosis of arsenicosis patient (WHO. 2005)

M. Laboratory Support for establishing exposure history of arsenicosis cases

Testing water: Consumption of drinking water with an arsenic concentration in excess of prevailing national standards for at least 6 months is necessary to establish an arsenicosis case. If data on arsenic concentration of previously consumed water is unavailable, an elevated concentration of arsenic in hair (>1 mg/kg of hair) or in nail clippings (> 1.5 mg/kg of hair) may serve as presumptive evidence of elevated arsenic exposure.

Testing biomarker: The arsenic concentration should be determined using a validated method performed by trained personnel in a laboratory meeting national standards and practising standard operating procedures.
Laboratory support provides ancillary information in instances where probable cases cannot be clinically confirmed or in instances or countries where a laboratory diagnosis is required for final confirmation. (Murphy,T & Guo,J.2004)

N. Types of specimen

Water: Arsenic exposure can be established by testing the water that is currently being consumed.

Hair and nail: Hair or nails provide circumstantial evidence for history of past exposure within the preceding nine months.

Urine: Both organic and inorganic forms of arsenic are excreted in the urine which will test positive for arsenic. Thus, recent exposure to arsenic can be established from urine samples provided the subjects have not been consuming sea-food in the preceding 4 days. Alternatively, the chemical form of arsenic must be differentiated by laboratory methods.

Blood: It is of no value in establishing chronic arsenic exposure because of the short half-life of arsenic in blood.

O. Collection and storage of water and urine samples:

For water and urine samples, it has been advised to collect 50 ml. Care must be taken to avoid contamination and prevent any changes during sample collection and storage. Plastic containers should be acid washed and traces of oxidizing agents should be avoided to preserve the oxidation state of the arsenic compounds. The container should also be completely filled to prevent oxidation from the air in the bottle. Concentrated hydrochloric acid (1 ml of acid in 100 ml of urine) can be used to prevent bacterial growth for urine samples. The samples are stable at room temperature for at least a week and at -20°C for 6 months. For longer periods, it is recommended that the samples be frozen at -80°C. (Rahman, M. 2003)

Urine and water samples can be shipped at room temperature. Avoid shipment before a weekend or holidays. All specimens must be accompanied by a duly filled request form containing information on the patient's name, referring doctor, clinical diagnosis and an address for sending results. The request form should be packed in a separate plastic bag for protection in the event of specimen leakage.

P. Hair and nail collection:

Care should be taken to avoid superficial arsenic contamination. The hair must be washed with arsenic free shampoo and also be free from colouring chemicals containing arsenic. For a female subject, collect 30 hairs of 6 cm in length from the base of hair; discard the hair beyond 6 cm. For males, collect 60 short hairs from the base. For nails, let them grow for 1 month then clip every finger and toe nail. Nail represents 9 months of exposure. Specimens of hair and nails can be stored at 4°C until tasted. Prolonged storage may lead to endogenous fungal growth at some instances. Hair and nails can be shipped at room temperature.

Q. Analytical procedures:

Historically, colorimetric and gravimetric methods have been used to determine arsenic. These methods are either semi-quantitative or lack of sensitivity. In recent years, the technique of atomic absorption spectrometry (AAS) has become the method of choice due to its selectivity and sensitivity in detection of arsenic. Thus, AAS may be considered as the standard reference method ('gold standard') for the evaluation of other test methods. A commonly used variant of the AAS technique is the highly sensitive hydride generation atomic absorption spectrometric method (HGAAS). For mass screening under field conditions, or in a situation where no laboratory facilities exist, it is often practical to use a reliable test-kit for testing arsenic. A number of such test kits are commercially available. The validity of these kits should be checked. It is also recommended that buyer countries should develop policy and guidelines for selection, import and use of these kits. Before using a test kit, all instructions and material safety data sheet must be read and understood. The persons performing the analysis must be trained in a laboratory that meets national standards and practices standard operating procedures. The range and limitations of the kit must be understood. Chemicals, i.e. sulphite and selenium or other impurities can interfere with the performance of some kits and these must be recorded.

R. Quality control:

Testing of arsenic should be undertaken by laboratories that have been nationally recognized and in which appropriate quality control measures are routinely performed. Such laboratories should incorporate both internal and external quality controls and follow accepted Standard Operating Procedures (SOP). The person performing the testing method should be appropriately trained in this area. It is advisable for national authorities to have policy and guidelines on the introduction and use of SOP in laboratories performing arsenic testing, including the use of kits and also to maintain a list of laboratories meeting these standards.

S. Interpretation of laboratory results

Water: The current WHO guideline value of arsenic in water is 0.01 mg/L (or 10 μg/L); also expressed as 10 part per billion (ppb). Thus, any sample containing arsenic concentration > 10 μg/L is considered to be positive.

Urine: A urine sample showing > 50 μg/L may be taken as evidence of recent exposure. The subject should not consume sea food during the previous 4 days.

Hair and nails: The value in hair and nails is not known with certainty. On review of the literature it can be assumed that arsenic concentration > 1mg/kg of dry hair and arsenic concentration > 1.5 mg/kg of nail may be considered as indicative of exposure to an unsafe dose of arsenic within the previous 11 months.

T. Arsenicosis case management:

Basic principles for management

Drugs used in the management of arsenicosis should be ideally based on solid evidence generated through randomized controlled clinical trials. However, more often, recommendations have to be made without such evidence. In those circumstances it is a mixture of less than adequate evidence and the consensus of experts in the area. The management of arsenicosis falls into this category. Management approaches for arsenicosis utilized in the Region to-date have included the use of many drugs, agents, and nutrients. Therefore, therapies that have not been validated in arsenicosis through randomized double-blinded controlled clinical trials, or have not been part of standard medical treatment, cannot be recommended at this point.

Available management strategies

Future studies will inevitably bring about major changes in management. Presently, the management of arsenicosis focuses on 5 key approaches:

a. Cessation of exposure to drinking water or other items with elevated concentrations of arsenic.

b. Administration of drugs or nutrients directed at hastening recovery or averting disease progression.

c. Provision of non-specific supportive care to improve physical symptoms or treat selected complications.

d. Secondary prevention of latent effects through medical surveillance.
e. Counselling and education to address psychosocial sequelae of the illness and provision of appropriate rehabilitation.

Cessation of exposure to arsenic contaminated drinking water

As there is no known specific treatment for arsenicosis, the prudent intervention is to stop consumption of arsenic contaminated water. Appropriate counselling for safe water options and health consequences of consuming arsenic contaminated water should be supported through standard information, education, and communication (IEC) strategies. In general, the water supply option for an area will depend on the availability, quality, and development potentials of available alternative water sources in a given area. A single option may not be suitable or affordable for people with different social and economic conditions. Some of the main strategies for safe water should include:

a. Treatment of surface water: It can be an option in areas with perennial surface water of adequate quantity and good quality. Some of the options include slow sand filters or pond sand filters; pressure filtration followed by disinfection; small scale conventional or prototype treatment plants; and conventional surface water treatment plants.

b. Rainwater harvesting: It has good potential for safe water supply in most parts where there is rainfall. It can be combined with household-based technology with provision for adequate storage tanks. This method is particularly useful in areas where adequate quantity and good quality of surface water sources are limited.

c. Deep tube well: In some areas, deep tube wells can provide water of acceptable quality. Before boring a deep tube well it is important to ensure that the deep aquifers are separated from the shallow contaminated aquifers by relatively impermeable layers. The quality of the water must be monitored for arsenic and other heavy metals that pose health risks.

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d. Treatment of arsenic contaminated water: In some areas, the only available option may be to treat the arsenic contaminated water. A variety of options are available depending on technologies, cost and acceptability and range from filter units for domestic use, through filter units for community level use to piped supply of arsenic treated water.

Administration of nutritional supplements

Administration of non-specific nutritional supplements or anti oxidants directed at hastening recovery or averting disease progression has been undertaken in many countries. Some commonly used anti-oxidants include beta carotene, vitamin E and vitamin C. Presently, there is no large-scale randomized controlled double blinded trial to evaluate the efficacy of this treatment regimens. Their use depends on the national policy and the recommendations of the concerned medical bodies in respective countries.

Provision of non-specific therapy

Symptomatic treatment for patients with keratosis and melanosis includes the application of keratolytic agents. Presently, 5-10% of salicylic acid and 10-20% of urea based ointment for the treatment of keratotic lesions is the most common prevailing practice. Higher doses need further evaluation.

