Practice Information Sheet No. 3

Caries

FLUORIDES AND CARIES MANAGEMENT

There are many different fluoride containing products available and choosing the appropriate fluoride therapy regimen can be difficult. The aim of this information sheet is to review the main types of fluoride therapies available and to provide some guidance as to their appropriate use.

Do we still need fluoride?

For over 60 years fluoride has been used in dentistry to control decay. It has been recognised as the major factor responsible for the reduction in caries experience, slower progression rate of caries when it does develop, and more recently for its potential to control early lesions. With the all-time low level of dental caries in 12-year-olds some patients may question the necessity of continuation of the use of fluoride.

Practice Information Sheet No.1 on the nature and aetiology of caries presented an overview on current concepts of caries. The presented model of the decay process viewed fluoride as the main factor facilitating protection (prevention) and repair (maintenance) processes in caries management. Carbohydrates and in particular sugar are recognised as the main contributing factors in caries initiation and progression. Sugar consumption in Australia is high and does not show any signs of going down, therefore, nearly everyone's teeth need protection in the form of fluoride. Without fluoride protection and with high sugar consumption the decay levels may go up to the level observed in some of the developing countries.

Lack of fluoride use would result in increased decay rate, unnecessary dental suffering for our patients and dental physicians would miss an opportunity of providing other types of dental treatment for example aesthetic work or periodontal care.

Taking into account the above facts on fluoride prevention relevance in our life there is only one conclusion that can be drawn:

In order to keep decay levels low the basic population approach to fluoride prevention such as water fluoridation is as relevant today as it was when water fluoridation was first introduced.

How fluoride works

There are two anticaries mechanisms of fluoride – the pre-eruptive and the post-eruptive. In the pre-eruptive mechanism fluoride is ingested and incorporated into the enamel during the tooth development process by formation of larger fluorapatite crystals. In the post-eruptive mechanism fluoride acts directly on the tooth surface by:

- lowering critical pH for demineralisation of enamel;
- enhancing remineralisation;
- inhibiting acid formation; and
- at higher concentrations, reducing growth and metabolism of bacteria.

Fluoride from all sources can inhibit decay through both mechanisms. Fluoride from water or toothpaste acts directly at the tooth surface in the oral cavity and when swallowed can be incorporated into the tooth structure of teeth that have not yet erupted. The swallowed fluoride also gets into body fluids eg. saliva and through that acts again at the tooth surface.

Fejerskov *et al* (1981) and Beltran and Burt (1988) in their publications suggest that the predominant action of fluoride is post-eruptive but the pre-eruptive benefit is also present.

What forms of fluoride are available?

Fluoride is used in dentistry for two reasons: to prevent the decay process and to remineralize the damaged tissues. Fluoride is available to many communities through the adjustment of fluoride concentration in the water supplies, via toothpastes, mouthrinses, tablets or drops used as dietary supplements and professional or self-application of fluoride-containing gels and varnishes. Some restorative materials used in dentistry also contain fluoride.

Fluoride products for home use such as toothpastes or mouthrinses vary in fluoride concentration.

Professionally prescribed products come in a variety of forms, varying in terms of chemical composition, form of application, concentration and frequency of administration.

Water fluoridation vs other fluoride sources – which is better?

Water fluoridation remains the most effective and socially equitable means of providing the caries preventive effects of fluoride to the community. Although fluoride has both pre-eruptive and post-eruptive effects, maximal caries-prevention will be achieved via the maintenance of a constant supply of ionic fluoride at the tooth surface/plaque interface (Fejerskov *et al,* 1981; Beltran and Bert, 1988). Thus, strategies aimed at frequent, low-level exposure to fluoride in the community (such as water fluoridation) are superior, in terms of caries prevention, to professional applications, which tend to be high-concentration fluoride gels but very much less frequently applied.

A recent publication by the National Health and Medical Research Council Working Group on the relative effectiveness of different fluoride sources accepted estimates which indicated a higher effectiveness of water fluoridation than other fluoride sources (National Health and Medical Research Council, 1991).

Water fluoridation has a number of advantages as a source of fluoride:

- cost-effectiveness;
- community-wide coverage ensuring socially equitable prevention of dental caries; and,
- a wide safety margin.

Strategies aimed at regular, low-level exposure to fluoride in the community are superior, in terms of caries prevention, to professional applications, notably to high-concentration fluoride gels (WHO, 1994).

