Current Status of Endemic Chronic Arsenicism(Arsenic Poisoning) in the World

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Since the latter half of the last century, endemic chronic arsenicism(ECA) has occurred on a huge scale in several areas in the world.

The Figure 1 shows major areas endemic for chronic arsenic poisoning due to ingestion of arsenic from drinking water in the world as of 2001 and new other endemic areas have also been successively reported from an another place of India, Nepal and Vietnam, etc. since 2001.

Various factors resulting in arsenic contamination of drinking water(both of surface water and underground water) are summarized as follows.

1. geographical and background conditions common to the endemic areas :
   dry inland basin, agricultural and/or stock farming area, volcanic belt,
   delta region in an estuary, area which once was sea, use of deep well
2. mining and refining activities
3. hydrogeological background :
   existence of arsenic-rich strata under water-source spots
4. geochemical background :
   a. oxidation theory :
      On ECA occurred recently on a mass scale in Ganges delta, it is speculated that arsenic contamination of groundwater is to be due to a decrease in groundwater level, accompanied by the pumping of a large amount of water for irrigation. A supply of oxygen(air) to underground is consequent on the decrease and through a series of geochemical changes arsenic may be free from arsenic compound(iron pyrites) in the stratum to move in the groundwater. However, the geochemical machanisms has not been clarified yet.
   b. reduction theory :
      In endemic areas where groundwater is not used so much for irrigation(Inner Mongolia etc.), another speculation is dominant that hyper-consumption of oxygen by mycrobes living in the underground which may change the environment deoxidated state and arsenic may be free from arsenic compound(ferric hydroxide) in the stratum to move in the groundwater.

In fact, hydrogeological and geochemical mechanisms on arsenic contamination of groundwater water are more complicated and special, and it is still difficult to under-

stand them comprehensively for the time being, although a lot of hydrogeologist and geochemist have worked to resolve the mechanisms in many asian fields endemic in this decade.

One or more of the above factors may induce arsenic contamination of groundwater. Among those in the map, each case of Chia-Nan Plain(Taiwan), Cordoba(Argentine), Antofagasta(Chile), Ronpibool(Thailand) and Guizhou(China : this is caused by arsenic contaminated coal-burning for daily life) had been known as endemic disease in the area about 100 years before and their causes belong to the above 1 or 2.

However, during these fifty years many cases of ECA caused by pumping up a large amount of water from underground for irrigation or waterworks have much attracted attention : the Comarca Lagunera, Torreon(Mexico), Kuitun, the Xinjiang Uygur Autonomous Region(China), Inner Mongolian Autonomous Region(China), Shaanxi Province(China), West Bengal (India), Bangladesh and Bekes(Hungary).

Arsenic contamination of drinking water due to mass use of groundwater now must be considered as a global environmental problem with underlying issues of population, food and water. In this context the ECA in Ganges delta is the most significant to report for today's subject.

The Ganges Delta(Figure 2) is recognized as the worst arsenic-contaminated area in the world. Bengal, prior to becoming British plantation, had a traditional irrigation system using surface water, which was also used for daily life. However, after British colonization, the irrigation system was eventually destroyed due to the construction of a road network.

Furthermore, with an increase in the population in the area, rice farming also began to be conducted in the dry seasons, using groundwater. Since 1962 many deep artesian tube- wells were dug and a large amount of water was pumped up(Figure 3).

As a result, the level of groundwater level fell, resulting in a series of geochemical changes, which were considered to have induced dissolution of arsenic from the soil into groundwater. Since 1970s residents in the areas begun to use well water instead of surface water under the help of WHO and Unisef for prevention of gastrointestinal infections endemic., using a hand-pump(Figure 4). The first patient with arsenic poisoning was discovered in 1983, following reports of arsenic contamination of well water since 1978. The contaminated area was expanding and the number of patients was increasing annually ; in 1988, six districts of West Bengal populated 30 millions were exposed to arsenic in drinking water.

