Simulating cost-effectiveness of fluoride varnish during well-child visits for Medicaid-enrolled children

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Record Status
This is a critical abstract of an economic evaluation that meets the criteria for inclusion on NHS EED. Each abstract contains a brief summary of the methods, the results and conclusions followed by a detailed critical assessment on the reliability of the study and the conclusions drawn.

Health technology
The study evaluated fluoride varnish application (FVA) by physicians when implemented within a well-child periodicity schedule (WCPS) to Medicaid-enrolled children at 9, 18, 24 and 36 months. This was compared with not providing such an intervention to Medicaid-enrolled children during the first 42 months of a child’s life (no FVA).

Type of intervention
Primary prevention.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised children enrolled in Medicaid, aged 9 to 42 months. Children enrolled in Medicaid were assumed to have a high risk of developing dental caries.

Setting
The setting was primary care. The economic study was conducted in North Carolina, USA.

Dates to which data relate
The effectiveness data were derived from studies published between 1978 and 2004. The price year was 2003. No information on the derivation of resource use data was provided.

Source of effectiveness data
The effectiveness data were derived from a synthesis of published studies.

Modelling
A decision analysis was conducted to assess the effects of dental disease and treatment costs after fluoride varnish had been applied to children aged between 6 and 36 months. A Markov model was developed to model dental caries, fluoride effectiveness and associated health states. Three-month cycle lengths were adopted.

Outcomes assessed in the review
The outcomes assessed in the review were:

the age-specific disease incidence;
the probability that a child would develop dental caries;

the probability that a child with dental caries receives treatment;

the probability of receiving dental treatment in hospital; and

the average effectiveness of fluoride varnish.

**Study designs and other criteria for inclusion in the review**
The probability of dental caries was derived from a cross-sectional study because of the lack of longitudinal studies of dental caries. No other information on study designs and inclusion or exclusion criteria were provided.

**Sources searched to identify primary studies**
Not reported.

**Criteria used to ensure the validity of primary studies**
Not reported.

**Methods used to judge relevance and validity, and for extracting data**
Not reported.

**Number of primary studies included**
Nine studies were included in the review, of which six were used to derive the effectiveness data.

**Methods of combining primary studies**
For most of the effectiveness data only one study was used. Data from three studies were combined to evaluate the probability of a child with dental caries receiving any dental treatment.

**Investigation of differences between primary studies**
Not reported.

**Results of the review**
The probability of a child having any new dental caries between the ages of 9 and 42 months was 0.035 per quarter.

The probability of a child receiving dental treatment once caries developed ranged from 0.2 to 19% between the ages of 9 and 42 months.

The probability of receiving dental treatment in hospital was 0.140 between the ages of 12 and 21 months, 0.310 between the ages of 24 and 33 months, and 0.135 between the ages of 36 and 42 months.

The average effectiveness of fluoride varnish was:

35.4% for 6 months;

57.1% in the first 3 months;

27.1% in the second 3 months;
14.1% between 6 and 9 months; and
7.4% between 9 and 12 months.

Measure of benefits used in the economic analysis
The summary benefit measure was the number of months without cavities per child. The measure of benefits was based on the effectiveness data.

Direct costs
The quantity/cost boundary adopted was that of the payer. The resource quantities and the costs were not reported separately. The study reported the average costs of FVA, dental treatment in the hospital setting and non-hospital treatment. Adverse events were not considered, since it was assumed that FVA had negligible adverse effects. The application cost was derived from a range of fees that some Medicaid programmes reimburse non-dental providers for FVAs. The midpoint was chosen. The cost of hospital treatment was obtained from the experience of pre-school-aged children enrolled in the Iowa Medicaid Program. Non-hospital costs were derived from a retrospective study. The costs were adjusted for inflation using the medical care component of the Consumer Price Index to reflect the 2003 US$ value. The costs were then deflated by 30% to reflect average Medicaid reimbursement fees as a proportion of estimated charges. The costs were discounted at an annual rate of 3%, as recommended by a panel on cost-effectiveness in health and medicine. This was appropriate given that the costs were incurred during more than two years.

Statistical analysis of costs
The costs were treated deterministically.

Indirect Costs
The indirect costs were not included in the analysis.

Currency
US dollars ($).

Sensitivity analysis
A one-way sensitivity analysis was conducted to test the robustness of the results. The parameters varied were the frequency and effectiveness of FVA, the probability of dental caries, the probability of receiving treatment or receiving treatment in the hospital, and the costs (hospital, non-hospital and the discount rate). A two-way sensitivity analysis was conducted to illustrate the joint effect of changing the probability of receiving treatment and non-hospital costs and to vary both the effectiveness of fluoride varnish and the probability of children with dental caries seeking treatment.

Estimated benefits used in the economic analysis
FVA was associated with 31.49 cavity-free months between the ages of 9 and 42 months, compared with 29.97 cavity-free months with no FVA. The incremental effectiveness was 1.52 cavity-free months.

