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Community-oriented Administration of Fluoride for the Prevention of Dental Caries: A Summary of the Current Situation in Asia

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ABSTRACT

Dental caries is the most prevalent chronic disease affecting human populations around the world. It is recognized that fluoride plays a significant role in dental caries reduction. Meanwhile, several low- and middle-income countries of Asia have not yet implemented systematic fluoride programs; contributing factors relate to misconceptions about the mechanisms of fluoride, low priority given to oral health in national health policy and strategic plans, and lack of interest among public health administrators. A workshop on the effective use of fluoride in Asia took place in Phang-Nga, Thailand, in 2011. A series of country presentations addressed some of the topics mentioned above; in addition, speakers from countries of the region provided examples of successful fluoride interventions and discussed program limitations, barriers encountered, and solutions, as well as possibilities for expanding coverage. Participants acknowledged that automatic fluoridation through water, salt, and milk is the most effective and equitable strategy for the prevention of dental caries. Concerns were expressed that government-subsidized community fluoride prevention programs may face privatization. In addition, the use of affordable fluoride-containing toothpastes should be encouraged. The workshop identified: strengths and weaknesses of ongoing community-based fluoride programs, as well as the interest of countries in a particular method; the requirement for World Health Organization (WHO) technical assistance on various aspects, including fluoridation process, feasibility studies, and implementation of effective epidemiological surveillance of the program; exchange of information;

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and the need for inter-country collaboration. It was acknowledged that program process and evaluation at the local and country levels need further dissemination. The meeting was co-sponsored by the World Health Organization, the International Association for Dental Research, and the World Dental Federation.

Globally, dental caries is among the most prevalent chronic diseases affecting human populations, and the occurrence is highly influenced by socio-behavioral conditions and exposure to disease prevention programs (Petersen, 2003). The World Health Organization (WHO) (Petersen, 2008) emphasizes the effective use of fluoride for the prevention of dental caries. The value of water fluoridation, salt fluoridation, milk fluoridation, and the development of affordable toothpastes is recognized. Population-wide automatic fluoridation measures (water, salt, milk) are considered the most equitable strategy for disease prevention (Petersen and Lennon, 2004). Although community-based interventions may have been implemented in several countries around the world, several developing countries have not implemented such programs; contributing factors seem related to a misconception that dental caries has been eradicated globally, with the consequent lack of interest in, or low priority given to, oral health by country public health administrations, non-inclusion of oral health in national health policy, and strategic plans with consequent inadequate support. A workshop on the use of fluoride in Asia took place in Phang-Nga, Thailand, in 2011. Speakers from countries of the region provided examples of successful interventions and discussed program limitations, barriers encountered, and solutions, as well as possibilities for expanding coverage.

Working Group sessions aimed to identify strengths and weaknesses of ongoing activities of community-based programs using fluoride, as well as to identify interest of participants in a particular method and perceived need for technical assistance, to exchange information, to address concerns, and to stimulate inter-country collaboration. Countries identified the need for guidance by the World Health Organization and technical assistance on planning and evaluation of community-based interventions. Particularly with regard to program evaluation, randomized clinical trials may not be the most feasible method for the measurement of evidence in public health practice. General discussion focused

Key Words

caries detection, fluoride, dental caries, public health, population-directed prevention, Asia.

on the need to strengthen health system research and translate the information into community-based practice.

COUNTRY EXPERIENCES

Malaysia

Strengths

Water fluoridation at a concentration of 0.7 mg F/L has been implemented in the country since the early 1950s. The program is maintained through a multi-sectorial involvement, including the Ministry of Health Divisions of Oral Health and Engineering, the Water Treatment Plant Authority, and the National Services Commission. Approximately 70% of the population benefits from water fluoridation. In general, water fluoridation has been successful.

Weaknesses

Marketing efforts by companies relative to the benefits of drinking “purified” water have increased worldwide. Consumption of bottled water and/or the use of filters that remove impurities has reached several countries. In Malaysia, the use of water filters has increased, although no exact figure or percentage was provided at the meeting. Concern was expressed about the fact that filters, particularly those designed to work by reverse osmosis, would actually *remove* fluoride from the water through the filtration process.

