

Economic implications of evidence-based caries prevention in pediatric dental practice: a model-based approach

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Abstract

Objectives: This paper presents an economic model which can be used to assess the potential implications of evidence-based caries prevention in pediatric dental practice.

Methods: Assessment of the evidence indicated that most children in the United States were likely to experience dental caries, though the severity of the disease would be minimal in most of them. Based on the evidence, it was concluded that annual recall examination and topical fluoride application would suffice as the norm for caries prevention. A model was developed to estimate the extent and cost of caries prevention in a traditional and an evidence-based pediatric dental practice.

Results: The model showed that evidence-based caries prevention resulted in a one-third decline in the number of recall examination visits provided, while the ensuing patient revenues from recall appointments declined by two-thirds in a calendar year.

Conclusions: Evidence-based caries prevention will likely result in a significant decline in preventive services revenues and create additional capacity in pediatric dental practices. This economic impact will likely be absorbed by the current undersupply of pediatric dentists and by the reformulation of practice revenue streams. (*Pediatr Dent* 23:66-70, 2001)

A paradigm shift in the practice of dentistry to evidence-based care has been reported.¹ Further, it has been remarked that "evidence-based dentistry will introduce a new factor that should be used in deciding on the services to be included in a dental insurance plan: the evidence for effectiveness."² This contention has significant economic implications for pediatric and general dental practices. Three-fourths of pediatric dental patients are covered by third-party arrangements, and, hence, practice economics is subject to governance by third-party payers.³

It has been reported that "dental caries, the dental disease that historically has engaged the most resources to treat, has declined."⁴ Compared to the children who benefited from the 1970s caries decline, "today's children show promise of needing even less restorative and reparative dental care."⁵ The changing disease patterns have resulted in a change in the pattern of services provided by dentists.⁴ It has been noted that "the overall mix of services will continue to shift toward diagnostic and preventive services."⁵

It has been observed that "with diagnostic and preventive services accounting for an ever-increasing proportion of the cost

of dental care, then, the need for and effectiveness of these services inevitably will come under intense scrutiny. Optimal intervals for recall examinations, the value of the periodic prophylaxis and radiographs, and the need for routine topical fluorides and sealants will be studied intensively."⁵ The "investigation to determine optimal use of diagnostic and preventive services in an era of declining disease will be conducted under the heading of "evidence-based dentistry."⁵

The objectives of the present study were to develop an economic model and assess the potential implications of evidence-based caries prevention in pediatric dental practice.

Methods

The investigation was conducted in two steps. First was evidence assessment and second was the development of the economic model based on the evidence and explicit assumptions.

Assessment of the evidence

The literature was reviewed to assess the evidence with regard to pediatric dental caries prevalence and prevention. It has been recommended that "a practical approach for a physician who is trying to understand the benefits and harm of preventive programs is to read widely and critically, and to trust clinical practice guidelines that are based on evidence, such as those of the Canadian Task Force on the Periodic Health Examination and the U.S. Preventive Services Task Force."⁶ Therefore, the following caries preventive modalities were studied utilizing the recommendations of the Canadian Task Force on the Periodic Health Examination and the U.S. Preventive Services Task Force: periodic oral examination, dental prophylaxis, and professional topical fluoride application.

Pediatric dental caries prevalence

The National Survey of Dental Caries in U.S. School Children: 1986-1987 initially highlighted the considerable decline in dental caries prevalence, though four out of five children still experienced at least one carious permanent tooth by 17 years of age.⁷ Comparison of the first (1971-1974) and the third (1988-1994) National Health and Nutrition Examination Surveys (NHANES I and III) confirmed the significant decline in the cumulative number of carious permanent and primary teeth, both treated and untreated, among children in the United States since the 1970s.⁸ However, despite the decline in dental caries prevalence, there was an early onset of caries

experience with a high proportion of the children (40%) manifesting at least one carious tooth by five years of age.⁹ NHANES III reaffirmed that many children still experienced caries in both the primary and permanent dentitions with half of the children aged five to nine years experiencing caries in the primary dentition while two-thirds of the children aged 12 to 17 years experienced caries in the permanent dentition.¹⁰ Further, one quarter of the children "accounted for about 80 percent of the caries experienced in permanent teeth."¹⁰

