Published in final edited form as:

Clin Pediatr (Phila). 2020 June ; 59(7): 706–715. doi:10.1177/0009922820908586.

Evaluating Partial Series Childhood Vaccination Services in a Mobile Clinic Setting

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Abstract

This study aims to evaluate the cost-benefit of vaccination services, mostly partial series administration, provided by a mobile clinic program (MCP) in Houston for children of transient and low-income families. The study included 469 patients who visited the mobile clinics on regular service days in 2 study periods in 2014 and 836 patients who attended vaccination events in the summer of 2014. The benefit of partial series vaccination was estimated based on vaccine efficacy/effectiveness data. Our conservative cost-benefit estimates show that, compared with office-based settings, every dollar spent on vaccination by the MCP would result in $0.9 societal cost averted as an incremental benefit in regular service days and $3.7 during vaccination-only events. To further improve the cost-benefit of vaccination services in the MCP, decision-makers and stakeholders may consider improving work efficiency during regular service days or hosting more vaccination events.

Keywords

mobile clinic; childhood vaccination; partial series; cost-benefit analysis

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Authors' note

The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention. Also, the earlier version of the analysis was conducted during WC's fellowship at the CDC. She is currently employed by Florida International University, Miami, FL.

Author Contributions

WC conceptualized the study, conducted the analyses, and wrote the manuscript. SMM designed the time study, supervised the mobile clinic data collection, and co-wrote the initial manuscript. FZ conceptualized and designed the study, reviewed and revised the manuscript. LCS conceptualized and designed the study, coordinated and supervised data collection and co-wrote the initial manuscript. JAB conceptualized and designed the study, and reviewed the manuscript. MM conceptualized the study, reviewed and revised the manuscript.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Supplemental Material

Supplemental material for this article is available online.

Pediatric mobile clinic programs (MCPs) often provide interim care to transient populations. Although mobile programs fulfill unmet medical needs, they have been criticized for potentially fragmenting medical care and treating patients who would otherwise have sought care in a medical home.[1] While these programs require substantial financial investment for medical supplies, staff, and administration, their benefits are not easily quantified. Historically, evaluations of MCPs have been limited to assessments of the number of patients served, medications provided, or screening tests performed over a given time period. Although evaluation approaches have evolved in recent years and now include assessments of cost savings through averted hospitalizations and emergency department visits, these are specific to preexisting medical conditions, such as asthma or dental care. Evaluation models of routine pediatric care provided by mobile clinics remain limited.[2–5]

This study evaluates vaccination services provided by a pediatric MCP in Houston. The program has been serving children from transient and low-income families in medically underserved areas in Houston since 2000. This study focuses on vaccination services, a major service of pediatric care. As children often receive care from multiple providers throughout their childhood, vaccines administered by pediatric mobile clinics are primarily for catch-up purposes. While existing literature commonly assumes that patients complete a full series of vaccines from one provider, many children receive partial vaccine series in mobile and nonmobile settings. To the best of our knowledge, no study has distinguished the provision of partial series from full series when evaluating vaccination services in any setting.

Methods

Data Collection and Participants

This evaluation is based on vaccination services provided by the MCP in 2014. The MCP has 4 English-Spanish bilingual providers and 5 English-Spanish bilingual staff members working in 2 fully equipped pediatric mobile clinics. For over 10 months of each year, the mobile clinics function like typical pediatric clinics offering well-child care, school and sports physicals, urgent care, laboratory services, and immunization. These are considered as regular service days. During late-July to August, the mobile clinics host vaccine-only events providing immunization to children whose vaccines are not up-to-date for school entry in the Fall. Data were collected separately for regular service days and summer vaccine-only event days to account for these operational differences (more detailed description in Appendix Table A1).

Regular Service Days.—A time study was designed to collect data for patients who visited either of the 2 mobile clinics during regular service days. Two data collection periods (April 28–May 8, 2014 and September 2–25, 2014) deemed to be representative of patient flow during regular service days were chosen. A time study flow sheet was used to document the time a patient arrived at the mobile clinic as well as the times that the patient was transitioned to different areas within the mobile clinic. Time data were verified before discharge and then used to calculate the time spent on each step of the visit (registration, waiting, and seeing a provider). Patient demographics (age, sex, preferred language, and insurance type), visit characteristics (new or returning patient, mobile clinic location, and type of visit), and travel time to the mobile clinic location were also captured. Vaccination records for each patient were photocopied. When patients informed the staff that there might be missing information in their record, historical vaccine records were obtained electronically by the staff from the Texas statewide immunization registry, ImmTrac.