Specific difficulties identified with the water fluoridation program were quality assurance and concerns on privatization of the water system.

Priorities

Other priorities identified were the need to conduct public health research to obtain information on fluoridation benefits to the community as a way to increase support for maintaining fluoridation. Another important issue identified related to occupational safety and recommendations were offered for the occupational health of persons handling the fluoride compound. It is necessary to institute precautions, since fluoride can be toxic: The acute Probably Toxic Dose established is 5 mg/kg body weight (Whitford, 1990). Adequate measures and surveillance are necessary to prevent workers from inhaling or ingesting amounts of fluoride that would be harmful. It is mandatory to institute education at the processing plant or operating facility and to enforce good manufacturing practices. Workers handling fluoride should be monitored periodically—for example, renal excretion analysis should be conducted every six months, at the maximum. The tolerable urinary fluoride concentration is 7 mg/L (Schlatter and Steininger, 1988). Adequate coordination to link the Ministry of Health officials with the WHO Global Oral Health Program so that proper interaction is established or strengthened was also recommended.

Singapore

Strengths

Singapore has had water fluoridation for 53 years, with an estimated coverage of 100%; this is based on the fact that there is

only one water supply system for the entire island. Estimates obtained in 1989 from calculations of Dean’s Community Index of Fluorosis (CFI) indicated the possibility of multiple fluoride exposure sources: The CFI was 0.56, which was close to the 0.60 threshold proposed by Dean (1942) for becoming a public health concern. A survey conducted by staff from the Ministry of Health indicated that 83% of children in Singapore used toothpaste containing fluoride; consequently, a decision was made to lower the concentration of fluoride in water from 0.7 to 0.6 mg F/L in 1992 and further to 0.5 mg F/L in 2008. Other vehicles of fluoride are also available to the population of Singapore. A multi-disciplinary committee has been established in the country, and one of its responsibilities is the review of articles on oral health to generate recommendations to the Ministry of Health.

Nepal

Strengths

Data on fluoride in drinking water in multiple water supplies and dental caries are available. Although the DMFT index may be considered low, untreated dental caries is high, making it one of the most highly prevalent childhood diseases in Nepal, with the consequent need for an effective community-based fluoride intervention.

Weaknesses

There are no automatic fluoridation systems available in Nepal; water fluoridation has been considered, but given the multiple sources of water supplies and the inability to utilize a central supply system, this method is not feasible at this time.

Recommendations

Considerations have been given to salt fluoridation, and a feasibility study is in progress. Only one salt trading company processes iodized salt, which could facilitate salt fluoridation.

Laos

Strengths

Laos established salt iodization with the assistance of United Nations Children’s Fund (UNICEF). Recently, the Ministry of Health, supported by the French organization Aide Odontologique Internationale and WHO, initiated the addition of fluoride to iodized salt.

Weaknesses

It appeared that, in countries with iodine deficiency, a motivation to increase salt ingestion may have been interpreted as beneficial. The need to reinforce community education activities was identified as a priority. The possibility of increasing iodine and fluoride concentrations *per* kilogram of salt, rather than the amount of salt ingested, was discussed. Collaborative efforts involving UNICEF and WHO should be encouraged.

Recommendations

The establishment of an epidemiological surveillance system was recommended by WHO as a priority. The need for strengthening

communication between the Directorate of Food and the Ministry of Health, to avoid conflicting messages on the reduction of salt ingestion, was also stressed.

Vietnam

Strengths

Water fluoridation at a concentration of 0.7 mg F/L has been available in Ho Chi Minh City since 1990. A step-by-step approach has been utilized for implementing this measure, and fluoridation has resulted in a decrease of dental caries in children.

Weaknesses

Seventy percent of the rural population does not benefit from the water fluoridation program.

Recommendations

Consideration has been given to introducing salt fluoridation in other areas of the country, ensuring that distribution of fluoridated salt to communities where water fluoridation is existent can be controlled.

Various mechanisms to exercise control through a strict epidemiological surveillance system were identified, an essential element of which is the census of water supplies and mapping of fluoride to prohibit distribution of fluoridated salt to communities where the fluoride concentration in water is optimal or above optimal. Community education on the benefits of fluoride is of the utmost importance, as is education on the consequences of fluoride exposure above optimal concentrations.