U. Preventive procedures:

Secondary prevention of latent effects

It should be done through medical surveillance. The management of arsenic-associated cancer patients should follow the prevailing national standards and practice for the management of cancer patients in general.

Counselling and education

They address the psychosocial sequelae of the illness and provide appropriate rehabilitation. Programs should be implemented on educating patients and other community members about basic public health aspects of arsenicosis and to dispel misconceptions that may lead to stigmatization, family and occupational disruption and other social hardship.

Table 5 in appendices shows the arsenicosis case management according to stages.

V. Protocol for case management for arsenicosis cases: (According to National Policy for Arsenic Mitigation 2004)

Primary health care services:

1. History and physical examination for detection of suspected cases of arsenicosis.
2. Counselling to terminate consumption of arsenic contaminated water and provision of information on arsenic free water supplies for patients with melanosis.
3. Provision of supportive care by topical keratolytic agents for patients with keratosis. Presently, 10-15% salicylic acid and urea 10-20% have been advised.
4. Periodic surveillance for skin cancer.
5. Patients and community education: counselling for social problem.
6. Advise concerning adequate nutrition.
7. Arrangement for rehabilitation services.
8. Refer to higher level, if indicated.

Secondary health care services:

1. Detailed exposure history and biological monitoring (as needed) of suspected cases referred from primary care providers.
2. Confirmatory physical examination for dermal lesions and systemic disorders.
3. Management of skin cancer and uncomplicated systemic disorders.
4. Management of Bowen's disease.
5. Provision of rehabilitation services.
6. Record keeping and public health reporting regarding confirmed cases.

Tertiary health services:

1. Management of secondary of invasion or metastasis skin cancer and internal cancers by surgery, radiotherapy and chemotherapy.
2. Management of major systemic complications and disorders.

3. Provision of rehabilitation services.
4. Research regarding therapeutic regiments.

Literature review

Article one:
Manifestation of arsenicosis patients and factors determining the duration of arsenic symptoms in Bangladesh

Abstract of the study

This study analysed a total of 1482 arsenicosis patients living in 6 of 496 upazillas (sub-districts) of Bangladesh, who were identified through household screening and then confirmed by a trained medical team headed by medical officer. Melanosis was common (97%) among them but about two-thirds (68.7%) of the patients were suffering from keratosis. Average age was 36 years and average duration of arsenic symptoms was 3 (median) years. About 50% of the patients had been drinking tube well water more than 24 years. Melanosis was significantly associated with younger patients (P=0.031), shallower tube well (P=0.005), and complication of conjunctivitis (P<0.001). Keratosis was also significantly associated with older age (P=0.022), shallower tube well (P<0.001), complication of conjunctivitis (P<0.001), bronchitis (P<0.001), loss of appetite (P<0.001), and wasting (P<0.001). Duration of arsenic symptoms was significantly associated with older age (P<0.001), male (P=0.002), married (P<0.001), smoking (P=0.002), longer duration of consuming tube well water (P<0.001), complication of conjunctivitis (P=0.002), loss of appetite (P<0.001), wasting (P=0.006), and social problem faced having arsenicosis (P=0.040). Multivariate odds ratio (OR) and 95% confidence interval (CI) indicated that keratosis (OR=2.00; 95% CI: 1.56-2.56) was significantly associated with longer duration of arsenic symptoms; loss of appetite (OR=1.40; 95% CI: 1.12-1.74) was a significant complication for longer duration. Similarly smoking (OR=1.33; 95% CI: 1.06-1.68) was positively associated with longer duration of arsenic symptom. These findings will help the policy makers of Bangladesh to understand about the factors that may affect the severity condition of the patients through prolongation of arsenic symptoms. (Hussain MK et al, 2001)

Article two:
Treatment delay period: the case of arsenicosis in rural Bangladesh

Abstract of the study:

Arsenic concentrations of tube well water that exceed acceptable limits pose a serious health problem in Bangladesh. Many Bangladeshis are now suffering from arsenic-related diseases. The objectives of this paper are to examine the extent of delay in seeking medical treatment by victims of arsenic poisoning and to identify factors contributing to this delay. Questionnaire survey successfully administered to 663 victims living in two rural areas of Bangladesh provided the major data source for this study. Analysis of survey data reveal that median delay period was 12 months, but the delay period ranged from 1 month to 18 years. Because of this extremely large range, the mean delay period was about 22 months. The study identified time of identification of symptoms of arsenicosis as the most significant determinant of treatment delay followed by treatment sought from members of mobile medical teams, perceived threat, and level of education. Based on the study findings, it is recommended that the Bangladesh government and NGOs involved in arsenic mitigation and prevention efforts should educate individuals at risk for arsenic poisoning about the benefits of seeking early treatment. This study also recommends continuing to dispatch mobile medical teams to the arsenic-impacted areas. (Paul BK, Brock VL, 2003)

Article three

Trends in water usage and knowledge of arsenicosis in Bangladesh: findings from successive national surveys

Abstract of the study:

The presence of arsenic in tube well water has been identified as a major health problem in Bangladesh. The Bangladesh Government, with international assistance, is attempting to mitigate the effects of arsenic by a major programme of tube well water testing and education about arsenic and how its ingestion can be avoided. In early 2000 the first nationally representative cluster sample survey of water use in Bangladesh found that knowledge of arsenicosis remained low, tube well water remained the dominant source of rural water, and few people knew if their tube well was safe from arsenic contamination or alternatively treated it for arsenic. This paper reports on a follow-up survey of the earlier study population to determine change over two years, and thus for the first time allows a measure of change at the national level. Awareness that there might be something wrong with tube well water had risen markedly, especially among women respondents. However, there had been only a minor increase in the proportion reporting that they had changed water sources. This indicates a lack of a clear message about the risks involved, and about how to respond to the problem. The health authorities lack good information as to the real dangers involved, and the most appropriate interventions, both in technical terms and in terms of economic and social acceptability. In the absence of such information, the most effective strategy may be to promote more rapid testing of wells and to encourage people to switch wells. (Bruce K. Caldwell et al, 2003)

Article four
Arsenic contamination awareness among the rural residents in Bangladesh

Abstract of the study:

Arsenic poisoning of tube well water, which constitutes the primary source of drinking water, has become the greatest health threat to the people of rural Bangladesh. Somewhere between 35 to 57 million people in the country are now suspected of being affected by drinking water contaminated with arsenic. While the Bangladesh government, non-government organizations (NGOs), and bilateral and multilateral assistance agencies are involved in combating this dreadful problem, all of their efforts to date have proceeded without having grassroots information about arsenic poisoning. The objectives of this study are to investigate the level of knowledge rural residents have regarding arsenic poisoning and to identify the correlates of that knowledge. Questionnaire surveys administered among residents of four rural areas in Bangladesh provided the major data source for this study. Twenty villages were selected from moderate and low arsenic risk regions and a total of 356 respondents, 177 from medium risk regions and 179 from low risk regions, were interviewed. Analysis of the survey data reveals that arsenic awareness is currently not widespread in the study villages, particularly in the low arsenic risk region. There are also gaps in arsenic knowledge regarding the diseases caused by arsenic poisoning and mitigating measures available to prevent contamination. This study identified arsenic risk region, level of education, gender, and age as important determinants of arsenic knowledge. The findings of this study will aid in making existing health education programs more effective and in reducing the risk of developing arsenic-related illnesses. (Paul, BK. 2004)

Article five

Increasing awareness of arsenic in Bangladesh: lessons from a public education programme.

