A Comparison of the Costs and Patient Acceptability of Professionally Applied Topical Fluoride Foam and Varnish

Robert Hawkins, BSc, DDS; James Noble, BSc; David Locker, BDS, PhD; David Wiebe, BSc, BA, DDS, DDPH, DGrt; Heather Murray, RDH, BA; Peter Wiebe, BSc, BA, DDS, DDPH, DGrt; Carolyn Frosina, RDH, BSc; Martha Clarke, RDH, BA

Abstract

Objectives: *In Canada and the United States, professionally applied topical fluorides (PATF) are usually applied as a gel or foam. However, fluoride varnish has also been found to be effective for caries prevention and may be a preferred method because less time is required and fluoride exposure can be better controlled. The goal of this study was to compare the costs and patient acceptability of two methods of PATF (foam and varnish).* ***Methods:*** *The study population was a convenience sample of high-risk children from the York Region and the city of Hamilton, Ontario, Canada, who had been identified as requiring fluoride therapy (n=256). Children received from dental hygienists either fluoride foam applied in trays or fluoride varnish painted on tooth surfaces. An observer recorded the time to perform each procedure, adverse outcomes, and the satisfaction of children with treatment.* ***Results:*** *The varnish technique took significantly less time compared to foam (5.81 vs 7.86 minutes; P<.0001). Significant differences between procedure times were found in all age groups, but the largest difference was for children aged 3–6 years (5.22 vs 8.61 minutes; P<.0001). Signs of gagging were observed in a lower proportion of participants who received varnish (3.8% vs 15.1%; P<.01), and this difference was largest for children aged 3–6 years (2.6% vs 29.7%; P<.01). The cost per varnish application, for children aged 3–6 years, was substantially less after labor costs were considered ($3.43 vs $4.43, CDN).* ***Conclusions:*** *Varnish applications were found to take less time and resulted in fewer signs of discomfort. These results support the use of fluoride varnish in caries prevention programs, especially for younger children. [J Public Health Dent 2004;64(2):106-10]*

Key Words: preventive dentistry, fluoride foam, fluoride varnish, children, health care costs, patient satisfaction.

Professionally applied topical fluoride (PATF) is provided annually by Ontario public health units to selected school-aged children who have been identified as being at high risk for dental caries. Evidence-based guidelines have recommended the use of APF gel for children who require PATF (1-3); but two alternatives, varnish and foam, also have been advocated by experts and may be particularly useful for treating young children and patients with gag-reflex problems. The following issues are of importance when considering PATF techniques (gel, foam, or varnish): caries prevention, the amount of fluoride ingested, patient acceptability, and cost of treatment.

The effectiveness of fluoride gel and varnish for caries prevention has been documented in two meta-analysis reports (4,5). In a head-to-head comparison study of caries-preventive effectiveness in a group of high-risk 12- to 13-year-olds, the mean three-year interproximal DMFS increments of varnish and gel groups were 1.4 and 1.9, respectively (6). These findings suggested varnish was at least as effective as gel in preventing interproximal caries. In the primary dentition, varnish also has been shown to be effective in caries prevention and the reversal of early enamel lesions (7,8).

No known clinical studies have assessed the caries-prevention effectiveness of fluoride foam. The effectiveness of APF foam is likely similar to that of APF gel because enamel fluoride uptake has been found to be equivalent (9) and APF foam products have the same fluoride concentration as APF gels.

Fluoride varnish may be a better alternative for young children because the risk of fluoride overingestion may be reduced (10). An advantage of using fluoride varnish is that it sets rapidly after application and adheres to teeth, thereby reducing the risk of rapid ingestion (11). Measurements of fluoride in the blood after topical fluoride treatments with varnish show fluoride levels well below toxic (12). Similarly, the exposure to and retention of fluoride foam by patients has been reported to be significantly less compared to APF gel application (9).