Brunei

Water fluoridation at a concentration of 0.5 to 0.7 mg F/L was implemented in 1987; currently, approximately 95% of the population receives benefits of water fluoridation. Toothpaste containing fluoride is also available in the country; in addition, fluoride varnishes are applied to children within the school setting.

Cambodia

Strengths

Cambodia instituted salt fluoridation at a concentration of 250 mg/kg in 2008.

Weaknesses

Loss of motivation has been observed among responsible parties in charge of program implementation, particularly due to poor quality assurance and inadequate technology and infrastructure; in particular, the existence of multiple salt processors who may not have access to proper technology and ignore the benefits of salt fluoridation has undermined the success of the program.

Priorities

There is a strong need for effective technology that can substantiate discussions at the political level; the need to educate both the government and the private sector on the importance of exercising quality control and the identification of individuals in

other countries who can provide technical assistance and capacity-building was also emphasized.

Thailand

Of the existing milk fluoridation programs in the world, Thailand has the largest program, benefiting over 700,000 children. It is the only country using fluoridated Ultra Heat Treated (UHT) milk. The concentration in the final product as ingested is 2.5 mg/L. The program has been supported by the Borrow Foundation, WHO, and, locally, by the Department of Health, Ministry of Public Health, the Food and Drug Administration Office (FDA), and the Royal Chitralada Project. Milk fluoridation is the only automatic dental caries prevention program targeting 4- to 12-year-old children in public schools. The collaboration of the royal family, local health authorities, and the dairy companies has contributed to the success of the program. The effectiveness of the program is monitored with renal fluoride excretion studies conducted yearly. Authorized laboratories conduct tests for fluoride content. Milk is maintained at the schools in refrigerators provided by the dairy companies. Involvement of dental/health professionals at the province level was identified as a challenge. Developing a manual of milk fluoridation using scientific evidence but written in plain language can be used to inform authorities and dairy companies, and to convince other interested persons to support the system. Ownership of local coordinators at the province level was also seen as a positive factor contributing to effective implementation. Barriers identified were related to FDA requirements and taxes imposed on milk; however, tax exemptions have been arranged through advocacy efforts at the tax department.

Hong Kong

The water fluoridation experience has been similar to that of Singapore. The concentration of fluoride in the water in 1961 was 0.8 mg F/L, and it was reduced to 0.5 mg F/L in 1988. A monthly monitoring of fluoride content is conducted at the processing plant; however, the need for also obtaining water samples at the consumer's end to monitor fluoride concentration was identified as essential. Effectiveness in dental caries reduction and enamel fluorosis status is assessed every 10 years through an oral health survey.

India

Following the success of using salt as a vehicle for iodine for the prevention of goiter, serious considerations have been given to the implementation of salt fluoridation for the prevention of dental caries. However, difficulties have been encountered in convincing authorities of the effectiveness and safety of salt fluoridation. Assistance from prominent organizations, in particular WHO, to clarify concerns with health authorities was deemed indispensable. An example of such concerns is the assumed incompatibility of iodine with fluoride; discussions at the meeting clarified that no such incompatibility exists. A recommendation given at the meeting was to conduct cost/benefit studies to demonstrate the economic advantages of such programs and the amount of money that the government would save over a period of years by implementing the community prevention program. Although information exists on the estimated cost

of salt fluoridation *per person per year*, it is recommended that such estimates be conducted at the country or region level to obtain accurate and pertinent data. In areas where fluoride may be present in water in optimal or above optimal concentrations, or where population groups may be receiving fluoride through the diet, recommendations were made regarding the need for estimating fluoride exposure through renal fluoride excretion studies to verify levels of exposure. To avoid distribution of fluoridated salt to areas where no additional fluoride was needed, the distribution network should be determined prior to the initiation of salt fluoridation; this would need to be complemented with a census of water supplies and fluoride exposure studies, so that the population receives optimal fluoride exposure. Recommendations were also made regarding the need to conduct feasibility studies that would facilitate the decision of selecting the most appropriate fluoridation method to be used; if salt fluoridation was the method of choice, packaging and storage conditions of processed fluoridated salt would need to be taken into consideration, to minimize the possibility of segregation of fluoride in large sacks. When sodium fluoride is added, care must be exercised regarding particle size. Sodium fluoride (NaF) is normally a very fine powder and, consequently, has a tendency to accumulate at the bottom of any package of whatever size. While the mixture may have been homogeneous at the conclusion of the production process, the small NaF particles tend to fall through the empty spaces between the coarser sodium chloride (NaCl) crystals.

