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Proceedings of The 1st International workshop on Health Risks of Arsenic Pollution of Drinking Water in South Asia and China

March 10, 2001

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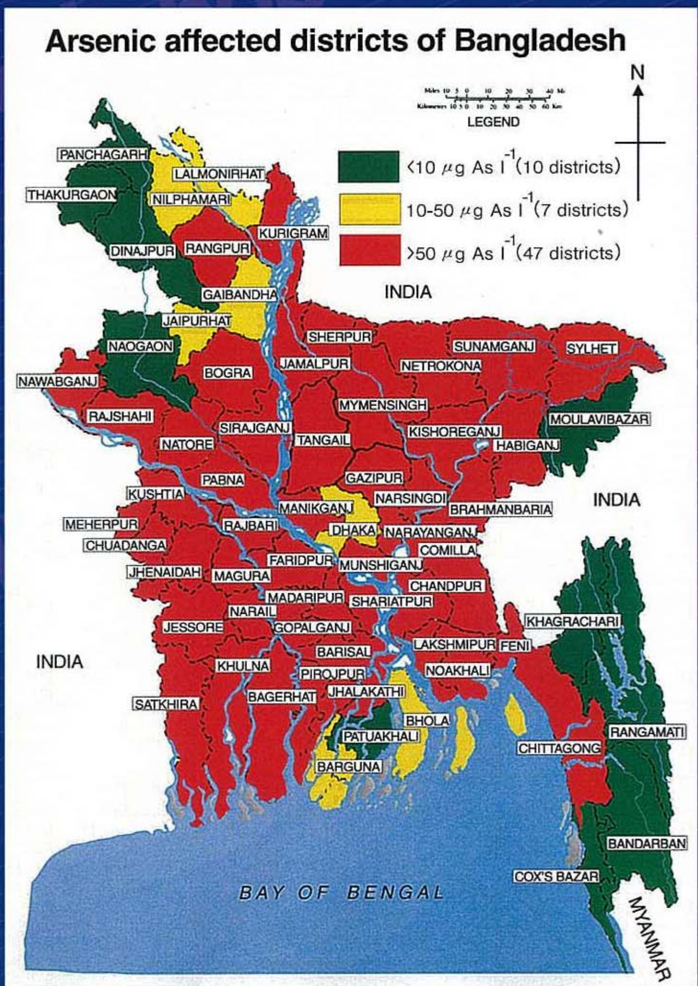
Edited by Michinori Kabuto



NATIONAL INSTITUTE FOR ENVIRONMENTAL STUDIES

独立行政法人　国立環境研究所

Foreword

Although adverse health effects of exposures to high level of arsenic and/or fluoride through drinking water originated from underground sources are not new in China or other regions, it is now recognized as one of the global environmental issues. It has been revealed that more than 100 million people in Bangladesh, West Bengal in India, China etc. are exposed to toxic dose of arsenic, among whom very serious cases of not only skin symptoms/lesions but also various cancers of skin, lung etc. have been occurring. (in case of fluoride intoxication its typical effect is called as fluorosis. Its combination effects with arsenic have also been suggested) It should be noted that air pollution with arsenic and/or fluoride through coal-burning may be another source of exposures related to their intoxications.

On the other hand, this issue is not only the problem for those developing countries. The developed societies have also become inescapable from those serious environmental pollutions, traditional type or modern type, in the developing countries through their transboundary transports accelerated with rapid internationalization of world trades, migrations etc., indicating that more emphasis should be given regarding such risk managements at the international level.

In every sense, I hope, on behalf of the participants to this workshop, this publication would be meaningful in promoting and extending studies and managements related to this one of the most serious environmental issues in the present world.

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Preface

This workshop was planned as part of an HDP (Human Dimension Programme for global environmental issues) study on arsenic pollution due to increasing uses of underground water and environmental planning, which was purposed to evaluate and summarize the state of knowledge and findings and also to consider the appropriate mitigation or alternative methods to stop as early as possible the expected huge amount of health burdens. To this workshop, 5 scientists were invited from India, Thailand and China to provide an overview of the general situations of arsenism and researches, and also two Japanese scientists who have been working on Bangladesh and China (Inner Mongolia), respectively for a brief introduction of their own researches as well as general comments and recommendations.

The time schedule was as follows:

10:00-10:15　Opening remarks　Gen Ohi (Director, NIES)

10:15-15:00　**Current Status of Arsenic Pollution and Health Impacts in**

10:15-12:00　●**West Bengal, Bangladesh and Thailand**

Arsenic pollution in West-Bengal India and Bangladesh

Dipankar Chakraborti (School of Environmental Studies, Jadavpur University)

Arsenicism in Ronphibun, Thailand~ past, present and future

Shouko Oshikawa (Epidemiology Unit, Prince of Songkla University, Thailand)

Comments and Discussion

An arsenism study on communities in Bangladesh

Chiho Watanabe　(School of International Health, University of Tokyo)

12:00-13:00 Lunch

13:00-15:00　●**China**

Progress on Arsenism Research in China

Jin Yinlong (IEHE, Chinese Academy of Preventive Medicine)

Current Situation of Arsenism in China

Sun Guifan (School of Public Health, China Medical University)

Assessment of Arsenic Removal from Drinking Water by New Adsorbents

He Gongli (IEHE, Chinese Academy of Preventive Medicine)

15:00-15:30 Coffee Break

15:30-16:15

Comments and Discussion

Study of arsenism via consumption of arsenic contaminated ground water and intervention study in water mitigation in Inner Mongolia

Takahiko Yoshida (Asahikawa Medical College)

16:15-17:00　**Q&A and Discussion**　Michinori Kabuto (NIES)

17:00　**Adjournment**

Contents

Session 1

Current Status of Arsenic Pollution and Health Impacts in West Bengal, Bangladesh and Thailand

1.1 Current Status of Arsenic Pollution and Health Impacts in West Bengal and Bangladesh

Mohammad Mahmudur Rahman[1], Kunal Paul[1], Uttam K. Chowdhury[1], Bhajan K. Biswas[1], Dilip Lodh[1], Gautam K. Basu[1], Shibtosh Roy[2], Ranajit Das[2], Bashir Ahmed[2], Imrul Kaies[2], Ajoy Kishore Barua[2], Shyamal K. Palit[2], Quazi Quamruzzaman[2] and Dipankar Chakraborti[1*]

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School of Environmental Studies (SOES), Jadavpur University, Calcutta, India is working on arsenic groundwater contamination in West Bengal-India for last 13 years and for last 6 years in Bangladesh jointly with Dhaka Community Hospital (DCH), Bangladesh. **Table-1** shows the overall arsenic situation in West Bengal-India ; **Table-1(A)** detailed study of one out of the nine affected districts; **Table- 1(B)** one out of the 74 affected Blocks and **Table-1(C)** one out of 2000 affected villages. **Table-2** shows the arsenic situation in Bangladesh; **Table-2(A)** detailed study of one out of 47 affected districts; **Table-2(B)** one out of 178 affected Police Stations and **Table-2(C)** one out of 2500 affected villages.

The overall arsenic groundwater contamination in West Bengal-India and Bangladesh is serious. More than 100 million people are living in arsenic affected districts. That does not mean all are drinking arsenic contaminated water but no doubt population are at risk. Although we are surveying for last 13 years and 6 years in arsenic affected districts of West Bengal and Bangladesh with about 40 people in our group but still we feel we have seen the tip of the iceberg. More we are surveying more and more people with arsenical skin lesions and affected areas are coming to limelight.

Arsenical skin lesion is late manifestation. When skin-lesions will appear on body depends on many factors like (a) concentration of arsenic in drinking water (b) how long one is drinking the contaminated water (c) how much one is drinking contaminated water per day (in many families we have found those drinking too much water have arsenic skin lesions while those drinking less have no skin lesions) (d) nutrition status of the people drinking contaminated water also plays an important roles. We have hundreds of example showing that poor people suffering from malnutrition showing arsenical skin lesions but people getting better nutrition are not showing any skin lesions drinking the same concentration (also close to same volume) of contaminated water. From our 13 years field survey screening more than 100,000 people from West Bengal and Bangladesh and having a list of 12000 registered arsenic patients with skin lesions, we can say that usually above 300 μg/l of arsenic in drinking water may show arsenical skin lesions (exceptions are always there). However, we have found a few patients with spotted melanosis drinking 90 μg/l (Kolsur village, Deganga Block, North 24-Parganas) of arsenic in drinking water in West Bengal and 80 μg/l in Samta village, Sarsa Police Station of Jessore District of Bangladesh. However these are exceptions. Children below 11 years normally do not show the skin lesions but we have registered a few hundred patients aged below 11 years from West Bengal, India and Bangladesh, when arsenic in their drinking water is quite high around 700μg/l and above. We have also observed that children suffering from malnutrition may also suffer from arsenical skin lesions even with lower arsenic in their drinking water (around 400 μg/l).

We have also found good co-relation between arsenic in hair, nail, urine and concentration of arsenic in drinking water.

After analyzing 32960 water samples from hand tube-wells of Bangladesh, we had noticed that in some parts of Bangladesh, the arsenic contamination in groundwater is minimum, some parts are almost arsenic contamination free and some parts are highly contaminated. While trying to find out

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the reason we noticed that out of the four geo-morphological regions of Bangladesh (a) Hill Tract (b) Flood Plain (c) Pleistocene Plain and Pleistocene Upland and (d) Deltaic Plain and Coastal Plain, Hill tract and Pleistocene Plain and Pleistocene Upland are usually arsenic contamination free. Some Flood Plain areas between Pleistocene Plain and Pleistocene Upland like Nilphamari, Lalmonirhat, Kurigram, Rangpur districts are also less contaminated. We have further noticed that in fringe area of Pleistocene Plain and Pleistocene Upland with Flood Plain; Hill Tract with Flood Plain and if river had eroded Pleistocene Plain and Pleistocene Upland and Hill Tract areas, some contamination are there (the probable reason may be heavy deposition of Holocene sediments). Deltaic Plain with Coastal belt and Flood Plain regions are the most arsenic contamination area of Bangladesh. At present about 44.2% of the water samples are above 50 μg/l in Deltaic Plain with Coastal belt and Flood Plain but from our West Bengal experience we expect in future more tube-wells in these areas may get arsenic contamination.

While analyzing of deep tube wells above 100 meter in 4 geo-morphological regions of Bangladesh, we found all tube wells above 100m in Pleistocene Plain and Pleistocene Upland and Hill tract are also arsenic contamination free (< 10 μg/l). In case of flood plain and Deltaic plain (including coastal plain) we had noticed that deep tube wells above 300m are mostly safe with respect to 50 μg/l but about 22% of tube wells above 300 m contain arsenic between 10 and 50 μg/l.

The source of arsenic in West Bengal-India and Bangladesh is geogenic. We have identified arsenic rich pyrite in bore-hole sediment samples.

Table-1: Overall arsenic situation in West Bengal-India

	West Bengal-India
Area in sq. km	89193
Population in million (according to 1991 census)	68
Total number of districts	18
Number of arsenic affected districts (groundwater arsenic above 50 μg/l)	9
Total number of water samples analyzed	100000
% of samples having arsenic >10μg/l	51
% of samples having arsenic > 50μg/l	34
Area of arsenic affected districts in sq. km	38865
Population of arsenic affected districts in million	42.7
Number of arsenic affected Blocks / Police Stations	74
Number of arsenic affected villages (approx.) where groundwater >50 μg/l	2000
People drinking arsenic contaminated water >50 μg/l (in million)	6
Districts surveyed for arsenic patients	7
Patients found from surveyed districts	7
People screened for arsenic patients from affected villages (preliminary survey)	86000
Number of registered patients with clinical manifestations	8500 (9.8%)
% of children having arsenical skin lesions of total patients	1.7
Total hair, nail, urine, skin-scales analyzed	27000
Arsenic above normal level in biological samples	77%

Table-1A: Arsenic situation in North 24-Pargana one of the nine arsenic affected districts of West Bengal-India

Area of the district in sq. km	4094
Population of the district in million	7.3
Number of Blocks / Police Stations in North 24-Parganas	22
Number of blocks / Police Stations surveyed	22
Number of hand tubewell's water sample analyzed	28872

Number of samples having arsenic >10 μg/l	15513 (53.7%)
Number of samples having arsenic >50 μg/l	9339 (32.3%)
Total blocks having arsenic >10 μg/l	20
Total blocks having arsenic >50 μg/l	19
Total blocks where arsenic patients identified	16
Total hair, nail, urine, skin-scales analyzed	21158
Arsenic above normal level (average) in biological samples	74.3%
Total population screened for arsenic patients from affected villages (preliminary survey)	15902
Number of registered patients with clinical manifestations	1622 (10.2%)
People drinking arsenic contaminated water >50 μg/l in million	1.15

Table-1B: Arsenic situation in Deganga, North 24-Paraganas one block out of 74 affected blocks in West Bengal-India

Area of the Block in sq. km	201
Population of the Block (according to 1991 census)	234141
Total hand tubewells in Deganga block	15886
Number of hand tubewell's water sample analyzed	8785 (55.3%)
Number of samples having arsenic >10 μg/l	5082 (57.8%)
Number of samples having arsenic >50 μg/l	3610 (41.1%)
Total hair, nail, urine, skin-scales analyzed	17365
Arsenic above normal level (average) in biological samples	67.6%
Total population screened for arsenic patients in affected villages (preliminary survey)	1574
Number of registered patients with clinical manifestations	409 (26%)
People drinking arsenic contaminated water >50 μg/l	96209
Number of hand tubewell's water analyzed from schools	127
Number of samples having arsenic >10 μg/l	74 (58.2%)
Number of samples having arsenic >50 μg/l	62 (48.8%)
Amount of arsenic falling on agricultural land from 3200 big-diameter irrigation tubewells in one year	6.4 tons

Table-1C: Arsenic situation in Kolsur village of Deganga block, North 24-Parganas one of 2000 affected villages of West Bengal-India

Area of Kolsur in sq. km	16.32
Population of Kolsur	16,879
Total number of hand tubewells in Kolsur	1550
Number of hand tubewell's water sample analyzed	1184
Number of samples having arsenic >10 μg/l	961 (81.1%)