Vaccine-Only Events.—For vaccine-only events (held during August 2–16, 2014), we documented patient age, sex, and vaccines administered (dose number and vaccine type). Dose numbers (ordinal number of a dose in a series) were confirmed from the immunization record the parent presented. Other information was not collected due to the large volume of patients and the limited time available per patient.

Evaluating Costs

Costs incurred during regular service days and summer event days were estimated separately. Summer events are for vaccination only. Thus, all resources consumed were attributable to vaccination services. For regular service days, we determined the proportion of resources consumption based on time spent on vaccination-related activities. We stratified observations by visit types and examined the differences in time use for registration, waiting, and seeing a provider. For visits with vaccination, we also distinguished time use by vaccine doses given.

We estimated 3 different types of cost (MCP's cost, direct cost, and societal cost) of vaccination services. MCP's cost is the portion of the total MCP program cost that is attributable to vaccination. The program cost, which covered all operating expenses (including overhead), was obtained from the MCP 2014 financial report. Our direct cost estimate included the cost of MCP, capital cost, vaccine cost, as well as travel cost for patients and parents traveling to the mobile clinics. The societal cost is direct costs plus time loss or opportunity costs of parents and volunteers (see Appendix: "Cost Estimates of Vaccination in a Mobile Clinic Setting" for more details).

Benefit Measures

While the benefit of full vaccine series is well documented,[8] there are insufficient data on the benefit by dose. Studies that compare different dose schedules usually report differences in vaccine efficacy/effectiveness or duration of protection. The benefit to each patient could also vary substantially due to differences in individual immune and memory responses or time interval between doses. There is no measure that reconciles benefits in all aspects.

In this study, we assume that each dose contributes to the benefit of a full vaccine series by a percentage (percentages of all doses sum up to 100%). Although imperfect, we based our percentages of per dose benefit primarily on efficacy/effectiveness data from existing studies.[9–19] For example, it is reported that 1 dose of single-antigen varicella vaccine is 85% effective at preventing any form of varicella and 2 doses of the same vaccine is 93% (mean of a range from 88% to 98% in post-licensure studies).[9] We, therefore, assume that the first dose contributes 91% (=85%/93%) and the second dose contributes 9% of the benefit of a full series of varicella vaccines. For vaccines without reliable efficacy/ effectiveness data, we searched for evidence on duration of protection or other benefit and made assumptions about per dose benefit accordingly. Table A3(a) in the Appendix summarizes the percentages used in the baseline analysis and the corresponding references.

To convert the percentages of benefit into benefit in dollars, we multiplied the percentages by the benefit of a full vaccine series in dollars. The full-series benefit is measured by direct and societal costs averted (more details in Appendix: "Benefit Estimates of Full Series of Vaccines"). Table A4 listed the benefit estimates we used and corresponding references.[8,20–22]

We also observed which dose in a vaccine series a patient received, so we were able to estimate the percentage of vaccines given by dose order (see Table A3[a]). Combining the benefit by dose order and proportions of doses by dose order, we estimated the total benefit of vaccines, mostly given as partial series, in the study.

Cost-Benefit Analysis

We estimated the incremental cost-benefit of receiving vaccination from the MCP in comparison to office-based settings. Namely, we assumed patients would go to providers in office-based settings for vaccination if the MCP was not available.

