ARTICLE

COMPARATIVE EFFECTIVENESS RESEARCH

Cost-effectiveness of Preventive Oral Health Care in Medical Offices for Young Medicaid Enrollees

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Objective: To estimate the cost-effectiveness of a medical office–based preventive oral health program in North Carolina called Into the Mouths of Babes (IMB).

Design: Observational study using Medicaid claims data (2000-2006).

Setting: Medical staff delivered IMB services in medical offices, and dentists provided dental services in offices or hospitals.

Participants: A total of 209 285 children enrolled in Medicaid at age 6 months.

Interventions: Into the Mouths of Babes visits included screening, parental counseling, topical fluoride application, and referral to dentists, if needed. The cost-effectiveness analysis used the Medicaid program perspective and a propensity score–matched sample with regression analysis to compare children with 4 or more vs 0 IMB visits.

Main Outcome Measures: Dental treatments and Medicaid payments for children up to age 6 years enabled assessment of the likelihood of whether IMB was cost-saving and, if not, the additional payments per hospital episode avoided.

Results: Into the Mouths of Babes is 32% likely to be cost-saving, with discounting of benefits and payments. On average, IMB visits cost $11 more than reduced dental treatment payments per person. The program almost breaks even if future benefits from prevention are not discounted, and it would be cost-saving with certainty if IMB services could be provided at $34 instead of $55 per visit. The program is cost-effective with 95% certainty if Medicaid is willing to pay $2331 per hospital episode avoided.

Conclusions: Into the Mouths of Babes improves dental health for additional payments that can be weighed against unmeasured hospitalization costs.

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VARIOUS STUDIES HAVE documented high and increasing rates of dental caries among children younger than 5 years of age[1,2] as well as related negative health consequences.[3,4] Most children with dental caries are in low-income families and use dental care infrequently, despite eligibility for services through public insurance.[2] The limited dentist supply and dentists' low rate of participation in Medicaid further preclude access, motivating many communities to examine alternate approaches to this pressing public health problem.[5]

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The pediatric primary care setting provides an alternative site to deliver preventive oral health interventions for preschool-aged children before they develop poor oral health.[6,7] Although very young children are unlikely to visit dentist offices, they frequently make well-child visits to primary care physicians.[8] Preventive oral health care programs in medical offices include screening and risk assessment, parental counseling, topical fluoride application, and referral to dentists for further assessment or treatment, if needed.[7] Topical fluoride varnish is viewed as a cost-effective component of oral health care for low-income children, with recommendations for use every 3 to 6 months in high-risk children younger than 6 years of age.[9-11] Studies have shown that intervention in preschool-aged children with fluoride varnish improves dental health and defrays costs but is not cost-saving.[12,13]

Evidence of the effectiveness of oral health care in medical settings is limited.[14] A program called Into the Mouths of Babes (IMB) was initiated in North Carolina (NC) in 2000 in which physicians are reimbursed by Medicaid to conduct dental screenings of children 3 years of age or younger, apply fluoride varnish, and counsel parents. Into the Mouths of Babes im-

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proved access to oral health care for children up to 3 years of age in NC.[15] Depending on age, 18% to 39% of children had fluoride applications compared with a national estimate that only 2.5% of children younger than age 4 years had fluoride treatments from dentists in 2006.[16] Furthermore, children who had 4 or more preventive IMB visits in medical offices had a 17% reduction in dental caries–related treatments (CRTs) up to 6 years of age compared with children who did not have IMB visits; the fact that physicians made referrals to dentists for treatment of the disease meant that children with IMB visits received treatment from referrals but also had improved dental health.[17-19]

By 2010, Medicaid programs in 42 states approved reimbursement of medical providers for preventive oral health services,[20] and advocacy groups called for expansion of reimbursement for physicians to apply fluoride varnish.[21] Furthermore, the Affordable Care Act (Title V, section 5304) requires demonstrations of new models of dental care including training of primary care physicians. Although fluoride varnish application in schools is cost-saving,[22] the cost-effectiveness of preventive dental care in early childhood is largely unknown.[23,24] This study assesses the cost-effectiveness of IMB services from the perspective of the NC Medicaid program.

