Fluoride prospects for the new millennium—community and individual patient aspects

Kenneth W. Stephen
Dental Public Health Unit, University of Glasgow Dental School, Scotland

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Over the past 2 decades, it has been suggested that with the generalized availability of fluoridated dentifrices, and coupled with a possible increased likelihood of fluorosis, the benefits of community-based fluoridation have receded. However, while this may be so for dentally motivated populations, there are convincing data to suggest that the least fortunate amongst us could still benefit from communally delivered fluoride. Furthermore, the deleterious effects of such program withdrawals have been demonstrated and, with respect to fluorosis fears, client assessment of their own fluorosis status has indicated few concerns. Alternative, centrally delivered means of fluoride dispensing, e.g. via schools, etc., although effective in the short-term, are impractical over longer time-spans. Nonetheless, at the individual level, fluoride supplements and dentifrices, in particular, are successful caries inhibitors. This is especially so if these vehicles are employed in their most effective, proven manners. Finally, fears relating to disfiguring fluorosis should be allayed, but where fluoride abuses result in mild mottling, a simple remineralizing technique obviates the need for traumatic restorative procedures. □ *Children; community-based; dental caries; fluoride; topical*

Kenneth W. Stephen, Dental Public Health Unit, University of Glasgow Dental School, 378 Sauchiehall Street, Glasgow G2 3JZ, Scotland

During the 1990s, throughout Western Europe it has been demonstrated that, generally, caries rates are falling (1), albeit such reductions as have been obtained are rarely found uniformly across all sections of child populations (2–4). Hence, in Scotland, 50% of decayed surfaces were found in 9% of the 5-year-old population in 1997 (5), in 7% of 12-year-olds in 1996 (6), and in only 6% of 5981 14-year-olds examined in 1998 (7). Furthermore, in all three of these Scots' age-groupings, dental caries levels were shown to be inversely related to socio-economic status.

Artificial water fluoridation

As a community-based procedure, artificial water fluoridation at the 1 ppm F level has been demonstrated consistently as effective in reducing dental caries prevalence world-wide (8), and particularly so in the socially disadvantaged (9). However, within the UK, little progress has been made regarding the implementation of this most worthwhile public health measure since the passing of the Water (Fluoridation) Act 1985 (10), following the judgement subsequent to a 2-year hearing in the Court of Session, Edinburgh (11). In addition, it has been stated that, in view of the multitude of fluoride sources available to today's society, there is a need to monitor the prevalence and severity of dental fluorosis in both fluoridated and non-fluoridated communities (12). Furthermore, it has also been suggested that, because of the generally improving caries pattern, consideration might be given to questioning the need for revision of a water fluoridation-based policy (13).

The expression of such views did, however, appear to ignore the fact that, as long ago as 1984, in the North-East Scottish town of Wick, it was demonstrated in a blind radiographic study that, after only 5 years of water defluoridation, there had been 38.7% ($P < 0.01$) deft, and 65.9% ($P < 0.01$) defs increases in 5-year-olds. There was also a corresponding 10.1% drop in caries-free teeth in this township, where the sole pharmacy then stocked only 1000 ppm fluoridated dentifrice (14).

Salt fluoridation

Whilst salt fluoridation (usually at 250 mg/kg NaCl) has long been advocated as an individually purchasable, community-based alternative to water fluoridation, Burt & Eklund (15) indicated that there was a need for fluorosis-related data where this vehicle had been employed. However, when subjects from the 350 ppmF salt-based study in the Szeged area of south-east Hungary (which had produced 53% dmft and 68% DMFT reductions in 6- and 13-year-olds, respectively) were examined under blind clinical, radiographic and photographic conditions 12 years after salt fluoridation cessation (16), no clinical fluorosis differences were found between the previously salt fluoridated cohort and an age-matched 'control' group from nearby Szeged city (17). In addition, when these teenagers were asked the standard Scottish Health Boards' Dental Epidemiological Programme question, introduced

in 1990, as to whether they were ". . . aware of any marks on your upper front teeth which will not brush off", not one previously salt-fluoridated nor non-fluoridated child replied in the affirmative. Thus, these pupils' own appraisal of the clinically and photographically recorded diffuse, symmetrical mottling was entirely negative. For the latter photographic assessment, 35 mm color slides from both test and control subjects were projected in random order before a "jury" of 2 lay and 4 dental observers, alongside a continuously projected comparator slide. This TFI = 2 scoring transparency (19) was from a series shown to 534 Manchester 14-year-olds (20), its appearance having been chosen by the greatest number (85%) as being the most dentally esthetically pleasing from a series of TFI = 0, 1, 2, 3, or 4 photographs of teeth 13–23. However, the blind clinical and radiographic examination of the above subjects revealed no residual caries-inhibiting benefits at all from the 350 ppm salt fluoridation program which had ceased 11.5 years earlier, again emphasizing the need for life-long topical contact of the fluoride ion.