Number of samples having arsenic >50 µg/l	859 (72.5%)
Total hair, nail, urine, skin-scales analyzed	3633
Arsenic above normal level (average) in biological samples	93.3%
Total population screened for arsenic patients (detailed survey)	11000
Number of registered patients with clinical manifestations	579 (5.27%)
People drinking arsenic contaminated water >50 µg/l	12238

Table-2: Overall arsenic situation in Bangladesh

	Bangladesh
Area in sq. km	148393
Population in million	120
Total number of districts	64
Total number of water samples analyzed	32960
% of samples having arsenic >10µg/l	56.3
% of samples having arsenic > 50µg/l	37.3
Number of arsenic affected districts (groundwater arsenic above 50 µg/l)	47
Area of arsenic affected districts in sq. km	112407
Population of arsenic affected districts in million	93.4
Number of arsenic affected Blocks / Police Stations	178
Number of arsenic affected villages (approx.) where groundwater >50 µg/l	2500
People drinking arsenic contaminated water >50 µg/l (in million)	25
Districts surveyed for arsenic patients	34
Patients found from surveyed districts	32
People screened for arsenic patients (preliminary survey)	17896
Number of registered patients with clinical manifestations	3695 (20.6%)
% of children having arsenical skin lesions of total patients	6.4
Total hair, nail, urine, skin-scales analyzed	10496
Arsenic above normal level (average) biological samples	93%

Table-2 A: Arsenic situation in district Lakshmipur one of the 47 arsenic affected districts of Bangladesh

Area of the district in sq. km	1456
Population of the district in million	1.5
Number of Blocks / Police Stations in Lakshmipur	4
Number of blocks / Police Stations surveyed	4
Number of hand tubewell's water sample analyzed	2662

Number of samples having arsenic >10 μg/l	2358 (88.6%)
Number of samples having arsenic >50 μg/l	2123 (79.8%)
Number of Police Stations having arsenic >10 μg/l	4
Number of Police Stations having arsenic >50 μg/l	4
Number of Police Stations surveyed for arsenic patient	3
Number of Police Stations where arsenic patients identified	3
Number of villages surveyed for arsenic patient	27
Number of villages where arsenic patients identified	25
Number of people screened for arsenical skin lesions(preliminary survey)	2138
Number of registered patients with clinical manifestations	504 (23.2%)
Number of the children (<11 years) screened for arsenical skin lesions	400
Number of registered child patients with clinical manifestations	25 (6.2%)
People drinking arsenical contaminated water >50 μg/l in million	1.2 (85%)
Total hair, nail, urine, skin-scales analyzed	1250
Arsenic above normal level (average) in biological samples	92%

Table-2B: Arsenic situation in Police Station Ramganj in Lakshmipur district out of 174 affected Police Stations in Bangladesh

Area of Ramganj in sq. km	169
Population of Ramganj	274000
Number of hand tubewell's water sample analyzed	2077
Number of samples having arsenic >10 μg/l	1853 (89%)
Number of samples having arsenic >50 μg/l	1668 (80.3%)
Total hair, nail, urine, skin-scales analyzed	503
Arsenic above normal level (average) in biological samples	92%
Total population screened for arsenic patients (preliminary survey)	970
Number of registered patients with clinical manifestations	300 (31%)
Number of children (<11 years) screened for arsenical skin lesions	183
Number of registered child patients with clinical manifestations	11 (6%)
People drinking arsenic contaminated water >50 μg/l	164390

Table-2C: Arsenic situation in one village Samta of Sarsa Police Station in Jessore district of Bangaldesh

Area of Samta in sq. km	3.2
Population of Samta	4841
Total number of hand tubewells in Samta	276
Number of hand tubewell's water sample analyzed	265
Number of samples having arsenic >10 μg/l	260 (98.1%)

Number of samples having arsenic >50 µg/l	242 (91.3%)
Total hair, nail, urine, skin-scales analyzed	830
Arsenic above normal level (average) in biological samples	96.3%
Total population screened for arsenic patients (detailed survey)	600
Number of registered patents with clinical manifestations	330 (55%)
People drinking arsenic contaminated water >50 µg/l	4356

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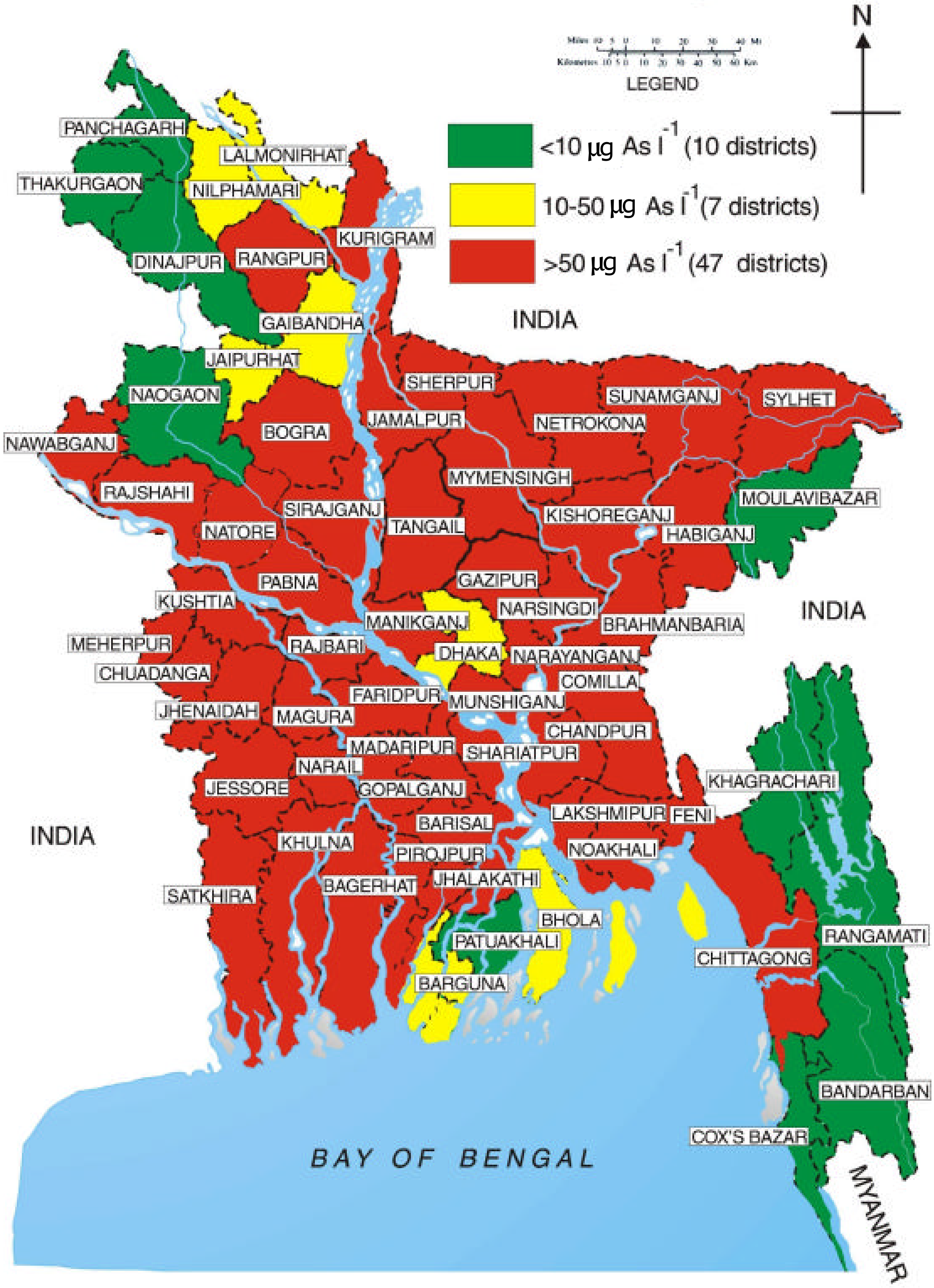
Skin lesions or symptoms observed in Bangladesh and West Bengal
(taken by Dr. Chakraborti)

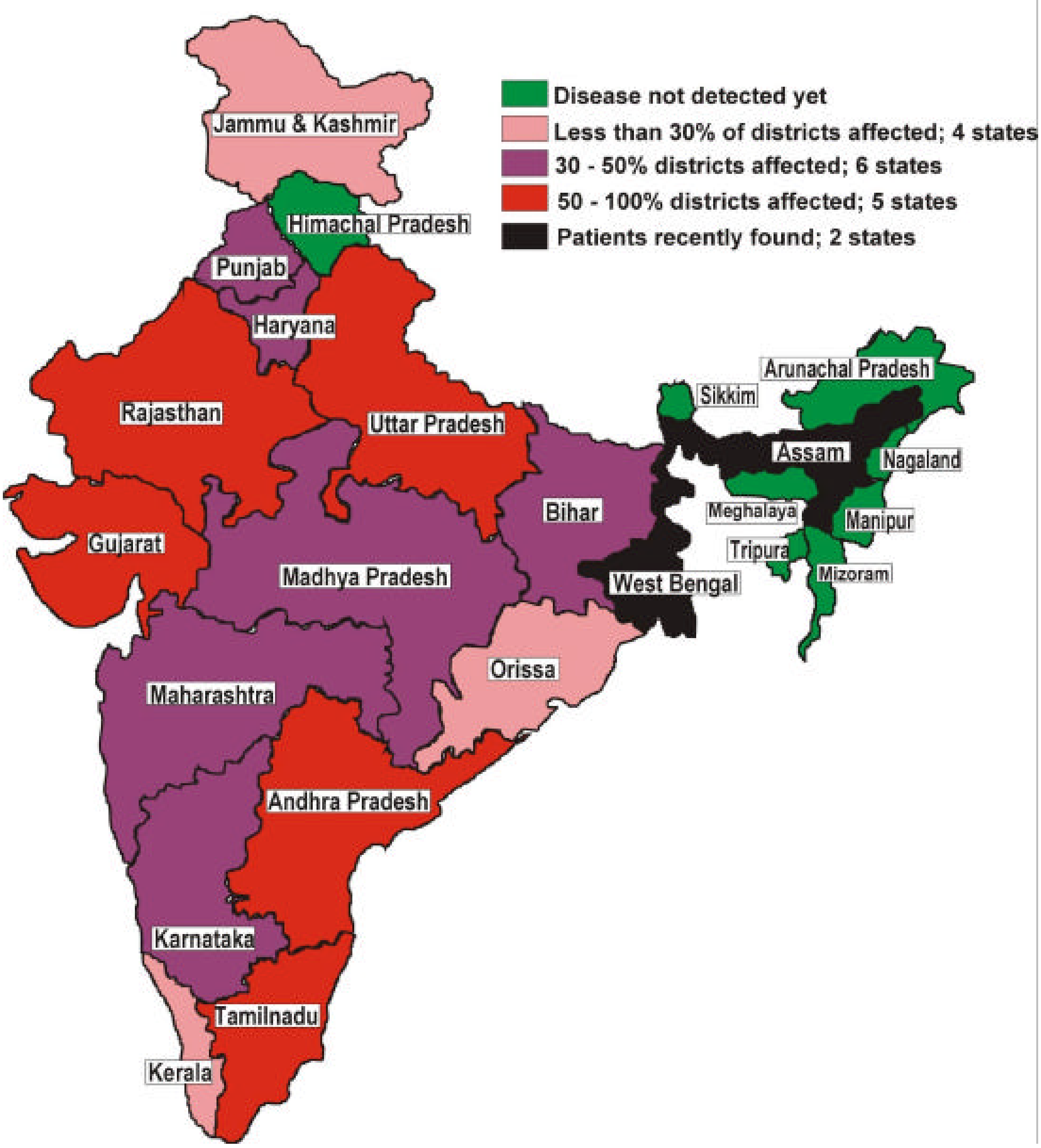
● Blocks where arsenic in groundwater found above 50 µg/l

Arsenic affected 9 districts and 69 blocks of West Bengal-India

Arsenic affected districts of Bangladesh



Endemic states for fluorosis of India



note)

The above 3 figures are showing the distributions of affected populations with arsenic or fluoride in West Bengal, Bangladesh and India, respectively. It is noteworthy that there are areas affected with both of them especially in West Bengal and Bangladesh.

1.2 Chronic arsenicism in Ronphibun, Thailand ~ past, present and future

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Tada Piampongsan[2],

Dipankar Chakraborti[3], Gautam Samanta[3], Badal Mandel[3],

Nobuyuki Hotta[4], Yasuko Kojo[4], Hiromi Hironaka[4]

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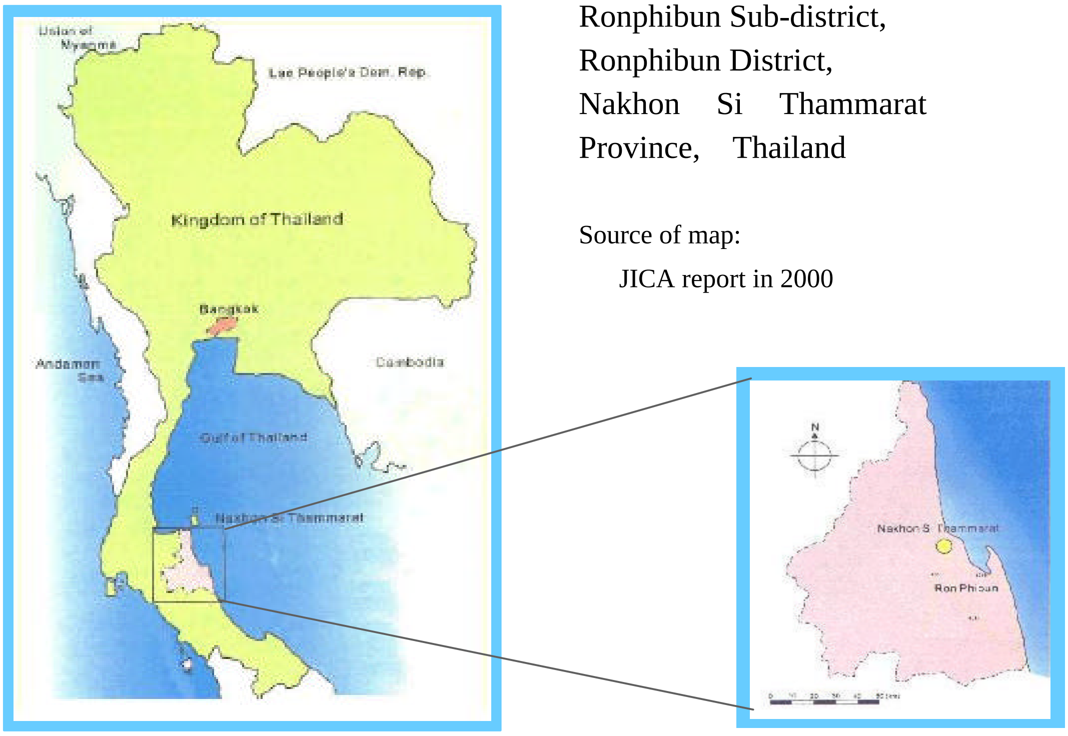
3. School of Environmental Studies, Jadavpur University, India

4. Asia Arsenic Network, Japan

PAST

Ronphibun



Ronphibun Sub-district, Ronphibun District, Nakhon Si Thammarat Province, Thailand

Source of map:
JICA report in 2000

Affected area

- Historical tin mining area
- Waste from mining activities deposited throughout the area.
- Environmental contamination by arsenic had been found in surface - and under ground - water, and soil.