METHODS

STUDY DESIGN

Participation by medical offices in the IMB program increased over time. By 2006, each NC county had at least 1 pediatric practice, family medicine practice, or community clinic participating in IMB. Each month, an estimated 40% of Medicaid enrollees younger than 3 years who were eligible for a visit that month had an IMB visit.[15]

During the study period (2000-2006), Medicaid paid for up to 6 IMB visits per child through 35 months of age. Services could be provided at any visit, although the recommended periodicity of well-child visits at 6, 9, 12, 15, 18, and 24 months is ideal for delivering IMB services. Many children did not see medical providers participating in the program or receive the full complement of 6 visits, although some children had at least 4 IMB visits. This observational population-based cohort study estimates the cost-effectiveness of the IMB program, measured as receipt of 4 or more IMB visits before age 3 years vs no IMB visits. We excluded children who had 1 to 3 IMB visits to avoid underestimating the cost-effectiveness.

DATA AND MEASURES

Our study included children enrolled in NC Medicaid at 6 months of age and deemed to be continuously enrolled for at least an additional 12 months during 2000-2006. We followed up children until they were 72 months of age or no longer enrolled in NC Medicaid. The study was approved by an institutional review board at The University of North Carolina at Chapel Hill.

A longitudinal analysis file of monthly observations per child was constructed using Medicaid claims. Because most gaps in Medicaid enrollment for these children were owing to administrative factors, we calculated continuous enrollment from the first to last date of enrollment. Children with conditions unrelated to dental caries (eg, surgery for cleft palate or mouth injury) were excluded. Medicaid reimbursement codes identified IMB visits (codes W8002, W8003, D0150, D0120, D1203, and D1330) and caries-related treatments (procedure codes beginning with D2-D9), including restorations, extractions, stainless steel crowns, and nerve-related treatments (pulpotomies/pulpectomies). Through January 2007, the IMB program paid $61 for the first IMB visit and $53 for subsequent visits; based on the visit distribution, we used $54.81 as the average IMB visit payment by Medicaid during the study period.

ECONOMIC EVALUATION ISSUES

Our cost-effectiveness analysis was conducted from the Medicaid program's perspective; analysis issues are discussed here.

Effects

Although poor access to dental care affects quality of life, conventional measures of quality-adjusted life-years may not be sensitive for assessing the impact of preventive oral health care. The main measure of effect was hospital episodes averted by IMB, assuming that it is worth paying something to avoid treatment under general anesthesia as well as associated pain, psychological implications, and other difficult-to-quantify effects.

Costs

We measured costs from the payer perspective using Medicaid payments in 2006 dollars as follows:

$$Pay_{\geq 4IMB} - Pay_{0IMB} = \$IMBVisits_{\geq 4IMB} + \$DentalServices_{\geq 4IMB} - \$DentalServices_{0IMB}$$

The payments for IMB recipients consisted of IMB visits plus all other services related to dental care, whereas only the latter component applies for children not receiving IMB visits. We measured 3 categories of dental service payments:

- Payments for hospital episodes for dental CRT, including emergency department visits with caries as a main diagnosis, physician services including anesthesiology, operating room expenses, overnight stays, and dentist services;
- Dentist office visit payments for CRT; and
- Dentist office visit payments for preventive services without CRT, including visits for planning treatments.

Medicaid payments were estimated by multiplying the monthly probability of any dental services by location (hospital-based, office-based with CRT, and office-based without CRT) by estimates of the Medicaid payments for each event type.

$$\$DentalServices = \begin{array}{l} Pr_{Hosp} * Pay_{Hosp} + Pr_{OffCRT} * Pay_{OffCRT} \\ + Pr_{Off.noCRT} * Pay_{Off.noCRT} \end{array}$$

If payments for IMB plus dental services for children who had 4 or more IMB visits were less than payments for dental services for children not receiving IMB, then the program was cost-saving to Medicaid. Otherwise, the incremental cost-effectiveness ratio provided the payments per hospital episode averted:

$$ICER = \frac{\begin{array}{c}\$IMBVisits_{\geq 4IMB} + \$DentalServices_{\geq 4IMB} \\ - \$DentalServices_{0IMB}\end{array}}{-(HOSP_{\geq 4IMB} - HOSP_{0IMB})}$$

The denominator was multiplied by −1 so that the outcome became hospital episodes averted. All quantities in the incremental cost-effectiveness ratio, except for the IMB visit payments, were derived as predicted values from regression analyses summed across all children and months of age.