Patient acceptability of PATF has been formally assessed in only one study, which was conducted with subjects aged 12 years and older (13). Varnish was generally found to be more acceptable than gel; however, the temporary tooth discoloration caused by varnish was reported as objectionable by some patients. Patient acceptability of foam has not been formally assessed.

The cost difference between caries prevention with APF gel versus fluo-

Send correspondence and reprint requests to Dr. Hawkins, Community Dentistry, Faculty of Dentistry, University of Toronto, 124 Edward Street, Toronto, Ontario, Canada M5G 1G6. E-mail: robert.hawkins@utoronto.ca. Drs. Noble and Locker and Ms. Clarke are with the Community Dental Health Services Research Unit, Faculty of Dentistry, University of Toronto. Dr. David Wiebe and Ms. Murray are with the York Region Health Services Department, Newmarket, Ontario. Dr. Peter Wiebe and Ms. Frosina are with the City of Hamilton Social and Public Health Services, Hamilton. Sources of support: Ontario Ministry of Health and Long Term Care grant #04170, and a Medical Research Council (MRC) summer student scholarship. Preliminary results of this study were presented at the IADR/AADR Conference, Mar 2002. Manuscript received: 11/22/02; returned to authors for revision: 1/16/03; final version accepted for publication: 4/2/03.

ride varnish may be substantial when application time is considered. It has been estimated that the clinical time for APF gel (including admission, treatment, discharge, and clean-up) is 20 minutes (2). Another estimate, only of treatment time, was given by Seppa et al. (6): six minutes for gel and two minutes for varnish applications. However, time estimates are not well supported and cost estimates must also take into account the higher cost of supplies, on a per application basis, for varnish.

Studies of PATFs have focused on caries prevention and other issues have for the most part been addressed only in editorials or review articles. A recent report in *Cochrane Review* on fluoride varnishes reported there is little information concerning acceptability of treatment or possible side effects (14). The purpose of this study was to compare the costs and patient acceptability of two methods of PATF (foam, varnish) in Ontario public health units. The objectives were to compare: the mean time taken to perform fluoride applications, the mean cost per application, the proportion of children who experienced adverse effects, and patient acceptability.

Methods

Study Design. A convenience sample was used of schoolchildren attending a public health dental clinic for preventive care. Children received from dental hygienists either fluoride foam applied with styrofoam trays or fluoride varnish painted on tooth surfaces. Subjects were assigned to groups based on the time of day they were scheduled to have fluoride treatment. Fluoride foam was applied for morning appointments and varnish was applied during afternoon appointments.

Study Population. The participants for this study were schoolchildren from the York region and the city of Hamilton, Ontario, Canada, who were identified as requiring PATF by a school-based dental screening program delivered by Ontario health units. These children were considered to be at high risk for dental caries because they had at least one smooth surface carious lesion. Children with asthma were only given foam because of the risk of adverse reactions with varnish application.

Sample Size. The estimated sample size for the comparison of treatment times between the fluoride application methods was 16 per group for each of the five dental hygienists in the York region. Therefore, the sample size was a minimum of 160 children. This estimate was calculated using standard formula with an alpha of 0.05, a beta of 0.15, and the minimum detectable difference was one minute. After data analysis of 164 cases, it was determined that a sample size of at least 250 cases was required to assess differences in categorical measures. The study was then expanded to include three dental hygienists from Hamilton.

Procedure. Topical fluoride applications were provided within public health settings during the school year and/or the summer. Following the dental screening, the parent of each child was informed of the study and consent was obtained for the delivery of PATF and inclusion in the study. At the time of the appointment, each parent was given a letter of invitation and a consent form.

Five registered dental hygienists (RDH) employed by York Region Health Services and three RDHs employed by the City of Hamilton Social and Public Health Services applied the selected PATFs. Treatment took place in a dental clinic with fixed dental chairs, lighting, suction, and compressed air. Duraphat™ fluoride varnish was applied directly to all tooth surfaces with a brush. Approximately 0.3–0.5 mL of vanish per child was used and quadrants were isolated with cotton rolls. Fluoride foam (Oral-B Minute-Foam™) was applied in stryofoam trays according to the manufacturer's instructions, with one exception—the application time for foam was four minutes, not the suggested time of one minute. The four-minute application of fluoride foam is recommended based on studies of enamel fluoride uptake (15, 16). When contact time is reduced to one minute, enamel fluoride uptake is significantly less.