Abstract of the study:

Experts are making a major effort to find technical solutions to the serious public health problems posed by arsenic in drinking water in Bangladesh, but public education strategies receive less systematic attention. This article presents the findings of a study evaluating the impact of a 1999 campaign by the 18 District Towns Project to educate the public about the arsenic problem in six Bangladesh towns, where half of the population was estimated to be using arsenic-contaminated domestic water: (1) Water users were advised not to consume arsenic-affected tube-well water; (2) A simple, temporary water treatment method was recommended for those using such water, if they had no safe alternative source; (3) Caretakers of tube-wells having arsenic-free water were advised to share their water sources with others. This evaluation study, utilizing a combination of quantitative and qualitative social research methods, found those influenced by the programme to have higher awareness levels and significantly lower levels of risk behaviour than others. Yet more than half of the at-risk, programme-influenced survey respondents were found still to be drinking (57%) or cooking with (54%) arsenic-affected water. Despite the fact that the campaign did not have a satisfactory public health impact, the experience can inform future efforts to educate the Bangladeshi public about arsenic. One finding is widespread confusion about trusted tube-well water being newly labelled as 'unsafe'. Some think the problem is in the hand pumps themselves. Awareness of life threatening danger from arsenic contamination was found to be low. Learning points from this experience are: the value of explaining together with water testing; giving people opportunities to ask questions; repeating

messages; continuing to educate children about the serious risks of consuming surface water; conducting community-wide education programmes for people of all ages; and evaluating the impact of specific public education strategies. Respecting such principles in public information campaigns will greatly help the public to benefit from future technical developments. (Hanchett K et al, 2002)

Article six

Knowledge of arsenic in drinking water: risks and avoidance in Matlab, Bangladesh.

Abstract of the study:

Widespread contamination of arsenic in Bangladesh has been jeopardizing the health of millions of people. Residents of Matlab, Bangladesh, are among the millions at risk. Using bivariate models in the analysis of survey data, knowledge of health risks and avoidance of arsenic exposure in response to widespread contamination of arsenic for residents of Matlab were estimated. The models examined individuals' knowledge of an arsenic problem in the household and knowledge of specific illnesses caused by arsenic exposure. The likelihood of avoiding exposure to arsenic contamination was further examined. Results of the estimation showed that individual's knowledge of arsenic problems in the household was gathered through awareness campaigns and by word of mouth and that knowledge of illnesses was predicated on education, health, presence of children, elderly and young women. Adoption of avoidance measures was not affected by exposure to arsenic-information sources, but level of education had a statistically significant positive effect on the decision to avoid arsenic exposure. Lack of convenience of safe drinking-water practices lead people to persist in drinking arsenic-contaminated water. (Aziz SN et al, 2006)

Article seven
Access to drinking water and arsenicosis in Bangladesh

Abstract of the study:
The discovery of arsenic contamination in groundwater has challenged efforts to provide safe drinking water to households in rural Bangladesh. Two nationally-representative surveys in 2000 and 2002 investigated water-usage patterns, water-testing, knowledge of arsenic poisoning, and behavioural responses to arsenic contamination. Knowledge of arsenicosis rose between the two surveys among women from 42% to 64% but awareness of consequences of arsenic remained limited; only 13% knew that it could lead to death. Behavioural responses to arsenic have been limited, probably in part because of the lack of concern but also because households are uncertain of how best to respond and have a strong preference for tube well water even when wells are known to be contaminated. Further work conducted by the survey team highlighted the difficulties in providing alternative sources of water, with many households switching back to their original sources of water. (Aziz SN et al. 2006)

Article eight

An eight year study report on arsenic contamination in groundwater and health effects in Eruani village, Bangladesh and an approach for its mitigation.

Abstract of the study:

Based on several surveys during 1997-2005 and visits of a medical team to Eruani village, Laksham upazilla, Comilla district, Bangladesh, the arsenic contamination situation and consequent clinical manifestations of arsenicosis among the villagers, including dermatology, neuropathy, and obstetric outcome, is reported here. Analysis of biological samples from patients and non-patients showed high body burden of arsenic. Even after eight years of known exposure, village children were still drinking arsenic-contaminated water, and many of them had arsenical skin lesions. There were social problems due to the symptoms of arsenicosis. The last survey established that there is a lack of proper awareness among villagers about different aspects of arsenic toxicity. The viability of different options of safe water, such as dug wells, deep tube wells, rainwater harvesting, and surface water with watershed management in the village, was studied. Finally, based on 19 years of field experience, it was felt that, for any successful mitigation programme, emphasis should be given to creating awareness among villagers about the arsenic problem, role of arsenic-free water, better nutrition from local fruits and vegetables, and, above all, active participation of women along with others in the struggle against the arsenic menace. (Ahamed S et al. 2006)

Article nine

Arsenic contamination in groundwater: a global perspective with emphasis on the Asian scenario.

Abstract of the study:

The incidence of high concentrations of arsenic in drinking-water has emerged as a major public health problem. With newer-affected sites discovered during the last decade, a significant change has been observed in the global scenario of arsenic contamination, especially in Asian countries. This communication presents an overview of the current scenario of arsenic contamination in countries across the globe with an emphasis on Asia. Along with the present situation in severely-affected countries in Asia, such as Bangladesh, India, and China, recent instances from Pakistan, Myanmar, Afghanistan, Cambodia, etc. are presented. (Mukherjee A et al. 2006)

Article ten

Magnitude of arsenic toxicity in tube well drinking water in Bangladesh and its adverse effects on human health including cancer: evidence from a review of the literature.

Abstract of the study:

Only after a decade from 1993, arsenic contamination of groundwater in Bangladesh has been reported as the biggest arsenic catastrophe in the world. It is a burning public health issue in this country. More than 50 percent of the total population is estimated at risk of contamination. Already thousands of people have been affected by the disease arsenicosis. Many more may be on the way to manifest lesions in future. We conducted a review of previous studies and published articles including MEDLINE database on this issue. We found that 59 districts out of 64 have been already affected by arsenic in underground drinking water, where this particular source of drinking water is the main source for 97 percent of the rural people. The water is unfortunately now a great threat for the human being due to high level of arsenic. Continuous arsenic exposure can lead people to develop arsenicosis, which in turn elevates the risk of cancer. Skin lesions are the most common manifestations in arsenicosis patients. Relatively poor rural people and other socio-economically disadvantaged groups are more affected by this exposure. Until now cancer patients have been relatively limited in Bangladesh. One of the reasons may be that several years are needed to show cancer manifestations from the beginning of arsenic exposure. But it is suspected that after some years a large number of patients will appear with cancer in different sites for arsenic exposure in drinking water. Various studies have been conducted in arsenic affected countries - notably in Argentina, Chile, China, Japan, and Taiwan -to find the potential of arsenic exposure to cause development of cancer. Among the arsenic related cancers, liver, lung, skin,

bladder and kidney cancers are reported to be prevalent in these countries. Unfortunately no scientific study has been yet conducted in Bangladesh to find the relationship between arsenic exposure and cancers in different sites of the body. So our aim is to conduct an ecological as well as a case-control study in the country in the future. (Khan MM et al. 2003)

Article eleven
Arsenicosis in Bangladesh: prevalence and socio-economic correlates.

Abstract of the study:
The potential effects of arsenic-contaminated drinking water on health are of concern, but our understanding of the risk factors of arsenicosis remains limited. This study assessed the prevalence of and socio-economic differentials in arsenic-associated skin lesions in a rural community in Bangladesh. Data were collected from a village where the Bangladesh Rural Advancement Committee has operated a health surveillance system and a community-based arsenic mitigation project since 1999. In total, 1654 residents in the study village were examined in May 2000 for arsenic-associated lesions on their skin. Socio-economic information was extracted from the surveillance system database covering the village. Nearly 2.9% of the study population had clinical manifestations of arsenic poisoning. The prevalence of arsenicosis was associated with age, sex, education and the economic status of the household. Multivariate analysis identified age and economic status as significant predictors of arsenicosis controlling for education and gender. In conclusion, a clear understanding of the socio-economic distribution of arsenicosis in different demographic and socio-economic groups will be useful in identifying the high-risk groups from arsenic-affected communities. More studies are needed to design effective interventions to mitigate the effects of arsenic in Bangladesh. (Hadi A, Parveen R. 2003)

Article twelve

Prevalence of arsenic related skin lesions in 53 widely-scattered villages of Bangladesh: an ecological survey.