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Table 1. Child-Level Descriptive Statistics for the Full and Propensity Score–Matched Samples[a]

	Patient Total (N=209 285)	≥4 IMB Visits (n=12 984)	0 IMB Visits (n=196 301)	Propensity Score for 0 IMB Visits (n=12 339)
Child-level variables				
Follow-up (Time enrolled in Medicaid, mo)	42.36	40.52	42.48	40.50
Monthly rates of dental treatment				
Hospital episode for CRT	0.0014	0.0011	0.0014	0.0015
Dental office visit for CRT	0.0082	0.0068	0.0083	0.0075
Dental office visit without CRT	0.0188	0.0198	0.0187	0.0213
Male	0.51	0.52	0.51	0.52
Race/ethnicity				
White	0.40	0.36	0.41	0.38
Black	0.37	0.38	0.37	0.37
Other	0.23	0.26	0.22	0.25
Hispanic	0.14	0.16	0.13	0.16
Well-child visits (6-36 mo)	3.41	5.49	3.26	5.47
Special needs (North Carolina program identification)	0.036	0.031	0.036	0.030
County-level variables (mean values in 2005)				
Medicaid eligibles/10 000 population	731.2	816.3	724.9	806.8
Dentists/10 000 population	4.3	3.4	4.3	3.4
Physicians/10 000 population	4.6	4.0	4.6	4.1
County population with fluoridated drinking water, %				
0-24	0.04	0.04	0.05	0.04
25-49	0.02	0.04	0.02	0.04
50-74	0.10	0.07	0.10	0.08
75-100	0.85	0.86	0.85	0.85
Urban status/metro adjacency of child's county				
Metro areas with population of >1 million	0.16	0.07	0.17	0.07
Metro areas with population of 250 000 to 1 million	0.45	0.25	0.47	0.27
Metro areas with population of <250 000	0.08	0.14	0.07	0.13
Urban population of >20 000, adjacent	0.18	0.34	0.16	0.33
Urban population of >20 000, not adjacent	0.01	0.05	0.01	0.03
Urban population of 2500-19 999, adjacent	0.10	0.10	0.09	0.11
Urban population of 2500-19 999, not adjacent	0.02	0.03	0.02	0.03
Completely rural or urban population of <2500, adjacent	0.02	0.02	0.01	0.03
Completely rural or urban population of <2500, not adjacent	0.02	0.04	0.02	0.04

Abbreviations: CRT, caries-related treatment; IMB, Into the Mouths of Babes.
[a]The propensity score final analysis file included 12 339 children in each group for a total of 1 036 301 child-month observations.

DISCOUNTING AND ACCOUNTING FOR UNCERTAINTY IN ESTIMATES

We estimated payments for all services from 6 to 72 months of age. Because all IMB visits occurred prior to 3 years of age, we used a discount rate of 3% per year beyond age 3 years for Medicaid payments and hospital episodes averted.

The analysis has uncertainty in the estimates of the monthly probability of each event (hospital episodes, office visits with CRT, and office visits without CRT). We generated 1000 bootstrap replications of the estimates and used a cost-effectiveness acceptability curve to depict the probability that IMB was cost-effective at different levels of willingness to pay for a hospital episode averted. The bootstrap sampled all observations for a child, so the confidence intervals are adjusted for repeat observations by child.

STATISTICAL ANALYSIS

The lack of program randomization in study design means that treatment selection could bias program impact estimates. If medical providers choose to provide IMB services based on the caries risk status of the child, then the population impact of IMB in reducing dental treatment costs can be overestimated or underestimated. For example, if children receiving IMB services were inherently less likely to have severe dental caries, the resulting estimates would underestimate the true effect of the IMB program on dental disease and treatment. We conducted the analyses using the propensity score–matched sample. Using the aggregated experience of each child up to 36 months of age, we used logistic regression to estimate the likelihood of having 4 or more IMB visits, controlling for child characteristics (eg, sex, age, race, Hispanic ethnicity, and special needs, as defined by the NC Medicaid program) and county characteristics. Controlling for the special needs indicator was important because these children might be more likely to see primary care physicians more often. To control for systematic differences between children in the treatment and comparison groups, we matched IMB to control observations using predictions from this propensity score regression and single nearest-neighbor matching without replacement.[25,26]

We used multinomial logistic regression to estimate the likelihood of the service category each month (hospital episode, dental office visit with CRT, dental office visit with no CRT, or no dental services). To estimate monthly Medicaid payments for each dental service category, we used linear regression models, estimated only for children receiving that service.