Sources of fluoride, other than water fluoridation, have their place in treatment or prevention of dental caries when water fluoridation is not available or in special circumstances when additional fluoride exposure is required.

When is additional fluoride therapy required?

Who benefits from either professionally or self-applied additional fluoride (McIntyre, 1995):

- moderate to high caries-risk individuals (see Practice Information Sheet No. 2);
- patients with reduced salivary flow, eg. those who are on medications reducing salivary-flow, have diseases that decrease salivary flow or have received radiation to the head and neck area;
- patients undergoing orthodontic treatment, or wearing removable partial dentures;
- patients following periodontal surgery, especially when root surfaces have been exposed;
- individuals suffering erosion of teeth eg from acid reflux, frequent vomiting, excess citrus consumption or wine tasting;
- patients with hypersensitive teeth; and
- some mentally or physically impaired individuals.

Professionally prescribed fluoride therapy may be required for individuals living in areas with or without fluoridated water supplies and the need for such a therapy is always assessed by a dental professional on an individual basis. Prescription of an additional fluoride therapy is usually associated with advice to the patient to increase the frequency of use of fluoride-containing toothpaste or to leave toothpaste on the teeth after brushing (spit and not rinse).

Professionally applied fluoride is usually recommended as a treatment and not just as a preventive method and only if at least one of the above mentioned conditions are present.

Fluoride supplements

Fluoride supplements were introduced as a water fluoridation substitute for children in nonfluoridated areas, and were intended for use only in areas with insufficient fluoride in the drinking water. Fluoride supplements have been found to be of little use as a caries prevention public health measure because compliance with the daily regimen is poor and the children who use them are usually from the more oral-health-conscious families (WHO, 1994). Daily administration of tablets at home requires a very high level of parental motivation, and campaigns to get parents to give their children fluoride supplements have not been very successful in many countries. All of that resulted in the impact of supplements on dental caries being the lowest in the economically underprivileged sections of the community (WHO, 1994).

Some recent studies have suggested that fluoride supplements can be a risk factor for dental fluorosis if taken during the tooth formation period (Pendrys *et al,* 1996; Clark *et al,* 1994; Puzio *et al,* 1993). The fluoride from tablets ingested and absorbed in one dose is different from the ingestion of fluoride from water where absorption is spread throughout the day (WHO, 1994).

Essentially, fluoride supplements have little impact on caries prevention in the presence of other fluoride sources, but present a clear risk of fluorosis (Review of water fluoridation: new evidence in the 1990s, 1998). For this reason, recommendations have been made to reduce the dosage schedules for fluoride supplements in industrialised nations. Set out in table 1 below are the guidelines with reduced dosages as recommended by an NHMRC Expert Advisory Panel (1993). These schedules are interim recommendations and include changes to the age of initiation and dosages for specific ages.

The current recommendations on supplement use vary between countries as they reflect variation in fluoride exposures in different parts of the world. The exposure to fluoride in Australia is obtained from numerous sources and as knowledge about these increases supplement schedules have tended to be reduced.

It has been shown that sucking a fluoride tablet for as long as possible, rather than immediately swallowing it, gives better results in caries management (WHO, 1994).

In today's situation of low caries prevalence, many children in nonfluoridated areas would not benefit from supplements (Rugg-Gunn, 1990; Horowitz, 1989). Therefore, blanket recommendations for all children populations in nonfluoridated communities is unnecessary and potentially harmful, as it increases the risk of fluorosis.

Riordan (1996) states that the *contribution of fluoride supplements to caries prevention is minimal and they should no longer be recommended as a preventive measure but may be useful in caries management for higher caries risk individuals.*

TABLE 1
Supplemental fluoride (mg) dosage schedule Australia

Age	Concentration of fluoride in water supply (parts per million)		
	<0.3ppm	0.3-0.5ppm	>0.5ppm
6mths – 4 years	0.25mg	0.00	0.00
4 – 8 years	0.50mg	0.25mg	0.00
8 years +	1.00mg	0.50mg	0.00

NHMRC 1993

Fluoride products other than toothpaste for self-application

There are several methods for self-application of fluoride therapies: toothbrushing with solutions or gels; applying gels or foams in trays; and mouthrinsing solutions. All products designed for home use contain lower concentration fluorides compared with products for professional application. In general all of these products and the methods of their application are useful in controlling dental caries but they are usually avoided in young children because of the risk of swallowing an excessive amount of fluoride and causing dental fluorosis. However, every case needs to be individually assessed and an appropriate treatment plan prescribed.