Although it may not be as convenient for the served patient population (mostly uninsured or Medicaid-eligible children in medically underserved areas) to turn to other providers like pediatrician's offices or Houston Health Department's immunization clinics (due to geographic barriers, time constraints, economic barriers, inconvenience in obtaining appointment for vaccination outside the wellness checkup window, difficulties in finding doctor accepting uninsured or Medicaid patients, etc), we assume some patients managed to do so, with the probability equal to the vaccine coverage rate. While we did not observe coverage rates when the MCP was not available, we used coverage estimates by vaccine component from the National Immunization Survey among children living below the poverty level in the City of Houston[24,25] (except for influenza vaccines; more details in the Appendix: "Vaccination Coverage Rates Used to Estimate Benefit of Vaccination in Office-Based Settings"). The coverage rates used for each dose of vaccine components are listed in Appendix Table A3(b). We calculated the hypothetical number of doses that could be given in office-based settings for each vaccine component. The incremental benefit of the MCP is the difference in cost averted among children who vaccinated in the MCP and in the office-based settings.

To calculate incremental cost of vaccination services provided by MCP compared with office-based settings, we made further assumptions on provider's cost of vaccination in office-based settings (more details in the Appendix: "Cost of Vaccination in Office-Based Settings,"). The cost estimates are summarized in Appendix Table A5.

Combining the cost and benefit estimates in the 2 settings, we derived the incremental benefit-cost ratio (BCR) for the MCP.

Sensitivity Analyses

Given uncertainties in various parameters in the model, we conducted a series of sensitivity analyses. Sensitivity analyses (1) to (4) assessed the impact of uncertainties in benefit estimation. We (1) showed varied vaccine coverage rate estimates within their 95% confidence intervals (see Appendix Table A3[c]); (2) let estimates of vaccine benefits (direct/societal costs averted) fluctuate below and above the baseline; (3) varied the percentage of benefit attributable to the *n*th dose; and (4) varied the percentages of doses given as the *n*th dose. In sensitivity analyses (5) to (8), we considered variations in cost elements, including: (5) the proportion of resources consumed attributable to vaccination during regular service days; (6) life years of mobile clinics vary; (7) opportunity cost of parents and volunteers; and (8) travel cost. In sensitivity analysis (9), we showed cost-benefit estimates in comparison to no vaccination, which means children would forgo vaccination had MCP not existed. We explained each analysis in more detail in the Appendix: "Sensitivity Analyses".

We conducted probabilistic sensitivity analyses for (1), (3), and (4) using a Monte Carlo Simulation approach and randomly drew input parameters 10 000 times from independent probability distributions (truncated normal distributions for (1) and uniform distributions for (3) and (4)) to estimate 95% credibility intervals of incremental BCRs. For (2) and (5) to (8), we performed 1-way sensitivity analyses. For (9), it is equivalent to a raw, rather than incremental, cost-benefit estimates from the baseline model.

Results

To evaluate vaccination services provided by the MCP in 2014, time study data were collected for 469 patients during regular service days and vaccine data were collected for 836 patients during summer vaccine-only events. During regular service days, 81.2% of the patients received vaccines. A visit by parent(s) with 1 child lasted 113 and 95 minutes on average in regular service days and during summer events, respectively (Table 1). No differences were found in age, sex, or number of doses given among vaccinated children across regular service days and summer event days. The patients' mean age was 9 years, with about half boys, and 3 doses as the average number of doses received among those vaccinated, in both regular service days and summer event days. Among regular-service patients, 67.6% were new patients and 89.9% were uninsured. A total of 62.7% spoke Spanish as their primary language, and 62.1% of families brought 1 child to the MCP for medical care (Appendix Table A2).

Costs of Vaccine-Related Activities

From the time study data, we estimated that 75% of regular service visit time was spent on vaccine-related activities, which was used as the proportion of resource consumption attributable to vaccination during regular service days of the whole year (Table 1). Visits that involved no vaccination or time spent on other services accounted for the remaining 25% of the regular service visit time. In 2014, vaccine services cost nearly $700000 ($39/dose) to the MCP, about $1720000 ($97/dose) as a direct cost, and nearly $1795000 ($101/dose) as a societal cost. The per dose costs were much lower in summer event days than in regular service days, due to the large volumes of vaccines administered at summer events.

