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PEOPLE-CENTRED APPROACHES TO WATER AND ENVIRONMENTAL SANITATION

Endemic Chronic Arsenic Poisoning - China

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Chronic arsenic poisoning in China caused by intake of high arsenic in drinking water and in dried local staple foods affects millions of inhabitants in vast rural areas resulting in endemic arsenicosis since 1950's with tens of thousands of confirmed arsenicosis patients. The Chinese government adopts a twofold approach to eliminate sources of arsenic intake. These are: - early detection and prevention; and provision of alternative arsenic-safe water supply and improved stoves to affected areas and families. Follow up studies indicate that consumption of arsenic-safe water could gradually improve symptoms of arsenicosis after 6 and 18 months. However, long term continuous cancerization of organs in arsenicosis patients requires close follow-up and research studies need urgently to be carried out.

Introdution

Chronic arsenic poisoning in China resulting in endemic arsenicosis in vast areas particular in rural areas, was first observed in the 50's and subsequently in the late 1970's and early 1980's in different localities. In China, chronic arsenic poisoning can be classified into two types based on the sources of arsenic intake into the human body. These are collectively known as Drinking water type due to consumption of groundwater containing natural high arsenic from medium and deep wells, and Coal-burning type caused by consumption of high arsenic contaminated dried local staple foods by burning coal rich in arsenic and fluoride at home for cooking, heating and drying foods. (1)

Drinking water type

In the late 1970's and early 1980's, arsenic-specific cutaneous changes were diagnosed in Kuitun of Xinjiang province. Inner Mongolia province was subsequently reported as another arsenicosis area in 1989, followed by Shanxi province in 1994. Recently, endemic arsenicosis was also found in Liaoning, Jilin, Ningxia and Qinghai provinces. The population at high risk is reported to be more than 4.5 million with over 35,000 confirmed arsenicosis patients. The arsenic concentration in wells as drinking water source was reported in the range of 200-2000 ppb with the highest level at 4440 ppb. (2)

The exposure of inhabitants to high arsenic drinking water in vast rural areas was due to the gradual improvement of living standard in rural China since the economic reform in 1978. Many peasants could afford to construct medium deep wells (20-30 metres) fitted with hand pumps at the house compound rather than to use the high salinity, bitter and astringent or fluoride-rich water from the traditional shallow wells and/or surface water from afar. Wells of 20-30 metres mostly tap water from the arsenic-rich aquifers thus exposed a large sector of rural population to chronic arsenic poisoning through consumption of the naturally occurring high arsenic in well water in the past three decades.



Figure 1. Provinces affected by chronic arsenic poisoning having tens of thousands of confirmed arsenicosis patients in China



Photo 1. & 2. Wells fitted with hand pumps in a house compound and a school




Photo 3. & 4. Burning coal in kitchen stoves for cooking and drying corn and hot peppers, Guizhou province.




Photo 5. Arsenic safe piped water supply to village home

Photo 6. A public water supply point of arsenic safe piped drinking water in a village. Villagers pay the

Coal-burning type

Coal-burning type chronic arsenic poisoning endemic areas are located mostly in southwestern China. The first patient was diagnosed in 1953 in Guizhou Province, but not until 1980's, more patients were identified. The main reason is that almost all families are burning coal in the open stoves indoors without chimneys, for cooking, heating and drying corn and peppers, the local staple foods as a means of preservation owing to the extremely high ambient air humidity during the local harvest season. This resulted in high arsenic and fluoride contamination in the dried corn and peppers as well as polluting the indoor air with high arsenic and fluoride particles. Through consumption of high arsenic and fluoride contaminated corn and peppers and constant inhaling arsenic and fluoride polluted air, local inhabitants mostly developed both arsenicosis and fluorosis. The population at risk is estimated over 1.3 million with more than 10,000 confirmed arsenicosis patients. The harmful effects to human body caused by coal-burning type are reported much more severe than those of the drinking water type due to intake of arsenic through consumption of high arsenic/fluoride contaminated corn and peppers and inhaling high arsenic/fluoride polluted indoor air. (3) This paper presents endemic chronic arsenic poisoning only.