Abstract of the study:
A survey was carried out to provide a representative assessment of prevalence and risk of arsenic-related skin lesions in relation to geographical distribution of arsenic in wells of rural Bangladesh as a necessary background for research into effects in pregnancy and cancer risks. A systematic random sample of 53 villages in four divisions of Bangladesh served by Gonoshasthaya Kendra was selected, and all women aged 18 years or more (n=16,740) were listed. Trained paramedics recorded the presence of skin thickening and nodules on the palms and soles, together with information on tube well use. The prevalence was related to the mean concentration of arsenic for the district as indicated by data from the British Geological Survey and to the date the first well in the village was installed. Overall, the observed prevalence was 176 cases (1.3%) in 13,705 women examined, varying from 0% in 26 villages to 23% in one; lesions were observed more frequently on hands than on feet. The estimate doubled with concentrations of arsenic from 11 to < or =50 microgram/L and increased more than 20 times at >50 microgram/L. In the absence of further information, priority for control measures should be directed at areas where the average concentrations of arsenic are above 50 microgram/L, especially in villages where skin lesions have been identified. (Khan MM et al. 2003)

Article thirteen

Arsenic exposure in pregnancy: a population based study in Matlab, Bangladesh.

Abstract of the study:

This study assessed the exposure of pregnant women to arsenic in Matlab, Bangladesh, an area with highly-elevated concentrations of arsenic in tube wells, by measuring concentrations of arsenic in urine. In a defined administrative area, all new pregnancies were identified by urine test in gestational week 6-8, and women were asked to participate in the assessment of arsenic exposure. Urine for analysis of arsenic was collected immediately and in gestational week 30. In total, 3,426 pregnant women provided urine samples during January 2002–March 2003. There was a considerable variation in urinary concentrations of arsenic (total range 1-1,470 μg/L, adjusted to specific gravity 1.012 g/mL), with an overall median concentration of 80 μg/L (25th and 75th percentiles were 37 and 208 μg/L respectively). Similar concentrations were found in gestational week 30, indicating no trend of decreasing exposure, despite the initiation of mitigation activities in the area. Arsenic exposure was negatively associated with socioeconomic classes and achieved educational level. There were marked geographical variations in exposure. The results emphasize the urgent need for efficient mitigation activities and investigations of arsenic-related reproductive effects. (Vahter ME et al. 2006)

Article fourteen

Arsenic in drinking water and reproductive health outcomes: a study of participants in the Bangladesh Integrated Nutrition Programme.

Abstract of the study:

This study examined 2,006 pregnant women chronically exposed to a range of naturally-occurring concentrations of arsenic in drinking-water in three upazillas in Bangladesh to find out relationships between arsenic exposure and selected reproductive health outcomes. While there was a small but statistically significant association between arsenic exposure and birth-defects (odds ratio=1.005, 95% confidence interval 1.001-1.010), other outcomes, such as stillbirth, low birth-weight, childhood stunting, and childhood under-weight, were not associated with arsenic exposure. It is possible that the association between arsenic exposure from drinking-water and birth-defects may be a statistical anomaly due to the small number of birth-defects observed. Future studies should look more closely at birth-defects, especially neural tube defects, to elucidate any potential health effects associated with arsenic exposure from drinking-water. Further, given the knowledge that serious health effects can result from chronic arsenic exposure, efforts to find alternatives of safe drinking-water for the population must continue. (Kwok R K et al. 2006)

Article fifteen

Chronic arsenic exposure and adverse pregnancy outcomes in Bangladesh

Abstract of the study:

BACKGROUND:

Chronic exposure to arsenic through drinking water has the potential to cause adverse pregnancy outcomes, although the association has not been demonstrated conclusively. This cross-sectional study assessed the association between arsenic in drinking water and spontaneous abortion, stillbirth, and neonatal death.

METHODS:

In this cross-sectional study, 533 women were interviewed. Information on sociodemographic characteristics, drinking water use, and adverse pregnancy outcomes was obtained through a structured pretested interviewer-administered questionnaire. The respondents reported use of a total of 223 tube wells; for 208 wells, water samples were measured using an ultraviolet/visible spectrophotometry method, whereas 15 were measured by flow-injection hydride generation atomic absorption spectrometry (FIHG-AAS).

RESULTS:

Excess risks for spontaneous abortion and stillbirth were observed among the participants chronically exposed to higher concentrations of arsenic in drinking water after adjusting for participant's height, history of hypertension and diabetes, and (for neonatal death only) age at first pregnancy. Comparing exposure to arsenic concentration of greater than 50 microg/L with 50 microg/L or less, the odds ratios were 2.5 (95% confidence interval=1.5-4.3) for spontaneous abortion, 2.5 (1.3-4.9) for stillbirth, and 1.8 (0.9-3.6) for neonatal death.

CONCLUSIONS:

These study findings suggest that chronic arsenic exposure may increase the risk of fetal and infant death. (Milton AH et al. 2005)

Article sixteen

Rural communities' preferences for arsenic mitigation options in Bangladesh

Abstract of the study:

In the context of arsenic contamination of groundwater in Bangladesh, this paper analyses rural people's preferences for arsenic-free drinking water options. A particular focus is on rural households' willingness to pay for piped water supply which can provide a sustainable solution to the arsenic problem, and how the preference for piped water supply compares with that for various other household/community-based arsenic mitigation technologies. The analysis is based on data collected in a survey of over 2700 households in rural Bangladesh. Six arsenic mitigation technologies were selected for the study: three-kolshi (pitcher) method, activated alumina method (household-based and community-based), dug well, pond sand filter and deep tube well (hand pump). The survey results indicate that, after taking into consideration the initial and recurring costs, convenience, associated risks and the advantages and disadvantages of each selected technology, the preference of the rural people is overwhelmingly in favor of deep tube wells, followed by the three-kolshi method. The analysis reveals a strong demand for piped water in both arsenic-affected and arsenic-free rural areas, and scope of adequate cost recovery. Between piped water and other arsenic mitigation technologies, the preference of the rural people is found to be predominantly in favor of the former. (Ahmed J et al. 2006)

Article seventeen

Arsenic related health problems among hospital patients in southern Bangladesh

Abstract of the study:

To assess the health effects of arsenic poisoning and to determine the relationship among duration and severity of skin lesions, exposure dose of arsenic, and nutritional status of people, 150 patients attending the Dermatology Outpatients Department of Sher-e-Bangla Medical College Hospital, Barisal, Bangladesh, were included in this cross-sectional study. The study was conducted during January-December 2000. Records of patients were collected prospectively using a pre-tested questionnaire, which included information on demography, sources of water for drinking and cooking, duration and amount of drinking-water obtained from shallow tubewells, clinical presentations, complications, and physical and laboratory findings. Water samples from tubewells currently being used by individual patients were examined. Nine percent of the patients were unaware that arsenic contaminated water causes diseases. Due to lack of alternative water supplies, 25% of the subjects were still drinking water from contaminated tubewells. About 18% did not complain of any clinical symptoms, except that their skin lesions were ugly-looking, and 82% had moderate or severe skin lesions. Thirty-one percent of the water samples had arsenic concentrations 10-fold higher than the permissible limit of 0.05 mg/L in Bangladesh and 50-fold higher than the WHO guideline value of 0.01 mg/L. The mean arsenic concentration in water was significantly associated with the severity of disease. Body mass index correlated inversely ($r=-0.298$, $p=0.013$) with the duration of disease after controlling for age. The findings suggest the need to enhance public awareness on negative health effects of arsenic poisoning in rural Bangladesh. From a public-health perspective, effective intervention strategies need to be developed to curb the exposure, strengthen rapid diagnostic facilities, establish

effective treatment facilities in rural areas, and improve the nutritional status of people. (Mitra A K et al. 2002)

Article eighteen

Analysis of Disability Adjusted Life Years (DALYs) among arsenic victims: a cross-sectional study on health economics perspective.