Though most children in the United States were likely to experience dental caries, the severity of the disease would be minimal in most of them. Therefore, caries prevention based on "classifying individual patients into low-, medium-, and high-risk caries groups is justified from a review of the epidemiological characteristics of caries."¹¹

Frequency of periodic oral examination

The U.S. Preventive Services Task Force found "little or no scientific evidence on which to recommend any specific optimal interval between dental examinations."¹² "The traditional basis of six-monthly recall examinations for all patients is shown from the literature to have no scientific support."¹¹ The U.S. Preventive Services Task Force concluded that "making a more specific recommendation than "see your dentist at least once a year" is inappropriate."¹² The American Dental Association (ADA) recommends a one year recall examination for children at low risk for dental caries (i.e., those with no carious lesion in the last year).¹³ However, children at moderate risk (i.e., those with one carious lesion in the last year) should receive six-monthly recall examinations while those at high risk (i.e., those with two or more carious lesions in the last year) should receive three-monthly recall examinations.¹³

Given the decline in dental caries, annual recall examinations would suffice as the norm, though most children would benefit from three to six monthly recall examinations at some point in time based on their recent caries experience.

Need for dental prophylaxis

The Canadian Task Force on the Periodic Health Examination found "poor evidence to include prophylaxis in recall dental visits strictly to prevent caries."¹⁴ Further commenting on the need for dental prophylaxis before professional topical fluoride application, it was noted that there is "good evidence to recommend that such prophylaxis be excluded from periodic dental examinations."¹⁴

Dental prophylaxis can be excluded as part of the preventive routine of a recall dental examination. However some children may selectively benefit from the prophylaxis when used to remove stain and calculus.¹⁴ Also, for apprehensive children needing restorative care, "the use of dental prophylaxis should be considered as an educational tool to allay patient fears regarding the manipulation of oral tissues."¹⁵

Professional topical fluoride application

The Canadian Task Force on the Periodic Health Examination reviewed the annual or biannual professional topical fluoride application and found "poor evidence to include this procedure in periodic dental examinations for the general population."¹⁴ However, they found "good evidence to support this procedure for those with very active decay or at a high risk of caries."¹⁴ Similarly, the U.S. Preventive Services Task Force noted that "there is little indication for topical fluoride appli-

cation in children who are receiving protection from fluoridated water and toothpastes and who have never had a cavity."¹² However, it was reported that "randomized controlled trials have concluded that professional topical applications of fluoride are effective in preventing caries."¹² Therefore, they recommended professional topical fluoride application "once a year depending on caries activity or risk."¹² The ADA recommends that children at moderate risk (i.e., those with one carious lesion in the last year) should receive professional topical fluoride applications every six months, while those at high risk (i.e., those with two or more carious lesions in the last year) should receive professional topical fluoride applications every three months.¹³ However, the ADA also does not recommend routine professional topical fluoride application for "individuals with low caries risk who reside in optimally fluoridated areas."¹³

Given the observation that most children in the United States will manifest at least one carious lesion by 17 years of age, professional topical fluoride application can be considered as part of the routine annual recall dental examination for all children. However, most children might benefit from professional topical fluoride applications every three to six months at some point in time, based on their recent caries experience.

Development of the economic model

The model was based on the following assumptions:

1. Pediatric dental practices work 50 weeks in a calendar year.
2. The number of patients seen in a pediatric dental practice was 185 per week based on the 1996 American Academy of Pediatric Dentistry (AAPD) Survey of the Career Trends and Practice Patterns of the New Pediatric Dentist.³
3. Half of the patients seen in a pediatric dental practice presented for diagnostic and preventive purposes. This was based on the 1987 National Medical Expenditure Survey (NMES) which reported that more than half (56%) of the dental procedures performed in the United States were preventive or diagnostic.¹⁶
4. The number of new patients seen in a pediatric dental practice was 23 per week based on the 1996 AAPD Survey of the Career Trends and Practice Patterns of the New Pediatric Dentist.³
5. Recall patients constituted a six-month cohort in a traditional pediatric dental practice with each patient in the cohort making two recall visits in a calendar year. This was based on the 1996 Medical Expenditure Panel Survey (MEPS), which reported that nationwide children visiting the dentist made 2.7 visits in the calendar year.¹⁷
6. Each recall patient in a traditional pediatric dental practice received a periodic oral examination (00120), dental prophylaxis (01120), and topical fluoride application (01203). This was based upon reports that dentists identified six-month intervals to repeat dental examination, dental prophylaxis, and topical fluoride application for children.^{18,19}
7. Four out of five recall patients in a pediatric dental practice were at low risk for caries requiring annual recall examination. This was based on the report "that around 80 percent of the patients in any given recall interval did not have any dental caries at recall" in a private pediatric dental practice.²⁰ Further, it was arbitrarily assumed that of the remaining 20 percent, half (10%) were at moderate risk for caries requiring six-monthly recall examinations and

Table. Sensitivity Analysis for the Economic Model Comparing “Traditional” versus “Evidence-based” Caries Prevention

	Annual caries prevention revenues			
	Number of recall visits in a year	Low fees* Mean - one s.d.	Mean fees*	High fees* Mean + one s.d.
“Traditional” caries prevention	3500	\$178,500	\$276,500	\$374,500
“Evidence-based” prevention with 10% caries-positive children	2013	\$54,351	\$90,585	\$126,819
“Evidence-based” prevention with 20% caries-positive children	2275	\$61,425	\$102,375	\$143,325
“Evidence-based” prevention with 40% caries-positive children	2800	\$75,600	\$126,000	\$176,400

*1998 AAPD Survey of Pediatric Dental Fees (ref.21)

the other half (10%) were at high risk for caries requiring three-monthly recall examinations.

8. The following fee schedule was used in the model based on the 1998 AAPD Survey of Pediatric Dental Fees representing the national average pediatric dental fees:²¹

Periodic recall examination (00120) = \$26 ± 10

Dental prophylaxis (01120) = \$34 ± 10

Topical fluoride application (01203) = \$19 ± 8

The model generated the following profile for a “traditional” pediatric dental practice:

- Number of preventive and diagnostic patients per week = Number of total patients per week x 0.5 = 185 x 0.5 = 93
- Number of recall patients per week = Number of preventive and diagnostic patients - new patients = 93 - 23 = 70
- Number of recall patients in a six-month period = Number of recall patients per week x 25 weeks = 70 x 25 = 1,750
- Number of recall patients in a calendar year = Number of recall patients in a six-month period x 2 = 1750 x 2 = 3,500

The model generated the following profile for an “evidence-based” pediatric dental practice:

- Number of recall patients per week in the first half of the calendar year = 70
- Number of recall patients in the first half of the calendar year = 70 x 25 = 1,750
- Number of recall patients in the second half of the calendar year = Number of moderate caries-risk patients x one recall visit + Number of high caries-risk patients x two recall visits = 1,750 x 0.1 x 1 + 1,750 x 0.1 x 2 = 175 + 350 = 525
- Number of recall patients in a full calendar year = 1,750 + 525 = 2,275

The model in the present study has two limitations. First is an underestimation of the preventive services provided and revenues generated due to the exclusion of new patients. This was done conservatively as it was not known as to how many of the new patients were transfer patients who might have already received the recommended caries preventive modalities. Second is the use of a single factor, past caries experience, for the caries-risk stratification. Dental caries is a multifactorial disease and no one model has found universal acceptance in identifying caries-risk in individual children highlighting

“practitioner’s dilemma in implementing the preventive guidelines.”²² Nevertheless this single factor was used in the present model, as it is simple for the clinical practitioner to employ and the ADA has noted that “at each subsequent (recall) visit, patients should be re-evaluated for their caries risk status using information gathered about the incidence or onset of new caries, and the progression of lesions during a defined period of time since the last visit.”¹³

Sensitivity analysis for the economic model was performed by varying the parameters as follows:

- Caries-positive children were estimated from a low proportion of 10 percent to a high proportion of 40 percent with a central proportion of 20 percent.
- Based on the 1998 AAPD Survey of Pediatric Dental Fees,²¹ the fee schedule was estimated from a low of mean minus one standard deviation to a high of mean plus one standard deviation with a central estimate on the mean.