(photograph1~ previous dredging site)

Affected people

- “Kai-dam” was endemic but cause was generally unknown locally.
- Most of residents had used shallow well water.
- In 1987, kaidam was officially recognized as chronic arsenicism when one woman was diagnosed at the Institute of Dermatology in Bangkok.

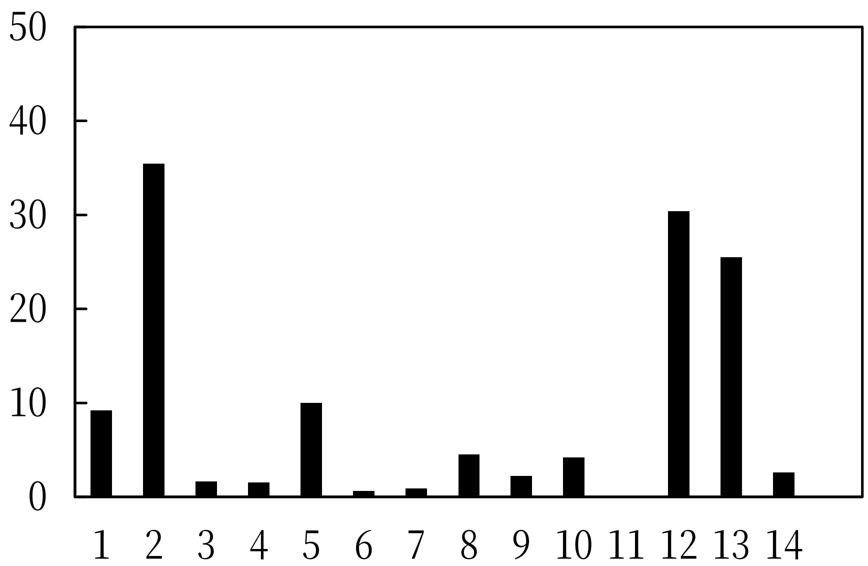
Governmental survey in 1987

- Ministry of public health set a station survey for clinical examination at Ronphibun District Hospital.
- Subsequently 1151 cases were diagnosed as chronic arsenicism and the severity of their lesions was classified into stage 1 to 4.*[1]
- The cases in severe stage were treated.
- Water in a large number of shallow wells was found to have high arsenic content (>0.05~4.45 mg/l), and the distribution of contaminated wells scattered not-homogeneously in the area.*[2]

*[1] The Report on Rectification of Arsenic Poisoning Problem in Ronphibun, Ronphibun District, Nakorn si thamarat Province: Nakorn si Thamarat Provincial Health Office, 1988.

*[2] The Office of National Environmental Board. *Report of Arsenic Contents of Well Waters in Ronphibun District, Nakorn si thammarat Province*, Bangkok: National Environmental Board, 1987.

Prevalence of shallow wells contaminated with arsenic (*>0.05mg/l) by village in 1987)*



The data from: Rodklai A, Shindell S. *Chronic arsenic poisoning in Nakorn si thammarat.* Ninth Report in Field Epidemiology Training Project, Bangkok. Undated.

Intervention programmes, 1987 ~

- Distribution of large water jars for storage of rain water
- Installing deep well
- Improvement and expansion of piped water supplies
- Closure of shallow wells more heavily contaminated with arsenic

Prevalence survey in 1994 *[1]

- Prevalence of subjects with chronic arsenicism was 26.3% in Ronphibun Sub-district.
- Prevalence varied among the villages.
- Higher prevalence was found in village 1 (53%), village 12 (50%) and village 5 (36%).

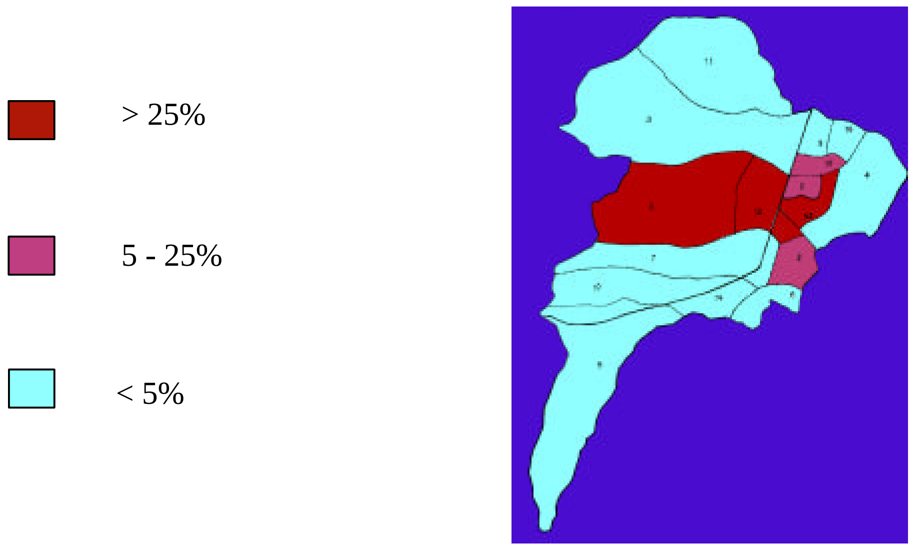
- 17.6% of households were still using shallow well water for drinking due to no supply of piped water.

*[1] .Rodklai A. *Prevalence Survey of Chronic Arsenic Poisoning and Health Status of the People in Ronphibun, 1994.* Report of an Epidemiological Survey in Ronphibun, Thailand, 1994.

Here are 2 figures showing the prevalence.

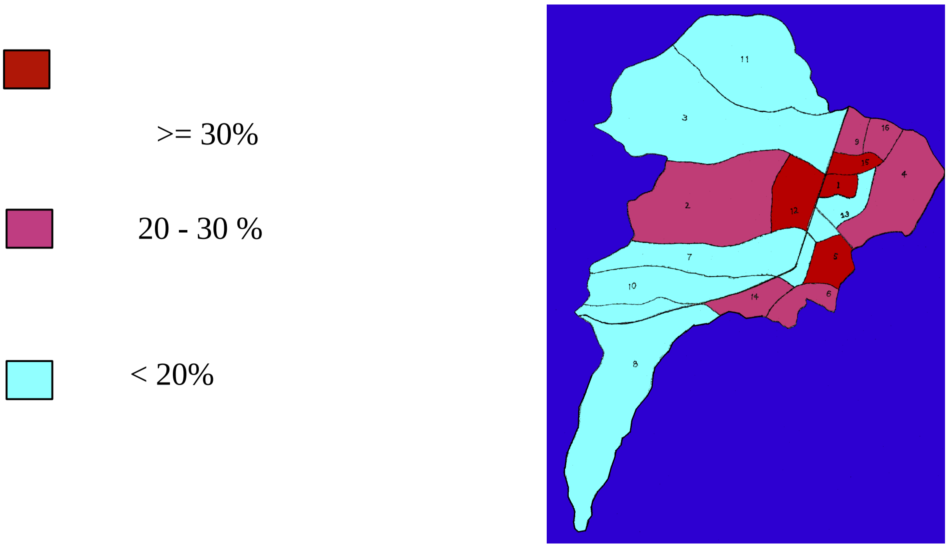
1. Prevalence of As contaminated wells (>0.05 mg/l) *by village (1987)*

*Data from ; Rodklai A, Shindell S. *Chronic arsenic poisoning in Nakorn si thammarat.* Ninth Report in Field Epidemiology Training Project, Bangkok. Undated.



2. Prevalence of subjects with skin lesions by village in 1994

. *Data from ; Rodklai A. *Prevalence Survey of Chronic Arsenic Poisoning and Health Status of the People in Ronphibun, 1994.* Report of an Epidemiological Survey in Ronphibun, Thailand, 1994.



CURRENT SITUATION : STUDIES IN 1997

Study 1~ changes in skin lesions severity following intervention in 1987

- Eight hundred and eighteen subjects with arsenical skin lesions first examined in 1987 and having address in Ronphibun sub-district were followed-up.

Study objectives:

- To describe changes in stage of skin lesions over the 10-year period since 1987
- To explore the role of drinking water in the changes

Methodology

- Questionnaire-based interview (sociodemography, history of residence, treatment, mining, water use)
- Visual assessment and photographic record of skin lesions
- Arsenic analysis of drinking water in the field
- Observation of well and water supply facilities
- Staging of skin lesions

Staging

The staging classification used in 1987 survey, was one proposed by the Institute of Dermatology, Bangkok.

Stage 0: no lesions (but may have elevated hair, nail, urine and/or blood As levels)

Stage 1:*palms/soles* Small pigmented macules or a few pin-headed dermal papules

Stage 2:*hands/feet* Multiple pin-headed dermal papules and/or large keratotic papules (>5mm diameter)

Stage 3:*hands/feet* Stage 2 lesions with pre-Bowen;s disease

Stage 4: *any site* Bowen’s disease, basal cell carcinoma, squamous cell carcinoma

The results of study

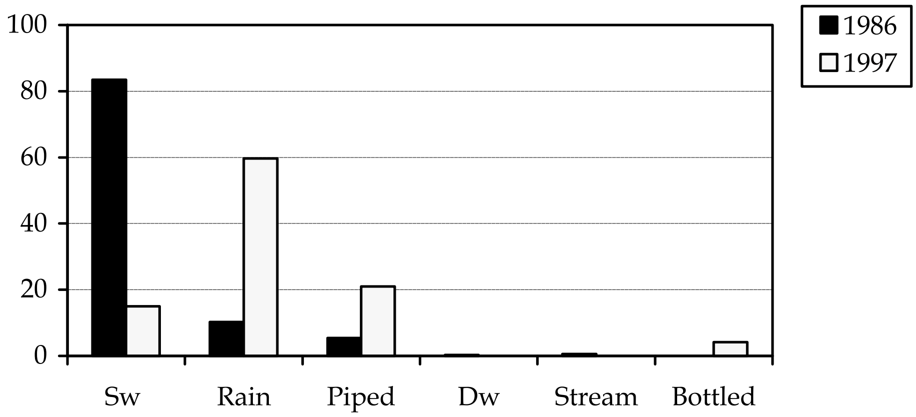
Follow-up status

- Out of 818 subjects, 334 (40%) could be followed-up and the remainder had died (35), migrated (193), were temporary absent (55) or were unknown (201).

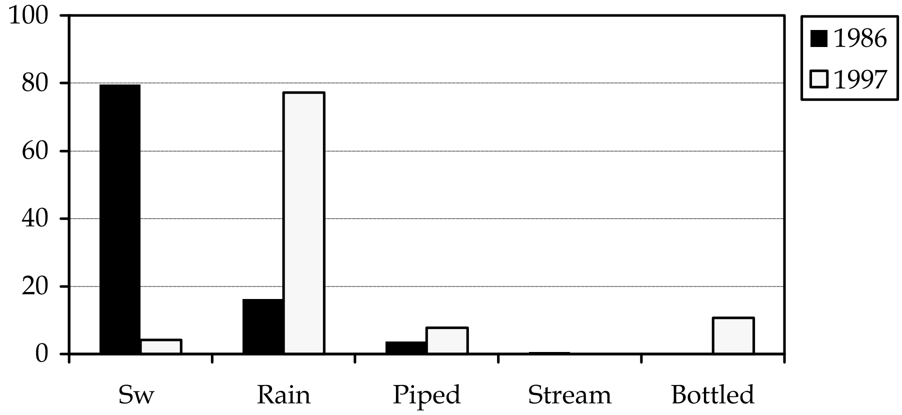
Change in stage over the 10 years

- Both regression and progression of skin lesions had occurred.
- Minimum proportions undergoing regression, assuming none of the missing had regressed, would be 29%.
- Minimum showing progression, assuming none of the missing had progressed, would be 5%.
- Among the 4 subjects who had progressed from stage 2 to stage 4, one had developed basal cell carcinoma and three Bowen’s disease in 1997.
- One of 2 subjects who had Bowen’s disease in 1987, had developed squamous cell carcinoma.

