Assessment of Arsenic and Iron Levels in Tube Wells of Government Run Institutions in a Block of Murshidabad District, West Bengal

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Abstract

Background: Murshidabad in West Bengal is considered as an endemic district for arsenic contaminated ground water. Iron is also a common inorganic material present in ground water which have ill effects on the body if beyond permissible limits. The present study was conducted to find out the level of arsenic and iron in the water samples in Government run institutions in one block of Murshidabad district.

Methodology: In this descriptive observational study, water sample reports of 26 Government run institutions in an arsenic affected block were analysed. WHO and Bureau of Indian Standard permissible and acceptable values of both materials were considered for analysis.

Results: As per Indian standards, only 26.9% of water samples in the study block were within acceptable limits for arsenic. If WHO recommended international standards were considered then more than 80% water samples were not safe as drinking water. In case of iron, only 7.7% water samples were within desirable limit as per Indian standards. While considering both arsenic and iron, only 1 water sample was seen to be within desirable limit.

Conclusion: In spite of ongoing arsenic mitigation activity in West Bengal the arsenic level was found to be above permissible level in the Govt run tube wells. Awareness generation for repeated testing of arsenic, use of arsenic removal method at household level and use of safe water for both drinking and cooking at community level should be stressed upon.

Keywords: *Arsenic, Iron, Drinking water, WHO permissible limit, Acceptable limit, Bureau of Indian Standards.*

Introduction

Arsenic has been one of the most notorious contaminants of ground water and hard to detect as arsenic has no flavour or odour. West Bengal with its nine districts is considered as an endemic state for arsenic contaminated ground water above WHO maximum permissible level of arsenic of 10 mcg/L.[1] As per government of West Bengal estimate, 79 blocks involving 26 million people across 2600 villages are worst affected with arsenicosis.[2] The US Environmental Protection Agency (EPA) classifies inorganic arsenic as a "human carcinogen".[3] Chronic intake of drinking water with above 50µg/L arsenic concentrations can cause the development of arsenicosis.[3]A systematicreview[4]had

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emphasised a large spectrum of systemic manifestations like chronic lung diseases, liver diseases, peripheral vascular disease, hypertension, to weakness, anemia and neuropathy.

Murshidabad is one of the nine affected districts of West Bengal with arsenic contaminated ground water. A three-year study in this district showed 26% of the tubewells were found to have arsenic above 50 microg/L while 53.8% had arsenic above 10 microg/L.[5] In a study in Jalangi, one of the worst affected block of Murshidabad, it was observed that 77.8% of the tube wells were found to have arsenic above 10 microg/l [World Health Organization (WHO)-recommended level of arsenic in drinking water]; 51% had arsenic above 50 microg/l [the Indian standard of permissible limit of arsenic in drinking water] and 17% had arsenic at above 300 microg/l [the concentration predicting overt arsenical skin lesions].[6]On the other hand, Iron is one of the most common inorganic material present in ground water and may have ill effects on the body if beyond permissible limits. It has been estimated that iron concentration of more than 1 mg/L in potable water hampers palatability and WHO recommends its level as below 0.3 mg/L.[7]As per GOI report, 15 districts of West Bengal including Murshidabad had iron level beyond 1 mg/L in ground water.[8]

With the current scenario of Murshidabad district the present study has been conducted in one block of this district with the following objectives.

1. To find out the level of arsenic and iron in the water samples in Government run institutions in one block of Murshidabad district
2. To determine separately whether the level of arsenic and iron is within acceptable limit and/or permissible limit in the absence of alternate source.
3. To find out the percentage of acceptable water sources taking both iron and arsenic levels into consideration

Materials and Method

The present descriptive observational study with cross sectional design was conducted in one block of Murshidabad district. A total of 14 blocks situated in the Gangetic belt of Murshidabad district are worst affected arsenic blocks. Out of them, Bhagwangola II block was chosen based on feasibility. Twenty-six tube wells were selected by simple random sampling out of all Government run tube wells situated in primary & high schools and ICDS centres where recent water quality sample test results were available from water testing laboratory.