Costs Averted by Vaccination

We derived the direct and societal costs averted by vaccine component using data of vaccine dose counts, percentages of doses by dose order, percentages of benefit contributed by each dose, and benefit of a full vaccine series (listed in Appendix Tables A3 and A4). The total direct and societal costs averted were over $2.5 million and over $7.3 million, respectively (Table 2). The benefit derived from vaccination during regular service days were more than that during summer event days (approximately $1.5 million vs $1.0 million of direct cost averted and $4.4 million vs $3.0 million of societal cost averted), since the total doses given in over 10 months of regular service days exceeded that given in summer-event months.

Cost-Benefit Analysis

Table 3 summarizes the cost-benefit results of vaccination services provided by the MCP in 2014 compared with office-based settings.

We found that the cost of vaccination in office-based settings was lower than costs in the MCP, primarily because of lower provider's cost (we assumed office-based providers' cost of vaccination was covered by administration fee, which was up to $22.06 per dose in Houston (Houston Health Department)[28]) and lower vaccination purchase cost (fewer vaccines administered in office-based setting). The cost difference was greater in the regular service days than in the summer event days.

The benefit of vaccines administered in alternative settings sums up to over $2.2 million in direct cost averted and $6.4 million in societal cost averted, which translates into about $340 000 and $917 000 as the incremental benefit of the MCP vaccination services in terms of direct and societal cost averted.

Taken together, the incremental direct (societal) cost was greater than the incremental direct (societal) benefit in regular service days, and the incremental direct (societal) BCR was less than 1. However, these ratios were more than tripled in the summer due to the intensive vaccine administration at summer events. The return in the form of societal cost averted during summer event days was close to $4 for every additional dollar spent on MCP compared with office-based settings. Taking both regular service days and summer event days into account, every additional dollar spent on MCP resulted in $0.49 direct cost averted and $1.29 societal cost averted.

Sensitivity Analyses

We checked the robustness of results through 9 sensitivity analyses (Table 4). According to the results, the effect of varying vaccine coverage rates as specified in sensitivity analysis (1) is very similar to the effect of varying vaccine benefits as specified in sensitivity analysis (2). Among the first 8 sensitivity analyses, uncertainties in coverage rate estimates and vaccine benefit estimates had the greatest impacts on incremental BCRs. In contrast, uncertainties in cost estimation, as specified in sensitivity analyses (5) to (8), had much smaller effects (narrower ranges, especially for (7) and (8)). Sensitivity analysis (9) shows the cost-benefit with no vaccination as the comparator. Assuming children served by MCP would otherwise forgo vaccination, the BCRs would be much higher. While this is more of an extreme case, our baseline scenario is much more conservative. The incremental direct (societal) BCRs for regular service days were below 1 in all of the first 8 scenarios. Summer event days had higher ratios for both direct and societal BCRs. Taking all service days together, the BCRs from (1) to (8) were between 0.39 and 0.59 considering direct cost and benefit and ranged from 1.03 to 1.55 considering societal cost and benefit. Based on these ratios, our baseline findings were robust to the considered variations in benefit-related or cost-related parameters.

Discussion

It is challenging to evaluate pediatric MCP vaccination services among children of low-income and transient families because of at least 3 reasons. First, almost all vaccines provided to the population in such a setting are partial series, and there is no study that distinguishes the benefit of partial series from full series. Second, comparing with existing sources of care, the incremental benefit brought by the MCPs is likely to be limited. Without MCP, children may still get vaccinated from other providers, though with possibly higher cost. Third, the benefit is often invisible if measured by vaccine coverage rates. The impact of the MCP could be easily diluted in aggregate level coverage statistics.

Our study suggested one way to tackle these challenges and quantify the cost-benefit of partial series vaccine administration in a mobile clinic setting. We allocated the benefit across doses primarily based on vaccine efficacy/effectiveness data, with the caution that real benefit contributed by each dose may differ substantially due to factors that may not considered here, such as duration of protection, individual responses, and time gap since last vaccination. For many vaccines, the efficacy/effectiveness of later doses was much smaller than earlier doses, which disfavors the benefit estimation of catch-up doses.

