Original Research Article

Role of Public Awareness Ensuring the Sustainability of Arsenic Mitigation

Abstract

Arsenic poisoning is the largest mass poisoning in history. It causes numerous toxic effects to human health which ultimately leads to cancer or Alzheimer's disease. Nearly 300 million people over 180 countries worldwide are suffering from the arsenic contaminated groundwater more than WHO directed limit. Despite of its potential fatal toxicities, there is no effective treatment for arsenicosis. Cost-effective arsenic removal technology is also a matter of considerable research. This study aimed to summarize individual and social issues related to arsenic problem and the remedies suggested by different authors to cope with the adverse effect of arsenic. Reported studies emphasized that only mass awareness and mass education can stop the spreading of this disaster. This study will be helpful for future research on the awareness on arsenic contamination and studies on assessing behavior in different context. Policymakers may find it as helpful resource since it describes the problem from grass-roots level.

Keywords: *Arsenic Contamination, Arsenic Awareness, Environmental Health Literacy, Mass Education, Risk Perception, Arsenic Remedies.*

Introduction

Consumption of water is essential for every life in earth. Water enriched with nutrients and minerals is vital for being healthy. Unfortunately, a big part of the present world is suffering from a threat-imperceptible through the sense organs. Arsenic, a metalloid is the aforementioned culprit and can exists as organic and inorganic compounds. However, organic arsenic compounds are less harmful to human being because of its low absorbing property in human body [1,2].

Arsenic poisoning is the largest mass poisoning of population in history. Nearly, 300 million people over 180 countries worldwide are suffering from the arsenic contaminated ground water more than WHO permissible limit of 10 μg/L [3,4]. Arsenic exposure in human occurs mainly through water and food. Despite of geogenic sources, anthropogenic sources also cause arsenic contamination [5–10]. Long-term ingestion of highly arsenic contaminated water may cause skin disorders, cardiovascular diseases, respiratory problems, complications of gastrointestinal tract, liver and splenic ailments, kidney and bladder disorders, reproductive failure, neuro-toxicity and cancer [11–14]. Along with these severe effects, it may damage brain function causing several neurological disorders ultimately leading to Alzheimer's

disease [11]. It also affects on cognitive function manifesting lifelong neuro-developmental and behavioral disorders in infancy or early childhood [15,16].

Despite of magnitude of potentially fatal toxicity, there is no suitable diagnosis method in early stage and effective treatment for arsenic triggered diseases so far [17–24]. Scientifically sound, cost-effective and acceptable methods for the removal of arsenic from ground water is still a matter of considerable research [25]. Most of the arsenic removal techniques do not function at a low level of concentration and are very much costly due to expense of energy and reagents [25,26].

Unfortunately, a vast majority of the affected people belongs to lower socioeconomic standard having poor literacy level with poverty stricken malnutrition[4,18,27–32]. Installation of high technology arsenic removal system both individually and publicly is nightmare to them. Supported medication for the victims also remain as a matter of laxity.

This study aimed to summarize individual and social issues related to arsenic problems. The remedies suggested by various authors are emphasized.

Objective

Arsenic mitigation is one of the concerning issues in present decades. Due to poisonous effects of arsenic, awareness among the people has to be raised. It is the only way to tackle arsenic toxicity [33]. Adequate knowledge of drinking water and awareness to use a good source of water can be a useful public health intervention which can prevent many health related problems globally. Without appropriate knowledge of the adverse health effects of arsenic exposure and mitigation options, people will not be motivated to participate in interventions initiated by governmental and non-governmental agencies [34,35]. In this scenario it is urgent need to study the people of affected areas from grass roots level. What they know, how they feel and how they behave against the imperceptible threat arsenic is the major concern of this study. The main objective of this review is to provide a comprehensive description of public awareness regarding arsenic and its remediation.