For water quality testing guidelines of drinkable water in accordance to- Bureau of Indian Standards (BIS) IS: 10500:2012 was followed in this study.[9] Standard of drinking water by this guideline differ from WHO standards for iron. Indian standards consider iron level 0.3 mg/l as desirable limit and there is no relaxation of the limit in absence of alternate source of water. WHO considers 0.1 mg/l as highest desirable limit and 1 mg/l as maximum permissible limit.[7]

In case of arsenic, fewdifferences existed between these two guidelines. WHO considers arsenic level 0.05 mg/l as desirable limit, whereas Indian standards consider 0.01 mg/l as acceptable limit and 0.05 mg/l as permissible limit in absence of alternate source.[9,10] Results were analysed in Microsoft excel.

Before conducting the study ethics committee clearance was taken from the institution and permission was taken from the concerned block authority.

Findings: The study was conducted in Bhagwangola II block of Murshidabad district and water report were analysed for 26 Govt run tube wells. It is evident from table 1 that as per Indian standards, only 26.9% of water samples in the studied block were within acceptable limits for arsenic. If WHO recommended international standards were considered then more than 80% water samples were not safe as drinking water. So far as iron was considered, only 7.7% water samples were within desirable limit as per Indian standards. If we considered both arsenic and iron, only 1 water sample was seen to be within desirable limit as evident from Fig 1a and Fig 1b.

Fig 2 depicted that 19% water samples were having both iron and arsenic beyond permissible level in absence of alternate water sources.

It is evident from table 2 that about 85% of water samples contain iron beyond permissible level as per WHO criteria.

Table 1: Level of arsenic and iron in studied water samples according to Bureau of Indian Standards (n=26)

Arsenic level (in mg/l)	**No (%)**
<0.01 Acceptable limit	7 (26.9)
0.01-0.05 Permissible limit in the absence of alternate sources	14 (53.8)
>0.05 Not permissible	5 (19.3)
Iron level (in mg/l)	
<0.3 Desirable limit	2 (7.7)
>0.3 Not permissible	24 (92.3)

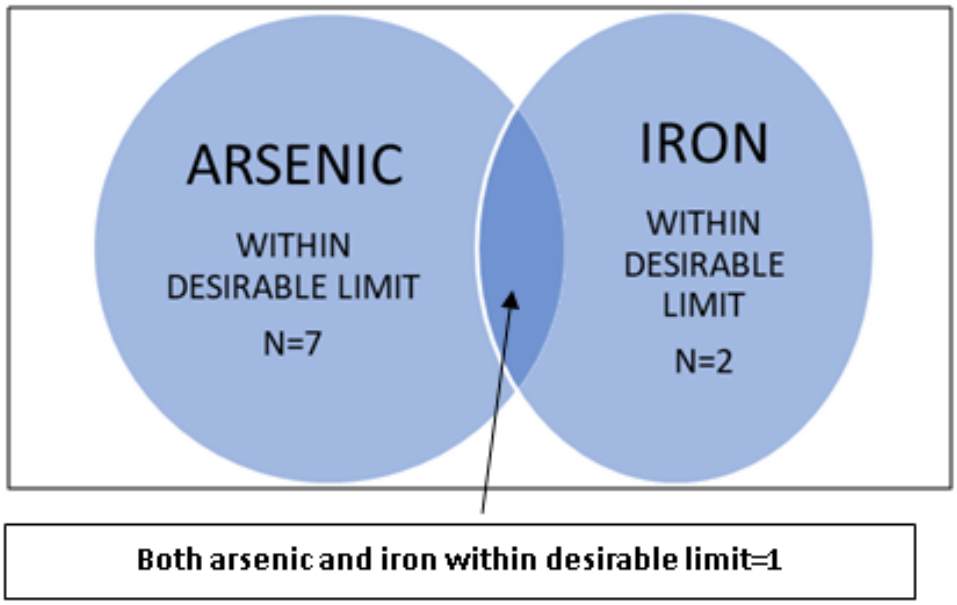

Fig 1: Water samples with desirable water qualities for both arsenic and iron (n=26)