Each regression controlled for the following observed characteristics:

- Into the Mouths of Babes indicator of 4 or more visits (and interactions with child age to allow treatment effects to vary by age);
- Child characteristics: sex, age, race, Hispanic ethnicity, special needs, and number of well-child visits up to age 3 years

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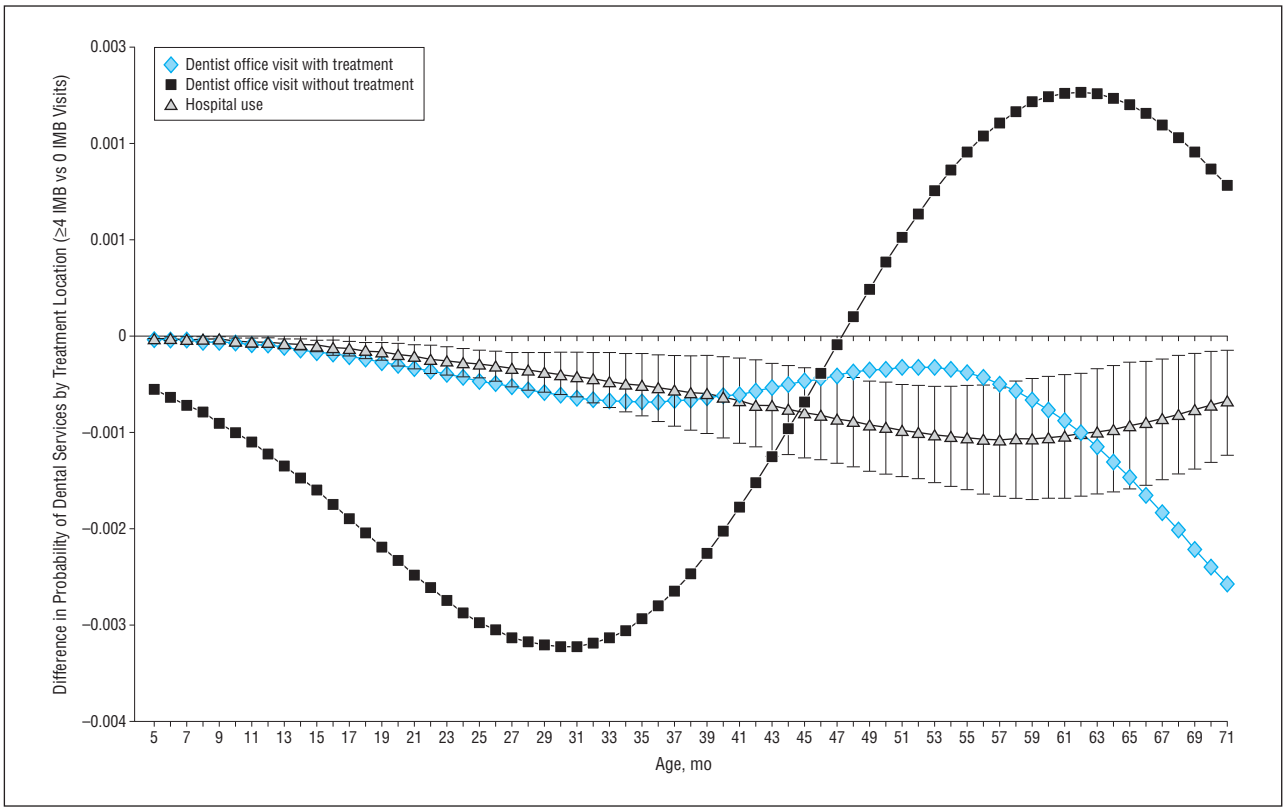

Figure 1. The effect of 4 or more Into the Mouths of Babes program visits on the probability of dental services by treatment location, with 95% confidence intervals for hospital use.

(squared values of age and well-child visits allowed for nonlinear effects);

- County characteristics: the number of general and pediatric dentists who treat children per 10 000 population, pediatricians and family physicians per 10 000 population, the county's Medicaid-eligible population younger than age 18 years, urban status of the child's county of residence,[27] and percentage of the county population with access to fluoridated public drinking water[28]; and
- Linear time trend to control for unmeasured state-level changes in socioeconomic conditions and provider supply.