Methods

A detail web-based searching of articles was performed in lens.org, which comprises Microsoft Academic, Crossref, PubMed, Core and PubMed Central directory. In addition to this, ERIC, Google Scholar, and Science Direct also covered. The key terms used for searching were ‘Arsenic Awareness OR Arsenic Contamination OR Arsenic Mitigation”. Finally, we had gone through the AI-based literature searching tools like Citation Gecko (http://www.citationgecko.com), Litmaps (http://www.litmaps.co) and Inciteful (http://inciteful.xyz) periodically to include the additionals. A thorough study leads us to 276 journals from which 72 meet our objective criteria. We found that majority of the studies belong to the area of Ganga-Meghna-Brahamaputra plain where the root of arsenic contamination is geogenic. Some reports from western context also have been incorporated at proper place for comparison purpose.

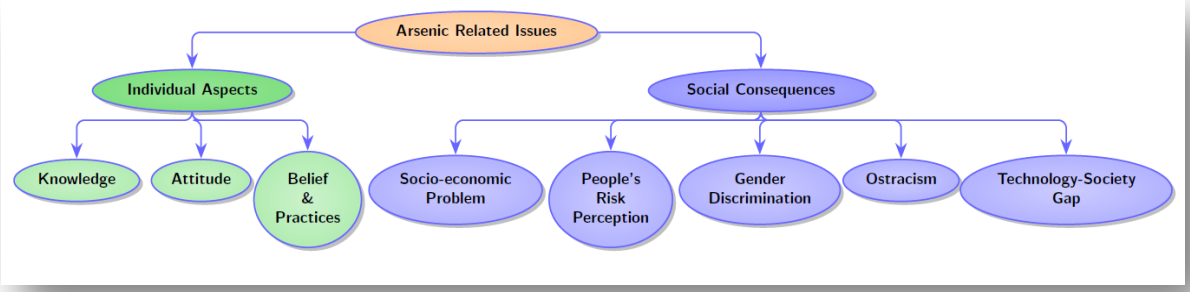
Result and Discussion

Arsenic contamination has had a profound impact at both the individual and community levels. It is a major threat to health, economy and social well being particularly in underdeveloped countries and remote communities. Drinking contaminated water is the primary route of exposure, and secondary exposure occurs through irrigation of plants with water containing arsenic or directly through contaminated soils. The low-cost efficient arsenic removal technique from water and disposal of arsenic containing sludge from the purifier is still unknown [36]. Adoption of new technology among households found ineffective due to presence of technology society gap in society [37,38]. The preventive measure will be effective only when there are awareness and access to information about environment quality [39]. However, there is lack of attention so far on the social dimension of the problem. For instance, many implemented mitigation options are not being maintained by the users and are being abandoned [21].

This study emphasizes the recent scenario of arsenic related social problems and their mitigation strategies based on recent studies. We divided our discussion in four parts. The first part describes the individual issues related to arsenic problem. Here we describe the problems in order to knowledge, attitude, beliefs and practices of individuals. The second part consists of social issues related to arsenic problem. The third part summarizes the modern studies using behavior change models and the final part is the summary of remedies suggested by different authors.

Individual Issues in Arsenic Contaminated Areas

Knowledge and awareness play very important roles in constructing people's risk perception, as it is difficult to perceive arsenic risk in the absence of any understanding of its existence and adverse impacts [40]. Public education programs promoting arsenic awareness could lower levels of engagement in risky behaviors by informing affected communities about arsenic contamination and its associated health risks [41]. Therefore, it is important to understand people's perception and awareness of the adverse effects of arsenic in order to tackle the psychosocial and health impacts. Without appropriate knowledge of the adverse health effects of arsenic exposure and mitigation options, people will not be motivated to participate in interventions initiated by governmental and nongovernmental agencies [35].
Fig 1: Arsenic related issue



Knowledge

Knowledge about ground water arsenic contamination and arsenicosis symptoms is important for individuals to stop spreading of the calamity. Majority of the studies reported poor

knowledge of the respondents in the affected areas. Most respondents did not know the health effects of arsenic, and very few are aware that arsenic could result in death [24,42–44]. Lack of awareness and resources are two major reasons in household's failure to take defensive activities [32]. There are a significant number of people using shallow tube-wells despite knowing that these wells could be contaminated with arsenic [45]. In many cases respondents do not take the arsenic problem seriously or cautiously. They know the term arsenic but do not know its negative impact on soil health, crop production and quality, and human health [46]. The receptivity of knowledge, however, differed by socioeconomic status of the population. For example, higher education increased the level of understanding and appeared to act as a catalytic agent to accept innovations [47]. Inadequate knowledge of source and route of arsenic leads to excessive exposure and when the disease happens, no prevention method come in this scenario. Some educated people from the economically higher backgrounds has proper drinking and cleaning facilities, but there is no awareness regarding lowering arsenic exposure [48].