More than one million residents drank contaminated well water(maximum arsenic concentration : 3.7mg/l). Typical arsenical skin lesion of melanosis was observed in

200,000 residents. According to the first report on this endemic disease by Dr. Saha, the average arsenic concentration of well water in seven districts of West Bengal was 0.32 mg/l(0 06 – 1.25 mg/l) during 1983 – 1987, and the duration of exposure to arsenic in drinking water, which induced the skin lesions, was between six months and two years. Based on these figures, the development of arsenic poisoning is estimated to have begun around 1980 – 1981 at the latest.

A simular situation of arsenic contamination of well water resulting in arsenic poisoning occurred at the Ganges Delta of Bangladesh, just adjacent to West Bengal. The diagnosis was first confirmed in 1993, and a survey has now continued, but the magnitude of arsenic poisoning in this region is predicted to be larger than that in West Bengal. It is reported that 2.5 millions of tube- wells are contaminated with more than 0.05 mg/l of arsenic and also estimated more than 30 millions people are drinking the contaminated tube-well water in Bangladesh.

As for the water-supplying system in the endemic areas of Ganges delta, it is still impossible to construct such permanent system as waterworks just for economical reason. As one of the measures Asia Arsenic Network equipped so-called " Pond Sand Filter" which uses pond-water for drinking through gravel-bed(for muddiness), sand-bed(for bacteria) and finally disinfection by chlorine. This began to operate at 1999 in Samta village in Bangladesh and is capable of providing non-arsenic water about for 100 families(Figure 5).

Although arsenic contamination of groundwater has occupied the worldwide attention, hydrogeological and geochemical mechanisms of the problem have not been sufficiently elucidated yet. However, a policy against ECA due to water-induced arsenic is common and evident to all of the endemic areas. It is to supply the exposed inhabitants with non-arsenic drinking water. With all many diverse approaches to the problem, it is sometimes quite difficult or takes long time to accomplish the water-providing system in developing or poor countries. The measures in the endemic areas are summarized at an attached sheet.

Lastly some of typical arsenical skin and vascular lesions are illustrated.

Figure 6. melanosis in the mucous membrane on the gum(West Bengal)
Figure 7. melanosis and leucodermia on the lower limb(West Bengal)
Figure 8. diffuse melanosis of the palm(West Bengal)
Figure 9. diffuse melanosis of the back of the hand(West Bengal)
Figure 10. diffuse and spotty hyperkeratosis of the palm(Toroku, Japan)
Figure 11. diffuse and spotty plantar hyperkeratosis(Inner Mongolia)

Figure 12. multiple Bowen's disease(Inner Mongolia)
Figure 13. Bowen's disease : erythema, hyperkeratosis and scale(Inner Mongolia)
Figure 14. diffuse melanosis, leucodermia and Bowen's disease on the chest(Toroku, Japan)
Figure 15. Bowen's cancer : squamous cell carcinoma(Nishikawa, Japan)
Figure 16. superficial basal cell epithelioma on the brow(Ronpibool, Thailand)
Figure 17. basal cell epithelioma on the medial angle of eye(Inner Mongolia)
Figure 18. basal cell epithekioma on the nose(Cordoba, Argentine)
Figure 19. keratoma senile(Toroku, Japan)
Figure 20. squamous cell carcinoma in the oral cavity(Toroku, Japan)
Figure 21. squamous cell carcinoma on the thumb(Inner Mongolia)
Figure 22. Raynaud's phenomenon on the fingers(Kuitun, China)
Figure 23. spontaneous amputations of toes due to chronic Raynaud's disease (Toroku, Japan).
Figure 24. ulcer on the lower limb called ulcus cruris chronicum(Comarca Lagunera, Mexico)
Figure 25. blackfoot disease : spontaneously amputated toes due to gangrene (Taiwan)
Figure 26. patient with blackfoot disease(Taiwan)
Figure 27. blackfoot disease : artificialy amputated lower limb(Comarca Lagunera, Mexico)