Discussion
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The social epidemiological study of chronic arsenic poisoning in five villages of Domkol block in Murshidabad district unfolded a number of issues which have either not been highlighted before or never been articulated at macro level. The nature of findings of research did not confine within the symptoms of chronic arsenicosis and relevant determinants, rather extended several steps beyond as consequences in detail and analyzed against the local ecological, social, political and cultural context, both at macro and micro levels. Although only five villages in Murshidabad district were studied – most of the features epitomized general picture of arsenic affected part of rural Bengal. In fact while being associated with the epidemiological team for IPGMER, Calcutta working in south 24 Parganas district (district located in extreme south of West Bengal and located nearly 200 – 300 Km from Murshidabad district) to get first hand experience of arsenic poisoning – similar kind of socio – cultural features, clinical manifestations and consequences have been noticed. But the suffering of people in Murshidabad district was more severe due to its long distance from Calcutta (south 24 Parganas is adjacent to Calcutta and communication is also very good), and extent of arsenic contamination of underground water.

Arsenic contamination of ground water, which was triggered by its excessive extraction for irrigation and simultaneous growing preference of ground water for domestic purposes, put thousands of people under threat. Exposure to arsenic affected the people in terms of physical impairment and disability as well as led to personal occupational, social and independence handicaps. It also affected the families and social fabric in various ways. Apart from direct impact on human health of the affected areas, arsenic contamination also has wider implication on ecology and economy of the region. Therefore ecological impact of arsenic poisoning needs more attention as it has long term consequences.

As mentioned earlier, the research revealed multidimensional issues, apart from the mainstream epidemiological issues. In other words, social epidemiology of arsenic poisoning was an entry point to society, human life, developmental policy and the whole paradigm of research methodology including its concepts and applications. Besides documenting and analyzing the distribution of manifestation and suffering due to the arsenic toxicity, methodological issues, policy issues, developmental issues and human rights issues are brought out.

Consequences of Arsenic Contamination

Human Suffering in the Affected Population

More than four fifth of total population in the study villages were exposed to arsenic and more than 5 percent of exposed population developed various forms of impairments over the years. The most common impairments were pigmentation and de-pigmentation patches over skin,
keratosis of palms and soles, respiratory impairments and neuropathy affecting both limbs. The symptoms encountered by the affected people were mainly pain in the patches on soles and palms, respiratory distress, weakness of limbs and dermatological discomfort to heat. Among them, first three were more distressing. The affected people had various combinations of impairments essentially beginning with pigmentation and de-pigmentation.

The severity of impairments was dependent on individual's arsenic exposure level. Arsenic exposure was associated with contamination level of water sources and with water consumption pattern, and duration of exposure which was influenced by various components of social structures including occupation, socio economic status, gender, religion, caste. Accurate measurement of duration of exposure was difficult as there was no reliable data. But according to the experts, the area was affected during the period of 1977. Nutritional status influenced pathophysiology of arsenic toxicity and hence impairment. While exposure level is a contributory factor for manifestation and its severity, nutritional status is likely to be the stronger determinants of severity of manifestation. Treatment with chelating agents removed arsenic from the body and hence decreased the impairment in few cases able to access it. Symptoms regressed in those who shifted to an arsenic free water source and had a fair nutritional status.

The following figure 1 shows the extent of consequences of chronic arsenicosis. 5.3% (410) of arsenic exposed population (7678) had impairments. Among them 311 persons (i.e. 4.1% of total exposed population) developed various forms of disabilities. 182 persons (i.e. 2.4% of total exposed population) had different forms of handicaps. Due to non-availability of data on exact time of arsenic exposure to individuals, the time lag between exposure and manifestation could not be measured. But it took approximately six months to one year to develop disability from concerned impairment. On the other hand it took nearly three months to one year to develop respective handicap. This time lag of development of disability and handicap depends on progress of disease, nature of activity, physical and social environment.
The impact of arsenic poisoning did not limit only up to impairment level. The impairments affected normal day-to-day activities by causing disability in various combinations among 75.8% of those with impairment. Rest 24.2% did not have any form of disability. As far as distribution of scale of disability was concerned (except in lifting and carrying disability, running disability and gripping disability) around 90% to 100% of total cases with disability performed customary normal activities but suffered discomfort and pain. Up to 9% of total cases with disability needed assistance in performing their tasks and a very few needed to become dependent on others (1%). This variation was due to nature and distribution of impairments. Lifting and carrying disability, running disability and gripping disability were the more strenuous variety of disabilities. Around 17% to 20% of total cases with this kind of disabilities needed assistance and 11% to 30%
needed to depend on others. Around 32% and 53% of lifting and carrying disability and running disability respectively could not perform the activities. Pain of soles and palms, weakness of limbs and respiratory distress affected normal locomotor activities, which included walking, climbing, running, cycling, lifting and carrying, confining and transfer. Pain of palms and soles along with weakness of upper limbs affected normal gripping activities. The people felt unusual discomfort (itching) due to exposure to heat due to sun and/or fire. Impairments also affected personal care of individuals, which included bathing, excretion, feeding and care of hands and feet. Mostly, personal care was affected due to lack or loss of functions pertaining to locomotion, gripping and dermatological discomfort. Scale of disability was essentially determined by severity of respective impairment. Gender, occupation, socio economic status, physical environment and lifestyle played major role on these factors to act upon various dimensions of disability. Capacity to bear the symptoms or suffering during the activity along with natural activity, felt need to seek assistance, readiness to accept the assistance vis-a-vis availability of physical assistance determine the severity scale of disability.