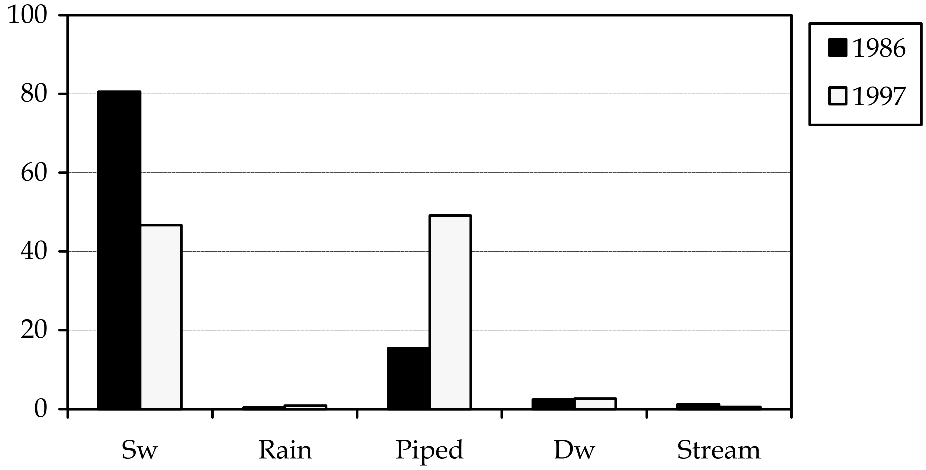
Change in drinking water: 1986 and 1997



Change in cooking water : 1986 and 1997



Change in bathing water : 1986 and 1997



Analytical methodology

- Used BINARY LOGISTIC REGRESSION to explore the relationship between pattern of drinking water and changes of skin lesions.
- Stratified on age and village of residence.
- Confined to stages 1 and 2 subjects in 1987, using separate models.
- The model was adjusted for occupation in mining.

The role of drinking water in the changes

- The use of rain water for drinking compared that of piped or bottled water has not been fully effective in reducing the severity of skin lesions.

Study2 ~ lesion type and severity

Among the followed-up subjects, a detailed description of cutaneous symptoms of chronic arsenicism was made in 203 subjects. The skin lesions showed;

- Wide variation in skin lesions was apparent.

    Type ~ hyperkeratosis, hyperpigmentation, depigmentaion

    Distribution ~ spotty, diffuse

    Site ~ trunk, limbs, palms, soles, etc.

    Severity

Study objectives

- To describe skin lesion profiles.
- To develop a preliminary model to explore relationship between exposure mode and lesion profile.

Methodology ~ detailed description of skin lesions

Physical examination done by a dermatologist specialized in these lesions.

- whole body observation ~ 16 sites
- using standardized form
- pigmentation, depigmentation and keratosis
- 4 levels of severity (-, +, ++, +++)
- Bowen's disease and skin cancer presence based on histopathological examination

Results

- Spotty pigmentation, diffuse pigmentation, spotty keratosis, diffuse keratosis and depigmentation were observed in 84%, 54%, 74%, 55% and 42%, respectively.
- Bowen's disease, basal cell carcinoma and squamous cell carcinoma were diagnosed in 12, 2 and 1 subjects, respectively.
- Preliminary analysis to explore relationship between exposure mode and lesion profile is going on.

FUTURE ~ WHAT STILL NEEDS TO BE DONE?

- Further studies on several aspects of arsenic contamination in Ronphibun are still needed.
- How can countermeasures be improved to reduce exposure to arsenic?

Further studies

- Continued follow-up of the subjects with chronic arsenicism.
- New case finding.
- Clarification of the role of drinking water.
- Exploration of possible pathways of contamination other than through drinking contaminated water.

Countermeasures

- Completion of the safe water supply in the contaminated area.
- Empowerment of residents to participate in decision-making regarding pollution abatement.
- Declaration of the contaminated area as a "Pollution Controlled Area" in order to officially accord high priority to pollution control measures.

1.3 Comments and Recommendation

An arsenism study on communities in Bangladesh

Chiho Watanabe

School of International Health, University of Tokyo

< See the slides on the next pages for the contents. >

Background

Bangladesh

population: 140,000,000 (700-800/km^2)
tubewell: >95% tubewell for drinking water
Risk population in BD: 35,000,000
first report of As patient: 1994

1

Comments and Recommendations

An Arsenism Study on Communities in Bangladesh

Chiho Watanabe and Ryutaro Ohtsuka
School of International Health
University if Tokyo

2

Focus

* Mazumder et al. (1998) West Bengal n=ca. 7,700
 skin lesions males>females
 malnutrition enhanced the symptom
* Tondel et al. (1999) n=ca. 1,500
 skin lesions males>females
* Ahsan et al. (2000) (n=167) males<>females **[As]u**

Dose-response relationship using biological media
Identification of modifying factors/sensitive population
* Tseng (1977) Taiwan
 male>females (skin cancer) males <> females

3

Two small communities , SV and SP, in northwestern Bangladesh were the subjects of this study.

4

Sadasibpur, Nawabganj Fall 1998

5

Serpur Vander, Nawabganj (spring 1999)

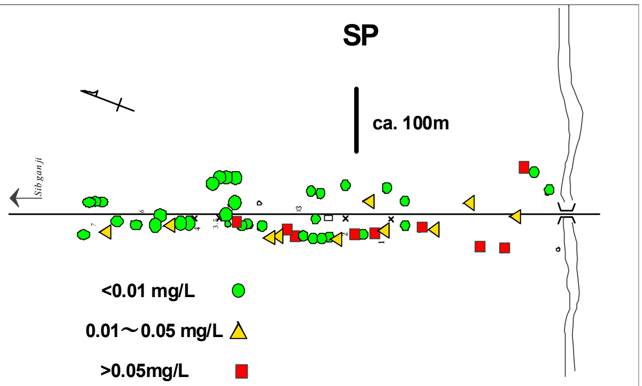
6

Flooded ricefield   Serpur Vander, August 1998

Almost the same area shown in the previous picture

7

8



Although some clustering can be seen, the geographical distribution As concentrations of the tubewells showed a patchy pattern, and appeared hardly predictive.

9

Table 2. Age, nutritional status, and As exposure in the groups divided by sex and by area [a]

area	sexAge [a]	Height [yr]	Body [cm]	Fat [b] Weight [kg]	$[As]_{tw}$ [a] percent [%]	$[As]_u$ [a] [mg/L]	[mg/gCr]
SV	male	36±1.5 (112)	162±5 (111)	52±7 (111)	10.7±1.4 (111)	28±.6.0 (104)	204±2.1 (64)
SV	female	36±1.4 (138)	151±6 (137)	43±6 (138)	21.4±1.2 (137)	26±6.6 (126)	219±2.4 (108)
SP	male	40±1.5 (108)	164±6 (107)	51±7 (100)	10.7±1.5 (108)	11±6.6 (108)	126±2.3 (69)
SP	female	35±1.5 (193)	152±5 (192)	44±7 (162)	20.9±1.3 (192)	10±6.4 (189)	174±2.5 (121)
ANOVA--							
	Area	ns	#	ns	ns	***	***
	[c]Sex	#	***	***	***	ns	#
	Area*Sex	#	ns	ns	ns	ns	ns

NOTES:

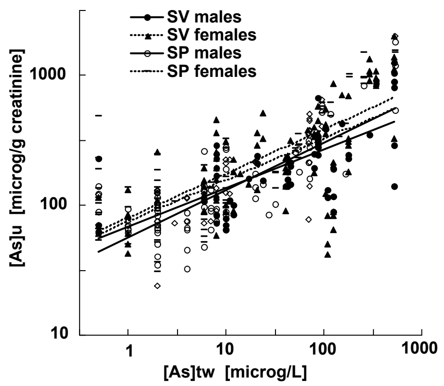
a. Geometric mean and SD are shown.

b. Calculated from skinfold thickness.

c. Two-way ANOVA using log-transformed variables.

d. *** p<0.001, # 0.05<*p*<0.1, ns = not significant (p>0.1).

10



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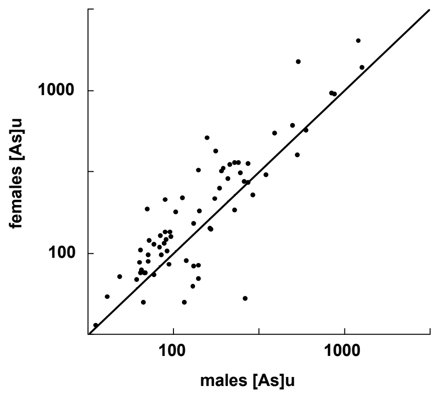

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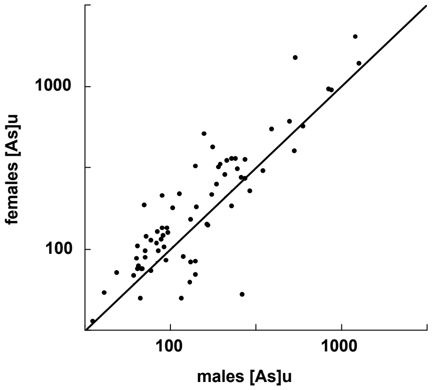


1 3

Table 3. Stepwise multiple regression analyses of urinary arsenic excretion ([As]u) *1

area	sex	adjusted -R^2	inter-cept	c	[As] tw	p	Age	p	fat percent *2	p
SV	mal	0.47	3.486	***	0.294	***	-0.293	+		
	fem	0.43	2.839	***	0.320	***				
SP	mal	0.64	3.515	***	0.356	***				
	fem	0.51	3.482	***	0.328	***			-0.440	*

NOTES:
*1; Parameter estimate and its significance are shown.
*2; A blank means that the parameter was not selected (entered) as a significant independent variable in the regression model.
*** $p<0.001$, * $p<0.05$, + $0.05<p<0.1$.

1 4

Table 1. Classification criteria of the dermatological stage (DS) and distribution of the subjects by DS

DS	Rank	Manifestation (Criteria for the stage a)	Prevalence [%] c	n (Frequency distribution b) (total = 468)	% of total
0		(none)		213	45.5
1	1	sole 1	53.8	148	31.6
2	2	sole 2	18.4	37	7.9
3	3	palm 1	9.8	43	9.2
	4	trunk 1	8.3		
4	5	sole 3	5.1	19	4.1
	6	palm 2	3.4		
5	7.5	sole 4	1.1	8	1.7
	7.5	trunk 2	1.1		
	9	palm 3	0.6		

For an individual diagnosed as sole = 3, palm = 2, trunk = 1, the corresponding ranks are 5, 6, and 4, respectively. The DS corresponding to the highest of these three ranks (=6), which is 4, is assigned as this individual's DS (see text for detail).
b. Actual distribution of the subjects classified for each DS.
c. Prevalence of the manifestation

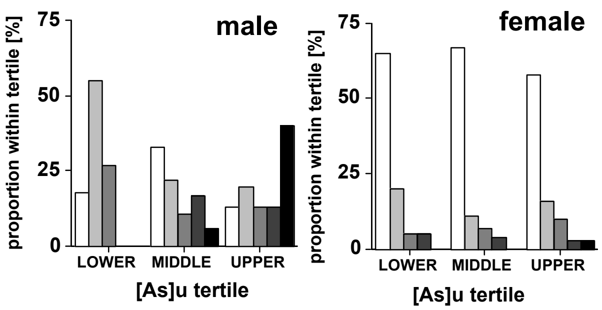
1 5

% Distribution of the Dermatological scores (Feb 199

			By village			By gender ($p<0.001$	
Grade	total		SP	SV		Males	Females
0	55	%	55	54	%	44	62
1	23		26	18		24	23
2	13		12	15		17	11
3	5		4	8		8	3
4	3		2	3		6	0
5	1		1	1		1	1
total	100		100	100		100	100
(N)	561		353	208		238	323

(Including those less than 20 yrs old)

1 6



Median Urinary As:
LOWER=76, MIDDLE=155,UPPER=402 ng/mg creatinine.
Skin manifestations: none (left,white) to severe (right,black)

1 7

Urinary arsenic
good correlation with twAs
stable
reflect recent exposure

Dose-response relationship
twAs determined uAs; little effect of sex, age, fat
females more resistant to chronic As

Other modifying factors
nutrition, micronutrients as modifying factors
effects on development

1 8

Session 2

Current Status of Arsenic Pollution and Health Impacts in China

2.1 The Current Situation of Endemic Arsenism in China

Guifan Sun
School of Public Health, China Medical University, P.R.China

Since the endemic arsenism was first found in the mainland of China in 1983 in Xinjiang Province, there have been more cases identified in Inner Mongolia, Shanxi and Guizhou Province. Total population exposed to arsenic has been over two million and the diagnosed patients came to 20 thousand. Now the epidemic area is still expanding. The etiology of arsenism in China is mainly divided into two types: 1. Drinking water type: Many people drink water from pump well 20~ 30m deep underground rich in arsenic from 0.2mg/L to 2.0mg/L, maximum up to 4.44mg/L. 2. Burning coal type: People use the coal containing high concentration arsenic as fuel for cooking, keeping warm and drying grains and peppers in kitchen, so the food and indoor air are seriously polluted by arsenic. The average arsenic concentration in coal is 876.3mg/kg. In polluted kitchen air is 445ug/m^3. In corns and peppers are 4.13 and 512.0mg/kg respectively. Although some preventive measures have been taken, how to remove arsenic from drinking water and prevent burning coal type arsenism is still an important problem now in China.

Distribution

In China, chronic endemic arsenism was first found in Jiayi and Tainan, Taiwan province in 1968. The area of the disease was about 300km^2 and the population was about 150 thousand. It is well known as the “Black Foot” disease.

However, the disease in the mainland of China was reported only in recent years. In the mainland, the disease was first found in Kuitun, Xinjiang province in 1983. The patients were more than 2000 and the population of the epidemic area was about 100 thousand.

In 1989, a large-scale survey was conducted in Chifeng, Bayanzhuoermeng district and Huhhot of Inner Mongolia Autonomous Region. The diagnosed patients were 1774, the population involved reached 600 thousand.

It was not until 1994 that arsenism was found in Datong Basin, Shanxi province. The epidemic area was over 900 km^2 and the exposed population were up to one million. Arsenism in all the places mentioned above was induced by water rich in arsenic.

In 1991, 2600 patients and 200 thousand population were found once again in six cities or counties of Guizhou province. The use of high arsenic coal was the reason of arsenism in this area.

By the end of 1997, it is estimated that the total population exposed has been over two million and the diagnosed patients has come to over 20 thousand. What's more , the epidemic area is still expanding.

Although the history of arsenism in the mainland is short, the situation and the spread of the disease are very serious.

Chronic endemic arsenism in China can be divided into two types according to the exposure sources. The first type is caused by drinking water, in which arsenic concentration is very high. The second type is caused by burning coal.