Abstract of the study:

Arsenic contamination of ground water is a major public health problem in Bangladesh. It is estimated that more than 20 million people are potentially exposed to arsenic poisoning. This cross-sectional study was carried out in Haziganj Upazilla under Chandpur district between September to December, 2001 with the objectives to assess the socioeconomic consequences and disease burden in terms of Disability Adjusted Life Years (DALYs). A total of 168 subjects suffering from arsenicosis were studied. Both age and disability weights were considered to calculate DALYs. Agricultural labour and housewives suffered more from the disease. A strong relationship ($p<0.005$) was found between duration of suffering and occupation of the subjects. Also, there was a strong relationship between age of onset and education of the study subjects ($p<0.006$). No deaths directly from arsenicosis were reported. It may be noticed that 47% of the patients would be living with disability for more than 51 years. A strong relationship exists ($p<0.002$) between educational level and Years Lived with Disability (YLDs). A total of 7930 YLDs were lost due to arsenicosis, which accounts for 1908 DALYs. (Molla A A et al. 2004)

Article nineteen

Social implications of arsenic poisoning in Bangladesh

Abstract of the study:

Besides its toxicity, groundwater arsenic contamination creates widespread social problems for its victims and their families in Bangladesh. There is, for instance, a tendency to ostracize arsenic-affected people, arsenicosis being thought of as a contagious disease. Within the community, arsenic-affected people are barred from social activities and often face rejection, even by their immediate family members. Women with visible arsenicosis symptoms are unable to get married and some affected housewives are divorced by their husbands. Children with symptoms are not sent to school in an effort to hide the problem. This paper employs mainly qualitative methods to interpret people's understandings about the toxic impact of groundwater arsenic poisoning on their social lives. Arsenic-affected patients in southwest Bangladesh were asked to determine their 'own priorities' in measuring arsenic toxicity on their social activities and to explore their perceptions about their own survival strategies. We found that patients' experiences reveal severe negative social impacts, and a sharp difference of perceptions about arsenic and social issues between arsenicosis patients and unaffected people. (Hassan MM et al. 2005)

Article twenty

Water consumption patterns in rural Bangladesh: are we underestimating total arsenic load?

Abstract of the study:

Risk related to the ingestion of any water contaminants depends on many factors, including the daily per capita amount of consumed water relative to body weight. This study explored the water consumption pattern of a rural arsenic-affected population in Bangladesh. The study findings are likely to contribute to the risk estimation attributable to ingestion of arsenic and other drinking water contaminants. A total of 640 individuals participated in this cross-sectional study carried out in an arsenic-affected rural population in Bangladesh. In this study daily per capita water consumption for drinking purposes was found to be 73.04 ml/kg/d (range = 71.24-74.84 ml/kg/d), which is higher than for both the US and Taiwan populations. This difference in per capita drinking water consumption might contribute to much higher lifetime cancer mortality and other morbidity risks from arsenic among the Bangladesh population compared to either the US or Taiwan populations. Arsenic is also ingested through cooking water which, if considered, might increase the risk further. The findings of this study highlight the urgent need for a holistic water supply programme for Bangladesh, with special emphasis on the arsenic-affected population. (Milton AH et al. 2006)

Article twenty one

Arsenic poisoning in Bangladesh: spatial mitigation planning with GIS and public participation.

Abstract of the study:

A PPGIS (Public Participatory Geographical Information System) has recently been developed in combination with PRA (Participatory Rural Appraisal) and GIS (Geographical Information Systems) methodologies to utilize GIS in the context of the needs of communities that are involved with, and affected by development programmes. The impact of arsenic poisoning in Bangladesh is 'tragic and painful' on patients' health and their social life what was described as the 'worse mass poisoning in human history' in a WHO report. Deep tubewell is said to be a source of arsenic-free safe drinking water and people are mainly interested in deep tubewell water rather than rainwater harvesting, dug-wells, and pond-sand-filters (PSF) approved by the BAMWSP (Bangladesh Arsenic Mitigation Water Supply Project). This paper mainly explores the application and suitability of GIS with local community participation in deep tubewell planning for arsenic mitigation. The relevant data for this study were collected from the field survey. The PRA methods were used to obtain social and resource information; while a GIS was used to organize, analyze, and display the information. Participants from three different focus-groups were asked to determine their 'own priorities' for spatial planning of deep tubewell for arsenic-free water. The study results valuable community perspectives on deep tubewell planning and reveals the suitability of PPGIS in spatial planning for arsenic mitigation with local community mapping overlay. The process of dialogue and preparation of mental mapping within each focus-group participants lead to enhance information about community needs of deep tubewell in the study area. (Hassan MM. 2005)

Article twenty two

Socio-economic status of chronic arsenicosis patients in Bangladesh

Abstract of the study:

The study showed that the maximum number of arsenicosis patients (71%) belonged to low income group and 29% belong to middle class income group but none was found in high income group and all these patients were from rural areas of the country. Majority of all these patients was related with the traditional occupation of the country like cultivation (53%) in addition to lower level of educational background (81.5%). Most of the patients of chronic arsenicosis were suffering from malnutrition (91%). The present study which reflects that the vast majority of patients of chronic arsenicosis in the country belonged to low income group, but also to low educational background and individuals, who had been suffering from malnutrition, needs a special consideration in the management of the problem. Emphasis has been given to have access to arsenic-free water and protein rich diet to people of arsenic affected areas. (Sikder MS et al. 2005)

Article twenty three

Value of arsenic free drinking water to rural households in Bangladesh

Abstract of the study:

Using contingent valuation survey data for about 2700 households in rural Bangladesh, and applying a multinomial logit model, the paper estimates the value of arsenic-free drinking water to the rural people. The estimates indicate that the rural people in arsenic-affected areas of Bangladesh place a low value on arsenic-free drinking water. It is about 10-14 percent of the amount they are willing to pay for piped water and only about 0.2-0.3 percent of the average household income. The implication of the result is that robust but costly arsenic reduction technologies such as activated alumina technology may find little social acceptance, unless heavily subsidized. (Ahmed J et al.2005)

Details about study

A. Research question

What is the level of knowledge about arsenicosis among primary school children?

B. Rationality of the study

To see the knowledge level of arsenicosis among primary school children in the arsenic affected areas.

This study will be helpful to implement the awareness program about arsenicosis in the arsenic affected areas among the school children. The family as well as the community will be more aware about arsenicosis through school children.

The study area 'Faridpur Sadar' was selected as it was a highly arsenic contaminated area. At present, 255 arsenicosis patients were identified and one arsenicosis patient was died at Faridpur Sadar.

C. Objectives

General Objective:

To assess the level of knowledge about arsenicosis among primary school children

Specific Objectives:

a. To assess the level of knowledge about arsenicosis among primary school children,

b. To identify the source of knowledge about arsenicosis, and

c. To find out the socio-economic and socio-demographic characteristics of the primary school children.

D. Variables

a. Socio-demographic characteristics

-Age

-Sex

b. Socio-cultural factors

- Economic condition

- Media exposure

Dependent variables:

Knowledge on arsenicosis

- What is arsenicosis?

- Route of transmission of arsenicosis

- Use of arsenic contaminated water

- Meaning of red and green coloured tube well

- Is arsenicosis contagious?

E. Methodology

- Type of study: Cross-sectional, Descriptive
- Study Population: Primary School Children
- Place of study: Three primary schools of Faridpur Sadar Upazilla at Faridpur district
- Period of study: March 2007- May 2007
- Sampling: Systematic
- Sampling technique: Purposive

- Calculation of sample size:

$n = [z^2 (p \times q)] / d^2 = [(1.96)^2 (0.5 \times 0.5)] / 0.05^2 = 384$ (round)

Due to time limitation and for convenience, 240 samples were taken. Three primary schools were selected randomly among 30 primary schools of Faridpur Sadar upazilla, where total sample was 150. Selected primary schools were: Alipur, Komolapur and Bhati Lakshmipur Government Primary Schools.

- From every selected primary school, students of class four and five were taken for the study. In every selected school, the total selected student of class four and five were 50.
- Data collection technique: Face to face interview in selected schools.
- Date collection tool: Structured questionnaire.
- Data analysis: Through SPSS programme.

F. Scoring knowledge:

A structured questionnaire was prepared for the study. As the study samples were very young in age, the questionnaire was made very simple.

The scoring was based mainly on 5 questions. Those were:

- Have you ever heard about arsenicosis?

- How arsenicosis can spread?

- Can we use arsenic contaminated water? If yes, in which purpose?

- What is the meaning of red and green coloured tube well?

- What is the minimum time to grow sign, symptoms of arsenicosis while drinking arsenic contaminated water?

The expected answers were:

-Yes.

- Arsenicosis can spread through drinking water.

- Yes, we can use arsenic contaminated water for washing clothes and bathing.

- Red coloured tube well means it is arsenic contaminated. Green coloured tube well means its water is arsenic free and safe.

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- Six months.

For every correct answer, the score is one. For every unexpected or wrong answer, score is zero.