We assessed the value added by the MCP in providing vaccination services in comparison to traditional settings, such as pediatricians' offices and Health Department immunization clinics. We assumed that some vaccines would still be administered with probability equal to the vaccine coverage rate among low-income children in Houston if the MCP had not existed. This population was possibly the closest to the population served by the MCP in terms of socioeconomic and demographic characteristics. However, since these coverage rates were reached given the existence of the MCP, they were likely to overestimate the real probability that children could obtain vaccination in other settings. As the coverage rates were often over 80%, the incremental benefit-cost of the MCP was very limited. We found that the societal BCR of MCP was over 4 when assuming children would forgo vaccination without MCP (as in sensitivity analysis 9). When taking the existing traditional setting into account, the incremental societal BCR of MCP dropped to 1.3.

Despite the various scenarios considered in the sensitivity analyses, our incremental cost-benefit results are largely unchanged. Compared with traditional settings, MCP showed incremental BCR less than 1 in regular service days and greater than 1 in summer event days. As the number of administered doses dramatically increased at the vaccine-only summer events, the benefit accumulated quickly while the cost per dose was actually decreasing. It implies that cost-benefit of immunization services in MCP would be largely improved by increasing the doses given. It can be achieved by either improving work efficiency to see more patients during regular service days or hosting more vaccination events during the summer. As the share of vaccination event days within the full year increases, the BCRs would exceed 1 even when direct cost and benefit are considered.

These results, however, do not speak to the overall cost-benefit of the MCP, as other types of services are also provided during regular service days. While mobile health clinics, in general, are found to produce significant cost savings and improve health outcomes in underserved groups,[33] evidence for pediatric care remains limited. The approach of this study can be used by future studies to estimate the overall costs and benefits of the full range of services provided by pediatric mobile clinics.

This study has several limitations. First, coverage rates were used to proxy the probability that vaccines would still be administered if the MCP was not available. This approach is likely to overestimate the chance of receiving vaccination in office-based settings. Second, the benefit contributed by each dose was specified based on available efficacy/effectiveness data. It by no means represents a comprehensive measure that summarizes the benefit of each dose in all aspects. It does not reflect differences in immune or memory responses to each dose by age, gender, race, or other individual characteristics either. For vaccines with insufficient efficacy/effectiveness data, assumptions about the contribution by dose were made based on other evidence available. We addressed these uncertainties by varying the percentages of benefit by dose order in sensitivity analysis (3). Third, we were unable to obtain information during summer vaccine-only visits about wait times, travel costs, and other elements that were captured during regular service days. This information would likely have affected the costs associated with receiving vaccinations at the MCP; however, sensitivity analyses (5) to (8) demonstrated that variations in cost elements did not change the overall conclusion of the study.

Conclusions

This study focuses on vaccination services, a major part of pediatric care, and estimates the cost-benefit of mostly partial series administration provided by a MCP in medically underserved areas. Results suggest that vaccination services provided by the MCP were not cost-saving during regular service days but so during summer vaccine-only events. Compared with office-based settings, every dollar spent on vaccination by the MCP would result in $0.9 societal cost averted as an incremental benefit in regular service days and $3.7 during vaccination-only events. The results were robust to various alternative assumptions for benefit-related and cost-related parameters. Decision-makers and stakeholders may consider improving work efficiency during regular service days or hosting more vaccination-only events to improve cost-benefit of the vaccination services. The approach of this study can also be used by future studies to estimate the overall costs and benefits of the full range of services provided by pediatric mobile clinics.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgment

The authors thank the families who participated in this assessment; Aditi Gupta, DO, Cassandra Garcia, MSN, RN, FNP-BC, Margaret Ugalde, RN, DrPH, CPNP, Marili Jackson, MSN, RN, CPNP, Evangeline Ortiz, CMA, Marcella Berrios, MA, Crystal Medina, MA, and Juanita Alvarado who provided services through the Texas Children's Hospital Mobile Clinic Program; Kay Tittle MS, RN, FACHE, Stan Spinner, MD, and Heidi Schwartzwald, MD, MPH, for support and guidance; Kayla A. Calhoun for research assistance; Keisha A. Wayne for data entry; and Virginia A. Moyer, MD, MPH, for editorial assistance.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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Table 1.

Cost Estimates for Vaccination-Related Services and Activities of MCP in 2014.

