Cost-Effectiveness Analysis of a Practice-Based Immunization Education Intervention

Luisa Franzini, PhD; Julie Boom, MD; Cynthia Nelson, MPH

Objective.—To evaluate the cost-effectiveness of academic detailing programs to improve immunization coverage in communities through implementation and evaluation of the Raising Immunizations Thru Education (RITE) program in the Greater Houston area.

Methods.—RITE was a preintervention and postintervention pilot study with randomized intervention and control sites implemented in private practices in pediatrics and family medicine. Changes in self-reported provider behaviors (n = 186) and comparisons of immunization coverage levels between intervention (n = 61) and control (n = 62) practices were evaluated. Intervention costs, computed from the perspective of an agency wanting to replicate the intervention, included direct expenses and time costs, based on time logs and compensation. Sensitivity analysis describes variations in costs. The cost-effectiveness ratio was computed as dollars per additional outcome unit.

Immunization rates for preschool-aged children in Houston, Texas have historically been below national averages. Factors that have been identified as adversely impacting childhood immunization rates include complexity of the childhood immunization schedule, missed opportunities, cost of vaccines to providers, fragmented childhood immunization records, deficient use of reminder/recall systems, parental and physician confusion regarding immunization needs, and concerns about vaccine safety. Studies show that academic detailing—expert health education for providers and clinic staff in their office—overcomes this multitude of immunization barriers to proper childhood immunization.

Academic detailing programs funded by the Centers for Disease Control and Prevention were implemented in several US states. To evaluate the effectiveness of these programs to improve immunization coverage in communities, we implemented an academic detailing program in the Greater Houston area—Raising Immunizations Thru Education (RITE)—that included an economic evaluation component. The following study questions were asked: 1) Does the RITE program improve immunization behaviors of health care workers?

Results.—The RITE intervention improved self-reported provider behavior. The immunization rates in the intervention group increased by 1%, whereas immunization rates in the control group decreased by 2%–3%, but the 3%–4% difference was not significant. A 1% increase in practice immunization rates costs $424–$550, depending on the up-to-date criteria used and the targeted age group.

Conclusions.—The costs for 1 additional child with up-to-date immunization status are higher than potential societal savings, as reported in the literature. This intervention does not have a favorable cost-benefit ratio.

KEY WORDS: academic detailing; cost analysis; immunization rates; knowledge of immunization guidelines

Ambulatory Pediatrics 2007;7:167–175

METHODS

Study Population

RITE was a preintervention and postintervention pilot study implemented from 2003–2005 in the Greater Houston area. To recruit practices, we identified all pediatric and family medicine providers in the Greater Houston area by using multiple state and local databases. From 852 identified practices, 309 were nonrespondent after 3 attempts, 188 could not be reached, 88 did not qualify, and 78 refused. We recruited the remaining 189 eligible sites to participate in RITE. Providers who saw less than a monthly minimum of 25 children aged younger than 4 years were excluded from recruitment. Informed consent was obtained in person by peer educators and data collectors. The Baylor College of Medicine Institutional Review Board approved the study.

Intervention

Practices in the intervention group received a 1-hour, peer-based educational lunch presentation—at their office—that focused on 3 major points: avoiding missed opportunities, using available resources to reduce barriers

AMBULATORY PEDIATRICS

Copyright © 2007 by Ambulatory Pediatric Association

Volume 7, Number 2

March–April 2007
1. Do you follow the current Recommended Childhood Immunization Schedule for giving immunizations?

2. What is the maximum number of vaccines that you are willing to give a patient during one visit?

3. Do you routinely screen immunization records at sick or injury visits?

4. Do you use minimum intervals for administering vaccines when a child is at risk for delay?

5. Do you use a standardized immunization form (form that allows vaccine documentation to be kept in one place) in your patients' charts?