Etiology

1. Drinking water type: In the 1970's, with the improvement of peasants' living conditions, the surface water is substituted by the pump well water to improve the water quality and to prevent the endemic fluorosis. Many people drink water from pump well 20~ 30m deep under the ground, which is unexpectedly rich in arsenic from 0.2mg/L to 2.0mg/L, maximum up to 4.44mg/L. It is reported that in some areas, the average arsenic concentration of drinking water is tens of times higher than the 0.05mg/L China standard.

2. Burning coal type: The local inhabitants use coal containing high arsenic as fuel for cooking , keeping warm and drying grains and peppers in kitchen, so that the food and the indoor air are seriously polluted by arsenic. It is a unique exposure of China , where the average arsenic concentration in coal is 876.3mg/kg, maximum concentration up to 9600mg/kg. The average arsenic concentration in kitchen air is 445μg/m^3, which is over 150 times higher than the hygienic standard of China. The arsenic concentration of the indoor floating dust is 3800mg/kg, which is 57 times as much as that of the control. The arsenic concentration of corns and peppers are 4.13 and 512.0mg/kg respectively. Recently, as the coal consumption grows continuously, the patients of burning coal type have been increasing sharply.

In the initial period of hyperkeratosis, we can see the hidden papules under the skin of the palms and the soles. The papules are semi-transparent in early phase, then keratinize to be helomaform, verruciform, rhagadiform and cauliflower-likeform. In the seriously affected patients, the hyperkeratotic skin fuse together, appearing to be withered tree roots or toad-like skin.

Chronic arsenic exposure can also induce the Bowen's disease. It mainly happens in long-term exposure areas. It can be solitary or multiple and may be found before the cancer or simultaneously with it. There is no difference in pathology between arsenic skin cancer and other skin cancers. The situation has happened in Huhhot of Inner Mongolia.

In addition to these peculiar signs, other arsenic-induced symptoms are all prevalent in the epidemic areas, such as fatigue, palpitation, numbness of hands and feet, abnormal sensation, skin capillarioscopy and peripheral circulation disturbance.

It is common for more than one members of a family being affected.

Preventive measure

Arsenism not only influence people's health, work and family happiness, but also bring them unimaginable pains in both soul and heart. The government has been paying high attention to endemic arsenism. In July 1992, arsenism was officially regarded as one of the eight endemic diseases which are administrated by the National Endemic Disease Office. A lot of medical groups and researchers were sent, special-purpose funds was allocated by the government to prevent and control the disease. The underground water has already been substituted by the tap water in Xinjiang. A large-scale water improvement project has been carried out in Inner Mongolia and Shanxi province. In Guizhou, the local government control the exploitation and use of high arsenic coal strictly, publicize the harmfulness of arsenic coal, and help the local residents rebuild the stoves. But there are a lot of work need to be done for prevention and treatment.

Up to now, only some villages have altered water supported by government and most of them are still use the polluted drinking water. Although some equipments of removal of arsenic were tested in some places, most of them have been stopped in use because they were both inconvenient and expensive. How to remove arsenic from water is still to be solved.

In order to organize the country's investigation and for deep researches, and to make cooperation with international organization and foreign experts, the Fluoride and Arsenic Society of China (FASC) was founded in 1996. In October 1998, the specialists all over the country gathered by the Fluoride and Arsenic Society of China (FASC) to discuss and make clinical diagnostic standard of arsenism. And in August 1999, Pan Asia-Pacific Conference on Fluoride and Arsenic Research was held in China. Now FASC is just making the preparation for the general survey throughout the country.

2.2 Progress on Arsenism Research in China

Jin Yinlong
IEHE, CAPM, China

< See the slides on the next pages for the contents. >

Progress on Arsenism Research in China

Prof. Jin Yinlong
Director
Institute of Environmental Health & Engineering, CAPM

- Introduction
- Current state of arsenism research
- Unsolved problems
- Future studies

1. Introduction

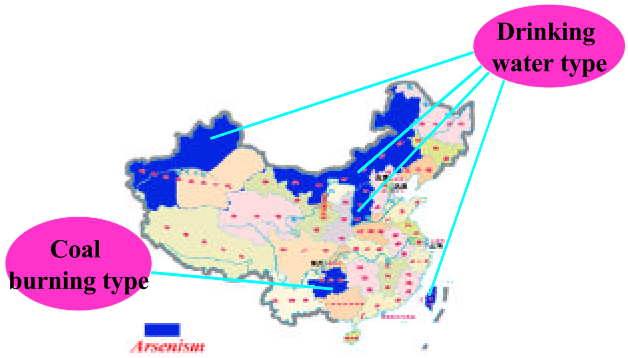
Arsenic is widely distributed in the environment and chronic consumption of arsenic-contaminated drinking water or coal is epidemiologically linked to many toxic effects. There are two types of endemic arsenism. In China, one is called drinking water type, the other is named as coal burning type.

Our government has also paid much attention to arsenism. It was taken as one of the main preventive endemic diseases by Ministry of Health in 1992, and its preventive program was also listed in the Ninth Five-Year Plan in 1996.

2. Current state of arsenism research

A great-scale investigation on arsenism has been conducted since 1980's, the situation, characteristic and principia of arsenism are almost clear now. The mechanism of arsenism also has been studied, for example, arsenic induces peroxidation, affects on the activities of protein, enzyme and nucleic acid, damages biomembrane and cell. On the other hand, many interfered studies by changing drinking water or improving stove have been carried out in arsenism areas.

1) Distribution of arsenism in China



2) Situation of arsenism areas (1998)

Type	Area	Concentration of arseinc (mg/L)	Arsenism patients (case)	Exposured population (10,000)
	Xinjiang	0.05-0.85	2000	10
Drinking water	Inner Monglia	0.129-0.596	2455	22
	Shanxi	0.03-1.41	3000	100
Coal burning	Guizhou	26.5-2116.7 mg/Kg	2600	20
Total			10,055	192

3) Characteristic of arsenism disease

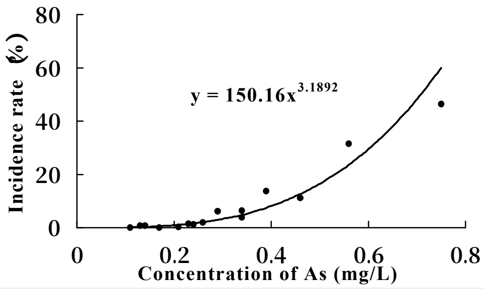
Hyperpigmentation, hypopigmentaion and keratosis are the most important characteristics of arsenism disease in China mainland, but it is blackfoot disease in Taiwan. There are some disputes on the pathological changes:

- Some authors suggested that the clinic behaviors of arsenism started with keratosis in palm like papilla, then progressed to hyperpigmentation and hypopigmentation.
- Some authors suggested that the disease started with hyperpigmentation and hypopigmentation clinically, it progressed to keratosis only when people drink water with high enough concentration of arsenic

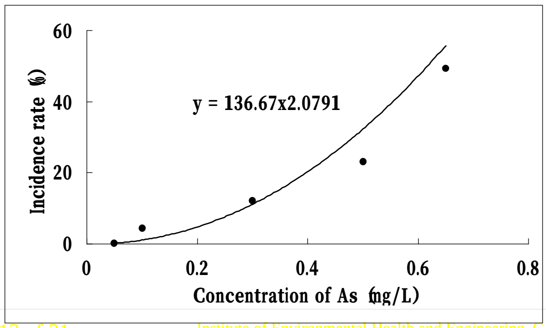
4) Dose-response relationship

Arsenism is mostly occurred in the people who drinks water or combusts coals with high content of arsenic. It has as obvious family assemble and region assemble characteristic.

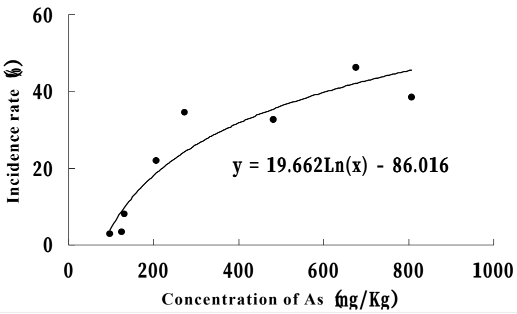
Relationship between concentration of arsenic in drinking water and incidence rate of arsenism in Xinjiang



Relationship between concentration of arsenic in drinking water and incidence rate of arsenism in Inner Monglia



Relationship between concentration of arsenic in coal and incidence rate of arsenism in Guizhou

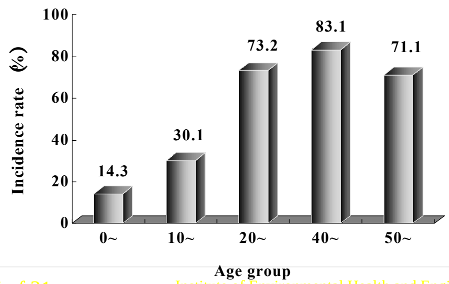


Slide 14 of 31 Institute of Environmental Health and Engineering, CAPM

1 3

Comparison of incidence rate of arsenism in different age groups in Xinjiang

(concentration of As is 0.75mg/L, drink for 5 years)



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1 4

5) Related to other diseases

Region	Cardiovascular		Cancer		
	Abnormal cardiograph (%)	Renal ult syndrome (%)	Digestive (%)	Respiratory (%)	Skin (%)
Xin jiang	78.9	34.7	17.4	52.2	
Inner Monglia	80.0	69.0	35.9	38.5	14.1

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1 5

6) Mechanism research

Study on the relation between peroxidation and arenism in Inner Monglia

The results show:

Arsenic in body can induce lipoprotein peroxidation and produce free radical as well as decrease the activity of SOD, GSP-Px. As a result damage people's health.

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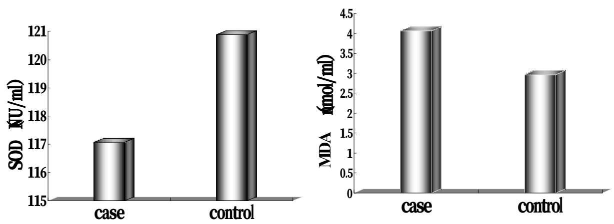
1 6

Comparison of SOD and MDA in blood in arsenism case and control group in Inner Monglia



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1 7

Study on interaction between arsenic and human erythrocyte by FT-IR

The results show:

Arsenic can affect the conformation and configuration of membrane phospholipid, decrease its fluidity, and stimulated peroxidation, as a result, damage the erythrocyte. On the other hand, arsenic can also change the secondary structure of membrane protein, affect its stability and function.

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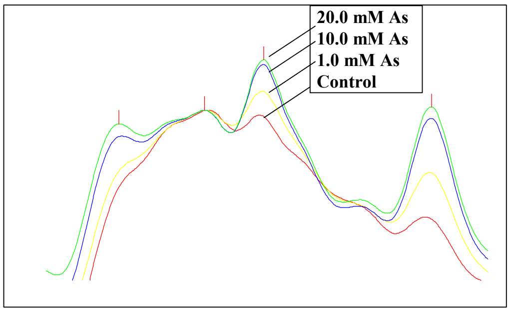
1 8

FT-IR Spectra of membrane phospholipid of human erythrocyte (1)



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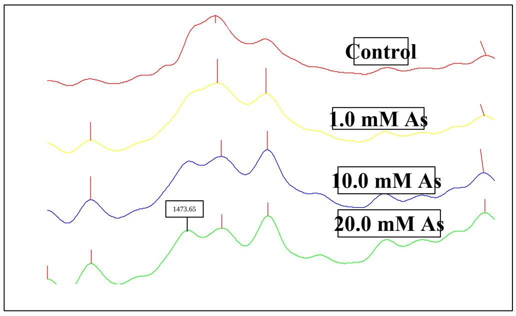
FT-IR Spectra of membrane phospholipid of human erythrocyte (2)



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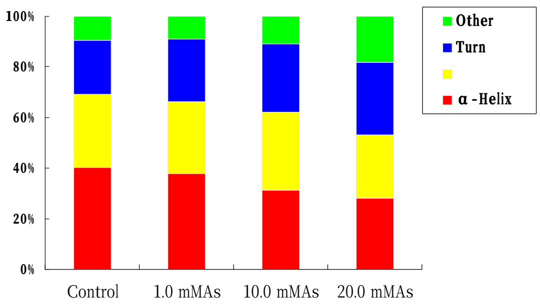
Effect of As（ III） on secondary structure of membrane protein



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7) Prevention and therapy of arsenism

Therapy by drugs：

1、 ***DMSA*： *increase the excretion of excessive arsenic in body as well as improve microcirculation***

2、 ***Se*： *increase the activity of GSH-P_X and Na^+-K^+-ATPase and improve microcirculation.***

Prevention：

1、 **Search water with low concentration of As, eliminate *excessive arsenic in body in water.***

2、 **improve the stove and decrease the concentration of As in indoor air.**

3、 **Study on the physical and chemical method for elimination of arsenic.**

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3. Unsolved problems

1、 Various criterion：

There were many studies of arsenism in China before, but they base on different diagnostic criterion, and different determination method for arsenic. So some results in different regions are not comparable.

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2、 The distribution of arsenism is unclear：

Major researches of arsenism are mainly carried out in north three provinces, such as Xinjiang, Inner Monglia and Shanxi province. While researches in south of China just have been began, for example in Huan and Jiangxi province. According to the National Survey on Drinking Water Quality and Water-born Diseases, there were total 5,630,000 people, who drink high arsenic content water (0.05mg/L). It seems that arsenism distributes in other regions beside Xinjiang, Inner Monglia, Shanxi and Guizhou.

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3、 Limited research on mechanism of arsenism：

The mechanism of arsenic toxicology is unclear, especially the bi-effects and carcinogen of arsenic. Many studies suggested that arsenism is associated to skin cancer, lung cancer, bladder cancer, and so on. However, it is necessary to study further in the molecular level.

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2 5

4. Future studies

Arsenism is not only located in Xinjiang, Inner Monglia, Shanxi and Guizhou province in China, but also in other regions, such as Ningxia, Shaanxi, Beijing, Jilin, Liaoning, Hebei and Henan province for drinking water type arsenism, Xichuan, Yunnan, Guangxi, Hunan, Hubei and Jiangxi province for coal burning type arsenism. To see the distribution and harm of arsenism in china, our government decides to carry out a national survey on arsenism.

