Interdisciplinary Perspectives on Drinking Water Risk Assessment and Management
(Proceedings of the Santiago (Chile) Symposium, September 1998). IAHS Publ. no. 260, 2000.

Fluorosis management in India: the impact due to networking between health and rural drinking water supply agencies

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Abstract India is one of 21 nations with serious health problems due to consumption of fluoride-contaminated drinking water. An estimated 62 million people in India (in 16 of the 32 states) are affected with dental, skeletal, and non-skeletal forms of fluorosis and associated health complaints. Even children of the age of 8 to 10 years have been crippled due to consumption of fluoride-contaminated water. Fluoride concentrations in drinking water vary from 1.5 to 39 ppm. To tackle the problem effectively, an innovative approach has been adopted. Networking between Public Health Engineering, health sector personnel, and nutrition experts of the individual states, and phasing in the activities with well-defined objectives for implementation, resulted in a multidisciplinary approach, with the main goal of providing safe/defluoridated water, preventing fluorosis, and improving the health status of the community through interventions. The information arising from research and development activities on fluorosis patients is translated into well-defined modules for clinicians to use in their outpatient departments while screening the patients. This is very important as the health complaints due to fluoride often overlap with manifestations of other diseases and can lead to incorrect treatment of patients. In the Fluorosis Management Programme, the emphasis is on generating awareness among professionals, developing information, education, and communication packages, involving the community, and devising specific strategies for using the technology for fluoride removal and other approaches for providing safe water and consuming calcium, vitamin C, and an antioxidant-rich diet on a sustainable basis.

INTRODUCTION

In India an estimated 62 million people, including 6 million children, have serious health problems due to consuming fluoride-contaminated water. Fluorosis is a well-defined clinical entity identified as early as 1937 (Short *et al.*, 1937). A programme for controlling the disease, through networking between rural drinking water supply implementing agencies and health departments came into existence in India during 1986–1987. The Ministry of Rural Development (subsequently re-named the Ministry of Rural Areas and Employment), the nodal Ministry under the Government of India, drew up the policies and action plan after several rounds of in-depth discussion with leading scientists/scientific organizations in the country, rural drinking water supply implementing agencies, and health department officials both in the Central and State Governments.

The policies and plans that evolved had inputs from those that administered the district and were looking after the needs and requirements of the village community.