Fluoridated milk

Another possible community-based vehicle for caries prevention which offers consumer choice is fluoridated milk, this having been shown in a double-blind clinical and radiographic study to produce caries reductions similar to that of fluoridated water (21). However, that particular project was school-based, and current EU legislation only permits a school-milk subsidy of approximately 30% for primary school pupils, albeit nursery school attendees in the UK can obtain free milk. Thus, even where costs are supplemented locally or nationally to enable widespread distribution of this beverage, its EU subsidy would cease at the end of primary schooling, i.e. at around 11 years of age. Hence any caries-related benefits which might have accrued by that time, should such milk have been fluoridated, would undoubtedly be lost thereafter. Furthermore, where nursery-/school-based milk delivery proves non-viable, it would seem unlikely that the individual motivation exists for families to purchase such fluoridated milk in dairies or supermarkets, thus rendering this vehicle impractical as a true community-based, caries-inhibiting alternative to water fluoridation, albeit the method is undoubtedly effective in reducing caries.

Fluoride supplements

With respect to individual fluoride prophylaxis; for many years fluoride supplements have been available but, since the early 1970s, their dosage recommendations have been lowered many times in many countries, as worries relating to their possible role in fluorosis-induction have increased. This has been especially so given the almost universal parallel usage of fluoride-containing dentifrices (22). However, evidence-based data do not exist that any fluoride supplement level of only 0.5 mg F per day from 2 years of age and upwards has ever inhibited caries in the deciduous dentition (23, 24). Indeed, even in the presence of fluoridated dentifrice usage, a dosage of 0.25–0.5 mg F from 2–3 years of age showed no caries benefit for 3–5-year-olds as long ago as 1978 (25).

In contrast, a dosage regimen recommended in Glasgow from 1972 (26) has been proven, clinically and radiographically, to reduce deciduous caries by 79% over a 4-year period (27), with no subsequent evidence of fluorosis in the later-erupting permanent teeth of these subjects (28). Here, parents were also advised that their child's teeth should be brushed, either with a fluoride-free dentifrice, or using only a small "pea-sized" fluoridated amount (of 1000 ppm F), once per day until 6 years of age, and that the supplement should be retained intra-orally until dissolved (29).

Fluoride rinses

The use of fluoride rinses has been well documented (30), albeit at the community-based level they are now employed less frequently than 2 decades ago. Nonetheless, as with other fluoride preparations, their caries-inhibiting value ceases once the practice ends and, as shown by Holland et al. (1985), the benefits endowed on 12-year-olds who had rinsed from age 6 were eliminated by age 16 years, i.e. after 4 years of non-rinsing participation, again emphasizing the need for continuous topical fluoride ion availability (31).

Fluoride-containing dentifrices

Fluoride-containing dentifrices might possibly be considered as both a community and individually-based caries inhibitor, given the ubiquitous nature of such products. Indeed, in 1994, WHO stated "There is now increasing evidence that the decline in the prevalence of dental caries recorded in most industrialised countries in the past 20 years can be attributed mainly to the widespread use of toothpastes that contain fluoride" (32). However, the fluoride concentration, formulation, and mode of usage, can produce varying levels of caries-inhibiting benefits. Hence, in a large-scale double-blind 3-year clinical study in Scotland (33) it was shown clearly that a 2500 ppm SMFP-containing dentifrice was superior to a 1500 ppm F formulation which, in turn, was superior to a 1000 ppm F preparation. Moreover, there were significant benefits when children were grouped as to whether they did or did not rinse their mouths post-brushing with a glass of water (34). Additional benefit was also endowed as per the frequency of tooth brushing incidents per day. These data have since been verified in further double-blind dentifrice studies in Scotland (35), North Wales (36), and in England (37). Furthermore, as a result of the original Chesters et al. (34) data, a prospective "Brush, Swish & Rinse" study was

