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# Fluoride Varnish for Caries Prevention: Efficacy and Implementation

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## Key Words

Dental caries · Evidence-based dentistry · Evidence-based practice · Fluoride varnish · Knowledge translation · Oral health

## Abstract

Many reviews support fluoride varnish (FV) as a caries-inhibitory agent. Evidence from 6 Cochrane systematic reviews involving 200 trials and more than 80,000 participants further confirms the effectiveness of FV, applied professionally 2–4 times a year, for preventing dental caries in both primary and permanent teeth. The relative benefit of FV application seems to occur irrespective of baseline caries risk, baseline caries severity, background exposure to fluorides, use of fluoride toothpaste and application features such as prior prophylaxis, concentration of fluoride or frequency of application. While the efficacy of FV is acknowledged in clinical practice guidelines globally, the implementation of this recommendation may still be an issue. Factors that may facilitate FV application in the USA include Medicaid eligibility, relationships with dentists/community centers and strong cooperation and communication between physicians and support staff. Barriers include insufficient time to integrate oral health services into well-child visits, difficulty in applying FV (lack of skills/training) and resistance among colleagues and staff. Research in the UK/Scotland also suggests

encouraging clinicians in their motivation to perform this treatment and addressing professional and parental concerns relating to possible negative consequences may be influential. Further research targeting cost-effectiveness and how FV in routine care may fit in with political agendas relating to, for example, inequalities in health care provision and access will also play a key part in stakeholder decisions to put resources into this issue.

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Fluoride has been the focus of caries-preventive strategies since the introduction of water fluoridation schemes midway through the last century [Marinho et al., 2013]. Fluoride varnishes (FV) were developed to prolong the contact time between fluoride and dental enamel and have been available in Europe, Canada and the USA for decades.

There are many reviews and meta-analyses which support FV as a caries-inhibitory agent in both primary and permanent teeth [Seppä, 1991; Helfenstein and Steiner, 1994; Bader et al., 2004; Petersson et al., 2004; Azarpazhooh and Main, 2008; Carvalho et al., 2010]. However, these reviews often fail to fully report the quantitative approaches used for data synthesis, and/or do not include a comprehensive search for individual trials and/or provide a formal evaluation of the risk of bias, so even their consistent results could be open to question.

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**Table 1.** The Cochrane Library and the COHG

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- The Cochrane Collaboration was founded in 1993 as an international, nonprofit and independent organization dedicated to bringing the same level of rigor to reviewing research evidence as should be used in the production of research evidence ([www.thecochranelibrary.com](http://www.thecochranelibrary.com)); the Cochrane Collaboration's output of systematic reviews (numbering over 7,600 to date), published online in the Cochrane Database of Systematic Reviews (CDSR), is now internationally recognized as the benchmark for up-to-date, accurate and reliable information about current best evidence on which to base decisions about developing, implementing and receiving health care [Cassels, 2013]
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- The COHG is responsible for identifying best evidence in dentistry; it currently comprises over 1,200 oral health care professionals, researchers and consumers from over 40 different countries; to date, the COHG has published 132 systematic reviews, 42 review updates and 66 protocols, with further reviews and protocols in preparation; to gauge the group's output quality, the COHG possesses an individual impact factor of 3.787 in 2014 for publication citations in its category, putting the group in the top 5 dentistry journals in the world
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The Cochrane Library [1996] and the Cochrane Oral Health Group (COHG) database (table 1) addressed these issues in their investigations of the effectiveness of FV as one of 4 topical fluoride modalities (FV, gels, rinses or toothpastes). Evidence from 6 systematic reviews involving 200 trials and more than 80,000 participants further supports the effectiveness of FV, applied professionally 2–4 times a year, for preventing dental caries in primary and permanent teeth (table 2). Additionally, the simultaneous use of FV with F toothpaste appears to significantly enhance the caries-inhibiting effect compared with the use of F toothpaste alone. The latest review [Marinho, 2013] also showed that the relative benefit of FV application seems to occur irrespective of baseline caries risk, baseline caries severity, background exposure to fluorides and application features such as prior prophylaxis, concentration of fluoride or frequency of application. It should be noted that this review assessed the quality of this evidence as moderate (including high risk of bias studies, with considerable heterogeneity). Nonetheless, the consistency and size of the reductions in caries increment in both primary and permanent dentitions throughout all the reviews (the majority showing 25–45% caries reduction), emphasizes the clinical efficacy of FV for preventing decay.