When should additional fluorides be used?

Professional or self-applied fluoride therapies are indicated only in patients with moderate to severe caries activity or risk (WHO, 1994).

Professional or home application – which is more appropriate?

Fluorides may be applied by a dental professional in the dental surgery or may be self-applied by the patient. In general, although some exceptions do exist, high-fluoride concentrations are applied professionally and low-concentration by the patient.

Professionally applied fluoride treatments are inherently expensive because they depend upon one professionally-trained person treating one patient at a time frequently with expensive equipment (Fejerskov *et al,* 1996).

Non-compliance with frequent use of low concentration fluoride agents may prompt the dental professional to recommend supervised self-application or professional application of concentrated gels. However, self-application of lower concentration fluoride agents at more frequent intervals will provide the greatest caries-prevention benefit.

High or low concentration?

Laboratory research suggests that fluoride is most effective in caries prevention when a low level of fluoride is constantly maintained in the oral cavity.

In incipient caries, low concentrations of fluoride are able to penetrate deeper into the body of the lesion and cause remineralisation. High concentration fluorides do not increase the fluoride concentration of enamel greatly, rather, they provide local protection at or near the tooth surface by incorporation in plaque and the oral mucosa (Fejerskov *et al,* 1996). During a cariogenic challenge, fluoride from these sources is mobilised to assist remineralisation and penetrates into the deeper parts of the lesion.

Essentially, the concentration of the fluoride agent to be used will depend on the patient's individual needs and his or her ability to comply with the recommendations. The greatest caries-prevention effects will be achieved with more frequent application of a lower concentration fluoride product, and hence this is the preferred mode of delivery when possible.

For high caries risk individuals where there are cavitated and non-cavitated lesions, the use of higher concentrations of fluoride may be necessary to tip the balance towards remineralisation. This may be particularly important where there are complicating factors such as intake of strongly acidic foods and beverages or an acidic oral environment.

Frequency of application

As causes of dental caries and response to treatment vary between patients a regimen of fluoride applications should be tailored to the needs of an individual patient rather than using the same routine for all patients. The individual patient's needs are usually established during the first visit but they have to be closely monitored and reassessed during subsequent maintenance visits to allow for the implementation of the appropriate treatment.

Special effort should be made by the dental professional to schedule fluoride therapy applications to newly erupted teeth within 12 months of eruption, preferably during the enamel maturation period (Harris and Christen, 1995).

Choosing a fluoride product: formulas and forms

Neutral, acidulated or stannous fluoride

The practitioner is frequently concerned about which procedure or agent should be employed in a given situation to provide a maximal degree of dental caries protection for the patient. Numerous clinical investigations have estimated the magnitude of the cariostatic benefits that may be expected from the various fluoride systems. It is apparent that all three types of fluoride therapy formulations result in appreciable cariostatic benefits of comparable magnitude with percentage reductions ranging from 27% to 36%. Thus the choice of the fluoride system is at the discretion of the dental professional (Fejerskov *et al,* 1996). Below are descriptions of each of the three agents.

Neutral sodium fluoride

Neutral sodium fluoride (NaF) was the first agent studied for effectiveness in preventing dental caries. Many studies throughout the world have confirmed the effectiveness of NaF in preventing caries (Fejerskov *et al,* 1996). There is a range of products available from weak NaF mouthrinses (200ppm) to 12,300ppm gels. Taste of the products vary from bland to flavoured.

Acidulated phosphate-fluoride

- Acidulated phosphate-fluoride (APF) was introduced based on the premise that greater fluoride uptake by enamel occurs under acidic conditions. Although initial studies of solutions of APF indicated that it might be superior to neutral NaF and stannous fluoride (SnF2), the body of literature on the agent indicates comparable effectiveness. APF mouthrinses are commercially available in various gels, mouthrinses and spot application pastes 100-200ppm for daily use and 900-1000ppm for weekly use. Available gels and foams contain 1.23% fluoride (12,300ppm).
- There is some evidence that the regular use of APF may damage tooth-coloured or ceramic restorations, therefore where such restorations are present use of APF should be avoided in preference to a neutral sodium fluoride.