An observer recorded the time taken to perform the application, adverse outcomes, and the satisfaction of children with the treatment. Procedure time was measured from when the child was seated and the dental hygienist was able to start the procedure until the child was able to leave the operatory chair. Caries-prevention effectiveness and the amount of fluoride ingested during the procedure were not measured. During the procedure, an observer recorded whether the following adverse outcomes occurred: vomiting, crying, gagging, excessive arm/leg movements, and other signs of distress.

After each procedure, the observer asked the following questions to assess the child's satisfaction: If you had to have fluoride again tomorrow, how would you feel? How did you feel during the fluoride treatment? Was the fluoride treatment pleasant or unpleasant? Did the fluoride make you feel like you wanted to gag? For each question, children selected from a list of multiple-choice options. This questionnaire was not validated and was based on the questionnaire used in the Warren et al. study (13). At the completion of the study, participating dental hygienists were given a self-administered questionnaire regarding their views of the PATFs used during the study.

Data Analysis. Data were entered and analyzed using the SPSS 10.1 and STATA statistical software packages. Statistical tests were used to compare the two methods of fluoride application (foam, varnish). STATA's robust estimator of variance and cluster options were used in linear and logistic regression analyses to account for the design effect of different hygienists providing the PATFs.

The variable "time" was entered in minutes and rounded to the nearest quarter-minute. Cost per application was the sum of the cost of labor to complete an application and the cost of supplies per application. The costs of supplies used in both techniques (e.g., saliva ejectors) were not included in the estimate. Labor and clinic costs, in Canadian dollars, were calculated from data supplied by York Region Health Services Department and the City of Hamilton Social and Public Health Services.

Results

A total of 256 children, aged 3–15 years, participated in this study. The mean age was 8.0 years (SD=2.6). Over one-half of participants were aged 7–10 years (51.0%), 30.0 percent were aged 6 years and younger, and 19.1 percent were aged 11 years and older. Topical fluoride treatment had been previously received by 38.3 percent of

subjects, and the vast majority of these children had received fluoride foam or gel (85.7%). Only three subjects reported they had previously received fluoride varnish.

Overall, the varnish treatment took significantly less time compared to foam (Table 1). The time difference was over 3 minutes for the youngest age group (3–6 years), but just over 1 minute for the oldest age group. Signs of gagging were observed in a significantly lower proportion of participants who received varnish ($P<.01$), and this difference was largest for children aged 3–6 years. Although relatively few children cried during the application of PATF, a significantly higher percentage of children who received foam showed other signs of distress or discomfort.

Table 2 presents the self-reports of children to multiple-choice questions about their satisfaction with treatment. A significantly higher percentage of participants in the foam group stated they would be unhappy if they had to have fluoride again the next day ($P<.01$). In addition, a significantly higher proportion of children in the foam group reported the foam application made them feel as if they wanted to gag ($P<.01$). Surprisingly, a higher percentage of children in the varnish group reported they were a little or very nervous during treatment. This was likely because virtually all children were receiving varnish treatment for the first time, but many had received foam at a prior dental visit. In the youngest age group only, a lower percentage of varnish subjects reported nervousness, and this would have been the first time that many of these children would be receiving any type of PATF.

The analysis was also stratified based on whether participants had previously received a PATF treatment. Time differences between the two application methods were consistent with the nonstratified analysis. Meaningful comparisons could not be made for categorical variables because of low sample sizes in the stratified groups. Only a small number of young children had previously received PATF, and few older children had not already received PATF.