6. Do you require written immunization history before giving vaccines?

7. Does your practice require an appointment for nurse-only visits?

8. Does your practice follow the CDC guidelines on valid contraindications and precautions to immunizations?

9. Does your practice use the chart-pull method to assess immunization rates?

10. Does your practice send monthly reminders for immunizations?

11. Does your practice send reminders to patients who are overdue for immunizations?

Figure 1. Behavioral survey.

To giving immunizations, and developing a unique action plan for each practice. RITE staff conducted 3 training sessions to train educational teams, with each educational team consisting of 3 presenters: 1 physician, 1 nurse, and 1 office manager. Each presenter delivered 1 section of the presentation to the entire practice as a group. For each presentation, physician presenters received $400, nurse presenters received $200, and office manager presenters received $150.

RITE staff conducted prepresentation and postpresentation activities, including scheduling presentations, preparing and delivering educational material and equipment, retrieval of completed forms, and mailing educational materials (reinforcements) to each practice on a monthly basis for 6 months after the presentation to reiterate the educational message. We considered, but did not adopt because of cost considerations, additional visits to the practice to reinforce the educational message.

Self-reported Provider Behavior

To assess behaviors of health care workers, prior to the presentation we distributed to all participants in the intervention group an immunization assessment questionnaire modeled after existing questionnaires. After the intervention, we mailed postintervention questionnaires to the practices along with instructions to complete and return the questionnaires. Intense follow-up encouraged questionnaire completion in nonrespondents. The 11 items included in the questionnaire to assess immunization attitudes and behaviors are reported in Figure 1. All invalid and missing values were excluded from analyses. Likert scale responses were collapsed into 2 categories: correct, coded “1,” and incorrect, coded “0.” The sum of all correct answers in a questionnaire yielded a total score between 0 and 11. We also used a score (1-4) for the number of correct answers to the knowledge of immunization guidelines and practice policy questions. Pre-intervention and post-intervention differences were tested.

Immunization Rates

Immunization chart reviews are the standard tool used to assess immunization practices at a provider’s site. RITE staff used the Clinical Assessment Software Application (CASA) developed by Centers for Disease Control and Prevention to conduct preintervention and postintervention mini-CASAs (50 charts per practice). Chart abstractors reviewed randomly selected charts of children
-aged 12–23 months at each intervention and control site, excluding practices with 2 or fewer records.

Up-to-date immunization status for children aged 12–23 months was compared in the intervention and control groups. The National Immunization Survey evaluates coverage levels for children aged 19–35 months. Funding restrictions prevented RITE project staff from assessing immunization coverage levels for this age group. Therefore, we used a subset of the data collected to analyze practice immunization rates for children aged 19–23 months.

We used recommendations from the American Academy of Pediatrics and the Advisory Committee on Immunization Practices to develop up-to-date criteria for every child on the date of the CASA. For example, at 23 months of age, the minimum criteria for up-to-date status is 4 DTaP (diphtheria and tetanus toxoids with acellular pertussis) vaccines, 3 polio vaccines, 1 MMR (measles-mumps-rubella) vaccine, 4 Hib (Haemophilus influenzae type b) vaccines, 3 HBV (hepatitis B) vaccines, and 1 varicella vaccine. Because combination hepatitis B–Hib vaccine is commonly used in Houston, we used 2 different sets of minimum up-to-date criteria. Criteria I includes single antigen hepatitis B and Hib vaccines, whereas criteria II takes into account the combined hepatitis B–Hib vaccine, which requires only 3 doses.

Mean immunization rate for each practice was calculated from immunization status for each record in the practice. Immunization rates for each study group preintervention and postintervention and changes in rates (postintervention minus preintervention) for each group were also calculated and compared across groups. Differences were tested with the \( t \) test.

Cost Estimation Methodology

In computing the cost of the intervention, we used the perspective of an agency wanting to replicate the intervention. Therefore, we computed only the intervention costs. Clinic costs related to the intervention, such as time spent at the presentation and costs associated with changes in immunization rates, were not included. The costs to families were also not included. Intervention costs were computed only for practices that completed the intervention because costs incurred in the intervention practices that withdrew before completing the intervention were minimal.