undertaken in Swedish 4-year-olds (38). Here, test and control subjects both brushed with 1000 ppm F dentifrice, but the test subjects were asked to "swish" the post-brushing F dentifrice slurry around their mouths for 1 min prior to spitting out, as compared to the control cohort which was asked merely to brush in their normal manner. As a result, an additional 26% reduction in deciduous interproximal caries was recorded in the test group at the end of the 3-year study. Thus, to enhance caries inhibition at the community or individual level, fluoride dentifrice instructions should recommend that subjects brush twice daily with a 1000 ppm F (at least) sodium fluoride preparation, this having been shown as superior to those containing SMFP (39). Furthermore, post-brushing, subjects should preferably only spit-out with no water-rinsing whatsoever, but certainly without the use of a full glass of water. It should, of course, be remembered, that there is no conclusive evidence via an adequately designed clinical trial [i.e. that which has the 80% power to deliver a 10% difference between test and control products, at the 5% level of significance (39)] that use of a dentifrice containing <900 ppm F has produced caries inhibition levels the equal of those with 900–1000 ppm F (40).

Fluorosis

With respect to fears regarding possible fluorosis induction, as stated by Hawley et al. (20) in the fluorosis perception study cited above, ". . . it is essential that a balanced view of the benefits and risks of the use of fluoride is maintained and proven benefits are not overwhelmed by largely unfounded aesthetic concerns". To this end, since 1990, the Scottish Health Boards' Dental Epidemiological Programme, in its biennial examinations of 12-year- or 14-year-old cohorts (approximately 6000 per sample) has included the fluorosis patient-perception question ". . . Are you aware of any marks on your upper front teeth which will not brush off?" (18). As a result, data now exist for 14,852 14-year-olds and 11,247 12-year-olds who have both been examined clinically and had this question posed (6, 7, 18, 41, 42). These revealed that, for the 14-year-olds, 10% were judged clinically to have diffuse and symmetrical opacities not inconsistent with a diagnosis of fluorosis, with the 12-year-olds being similarly scored. However, for those subjects who noticed such markings, involvement dropped to only 2.9% for both 14-year-olds and 12-year-olds. Additionally, when the most recent cohorts (6, 7) were assessed against the Hawley et al. (1996) "Impact Factor" color photograph (20), the examining clinicians rated only 1.5% of 14-year-olds to be more severely involved than that comparator image, and 1.8% of 12-year-olds were so classified. Of those latter 14- and 12-year-olds, only 0.75% and 1.0%, respectively, were aware of such symmetrical tooth markings. Hence, at a public health level, fluorosis would not appear to be a problem to this 26,099 sample of young Scots.

Should fluorosis occur, however, the days are long since past when any member of the dental profession should consider the esthetic correction of such teeth via mutilating crown, or veneer preparations, as the tried and tested, wholly atraumatic pumice abrasion and remineralization technique of Powell & Craig (43), produces esthetically acceptable results after only a few chair-side visits, even for fluorosis scores of TFI = 5/6. Indeed, this method was approved by the UK General Dental Council for implementation via dental hygienists as long ago as October 1986 (44), albeit the final Powell & Craig (42) recommendation for application of a calcium sucrose phosphate preparation, has been superseded by the application of a 2.3% F varnish at the end of each visit, as the original calcium sucrose phosphate gel is no longer manufactured.

Lastly, regarding the question of the combined use of fluoride supplements and fluoride dentifrice, only an efficacious 1000 ppm F dentifrice should be used following tooth eruption. However, in youngsters, this must be supervised, and the volume applied not ". . . greater than the size of a small pea" (45). Furthermore, as it was stated in a 1981 British Society for Dental Research Workshop (46) ". . . when prescribing fluoride dosages, it was probably illogical to suggest a single regimen for every child in the UK", the Scottish consultants in dental public health recently issued a simple A4-sized laminated guideline (47). This has been distributed to all dental practitioners in Scotland to assist them in recommending the most therapeutically appropriate fluoride supplement/dentifrice caries-inhibiting regimen for each of their young patients. By so doing, it is to be hoped that the relatively high caries levels which still pertain in the Scots' socio-economically deprived will be reduced, even in the absence of community-based fluoride delivery.

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