Using predicted estimates of the likelihood of dental service use and Medicaid payments, we averaged the estimates across all children in each age-month and then aggregated the experience over 6 to 72 months of age to estimate cumulative costs and effects. Although within each child's experience the months are not independent (eg, a child who has a hospitalization 1 month for dental disease is not likely to have a hospitalization in the next month for dental disease), this approach predicts the experience for Medicaid-eligible children of each age, so that the aggregation during the 6-month to 72-month experience provided cumulative population estimates. All analyses were conducted in Stata/IC version 12 (StataCorp).

RESULTS

Table 1 provides descriptive statistics for the full sample of 209 285 children by IMB visit category (0 vs ≥4). All children entered the analysis at 6 months of age and were followed up while enrolled in Medicaid for approximately 42 months on average. Some characteristics differ by IMB visit categories; in particular, children having 4 or more visits had more well-child visits on average before 3 years of age (5.5 vs 3.3). Monthly dental treatment rates were very low, with fewer than 2% of children receiving any dental treatment in a given month. The last column of Table 1 contains statistics for the propensity score–matched sample of children with 0 IMB visits; these statistics corresponded very closely to the statistics for children with 4 or more IMB visits, showing that propensity score matching produced an appropriate comparison group.

Figure 1 provides the rates of dental service use predicted from the service regressions. (Results from all regressions are available on request.) Compared with children with 0 IMB visits, children receiving 4 or more IMB visits had a lower likelihood of having dental CRT in a hospital or dentist office at each month of age. Into the Mouths of Babes resulted in a statistically significant reduction in the likelihood of having a hospital episode related to dental caries, as shown by the 95% confidence interval bars in Figure 1. Children receiving 4 or more IMB visits before age 3 years were more likely to have a nontreatment visit (including preventive visits as well as visits to identify but not treat dental caries) beyond 48 months of age than were children with 0 IMB visits, although the effect is not statistically significant at $P < .05$.

Table 2 provides estimated mean Medicaid payments for the 3 dental service categories conditional on receiving CRTs. Children with 4 or more IMB visits had lower Medicaid payments for hospital or dentist office treatments, suggesting fewer treatments within a treatment episode.

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Table 2. Regression Predictions of Mean Values per Child 6 to 72 Months of Age for Medicaid Payments for the Propensity Score–Matched Sample[a]

	Medicaid Payments, Mean (95% CI), $	
	≥4 IMB Visits	0 IMB Visits
Hospital episode for caries-related treatment	2936 (2035-3247)	3051 (2150-3362)
Dental office visit with caries-related treatment	334 (271-423)	362 (299-452)
Dental office visit without caries-related treatment	84 (73-96)	84 (73-96)

Abbreviation: IMB, Into the Mouths of Babes.
[a] Preparation of payment data involved (1) the exclusion of records with payments in the lowest 5 percentiles within each category that were likely not reflective of true costs and (2) reclassification of 3301 child-month observations with 12 or more dental treatments as dental hospitalizations despite having a primary diagnosis other than dental caries.

Table 3. Cumulative Differences (≥4 IMB Minus 0 IMB Visits) in Payments and Hospital Episodes Averted (Aggregated Over 6 to 72 Months of Age) of the Propensity Score–Matched Sample With Discounting

	Discounted, $[a]
Incremental dental payments	–231
IMB visit payments ($54.81/IMB visit)	242
Incremental hospital episodes averted, No.	0.0360
Probability cost-saving ($54.81/IMB visit), %	32.0
Assuming IMB visit payment is $54.81, willingness to pay needed per hospital episode averted for 95% probability that IMB is cost-effective	2331
Maximum IMB visit payment for 100% cost-saving	33.67

Abbreviation: IMB, Into the Mouths of Babes.
[a] Dental payments discounted at 3% per year from age 3 years onward. IMB visit payments, which all occurred before age 3 years and are not discounted, are calculated based on the mean number of visits (4.42) multiplied by $54.81 per visit.