Included in the intervention cost are the costs of recruiting and training the presenters, the presentations, and mailing reinforcements. Research costs of developing and evaluating the intervention are not included. Intervention costs are computed by using direct expenses and time costs associated with implementing the intervention.

Direct Expenses

Direct expenses included the following costs: RITE distribution materials and letterhead; materials and food for the training sessions; educational materials, equipment, supplies, and food for the presentations; payments to presenters; materials to serve as educational reinforcements; and office supplies. The project administrator recorded direct expenses for all 83 completed interventions by using invoices, budgets, and records of supply orders. Direct expenses per intervention were computed by dividing total expenses by the number of interventions.

Time Costs

Time costs included the cost of time RITE staff spent on training sessions, presentations, and mailing reinforcements. Project staff completed time logs listing all intervention-related activities on an ongoing basis throughout the project. They estimated the duration of time in training session activities and selected 10 presentations to estimate the time cost for the presentations.

Four types of staff (a project coordinator, an administrator, an assistant, and a health nurse) worked on the intervention. Staff cost consisted of compensation (salaries and fringes) paid to staff for time spent working on the intervention. Yearly compensation in 2004 was obtained for each staff and was then divided by 115 200 minutes (40 hours a week for 48 weeks a year) to obtain compensation per minute.

Time costs for each activity were obtained by multiplying mean duration in minutes of the activity by compensation per minute for staff performing the activity. Intervention time costs for the intervention were obtained by adding time cost of all activities required for the entire intervention.

Total Costs

Total costs were obtained by adding direct expenses to time costs.

Sensitivity Analysis

The sensitivity analysis describes how costs per intervention vary based on including or excluding specific costs. The first scenario assumes that a staff person at the assistant level carries out all staff activities required for the intervention. The rationale for this scenario is that, over time, the assistant did in fact take over all activities required for the intervention. The second scenario excludes equipment costs. The rationale for this scenario is that it may be possible in replicating the intervention to use existing equipment at different sites or to use equipment obtained from a central organization. The third scenario assumes that a nurse, instead of the educational team (physician, nurse, and manager) does the presentation. The presenters’ costs are a large part of presentation costs, and this scenario considers a lower-cost alternative. However, changing presenters from a team of peers to a nurse eliminates the unique peer-to-peer feature of RITE and is likely to affect the effectiveness of the intervention.

Cost-effectiveness Analysis

The cost-effectiveness analysis used costs from the agency’s perspective. In investigating cost-effectiveness, we considered 2 outcomes that the intervention attempts to influence: provider behavior and immunization rates. Though it is changes in actual rates of immunizations that
are the most important outcome, we also measured self-reported provider behavior as an intermediate outcome. The cost-effectiveness ratio was computed as dollars per additional outcome unit.

Cost benefits of the intervention from a medical sector and societal perspective were evaluated using the medical sector and societal benefits—assessed using published literature—of changes in immunization rates associated with the intervention.

RESULTS

Of the original 852 sites, 189 practices (22%) agreed to participate in RITE. These practices were randomized into an intervention (n = 95) group and a control (n = 94) group (Figures 2 and 3). Twelve intervention sites withdrew between the time of recruitment and scheduling the presentations, so that 83 practices received the intervention. Reasons for withdrawal included lack of time to participate, no longer seeing pediatric patients, meeting exclusion criteria, reluctance to allow RITE staff to collect surveys/conduct CASA, and closure of the practice.

Self-reported Provider Behavior

As shown in Figure 2, 187 individuals (34% of those who completed prequestionnaires) completed matched prequestionnaires and postquestionnaires from 57 practices. Survey scores showed significant increases for 3 individual immunization behaviors: willingness to give the maximum number of immunizations due at 1 visit (P < .001), routinely screening immunization records at sick or injury visits (P < .05), and using minimum intervals when a child is at risk for delay (P < .001).

