Preventive Policy against Hazardous Effects of Drinking Arsenic-Polluted Well Water in Shanxi, China

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Purpose
To research the characteristics of morbidity and the distribution pattern of endemic arsenism due to drinking water with high arsenic contamination.

Method
Analyzing the data from general investigation, clinical examination as well as intervention trials.

Results
The area with high contamination of arsenic in well water (arsenic concentration of higher than 0.05mg/l) is about 2000 km² where 100,000 people are living in 79 villages with high-arsenic contamination. In this area, about 5,000 patients with typical symptoms of arsenic poisoning have been found, with showing the trends of family accumulation. The morbidity increases with age, but does not differ between men and women. The skin lesions are different among different endemic districts. The peripheral nerve lesions are also significantly different (p<0.01). The cancer mortality in the disease areas has been several times higher than those in other areas. Arsenic concentrations of well water could be related to local geological structure as well as hydrogeology conditions.

Conclusions
The high dosage of and long exposure to arsenic through drinking well water are associated with high prevalence and severity of the related disease symptoms in disease areas of Shanxi province. But it should be emphasized that the comprehensive measurements of treating water for tackling the disease have been so effective that the morbidity rate has recently been decreasing.

Please refer to the PowerPoint presentation on page 59
Status and Prevention and Control strategy of Endemic Arsenism in China

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I. Background

Endemic arsenism is usually caused by excess arsenic intake from high arsenic drinking water, high arsenic air and high arsenic foods for a long time. The endemic arsenism was firstly found in Xinjiang in China in 1983, it was identified as a new endemic disease by our government in 1992, and has been listed into the national prevention and control plan of priority disease.

Up to now, the population exposed to arsenic has exceeded 2 million and the patients diagnosed has been up to 20,000. China is a new large arsenism country followed India and Bengal. Endemic arsenism in China is one of very important health problems faced in this century.
II. Characteristics of endemic arsenism in China

- Widely distributed and has an expanding trend
- Located in some poor and underdevelopment areas of Midwest in China
- Multiple types such as drinking-water type, coal-burning type and others were involved
- High arsenic and high fluoride simultaneously existed in some areas

III. Status of endemic arsenism in China

Distribution of arsenic concentration in drinking water in Inner Mongolia

The arsenic concentrations of 46% wells exceeded the national standard for drinking water among 303 wells investigated, they mainly were 0.1-0.5 mg/l which accounted for 34%.
The arsenic concentrations of 33% wells exceeded the national standard for drinking water among 2,364 wells investigated.

The arsenic concentrations of 141 wells investigated in one village all exceeded the national standard for drinking water and mainly were 0.05-0.2mg/L, which accounted for 74%.

<table>
<thead>
<tr>
<th>Region</th>
<th>Population Investigated</th>
<th>Patients</th>
<th>Prevalence rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inner Mongolia</td>
<td>15,147</td>
<td>2,808</td>
<td>18.54</td>
</tr>
<tr>
<td>Shanxi</td>
<td>51,278</td>
<td>5,897</td>
<td>11.50</td>
</tr>
<tr>
<td>Xinjiang</td>
<td>50,760</td>
<td>2,561</td>
<td>5.04</td>
</tr>
</tbody>
</table>
The relationship between arsenic concentrations of drinking water and prevalence rates of arsenism in Xinjiang

The prevalence rates of arsenism in residents were increased with the increasing of the arsenic concentrations of drinking water.

The relationship between arsenic concentrations of drinking water and abnormal rates of arsenic in human urine

The abnormal rates of arsenic in human urine were increased with the increasing of the arsenic concentration in drinking water.
The relationship between years of drinking high arsenic water and the prevalence rates of endemic arsenism in Xinjiang

The longer high arsenic water drunk, the higher prevalence rate of the endemic arsenism occurred.