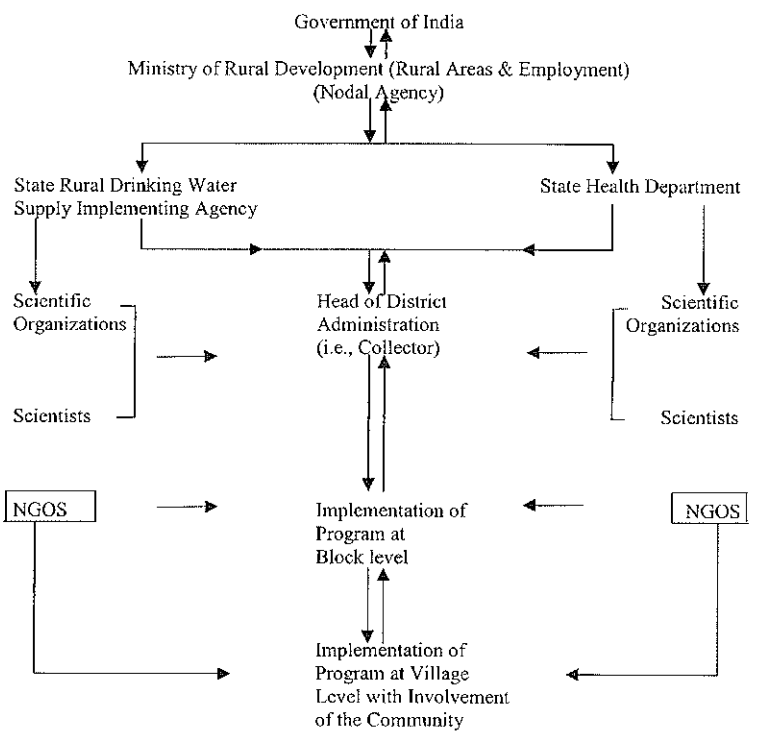
Basic plan

India had the unique opportunity, when the national Drinking Water Mission was launched during 1986–1987, to formulate a submission on "Control of Fluorosis", as there were substantial scientific data that had emerged from the country over a period of five decades through research and development activities supported by Central and State Government, as well as international funding agencies (Susheela & Ghosh, 1990). The data that were then available on indigenously developed fluoride-removal technologies were identified for large-scale field operations and testing. Water-quality testing laboratories were strengthened in terms of infrastructure and capacity-building of the personnel, so that sustainability of safe water is ensured.

FLUOROSIS CONTROL PROGRAMME IN INDIA

An overview of networking

As fluorosis can be easily prevented through appropriate interventions, provided the disease is diagnosed at the very early stages, the following protocol was designed, developed, and field-tested for use in rural areas (Susheela, 1993), and is presently used very widely in the country:



Another basic issue that was dealt with is awareness and updates for doctors, dentists, and public health engineers on all aspects of fluoride action on body tissues, fluorosis, and its prevention. In addition, emphasis was placed on provision of safe water, and the options available are incorporated into the training module. The options are: (a) providing safe water through existing safe water sources, (b) bringing water from a distance if economically viable, (c) making use of rainwater (rainwater harvesting) if rainfall is adequate, or (d) chemical treatment. The two major technologies that have been indigenously developed for fluoride removal from water are:

- Nalgonda technology using lime and alum; and
- Activated alumina technology, which has undergone several innovations through research and development during the last decade, resulting in the development of a domestic filter (Iyengar, 1998).

These two technologies have been scaled-up for use in (a) community plants, (b) hand pump attached versions, and (c) domestic filters.

The last and the most important aspect of the national programme on "Control of Fluorosis" was sensitizing grass root level functionaries and bringing out appropriate IEC (information, education, communication) material about the disease and all aspects dealing with its prevention for operationalizing the action plans.

Field operations

As the disease is quite widespread in 16 of the 32 states and union territories of the Indian Republic, adequate precautions had to be introduced for carrying out meaningful activities involving the community in a short time span and with judicious use of funds.

How to determine whether a village is endemic for fluorosis

There are two options available:

- The first option is to test the drinking-water quality, with a focus on fluoride, of all water sources, including both groundwater and surface water. Although it is a time-consuming exercize and involves enormous expenditure, in many districts such activities have been carried out. The data reported in Tables 1(a) and (b) reveal the nature of the activities and the data generated.
- The second option is to select villages through a Dental Fluorosis Survey in school children of the age of eight years and above, and to locate endemicity for fluorosis. In the villages that were selected, water-quality testing was conducted also (Table 2).

The latter approach is preferred as it saves time, energy, and funds.

Responsibilities of the Health Department

It is the responsibility of the Health Department to carry out a benchmark health survey assessing the magnitude of the health problem due to fluorosis. A house-to-

Table 1(a) Drinking water fluoride levels in three blocks in the State of Andhra Pradesh.

Site no.	Block	No. of water samples tested	Sources with fluoride <1 (mg l^{-1})	Sources with fluoride >1 (mg l^{-1})	Fluoride range (mg l^{-1})
1	Thamballapally	100*	65	35	1.6–3.3
2	Medak	121*	54	67	1.6–6.5
3	Nadigama	168*	115	115	1.6–7.1

*hand pump, bore well, open well.

Source of information: National Environmental Engineering Research Institute, Nagpur, Repost (1997).

Table 1(b) Information on water fluoride level in 14 blocks of Dindigal district in Tamil Nadu.