Mean change in preintervention and postintervention overall scores were significant for the 11 immunization attitude and behavior questions (0.45; P < .05) and for the 4 knowledge of immunization guideline questions (0.48; P < .05), indicating improvement in overall self-reported immunization behaviors.

Immunization Rates

After withdrawals and exclusions, 61 intervention CASAs and 62 control CASAs were used in the analysis of the 12–23 month age group (Figure 3). For the analysis of the subset of children aged 19–23 months, 53 intervention practices and 54 control practices contained enough children to be included in the analysis.

Children aged 12–23 months.—Immunization rates decreased by 3% (criteria I and II) in control practices and increased by 1% (criteria I and II) in intervention prac-
ambulatory pediatrics

Cost-Effectiveness Analysis of a Practice-Based Immunization Education Intervention

171

Intervention Group
95 practices

Control Group
94 practices

Withdraw
12 practices

Received Intervention
83 practices

Withdraw/Lost-to-follow-up
14 practices

CASA
69 practices

Valid CASA
61 practices

55% pediatric, 44% family medicine,
19% large, 52% Vaccine for children

Valid CASA
62 practices

62% pediatric, 38% family medicine,
46% large, 82% Vaccine for children

852 Sites
1674 Providers

189 Yes Responses

Figure 3. Flow of participating practices throughout the study. Immunization rates.

tics. Pre-intervention and post-intervention changes were not significant (Table 2).

Children aged 19-23 months.—In this subset of children, immunization rates decreased by 2% (criteria I) and 3% (criteria II) in control practices and increased by 1% (criteria I and II) in intervention practices. Pre-intervention and post-intervention changes were not significant (Table 3).

Costs

Direct Expenses

Direct expenses per intervention averaged $1534, including expenses for the presentation itself ($1293), of which the largest component was the $750 payment to the presenters. Other expenses per intervention were $33 for training the presenters, $25 for mailing rein-

Table 1. Cost-Effectiveness for Provider Behavior Outcomes

<table>
<thead>
<tr>
<th>4 QUESTIONS SCORE</th>
<th>Incremental cost</th>
<th>Incremental outcome</th>
<th>Number of correct answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention cost</td>
<td>$1,693 (CI: $1,676 to $1,711)</td>
<td>Pre-intervention</td>
<td>2.44 (CI: 2.27 to 2.61)</td>
</tr>
<tr>
<td>Average attendance</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention cost per person</td>
<td>$212 (CI: $209 to $214)</td>
<td>Post-intervention</td>
<td>2.92 (CI: 2.76 to 3.09)</td>
</tr>
<tr>
<td>Incremental cost</td>
<td>$212 (CI: $209 to $214)</td>
<td>Incremental outcome</td>
<td>0.48 (CI: 0.31 to 0.65)</td>
</tr>
<tr>
<td>Cost-effectiveness ratio = $437</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>11 QUESTIONS SCORE</th>
<th>Incremental cost</th>
<th>Incremental outcome</th>
<th>Number of correct answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention cost</td>
<td>$1,693 (CI: $1,676 to $1,711)</td>
<td>Pre-intervention</td>
<td>5.18 (CI: 4.90 to 5.45)</td>
</tr>
<tr>
<td>Average attendance</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention cost per person</td>
<td>$212 (CI: $209 to $214)</td>
<td>Post-intervention</td>
<td>5.62 (CI: 5.32 to 5.93)</td>
</tr>
<tr>
<td>Incremental cost</td>
<td>$212 (CI: $209 to $214)</td>
<td>Incremental outcome</td>
<td>0.45 (CI: 0.14 to 0.75)</td>
</tr>
<tr>
<td>Cost-effectiveness ratio = $474</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 2. Cost-Effectiveness for Immunization Rates: Children 12 months to 23 Months of Age

