

## RECENT STUDIES ON ENDEMIC FLUOROSIS IN CHINA

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**SUMMARY:** The progress of recent research on the prevention and treatment of endemic fluorosis in China is reviewed. New types of endemic fluorosis areas have been discovered and surveyed. Regulations and standards for health management have been formulated. The biological effects of fluoride have been further investigated. The importance of fluoride research has gained greater recognition and international exchanges have increased.

Twenty nine of China's 30 provinces have endemic fluorosis areas. Areas of three types - water, coal-burning, and tea-drinking - have been found in 26, 14, and 5 provinces, respectively. Surveys in 1990 revealed that 300 million people live in such areas, of whom 3 million have skeletal fluorosis and 40 million have dental fluorosis.

Successes in the prevention and treatment of endemic fluorosis include:

- 1) gathering epidemiological data on prevalence and severity throughout the country;
- 2) implementing preventive measures that reduce drinking water and indoor air levels of fluoride, by changing water sources and types of stoves; and
- 3) developing methods of health regulation by early diagnosis and treatment.

### Survey of new types of endemic fluorosis areas

Epidemiological investigations into coal-burning fluorosis have proceeded since 1988. For example, one project in the Sanxa area has been reported, on the extent of such pollution and its health effects. Twenty new types of stoves have been designed, which not only reduce fluoride pollution but save coal as well. Information has been published on new anti-fluoride medicaments, on the scientific and technical base for prevention and treatment, and on establishment of health regulations and standards.

In some areas of Xizang, Xinjiang and Nei Mongol provinces, the fluoride contents of tea infusion are over 2 mg/L. Prevalences of dental fluorosis in children and skeletal fluorosis in adults are over 40% and 20%, respectively. Some people have been exposed for several years to high fluoride intakes from both drinking water and tea infusion.

Endemic areas have been discovered where high levels of fluoride and other microelements coexist in the living environment. For example, it was found that coal-burning in some areas of Guizhou and Hubei provinces caused simultaneously high intakes of aluminium, selenium and arsenic as well as fluoride from the polluted indoor air, while in some areas of Xinjiang and Nei Mongol provinces the well water contained high levels of both arsenic and fluoride.

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### Effective measurement of endemic fluorosis

Two advanced methods for determining the fluoride content of micro-samples are: a microdiffusive/combined electrode method and a microabrasive/opposite electrode method. The former is used for determining 5 ng ionic fluorine in a sample of 100  $\mu$ l, and the latter for determining at least 0.05 ng ionic fluorine in a sample of 1  $\mu$ l. Other improved electrode methods are extensively used for determining fluoride content in a variety of environmental and biological samples, such as: coal, water, air, corn and vegetables from endemic areas; teeth, nail, hair, saliva, blood, and urine from the human body; and bone, heart, liver, kidney, and brain - even of cells - from experimental animals.

In laboratory experiments, some variables affecting immunology, genetics, microelemental metabolism, and enzymology have been investigated, in order to discover early adverse effects of fluoride on human health. So far the tests, though having the advantage of being very sensitive, are unsuitable for early diagnosis of skeletal fluorosis, because of their low reliability and specificity. However, "a syndrome of articular fluorosis" and "an X-ray syndrome of bone transformation in skeletal fluorosis" are promising approaches which could facilitate early diagnosis of skeletal or articular fluorosis and provide fresh evidence for revising the standard for X-ray diagnosis of skeletal fluorosis.

Among over 10 recently developed medicaments for treating fluorosis, the one containing boron has the best understood mechanism for countering the action of fluoride. That is, boron integrates itself with fluoride in the body to form tetra-fluoroborate which can be excreted in urine, and reduces the permeability of fluoride through cellular membranes. All of these medicaments, however, are still in the stage of animal experiment or small clinical test.

More than 30,000 engineering projects, to reduce fluoride levels in drinking water by changing water sources, have been constructed in recent years, benefiting a population of 20 million. The 60% with skeletal fluorosis, for example, have already been on the mend since 1983, when the high fluoride levels in drinking water were lowered in Shandong and Shanxi provinces. The effects of electrodialysis and carbonized bone on the elimination of fluoride from drinking water are also being explored.

As for coal-burning fluorosis, the new types of stoves that save coal and reduce domestic air pollution are now widely used, by over 150,000 families. Levels of pollutants in indoor air, such as fluoride, sulphide, and carbon monoxide, have been decreased to 5-20% of original levels, complying with requirements of the national standard for atmospheric health in residential areas. Advanced farming techniques, adopted to shorten the time of stoving corn, are very helpful in reducing the chance of fluoride pollution of food by coal-burning.