The people who have considerable knowledge and awareness concerning the contaminated water are willing to pay for a good source of water [34]. A questionnaire based survey in the affected area of Combodia revealed that like other countries knowledge of the problem does not appeared to be gendered, but wealth and education level do impact upon knowledge [49]. People's education, age, or gender has no effect on knowledge of an arsenic problem in the household [27]. In many cases the improvement in awareness for people with low education and low income is even higher than for people with higher education and higher income, perhaps because better educated respondents start with more knowledge [50].

Attitude

There are several reports on the maintenance and monitoring systems. Owners of private wells are more often forget what kind of treatment they are using, and are not interested better maintenance or monitoring of their treatment systems [51]. People are more likely to trust previous reports on arsenic concentration and contaminated cases that are safe but not updated. The previous reports on arsenic concentration and contaminated cases overwhelmed their risk perception and general knowledge [45]. A questionnaire survey for the assessment of attitudes towards receiving information regarding genetic susceptibility to the effects of arsenic in drinking water was conducted recently. The vast majority of the participants in the rural, low resource setting were interested in receiving information on their genetic susceptibility to the effects of arsenic exposure and being motivated to reduce their exposure if they learned they were at elevated genetic risk for arsenic toxicities [52]. Another questionnaire based study revealed the differences of attitude of the patient and non-patient respondents between pre and post participation in arsenic mitigation programs were positively significant. It was also observed that education, farm size, organizational participation, contact with the sources of the information and annual family income had significant positive relationship with the change in attitude of the patient respondent [53]. Without significant motivation or a requirement some households will never test their well for arsenic, perhaps due to low perceived personal risk or other factors. Even with mandatory testing or intense motivation, the problem of arsenic exposure still isn't solved by the act of testing; testing is just the first step on the road to effective arsenic mitigation [54].

The individual strategy adopted by victims is more tragic. They keep safe distance from the unaffected people in order to avoid social embarrassment. The most seriously affected

patients do not feel able to go outside thinking that, if they leave their home, people will make hurting comments to them. Some patients decide not to attend social activities and functions, and even not to continue with some personal relationships [55].

Belief & Practices

Almost one third of the population still using arsenic contaminated water knowingly. Primary reason for continuing to use arsenic contaminated tubewells is distance and other reasons are non-cooperation of the owner of safe tube wells, bad taste of water after treatment and beliefs of no arsenic contamination are notable. Some relied on divine protection and others have the misconception of arsenic removal by cooking. Access to health service is particularly difficult for poor patients, as they often have to face problems associated with accessing service like, non availability of medicines in the hospitals, traveling long distance, purchasing medicine in most cases etc. Furthermore length of time needed for reversal of symptoms lead to loosing faith on efficacy of treatment, which cascades to negligence of patient's part in seeking health care. Women are less likely to get treatment for arsenicosis than men. As there appear to be specific difficulties for women particularly for poor women in accessing health care, social and cultural values make it difficult for them to attend to their own health needs and to travel to service providers [17].

In terms of infectious disease risk, cooking practice is much less problematic than drinking water, since cooking involves boiling water and killing pathogens. In the case of arsenic contaminated water, however, cooking may be more dangerous than drinking, because boiling arsenic contaminated water increases the concentration of arsenic. There is widespread interest in piped supply water, but many cannot afford it or do not live in areas reached by piped supply lines. Poor people are found to be significantly less likely than others to consider taking a piped supply connection, presumably because they do not want to pay water bills [41].