Stannous fluoride

Stannous fluoride (SnF_2) is relatively unstable, and a freshly prepared solution is necessary for each patient, however, some stable anhydrous formulations are available. SnF_2 products can lead to staining (Harris and Christen, 1995) of demineralised lesions as the stannous ion precipitates causing a black deposit within the demineralised tooth structure. Staining of teeth is less frequent with the lower concentration products. SnF2 products are available in gels, mouthrinses and spot application pastes.

Gels, foams, varnishes or mouthrinses

In practice the gels are often used due to their ease of application and reduced time when trays are used (Harris and Christen, 1995). However, the data does suggest that fluoride applied in gel form may be slightly less effective than solutions (Harris and Christen, 1995). Fluoride mouthrinsing is contraindicated in children under the age of 6 years due to the uncontrolled swallowing reflexes (WHO, 1994) that may lead to excessive fluoride intake and the high risk of dental fluorosis). The latest form of fluoride available is a foam. The Whitford et al study (1995) compared two APF products, a gel and a foam, with respect to the amounts of product and fluoride (F) applied, salivary F concentrations, and enamel F uptake. The authors concluded that: 1) the two products (gel and foam) were equivalent with respect to enamel F uptake; 2) only about one-fifth as much of the foam product is required for adequate coverage of the teeth, which significantly reduces F exposure and retention by the patient. The reduced quantity of fluoride used per tray and lower amount of fluoride available to be swallowed when foam product is used suggest that foam may become a product of choice for children.

Although there is evidence that fluoride varnishes result in a higher concentration of fluoride in the enamel compared with other fluoride therapies, this increase does not necessarily lead to greater effectiveness (Fejerskov, 1996). Fluoride varnishes are retained on the tooth surface for a prolonged time increasing the duration of the effect of fluoride. They need to be used very carefully in young patients due to high concentration, however for children a spot application of a varnish is preferred to a full mouth fluoride treatment. The recommended maximum dose for Duraphat (5% NaF = 22 600ppm) is 0.25 mL for primary dentition, 0.4 mL for mixed dentition and 0.75 mL for permanent dentition. The products available on the market range from 7000 to 22 600ppm.

General principles to keep in mind when prescribing fluoride therapy

The choice of material and concentration depends largely on a management plan that is most appropriate to the patient's needs, wishes, ability and lifestyle.

Use low concentration fluoride where possible

The critical requirement for maximum protection against dental decay is the maintenance of a low concentration of fluoride at the dental tooth-plaque interface. Potential non-compliance with frequent use of low concentration fluoride agents may prompt the dental professional to recommend supervised self-application or professional application of concentrated gels.

Oral clearance rate

The higher the salivary flow rate, the quicker the oral fluoride is cleared, and vice versa. For this reason it is recommended that fluoride therapy are applied just before bedtime to provide maximum dose effectiveness, since saliva secretions slow down to a minimal rate during sleep.

Diet

The more acidic the oral environment, the less the salivary protection is able to counterbalance the demineralisation effect of the acid: therefore higher concentrations of fluoride are necessary at the tooth surface to assist in inhibiting the demineralisation process.

Exposure to fluoride from other sources

It is important to take a detailed past and present fluoride history. When preparing a management plan care needs to be taken to ensure an adequate exposure to fluoride from toothpaste and water where available. Additional fluoride therapy supplements and everyday exposure to fluoride for the majority of patients is required only for a short period of time.

Compliance

When recommending self-applied fluoride therapy it is important to ensure that the patient is able to follow the instructions. Patients with a history of irregular brushing may be less likely to follow the recommendations on use of a home fluoride therapy. Children when using any fluoride containing product at home should always have direct adult supervision.

For children

When prescribing additional fluoride therapy for children under the age of six, caution should be exercised in order to reduce the risk of dental fluorosis. Studies have indicated that prior to this age their swallowing reflex cannot be sufficiently controlled therefore fluoride mouthrinses should not be given and toothpaste should be used sparingly. Concentrated gels should also be used with great caution to avoid acute toxicity. The amount of gel should always be minimised and should at no times exceed a total of 2mL per tray (Fejerskov et al, 1996).

Damage to composite resin and porcelain work

There is some evidence that the regular use of acidulated phosphate-fluoride, may damage composite resin work and should be avoided in preference of a neutral sodium fluoride.

Fluoride therapy should be reduced as soon as evidence of control of caries is observed

Additional fluoride therapy is usually required in the initial stage of the patient's management and is carried out until the clinician is confident that the patient has regained a control over the decay process and that there is a balance between factors promoting decay and preventing the decay process (see Practice Information no.1).

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