Site. no	Name of the block	No. of panchayats	Population	No. of villages	No. of water samples tested/existing	Sources with fluoride concentrations: 1.0–2.0 (mg l^{-1})	2.1–3.0 (mg l^{-1})	3.1–4.0 (mg l^{-1})	4.1 (mg l^{-1})	Population at risk
1	Kodaikanal	12	44 322	65	85/85	None	None	None	None	None
2	Oddan Chathram	31	84 369	144	165/165	None	None	None	None	None
3	Athoor	25	135 673	82	85/85	3	None	None	None	18 587 at risk (13.7%)
4	Nillakkottai	10	44 283	56	43/69	17	1	None	None	30 068 at risk (67.9%)
5	Bhatlakundu	11	51 468	39	74/74	30	10	1	1	29 130 at risk (56.6%)
6	Dindigal	15	89 452	100	118/118	39	9	2	2	69 504 at risk (77.7%)
7	Vadi Madurai	17	72 908	151	206/206	59	21	3	1	44 911 at risk (61.6%)
8	Shanarpatty	21	93 471	121	153/153	69	29	3	2	59 821 at risk (64%)
9	Natham	21	84 759	138	179/179	78	23	2	1	72 892 at risk (86%)
10	Reddiarchathram	22	98 626	128	180/180	78	69	18	4	98 626 at risk (100%)
11	Palani	14	38 675	52	71/71	16	2	None	None	29 276 at risk (75.7%)
12	Thoppanam Patty	23	71 698	108	147/147	40	7	2	1	44 811 at risk (62.5%)
13	Gujiliamparai	8	32 386	55	65/65	29	3	None	None	22 799 at risk (70.4%)
14	Vedasandur	13	36 423	105	140/140	59	4	1	None	31 651 at risk (86.9%)
Total		243	978 513	1344	1711/1737	517 (30.2%)	178 (10.4%)	32 (1.9%)	12 (0.7%)	5 646 022 at risk (57.7%)

Source of information: Gandhigram Rural University report to the Government of India Ministry of Environment and Forest (1991).

Table 2 Dental fluorosis survey data in school children from all the 18 districts of Gujarat State.

Site no.	Name of the district	No. of schools surveyed	No. of students examined in the schools (8 years and above): Boys	Girls	Total	No. of students with DF	Percentage affected with DF
1	Ahmedabad	199	27 947	20 123	48 070	8 537	17.75
2	Gandhinagar	29	4 436	4 023	8 459	967	11.43
3	Mehsana	415	62 322	38 912	101 234	25 307	24.9
4	Banaskantha	367	36 463	20 925	57 388	10 032	17.78
5	Sabarkantha	278	21 000	18 405	39 405	5 728	14.5
6	Baroda	240	13 826	11 825	25 651	4 329	16.87
7	Kheda	210	24 064	19 219	43 283	5 266	12.16
8	Panchmahal	311	34 603	25 729	60 332	5 207	8.4
9	Bharuch	42	4 781	4 459	9 240	1 378	14.9
10	Surat	19	1 697	1 581	3 278	260	7.9
11	Valsad	14	1 939	1 889	3 828	101	2.6
12	Junagadh	50	7 075	5 314	12 389	4 097	33
13	Amreli	75	9 159	7 975	17 134	2 855	16.6
14	Surendranagar	71	7 442	6 010	13 452	2 961	22
15	Jamnagar	28	3 070	2 316	5 386	838	15.5
16	Bhavnagar	77	10 667	8 472	19 139	2 714	14.1
17	Rajkot	44	6 065	7 320	13 385	1 971	14.7
18	Kutchch	13	1 599	1 561	3 160	640	20.25
Total		2 482	278 155	206 058	484 213	83 188	% range: 7.9–24.9

DF = Dental fluorosis.
Source of information: Gujarat Health Department, 1996–1999.