In some cases, social ostracism and superstitious problem is found to be catastrophically insisting among the communities. There is an increasing tendency to avoid arsenicosis patients even within families—they are indirectly neglected and isolated [55]. However, long term social impacts and adverse situational behavior make them to mental disable. In the long term way to life leading, it may appear as a social disaster for the greater context of arsenic hazards [56]. Some victims hesitate to acknowledge their disease [24]. In many cases tubewells remained unmarked/untested and this is an alarming situation for the nation [30]. There is shame associated with red tubewells, which may have implications for families with arsenic contaminated tubewells [57].

Social Consequences of Arsenic Hazards

The social consequences of the arsenic crisis are far-reaching and tragic. There has been little or no social education concerning the treatment of persons affected by arsenic poisoning. Arsenic is not the only cause of toxicity to human health, but it results in major social dislocation for the affected people. Patients' are living with social uncertainty, social injustice, social isolation and problematic family issues. There is a sharp difference of perceptions about arsenic and social issues between the arsenicosis patients and unaffected

people. The latter group mainly focused on measures to prevent arsenic induced diseases, such as the consumption of deep tubewell water, rather than on the existing social problems experienced by affected people [55].

In fact, millions of people are at risk from arsenic. One third of the population living below the poverty line is illiterate. This means that poisoning by arsenic impacts their socioeconomic and health status and, as a result, puts an additional financial burden on the government, leading to massive economic inefficiencies. Arsenicosis patients in a lower income group are found to be more likely to encounter economic and social challenges such as difficulties in receiving treatment, lack of medicine in the hospitals, limited access to hospitals, long wait times for receiving treatments, discrimination in service delivery, lack of separate facilities for female patients, and difficulty in buying medicines [18].

Socioeconomic problems

The distribution of natural arsenic hazard in the environment is socioeconomically random. There is no evidence that higher socioeconomic status (SES) households are avoiding areas with arsenic or that lower SES groups are disproportionately residing in areas with arsenic. Instead, disparities in exposure arise from differing rates of protective action, primarily testing well water for arsenic, and secondly treating or avoiding contaminated water [51]. Lower-caste, less educated, and unemployed members of the population are found to be the most vulnerable, requiring immediate arsenic mitigation [58]. Many of the rural poor are agricultural laborers. Often, when employers discover their affliction, the affected workers immediately lose their jobs leaving no option to them other than migrate to urban areas [59]. If an adult is affected with arsenicosis, there are subsequent problems in maintaining income stability, particularly if they are very poor, but sometimes they are the only earning members in their respective families. If they are absent due to sickness, they are not paid for days missed. The vast majority of local people cannot afford doctors' prescription fees and the cost of medicines over an extended period. They often present when their illness is already at a critical stage, when there is very little chance of recovery [55]. Apart from high medical expenses, they also suffer from wage losses due to inability to work [28].

Women are more socially damaged than men by arsenic related illnesses, no doubt because of their generally lower social status. If unmarried, they find it difficult to find a husband; and if married they may be abandoned or divorced. They are less likely to talk about arsenic related health problems and are more likely to attend to the health needs of others than those they themselves face. Mental health problems, such as depression, may also result from intense social isolation or ostracism of arsenicosis patients [57].

Education is another factor influencing people's responses to the arsenic crisis. Women are generally less educated than men at all socioeconomic levels. Better-educated people are found to be more likely to understand the mechanisms of arsenic poisoning. Economic status affects a family's ability to take advantage of safe alternative water sources. It is middle or high income households who turn to the piped supply water alternative. Other important social factors are nutritional and health status. People who are malnourished may be more vulnerable than others to chronic arsenic poisoning. Another social consideration is daily working conditions. People doing heavy labour-agricultural labourers or construction workers, for example, drink large quantities of water and so may be at higher risk than people with less physically demanding occupations [41].

In some cases, social ostracism and superstitious problem is found to be catastrophically insisting among the communities. While it is one of the main causes that is directly inhibit their normal life style and daily working activities. However, long term social impacts and adverse situational behavior make them to mental disable. In the long term way to life leading, it may appear as a social disaster for the greater context of arsenic hazards [56].