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2 6

Study protocol

1、 Organize a team of national investigation on arsenism
2、 Reported the concentration of As in water and coal and situation of arsenism in each region by the charge department of endemic disease.
3、 According to the reported information, select the typical regions of arsenism.
4、 Unify design and survey base on the standard for determining arsenism region caused by arsenic in environment and standard for diagnosing arsenism.

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2 7

Content of studies

Investigation of environmental factor：

determine the concentration of As in water , soil, food, coal, indoor air and some biologic materials in selected regions

Investigation of arsemism：

investigated the population data, situation of drinking water, situation of coal consumption, residence condition, history of disease and life style base on the standard for determining arsenism region caused by arsenic in environment and standard for diagnosing arsenism.

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2 8

Purpose

1、 Map the distribution of arsenic in drinking water and coal in whole country.

2、 Map the distribution of arsenism areas, exposed population and arsenism patient in whole county.

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2 9

2.3 Assessment of Arsenic Removal from Drinking Water by New Adsorbents

He Gongli, Yang Jiaolan, Yu Xiaoyi and Yue Yingling
(Institute of Environmental Health and Engineering, CAPM,
Nan Wei Road, Beijing, 100050,China)

SUMMARY: Efficiency comparison of arsenic removal from drinking water by cerium hydroxide, magnum oxide, calcium oxide and Cu-impregnated activated carbon has been carried out. Effect of contact time on the efficiency of arsenic removal by cerium hydroxide and Cu-impregnated activated carbon has been investigated. The removal of arsenate ion by coprecipitation with cerium hydroxide and Cu-impregnated activated carbon for 24 hr was more than 98% at neutral pH. The contact time effects evidently the efficiency of arsenate ion removal.
KEYWORDS: arsenate, coprecipitation, cerium hydroxide, and Cu-impregnated activated carbon

Introduction

Arsenic is a toxicant with widespread biologic effects. It has been defined as priority consideration carcinogen by the Center of Disease Control of the United States (CDC) and International Association for Research Cancer (IARC) [1]. The hygienic standard of arsenic in drinking water is turning the stricter on International. Japan and German reduced the standard level of arsenic in drinking water from 0.05mg/L to 0.01mg/L in 1993 and 1996, respectively [2-3]. Pontius[4] reported that a new rule for arsenic in drinking water was announced in the United States in 1992. Preliminary calculation for the maximum contaminant level (MCL) suggest that a value of 0.002mg/L will likely be proposed, which is a 25-fold decrease from the present interim MCL value of 0.05mg/L. If this new MCL is adopted, arsenic could become a new substance of concern and it may be a challenging task for treatment technology in the future.

Major treatment methods to remove oxyanions of arsenic include complexation with polyvalent metal species such as ferric iron and coprecipitation with amorphous hydrous metal oxides, lime softening, ion-exchange and activated alumina. The conventional methods of arsenic removal such as coagulation precipitation with lime, alum, or ferric sulfate produce a wet bulky sludge and often require final filtration for secondary treatment. Recent literature shows that various hydrous oxides of rare earth elements exhibit high-adsorption capacity for anions. Various adsorption studies of metal ions have been done on silica-water interface. The materials improved with rare earth elements can remove 99.9% of arsenate from aqueous solution [5]. Which prompted that some typical mechanisms of interact can exit between rare earth elements and arsenate.

The concept of multiple separation by chemisorptive filters was applied and investigated in the process of arsenic removal from water. Chemisorption filters were made by the paper manufacturing method and consisted of cellulose, cationic and anionic ion exchangers, activated carbon and a corresponding chemical agent. Chemisorption filters were activated with Ag^{+}, Mg^{2+}, Cu^{2+}, Al^{3+} and Fe^{3+} ions. The best result in arsenic bonding was obtained when Cu^{2+} ions were applied for chemical activation of activated carbon. The effectiveness of this adsorbent was 0.18mmol/g [6].

In the present study, metal oxides were used for the removal of arsenate ion by coagulation precipitation in aqueous solution at different pH and contact time. The kinetic study of coagulation precipitation of arsenic was conducted. The objectives of this work are (1) to evaluate the efficiency of arsenic removal from drinking water by different adsorbents and (2) to determine the optimum operation parameters affecting the removal of arsenic by cerium hydroxide and Cu-impregnated activated carbon, such as raw water pH values, contact time and initial concentrations of arsenate.

Materials and Methods

Chemicals and materials used in this study included:

$Ce(OH)_4$: cerium hydroxide (prepared by our laboratory)

MgO: magnum oxide (analytical grade)

CaO: calcium oxide (analytical grade)

Cu-AC: Cu-impregnated activated carbon (prepared by our laboratory)

Arsenic solution with different concentrations was prepared by dissolved dibasic sodium arsenate in deionized water.

Cerium hydroxide preparation: dissolved 5g $Ce(SO_4)_2$ into 100ml deionized water, add 2%NaOH solution(excessive), producing a yellow precipitate that was filtered with filter paper, washed with deionized water to neutrality, and dried it in drier. A yellow powder product was obtained.

Cu-impregnated activated carbon preparation: To 100ml of 5% $CuSO_4$ solution was added 40g of powder activated carbon (40 mesh). The mixture was shaken for 24 hours at room temperature and filtered with filter paper. The residue was washed repeatedly with deionized water and dried it at room temperature.

Coagulation precipitation of arsenic in a batch experiment: 30mg of four adsorbents (see Table 1) were suspended, respectively, in 100ml of arsenic-containing water with continuous stirring. After mixing for 1-2 min, followed by static reaction at room temperature for 24 hours. The supernatant was drawn off by suction for determination of pH and arsenic. The arsenic concentration in the raw water and treated water was determined by GFASS method.

Results and Discussion

The main findings of the different adsorbents examined are given in the Table 1. Four adsorbents are effective for As^{5+} removal. But a disadvantage of MgO and CaO is that the pH value in the treated water is about 10-12. It is too high as drinking water use.

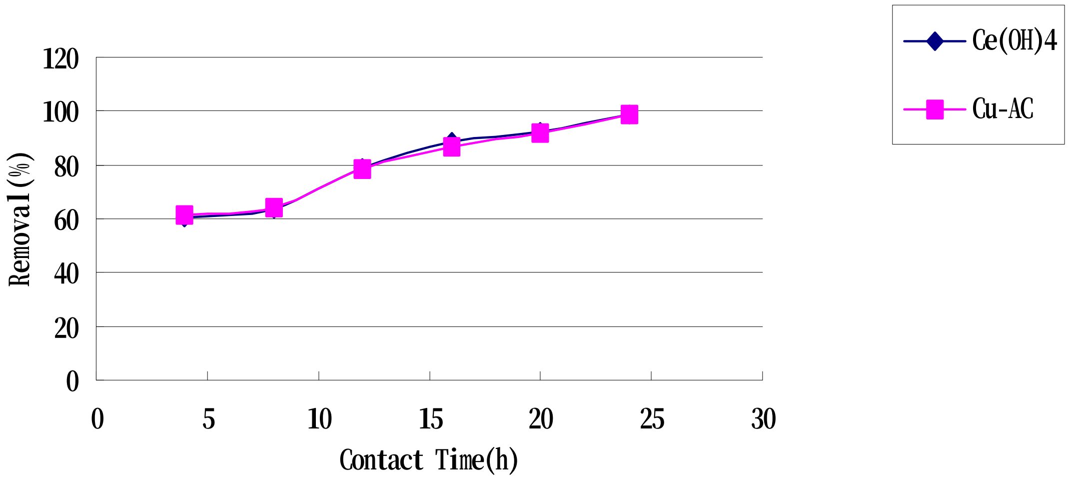
Effect of contact time on the efficiency of arsenic removal by cerium hydroxide and Cu-impregnated activated carbon: Removal of arsenate ion at different contact time at raw water pH 7.16 is summarized in Figure 1. The percentage removal of arsenate ion increased as the contact time increased. The removal was found to be more than 98% at 24 hr contact time. When contact time decrease from 24hr to 4 hr, removal of arsenate ion decreased from 99.0% to 60.4% for cerium hydroxide and from 98.7% to 61.3% for Cu-impregnated activated carbon.

Effect of initial concentrations of arsenic on the efficiency of arsenic removal by cerium hydroxide and Cu-impregnated activated carbon: Removal of arsenate ion by cerium hydroxide and Cu-impregnated activated carbon at different pH and initial concentrations are summarized Figure 2a and 2b. The removal was found to be more than 99% for both adsorbents of cerium hydroxide and Cu-impregnated activated carbon in the final pH range of 4.5 to 7.5 at the initial concentration of 0.52mg/L. The percentage removal of arsenate ion decreased as the initial concentration of arsenate ion increased. Removal of arsenate ion decreased from 99.6% to % for cerium hydroxide, and from 99.6% to % for Cu-impregnated activated carbon with an increase in concentration from 0.52 to 1.98mg/L. Arsenate can be removed down to 0.002mg/L when the initial concentration of 0.52mg/L was taken.

Table 1. Efficiency of As^{5+} removal of different adsorbents
For 100ml of water over 24 hr at room temperature

Group	Adsorbents and amounts (mg)	Raw Water		Treated Water		
		As(mg/L)	pH	As(mg/L)	Removal(%)	pH
		0.514	4.49	0.002	99.6	6.17
A	$Ce(OH)_4$-30	0.531	7.16	0.005	99.0	7.20
		0.526	9.18	0.022	95.8	7.94
		0.514	4.49	0.022	95.7	9.89
B	MgO-30	0.531	7.16	0.036	93.2	10.5
		0.526	9.18	0.045	91.4	10.7
		0.514	4.49	0.021	95.9	11.5
C	CaO-30	0.531	7.16	0.031	94.2	12.6
		0.526	9.18	0.039	92.6	12.8
		0.514	4.49	0.002	99.6	5.32
D	Cu-AC-30	0.531	7.16	0.007	98.7	6.89
		0.526	9.18	0.017	96.8	8.45

Figure 1. Effect of contact time on the efficiency of arsenic removal by $Ce(OH)_4$ and Cu-AC



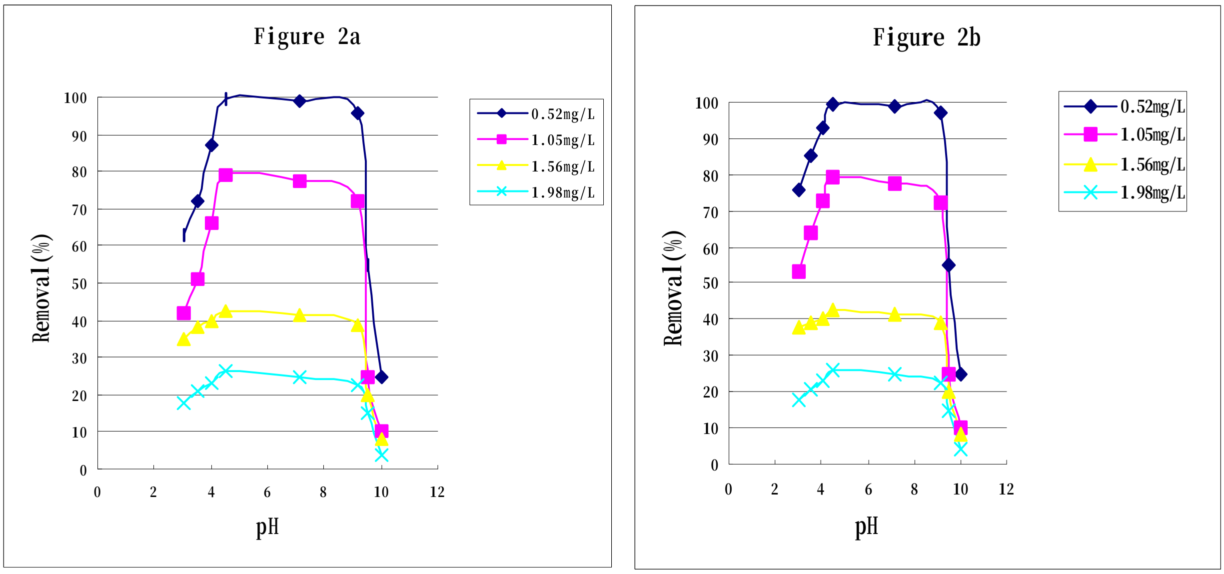


Figure 2 Removal of arsenate ion by cerium hydroxide and Cu-impregnated activated carbon as a function of pH and initial concentration. Adsorbents amount was 30mg; contact time, 24hr; and temperature, 20℃.
2a cerium hydroxide; 2b Cu-impregnated activated carbon

Reference

[1] Jeffer A L., Robert FS, Christopher TD, environmental toxicants. Priority Health Conditions, 1993, 77

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[4] Pontius FW, A current lood at the federal drinking water regulations, J. Am Water Works Assoc., 1992,84: 36

[5] Syed AW., Haron J., Akira V., et al. Removal of arsenite and arsenate ions from aqueous solution by basic yttrium carbonate, Water Research, 1996, 30(5): 1143

[6] Ljubinka VR, Milan MM., Arsenic removal from water by chemisorption filters, Environmental Pollution, 1992, 75: 279

2.4 Comments and Discussion

A Study of arsenism via consumption of arsenic contaminated ground water and intervention study in water mitigation in Inner Mongolia.

Takahiko Yoshida
Asahikawa Medical College

To study a relation between arsenic (As) exposure and As related skin lesions, field researches were done on villagers who drunk naturally As contaminated well water in Inner Mongolia. Then to evaluate a reversibility of skin lesions associated to As exposure, interventional study by providing drinking water with lower concentration of As in mitigation were conducted as periodical follow up studies after changing water source. Correlation between As exposure index or As exposure duration and skin lesions were analyzed on individual villagers. Skin symptoms were obvious in male than female, especially in skin dyspigmentation. As exposure index were related with hyperkeratosis on palm in both adult and children. While hyperkeratosis on sole had good correlation with As exposure index in adult but in children. Correlation between skin dyspigmentation and As exposure index was observed in male adult. As exposure duration and skin symptoms also showed good correlation. Dyspigmentation of skin were prominent in male. Biological exposure monitoring showed weaker correlate to skin symptoms compare than past As exposure indexes. $2^{nd}/1^{st}$ methylation ratio of As was higher in children, then adult female than male. The results showed that gender difference and methylation potency have some role on status of skin lesions. Both hyperketatosis and dyspigmentation were improved by water mitigation. Urine 8-OHdG, reflects DNA damage also decreased by avoiding As exposure. The intervention study showed that avoiding of As exposure was effective to the improvement of skin lesions and decrease the risk of carcinogenesis.