Current situation of endemic chronic arsenic poisoning

The current problem of endemic arsenicosis in China is considered a grave public health problem. The magnitude and the scale of the problems in the affected areas are still not fully known on the one hand, while on the other hand new endemic areas are continuously emerging. High arsenic concentration of well water was detected in pocket areas in 21 provinces out of 30 provinces in China. It is expected that more and more high arsenic contaminated wells and cases of arsenicosis would be detected and diagnosed in these provinces gradually. The magnitude of chronic arsenic poisoning in China is hitherto unknown and the epidemiological information on arsenicosis patients in most areas is still unavailable. The report today on the scale of drinking water chronic arsenic poisoning in China is likely the tip of the iceberg. There is an urgent need, therefore, for the government to investigate the extent of endemic chronic arsenic poisoning in China for in depth understanding of the magnitude of the problem and the population affected for effective prevention and management of this silent public health calamity.

Nature of endemic chronic arsenic poisoning in China

Pattern of arsenicosis patients' distribution

In the drinking water type endemic areas, due to geological factors, high and low arsenic wells in the affected areas are spreading sporadically in the same locality. Some wells would have high arsenic concentration and others have arsenic level lower than the government standard of 50 ppb. Similarly, in the coal-burning type endemic areas, not all of the families use the arsenic-rich coal. Hence, a scattered distribution pattern of patients is observed in accordance with the locations of high arsenic wells and families using high arsenic coal. Such scattered nature of patient distribution and high arsenic in water and in coal complicates the problem further as the authorities have to deal with vast areas in providing inputs for preventive and mitigating measures with the already limited financial and human resources.

Epidemiological characteristics of cancer incidences in endemic areas

In a long term follow up study on the residents' fatal causes of mortality in Heihe village, one of the endemic arsenicosis villages in Inner Mongolia, where the local inhabitants are consuming high arsenic water for almost 30 years, malignant tumor tops the list at 71.72%, among which, respiratory system, digestive system and skin diseases are accounted for 38.5%, 35.9% and 14.1% respectively. (4) Arsenic is a definite carcinogen to humans. The latent period for chronic arsenic-related cancer could be 20-30 years. As the inhabitants in most endemic areas in China have now been exposed to high arsenic for some 20 years or longer, it could encounter the high risk of cancer outbreak in the coming years. Tak-

ing effective measures to screen all high arsenic wells and to cut off the exposure by motivating people using wells in the neighbourhood having low arsenic concentration while waiting for the provision of alternative arsenic-safe water supply are the correct ways to reduce arsenicosis incidence and the potential cancer peak in rural China in the future. This is a very valuable lesson for other arsenic affected countries to learn and to take action in preventing a public health calamity on endemic cancer in people in the arsenic affected countries.

Government approach for prevention of endemic chronic arsenic poisoning

The approach adopted by the Chinese Government to prevent endemic chronic arsenic poisoning by eliminating sources of arsenic intake is twofold: early detection of arsenic contamination in drinking water, foods and environment; and the provision of permanent arsenic-safe piped water supply to the affected population and the improved stoves to the affected households. The Ministry of Health is responsible for test of arsenic concentration in wells in the affected areas, supported by local provincial governments. UNICEF has been provided some financial assistance in carrying out the wide scale of testing arsenic concentration in wells of high risk areas in the seven affected provinces namely Xinjiang, Shanxi, Inner Mongolia, Liaoning, Jilin, Ningxia and Qinghai. So far more than 50,000 wells have been tested. Wells having arsenic level higher than 50 ppb were identified and marked. Well-arsenic maps in respective provinces are being developed. The Ministry of Water Resources works with respective local governments to provide arsenic-safe water to the most affected areas on priority basis recommended by the Ministry of Health. While the Government is yet to develop the policy for endemic arsenicosis prevention, large amount of budget will be required by the central and local governments for tests of arsenic contamination in all wells in the vast known affected areas and the potential affected areas. Although the Government has allocated sizable budget (RMB 850 million or US$106 million) to the Ministry of Water Resources for provision of alternative arsenic-safe water supply in high risk areas in the late 2000, (5) the fund is still falling short to meet the demand. The provision of alternative arsenic-safe water supply and improved stoves coupled with people habits/behaviour change are the key measures to eliminate intake of arsenic.

Early detection and prevention

Efforts are being made by some provincial governments to test arsenic concentration in wells in risk areas. The approach adopted is that when one well in a village has arsenic level higher than the government standard of 50 ppb, all wells in the village will be tested and mapped. Such well-arsenic map would be the valuable information to policy/decision makers in the central and local governments for increasing financial allocation for provision of arsenic-safe water supply to the affected rural population, and as an effective motivational tool to convince inhabitants to use their neighbours' wells that are arsenic-safe as interim measure while waiting for the provision of arsenic-safe water supply. At the same time, the local Centre of Endemic Disease Control medical officers should speed up surveys on identification of arsenicosis patients.