People's Risk Perception

Risk perception is positively related to adoption of mitigation options. Arsenic mitigation is highly likely to be successful among communities with greater perceived health and economic risks. The households with higher perceived social discrimination risk should be targeted for arsenic awareness program along with the mitigation. A majority of the respondents are willing to adopt arsenic mitigation technologies as a result of their higher perceived risks to health and income than social discrimination risk. Respondents' caste, education level, agricultural landholdings, and social trust are the strongest predictors of perceived health risks. In addition to these factors, income, sanitation practices, people's prioritization of socio-environmental problems, arsenic awareness, and social capital, are the strongest predictors of perceived economic risk. Respondents' agricultural landholdings, prioritization of social problems, arsenic awareness, and social capital, are the strongest predictors of perceived social discrimination risk [60].

Ostracism

Arsenicosis victims suffer from social ostracism, social hatred, and enormous psychological trauma. They encounter critical social and economic challenges in the form of social isolation and hatred by their respective communities and loss of jobs, respectively (18). Because of illiteracy and lack of information, many confuse the skin lesions with leprosy, which among village people is considered a contagious killer. As a result, those who have early symptoms of arsenicosis do not disclose their condition to avoid certain ostracism. When family members come to know of a sufferer's warts and black spots, they tend to avoid direct contact with the affected person. Sufferers in rural areas are not allowed to appear in public. Affected school-age children are prevented from attending schools and are avoided by their friends and classmates. Adults are barred from attending cultural/religious functions [59].

Arsenicosis patients are apparently neglected by the group peoples who believe, it might be the result of any previous curse or sin. People drink water from the same arsenic contaminated water sources, but only some were affected by infection. Many local villagers, therefore, understood infection to be preordained and beyond human control; anyone could become affected by infection, if it was written in their forehead. Here, infection is understood and explained as a curse of God, which is inscribed in one's forehead because of past transgressions. People believed that, to get rid of such infectious disease, these past transgressions needed to be redressed through good deeds or by solemn prayer to God [1]. In the community, superstitious and social ostracism problems has turned into social hazards for an arsenicosis patient which is directly insisted daily life style, social status, access and deny participating any social meeting. Surprisingly it is considered that almost all the communities openly or ultimately and unconsciously arsenic affected owing to continuous taking contaminated food and gradually leads to worsen health condition [56].

Within the community, arsenic-affected people are barred from social activities and often face rejection, even by their immediate family members. People feared arsenicosis and assumed the disease to be contagious, even though they are unaware of its symptoms. As a result, some patients experience social problems due to the visibility of black spots on their bodies. Some unaffected people are angry and aggressive. They think that patients should either stay in their homes or leave the village [55].

Gender Discrimination

Gender is one important factor to be considered. The arsenic-affected people, particularly the women are suffering from ostracization and discrimination, and losing their social relation with the neighbors and relatives [61]. Women are more likely than men to think that arsenic-related disease is hereditary or contagious. This idea in itself, of course, has powerful implications for marriage arrangement and other social relationships, as whole families might be stigmatized by the arsenic-related illness of one or more members. Another gender consideration is the social assignment of water management roles. In the majority of households, women have responsibility for water collection and storage; so they are the ones who need to understand about arsenic risks and household-level mitigation measures [41].

The gender inequalities related to arsenicosis are manifested in the access to health care and in the degree of social stigma: women are the biggest victims, unmarried women in particular. Young girls and women are more affected as they are comparatively more exposed to contaminated water and show no interest for treatment [62,63]. When the husband finds symptoms of arsenicosis on her body, he often refuses to keep her under the same roof. If the woman is fortunate, the husband simply sends her back to her parents for treatment. In most case, however, the husband finds it too risky to maintain the marital relationship and seeks divorce. In a rural setup, a divorcee is often socially maltreated even under normal circumstances. A divorcee with a fatal disease is considered a social burden. As a result, the divorced women find no place in the society and, with their children, become destitute. In villages, it becomes a problem for parents to get their affected daughters married. Life becomes miserable when one of the partners of a married couple is arsenic-affected [59].

Technology Society Gap

Installation of sustainable technology for removal of arsenic from drinking water is most important mitigation strategy. However, in many cases there is a technology-society gap responsible for the failure of this strategy. Building trust with community through direct interactions and communication by scientists proved vital for bridging the technology society gap at a critical stage of technology deployment [37,38,64].