Estimations of cost per application for each technique are shown in Table 3. The cost of supplies was higher for varnish applications; however, when labor costs were considered, the varnish technique was 42 cents less expensive than foam. For the 3–6 year-old group, the cost difference was considerably larger ($1.00 CDN) due to the difference in application time between the techniques. The cost difference was much lower or negligible for the older age groups ($0.23, $0.07).

Only one child vomited during the treatment and one child refused any fluoride treatment. No substantial problems were reported by parents; one child in the varnish group complained about the temporary tooth discoloration.

In the dental hygienist acceptability questionnaire, all hygienists rated varnish as good or better than foam in terms of procedure time, and their ability to control patient ingestion of fluoride. Results for the other questions tended to favor the use of varnish and no hygienist rated varnish as much worse than foam. Statistical tests were not possible on these data due to the small sample of hygienists.

Discussion

Ontario public health units currently provide PATF to children at high risk for dental caries. Last year, high-risk children in the York region and the city of Hamilton received 895 and 344 PATFs, respectively. Evidence-based recommendations and reviews have supported the use of PATF for caries prevention; however, the issues of cost and patient acceptability rarely have been addressed. Furthermore, although the use of fluoride varnish for caries prevention is common in Europe, it is seldom used in Canada and the United States. This report presents results from a study comparing the costs and patient acceptability of the use of fluoride foam and varnish in Ontario public health dental clinics.

Significant time differences between varnish and foam applications were found in this study for all age groups. The largest time differences were found in the youngest age group, likely because younger subjects have less tooth surface that needs to be painted with varnish (i.e., fewer and smaller teeth). In addition, foam treatment can take longer for young children because trays may need to be

TABLE 1
Comparison of Time Differences and Observation Reports Between Topical Fluoride Foam and Varnish Groups, by Age Group

Treatment Characteristic/Age Group	Foam	Varnish	*P*-value*
Mean time of procedure (SD)			
Overall	7.86 (1.63)	5.81 (1.62)	<.0001
3–6 years	8.61 (2.30)	5.22 (1.21)	<.0001
7–10 years	7.63 (1.19)	6.03 (1.78)	<.0001
11 years and older	7.36 (0.94)	6.14 (1.52)	.027
% of children who showed signs of gagging during procedure			
Overall	15.1	3.8	.002
3–6 years	29.7	2.6	.009
7–10 years	9.5	5.9	NS
11 years and older	7.7	0.0	NS
% of children who cried during procedure			
Overall	3.2	1.5	NS
3–6 years	2.7	2.6	NS
7–10 years	4.8	0.0	NS
11 years and older	0.0	4.3	NS
% of children who showed other signs of distress (e.g., excessive fidgeting)			
Overall	9.5	2.3	.014
3–6 years	13.5	2.6	NS
7–10 years	9.5	2.9	NS
11 years and older	3.8	0.0	NS

*Linear or logistic regression analysis, with robust variance estimation and cluster option, to assess differences between groups: NS=not significant.

TABLE 2
Percentage of Participants with Negative Comments to Satisfaction Questions Asked Regarding PATF Received (Questions were asked immediately after fluoride treatment)

Questions (Responses)/Age Group	Foam (%)	Varnish (%)	*P*-value*
If you had to have fluoride again tomorrow, how would you feel? (Responses: I would be a little unhappy/I would be very unhappy)			
Overall	19.8	7.1	.003
3–6 years	21.6	8.1	NS
7–10 years	20.6	7.4	.027
11 years or older	15.4	4.5	NS
How did you feel during the fluoride treatment? (Responses: a little nervous/very nervous)			
Overall	23.0	28.9	NS
3–6 years	24.2	18.4	NS
7–10 years	22.2	33.8	NS
11 years or older	23.1	31.8	NS
Was the fluoride treatment pleasant or unpleasant? (Responses: a little unpleasant/very unpleasant)			
Overall	13.6	10.6	NS
3–6 years	16.2	5.4	NS
7–10 years	11.3	15.4	NS
11 years or older	15.4	4.8	NS
Did the fluoride make you feel like you wanted to gag? (Responses: yes, a little/yes, a lot)			
Overall	31.7	16.0	.002
3–6 years	40.5	11.4	.009
7–10 years	31.7	17.6	.027
11 years or older	19.2	18.2	NS

*Linear or logistic regresssion analysis, with robust variance estimation and cluster option, to assess differences between groups: NS=not significant.