Disability resulted in disadvantage to the individual and caused handicap pertaining to independent existence, occupational activity and social integration. Personal care was essentially a part of individual existence, which was affected by concerned disabilities. Around three fourth of the population with disability bore the suffering and around one fourth (25%) or less tried to adapt to some alternative mode of life style in order to cope with the disadvantages and maintain an individual existence (except in feeding disability due to gripping and environmental disability and hands and feet care disability). On the other hand around one third (more than 35%) and two third (more than 60%) of gripping disability and environmental disability respectively adapted to cope with the disadvantages with regard to feeding. More than 40% of population with hands and feet care disability had to adapt. There were some unavoidable circumstances when alternative mode of life style could not remain possible and around 5% of the population with disability needed to seek support, preferably from household members.

Around three fourth of the people with disability (walking, climbing, running and environmental disability) could maintain their customary normal occupational activities. In other words around 25% of population with the disabilities encountered disadvantage with regard to their occupation. But people with gripping disability, confining and transfer disability and lifting and carrying disability had higher proportion of occupational handicap (45-50%, 60% and 82% respectively). Around 10-20% of population with disability intermittently encountered more disadvantages primarily due to seasonal changes (weather or harvest or sowing season), but could perform normal occupational activity by slowing the pace. Around 10% of people with disability needed to curtail the burdensome activities, as the self-adjustment did not work and tried to contribute in rest of the occupational activities. Proportion of curtailment of occupational activity was much higher with regard to gripping disability, confining and transfer disability and lifting and carrying disability (15-30% of people with these disabilities). If curtailment did not work, people
usually shifted to modified form or alternative form of activities, which were lighter in nature. About (or less) 8% of the people with disability belong to this category. But shifting to modified form or alternative form of activities was resulted to more by persons with gripping disability and lifting and carrying disability (more than 12% and 45% respectively).

All social integration handicaps were directly due to the dermatological impairment. In fact total number of persons having social integration handicap (due to impairment) was more than physical independence and occupational handicap due to disabilities. Social stigma, embarrassment and lack of assertiveness on account of dermal disfigurement were responsible for social integration handicap. Locomotor disability (walking and cycling) also contributed in the social integration handicap (less than 20% of the disability).

Severity and nature of disability were the major determinants of grade of handicap. But the social structures including socio economic status, gender and occupation, physical environment, life style, nature of activity, physical support, seasonal variation and topography strongly influenced the grade of handicaps. Availability of alternative occupation, opportunity to change the life style and viability of alternative amenities interfacing ability or compulsion or both to change behavior or lifestyle and occupation strongly influenced the grade of handicaps. The general response to the disability among the people was to reduce the dependence with out compromising with self-esteem and eager to maintain the normal productive life and self-dignity. Therefore, there was always an effort to bear the suffering as long as possible or to seek alternative or self-adjustment. Seeking of physical support was frequently linked with occupational background and gender of both the sufferer and the assisting person and inter personal relation.

As far as asking physical assistance was concerned, it was far less with regard to excretion activity as compared to bathing and feeding. Probably among all daily habits, excretion was the most personal activity, which needed privacy and so despite difficulty, people avoided taking help from others. Apart from that, duration of excretion was shorter as compared to feeding and bathing. Distribution of grade of handicap, percentage of handicap in respective impairment categories and conversion of disability to handicap in each socio economic status category shows that people from lower socio economic status suffered more from the consequences of arsenicosis. Possible explanation would be poorer suffer more from arsenic poisoning. Apart from that, coping mechanism, occupational pattern, and response at household level favored the people belonging to relatively higher socio economic status. It was found that landless laborers required maximum physical work (as compared to other occupations) so disabilities led them to more a disadvantageous position. Household work was next most laborious work and done only by women. Moreover, household work also includes secondary economic activities, so they showed next higher proportion of occupational handicap. Conversion rate (i.e. conversion from disability to handicap) was highest among landless laborers followed by women involved in household work, milkmen, agricultural laborers, students and so on.
Women had greater disadvantage as compared to men with regard to excretion activity due to social norms and unfavorable physical environment. Despite having more severe form of impairment, men got advantage over women, as they could excrete in public place, in open field and their occupational pattern also eased to relieve. Lower status of women led to greater disadvantage with regard to social integration due to keratosis (even they had milder form of impairment). But pigmentation can be covered under cloths and women could manage to hide the symptoms.

Economic activity of households was affected due to manifestation. Due to non-existing social support, often the other household members bear the burden of economic activities, which means that the young people actively participated to contribute in household economy after quitting school. This trend indeed helped to maintain their economic status. But unfortunately this trend arrested the growth and prospect of the young generation of poor families. Primary and secondary education in government schools are free in rural West Bengal, but the economic hardship on account of arsenic manifestations of the elders prevented to avail the opportunity. More over the academic activity of the young generations were also affected by their manifestation. Till date there was no major economic shortfall due to the disease as the household economic activities were being self-adjusted by means of active participation of young generation in economic activity. But if the disease trend continues further, the time is not far when the internal adjustment cannot be over stretched and that will be beginning of economic disaster. Therefore, consequences can be foreseen as either selling of property leading to gross impoverishment and widening gap of rich and poor along with mass exodus of the people from village to town in order to seek alternatives to save own lives and livelihood. It will be another negative impact on social fabric. The situation will be similar to mass exodus of the population from drought-affected villages to nearby town.