< See the slides on the next pages for the contents. >

Study of arsenism via consumption of arsenic contaminated ground water and intervention study in water mitigation in Inner Mongolia.

YOSHIDA, Takahiko
Department of Hygiene,
Asahikawa Medical College

1

2

Information of Gangfangying village

- One of 47 villages of Baotou city locates at the eastern boarder of city.
- Population 2080, representing 480 households.
- Major occupation, agriculture.
- Water for drinking and cooking:
  - In the past, six public open wells (shallow well).
    - As concentration; 0.00068ppm (only existing open well)
  - From 1979, gradually replaced by pump tube-well (deep well, approximately 330 wells)
    - Average As Conc.;0.133ppm (ranging from 0.0001-1.79)
  - Pipeline water established at late August,1999.
    - As concentration; 0.037ppm. All villagers were asked to use it.
- Arsenism
  - Appearance of first case; 1996.
  - Estimated As-related patients; 20%.
  - Short history of As esposure. No malignancy case.

3

Aim of study

- Assess the extent of As exposure until summer of 1999.
  - As exposure index: Σ(Conc.of well water x used years)
- Evaluate the severity of the symptoms with the correlation of individual As exposure.
  - <u>Skin</u>, cardio vascular, peripheral nerves, etc.
  - As exposure index, As exposure duration
- Research the factors that influence the symptoms.
  - Methylation of As, 8-OHdG (reflect DNA damage), etc.
- Evaluate potential changes in existing health effects by the intervention.
  - Intervention: change water source to lower As concentration.
  - Periodical follow-up health check after the change of water source.
    - July, 1999 as before; March, 2000 and September, 2000 as 6 or 12 months after.

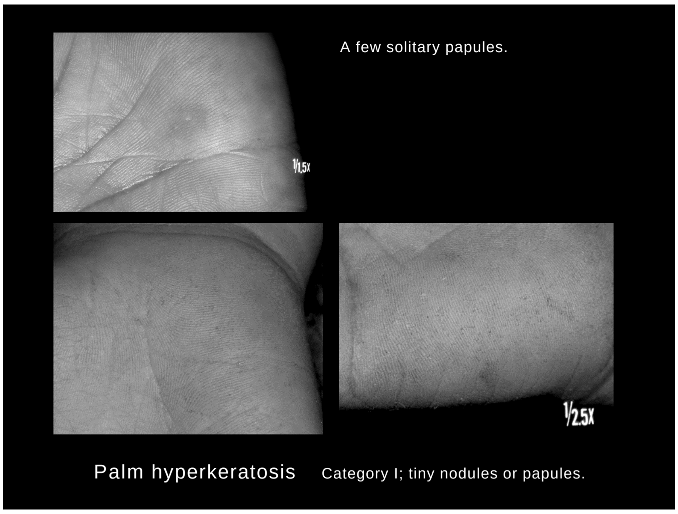
4

Representative public open well in the village.
Only the existing open well in the village; North open well.

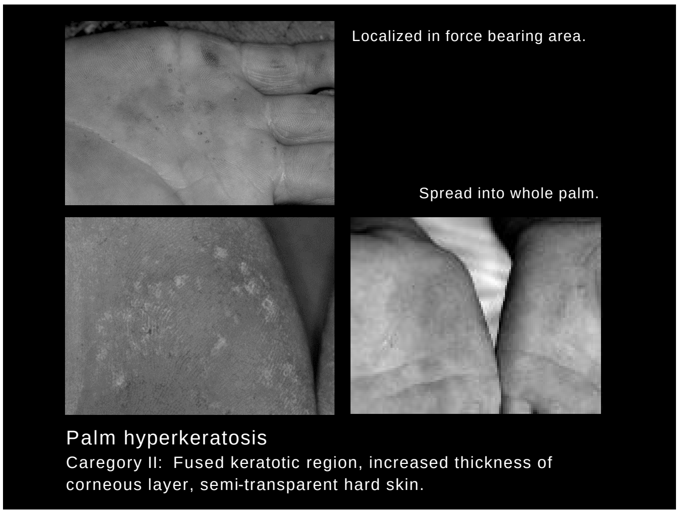
5

Representative personal pump-well in the villager's yard.

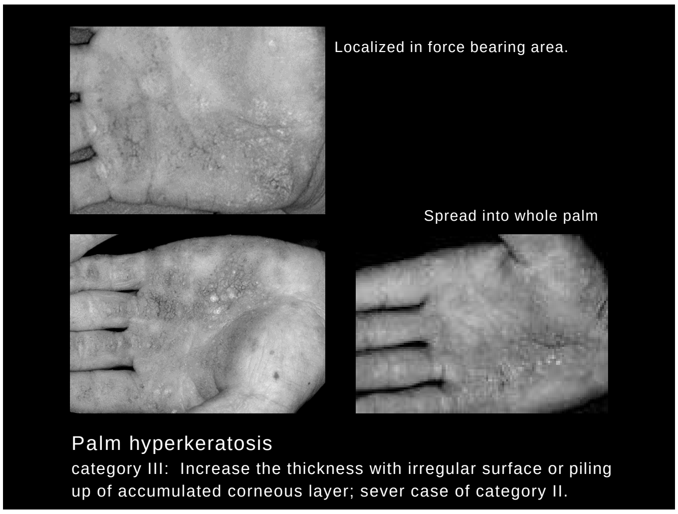
6


A few solitary papules.
1/1.5X
1/2.5X
Palm hyperkeratosis
Category I; tiny nodules or papules.

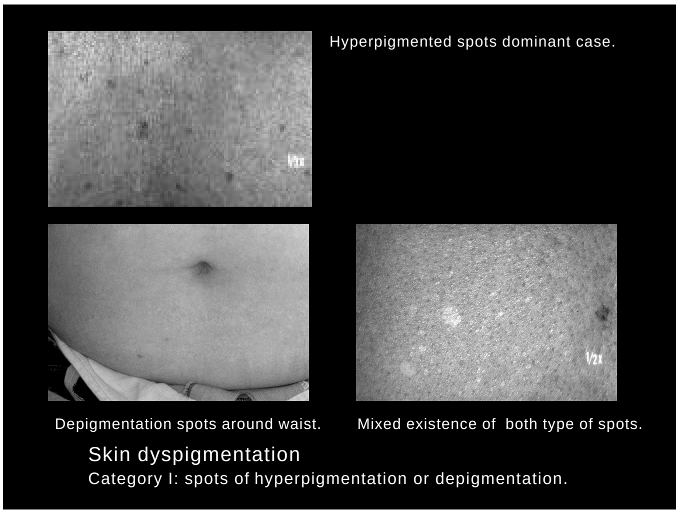
7


Localized in force bearing area.
Spread into whole palm.
Palm hyperkeratosis
Caregory II: Fused keratotic region, increased thickness of corneous layer, semi-transparent hard skin.

8


Localized in force bearing area.
Spread into whole palm
Palm hyperkeratosis
category III: Increase the thickness with irregular surface or piling up of accumulated corneous layer; sever case of category II.

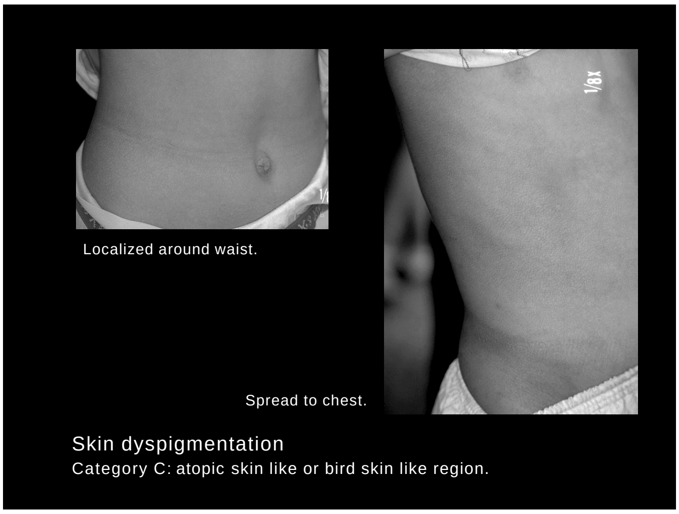
9


Hyperpigmented spots dominant case.
Depigmentation spots around waist.
Mixed existence of both type of spots.
Skin dyspigmentation
Category I: spots of hyperpigmentation or depigmentation.

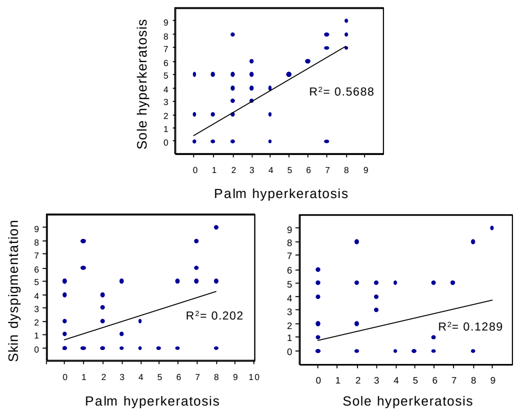
10


Skin dyspigmentation
category II: typical dyspigmentation, rain drops shape dispigmented spots on diffuse hyperpigmentation (dirty road).
Spread to whole trunk
Spread to thigh.

11

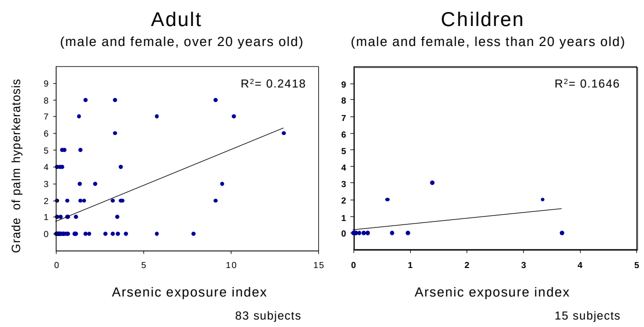

1/8X
Localized around waist.
Spread to chest.
Skin dyspigmentation
Category C: atopic skin like or bird skin like region.

12



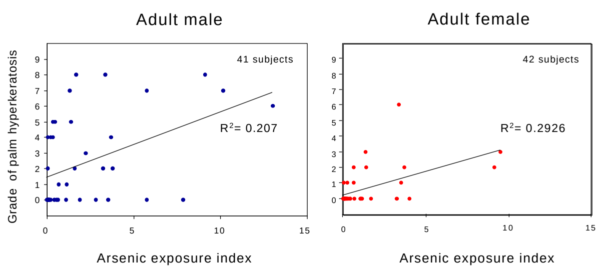
Correlations between skin symptoms; palm or sole hyperkeratosis, and skin dyspigmentation

13



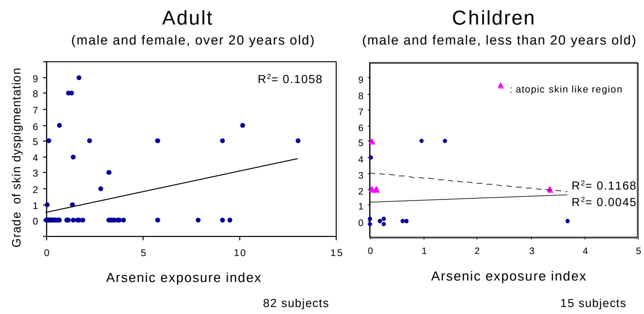
Comparison of the correlations between arsenic exposure index and palm hyperkeratosis in age.

14



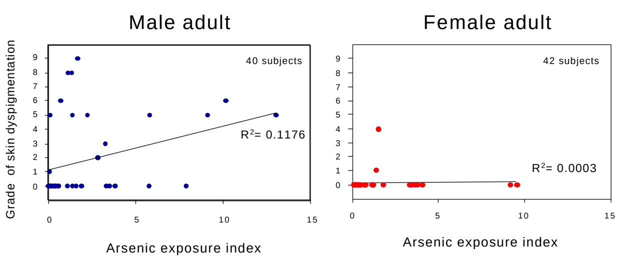
Gender difference of the correlation between As exposure index and palm hyperkeratosis.

15



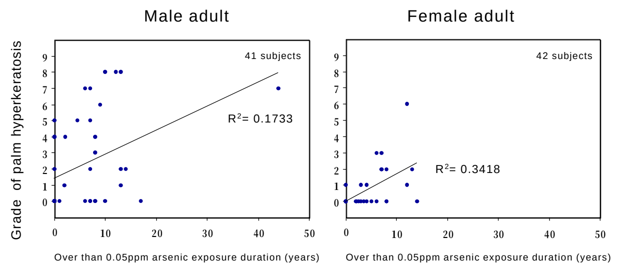
Comparison of the correlations between arsenic exposure index and skin dyspigmentation in age.

16



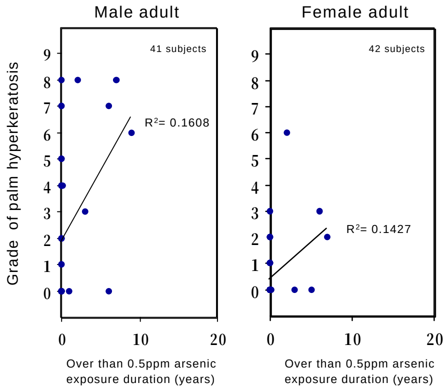
Gender difference of the corelation between As exposure index and skin dyspigmentation.

17



Gender difference of palm hyperkeratosis in villagers who had been drinking water over than 0.05ppm.