<table>
<thead>
<tr>
<th>CRITERIA I*</th>
<th>Incremental cost</th>
<th>Incremental outcome</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Immunization rate</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control, 47% (CI: 42% to 52%)</td>
<td>44% (CI: 39% to 50%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post-intervention, 44% (CI: 39% to 49%)</td>
<td>45% (CI: 40% to 51%)</td>
</tr>
<tr>
<td>Intervention cost = $1,693 (CI: $1,676 to $1,711)</td>
<td>Incremental cost = $1,693 (CI: $1,676 to $1,711)</td>
<td>Cost-effectiveness ratio = $424</td>
<td></td>
</tr>
<tr>
<td>Incremental cost = $1,693 (CI: $1,676 to $1,711)</td>
<td>Incremental outcome = 4% (CI: -2% to 10%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost-effectiveness ratio = $443</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CRITERIA II*</th>
<th>Incremental cost</th>
<th>Incremental outcome</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Immunization rate</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control, 58% (CI: 53% to 63%)</td>
<td>59% (CI: 53% to 65%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post-intervention, 55% (CI: 49% to 60%)</td>
<td>60% (CI: 55% to 65%)</td>
</tr>
<tr>
<td>Intervention cost = $1,693 (CI: $1,676 to $1,711)</td>
<td>Incremental cost = $1,693 (CI: $1,676 to $1,711)</td>
<td>Cost-effectiveness ratio = $443</td>
<td></td>
</tr>
<tr>
<td>Incremental cost = $1,693 (CI: $1,676 to $1,711)</td>
<td>Incremental outcome = 4% (CI: -1% to 9%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Criteria refer to different methods for determining up to date immunization status based on different Hepatitis B and Hib vaccines

Time Costs

On average, project staff spent 636 minutes per training session, 364 minutes for preparing and completing a presentation, and 42 minutes for mailing reinforcements. The annual compensations were $51,720 for the coordinator, $48,095 for the administrator, $40,293 for the assistant, and $38,733 for the health nurse. Time costs were $159 per intervention, including $8 per intervention for the training sessions ($223 per session), $137 for the presentations themselves, and $15 for the reinforcements.

Total Cost

Total cost per intervention was $1693 ($1534 in direct expenses and $159 in time costs). The intervention cost per health care provider was $212, given average attendance of 8 providers.

Sensitivity Analysis

In the first scenario, where it is assumed that a staff person at the assistant level carries out all the activities, the intervention cost was only $9 lower than in the base case. In the second scenario, which excludes equipment costs, the intervention cost was $1415, which is lower than the base case by $278. In the third scenario, where a nurse rather than the educational team does the presentation, the intervention cost was $1143, which was $550 lower than in the base case.

Cost-effectiveness Analysis

Cost-effectiveness of Self-Reported Provider Behavior

The incremental cost consisted of the intervention cost per health care provider ($212). The incremental outcomes (differences between the mean of correct questions pre-intervention and post-intervention) ranged from 0.45–0.48 and were significant. The cost for 1 additional correct answer to the 4 knowledge of immunization guideline questions was $437, and the cost for 1 additional correct answer to the 11 immunization attitude and behavior questions was $474 (Table 1).

Cost-effectiveness of Immunization Rates

The incremental cost consisted of the cost of the intervention ($1693). The incremental outcomes (pre-intervention and post-intervention differences in mean up-to-date immunization rates in the intervention group minus the pre-intervention and post-intervention difference in mean up-to-date immunization rates in the control group) ranged from 3%–4% but were not significant. The costs to increase up-to-date immunization rates by 1% ranged from $424–$555, depending on the up-to-date criteria and the targeted age group (Tables 1 and 2). In the sensitivity analysis, the most favorable cost-effectiveness ratio was $288 (scenario 3, criteria I for 12–23 months old).