There were 22 deaths from suspected arsenic poisoning reported during fieldwork. All deaths occurred from 1990 to 1997. 95% (i.e.21 persons) were from poor family. All deaths occurred before field visit and according to the concerned family members before death all 22 people were bed ridden for several weeks. All of them had severe breathing trouble, weakness and majority of them developed suspected jaundice due to liver failure. All of them were suffering for more than a decade and some of them were first suspected cases in their respective villages. Family history said that even before they became bed ridden, all had severe occupational and physical independence handicaps. They were depended on their family members to support in excretion, bathing and feeding. They stopped going to field and women stopped doing the majority of the household activities. Mostly they were confined to their houses. This stage continued for nearly six months to one year before they became completely bed ridden.
Some studies (in West Bengal and Bangladesh context) showed that long-term exposure to arsenic might lead to peripheral vascular disease, which led to edema and gangrene. In advanced stage amputation of the affected limb/s is the only solution. Malignancy, congenital malformation, low birth weight and spontaneous abortion are the other major problems that might occur in future. Although less, there were reports of malignancy due to long-term exposure of arsenic in West Bengal. In Bangladesh there was report of high incidence of diabetes mellitus among arsenic exposed population. [Chakraborty D 1996 (a), 1998 (c), Roy S, Guha Majumdar DN 1998, Saha KC 1998, Rahman Maidul AZM 1998.] So there is possibility of these manifestations even in the study villages in due course of time. [See photograph in the next page]

Due to wide media coverage along with involvement of health and irrigation department, people were made aware of the problem. Probably the problems regarding superstition may no longer exist or reduce, if the present trend of awareness generation continues. But the stigma will remain or increase, particularly pertaining to marriage and job. Growing anger and frustration among the people may turn the arsenic problem as major political issue. In fact some local newspaper reported arsenic as one of the issues in some panchayat election in other districts.

**Wider Ecological and Health Impact**

Several studies worldwide show impact of arsenic in ecosystem. The magnitude of arsenic problem in West Bengal (both duration and concentration of arsenic) is sufficient to pollute the ecosystem and hence the food chains. Arsenic polluted water contaminates soil, and plants grown in the soil. The arsenic can flow from vegetable product to human body or animal. The animal product can also become potential source of arsenic. It fact some studies showed that arsenic concentration of milk is several time higher than plasma level. Indeed organic arsenic (found in food chain) is much less toxic than inorganic arsenic (from ground water), but long term exposure of organic arsenic would further affect the population who have already been exposed and the people living in non arsenic zone through consumption of foods grown in arsenic contaminated soil.

The new agricultural policy brought significant benefits in terms of crop production and eventually improvement of economic condition of poor farmers. On the other hand arsenic contamination of ground water on account of extensive extraction of ground water, which has been part of modern agricultural practice resulted in a major public health problem. The present agricultural practice, which has been developed in last three decades, cannot be reverted over night. On the other hand there is urgent need to stop the spread of arsenic. Therefore, the present situation has become a major challenge to the policy makers.
Photo 11 (above): Peripheral vascular disease due to chronic arsenicosis. The person had been suffering for more than a decade. Amputation of his left leg was done as it became gangrenous due to peripheral vascular occlusion. The incidence occurred a year before taking photograph. The right leg also developed similar kind of manifestation, which started with swelling. But there is no gangrene.

[The photograph was taken in IPGMER, Calcutta]
Methodological Issues

Establishment of Interlinkages of All Determinants as Prime Objective of Social Epidemiological Study

The cardinal features of methodology of social epidemiological study of arsenic poisoning are:

a) Identification of social determinants associated with arsenic toxicity and the impact of chronic arsenicosis, establishing processes or meaningful linkages among them as the major outcome of the study. Social epidemiology can be broadly defined as the study of the relations between "social factors" and disease in population. In other words it is method and disciplinary approach, which provides the foundation for researching and understanding the contribution of social factors and process to the patterns of health and illness in the population. Hence social epidemiological study should not confine only to the study of individual social determinants (as being witnessed in many public health literature). All social phenomena are interconnected (not individual entity) and primary objective of social epidemiological research is to establish the process in order to get right picture of disease occurrence and distribution. Furthermore, social epidemiology does not limit up to the study of the disease only, rather it incorporated epidemiological study of its physical and social consequences; one approach to doing so being the study of impairment, disability and handicap. Thus ideal social epidemiological study is more challenging task as it incorporates all aspects of disease occurrence and causal factor, deals with their complex mechanism, traces till end stage of sequels of disease and establishes and explains the inter linkages.

b) A complex inter-linkage between natural science, bio-medical sciences and social science aspects of disease is identified in social epidemiological paradigm. In order to conduct social epidemiological research on arsenic poisoning, the existing social, behavioral, cultural, and demographic variables along clinical manifestations are dealt with to explain the complex mechanism among them. In addition to that geo-chemical aspect of arsenic contamination phenomenon was linked to give complete picture of the problem. It is equally important to incorporate the natural science aspect of disease in social epidemiological study. In fact many social epidemiological studies suffer due to negation of the biological dimension of disease occurrence. Thus there is need of epidemiological research balancing both social dimensions and conventional epidemiological methods.