### Biological effects of fluoride and their mechanisms

More and more studies on the non-skeletal effects of fluoride, involving almost all systems and parts of the body, have been conducted by Chinese scientists since 1986. The fact that central and peripheral nerves are damaged directly by fluoride corrects an old point of view that the damaged function

of motor nerves should be imputed to osteoproliferation of vertebrae. Fluoride conjugates the phenolic hydroxyl of tyrosine by hydrogen bonding, interfering with the biological anabolism of thyrotropic hormone. Both non-specific and specific immune functions are inhibited by fluoride. The prevalence of tracheo-bronchitis is significantly higher in residents of endemic fluorosis areas. Fluoride can be transferred from the pregnant woman to the fetus and then interfere with the development of the central nervous system of the baby. Fluoride has some adverse effects on the biological functions of normal components in the blood, the electrocardiogram and the heart pump activity. The biotransformation of the liver and urinary function of the kidney are decreased in patients with fluorosis. Fluoride inhibits the activities of SOD and GSH-Px, resulting in a heavy cumulation of free radical and peroxide and then in various cell damage. By using the methods of biophysical analysis and quantum chemical calculation, it has been shown that fluoride has a very strong ability to form a hydrogen bond with the phenolic hydroxyl of tyrosine in proteins, even changing the normal hydrogen bonds of  $O\cdots HO\langle\bigcirc\rangle R$  and  $N\cdots HO\langle\bigcirc\rangle R$  into an unusual hydrogen bond of  $F\cdots HO\langle\bigcirc\rangle R$ , and then destroying the normal spatial conformations of various proteins - perhaps one of the most essential mechanisms of fluoride toxicity yet known.

### Regulation and standards for health management of endemic fluorosis

*The Handbook of Prevention and Treatment of Endemic Fluorosis*, published in 1991 by the Department of Endemic Disease Control, Ministry of Public Health, describes almost all methods and standards in the field of fluoride research. Use of the handbook will make management of endemic fluorosis more scientific and beneficial.

A national surveillance network for endemic fluorosis control was set up in 1991, and each year a lot of data collected by the network have been referred to the Department of Endemic Disease Control.

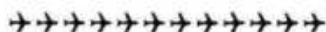
The regulation and standards of endemic fluorosis were formulated by the Endemic Diseases Branch of the National Committee for Health Standards and Techniques, which proposed a series of research projects for coming years. The aims included standards for diagnosing dental and skeletal fluorosis, recognition of endemic areas, evaluation of preventive effects and fluoride intakes, fluoride sampling and analysis, and assessment of therapeutic effects. Corn and fly ash reference materials, prepared and certified for fluoride composition to meet the need for quality analytical control when monitoring domestic soot fluoride pollution, have been approved by the National Bureau of Technical Supervision.

### Increase of fluoride research status and international exchanges

More and more scientists are taking part in research projects on the prevention and treatment of endemic fluorosis, including postgraduates in some 20 medical colleges and universities who have finished or are preparing dissertations.

In recent years two national conferences on endemic fluorosis, three conferences of the Chinese Society for Fluoride Research, and ten specialist training

classes for the prevention and treatment of fluorosis have been held, in addition to several district symposia on fluorosis convened by local experts. At international conferences Chinese scientists have reported on their research, while Chinese and foreign experts have been invited to each other's countries to give special lectures. The increased quality and importance of fluoride research has been recognized by the World Health Organization and the Chinese government. Both will sponsor the 20th Conference of the International Society for Fluoride Research, to be held in Beijing from September 5 to 9, 1994.



#### A NOTE FROM THE EDITOR

Before the next issue of this journal appears, many of us will meet in September at our Society's 20th Conference in Beijing, China (see below). The co-sponsorship of this gathering by the Chinese Ministry of Public Health and the World Health Organization is a measure of its scientific importance. The International Society for Fluoride Research was founded in 1967 at a Conference in Frankfurt, Germany, following similar successful international conferences in Bern, Switzerland, in 1962 and in Detroit, USA, in 1966. Since those times, world-wide awareness of fluoride pollution and its effects has greatly increased. Our Society has played, and continues to play, a major role in that development.

John Colquhoun

#### THE 20th CONFERENCE OF THE INTERNATIONAL SOCIETY FOR FLUORIDE RESEARCH

will be held in Beijing, People's Republic of China, on September 5-9, 1994. The Conference is co-sponsored by the Consultant Committee on Endemic Fluorosis of the Ministry of Public Health of the People's Republic of China and the World Health Organization. The official language of the Conference will be English. All are welcome. In addition to the interesting scientific programme there will be local tours to places of historic interest. The registration fee is US\$200 - send to: ISFR '94 Scientific Secretariat, Dr Liang Chaoke, Institute of Environmental Health and Engineering, Chinese Academy of Preventive Medicine, 29 Nan wei Road, Beijing 100050, People's Republic of China. FAX: 0086-01-3011875. Phones: 0086-01-3013987 or 0086-01-3038761-Ext.261.

#### THE SIXTH FLUORINE SYMPOSIUM

will take place in Szczecin, Poland, on September 14-16, 1994. For further information contact Professor Zygmunt Machoy, Department of Biochemistry, Pomeranian Medical Academy, Al. Powstanców 72, 70-111 Szczecin, Poland.