Indeed, the recommendation to use FV for caries prevention now appears globally in clinical practice guidelines [Centers for Disease Control and Prevention, 2001; National Institutes of Health, 2001; Welbury et al., 2004 (European Academy of Paediatric Dentistry); American Dental Association Council on Scientific Affairs, 2006; Scottish Dental Clinical Effectiveness Programme, 2010; Department of Health, 2014 (UK); Scottish Intercollegiate Guidelines Network, 2000, 2005, 2014]. Additionally, governments from around the world are promoting FV in preventive health care programs [Seppä, 1991; British Association for the Study of Community Dentistry, 2000; Central Evaluation and Research Survey, 2005 (Childsmile, Scotland); Moberg et al., 2005 (Sweden); Australian Northern Territory Oral Health Promotion Plan, 2011–2015; American Academy of Pediatrics, 2013; Oral Health America, 2013].

Nevertheless, despite evidentiary, professional and government support already in place, FV may still be underutilized in dental primary care. The evidence for this is, as yet, mostly anecdotal, but there is a growing literature exploring the lack of adoption in the USA and the UK. One study investigated the level of fluoride use and knowledge among 599 dentists in Texas [Bansai et al., 2012]. Despite the majority of respondents saying they used fluorides routinely, only 15.7% of general dentists, 30.8% of pediatric dentists and 20.5% of public health dentists chose to use FV over other topical fluorides. The authors suggest that this was due to an inadequate understanding of the predominant mode of action of fluoride. The concern was that the continued use of historically preferred alternative topical fluorides, particularly the acidulated phosphate fluoride foam/gels, was reflecting a lack of knowledge of, or deliberate failure to adhere to, current best practice guidelines. Unlike FV, the use of acidulated phosphate fluoride on infants and very young children, as well as developmentally disabled patients, is no longer considered practical or safe.

Medicaid programs in most US states now reimburse medical clinicians for providing oral health screening and applying FV in young children. However, very few studies have investigated the barriers and facilitators of clinician participation. One study found less than a third of their respondents – medical clinicians registered to provide FV in Connecticut – actually provided that service [O'Callaghan and Douglass, 2013]. The most common reason reported for their not providing FV was inadequate training. Another study in North Carolina investigated different training strategies relating to the applica-

**Table 2.** Summary of FV-related systematic reviews in the Cochrane Library up to February 2015

Study	Title
Marinho et al. [2003]	Topical fluoride (toothpastes, mouthrinses, gels or varnishes) for preventing dental caries in children and adolescents
Marinho et al. [2004a]	One topical fluoride (toothpastes, or mouthrinses, or gels, or varnishes) versus another for preventing dental caries in children and adolescents
Marinho et al. [2004b]	Combinations of topical fluoride (toothpastes, mouthrinses, gels, varnishes) versus single topical fluoride for preventing dental caries in children and adolescents
Hiiri et al. [2010]	Pit and fissure sealants versus fluoride varnishes for preventing dental decay
Benson et al. [2013]	Fluorides for the prevention of early tooth decay (demineralized white lesions) during fixed brace treatment
Marinho et al. [2013] <sup>1</sup>	Fluoride varnishes for preventing dental caries in children and adolescents

<sup>1</sup> The review by Marinho et al. [2002] was superseded by this updated revision.

tion of FV. They found the method and intensity of training had no significant effect on the rate of FV application [Slade et al., 2007]. Indeed, only 56% of all their participating medical practices, regardless of trial group, had provided FV throughout the trial.

It is reasonable to posit that adherence to FV recommendations, whatever the strength of its evidential support, will vary between countries and regions with different political and economic agendas, reimbursement systems and patient access to care. Certainly, the transfer of guidance recommendations into clinical practice is almost always a slow and haphazard process [Grol, 2001; Grimshaw et al., 2004]. Nevertheless, the sparse literature does identify some factors that may facilitate FV application by US medical care providers, should that be required by stakeholders: Medicaid eligibility, working relationships with dentists or community centers for referrals, and strong cooperation and communication between physicians and support staff. Barriers to address may be insufficient time to integrate oral health services into well-child visits, difficulty in applying FV (lack of skills/training), resistance among colleagues and staff, difficulty referring children to a dentist and low volume of eligible patients [Lewis et al., 2005; Slade et al., 2007; O'Callaghan and Douglass, 2013].

In the UK, FV is the remit of general dental practitioners and their practice team. Caries here is still a significant clinical problem for much of the population; it is associated with considerable adult and child morbidity and accounts for millions of pounds of the National Health Service (NHS) yearly costs. This has prompted a number of government-funded preventative oral health

initiatives and programs over the last decade, most of which include FV application. Like the USA, currently there is scant information about the effectiveness of these programs. Different remuneration contracts in England, Scotland, Wales and Northern Ireland mean that the variation in the available routine treatment data makes it difficult to access this information. The most accessible data relating to UK FV application are in Scotland [ISD Scotland, 2010].