Relevance of Sociological Dimensions and Social Categories in Social Epidemiology of Arsenic Toxicity

In social epidemiology, SES, religion, caste and gender have been most important aspects of study. People belong to higher socio economic status was fewer sufferers in terms of conversion rate and severity of problems. Their better nutritional status, access to proper treatment facilities and arsenic free water put them in more advantageous situation as compared
to poor people. Availability of assistance, nature of occupation, favorable physical environmental
condition helped higher SES to cope the problems more easily. The study showed SES played
very strong role as determinant and in distribution in impairment, disability and handicap. Muslims
and scheduled caste were relatively more exposed to arsenic due to occupational and SES
background. Suffering was also more as compared to higher caste Hindus. The present study
showed gender as an important factor in causing impairment, disability and handicap. Linkage
with occupation, family structure, water consumption pattern, gender was found to be important
factor associated with severity of impairment, where males were more often and severely
affected. Association of gender variable with occupational pattern, family support, coping
mechanism, social status added further dimension to disability and handicap.

**Relevance of ICIDH in Social Epidemiology of Arsenic Toxicity**

In order to study consequences of chronic arsenicosis, WHO's International Classification
of Impairment, Disability and Handicap (ICIDH), was selected because this is available as a
comprehensive tool to measure disease consequences and allows for incorporation of social
dimensions in quantitative data. It has been used worldwide and a number of studies have been
published in regard to its usefulness. There are several positive points with ICIDH, like the
terminology in each section has been clearly mentioned and defined to avoid semantic debate.
The entire classification (i.e. impairment, disability and handicap) has been further divided into
simplified units for better understanding and scaling of disability and handicap is also helpful in
quantification.

Users of ICIDH worldwide, however, gave mixed response from complete rejection to
acclaim. But general opinion was that consequences of any disease have been essentially
context specific (occupational pattern, amenities, culture, society, race, nation etc.) and uniform
method of quantification cannot be followed unless some modifications are made. In fact,
technical expert committee members of WHO, who constructed ICIDH also suggested
modification according to need. While ICIDH was being used in arsenic research, number of
methodological limitation / shortcomings were encountered which require special attention and
needed several changes. These are as follows:

- The relation among impairment, disability and handicaps are not linear as being
  mentioned by WHO's handbook, because the relationships are very complex and
  number of external factors (like physical, economic, social and cultural) play a major
  role in shaping the nature of impairment, disability and handicap. There are some
  specific situations where handicaps occur without relevant disability. In other words
  impairment directly led to handicap skipping disability. It reveals multidimensional
  nature of impairment, disability and handicaps, which have not been explicitly
  mentioned in ICIDH.
In ICIDH, there was no mention of severity of impairment. But in the social epidemiology study of arsenic poisoning the impairments was classified into severity category and was correlated with other variables including consequences of diseases. This correlation gave more clarity regarding extent of roles of other variables on impairment and consequences.

Disability as a precursor of another variety of disability is not mentioned in ICIDH, but found to be relevant in the context of chronic arsenicosis. Addressing them as ‘primary’ and ‘secondary’ disability, a detailed analysis has been made in the chapter on Disability. For example, linking walking disability and lifting disability with bathing disability was not mentioned anywhere in ICIDH. But this study demonstrates the interlinkages. Similarly there are several examples regarding interlinkages among various dimensions of disability.

ICIDH mentioned that only handicap has been socialized whereas impairment and disability are exteriorization and objectification of disease only. But social epidemiological study of chronic arsenicosis revealed presence of social dimensions in all three planes of disease consequence. As a matter of fact, social factors have very strong presence and strengthen further linkages among impairment, disability and handicap. ICIDH gave objective view while conceptualizing disability. But the study showed that there was subjective view among the sufferers while they perceive the restriction of their activities. Grading of severity in ICIDH by degree of assistance, which was found to be influenced by several social factors in addition to the ‘objective’ biological factor of severity of impairment.

ICIDH scale/grade categories regarding disability and handicaps were modified according to relevance. Some scales were not included as being found not relevant and in order to avoid semantic debates. For instance in disability, ‘aided performance’ was not included, as in the study villages it was found that the possible aid to ease the weakness of limbs can not be applicable due to terrain, nature of daily activity and maintenance cost.

**Quantitative Estimation of Arsenic Exposure at Individual Level**

Arsenic is a global problem and several research papers have been published related to various aspects of arsenic problem based on laboratory and field based study. Several studies including the context of West Bengal tried to prove dose response relationship i.e. establishing positive correlation between amount of arsenic intake and arsenic concentration in excreted materials. In animal studies, measured amount of arsenic was fed for certain duration and arsenic depositions were measured in different body tissues. This kind of research maintains strict measurement system in each quantum of intake and tissue sample as well. Animals were also
selected based on certain standardized protocol (like species, age, weight etc.) to eliminate other possible variables and showed almost linear relationship as the methodologies are being adapted almost immaculate. Similar kind of researches has been attempted on human beings but similar laboratory methodologies could not be applied due to ethical reasons. Many measurements were based on assumptions or near assumptions. Thus a number of methodological fallacies have been noticed.