	Regular Service Days[a]	Summer Event Days[a]	Total
Direct cost (attributable to vaccination) [b]			
MCP program cost, $	783764	105914	889678
Part attributable to vaccination, $	587823	105914	693737
Capital cost[c], $	110275	14902	125177
Part attributable to vaccination, $	82706	14902	97608
Vaccine purchase cost, $	579903	324674	904577
Travel cost			
No. of parents	3650	1500	
No. of patients	4625	1900	
Round trip cost per person, $	2.5	2.5	
Travel cost of parents and patients, $	20688	8500	
Part attributable to vaccination, $	15516	8500	24016
Direct cost [b] *, $*	1265947	453990	1719938
Direct cost per dose, $/dose	106.11	77.21	96.57
Societal cost [d]			
Direct cost[b], $	1265947	453990	1719938
Time loss of volunteers[d]			
No. of hours served, hour	1573	409	
Value of time (hourly wage), $/hour	7.25	Varied by title	
Opportunity cost of volunteers, $	11401	9742	
Part attributable to vaccination, $	8550	9742	18292
Time loss of parents[d]			
Average 1-way travel time, minutes	15	15	
Average early arrival time for a visit, minutes	7	60	
Average waiting time (total transit in a visit) spent by parent with			

	Regular Service Days[a]	Summer Event Days[a]	Total
1 child	76	5	
2 children	94	10	
3 children	125	15	
4 children	112	20	
Total time spent on a visit by parents with			
1 child	113	95	
2 children	131	100	
3 children	162	105	
4 children	149	110	
Total time of all parents in 2014, hours	7187	2,408	
Value of time (hourly wage), $/hour	7.25	7.25	
Opportunity cost of parents, $	52106	17455	
Part attributable to vaccination, $	39079	17455	56534
Societal cost[d]*, $*	1313577	481187	1794765
Societal cost per dose, $/dose	110.11	81.83	100.77

Abbreviation: MCP, mobile clinic program.

[a] The numbers represent estimates for all regular service days and all summer event days in 2014.

[b] Direct cost refers to direct medical and nonmedical costs for vaccination-related services and activities of the MCP, including cost borne by the MCP, capital cost, vaccine purchase cost, and patients' and parents' travel cost.

[c] Capital cost is the annualized donor-paid purchase cost of 2 mobile clinics in 2014 dollars.

[d] Societal cost is the sum of direct cost and opportunity cost or time loss of volunteers and parents (traveling to and waiting at mobile clinics). To value the time of volunteers, median hourly wages corresponding to the occupations of volunteers with various titles were used. For the values of parents' time or volunteers with unknown titles, we used the minimum hourly wage in Texas in 2014, obtained from the Bureau of Labor Statistics.

Table 2.

Estimation of Direct and Societal Cost Averted by Vaccine Component Among MCP-Vaccinated Children in 2014.

Vaccine Component[a]	Direct Cost Averted[b], 2014 $			Societal Cost Averted[c], 2014 $		
	Regular Service Days	Summer Event Days	Total	Regular Service Days	Summer Event Days	Total
DTaP	301402	213117	514519	1656541	1171318	2827859
Hep A	19549	10200	29749	38154	19907	58061
Hep B	15964	7588	23552	109799	52193	161992
Hib	35250	21613	56863	71516	43850	115366
HPV						
Female	144824	82666	227490	144,824	82666	227490
Male	53750	30725	84475	53750	30725	84475
Influenza	10560	0	10560	11294	0	11294
IPV	204249	136454	340703	495819	331246	827064
MCV4	2532	1383	3915	9763	5330	15092
MMR	608822	432523	1041345	1322765	939725	2262490
PCV13	35224	21659	56883	93754	57649	151402
Rota	3919	1284	5203	6996	2292	9288
Tdap	23053	12893	35945	36459	20391	56850
Var	79218	48266	127484	328470	200129	528599
Sum, 2014 $	1538316	1020370	2558686	4379903	2957419	7337322

Abbreviations: MCP, Texas Children's Hospital Mobile Clinic Program; DTaP, diphtheria and tetanus toxoids and acellular pertussis vaccine; HepA, hepatitis A vaccine; HepB, hepatitis B vaccine; Hib, *Haemophilus influenzae* type b conjugate vaccine; HPV, human papillomavirus vaccine; IPV, inactivated poliovirus vaccine; MCV4, quadrivalent meningococcal conjugate vaccine; MMR, measles, mumps, and rubella vaccine; PCV13, 13-valent pneumococcal conjugate vaccine; Rota, rotavirus vaccine; Tdap, tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccine; Var, varicella vaccine.