TABLE 3
Estimation of Cost per Application for Each Professionally Applied Topical Fluoride (PATF) Technique (All Prices in Canadian Dollars)

Type of PATF/ Cost Component	Cost	Cost/ Application ($)
Foam		
Labor, dental hygienist	$0.426 (average salary/minute)	3.35
Fluoride foam (Oral B)	$36.99 (est. 140 applications/bottle)	0.26
Styrofoam trays	$24.95/package (50 applications)	0.50
Total cost	Overall	4.11
	Patient aged 3–6 years	4.43
	Patient aged 7–10 years	4.01
	Patient aged 11 years and older	3.90
Varnish		
Labor, dental hygienist	$0.426 (average salary/minute)	2.48
Fluoride foam (Duraphat)	$26.95 (est. 25 applications/tube)	1.08
Brush tips	$7.95 (100/box)	0.08
Cotton rolls	$24.00 (2,000/box, est. 4 per appl.)	0.05
Total cost	Overall	3.69
	Patient aged 3–6 years	3.43
	Patient aged 7–10 years	3.78
	Patient aged 11 years and older	3.83

individually trimmed and fitted. Dental hygienists often had difficulties getting trays into small mouths and, in some instances, upper and lower trays were applied separately for 4 minutes each. For young children, the average time difference of 3½ minutes between application techniques can be considered clinically significant because of the behavior problems that some children of this age may exhibit. For older children, time differences were less because varnish would have to be applied to more tooth surface and dental floss may be needed to apply varnish between tight interproximal contacts.

Although both types of fluoride application were generally well accepted by most children, observer reports and the self-reports of children tended to favor the use of varnish. In particular, a lower percentage of children who received varnish were observed to gag during treatment and a lower percentage of these children reported they felt like gagging. The likely reasons for these findings are because less fluoride varnish was in patients' mouths at a given time and hygienists would have had better moisture control with the varnish technique. Both of these factors would likely have reduced the amount of fluoride ingested by children.

Few patients complained about the temporary tooth discoloration caused by varnish application. In the Warren et al. study, a high percentage of children found the discoloration to be objectionable (13). However, only subjects aged 12 years and older were included in the study, and older children may be more likely to be concerned about tooth appearance. The discoloration is temporary and disappears after toothbrushing, and clear varnish is available from some manufacturers. The degree of tooth discoloration may be reduced by not coating the labial surfaces of maxillary anterior teeth unless those surfaces have active caries or are at risk for caries (10).

By far the most important factor in the cost per application was the cost of labor. Consequently, the faster technique, varnish, was the least expensive when labor costs were considered. Cost differences were relatively minor for a single application, but in public dental programs that have a large volume of patients, the use of varnish may result in a substantial savings of dollars or hygienist time. In other

words, for a given amount of funds and personnel time, more fluoride applications could be provided using varnish. Additionally, varnish is more convenient to use in outreach situations because suction is not required and clean-up is easier.

There were several limitations to this study. First, a convenience sample was used and may not be representative of high-risk schoolchildren in Ontario. A second limitation was that the participants and observers were not blinded to the application technique being used. Finally, two factors may have favored the results of the foam group: (1) hygienists did not have prior experience with the use of varnish for caries prevention because they had exclusively used the foam technique in public health clinics, and (2) some hygienists reported they were initially resistant to the use of varnish. The impact of the first limitation cannot be formally assessed, but it is likely that subjects were at least representative of high-risk schoolchildren in York and Hamilton because subjects were selected over several months and health clinics treated patients from different areas of each region. The potential for bias due to the latter two limitations should be minimal because the participants and observers did not have a vested interest in the outcome of the study, and hygienists reported that they readily became accustomed to using varnish.