DISCUSSION

The RITE program employed academic detailing and peer education to improve immunization behaviors among all types of staff and to increase immunization coverage levels in provider offices. Overall, self-reported immuni-
Table 3. Cost-Effectiveness for Immunization Rates: Children 19 months to 23 Months of Age

<table>
<thead>
<tr>
<th>CRITERIA 1*</th>
<th>Incremental cost</th>
<th>Incremental outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intervention cost</td>
<td>Immunization rate</td>
</tr>
<tr>
<td></td>
<td>$1,693 (CI: $1,676 to $1,711)</td>
<td>Control</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post</td>
</tr>
<tr>
<td></td>
<td>Incremental cost</td>
<td>= $1,693 (CI: $1,676 to $1,711)</td>
</tr>
<tr>
<td></td>
<td>Cost-effectiveness ratio = $555</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CRITERIA 2*</th>
<th>Incremental cost</th>
<th>Incremental outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intervention cost</td>
<td>Immunization rate</td>
</tr>
<tr>
<td></td>
<td>$1,693 (CI: $1,676 to $1,711)</td>
<td>Control</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post</td>
</tr>
<tr>
<td></td>
<td>Incremental cost</td>
<td>= $1,693 (CI: $1,676 to $1,711)</td>
</tr>
<tr>
<td></td>
<td>Cost-effectiveness ratio = $511</td>
<td></td>
</tr>
</tbody>
</table>

*Criteria refer to different methods for determining up to date immunization status based on different Hepatitis B and Hib vaccines.

zation behaviors of participants improved 6 months following the intervention. At 1-year follow-up, practice-based immunization rates in the intervention group had increased by 1%, whereas they had decreased by 2%-3% in the control group. The overall increase of 3%-4% was not significant. The decrease in immunization rates in the control practices mirrors the trend in immunization rates in the city of Houston, where rates fell from 2003 to 2004.

Continuing medical education using traditional didactic teaching methods has little impact on physician behavior. Interventions consisting of multiple types of educational modalities are more likely to result in behavior changes.

Employing physician leadership or opinion leaders, tailoring interventions to each practice, and including entire staff in educational interventions can produce positive effects on physician behavior. We engaged all types of staff to participate in the identification of areas in their offices that needed improvement and to choose strategies that accomplished their goals. Our results indicate this method is effective in changing overall self-reported immunization behaviors. However, since only 34% of individuals who completed a prequestionnaire completed a matching postquestionnaire, there may be respondent bias. Depending on the outcome used, the RITE intervention resulted in cost-effectiveness ratios between $437 and $474 per additional correct answer. These cost-effectiveness ratios cannot be translated into cost-per-life-saved or cost-benefit ratios with available data.

We expected this improvement in self-reported immunization behaviors to translate into increased practice-level immunization rates. Results indicate, however, that RITE had little impact in achieving higher coverage levels in participating practices.

We hypothesize several reasons for the minimal increase in practice immunization coverage. First, the RITE program included a single on-site visit and delayed chart assessment until after the educational sessions. Literature review indicates that using multiple on-site visits is necessary to induce sufficient provider behavior change. The monthly reinforcements we mailed to practices are not a substitute for personal office visits. Interventions that provide chart review results prior to educational sessions have been shown to increase immunization rates in practices.

In addition, behaviors known to increase practice immunization rates did not show improvement following the intervention. For example, use of recall systems, proven to increase immunization coverage levels by recalling children when they are overdue for immunizations, did not improve. Although the RITE curriculum emphasized the use of recall, we were not able to provide hands-on training and support to set up recall systems.

Despite the nonsignificant increase in immunization coverage levels, we evaluated the cost-effectiveness of the program. Several arguments in the health economics literature point to the usefulness of economic evaluation of interventions that have nonsignificant effects on outcomes. First, lack of statistical significant differences between outcomes in an intervention group and a control group does not mean that the difference in outcomes is zero because "the difference between the 2 sample means remains the best estimate of effect differences rather than zero." In our study, the best estimate of the effect of the
intervention on immunization rates is an increase of 3%–4%, depending on the criteria used. Second, using the conventional threshold $P$ value of 0.05 to reject the null hypothesis may not be appropriate if agencies deciding whether to implement the intervention are willing to accept higher risk of inappropriately rejecting the null. In our study, there were differences in immunization rates that were significant at the 10% error level, which may be acceptable to some decision makers. We think that this study provides valuable information in that it represents a thorough cost-effectiveness evaluation of academic detailing, which has not been previously evaluated.