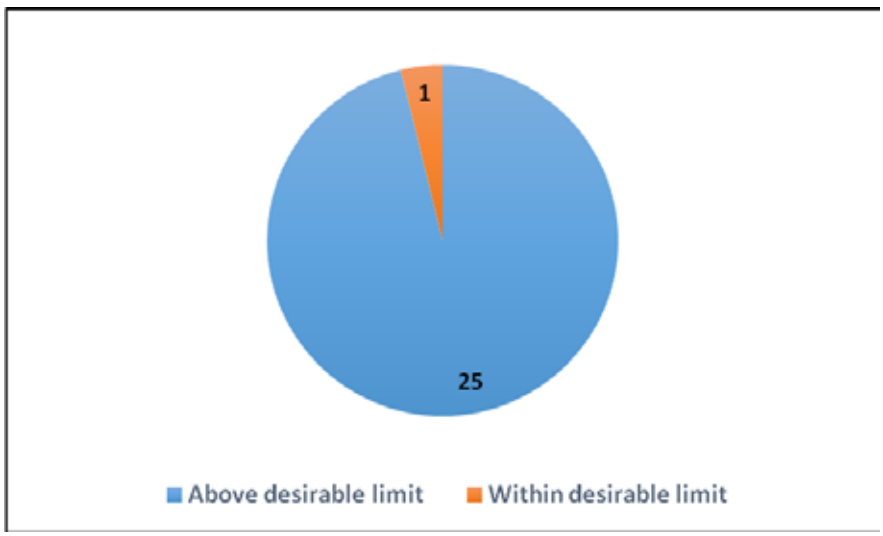

Fig 2: Water samples with desirable qualities (n= 26)

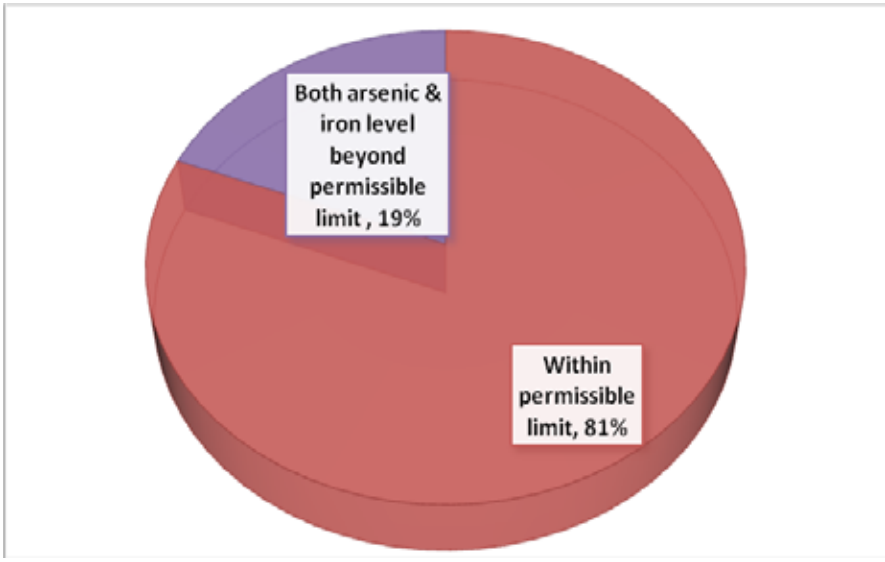

Fig 3: Samples having both arsenic and iron beyond permissible level even in absence of alternate sources

Table 2: Level of iron in water samples as per international drinking water standards by WHO

Iron Level	No (%)
Iron level within highest desirable level (<=0.1mg/dl)	1 (3.8)
Iron level above highest desirable level but within maximum permissible level (>0.1 <1.0mg/dl)	3 (11.5)
Iron level above maximum permissible level	22 (84.7)