Patients with pigmentation
Patients with hyperkeratosis

Skin cancer

The distribution of coal-burning type arsenism in Guizhou province

1 nature village
Exposure population 190
Patients 56

54 nature villages
Exposure population 20,981
Patients 1,919

19 nature villages
Exposure population 6,146
Patients 1,919

29 nature villages
Exposure population 18,082
Patients 420

Patients with hyperkeratosis

Skin cancer

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29 nature villages
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Patients 420
Coal with high arsenic

Black wall

Coal burning

Stove
The arsenic content of coal in the arsenism counties of Guizhou province

<table>
<thead>
<tr>
<th>county</th>
<th>Arsenic content of coal (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xingyi</td>
<td>265 352</td>
</tr>
<tr>
<td>Anlon</td>
<td>418 530</td>
</tr>
<tr>
<td>Xingren</td>
<td>624 852</td>
</tr>
<tr>
<td>Zhijin</td>
<td>2,167 58</td>
</tr>
</tbody>
</table>

The arsenic contents in roasted corn and chili in the arsenism counties of Guizhou province

<table>
<thead>
<tr>
<th>county</th>
<th>Arsenic contents (mg/kg)</th>
<th>corn</th>
<th>chili</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xingren</td>
<td>4.1 2.8</td>
<td>512 300</td>
<td></td>
</tr>
<tr>
<td>Anlong</td>
<td>6.7 11.9</td>
<td>688 586</td>
<td></td>
</tr>
<tr>
<td>Xingyi</td>
<td>7.0 12.5</td>
<td>693 545</td>
<td></td>
</tr>
<tr>
<td>Zhijin</td>
<td>43.6 16.3</td>
<td>610 77</td>
<td></td>
</tr>
</tbody>
</table>

The higher arsenic concentrations of coal, the higher arsenic content in roasted food, especially in roasted chili.
### Comparison of As contents in environmental media between before and after stove improved in Guizhou Province

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Coal (mg/kg)</td>
<td>524 ± 602</td>
<td>324 ± 150</td>
</tr>
<tr>
<td>Indoor air (mg/m³)</td>
<td>0.26 ± 0.09</td>
<td>0.06 ± 0.03</td>
</tr>
<tr>
<td>Rice (mg/kg)</td>
<td>0.41 ± 0.26</td>
<td>0.26 ± 0.11</td>
</tr>
<tr>
<td>Roasted corn (mg/kg)</td>
<td>4.13 ± 2.76</td>
<td>0.56 ± 0.32</td>
</tr>
<tr>
<td>Roasted chili (mg/kg)</td>
<td>512 ± 300</td>
<td>46.43 ± 159.58</td>
</tr>
<tr>
<td>Drinking water (mg/l)</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Fresh vegetables (mg/kg)</td>
<td>0.2</td>
<td>0.2</td>
</tr>
</tbody>
</table>

### Comparison of human exposure between before and after stove improved in Guizhou Province

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Population investigated</td>
<td>8,958</td>
<td>20,981</td>
</tr>
<tr>
<td>Arsenic content in urine(mg/l)</td>
<td>0.95 ± 0.53</td>
<td>0.11 ± 0.01</td>
</tr>
<tr>
<td>Total intake (mg/day/person)</td>
<td>4.76 ± 2.24</td>
<td>1.12 ± 1.23</td>
</tr>
<tr>
<td>Occurrence rate of arsenism (%)</td>
<td>17.3</td>
<td>9.1</td>
</tr>
</tbody>
</table>
So far, only some provinces (municipalities) such as Inner Mongolia, Shanxi, Xinjiang and Guizhou have been investigated on endemic arsenism, while how many population exposed to arsenic and number of endemic arsenism were still not known in the whole country. So we started to carry out a national survey on the distribution of endemic arsenism in 21 provinces in 2001.

IV. A national investigation on the distribution of endemic arsenism in China

1. Selection of survey region

16 provinces and cities were chosen for investigation on drinking-water type arsenism according to historical water monitoring data and 5 provinces and cities for investigation on coal-burning type arsenism according to contents of coal arsenic.

2. Investigation contents

Collection of data

- demography
- type of water sources
- economy status
- type of fuel
- water supply moods
- type of main foods and vegetables
3. Expecting results

1. Map of distribution of drinking-water arsenism

? . Map of distribution of coal-burning arsenism

? . Map of distribution of endemic arsenism
V. Problems

- Lack of low arsenic water sources
- Lack of low arsenic coal in arsenism areas
- High arsenic and high fluoride existed simultaneously
- Economic underdevelopment in arsenism areas
- The cancer morbidity will increase in the future 10 years

VI. Strategy of prevention and control

Coal-burning type
- To develop cleaning fuel
- To improve stoves and ventilation system
- To study new substitute energy resource

Drinking-water type
- To enhance health education to increase public awareness of the arsenism
- To increase invest from government
- To develop equipments for removing arsenic
- To move water from south to north of China (650 million RMB)
- To find low arsenic water sources
- To develop international cooperation and exchange