The sensitivity analysis assumed that, of the caries-positive children, half were at moderate risk for caries requiring six-month recall examinations, while the other half were at high risk for caries requiring three-month recall examinations.

Results

The model demonstrated that a “traditional” pediatric dental practice provided 3,500 recall examination visits in a calendar year. The procedures performed at each recall visit consisted of periodic oral examination (00120); dental prophylaxis (01120); and topical fluoride application (01203). Recall visits generated an annual revenue of \$276,500.

The model showed that, following the adoption of “evidence-based caries prevention,” the same pediatric dental practice provided 2,275 recall examination visits in a calendar year. The procedures performed at each recall visit consisted of periodic oral examination (00120) and topical fluoride application (01203). Recall visits generated an annual revenue of \$102,375 under the new paradigm. Therefore, “evidence-based caries prevention” resulted in a one-third (35%) decline in the number of recall examination visits provided while the ensuing patient revenues declined by two-thirds (63%).

Sensitivity analysis affirmed that following the adoption of “evidence-based caries prevention,” the annual number of recall visits increased with caries prevalence. This was paralleled by an increase in caries prevention revenues with increasing caries prevalence (Table).

Discussion

The present study assessed the economic implications of evidence-based caries prevention in pediatric dental practice. This issue arose due to the significant differences noted between traditional and evidence-based caries prevention. The traditional state of caries prevention with regard to the use and frequency of different preventive modalities in pediatric dental practices remains anecdotal and actual data has not been fielded. However, this issue has been addressed for general dentists pertaining to their pediatric patients and was used in the present study to exemplify traditional caries prevention in pediatric dental practice.^{18,19} Most general dentists reported six-month intervals to repeat dental examination, dental prophylaxis and topical fluoride application for children.^{18,19}

Evidence-based caries prevention, however, was markedly different from the traditional approach described. The evidence suggested annual recall examination visits and professional topical fluoride applications for all children, although some children at greater caries-risk would benefit from increased frequency of these preventive modalities.^{12,13} Further, the evidence recommended the exclusion of dental prophylaxis from periodic dental examinations.¹⁴

Public health advocates might question even the annual professional topical fluoride application for all children focusing upon the involved costs and the number needed to treat (NNT), i.e., “the number of patients one would need to treat for one year in order to prevent one adverse outcome.”²³ A recent meta-analysis on the caries-inhibiting effect of fluoride gel treatment in six-to-15-year-old children concluded that the NNT was 18 in a population with a caries incidence of 0.25 DMFS per year, while the NNT was 3 in a population with a caries incidence of 1.5 DMFS per year.²⁴ However, from the perspective of the clinical practitioner in an office setting dealing with individual patients for whom “one cavity is one too many,” and given the observation that most children in the United States will manifest at least one carious lesion by 17 years of age, routine annual professional topical fluoride application for all children seems prudent.⁷ The ADA has noted that “a “shotgun” approach to caries prevention may well deliver preventive services to a low-risk segment of the population that could be more effectively used on the high-risk segment.”¹³ But in the absence of valid office-based caries-risk prediction for individual patients, this preventive fluoride measure appears justified, given that dental caries is “a chronic, infectious, multifactorial disease process.”¹³

On the other hand, it might be argued that the caries decline might reverse if professional topical fluoride application frequency is decreased from biannual to annual, as envisaged in the present study. This is a non sequitur for the following two reasons. Firstly, a randomized community-based clinical trial of professionally applied APF gel has demonstrated that there is no significant effect on dental caries reduction of annual versus biannual application.²⁵ Secondly, the decline in caries levels has been a secular trend with no single preventive measure found responsible for the dramatic decline.²⁶