For example, in many studies in West Bengal, quantum of arsenic consumed by individual was equated with arsenic concentration of domestic water. But this methodology invites number of controversies like:

i.) How can the researchers make sure that the sample population consumes water from the same source throughout the year? In fact the present research showed very complex nature of water consumption which has been influenced by migration, seasonal variation, sex, occupation, age, individual drinking pattern, location of water source, condition of hand pump, influences of technical experts or health worker and indeed physical strength of individual (particularly when it is linked with carrying relatively safe drinking water from distant sources to avoid further arsenic contamination from domestic sources).

ii.) How can the researchers assume the consumption of water is same in every individual? In fact the aforementioned factors greatly influenced the amount of consumption.

Therefore it is easily understandable that if the amount of water and concentration of arsenic are not measured properly, the study would turn meaningless. Moreover, duration of contamination is difficult to know since day of beginning of contamination of ground water of a particular source is not known, and similarly for the changing pattern of concentration. Thus on the basis of these methodological shortcomings, the findings (i.e. positive dose response relationship) cannot be claimed so robust. Taking all these issues into account the present study developed new parameters where arsenic concentration levels from all probable sources were included. During individual level assessment average daily consumption of water from all sources in past one year was taken and total arsenic content in total quantum of water intake in past one year was calculated. Average was measured as arsenic consumption per liter of water per day.

**Nutritional Status as Determinant of Impairment**

Some research papers explained the role of various nutrients (like protein, vitamins, minerals etc.) on detoxification of arsenic in liver and early elimination from body. The relation between mal-nutrition and toxicity of arsenic had been proven in laboratory settings (animals) and controlled clinical settings. [Vahter Marie] Some researchers stated their general observation of magnitude of clinical manifestation and linkage with nutritional status at community level. But in
their study design this important variable was not mentioned anywhere. In this study, examination of the relationship between mal-nutrition and toxic manifestation of arsenic poisoning has been attempted at population subgroup level where multiple factors play together in disease modification. Body Mass Index (BMI) and consumption of calories and proteins have been taken as parameter of nutritional assessment of the people with manifestations. It was proved that people with lower BMI encountered more severe form of impairment.

Estimation of Socio Economic Status

Estimation of Socio Economic Status is a major methodological issue in a sociological study. Every measurement has its own limit and it cannot be made universal as each society bears unique nature of lifestyle, value, culture and perception of life. In the context of arsenic poisoning no sociological study has been done so far. In the epidemiological study linking SES with chronic arsenicosis manifestation was virtually absent except mentioning few words on 'poverty' at the end of very few research articles. In other epidemiological studies (not linked with arsenic), socioeconomic status has been taken very insignificantly like just mentioning “very poor, poor, rich, very rich” or lower class, middle class, upper class” or just “rich, poor” without mentioning criteria for making socioeconomic stratification. Few of them stratified by mentioning income in figures. But in rural Bengal, household income cannot be measured only in terms of quantum of money. Many household requirements are met through own production or being paid in kind at the cost of labor. Thus fulfillment of various requirements is not through exchange of money and therefore not tangible to measure. Income as economic stratification in urban control may be applicable where most of the products are purchased in exchange of cash. Many economic researches adapted various other methods in economic stratification like Planning Commission's national level poverty line, National Sample Survey Organization's data, calorie intake, housing pattern or combination of several factors. But all of them are debatable due to various reasons:

- In multi ethnic, multicultural, heterogeneous society with ecological, developmental and occupational variations across regions, a uniform national level stratification cannot be applicable.

- Calorie intake is very much context specific. Moreover due to market economy, even in rural areas the food habits are changing rapidly. So calorie intake as a sole parameter in SES stratification was not applicable.

- Housing can at best be supportive evidence of economic condition but not sole index.

- Landholding can be an important parameter in economic stratification particularly in agriculture-based community. But it cannot be sole parameter as, there are increasingly households who are dependent on other occupation with or with out possessing any
lands. Also, the economic meaning of the same landholding area differs widely with differing quality of soil, availability of water for irrigation etc.

• Lastly and most important methodological issue is in the socioeconomic study, where economic status is clubbed with socioeconomic value, life style and minimum needs of an individual of any given society, all researches looked through their own lenses. What the given society perceives often has not been given priority. It is important to note that the researchers are essentially external and begin with internationalization of norms, values and culture of their own society instead of the study population's own understanding of life and values.

Keeping these views in mind, socioeconomic status of the households in the study villages has been classified according to the villagers' perception of minimum need and the minimum income / resources necessary to fulfil it. Use of this for analysis has been found to corroborate observed reality of the study population and allow for statistical analysis as well as seek explanations through case studies.

Relevance of Studying Occupation in Social Epidemiology of Arsenic Toxicity

Occupation played a significant role in arsenic exposure and hence manifestation, although it has not been acknowledged in many scientific literature on arsenic epidemiology of arsenic toxicity. Agricultural laborers and cultivators are exposed to arsenic when they drink arsenic polluted water in fields but domestic water may be arsenic free or less in content due to change in water source. Severity of disability and handicaps were strongly associated with occupational background of individuals. People who were involved in strenuous activities (for instance landless laborers, household activities) had more severe form of disability & occupational handicap. Occupational background also favored to get assistance due to physical proximity. There was less severe grade of physical independence handicap due to excretion disability among land less laborers as they could relieve in the field. On the other hand women, despite having less severe form of impairments had more disadvantage as they remained at home and most of them did not have own toilets.

