

## Topical vs. Systemic

**1. Centers for Disease Control; *MMWR Weekly Report*. Vol 50, No. RR-14, August 17, 2001, p. 4.**

“The prevalence of dental caries in a population is not inversely related to the concentration of fluoride in enamel (37), and a higher concentration of enamel fluoride is not necessarily more efficacious in preventing dental caries (38).”

**2. Featherstone JDB, M.Sc., Ph.D. , Cover Story; *J American Dental Association*, Vol. 131, July 2000, p. 890.**

“Importantly, this means that fluoride incorporated during tooth mineral development at normal levels of 20 to 100 ppm (even in areas that have fluoridated drinking water or with the use of fluoride supplements) does not measurably alter the acid solubility of the mineral. Even when the outer enamel has higher fluoride levels, such as 1,000 ppm, it does not measurably withstand acid-induced dissolution any better than enamel with lower levels of fluoride. Only when fluoride is concentrated into a new crystal surface during remineralization is it sufficient to beneficially alter enamel solubility. The fluoride incorporated developmentally – that is, systemically into the normal tooth mineral – is insufficient to have a measurable effect on acid solubility.”

**3. Centers for Disease Control; *MMWR Weekly Report*. 1999;48:933-940.**

“Fluoride’s caries-preventive properties initially were attributed to changes in enamel during tooth development because of the association between fluoride and cosmetic changes in enamel and a belief that fluoride incorporated into enamel during tooth development would result in a more acid-resistant mineral. However, laboratory and epidemiologic research suggests that fluoride prevents dental caries predominately after eruption of the tooth into the mouth, and its actions primarily are topical for both adults and children.”

**4. Limeback H. “A re-examination of the pre-eruptive and post-eruptive mechanism of the anti-caries effects of fluoride: is there any anti-caries benefit from swallowing fluoride?” *Community Dentistry and Oral Epidemiology* 27: 62-71, 1999.**

“It was always assumed that fluoridated drinking water had systemic benefits with respect to dental caries. Unfortunately, not a single, well-controlled water fluoridation study has ever been conducted to determine just how much of the anti-caries effect was from ingested fluoride (the pre-eruptive, systemic theory) and how much of the anti-caries effect was from fluoride interacting with the tooth surfaces after tooth eruption (the topical theory).”

“Avoiding the topical effects of fluoride can only be achieved in clinical drug trials involving the ingestion of enteric-coated fluoride tablets as supplements.”

“Other than Bibby’s attempt in the 1950s, no study on fluoride supplements has ever been conducted to separate out the topical effect of fluoride supplements from the systemic benefits.”

“Given the widespread use of other fluoride therapies such as topical fluorides (from professional treatments and daily use of over-the-counter fluoridated oral care consumer products) and the low rate of caries even in non-fluoridated communities of industrialized

countries, it is doubtful that the anti-caries effect of fluoride supplement ingestion, if there is one, could even be detected.”

“It is no longer acceptable to use fluoride supplements on large populations, even if the caries rate is higher than average.”

**5. Shellis RP, et al. “Studies on the cariostatic mechanisms of fluoride”. *International Dental Journal* 44; 263-273,1994.**

“Following the work of Dean and colleagues, which established fluoride as a potent agent for caries prevention, the predominant view for some time was that fluoride reduced the solubility of dental mineral and that, for caries prevention, it was essential to make fluoride available during tooth formation, for incorporation into the mineral. Preventive measures based on this view included fluoridation of public water supplies to the 1 mg/L level or, alternatively, supplying fluoride in tablet form to children. This approach has, however, ceased to be prevalent.”

**6. Ten Cate JM, et al. Mechanistic Aspects of the Interactions Between Fluoride and Dental Enamel. *Critical Reviews in Oral Biology and Medicine*. 2(2):283-296, 1991.**

“ Supplying fluoride in large amounts after the teeth erupt in the oral cavity (i.e., aimed at depositing fluorapatite in the outer layers of the enamel) has not proven to give sufficient long-term protection against a cariogenic attack. Preventive therapies should, on the contrary, be based on the modern understand of the mechanism of action. Fluoride rinses, lacquers, and the use of fluoride toothpastes cause an elevation of the fluoride levels in the oral fluids, at which level the dynamic pattern of demineralization and remineralization have been shown to be affected. Semiannual topical treatments seem particularly useful in those individuals who have shown a high caries activity.”

**7. Thylstrup A. “Clinical Evidence of the Role of Pre-eruptive Fluoride in Caries Prevention”, *J Dent Research*. Vol 69 Special Issue, February 1990, pp 746 and 747.**

“Both clinical and laboratory data combine to support the view that the relative importance of pre-eruptive fluoride to human caries progression is of borderline significance compared with the more important post-eruptive effect.”

“Hence, fluoride at concentrations normally present in the plaque due to water fluoridation or topical fluorides does not completely prevent caries initiation but reduces the rate of lesion progression about 50%, in agreement with laboratory research data. For complete arrest – i.e., a 100% reduction of lesion progression – it has been shown that the removal or mechanical suppression of acid-producing bacterial accumulations is required.”

“However, because fluoride in itself, in concentrations normally present, is unable to arrest active lesion progression, the treatment strategy for individuals requires identification of cariogenic plaque, removal of such plaque, and patient education on appropriate cariogenic plaque control measures.”

“Daily use of fluoride-containing dentifrice from the beginning of tooth eruption is probably the most efficient measure to control caries in individuals, since this procedure combines control of cariogenic plaque with daily delivery of post-eruptive fluoride.”

Fluoride supplements: “Workers who have attempted to use such data to discriminate between the pre- and post-eruptive fluoride effect seem to agree, however, that the issue is difficult to resolve, since none of the studies was specifically designed to answer this question.”