China

The challenges in formulation of fluoride policies and program implementation and sustainability were discussed at a symposium in 2006 (Petersen *et al.*, 2008). Because China is a 'mega-country', various fluoride prevention methods have been used in the past, including water at a concentration of 0.8 to 1.0 mg F/L in the Province of Guangzhou between 1965 and 1976. Fluoridation was stopped for two years because of the unavailability of the fluoride compound, and it was reinstated in 1983 when the program was stopped under pressure from anti-fluoridation groups. Salt fluoridation in concentrations of 200 to 250 mg/kg was used in groups of children in Wuhan city. All children had 3 meals in the kindergarten each day, and the average salt consumption was 3 to 4 g *per day*. Clinical dental conditions and urinary levels were assessed. Compared with the control group, these children showed about 50% reduction in caries experience (mean dmft and dmfs) at the end of the trial. Diverse school-based prevention programs in various provinces have also been implemented. Topical varnishes and gels have been used in schools; in addition, since 2008, schools in 24 provinces have been applying pit and fissure sealants. The main aim has been to focus on children and older people. There have been serious concerns about the manpower required for program implementation.

OTHER COMMUNITY-BASED PREVENTION PROGRAMS USING FLUORIDE

Participants decided to discuss other community-based prevention programs, such as toothbrushing with dentifrice containing

fluoride, varnishes, mouthrinse programs, and fluoride supplements. It was clear that none of these alternatives can be considered automatic caries prevention systems, because they require a cooperative effort or direct action from either the individual or the health professional.

Toothbrushing in schools with toothpaste containing fluoride is conducted in various countries, *e.g.*, Thailand and Pakistan. In Brunei, school-based fluoride varnish is also available to all children. School-based programs are conducted by dental personnel or by schoolteachers. In Korea, fluoride mouthrinse programs are conducted and assisted by the teachers. A general recommendation was that school-based prevention should be integrated with general health activities, particularly if there was an existing activity already in place—for example, vaccination campaigns.

Fluoride supplements are being used in Indonesia under a school-based distribution program, and children are instructed to swallow a tablet. The evidence in favor of fluoride tablets is questionable, particularly because of compliance issues, particularly in home-usage-based programs, and because current evidence suggests that children should swish, suck, or chew the tablet instead of swallowing it. Thus, this approach may have little relevance in the context of a public health program. School-based programs under supervision of a teacher or other competent person would increase success possibilities. Discussions at the meeting emphasized the fact that fluoride supplement programs demand a cooperative effort from the individual or administrative personnel, as opposed to, for example, the provision of fluoridated milk in an existing school distribution program in which children will receive the milk as part of their meals without conflicting cooperative effort.

CONCLUSIONS

- (1) Assistance from prominent organizations such as WHO to clarify concerns with health authorities was deemed indispensable.
- (2) Feasibility studies are essential prior to developing or instituting a fluoridation program (water, salt, or milk).
 - (a) An essential element is the census of water supplies and mapping of fluoride.
 - (b) If alternative community-based prevention programs (salt or milk) are contemplated, the specially trained personnel required for implementation and monitoring should be considered prior to initiating such programs.
- (3) Community education on the benefits of fluoride is fundamental; education should also include consequences of fluoride exposure above optimal concentrations.
- (4) Countries need technical assistance and guidance on planning and evaluating community-based interventions.
- (5) Technical assistance to include capacity-building on fluoridation methodology and surveillance is imperative for the success of the program.
- (6) Population-wide automatic fluoridation measures are considered the most effective and equitable dental caries prevention methods and require no cooperative effort or direct action by the population. Such measures have a significant beneficial impact, particularly in deprived populations.