Lack of awareness and relevant information is one of the major hurdles in any arsenic mitigation program. In very few cases the users are able to recognize the arsenic removal plants as an asset for the community and maintain them properly. Without cost sharing it is difficult to instill in users' minds a sense of ownership. The reasons for ineffectiveness and poor performance of these arsenic removal plants include improper maintenance, sand gushing problems, a lack of user-friendliness and absence of community participation [65].

The assessment of technologies and their impact on local social structures is extremely tricky especially if performed by outsiders. It is therefore inevitable to develop active participation processes of local communities and organizations working at the local level. However, there is still a lack of long-term vision and understanding of some of the consequences of introducing new forms of co-operation between villagers, such as organizing monitoring, operation, or maintenance systems. Suffering most from this problem are again the rural poor. They form by far the largest section of the population and at the same time have least access to societal resources [66].

Modern Approaches using Behavioral Model

Behavioral models and theories are designed to understand people's behavior and identify the underlying factors that influence it. In recent years, there has been increased interest in the application of these theories in the areas of health and the field is continuously developing. However, factors like environmental, social, cultural, economic, and political influences are given no attention within these theories causing low effectiveness of a health promotion strategies based on these theories.

Health Belief Model

Health Belief Model is one of the earliest and most influential models in health promotion. The theory has developed time to time and now it has six factors such as perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cue to action and self-efficacy to suggest the likelihood of adoption of the health behaviors [67,68]. A questionnaire based cross-sectional study was attempted to assess awareness and attitudes of women in Sanandaj, Iran, regarding toxic metal-contaminated rice based on the Health Belief Model (HBM). The findings of the study revealed the necessity of raising public awareness and increasing risk perception regarding the adverse effects of toxic metals. Increased risk perception, and subsequently, increased public awareness about the adverse effects of toxic metals result in behavioral changes and promote protective behaviors against the adverse effects of toxic metals, such as reduced consumption of toxic metal contaminated rice or its substitution with toxic metal-free varieties [69]. Another study was performed to design and evaluate a household-level arsenic education and well water arsenic testing intervention to increase arsenic awareness in Bangladesh. This was assessed through a pre and post intervention quiz concerning knowledge of arsenic. Educational materials were designed based on constructs from the Health Belief Model. Results suggested that arsenic education coupled with water arsenic testing programs can be used effectively to increase arsenic knowledge in the population [70].

RANAS Model

Risks, Attitudes, Norms, Abilities, and Self-regulation (RANAS) approach to systematic behavior change is an established method for designing and evaluating behavior change strategies that target and change the behavioral factors of a specific behavior in a specific population. These five block factors must be positive with regard to the new behavior for its formation. HBM is an individualist psychological model, whereas the RANAS approach accounts for the interaction between individuals, communities, and the environment [71,72]. A questionnaire based assessment was done in Bangladesh using acceptance factors from the

RANAS model. The aim of the study was to determine the acceptance and use levels of eight available arsenic-safe water options in Bangladesh. A major finding of this study was that one third of households in Bangladesh who are at risk of drinking arsenic-contaminated water, and who have access to one of the eight arsenic-safe water options, do not use these options. Some options are used by as little as one-third of those who could make use of them. This implies that the number of people at risk of developing arsenicosis in Bangladesh may be underestimated. The results in users' low commitment, indicating that if there were another safe water option, these users would change immediately [73]. Another important RANAS model based study on switching to existing arsenic-safe wells was performed. They argued that developing behavior change interventions based on psychological theory and evidence will enhance the effects of a risk information intervention to encourage switching to arsenic-safe wells. It revealed that commitment, the descriptive norm, self-efficacy and perceived vulnerability are the main predictors of the probability of using neighbouring arsenic-safe wells. Interventions developed to target these factors increased behaviour change effects of a risk information intervention by up to 48 per cent. The most successful interventions to promote well-switching were implementation intentions in combination with information and reminders delivered by local health promoters. Public commitment had an unexpected negative effect on people switching to arsenic-safe wells. Increase in the behavior change effect of theory-based and evidence-based interventions support the usefulness of an applied approach of intervention development [74]. Another questionnaire based survey in southwestern Bangladesh aimed to determine why, as well as the extent to which, people are expected to remain attached to using these unsafe water options, compared to the following four safer drinking water options: deep tubewells, pond sand filters, vendor water, and rainwater harvesting. The safe alternatives (deep tubewell, rain water harvesting, pond sand filter, and vendor water) score significantly better than pond water and are estimated to have the potential to be adopted by pond water users. Deep tubewell, rain water harvesting, and pond sand filter also score better than shallow tubewells and could also have the potential to replace them [75].