The average number of treatments per child up to the age of 42 months was 0.125 with FVA and 0.179 with no FVA. The incremental effectiveness was 0.054.

Cost results
The cost of FVA was $181.66. The cost of no FVA was $170.73. FVA was associated with an additional cost of $10.93 per child between the ages of 9 and 42 months.
Restorative treatment costs were reduced by $52.00 with FVA, although the application costs of fluoride varnish were $64.00.

**Synthesis of costs and benefits**

The cost and effectiveness data were combined as incremental cost-effectiveness ratios. FVA resulted in an incremental cost per cavity-free month of $7.18 and an incremental cost per treatment averted of $203.00. The results were shown to be sensitive.

The sensitivity analysis revealed that FVA resulted in lower total costs when fluoride varnish effectiveness was 1.25 times greater, when non-hospital costs were doubled, and when hospital costs were 1.5 times greater than the base-case. The total cost of FVA was lower when the probability of receiving restorative treatment was 1.5 times greater, the likelihood of treatment occurring in the hospital was 1.5 times greater than the baseline case, and cavitation rates were nearly doubled. Increasing the number of applications of fluoride varnish from 4 to 6 between 9 and 42 months increased the effectiveness to 1.87 cavity-free months compared with no FVA, but with an incremental cost-effectiveness ratio of $15.59 per cavity-free month gained.

The two-way sensitivity analysis revealed that FVA was cost-saving when increased numbers of children received dental treatment and non-hospital costs doubled from base-case. When the effectiveness of fluoride varnish fell below two-thirds of the base-case, FVA was found not to save money despite the increased use of dental treatment.

**Authors' conclusions**

Although the use of fluoride varnish is effective in decreasing early childhood caries in low-income populations, it is not cost-saving in the first 42 months of life.

**CRD COMMENTARY - Selection of comparators**

The justification for the treatment options was implicit. FVA is increasingly promoted for very young children as a preventive measure. No FVA represented usual treatment since the majority of Medicaid-enrolled children received no preventive dental care. You should decide if this represents current practice in your own setting.

**Validity of estimate of measure of effectiveness**

The effectiveness evidence came from the literature. However, the methods and conduct of the review were not reported, and there was no information on the search and inclusion or exclusion criteria. The issue of uncertainty was addressed in the sensitivity analysis. This showed that the choice of parameters had a significant impact on the incremental cost-effectiveness ratio. The authors reported the limitation of having inadequate data to derive probabilities and costs. Data for the effectiveness of fluoride varnish, for example, were based on a study that only included children over the age of 2 years. Several assumptions were made in deriving the estimates of effectiveness. For example, it was assumed that FVA had no adverse effects, and that its effectiveness was the same when applied by both dental and medical practitioners. It was also assumed that the probability of developing caries was constant, and that once dental caries was detected, the child would be referred for treatment and could continue to receive preventive dental care in a medical office.

**Validity of estimate of measure of benefit**

The measure of benefit was derived from the model. Months gained in a cavity-free state is a disease-specific outcome, and the authors noted that since a standard health outcome such as quality-adjusted life-years was not used, this programme could not be compared with other medical and dental interventions.

**Validity of estimate of costs**

The costs included were consistent with the perspective adopted in the study, although it was restricted to the direct medical costs. Knock-on savings due to the study, including an increase in the children's ability to learn, decreased use
of dental emergency services and increased caregiver productivity by postponing or diminishing time away from work, were not included. The authors noted the limiting effect of these omissions. The study would have benefited had more information been provided on what resources were included in the costs. The costs and the quantities were not reported separately, which may limit the reproducibility of the results. A thorough sensitivity analysis was undertaken to assess the robustness of the results when the estimated costs were modified. The authors discounted the costs at a rate of 3% based on guidance from a panel on cost-effectiveness in health and medicine, which was appropriate. The date to which the prices referred was reported, which aids future reflation exercises.

Other issues
The authors did not compare their findings with those of other studies. The issue of generalisability to other settings was not considered. Several sensitivity analyses were performed which enhance, in part, the external validity of the study. The authors do not appear to have presented their results selectively and their conclusions reflected the scope of the analysis.

The authors noted some limitations to their study, some of which have been outlined already. For example, the limited data from which they derived estimates of probabilities and costs. The authors also noted that the findings of the study were limited to just the first 42 months of a child's life. Consequently, the costs and benefits after early intervention for older children cannot be inferred. Finally, the outcomes considered were the absence or presence of dental caries. The authors noted that additional benefits of the intervention might have been captured had changes in the severity of the caries been measured.

Implications of the study
The authors made the following recommendations.

There is a need for longitudinal controlled studies of the effectiveness of fluoride varnish in children enrolled in Medicaid, particularly of those aged younger than 2 years.

There is a need for research to evaluate a child's transition of care from the medical setting, where the intervention has occurred, to a dental setting to determine the long-term economic effect of the intervention.

Better targeting of FVA at children with the highest risk of caries would improve the economic effectiveness of the intervention.

Timing and compliance with the WCPS are important in targeting the high-risk population.

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