Range for satisfactory score: 3-5

Range for non-satisfactory score: 0-2

G. Study, collected data and interpretation:

From the 3 month study of 3 selected primary schools, the following data were found:

Independent variables:

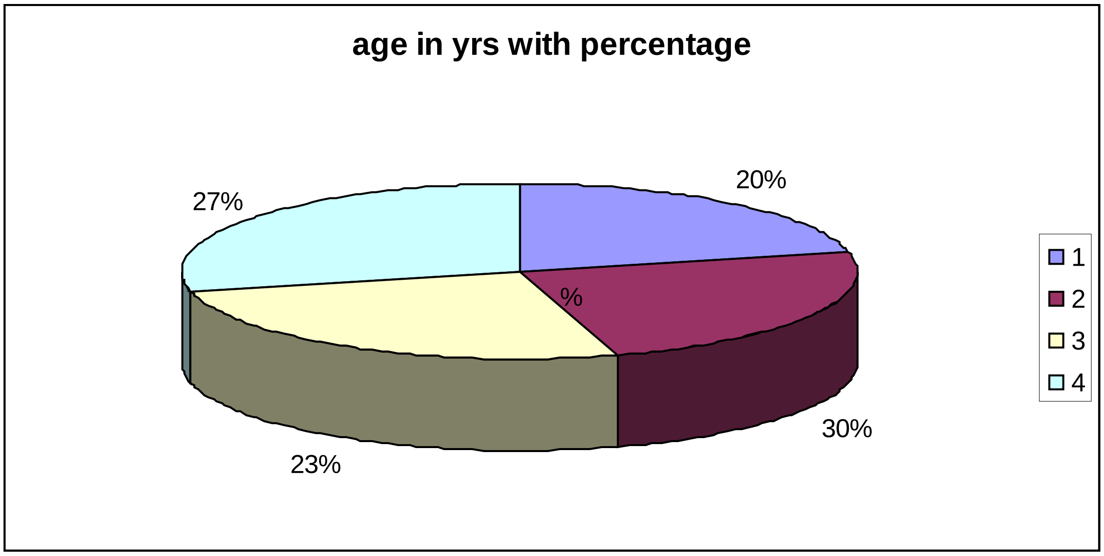
a. Socio-demographic characteristics

Age:

Among 150 study sample, the age distribution was as follows:

Age in years	Total number	Percentage (%)
9	30	20
10	45	30
11	35	23
12	40	27
	150	100

Interpretation of age distribution:



Here, 1= 9 years, 2= 10 years, 3= 11 years, 4= 12 years.

From analysis through SPSS, the age distribution was as follows:

Mean = 10.57

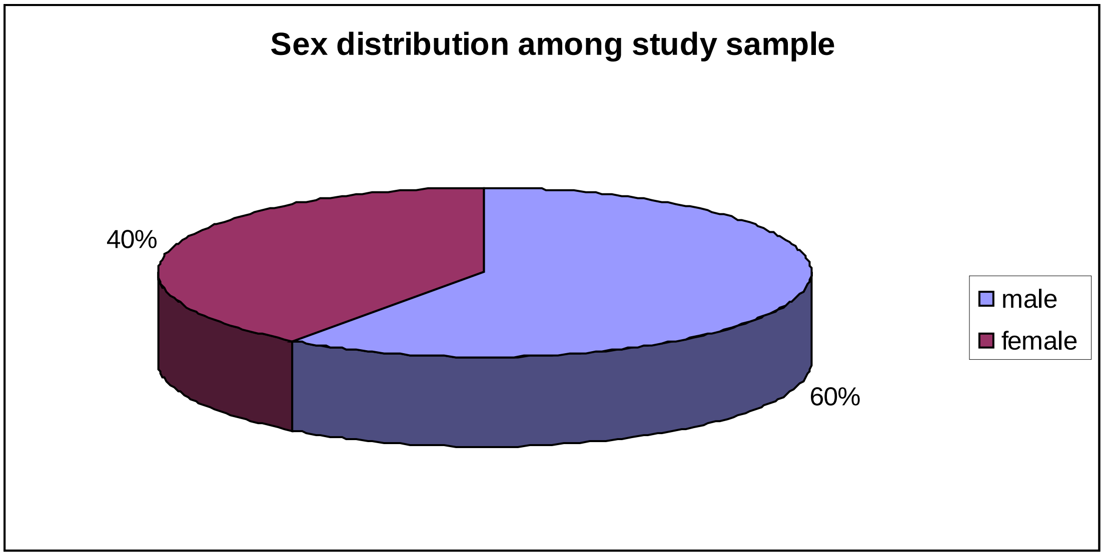
Mode = 45

Median = 10.5

Sex:

Among 150 study sample, 60 (40%) were female and 90 (60%) were male.

The sex distribution was as follows:



b. Socio-cultural factors

Economic condition

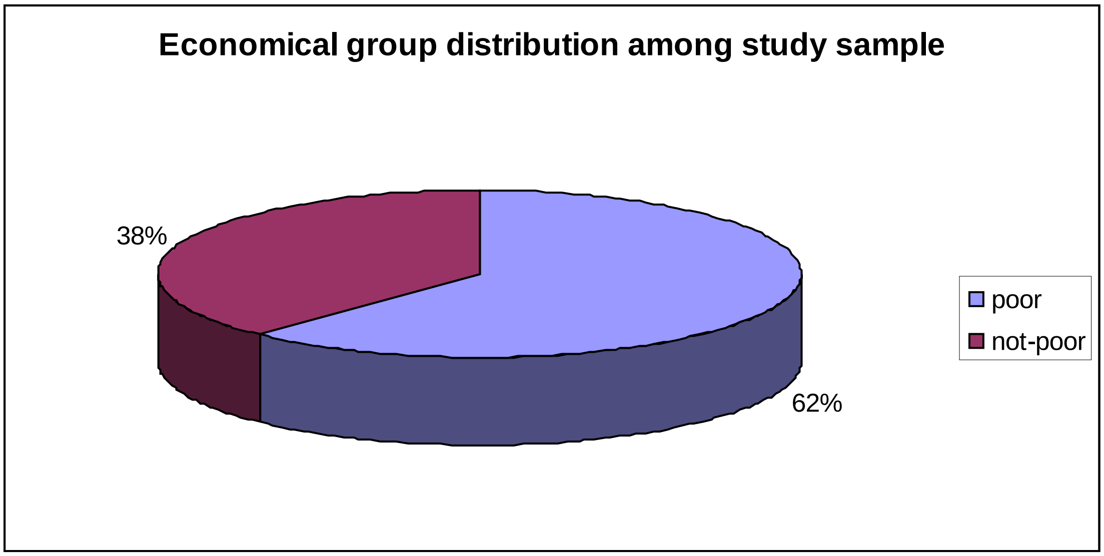
In this study, the study samples are divided into 2 groups in the following way:

a. Poor economic status: Where monthly family income is less than 1000 Taka irrespective of family size.

b. Not-poor economic status: Where monthly family income is more than 1000 Taka irrespective of family size.

In the study, 93 (62%) study sample were found as poor economic status, whereas only 57 (38%) study sample were found as not-poor economic status.

The economical group distribution among the study sample was as follows:



Media exposure:

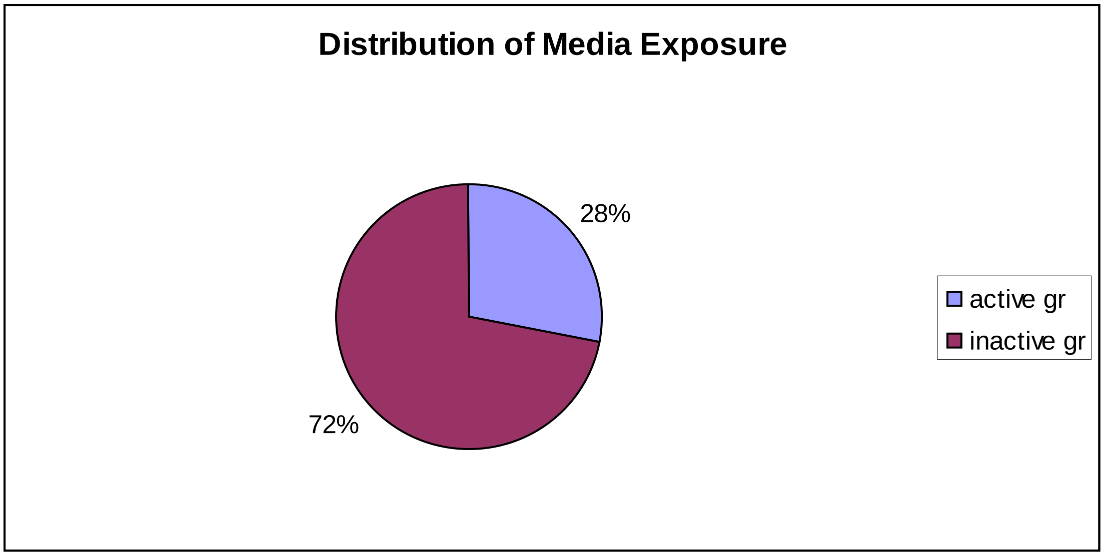
Here, the term 'Media exposure' means access to the radio, television, and print media with arsenic related news. The study samples were divided into 2 groups:

Actively media exposed: Who are always exposed to the media

Inactively media exposed: Who are only sometimes exposed to the media

Among the study group, only 42 (28%) sample were found as actively media exposed whereas 108 (72%) sample were found as inactively media exposed.