- (7) Process implementation and evaluation at local and country levels need further dissemination.
- (8) In countries with water fluoridation programs, it is important to determine the types of filters families may be using in their homes, since filtering systems using reverse osmosis methodology actually *remove* fluoride from water.
- (9) In countries where water fluoridation is limited and is not feasible to implement in other communities, salt or milk fluoridation can be considered.
- (10) The need to establish an epidemiological surveillance system was identified as a priority.
 - (a) Strict planning is essential, particularly with regard to the distribution network.
 - (b) Monitoring of water, salt, and milk must be conducted at the processing plant and at the consumer end to ensure that the correct amount of fluoride is being delivered to the user.
- (11) If alternative community-based prevention programs (salt or milk) are contemplated, the specially trained personnel required for implementation and monitoring should be considered prior to initiating such programs.
- (12) Community-based fluoride programs must take into consideration the occupational safety of personnel in charge of handling fluoride.
- (13) There is a need to strengthen health system researchs and translate the information into community-based practice.
 - (a) There is a need for strengthening communication between the Directorate of Food and the Ministry of Health to avoid conflicting messages on the reduction of salt ingestion.
 - (b) The existing body of knowledge indicates that iodine and fluoride are compatible.
- (14) There is an eminent need to develop a simple handbook (an “elementary treatise”) with information about fluoridation methods, benefits, savings, quality control, and surveillance which can be used in countries as a way to support the decision to develop or maintain fluoridation programs.
- (15) Government-subsidized community fluoride prevention programs may face privatization in some countries. Careful management of the situation should be considered.

RECOMMENDATIONS TO COUNTRY DIRECTORS OF ORAL HEALTH PROGRAMS

General Recommendations

- (1) Recommendations from WHO and Food and Agriculture Organization (FAO) for reducing the intake of salt should not be overlooked.
- (2) School-based prevention should be integrated with general health activities—for example, diet and nutrition, and vaccination campaigns.
- (3) Caution should be exercised in the selection of fluoride supplements for school-based prevention programs, since such an approach has modest relevance in a population-directed program, due to difficulties in various countries resulting from compliance issues and inappropriate instructions to the children.

Specific Recommendations

- (4) Tax exemptions on equipment and elements required for use in the fluoridation program should be negotiated with corresponding authorities to facilitate program implementation and reduce cost.
- (5) Establishment of a multi-disciplinary committee or national commission to assist, coordinate, and advise on fluoridation programs, including epidemiological surveillance, is essential.
- (6) Cost/benefit studies are useful to demonstrate to authorities the economic advantages of fluoridation programs and can clearly demonstrate the amount of money the government would save over a period of years by implementing the community prevention program. Such estimates must be conducted at the country level.
- (7) In areas where fluoride may be present in water in optimal or above-optimal concentrations, or where population groups may be suspected of receiving fluoride through the diet, the estimation of fluoride exposure through renal fluoride excretion studies is essential to verify levels of exposure. Such information will be useful in deciding whether community fluoridation is indicated and will also aid in monitoring post-implementation community dental caries prevention programs using fluoride.
- (8) If salt fluoridation is the method of choice, environmental, packaging, and storage conditions of processed fluoridated salt should be taken into consideration, to minimize the possibility of segregation of fluoride in large sacks.
- (9) If lower salt intake could be ensured in a population, increased concentrations of iodine and fluoride should be considered.

SUMMARY OF KEY WORKING GROUP CONCLUSIONS

- (1) Population-wide automatic fluoridation measures are considered the most effective and equitable dental caries prevention methods.
- (2) Feasibility studies are essential prior to developing or instituting a fluoridation program (water, salt, or milk).
- (3) Community education on the benefits of fluoride is fundamental.
- (4) Countries need technical assistance and guidance on planning, implementing, and evaluating community-based interventions.
- (5) The need to establish an epidemiological surveillance system was identified as a priority.
- (6) There is a need to strengthen health systems researchs and translate the information into community-based practice.
- (7) There is an eminent need to develop a simple handbook (“elementary treatise”) with information about fluoridation methods, benefits, savings, quality control, and surveillance which can be used in countries as a way to support the decision to develop or maintain fluoridation programs.
- (8) Government-subsidized community fluoride prevention programs may face privatization in some countries.

- (9) Sharing of community experiences from use of fluorides and recommendations made national and international public authorities is considered important. Useful reports on the implementation of fluoride programs are listed under the References.

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