Discussion

The present study observed 19.3% of water samples had arsenic level above 0.05 mg/l which was considered as Indian standard of permissible limit. About 73% had level above 0.01 mg/l which was recommended level of arsenic in drinking water by WHO. In a study in Jalangi and Sagarpara GP of this district,it was shown as 51%, 78% and 58.8%, 86.2% respectively.[6,11] Somewhat better observation was reported in Murshidabad district as a whole (26% and 53%) and Gaighata block of 24 Parganas (N) (40.3% and 59.2%).[5,12] The ground water information booklet of 24 parganas (S) showed also the high arsenic level in sporadic manner in patches in 9 blocks with a range of 0.001 to 3.32 mg/l.[13] The difference might be due to the difference of area and period at which the study was carried out, because in many places the mitigation activity had already carried out. The Ganga-Brahmaputra plains in India and the Padma-Meghna plains in Bangladesh together constitute the most widespread arsenic-affected area in the world. But arsenic contamination of ground water has also been reported from upper and middle Ganga plain and Terai area of Nepal. Study in middle ganga plain in Bihar and three districts Ballia, Varanasi and Gazipur of Uttar Pradesh in the upper and middle Ganga plain, tube wells showed arsenic contamination.[14,15] Several studies conducted in Bangladesh revealed arsenic concentration above 0.05 mg/l varied from 37% to 59%.[16,17] Terai area of Nepal was not an exception too. The status report published in 2003 demonstrated that 23% of the samples were containing 0.01 to 0.05 mg/L of arsenic and the 8% of the samples were containing more than 0.05 mg/L.[18] Recent status showed a better result of 7.9% and 2.3% respectively.[18] So not only the Gangetic belt of West Bengal, arsenic contamination of ground water had become a public health problem in South East Asia also as evident from the study in Vietnam and Cambodia.[19,20] Recent contamination was also reported from Pakistan, Myanmar, China and Afghanistan.

A study in UP showed that older tubewells had a greater chance of contamination for arsenic. But in the present study the tubewells were set up within a span of

5 to 8 years. So, this analysis could not be done in that light. The present study observed the concentration of arsenic ranged from 0.004 to 0.115 mg/l with mean and median level of arsenic being 0.033 and 0.006 mg/l (SE 0.019) respectively. A study in 2 villages of northern Vietnam showed however higher concentrations ranged from 0.0128 to 0.884 mg/l with mean being 0.6147 and 0.1601mg/L, respectively.[19] In two villages of Cambodia, concentrations had wide range of 0.00664 to 1.543 mg/l, with average and median concentrations of 0.552 and 0.353 mg/L, respectively.[20]

So far as iron concentration of ground water was concerned, as per WHO standard, 84.6% of tubewells was above permissible level of 0.1 mg/l. According to Bureau of Indian Standards, 92.4% had iron level above desirable limit of 0.3 mg/l. It was also found that only 1 tube well was safe so far as both arsenic and iron were concerned. A study in Bihar had also reported simultaneous high concentration of arsenic and iron in tube wells.[14] In Ground Water Year Book of West Bengal (2014- 15), it was seen that concentration of iron ranged from traces to 26 mg/l with an average of 0.8 mg/l and 40% of the analysed samples showed higher Iron concentration. In Murshidabad, 79.6% tube wells had iron level more than 0.3 mg/l.[21] A study in different districts of West Bengal revealed iron level of 2 mg/l from a sample of pond in 24 Parganas (S) and Howrah district, but samples from tube wells were within normal limits.[22]

According to U.S. EPA the standard concentrations of iron in drinking water should be less than 0.3 mg/l, but sometimes it varies due to use of cast iron, steel or galvanised iron pipes in water distribution system. Presence of iron in water promotes growth of undesirable iron bacteria that result in deposition of slimy coating in the piping.[22] Elevated iron levels in water can impart objectionable taste and colours too.[22] Chlorination of groundwater that contains iron may result in low-level or no residual chlorine level in treated ground water as observed in a study in Bangladesh.[23]

Conclusion

The two primary approaches in arsenic mitigation involve provision of alternative, arsenic-free water supply as a permanent solution and provision of arsenic removal technology to households and communities as a short-term measure. In spite of having this mitigation technology, still the arsenic level was found to be above permissible level in the Government run institutions tube wells in the study block. Arsenic mitigation in West Bengal has given an utmost importance in the comprehensive National Rural Drinking Water Program in 12th 5-year plan, but still it is a long way to go. Awareness generation for repeated testing of arsenic, use of arsenic removal method at household level and use of safe water for both drinking and cooking at community level should be stressed upon. Supply of surface water through pipe lines and use of arsenic free shallow dug wells can be recommended as long-term measure, but rain water harvesting can be adopted as an eco-friendly approach with additional benefits of recharging the ground water aquifers.

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