The distribution of media exposure was as follows:



Dependent variable

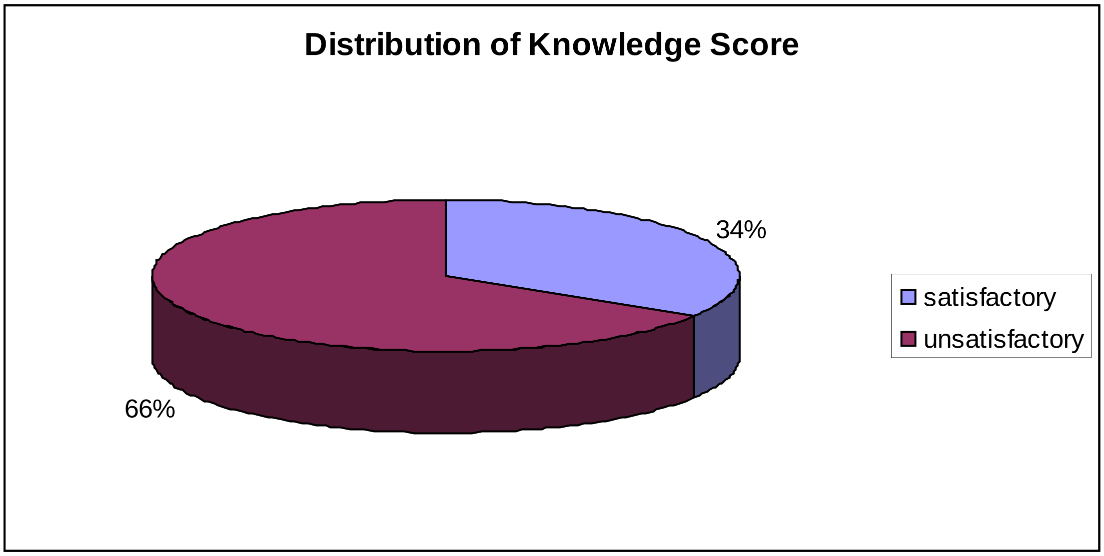
Knowledge on arsenicosis

A structured questionnaire was prepared to assess the level of knowledge about arsenicosis among the selected study sample.

As previously mentioned, the scoring was based on mainly the answer of 5 questions. The satisfactory score was 3-5, and the unsatisfactory score was 0-2.

Only 51 study sample (34%) gave the satisfactory answer, whereas the 99 study sample (66%) gave the unsatisfactory answer.

The distribution of knowledge score was as follows:



H. Relationship of media exposure with knowledge level of arsenicosis

1. Data

Score	Active media exposure	Inactive media exposure	Total
satisfactory	36	15	51
unsatisfactory	06	93	99
Total	42	108	150

2. Assumption: There is a relation between media exposure and knowledge level of arsenicosis.

3. Hypothesis:

H_0: There is no relation between media exposure and knowledge level of arsenicosis. (Null Hypothesis)

4. Test statistic: The test statistic is

$$X^2 = \Sigma \frac{(\text{Observed frequency} - \text{Expected frequency})^2}{\text{Expected frequency}}$$

5. Distribution of test statistic:
When H_0 is true, distribution is approximately as x^2 with (c-1)(r-1) = (2-1)(2-1)=1 degree of freedom.

6. Decision Rule:
H_0 will be rejected if the computed value of x^2 is equal to or greater than 3.841

7. Calculation of test statistic: The test statistic is

$$X^2 = \Sigma \frac{(\text{Observed frequency} - \text{Expected frequency})^2}{\text{Expected frequency}}$$

Here, e_1= (51/150) x 42 = 14.28
e_2 = (51/150) x 108 = 36.72
e_3= (99/150) x 42 = 27.72
e_4= (99/150) x 108 = 71.28

x^2 = [(36 – 14.28)^2 / 14.28] + [(15 – 36.72)^2 /36.72] + [(6 – 27.72)^2 / 27.72] + [(93 – 71.28)^2 / 71.28]= 33 + 12.85 + 17 + 6.62 = 69.47

8. Statistical decision: As 69.47 is greater than 3.841, H_0 is rejected. For this test, $p< 0.005$

9. Conclusion: There is a relationship between media exposure and knowledge level of arsenicosis.

10. Odds Ratio and 95% Confidence Interval:

Here, Odds Ratio = [(36/51) / (6/99)] = (0.7/0.06) = 11.67

Here, P_1 = (36/51) = 0.7
P_2 = (6/99) = 0.06

$$SE(P_1 - P_2) = \sqrt{[P_1(1-P_1)/n_1 + P_2(1-P_2)/n_2]}$$
$$= \sqrt{[0.7(1-0.7)/51 + 0.06(1-0.06)/99]}$$
$$= 0.068$$

$P_1 - P_2$ = 0.7 – 0.06 = 0.64

95% Confidence Interval of $(P_1 - P_2)$ is: $0.64 \pm 1.96 \times 0.068$
= 0.5067 to 0.7732

Discussion

The study methodology and findings were as follows:

A three month study was conducted in three primary schools of Faridpur Sadar District. The study type was descriptive, cross-sectional study. At first among thirty primary schools of Faridpur Sadar upazilla, three primary schools were selected for the study. The selected schools were: Alipur, Kamalapur and Bhati Lakshmipur Government primary schools.
Only the students of class four and five were selected for the study. The total sample was taken purposively and it was 150. A prepared structured

questionnaire was used to conduct the study. The questions in the questionnaire were both open and close-end type.

The variables taken for the study were age, sex, economic condition, media exposure and finally, the knowledge level of arsenicosis.

The age range among the study sample was 9-12 years, mean= 10.57, mode = 45, and median = 10.5.

Among the study sample, male was 60% and female was 40%.

Only 38% among the study sample were not considered from poor socio-economic status, the rest 62% were considered as poor.

Media access or media exposure became an important part of the study. Only 28% of the study sample was considered as having active media exposure. The rest of study group (72%) was found as not having an active media exposure.

Based on mainly 5 selected questions, the knowledge level of arsenicosis was judged or scored. Only 34% got the satisfactory score, the rest 66% got the unsatisfactory score.

Through a hypothesis testing, it was proved that there was a relationship between media exposure and knowledge level of arsenicosis. Here, Odds Ratio is 11.67 and 95% Confidence Interval is from 0.5067 to 0.7732. The children, who had active media access at their home or family, got better scores in knowledge level of arsenicosis exam. We hope most of the students will improve their knowledge level through active health promotion and media coverage on arsenicosis in their community by different health organizations.

From the different study abstracts of literature review, it was found that no study was similar with the conducted study. Only a study was conducted on the knowledge level of adults, but not on primary school children. In that sense, this study is very unique and important for the following reasons:

a. School children especially the age group 9-12years can contribute in the society for social awareness.

b. They also can actively participate in arsenic mitigation program.

c. Primary school textbook can include a chapter on arsenicosis.

d. Children as well as their family can be more aware about arsenic free safe drinking water.

Conclusion of the study

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Recommendation

Though the Faridpur Sadar upazilla is a highly arsenic contaminated area, the awareness and knowledge level about arsenicosis among primary school children was found poor. It was also found that the media campaign about arsenicosis in that area was not high.

To increase the social awareness, the following measures can be taken:

a. Increase media campaign in the arsenic contaminated area.
b. Increase health promotion and health education about arsenicosis.