Current population-based approaches designed specifically to improve children's dental health in Scotland are delivered within the Childsmile program [Central Evaluation and Research Survey, 2005]. Prior to October 2011, dentists in Scotland were paid a general capitation fee to cover preventive treatments that they should be providing to all their child patients, including oral hygiene advice and FV application. One strategy Childsmile explored was specifically remunerating a proportion of Scottish dentists for every FV application in addition to the general capitation fee. Taking this treatment out of general capitation meant that it was finally possible to identify how many FV applications were actually being performed by these dentists. Considering that these dentists were purposively selected due to their interest and participation in programs related to children's dental health, and that the only topical fluoride treatment being remunerated was FV, the result was somewhat surprising to stakeholders: less than half the eligible children seen were provided with this treatment, and only 8% of these children received it twice a year [Central Evaluation and Research Survey, 2012]. To better inform future policy decisions relating to preventative oral health care national

initiatives, now all dentists in Scotland can claim remuneration for FV applications.

Two recent national studies, conducted independently, examined current practice and beliefs relating to FV application per se [Gnich et al., 2015, for the Childsmile program] and to FV as part of the overall management of dental caries in children [Elouafkaoui et al., 2015, for the Translational Research in a Dental Setting (TRiaDS) program]. Both of these studies assessed beliefs using the theoretical domains framework [Michie et al., 2005]. The theoretical domains framework consolidates 33 psychological models to guide the identification of potential targets for behavior change interventions [Cane et al., 2012]. Together, these studies included approximately 50% of all dentists in Scotland. Furthermore, given the low self-reported rates of FV application by respondents, neither study sample was restricted to enthusiastic, FV guidance-adherent dentists. These studies, therefore, provide a cohesive platform to further an understanding of why FV is an apparently neglected treatment in Scottish primary dental care:

- The Childsmile survey (n = 1,090) found that the likelihood of a decision to apply FV was positively associated with an awareness that it is a guideline-recommended behavior, perceiving that it is part of their professional duty, believing that it would have more positive than negative consequences, feeling motivated to do it, having a supportive practice environment, believing that FV is something parents want for their children and already having a habit of applying FV.
- The TRiaDS survey (n = 131) looked at current practice and beliefs associated with preventive management in general, including in that definition a collection of 6 behaviors: give toothbrushing advice, demonstrate toothbrushing, give dietary advice, apply FV, place preventive fissure sealants and check existing fissure sealants at each recall visit. It found that only 10% of dentists in the study were applying FV, making it the least performed of all the preventive behaviors. The main belief specifically associated with FV application was motivation, that is, the more motivated dentists were to apply FV, the more likely they were to apply it.

Both studies provide information on where to focus future efforts to encourage FV application by dentists in Scotland, should stakeholders require it. For example, the result that more frequent FV application is associated with perceptions of it being a professional responsibility suggests that one way forward is to encourage this belief in undergraduate and postgraduate dental education. The association of FV application and perception of pa-

rental desire suggests that an intervention aimed at raising parental awareness and expectations that FV should be a part of routine care for their child may be effective. Developing more of an understanding of what underlies the motivation of dentists to apply FV, when remuneration, professional and government support is already in place for a readily available, safe, painless, easy and quick treatment, is an avenue requiring more in-depth exploration. Also, despite the majority of guideline recommendations, including assurances that FV is a safe treatment, more research specifically investigating adverse effects in different age groups may address professional and parental concerns relating to possible negative consequences. There is no evidence to suggest that dentists in Scotland are less professional, caring or evidence based in their beliefs and practice than their international colleagues. It is highly likely that similarly directed interventions could also encourage FV application in dental primary care elsewhere.

However, it is unlikely that just presenting more evidence of FV as an efficacious treatment will be enough to merit future commitment of scarce economic resources by stakeholders to encourage FV application when appropriate. Further research targeting the cost-effectiveness of blanket population programs, and how the implementation of this treatment in routine care may or may not fit in with political agendas relating to, for example, inequalities in health care provision and access, may at least ensure that the relevant policy decisions are well informed.

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### Author Contributions

D.B. and J.E.C. contributed to the development and conducting of the evidence review, result interpretation and co-authored drafts, and both authors approved the final version of the paper.

### Disclosure Statement

The authors have no potential conflicts of interest to declare.

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