Provision of arsenic-safe water supply and improved stove

(i) In drinking water type affected areas - Government priority is to provide permanent alternative arsenic-safe piped water supply to the affected areas and the promotion of household harvesting rain and snow in some areas. The financial investment for the arsenic-safe water supply scheme is from the central and local governments as well as community. Community is to provide about 1/3 of the capital cost and responsible for the operation and maintenance (O&M) of the water supply system. After ensuring the financial input and commitment for O & M by the community, a user pay piped water supply system will be planned and installed.

(ii) In coal-burning type affected areas - Government initiated the promotion of improved stoves for mitigation of coal-burning type fluorosis in the late 1980's. The scheme is now also applied for coal-burning type arsenicosis.

Social education and public awareness creation

The Government has initiated intensive education at community level to create the awareness among the affected population on the severe health effects of chronic arsenic poisoning particularly to children in the long term. UNICEF had also provided support in developing the educational materials in both drinking water and coal-burning types affected areas. Heads of households especially parents in the affected areas are advised to take preventive action to eliminate further arsenic intake by their family members. The entry point of awareness creation could start in and through schools to educate the children, who, in turn, would educate/motivate their parents and community members to take "self" preventive actions.

Protecting the high-risk population, women and children – A top priority

In affected areas, young children bodies are easily susceptible to harmful effects of high arsenic intake. The investigation of Wakayama arsenic contamination of baby formula incident in 1950's in Japan reported that arsenic could injure the brain and other organs' function of the affected children in the long term.(6) For arsenicosis to develop, it takes 5-10 years of consumption of high arsenic drinking water. However, arsenicosis symptoms have been diagnosed in 4- and 18-month infants in high arsenic contaminated drinking water areas in China and Thailand. (7) Some studies are currently being carried out to assess the possibility of transferring arsenic from mother to child and its possible routes. In a preliminary



Photo 7. Hyperkeratosis on the palm of an arsenicosos patient before consuming arsenic-safe water supply

Photo 8. Improvement of hyperkeratosis on the palm of the same patient after 18 months consuming arsenic-safe water supply provided by the Government.

finding of studies reported that arsenic could pass through placenta barrier and excrete via milk, thus threatening the foetuses and infants consequently. (8) Protection of women, in particular women in their reproductive ages, from intake of arsenic either in contaminated drinking water and/or food, is an important task. For the wellbeing of the future generation on whom we rely to take up the heavy tasks for the development of the future China, the protection of women and children in the affected areas is a top priority.

Improvement of arsenicosis symptoms after consumption of arsenic-safe water supply

A follow-up investigation on the provision of alternative arsenic-safe water in two areas in Shanxi province and Baotou of Inner Mongolia was carried out during 1997-2000. Gradual improvement of skin pigment change and remission of hyperkeratosis have been observed among arsenicosis patients after respectively six and eighteen months consuming arsenic-safe water. Similar improvement is also reported in other areas where alternative arsenic-safe water has been provided. For example, in some severe arsenicosis endemic areas in Xinjiang province, on average, 76.9% improvement on clinical symptoms of arsenicosis patients was reported after 3 years of provision of arsenic-safe water supply in affected areas. (9) However, the long term continuous cancerization of organs in patients requires close follow-up and research studies need urgently to be carried out. (10) Our experience, obtained through relatively short term observation, has shown clearly that provision of alternative arsenic-safe drinking water is a most effective measure to eliminate chronic arsenic poisoning.

Lessons learnt

The experience gained from our over 30 years on managing the endemic chronic arsenic poisoning in China is to deal with the problem fundamentally by cutting off the source of arsenic in drinking water and in food. The only sure way to reduce endemic arsenicosis and human suffering in affected areas is to stop the population at risk exposure to high arsenic drinking water and food. The effective measures are:

- For drinking water type - Early detection of arsenic in wells as drinking water source in affected areas and advise/motivate inhabitants to consume water from those wells in the neighbourhood that have arsenic concentration below 50 ppb, while waiting for the provision of alternative arsenic-safe water supply. Although a permanent arsenic-safe piped water scheme may require relatively higher financial investment at the beginning, quality of water supplied can be ensured below the government arsenic standard of 50 ppb. It is, therefore, more cost- and health-effective in the long term according to our experience in China.
- For Coal-burning type - Provision of improved stoves with chimneys to affected families to vent away the polluted air from burning high arsenic and fluoride coal.
- Intensive social education to create public awareness in affected areas to motivate behaviour change and take "self" preventive action.

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