**8. Ogaard B. “Effects of Fluoride on Caries Development and Progression *in vivo*.” *J Dent Research* Vol 69 (Special Issue) 813-819, February 1990.**

“It is generally postulated that a fluoridated apatite is the most desirable product of topical treatment and that the effectiveness of a topical agent is proportional to its ability to deposit fluoride as fluorapatite in the enamel. ... Nearly all presently available fluoride agents are based on this concept. However, only a very moderate increase in the firmly bound fluoride is obtained with these agents. ... Such small amounts of apatitically bound fluoride as are deposited in the enamel after topical treatment are unlikely to account for the large cariostatic effect. Recently, it was found that even shark enamel, containing nearly exclusively fluorapatite, had a limited resistance against caries attacks in an intra-oral human caries model.”

**9. Margolis HC, et al. “Physicochemical Perspectives on the Cariostatic Mechanisms of Systemic and Topical Fluorides”. *J Dent Research* Vol 69 (Special Issue) 606-612, February 1990.**

“For example, Aasenden et al. (1971) found that the mean fluoride concentrations in central incisors, at the approximate depth of 0.5 um, from a fluoridated (1 ppm) and a non-fluoridated (< 0.1 ppm) community were 3000 ppm and 2100 ppm, respectively. When these results are placed into the context of the present model, a concentration of 3000 ppm corresponds to a degree of fluoride substitution of 8%, whereas 2100 ppm corresponds to a substitution level of 5.6%. According to the results shown in Fig. 2, this difference in the degree of incorporation of fluoride into enamel mineral would not result in a significant difference in enamel solubility. In fact, such levels of fluoride incorporation should provide little caries protection by reducing enamel solubility.”

“A fair assessment of clinical findings suggests, however, that the observed caries reduction due to water fluoridation cannot be attributed solely to the incorporation of fluoride. In fact, as noted above, it has been suggested (Fejerskov et al., 1981; Hardwick et al., 1982) that the cariostatic effect provided through water fluoridation results predominantly from a topical effect.”

**10. Featherstone JDB, et al. “Dependence of *in vitro* Demineralization of Apatite and Remineralization of Dental Enamel on Fluoride Concentration.” *J Dent Research* Vol 69 (Special Issue) 620-625, February 1990.**

“In the present study, the pH-cycling de/remineralization model that we used was designed to simulate results found *in vivo* at highly susceptible sites around orthodontic brackets.”

“Carbonated-apatite was chosen as a model material for investigation of the dissolution rate, since it more closely approximates the composition of dental enamel than does pure hydroxyapatite.”

“The observed reductions in dissolution rates were therefore a result of either fluoride in solution, fluoride adsorbed to the carbonated-apatite surface, or of fluoride effectively promoting the formation of a very thin coating of a low solubility phase such as fluorapatite. They could not have resulted from fluoride incorporated in the original apatite or from mass action effects

due to rapid increases in calcium or phosphate concentrations in the buffer solution as dissolution proceeded.”

“Wong et al, (1987) using palletized hydroxyapatite, fluorapatite, or hydroxyapatite with surface-adsorbed fluoride showed that incorporated fluoride only had an effect when it was present at concentrations equivalent to those in pure fluorapatite (38,000 ppm).”

“What is important is that an increase in fluoride in the treatment solution does not mean a directly proportionally larger effect. Fig. 4 illustrates the calculated percent protection afforded by fluoride in the treatment solutions, based on Eq. (2). According to these calculations, a fluoride concentration of 62 mg/L (3.3 mmol/L) would provide 80% protection and 178 mg/L (9.4 mmol/L) would give 90% protection. Although these values are based on an in vitro model and cannot be directly translated to the oral environment, the results indicate that near-optimum fluoride effects can readily be achieved with quite low concentrations in a daily fluoride rinse regimen.”

**11. Carlos, James P. (Director, National Caries Program, National Institute of Dental Research)**  
**“Comments on Fluoride”. *The Journal of Pedodontics*, Winter 1983.**

“In 1970, during a meeting in Switzerland on fluoride research, I was astounded to hear the statement from a European cariologist of great reputation that the mechanism of action of fluoride against dental caries was entirely topical! At that time I believed, along with the majority of American caries researchers, that fluoride worked because it became incorporated into enamel – especially developing enamel – to increase its resistance to acid demineralization. We thought that where this could not be accomplished preeruptively by water fluoridation, we ought to try to achieve the same goal posteruptively by short-term regimens of very high-concentration fluoride solutions and gels. I thought that my European colleague was very poorly informed.

Now, twelve years later, I continue to be impressed by the wisdom of his assertion. Probably it was not completely correct; absolute statements about biological processes rarely are. However, each year since then the evidence has continued to accumulate to support the hypothesis that the anti-caries mechanism of fluoride is *mainly* a topical one.”

**12. Fejerskov O. et al. “Rational use of fluorides in caries prevention”. *Acta Odontol. Scand.* 1981, 39:241-249.**

“Until recently most caries preventive programs using fluoride have aimed at incorporating fluoride into the dental enamel. The relative role of enamel fluoride in caries prevention is now being increasingly questioned, and based on rat experiments and reevaluation of human clinical data, it appears to be of minor importance.”

“That topical fluoride programs together with daily use of fluoride toothpaste is not to be considered as a second class type of caries treatment as compared to water fluoridation is clearly demonstrated by the results obtained in the Danish Child Dental Health Program.”

“As a direct consequence any method which places particular emphasis on incorporation of bound fluoride into dental enamel during formation may be of limited value. Therefore, there is limited scientific data to support the assertion that systemic fluoride treatment should be initiated from shortly after birth.”