[a] Vaccine components were based on vaccines administered among the MCP patients in 2014.

[b] The direct cost averted associated with a full series of each vaccine component is the net savings per child from averted doctor visits, hospitalizations, and death minus cost associated with adverse events of vaccination. The numbers were calculated using the following information (1) number of doses for each vaccine component; (2) percentages of doses by dose order; (3) percentages of benefit attributable to each dose; and (4) direct cost averted of a full series of each vaccine. (1)–(3) are reported in Appendix Table A3(a), and (4) is reported in Appendix Table A4. All costs were adjusted to 2014 dollars.

[c] The societal cost averted associated with a full series of each vaccine component is the direct cost averted plus productivity loss due to mortality and morbidity. The numbers were calculated using the following information: (1) number of doses for each vaccine component; (2) percentages of doses by dose order; (3) percentages of benefit attributable to each dose; and (4) societal cost averted of a full series of each vaccine. (1)–(3) are reported in Appendix Table A3(a), and (4) is reported in Appendix Table A4. All costs were adjusted to 2014 dollars.

Table 3.

Cost-Benefit Results of MCP Vaccination Services in 2014 (All Costs and Benefits Were Adjusted to 2014 Dollars).

	Regular Service Days[a]	Summer Event Days[a]	Total
Vaccinating at MCP			
Cost			
Direct cost[b], $	1 265 947	453 990	1 719 938
Time loss[c], $	47 630	27 197	74 827
Societal cost[d], $	1 313 577	481 187	1 794 765
Benefit			
Direct cost averted[e], $	1 538 316	1 020 370	2 558 686
Societal cost averted[f], $	4 379 903	2 957 419	7337322
Vaccinating elsewhere without MCP			
Cost			
Direct cost[b], $	660 177	362 508	1 022 685
Time loss[c], $	41 114	19 251	60 365
Societal cost[d], $	701 292	381 758	1 083 050
Benefit			
Direct cost averted[e], $	1 329 917	888 446	2 218 363
Societal cost averted[f], $	3 827 844	2 592 713	6 420 557
Incremental cost-benefit			
Incremental cost[g]			
Incremental direct cost, $	605 770	91 482	697 253
Incremental societal cost, $	612 286	99 429	711 715
Incremental benefit[h]			
Incremental direct benefit, $	208 399	131 924	340 322
Incremental societal benefit, $	552 059	364 706	916 765
Incremental BCR			

	Regular Service Days[a]	Summer Event Days[a]	Total
Incremental direct BCR	0.34	1.44	0.49
Incremental societal BCR	0.90	3.67	1.29

Abbreviations: MCP, Texas Children's Hospital Mobile Clinic Program; BCR, benefit-cost ratio.

[a]The numbers represent estimates for all regular service days and all summer event days in 2014.

[b]Direct cost refers to direct medical and nonmedical costs for vaccination-related services and activities, For MCP, it includes cost borne by the MCP, capital cost, vaccine purchase cost, and patients' and parents' travel cost (see Table 1). For other providers when MCP is not available, it includes vaccine administration cost, vaccine purchase cost, and patients' and parents' travel cost (see Appendix Table A5).

[c]Opportunity cost or time loss of volunteers and parents (traveling to and waiting at mobile clinics). To value the time of volunteers, median hourly wages corresponding to the occupations of volunteers with various titles were used. For the values of parents' time or volunteers with unknown titles, we used the minimum hourly wage in Texas in 2014, obtained from the Bureau of Labor Statistics.

[d]Societal cost is the sum of direct cost and time loss.

[e]The direct cost averted associated with a full series of each vaccine component is the net savings per child from averted doctor visits, hospitalizations, and death minus cost associated with adverse events of vaccination. All costs were adjusted to 2014 dollars.

[f]The societal cost averted associated with a full series of each vaccine component is the direct cost averted plus productivity loss due to mortality and morbidity. All costs were adjusted to 2014 dollars.