The study revealed very important methodological flaws in economic survey by the government i.e. women's contribution in household economy. Prior to fieldwork, district level economic survey data (1991 census) were collected and data on study villages were analysed. But after fieldwork, the analysed primary data of the same villages portrayed different picture. Census showed, women's participation in the work place is marginal (2.6%) and they are mainly involved in making puffed rice, sweets, bidi, handicrafts, earthen utensils etc. and selling them in the market or to middle level traders. Some of them work as domestic servants in the houses of rich families and participate in domestic or secondary agricultural activities. As their earning is tangible i.e. in terms of money (cash) or in kind, they were included in census reports. But it is
very important to note that most of the women involved in assisting in major household occupations like boiling paddy and drying under the sun, bringing paddy to nearest husking machine or husking manually by using traditional manual machine, removing pulse seeds from dried fruits or removing skin of pulses by manual traditional machine, milking the cattle, making curd or paneer from milk etc. – are not directly generating resources (in cash or in kind). But their contribution towards household income was unquestionably important.

Relevance of Health Service Study in Social Epidemiology of Arsenic Toxicity

Health services can play a major role in disease modification. But regarding chronic arsenicosis in study villages, role of health service as epidemiological determinant was not so explicit. Because effective drug treatment was available only in Calcutta and very few people could avail them. Therefore, it had little impact on majority of untreated sufferers. But study of health service in social epidemiological study has great value in prospective study and also in policy level. Preference of system of treatment by the people can give background information and can be useful if decentralization of arsenic treatment facility takes place in future. Gender discrimination at subtle level can also give possible consequences if arsenic treatment is decentralized and privatized.

Impact of treatment, even to the few, also demonstrated the links of treatment with SES, occupation and gender. Analysis of treatment seeking behavior showed that unless the treatment facility is decentralized, the general population could not get access to it.

Policy Issues

Access to Treatment Facility

Despite repeated information dissemination to the government by concerned scientists, doctors through lecture, publication, projects and workshops regarding danger of arsenic contamination of ground water and resulting biggest public health hazard, no comprehensive steps have so far been taken. Most of recommendations remain buried under red tape and some piece meal approach has been taken but could not address the population at large. Treatment facility still remaining in Calcutta and people from far-flung villages could not visit, like people in study villages could not afford to visit hospital in Calcutta to get treatment. On the other hand due to carelessness and lack of accountability, essential drugs for chronic arsenicosis worth thousands of rupees got wasted in the district of Murshidabad.

Chelating agent (D-penicillamine) for treatment of arsenic poisoning requires regular follow up by doctor. But with the existing health service delivery system it is impossible to do so. West Bengal's primary health care is in a dilapidated state. In the district of Murshidabad several PHCs are functioning without the required staff. In the study villages the post of Medical Officer is lying vacant for years and one CHSO runs area once or twice a week. Most of the time local
pharmacists dispose drugs. During immunization day the PHC becomes active. Block PHC (of Domkol) also running with insufficient staff. This pathetic health service delivery system of rural West Bengal indicates, decentralized mode of arsenic treatment would remain distant dream if the health service system is not revamped.

**Access to Arsenic Free Water**

There has been little action to provide arsenic free water except establishing some filters on a pilot basis. By and large the population remains unattended. Encouraged by the results of the filters, many state level policy makers consider them the only panacea available to combat the arsenic menace. But there is no comprehensive policy with regard to handling of filtrate, which is highly arsenic containing. Moreover there is no study on the feasibility, utility, sustainability and maintenance of filters. However, some international donors agreed to provide financial assistance to provide arsenic filters at community level. Several organizations and individuals are working out development of low cost filters made by locally available materials. Some of them already started campaigning to promote local filters linking with the local employment generation! But the root issue i.e. handling filtrate has not been spelled out. Nevertheless, as an emergency measure to combat the present situation and before getting the benefits of more long term and sustainable steps that prevents the extraction of underground arsenic, filters will definitely reduce the arsenic exposure.

**Role of Media**

Media played major role to bring the issue at higher level. Regular publication of reports sensitized the people. But media should be careful while publishing the report. To make the news more sensational many over enthusiastic reporters publish photographs and personal lives of many patients which invite new problems to families like denial of job to other family members who are not affected, problem in marriage and indeed they face more embarrassing situation in social gathering. Media can take major initiative to educate people and in advocacy at the government level.

**Economic Development Issues**

The arsenic contamination of ground water also raises questions regarding choice of development model, which was driven by technological inputs to exploit resources assumed to be available bounty in nature. Arsenic poisoning is essentially a result of unsustainable agricultural development policy. In order to bring green revolution, state adopted a number of policies, which were techno centric, exploitative to nature and unsustainable – like promotion of ground water irrigation, selection of high yielding variety seeds and making more arable lands through deforestation and conversion of fallow and wasteland into agricultural lands. These all-positive steps towards agriculture development triggered arsenic contamination. On the other hand the existing system for irrigation (like traditional canal irrigation or irrigation from water bodies) becomes defunct due to lack of state support. Arsenic problem should be eye opener for so called
“pro-development” policy makers, who believe that the dominant state of the art kind of technology is the only solution to the problem related to human development.