Table 3 provides estimates of the impact of 4 or more IMB visits on the key components of the incremental cost-effectiveness ratio, representing cumulative payments from 6 to 72 months of age for the propensity score–matched sample with discounting. The cumulative reduction in Medicaid payments for dental services was $231. Having 4 or more IMB visits was not cost-saving on average because the average IMB payment for this group was $242, or $11 more than the average reduction in dental payments. The bootstrap estimates in the cost-effectiveness plane (**Figure 2**A) showed that having 4 or more IMB visits unambiguously averted hospital episodes and had a 32% chance of being cost-saving.

The cost-effectiveness acceptability curve in Figure 2B depicts the cost per hospital episode averted for the other 68% of the estimates in which IMB improved health (ie, averted poor outcomes) but at some additional cost.[29] Depending on a Medicaid policy maker's value of averting hospital episodes (eg, the value of avoiding the unmeasured costs such as pain and suffering as well as lost time at school or parental employment when a child is hospitalized), IMB may still be cost-effective. If Medicaid feels that avoiding a hospital episode for CRT is worth at least $2331, the probability that providing 4 or more IMB visits to each Medicaid-enrolled child is cost-effective is 95%.

A lower visit payment could increase the likelihood that IMB is cost-saving as long as reducing the payment does not affect medical provider provision of services that contribute to IMB effectiveness. The last row of Table 3 shows that the estimated maximum amount that NC Medicaid could pay for an IMB visit to have virtual certainty that the program is cost-saving is $33.67.

We conducted sensitivity analyses for discounting and the full sample. Discounting usually decreases the cost-effectiveness of preventive programs because expenditures for preventive services occur in the short run, and savings in terms of reduced treatments for disease come later and are more heavily discounted. Providing estimates for the full sample is important because if selection is not a problem, then the full sample estimates are generalizable to the population. Without discounting, the likelihood that having 4 or more IMB visits is cost-saving increased to 47.9%, so the program is close to break even. The estimated maximum payment per IMB visit that could achieve cost-saving with virtual certainty ranged from $30.93 (full sample with discounting) to $34.84 (propensity score–matched sample without discounting).

COMMENT

This analysis showed that the provision of repeat oral health visits in medical offices reduced hospitalizations and office visits for dental CRT, but the implications for Medicaid payments are more nuanced. Assuming payment of $54.81 for an IMB visit, the probability that the program reduced total Medicaid program expenditures (ie, was cost-saving) for hospital episodes was 32%. Dental caries involves costs beyond service payments,[30] and the analysis did not adjust for the pain, suffering, and indirect costs such as lost parental work time associated with CRT. Considering the value of avoiding unmeasured costs associated with hospitalizing a child, the IMB program is 95% likely to be cost-effective if Medic-