An economic model was developed in the present study based upon the differences in the traditional and evidence-based caries prevention. The model demonstrated that, upon the adoption of evidence-based caries prevention, there was a one-third decline in the number of recall examination visits provided. The model likely underestimated the number of recall visits as it was based on annual recall visit for most children only from the aspect of caries prevention. However, some

children might need more frequent recall examination visits based upon other needs such as growth and development assessment, trauma follow-up, etc. Nevertheless, the trends in practice economics, as demonstrated by the model in the present study, appear valid as dental caries remains the predominant pediatric dental disease in the United States and most dentists recall their patients to prevent caries.^{18,27} This potential creation of additional capacity has implications for the pediatric dental workforce requirements. It has been noted that “evidence-based management may result in change of professional manpower levels” with every dentist seeing “two or three times their current numbers of patients.”¹¹ This indicates the need for consideration of the evidence-based paradigm in the computation of future pediatric dental workforce projections to maintain pediatric dental practice in a robust economic state. However, the economic impact of the evidence-based paradigm on the pediatric dental workforce will likely be counterbalanced by the current undersupply of pediatric dentists, geographic distribution, and associated access among other issues.

The model developed in the present study demonstrated that, upon the adoption of evidence-based caries prevention, revenues generated by caries prevention declined by two-thirds. This may have significant impact upon overall practice gross income as “dental caries remains the single most common disease of childhood that is not self-limiting or amenable to a course of antibiotics,”²⁸ and most dentists recall their patients to prevent caries.¹⁸ Further, the increasing importance of recall patients to practice economics is emphasized by an outcomes assessment study in pediatric dentistry that demonstrated “a growing recall patient population” with limited therapeutic needs over a 15 year period (1980-1994).²⁹

It is likely that evidence-based caries prevention will garner the attention of third-party payers, given a recent estimate that the provision of combined topical fluoride application and prior dental prophylaxis to Canadian children costs \$100,000,000 per year.²⁵ For the United States this amount would be approximately 10 times as much, given the population factor of 10. Needless to say that, given the push for evidence-based dental practice and the increased role of third-party payers in pediatric dentistry, evidence-based caries prevention does not bode well for clinical practice revenues. It has been noted that “the dental sector is shrinking as a percentage of the gross domestic product. The flattening of the dental care growth rate can be traced to the late 1970s, about the time at which reductions in dental caries among children and other aspects of the improvement in oral health became apparent.”⁴

Pediatric dentists need to engage in what economists term “creative destruction,” thereby reformulating practice revenue streams to reflect the changes in disease patterns and economic realities. There are numerous beneficial services provided gratis at the present time such as behavior management, anticipatory guidance, dietary counseling, oral hygiene instruction, etc. There is a need to recognize these services and be reimbursed appropriately. Further, expansion of services such as the amount of orthodontic treatment might make up the difference in practice revenues.

The results of the economic model in the present study highlight an issue that was mentioned in an editorial accompanying the first of the recommendations for preventive measures by the U.S. Preventive Services Task Force.³⁰ It was aptly noted that implementation of the “recommendations will not be easy” since “reimbursement for clinical preventive services still lags behind fees for treatment of symptomatic disease.”³⁰ This was

underscored by the 1998 AAPD Survey of Pediatric Dental Fees with periodic recall examination (00120) costing less than one-half of that of a one surface-primary amalgam restoration (02110).²¹ There is, therefore, a need to restructure pediatric dental fees emphasizing and increasing preventive services fees.

It has been remarked that “when the bulk of the cohort with high levels of disease and resulting need for restorative treatment passes from the scene in 20 to 30 years from now, dentistry and oral health will have undergone a nearly complete transition.”⁵ Pediatric dentistry is the specialty that meets the leading edge of population dynamics and, therefore, is the forerunner of change in dentistry at large. Given the evidence-based reduction in the delivery of preventive services and the consequent economic fallout, pediatric dental practices are poised for a dramatic transition.

Conclusions

- Evidence-based caries prevention will likely result in a significant decline in preventive services revenues and create additional capacity in pediatric dental practices.
- The economic impact of “evidence-based caries prevention” will likely be absorbed by the current undersupply of pediatric dentists, geographic distribution, and associated access, among other issues.
- There is a need to reformulate practice revenue streams by reimbursement of services currently provided gratis and modifying pediatric dental fees by emphasizing and increasing preventive services fees rather than the usual focus on restorative services.

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