An extensive literature documents that immunizations are highly cost effective. Childhood immunizations have favorable cost-benefit ratios from both a medical sector perspective and a societal perspective, which takes into account reduced morbidity and mortality due to immunization. For example, each dollar invested in DTaP produces a savings of $9 in medical costs and $27 in societal costs. Medical and societal cost savings for each dollar invested in vaccines are $3.40 and $6.10 for polio, respectively, $10.30 and $13.50 for MMR, respectively, $1.40 and $2.20 for Hib, respectively, $0.50 and $2.00 for hepatitis B, respectively, and $0.90 and $5.61 for varicella, respectively. By adding these savings, we obtain potential savings of $25 in medical care costs and $54 in societal costs for the immunizations considered in this study. These savings overestimate savings that can be attributed to up-to-date immunization status, as children who are not up-to-date are likely to be missing only some, not all, of the recommended immunizations. However, we found no literature on cost-benefit ratios for up-to-date immunization status.

In our study, the RITE intervention increased practice up-to-date immunization rates by about 3%–4% compared with controls (though the difference was not significant), and the cost-effectiveness of the intervention varied between $424 and $555 for a 1% increase in immunization rates, depending on the up-to-date criteria used and the targeted age group. The cost of an additional child with up-to-date immunization status decreases as the practice size increases. Thus, for example, in a practice with 100 children in the target group, costs are between $424 and $555, whereas in a practice with 200 children, costs are between $212 and $278. In the sensitivity analysis, the lowest cost per additional child with up-to-date immunization status is $287 for a practice with 100 children and $144 for a practice with 200 children (scenario 3).

In any case, the costs for 1 additional child with up-to-date immunization status attributable to the RITE intervention computed in this study are higher than the potential savings of $25 in medical care costs and $54 in societal costs, indicating that the intervention does not have a favorable cost-benefit ratio from a medical and societal perspective. The costs computed include only the cost of the intervention and not the additional medical and societal cost of providing the immunizations. If those medical and societal costs were included, the cost-benefit ratio would be even less favorable. Thus, the result that the intervention is not cost effective from a medical and societal perspective is conservative, because this cost-benefit analysis underestimates costs (because it excludes medical and societal costs) and overestimates the benefit (because children who are not up-to-date are likely to be missing only some, not all, of the recommended immunizations). Even when combining the higher effectiveness rate (11%) found in a similar study with our costs, the RITE intervention does not have a favorable cost-benefit ratio.

It is worth considering possible modifications to the intervention aimed at increasing practice immunization rates, including multiple on-site visits and more training and support to implement changes proven to be effective, such as client recall systems. Such modifications would increase effectiveness and costs, and the modified interventions would have to be assessed for cost-effectiveness.

ACKNOWLEDGMENTS

We thank Claudia A. Kozinetz, PhD, and Larry E. Laufman, EdD, for their evaluation of the RITE pilot program in Houston, Texas and we thank the reviewers and the editor for their useful comments. Funding for the project was provided by the Centers for Disease Control through the Texas Department of State Health Services. Grant #TDH Document 175149941302002. The grant was awarded to Julie A. Boom, MD.

REFERENCES

17. Koepke CP, Snyder BA, Vogel CA. Assessing the effectiveness of Pennsylvania’s Immunization Education Program (IEP), an evaluation of IEP’s ability to increase immunization rates and improve provider immunization knowledge and behaviors. 1999 Dec. (Available from the Office for Children’s Health Policy Research at Albert Einstein Medical Center.)