To mitigate the arsenicosis problem, following measures can be taken:
a. To build a good network for identification and management of arsenicosis patients throughout the country.
b. Provision of alternative arsenic free water options in the arsenic contaminated area at reasonable cost.
c. Provision of free or low cost treatment for arsenicosis patients.

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Appendix

a. Tables

Table 1: Chemical nature of arsenic:

Formula	As
Atomic number	33
Atomic weight	74.9216
Position in periodic table	VA
Density at 32° Farenheight	5.73
Melting point	11.39° Farenheight
Boiling point	1497.2° Farenheight

Types of Arsenic compounds	**Inorganic** (trivalent, e.g. arsenites, and pentavalent, e.g. arsenates); Inorganic arsenic are more toxic. Trivalent form is 60 times more toxic than pentavalent form. In Bangladesh, both tri and pentavalent compounds have been found in water. **Organic** (mono and di-methyl arsonic acid, Na-cacodylate, atoxyl, stoversol,etc.) . They do less harm and are readily eliminated by the body.

Table 2: Arsenic toxicity in different organs:

Organ	Sign and symptoms
Skin	Symmetric hyperkeratosis of palms and soles, melanosis or depigmentation, Bowen's disease, Basal cell carcinoma and Squamous cell carcinoma.
Liver	Enlargement, jaundice, cirrhosis, non-cirrhotic portal hypertension.
Gastrointestinal system	Non-specific abdominal discomfort, anorexia, intermittent diarrhoea.
Nervous system	Peripheral neuropathy, hearing loss.
Cardiovascular system	Hypertension, peripheral vascular disease (gangrene), atherosclerosis.
Hemopoietic system	Anaemia, leucopenia.
Respiratory system	Non specific respiratory complaints, chronic dry cough, shortness of breath, chronic bronchitis, lung cancer.
Endocrine system	Diabetes mellitus and goiter.
Reproductive system	Spontaneous abortion, still birth, neonatal death.
Carcinogenic	Bowen's disease, squamous cell carcinoma, basal cell carcinoma, lung cancer (industrial exposure), bladder cancer and other internal cancer (prostate cancer).
Constitutional	Fatigue, malaise, weakness, weight loss.

Table 3: Differential diagnosis of non-cancer skin lesions:

Category	**Major conditions for consideration**	**Distinguishing features**
Diffused melanosis	Actinic dermatosis Melasma Ashy dermatosis	Found on exposed part of the body. Found mainly on face. Diffused pigmented macules mainly on trunk.
Spotted melanosis	Pityriasis versicolor Freckle Lichen planus	Hyperpigmented macules with fine scale on trunk, face, neck, and extremities. Mottled pigmentation on face and trunk increases with sun exposure. Starts with violaceous pruritic papular

		lesion on trunk and extremities and produces spotty pigmentation on resolution.
Leucomelanosis	Idiopathic guttate hypomelanosis Pityriasis versicolor Pityriasis- lichenoides chronica Leprosy	Multiple depigmented macules on trunk and extremities. Hyper & hypo-pigmented macules with scales on trunk, face, neck & extremities. Erythematous papular lesion followed by hypo-pigmented macules. Macular hypo-pigmented or erythematous lesions, usually with loss of sensation. There may be involvement of peripheral nerves which are usually thickened and tender.
Diffused keratosis	Psoriasis (palms & soles) Eczema Occupational keratosis Pitted keratolysis	Diffused keratoderma on palms & soles, with or without scaly psoriatic patches on the other sites. Lichenified lesions with pruritus and occasional oozing. Keratotic lesions corresponding to site of friction. Scaly fissured keratotic lesion, with or without fissures on webs. Multiple pitted (depressed) & keratotic lesions on soles.

Category	**Major conditions for consideration**	**Distinguishing features**
Nodular keratosis	Occupational keratosis Verruca vulgaris Corns/calluses Seborrheic keratosis	Same as above. Multiple verrucous pigmented papules and nodules on trunk, extremities, and dorsum of hands and feet. Localized keratotic lesions at the site of friction. Discrete well-defined pigmented papules and plaques on sun-exposed areas.

Table 4: WHO protocol for diagnosis of arsenicosis patients

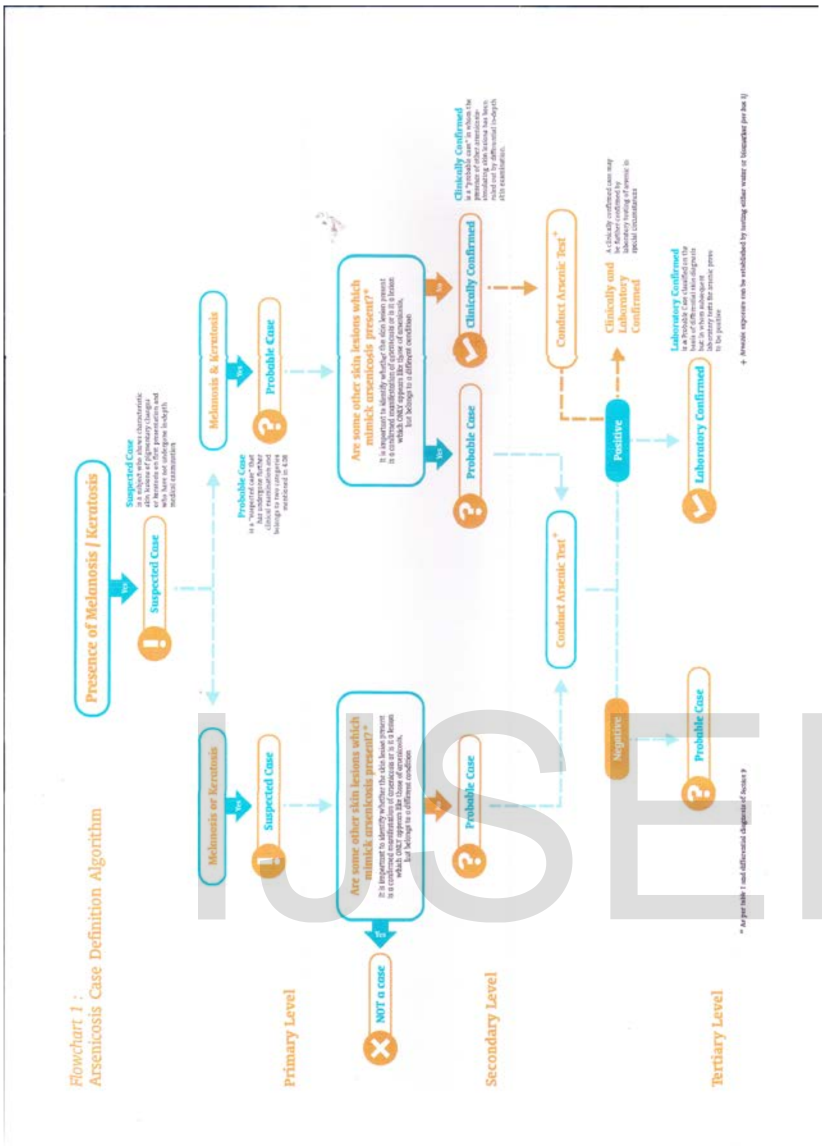

Table 5: Arsenicosis case management

Preclinical stage	**Initial stage (mild)**	**Secondary stage (moderate)**	**Tertiary stage (severe)**
No clinical manifestation	Melanosis Keratosis Conjunctivitis Bronchitis- chronic cough, breathing difficulty. Gastroenteritis- nausea, abdominal pain.	Leucomelanosis Hyperkeratosis Non pitting oedema of leg Peripheral neuropathy- tingling, distal numbness, burning sensation, impaired sensation, cold hepatopathy.	Nephropathy Hepatopathy Gangrene Cancer of skin, bladder, lung.
Management			
Stop intake of arsenic contaminated water. Dietary supplement. Follow up.	Stop intake of arsenic contaminated water. Dietary supplement. Antioxidant (Vitamin A, C, E) Application of keratolytic agent (Salicylic Acid & Urea) Symptomatic treatment. Follow up.	Stop intake of arsenic contaminated water. Dietary supplement. Antioxidant (Vitamin A, C, E) Application of keratolytic agent (Salicylic Acid & Urea) Symptomatic treatment. Cryo-surgery or operative removal of hyperkeratotic lesion.	Complication specific management. Surgery. Chemotherapy. Radiotherapy.