Growing rural urban disparity coupled with improvement in communication resulted in nonavailability of many local agro and animal products (like milk, fruits, egg, fish etc.) or become very expensive for the poor villagers. This leads to nutritional imbalance and hence aggravated arsenic symptoms. Declining pulse production is a national phenomenon and poor people mainly face the consequences in the form of rising food imbalance. The study in the five villages in Murshidabad district revealed how malnutrition (due to low calorie, low protein and vitamin intake) led to aggravated arsenic manifestation. As a matter of fact, several publications proved link between malnutrition and arsenic manifestation and explained at molecular level. Thus modern development paradigm in long run benefited few at the cost of the majority.

**Human Rights Issues**

Since Universal Declaration of Human Rights (1948), several public health related issues have been incorporated in broad framework of human rights. Right to live with human dignity, Right to livelihood, Right to good health and medicinal assistance and Right to healthy environment are collectively associated with the health of individuals and community. The social epidemiological study of chronic arsenic poisoning shows that the problem is essentially one of the violations of human rights. The state’s developmental policy triggered the arsenic contamination leading to suffering of millions of people. On the other hand state is primarily responsible for not enabling the citizens to enjoy their right to health; hence right to life. In 1998, National Human Rights Commission (NHRC) had called upon the center and the West Bengal government to continue with the requisite measure for providing safe drinking water in the state. This decision had come in response to a petition filed in 1995 seeking NHRC’s intervention into the problem of arsenic contaminated water. Unfortunately no comprehensive steps have so far been taken except sinking some more tube wells. Already in several villages angry people have started showing protests. In some panchayat polls arsenic problem became major issue and existing ruling party was thrown out of power in villages. This unprecedented phenomenon showed as to what extent peoples’ protests could reach, if the state continues its apathy towards their suffering.

**Research - Existing Gaps**

Research by institutions of Calcutta for instance SOES-Jadavpur University, SSKM Hospital, All India Institute of Hygiene & Public Health, School of Tropical Medicine, Bose Institute etc began in the mid eighties and has now reached a plateau. The present research papers and documents are not bringing out any new dimensions and insights. In international conferences on arsenic poisoning (in 1998), experts from West Bengal and Bangladesh reflected the same findings that had been reported in the eighties and nineties. There has been significant improvement with regard to measurement techniques of arsenic from ground water. The present
atomic absorption spectra-photometry technology has made the analysis faster and more accurate, but needs a centralized laboratory because of the costly and cumbersome equipment required. Availability of kits to measure arsenic in the field also helped researchers to get immediate results. Hence the modern technique helped to measure extent of arsenic contamination from a larger number of water samples in a short period. Jadavpur University, which has the atomic absorption spectra-photometry technology, has planned an innovative methodology of involving the community for getting samples from remote villages. No such system was available or heard of in Murshidabad district yet, but it could be useful if adequately standardized and coupled with preventive and treatment related action.

Impact of arsenic on fertility, pregnancy and its outcome are very important issues. Several publications from different part of the world showed how arsenic contamination caused abortion, premature labor, low birth weight, birth defect etc. So far there is no complete community level data on this issue in the context of West Bengal.

Research on social dimensions of arsenic problem is virtually absent and thus there is no policy to deal with social issues. Driven by preconceived idea, medical intervention has been considered to be the only solution. Major obstacle in promoting chelating drugs to cure arsenic symptoms is its high cost. But there is no attempt to either decrease costs or provide adequately through the public services. There is also no attempt to explore the role of alternative system of medicine (like ayurveda etc.) in order to reduce arsenic burden from the body. In fact arsenic and its toxic effect was known even in ancient times, so there may be a possibility of remedy in other systems but nothing happened so far.

**Issues for the Future**

The following issues are broadly divided into two distinct groups:

**Research**

Four areas of social epidemiological research in arsenic poisoning require further detailed study. The rationale behind selecting these areas is to monitor and deal in the most effective and contextually appropriate manner with the long term impact of arsenic poisoning in every sphere of human life and society.

a) Prospective cohort study (longitudinal) in selected village/s is necessary to find long term and ongoing impact of arsenicosis on human health and suffering, as well as assess the impact of any intervention (like drug therapy and arsenic free water). This must include the impact on fetus and reproductive health.

b) Study on long-term economic impact including role of impairment, disability and handicap as disease consequences including measuring productivity of work force, expenditure on health along with productivity of land and overall village economy.
c) Study of societal consequences that develop over the years – including change of status and role of men and women in household and societal level, changing behavioral pattern towards women, impact on women’s lives, psychological study of sexuality, marriage, occupational changes and migration.

d) Operation research for assessing relative impact of intervention in agricultural policies, water use policies, cost benefit analysis of filters, use of chelating agents.

Action

The purpose of action is to reduce disease burden and the consequences, change of present developmental paradigm into more sustainable approach, restoration of natural harmony and early detection and report of new arsenicosis cases and notification of contamination of new water sources through active surveillance. The action can be divided into two broad categories 1) Reduce arsenic exposure, 2) Reduce burden and consequences of the disease (based on social epidemiological findings) and 3) Arsenic Surveillance.