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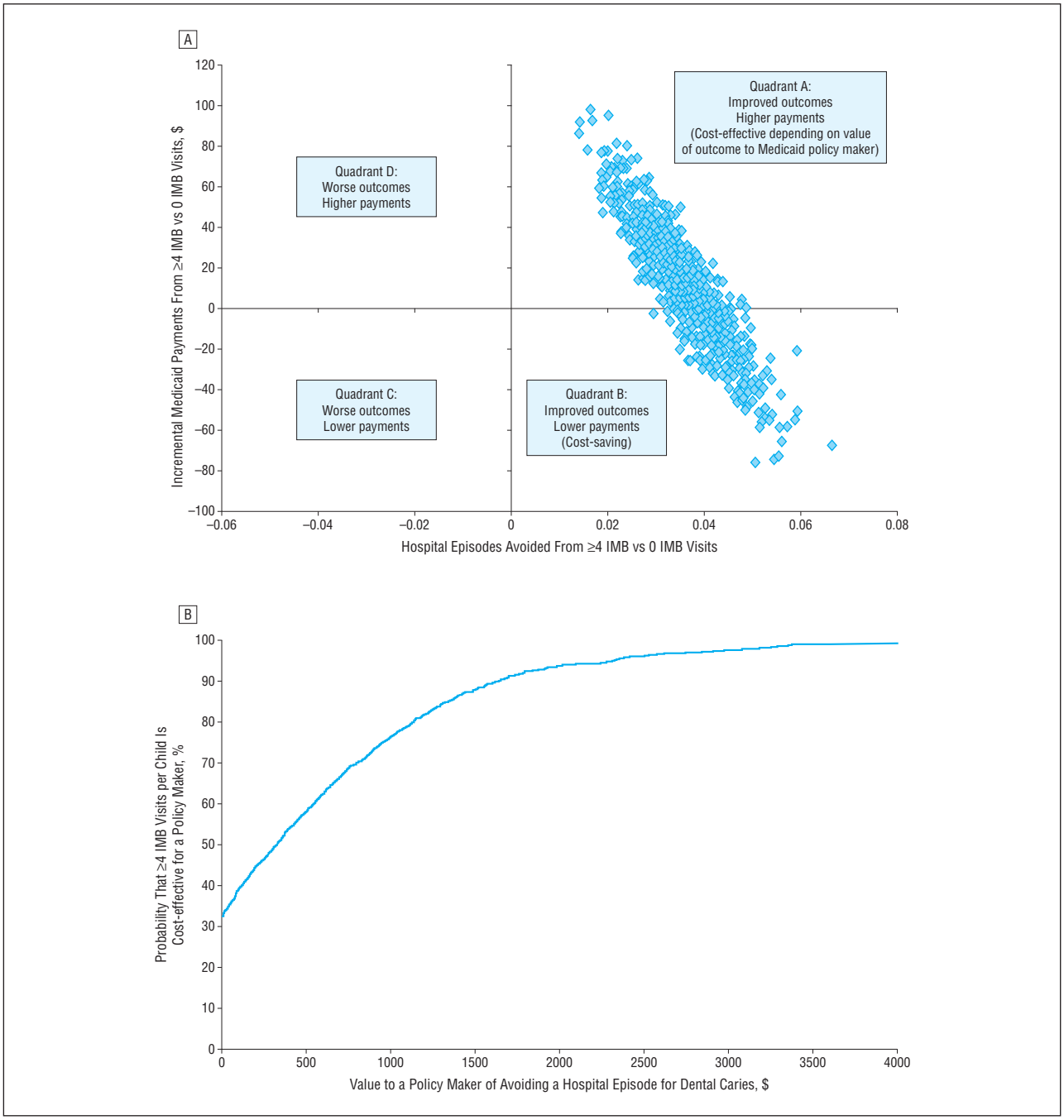

Figure 2. Graphs of cost-effectiveness including data for children from ages 6 to 72 months. A, Incremental cost-effectiveness plane (bootstrap estimates from propensity score sample with discounting). B, Cost-effectiveness acceptability curve (cost per hospital episode avoided for dental caries) from the propensity score sample with discounting.

aid is willing to pay at least $2331 to avert a hospital episode.

Currently, some states pay less for preventive oral health care in medical offices than the NC program, however, the service package may be less comprehensive and/or physician participation may not be as high. The effectiveness of the various components of the IMB visit in NC cannot be separated. If the effectiveness is attributable primarily to fluoride varnish, then a lower payment for varnish alone (eg, $15 as is paid in some states) could lead unambiguously to cost-savings. If screening, counseling, and referral are important components that affected outcomes, then reimbursement for these services may be required to achieve similar outcomes. If the components that were effective could be provided at $34 per IMB visit, then the program would be cost-saving with virtual certainty based on this study.

Several factors limit the results of this study. The use of observational data means the results may be affected by patient selection and may not be generalizable to the entire population. Children who had 4 or more IMB visits had more well-child visits before age 3 years than children who did not have any IMB visits; while well-child visits provide a good opportunity for IMB services, the propensity score–matched sample may be healthier on average

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or more focused on good health practices than the rest of the full sample that did not have IMB visits. If these children have worse dental health, then the potential reduction in treatments and payments from IMB could be greater for this group. The full sample results were close to the propensity score sample results, but selection based on unobserved factors could still bias the results. Furthermore, the study only assessed dental treatments rather than dental health. The IMB program probably decreased rates of dental caries and increased the rate of treatment for those experiencing dental disease.

Overall, the IMB program improved dental health outcomes for Medicaid-enrolled children, with a 32% chance of cost-saving. The benefits may be worth the extra Medicaid payments from a societal perspective that encompasses all the costs of dental caries. Identification of the most effective components of the IMB service package and the costs of those components could determine the most appropriate rate for the IMB services. If payment is set to achieve the medical provider and family participation rates experienced in NC, then preventive oral health services in medical offices can be cost-effective (depending on the valuation by the policy maker) and possibly cost-saving.

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