In conclusion, varnish applications were found to take less time and resulted in fewer signs of discomfort. These results support using fluoride varnish in caries prevention programs, especially for younger children. From a public health perspective, the use of fluoride varnish has several advantages compared to gel or foam treatments (10). Fluoride varnish is safe and easy to apply, fluoride ingestion is minimal, and this application method has greater patient acceptability. Treatment can be provided at a lower cost due to the reduced application time, and caries-prevention effectiveness is equivalent to gel and foam methods. For these reasons, it is more appropriate to use fluoride varnish in public health settings when treating high caries-risk children.

Acknowledgments

This research was supported by Ontario Ministry of Health and Long-Term Care grant #04170, and a Medical Research Council (MRC) summer student scholarship. The authors would also like to thank the dental hygienists and staff of the York Region Health Services Department and the City of Hamilton Social and Public Health Services.

References

1. Woodward GL, Lewis DW. The use of professionally applied topical fluorides in the North York Public Dental Program. Toronto, ON: Community Dental Health Services Research Unit, University of Toronto, 1995; Quality Assurance Rep no 8.
2. Leake JL, Main PA, Ho E. Evidence-based recommendations for the use of professionally applied topical fluorides in the North York Public Dental Program: an evidence-based report. Toronto, ON: Community Dental Health Services Research Unit, University of Toronto, updated 1999; Quality Assurance Rep no 19.
3. Hawkins RJ, Locker D. Evidence-based recommendations for the use of professionally applied topical fluorides in Ontario public dental programs: an evidence-based report. Toronto, ON: Community Dental Health Services Research Unit, University of Toronto, updated 2000; Quality Assurance Rep no 20.
4. Helfenstein U, Steiner M. Fluoride varnishes (Duraphat™): a meta-analysis. Community Dent Oral Epidemiol 1994; 22:1-5.
5. van Rijkom HM, Truin GJ, van't Hof MA. A meta-analysis of clinical studies on the caries-inhibiting effect of fluoride gel treatment. Caries Res 1998;32:83-92.
6. Seppa L, Leppanen T, Hausen H. Fluoride varnish versus acidulated phosphate fluoride gel: a 3-year clinical trial. Caries Res 1995;29:327-30.
7. Petersson LG, Twetman S, Pakhomov GN. The efficiency of semiannual silane varnish applications: a two-year clinical study in preschool children. J Public Health Dent 1998;58:57-60.
8. Autio-Gold JT, Courts F. Assessing the effect of fluoride varnish on early enamel carious lesions in the primary dentition. J Am Dent Assoc 2001;132:1247-53.
9. Whitford GM, Adair SM, McKnight Hanes CM, Perdue EC, Russell CM. Enamel uptake and patient exposure to fluoride: comparison of APF gel and foam. Pediatr Dent 1995;7:199-203.
10. Bawden JW. Fluoride varnish: a useful new tool for public health dentistry. J Public Health Dent 1998;58:266-9.
11. Blinkhorn A, Davies R. Using fluoride varnish in the practice. Br Dent J 1998; 185:280-1.
12. Ekstrand J, Koch G, Petersson LG. Plasma fluoride concentration and urinary fluoride excretion in children following application of the fluoride-containing varnish Duraphat. Caries Res 1980;14:185-9.
13. Warren DP, Henson HA, Chan JT. Dental hygienist and patient comparisons of fluoride varnishes to fluoride gels. J Dent Hyg 2000;74:94-101.
14. Marinho VCC, Higgins JPT, Logan S, Sheiham A. Fluoride varnishes for preventing dental caries in children and adolescents (Cochrane Review). In: The Cochrane Library, Issue 3, 2002. Oxford: Update Software.
15. Wei SHY, Lau EWS, Hattab FN. Time dependence of enamel fluoride acquisition from APF gels. II. In vivo study. Pediatr Dent 1988;10:173-7.
16. Wei SHY, Hattab FN. Fluoride retention following topical application of a new APF foam. Pediatr Dent 1989;11:121-4.