Reduce Arsenic Exposure:

Immediate steps

1) To bring immediate relief to the patients, distribution of chelating agents for severely ill patients and pregnant women (after studying its feto-toxic effect) and provision of safe drinking water to be done. For short-term measure low cost filter made by locally available material (like alum, charcoal etc.) should be promoted. Special awareness with regard to handling filtrate to be given to people.

2) Strict measures to stop misuse of ground water including awareness generation with regard to linkage between ground water misuse and further arsenic contamination.

Intermediate steps

1) Use of rainwater (which is arsenic free) for drinking purpose. There are some countries like Thailand where in order to get arsenic free water roof is used to collect water and stored in enclosed place with proper biological method which can keep water portable for several weeks. West Bengal has high rain fall (1300mm to 1750mm/year) and lasts for several months. Arsenic symptoms would definitely improve if people drink arsenic free water for a considerable period.

2) Promotion of surface water (wells and ponds) for drinking purpose. But specific precaution should be taken like water should not be contaminated with microbial and chemical agent (away from sanitary land fill, defecation, concrete base around the well, cover facility in wells, raised boundary of pond in order to prevent pesticides and microbial contamination etc.). Community participation is more desirable.
Long term strategy

1) Revival of traditional irrigation system like increasing capacity of water bodies to hold sufficient amount of rainwater and can be used in irrigation.

2) Gradual shifting to crops that require less amount of water and are ecologically justifiable, economically sustainable and culturally acceptable. Help from genetic scientists is required to develop such particular variety of seeds.

3) More emphasis should be given on pulses and green vegetable production. Courtyard, unused part of domestic land can be used for traditional varieties of green vegetables, which require lesser attention and investment.

4) Social forestry including traditional fruit bearing trees (like Indian gooseberry) should be promoted. Community participation in social forestry should be given paramount importance.

5) Lastly, comprehensive strategy for overall development including agriculture, health, education and social development. It is to be remembered that arsenic poisoning is not an isolated phenomenon; rather that it has been one of the eventualities of present trend in modern developmental paradigm which is skewed in nature. Therefore until and unless the intervention reaches the roots of the problem, manifestations cannot be controlled.

Reduce Burden and Consequences of the Disease
This action can be broadly divided into four categories:

Medical intervention & health services:

1) As immediate measure decentralization of treatment facilities for arsenicosis up to block level should be done. Special attention to be paid to the poor as they were the worst sufferers.

2) Development of general treatment protocol for arsenic patients according to the symptoms and sensitizing Government doctors and private practitioners for rational treatment.

3) As immediate measure, establishment of physiotherapy facility at block level for patients with neurological manifestations.

4) Development and distribution of low cost keratolytic agents (which can dissolve hard keratosis patch) to reduce suffering from keratosis. In fact, IPGMER started using ointment of combination of low cost keratolytic agent and found it useful for patients.
5) Research on neurological and respiratory manifestation of arsenic poisoning, as these are more debilitating and progressive in nature.

6) Conduct research in alternative systems of medicine, which are proved to be effective.

**Social security:**
1) Poor and marginalized sections should get greater attention in all interventions.

2) Food security for poor people must be ensured.

3) Economic and physical rehabilitation of the people particularly those who are severely affected.

**Awareness:**
1) More awareness is required for the doctors and politicians as they are the policy makers. They have to understand that only techno centric approach like drugs and filter cannot solve the vast problem. The policy makers should understand the complexity of the problem, which needs a multi prong strategy. The present study will help to get insight of the problem.

2) Awareness for local politicians, panchayat members and villagers with regard to scientific explanation of arsenic problems, manifestations and feasible and sustainable solution. Empowering people to demand their rights will be essential part of their awareness program.

**Integrated Planning**
Integration of the aforementioned approaches is essential to get complete relief from the arsenic menace. Arsenic problem is essentially result of faulty developmental policy in all dimensions. Therefore, a multidisciplinary team consisting people from all backgrounds should be part in planning process.

**Arsenic Surveillance**
Early detection and report of new arsenicosis cases and notification of arsenic contamination of new water sources may be done through following methods:

**Strengthening health service**
1) Sensitization on chronic arsenicosis, its clinical diagnosis and treatment of all health staff.
2) Availability of field test kits to detect arsenic in ground water in all block PHCs. After diagnosis of chronic arsenicosis cases, water samples of all suspected sources to be tested for arsenic.

3) Development of arsenicosis line listing and monthly reporting of all suspected cases to higher authority. Development of mechanism of regular data flow to state head quarters. Even zero reporting is also very important in surveillance.

4) Networking with private doctors to report any suspected cases of chronic arsenicosis.

Community participation
1) Community to be sensitized on early detection and reporting of chronic arsenicosis.
2) Community to be empowered to test water samples of both domestic and irrigation sources.

Inter sector Coordination
1) Health department, agriculture, irrigation, public health engineering and panchayat should work together in order to detect and report arsenic in ground water. Good coordination among these departments at all levels is required.

2) Irrigation department should periodically check arsenic level in all irrigation pumps and report to higher authority and also share the findings with health and public health engineering department.