[g]Incremental cost equals to the direct (societal) cost of vaccinating at MCP minus the direct (societal) cost of vaccinating elsewhere without MCP.

[h]Incremental cost-benefit refers to the difference in cost divided by the difference in benefit when comparing vaccinating at MCP with vaccinating elsewhere without MCP.

Table 4.

Sensitivity Analyses[a].

	Incremental Direct BCR			Incremental Societal BCR		
	Regular Service Days	Summer Event Days	Total	Regular Service Days	Summer Event Days	Total
Baseline Model	0.34	1.44	0.49	0.90	3.67	1.29
Sensitivity Analyses						
(1) Varying vaccine coverage rates	0.28–0.41	1.16–1.72	0.40–0.58	0.74–1.06	2.96–4.40	1.06–1.52
(2) Varying estimates of direct/societal costs averted	0.27–0.41	1.15–1.73	0.39–0.59	0.72–1.08	2.93–4.40	1.03–1.55
(3) Varying benefit attributable to the n^{th} dose	0.33–0.39	1.38–1.66	0.47–0.56	0.86–1.02	3.51–4.17	1.23–1.46
(4) Varying percentages of doses given as the n^{th} dose	0.32–0.39	1.41–1.86	0.46–0.56	0.86–1.01	3.64–4.65	1.24–1.47
(5) Varying % of resources attributable to vaccination	0.30–0.41	1.44	0.43–0.56	0.78–1.07	3.67	1.13–1.49
(6) Varying life years of mobile clinics	0.31–0.37	1.26–1.55	0.44–0.52	0.81–0.96	3.25–3.92	1.15–1.37
(7) Varying value of parents' and volunteers' time	0.34	1.44	0.49	0.88–0.90	3.67– 3.83	1.27–1.29
(8) Varying travel cost	0.34–0.35	1.43–1.46	0.49–0.49	0.90–0.91	3.63–3.70	1.28–1.29
(9) No vaccination as the comparator	1.22	2.25	1.49	3.33	6.15	4.09

Abbreviations: BCR, benefit-cost ratio; MCP, Texas Children's Hospital Mobile Clinic Program.

[a]The baseline model estimates the incremental cost-benefit of the MCP relative to other vaccination providers, assuming, in absence of the MCP, some vaccines were administered elsewhere with probability equal to vaccine coverage rates. The incremental direct (societal) BCR is incremental direct (societal) cost averted (difference in direct or societal cost averted among vaccines received from the MCP and vaccines received elsewhere) divided by the incremental direct (societal) cost (differences in direct or societal cost of vaccination in the MCP and vaccination elsewhere).

Sensitivity analysis (1) assumes vaccine coverage rates vary within the 95% confidence intervals of the estimates (listed in Appendix Table A3[c]) following truncated normal distributions.

Sensitivity analysis (2) assumes the benefit estimates (direct/societal costs averted) of non-influenza vaccines vary 20% below and above the baseline levels; the benefit estimate of IIV varies from 50% to 150% of the baseline; and the benefit estimate of LAIV varies from 0% to 110% of the baseline.

Sensitivity analysis (3) assumes the percentages of benefit attributed to each dose vary 20% below and above the baseline levels (starting from the dose with the greatest benefit share).

Sensitivity analysis (4) assumes the percentages of each dose administered vary 20% below and above the baseline.

Sensitivity analysis (5) assumes the percentage of resources used for vaccination during regular service days varies from 65% to 85% (10 percentage points below and above the baseline).

Sensitivity analysis (6) assumes the life years of mobile clinics vary from 5 to 20 years.

Sensitivity analysis (7) assumes the opportunity cost per hour for volunteers (whose titles were unknown) during regular days was the average wage in Houston and opportunity cost per hour for parents varies from the minimum to the average wage in Houston.

Sensitivity analysis (8) assumes travel cost varies 20% below and above the baseline.

Sensitivity analysis (9) assumes that children would forgo vaccination had MCP not existed.

The reported results of (1), (3), and (4) are the 95% credible ranges of incremental BCRs generated by Monte Carlo simulation (10000 iterations).