18



Gender difference of palm hyperkeratosis in villagers who had been drinking water over than 0.5ppm.

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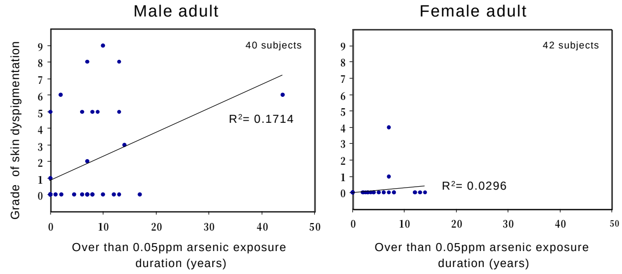
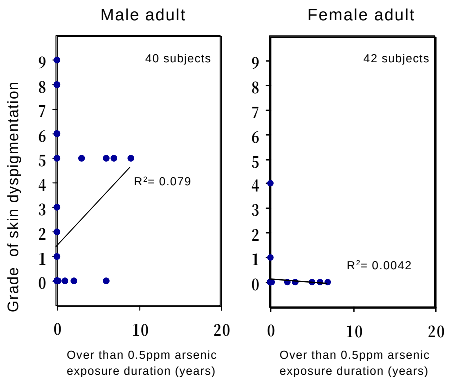


Gender difference of skin dyspigmentation in villagers who had been drinking water over than 0.05ppm.

20



Gender difference of skin dyspigmentation in villagers who had been drinking water over than 0.5ppm.

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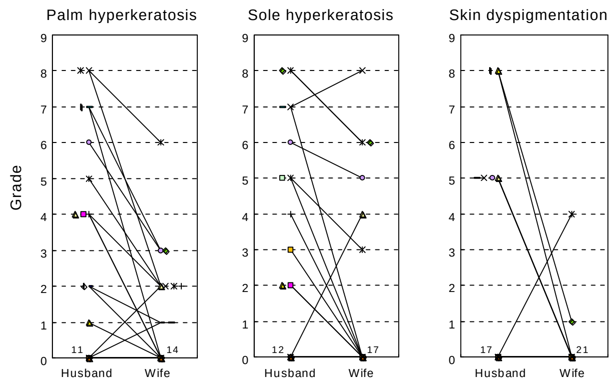
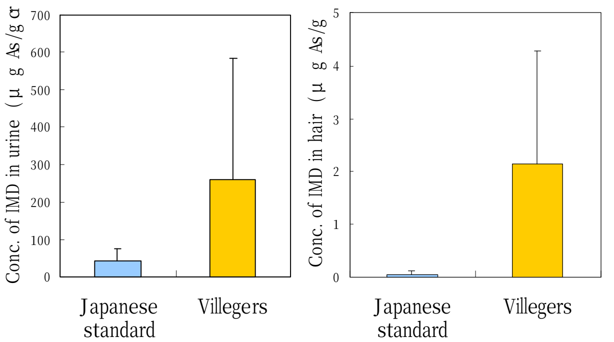


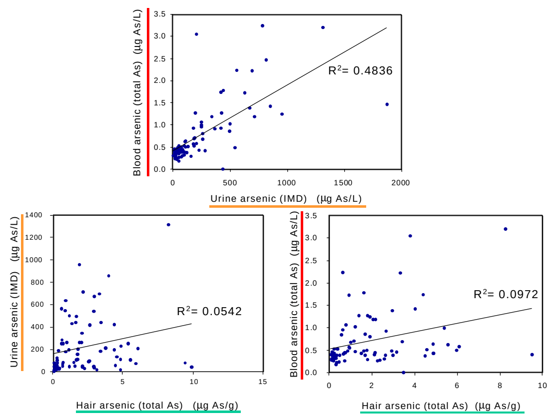
Comparison of skin regions between married couples who had been drinking same well water. 23 couples

22



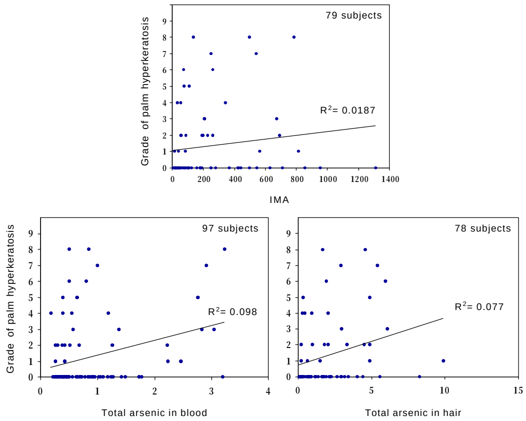
Biological monitoring indexes of the villagers' samples before water source change.

23



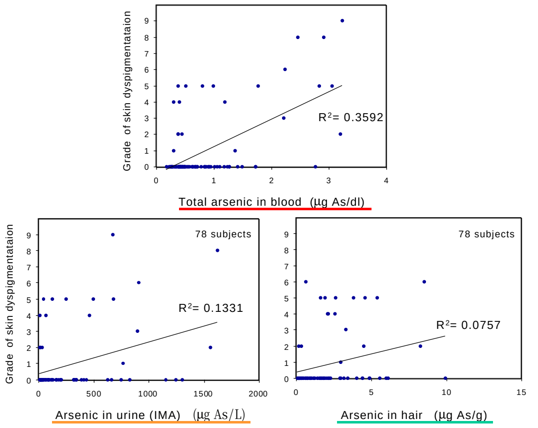
Correlations between arseic biological exposure monitoring indexes; blood As, urine As and hair As.

24



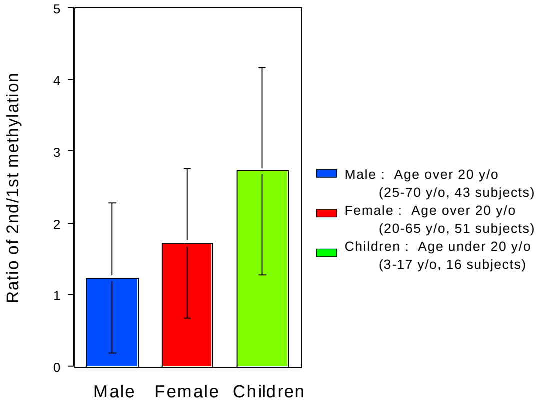
Correlations between As biological monitoring indexes and palm hyperkeratosis in all subjects.

25



Correlations between As biological monitoring indexes and skin symptoms in all subjects.

26



Population difference of 2nd/1st methylation ratio.

27

Origin of new pipeline water for the village
(Under construction of building)

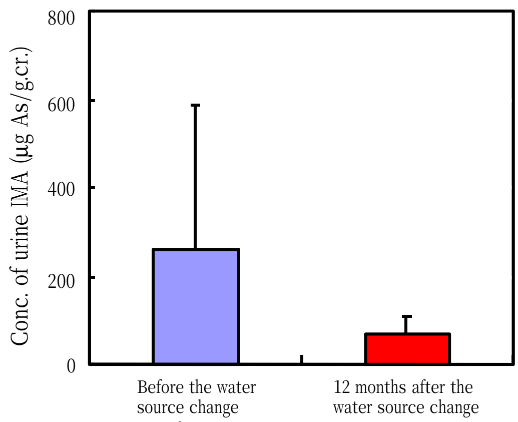
28

Building for new pipeline water supply facility.

29

Faucet of pipeine water in a villager's home.

30



Decrease of urine arsenic concentration from villagers by the intervention.

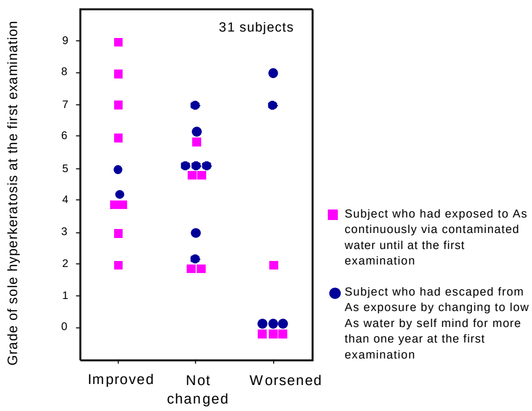
31

Follow up check of villagers at 12 months after the intervention by comparison with former photographs.

32

Changes of palm hyperkeratosis by changing drinking water.

33



Changes of sole hyperkeratosis by changing drinking water.

34

Changes of skin dyspigmentation by water source change.

35

Improvement of palm hyperkeratosis. 42 y/o male (ID #006), left palm.

36

Before the water source change.
(August, 1999)

6 months after the water source change.
(March, 2000)

12 months after the water source change.
(September, 2000)

Improvement of palm hyperkeratosis. 37 y/o female (ID #022), right palm.

37

Before the water source change.
(August, 1999)

6 months after the water source change.
(March, 2000)

12 months after the water source change.
(September, 2000)

Improvement of sole hyperkeratosis. 42 y/o female (ID #106), right sole.

38

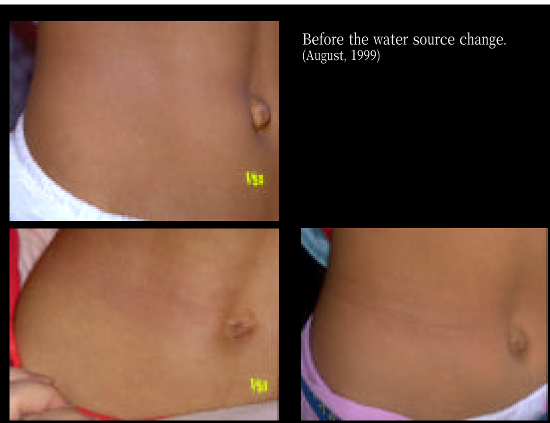
Before the water source change.
(August, 1999)

6 months after the water source change.
(March, 2000)

12 months after the water source change.
(September, 2000)

Improvement of skin dyspigmentation. 47 y/o male (ID #119), abdomen.

39



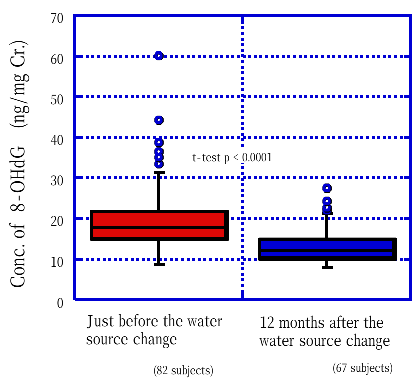
Before the water source change.
(August, 1999)

6 months after the water source change.
(March, 2000)

12 months after the water source change.
(September, 2000)

Improvement of atopic skin like region. 11 y/o female (ID #073), abdomen.

40



Decrease of urine 8-OHdG from villagers by the intervention.

41

Results

- Villagers had been exposed and were exposed to As.
- Arsenic skin lesion:
  - Sever in male adult, especially at dyspigmentation
- Arsenic exposure index:
  - Good correlate with hyperkeratosis in adult but in children.
  - Good correlate with dyspigmentation in male adult but in female adult and children.
- Biological exposure monitoring:
  - Reflect the present As exposure.
  - Not reflect the symptoms as result of past exposure.
- Symptom differences:
  - Gender •Age •Methylation ability

42

Results (continue)

- Influences of water source change
  - As exposure were reduced.
  - Skin alternations, major arsenism symptom were improved generally.
  - DNA damage were decreased.
- Improvement of water quality is effective to improve arsenism at least skin legions.

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Recommendations

- Mixed exposure and health effects of other elements with As should be consider.
- Further follow-up should be conducted to find further health problems such as cancer even if their As exposure had stoped.
- Effectiveness for improvement of water quality should be evaluate on other health alternations.
  - Cardiovascular, peripheral nerves, psycologiy, etc.
- Epidemiological and experimental studies should be conducted for treatment and prevention of arsenism.
  - Study for symptom differences between population.
    - Gender, age, neutrition, another elements, etc.

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Recommendations (Continue)

- Clinical surveys of residents and chemical analysis of water should be conducted in whole country wide.
- Improvement of water quality is necessary to stop occurring of new arsenism patients.
- Education
  - For residents
  - For government?

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Session 3

Concluding Remarks

Major Points Confirmed and Recommendations for Future Studies

Michinori Kabuto
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Throughout this workshop, the current information on the affected areas with arsenic (and also fluoride in some parts) and populations in Bangladesh, West Bengal, Thailand and China has been overviewed and summarized, showing that population who have been drinking the underground water polluted with arsenic exceeding the international standards may count more than 100 millions in these areas. Although the skin lesions or symptoms such as hyper- or hypo-pigmentations or keratosis are most prevalent, it is expected that cases of various cancers including skin, lung etc. would increase if As measurements and disease surveillance are advanced. Moreover, if their exposures are prolonged among the people in highly polluted areas would continue chronically, an increasing trend of those diseases are predicted to be intensified and extended.

According to the several studies in Bangladesh and China, arsenic concentrations vary area-to-area and also even well-to-well in a small village, suggesting that much efforts are needed to diagnose each of the wells for good risk managements. And when high concentration is found for each of wells, however, it must be urgent to apply one of the most convenient methods or to change the water source to an alternative one in order to avoid its serious risks. With risk management, it is highly recommended to adopt the top-down type of governmental actions, since the affected areas are basically very poor in terms of economic status, risk knowledge as well as risk awareness and perception.

In the workshop, although the causal relationships between arsenic exposures and their specific effects have been indicated generally, further discussions especially with respect to recommendations for the future studies were also made based on those given by Dr. T. Yoshida, the last speaker, as shown in his slides. That is,

1) exposures and their health effects of other elements in addition to arsenic should be considered.
2) follow-up should be conducted to investigate more adverse effects such as cancer, since they may be expected even after exposures to arsenic are stopped.
3) effectiveness for improvement of water quality should be evaluate on other health alternations such as cardiovascular, peripheral nerves, psychology, etc.

4) epidemiological and experimental studies should be extended for prevention and treatment of arsenism with special attentions to symptom differences by population, gender, age, nutritional status, another elements etc.
5) clinical surveys on residents and chemical analysis of water should be extended to the whole country level.
6) improvement of water quality must be essential to prevent new cases of arsenism, and
7) education of appropriate knowledge for the residents as well as governors seems also essential.

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