Remedies

Awareness is positively related to remediation options. Before offering practical remediation options it is necessary to increase public awareness so that fighting the combat against arsenic gain success. Environmental education and knowledge empowerment may help to change the traditional culture, ostracism and superstitious problems to achieve sustainability [35,55,56]. Misconceptions and myths regarding arsenic must be strictly eliminated. Arsenic is such an element, the toxicity of which does not reduce after boiling. Therefore people should avoid arsenic contaminated water for drinking and cooking. Immediate action must be taken to stop the use of contaminated water [25]. The use of alternative arsenic free sources of water such as dugwells and arsenic removing filters must be encouraged among people [1,61]. There is a serious need of public education programme to create mass awareness. Government and NGOs must pay considerable attention to poor villagers having little or no education irrespective of gender, age and locality [24,41,59,76]. A reduced arsenic standard for drinking water, testing all available drinking water sources, and sustainable and cost-effective arsenic mitigation programs that include participation of the people are urgently needed [18]. The remedy measures will be more effective when people can access more water sources with regular monitoring along with the regular enlighten activities [18,32,45,46,61,77].

Fig 2: Remedies

To raise awareness the role of media is crucial. Arsenic mitigation programs should be promoted among the communities that perceive higher social discrimination risk, highlighting the potential social discrimination because of the risk of arsenicosis [41,60]. The government may firstly use various channels to make the households aware and importantly provide effective water supply to them having no alternative options [32]. Regular health check-up camps and intervention programmes are very important to reduce arsenic related mortality and morbidly in affected community. Introduction of regular monitoring and treatment of the people exposed to arsenic are also required. Duration of exposure, dosage, concentration of arsenic in drinking water, nutritional status, inter-individual variability and recreational habits like smoking, drinking etc. are the most important factors to be considered to stop the spreading of the disease [62].

There should be some preventive law to control and constantly monitor installations hand pumps/ tube wells, industries and arsenic removal plants in order to restrict arsenic contamination in ground water [31]. Since people are heterogeneous in nature having varying perceptions to a common problem the upper class community who are more likely to adopt should be targeted for immediate arsenic mitigation. The rest seek to emulate the former in many situations will adopt the technology more likely [60]. Increased public awareness will reduce the technology-society gap and people will be more benefited by accepting the new water supply schemes [27,44]. In addition, the various adsorbents and technologies for

arsenic removal and their potential negative environmental consequences need to be addressed so that a significant and influential decision can be taken to limit health risks and increase the efficiency of arsenic removal. Moreover, further research is required to develop efficient and cost-effective arsenic removal technologies [26].

Conclusion

The situation has not changed drastically in last two decades. Lack of public awareness, negative attitude of individuals and inadequate government initiatives may be the primary reasons for this circumstance. There is a high chance of failure of mitigation options until and unless people become aware and perceived the risk associated with arsenic contamination. Increase of knowledge through health and environmental education of individuals may bring the positive attitude to them. This change in attitude must change their perceptions to the problem. Thus, the social ostracism and gender discrimination will be diluted in time and certainly removed from the society. Proper and regular training on arsenic removal systems is required on urgent basis. Installation of water treatment plants in locality from government is necessary. The people should be encouraged to install small water treatment plants in locality and /or transportation of arsenic free water from outside. The cultivation of crops which required large amount of groundwater must be stopped. These crops may also be transported from outside leading to reduced arsenic intake. Transportation of crops and water from outside may be a good career option for people. There are various scopes of future research on arsenic related issues, particularly in social dimension. Advanced behavioral theory and models may predict more accurately the adopted change in behavior of people. Finally, it is not so far when we can stop the spreading of the arsenic disaster.

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