house survey is preferred, instead of camp-based, to cover 100% of the population of the village. While carrying out the survey, the three forms of fluorosis—dental fluorosis, skeletal fluorosis, and non-skeletal fluorosis—were identified separately. For non-skeletal fluorosis, significance was attached to early warning signs of fluoride toxicity manifestations, namely: non-ulcer dyspeptic complaints and other clinical manifestations (details are provided in the module developed for clinicians for use in outpatients' clinics). Early warning signs are the most important complaints or manifestations that the community ought to recognize, as it is those complaints that disappear when interventions are introduced (Susheela, 1995). The benchmark health survey results of Kurnool District in the State of Andhra Pradesh reveals the prevalence of the three forms of fluorosis (Table 3).

Table 3 Prevalence of the various forms of fluorosis in Kurnool District of Andhra Pradesh.

Total population surveyed	Population affected with: dental fluorosis	skeletal fluorosis	non-skeletal fluorosis	Disease manifestations, in total	Percentage affected
1 491 791	43 927	8 833	30 400	83 160	5.6

Survey data emerged since launching of the Technology Mission Activity.

Responsibilities of the Rural Drinking Water Supply Implementing Agencies

It is the responsibility of the implementing agencies to carry out water-quality testing with a focus on fluoride, total dissolved solids (TDS), hardness, alkalinity, sulphate (SO_4), and other parameters, and to decide a strategy for provision of safe water.

The data thus generated by water-quality testing of all sources are further classified into four categories based on fluoride level.

- Category I: Water sources having a fluoride level 1.0 mg l^{-1} or below (considered as safe sources).
- Category II: Water sources having a fluoride level ranging from 1.1 to 2.0 mg l^{-1} (marginally high fluoride level).
- Category III: Water sources having a fluoride level ranging from 2.1 to 5.0 mg l^{-1} (high-risk sources).
- Category IV: Water sources having a fluoride level of 5.1 mg l^{-1} or greater (extremely high risk sources).

The earlier practice of testing 10 to 15% of raw water sources and implementing a strategy for erecting defluoridation plants based on those data has changed. Instead, it has now been made mandatory that 100% of sources be tested for water quality before any decision is taken for provision of safe water.

Data generated through Health and Rural Water Supply Implementing Agencies (RWSIA)

The total population in a village dependent on Category I, II, III, or IV water sources is identified.

The prevalence of dental, skeletal, and non-skeletal fluorosis in the population of the villages categorized I to IV is ascertained.

The villages are prioritized for provision of safe water. Category IV villages would, however, be the first priority.

Category III villages would follow as the second priority and RWSIA would commence its activities.

However, in Category II and Category I villages, epidemiological survey data are scrutinized and if fluorosis is prevalent, those households are identified and they are diverted to the existing safe sources of water in the village (through appropriate labelling of the sources. The contaminated sources are marked unfit for consumption, but they can be used for other purposes) (Susheela, 1998).

Interventions for prevention of fluorosis

The provision of a sustained supply of (a) safe water and (b) nutritional interventions is being practised in India for preventing fluorosis.

Safe water intervention Depending upon: (i) raw water quality, (ii) geohydrology, (iii) geomorphology, (iv) topography/terrain, (v) population/community to be catered

to, and (vi) annual rainfall pattern, an area-specific plan of action is drawn up and implemented for providing a sustainable source of safe water.

Nutritional intervention At presently, nutritional intervention is being practised with patients who have fluorosis and seek hospital intervention. Nutritional intervention requires counselling of the patients and education of the female members of the households who are responsible for cooking and serving food for the family. They are educated about the locally grown/available food, or agricultural crops that are high in calcium, vitamin C, and other antioxidants, and that need to be consumed on a daily basis through breakfast, lunch, and dinner.

The fluoride levels in blood, urine, and drinking water are monitored for a period of three to six months when the complaints due to non-skeletal fluorosis gradually disappear, providing great relief to the patient. They would then continue the dietary regime that they have practised and continue to consume safe water, thereby preventing the disease and beginning to enjoy better health.

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