Cost of Vaccine Administration Among Pediatric Practices

abstract

OBJECTIVE: The goal was to describe variable costs to providers of delivering childhood immunizations.

METHODS: We documented variable costs (costs that vary with the amount of services rendered), including time spent by pediatric staff members and physicians on immunization-related activities, as well as supply costs and medical waste disposal costs. Ten private pediatric practices in the Denver, Colorado, metropolitan area participated in the study. Among the 7 practices that provided us with payment data, 8 health plans were mentioned by ≥2 practices. There were 37 different agreements between the health plans and practices for vaccine administration payments.

RESULTS: The total documented variable cost per injection (excluding vaccine cost) averaged $11.51, calculated from the following categories: nursing time, $1.71; billing services, $2.67; nonroutine services, $1.64; registry use, $0.96; physician time, $4.05; supplies, $0.36; medical waste disposal, $0.12. Nonroutine activities primarily included performing vaccine inventory and ordering, providing vaccination records to requesters, and answering parent telephone questions about vaccinations. With the use of a simulation model to compensate for the small number of participating practices, the calculated total variable cost per injection was $11.83. When 2 vaccines were administered, we compared the sum of the 2 payments with the sum of the 2 variable costs ($23.02). More than one third of the payment agreements (13 of 37 agreements) paid the practices less than the combined variable costs for 2 immunizations.

CONCLUSION: This study shows that the variable costs of vaccine administration exceeded reimbursement from some insurers and health plans. *Pediatrics* 2009;124:S492–S498

AUTHORS: Judith E. Glazner, MS,[a] Brenda Beaty, MSPH,[b] and Stephen Berman, MD[c,d]

[a]Department of Health Systems, Management, and Policy, Colorado School of Public Health, Aurora, Colorado; [b]Colorado Health Outcomes Program and [c]Department of Pediatrics, University of Colorado School of Medicine, Denver, Colorado; and [d]Department of General Academic Pediatrics, Children's Hospital, Aurora, Colorado

KEY WORDS

vaccine administration, variable costs, immunizations

www.pediatrics.org/cgi/doi/10.1542/peds.2009-1542H

doi:10.1542/peds.2009-1542H

Accepted for publication Aug 25, 2009

Address correspondence to Stephen Berman, MD, Children's Hospital, 13123 E 16th Ave, B032, Aurora, CO 80045. E-mail: berman.stephen@tchden.org

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

FINANCIAL DISCLOSURE: *The authors have indicated they have no financial relationships relevant to this article to disclose.*

Immunization-related activities account for a considerable proportion of the office practice activities of primary care pediatricians. During the past decade, the Centers for Disease Control and Prevention and the American Academy of Pediatrics have tried to increase the proportion of children who receive all vaccinations in the context of comprehensive primary care or in their medical homes,[1–3] because referrals out of the medical home can result in scattered immunization records,[4] delayed immunization, and a reduction in continuity of care.[1,2,5–7] Moreover, providing all vaccinations in children's medical homes improves vaccination rates and other aspects of primary care.[1,7–9] The sustainability of primary care private practice settings immunizing most children requires adequate payments from both public and private payers for administration of vaccines and reimbursement of the costs of vaccines when they are not provided free of charge by the federal Vaccines for Children program. To determine whether payments are adequate, it is necessary to determine practices' variable costs for vaccine administration.

This study's focus was to measure the variable costs to pediatric practices of vaccine administration in 2007 and to compare the costs with health plans' payment levels, to determine whether pediatric practices are being paid adequately for their work. Moreover, because we completed a similar study in 2001,[10] we were able to compare the earlier costs with those found in the current study, to determine whether there was a difference between the 2 periods.

METHODS

Participants

Ten private pediatric practices in the Denver, Colorado, metropolitan area participated in the study. The practices varied in urban/suburban location and in size, with 4 urban and 6 suburban practices. The number of physicians in the participating offices ranged from 3 to 8, with a median of 6. Six practices participated during August 2007 and 4 participated during October, November, and the first week of December. We included the 4 pediatric practices that had participated in the 2001 immunization administration study. The other practices were selected on the basis of their previous willingness to participate in other research studies conducted by Dr Berman. In Colorado, practices are paid on a fee-for-service basis. Colorado is not a universal-purchase state.

Data Collection

We estimated pediatrician practice costs by using a microcosting approach. This method involves individual measurement of resources used to provide a given medical service and is the method for estimation of costs preferred by the US Panel on Cost-effectiveness in Medicine.[11] By using this approach, we collected time and cost data on every immunization-related activity performed by practice staff members, as well as the cost of immunization-related supplies. All staff members at participating practices completed time diaries for these activities for a minimum of 2 days, as long as data for ≥100 injections (or oral vaccine administrations) were recorded; this was required to achieve stability of time and cost estimates. Smaller practices kept diaries for 3 days to reach the threshold of 100 injections. There were 4 different diaries for 4 distinct types of activities, that is, nursing, billing, using and updating the immunization registry, and nonroutine activities such as vaccine inventory and ordering and answering telephone questions about vaccinations. Table 1 shows the tasks in each diary for which times were recorded.

TABLE 1 Immunization-Related Activities Recorded by Staff Members of Pediatric Practices in the Denver Metropolitan Area in 2007

Routine nursing activities (occur each time vaccination is given)
Obtain parental consent
Provide vaccine information to parent
Review medical or registry record for vaccination history
Complete vaccination log in chart
Fill out patient's injection record
Draw and give vaccine
Nonroutine activities (occur at times other than when vaccination is given)
Order vaccine
Inventory vaccine
Provide vaccination records to requesters
Answer telephone questions about vaccinations
Receive vaccination-related continuing education
Billing activities
Update information on patient's billing records
Receive payment at time of service
Obtain billing information for new patient
Produce bill for insurer or patient
Mail bills
Post payments
Make bill adjustments
Immunization registry activities
Screen registry data to prepare for upcoming appointments
Enter injections into registry database
Enter history and demographic data
Solve registry technical problems

Physicians were not asked to keep time diaries but were interviewed about the time they spent on immunization activities during a well-child visit, as well as immunization-related activities occurring outside the visit. Practice administrators also were interviewed and were asked to provide data on items such as the monthly cost of waste disposal, whether the practice had bought a new refrigerator since the beginning of the vaccine schedule's expansion, and vaccine-ordering practices, in addition to the time they spent on immunization activities.

After all data were collected and verified, we completed a spreadsheet for all staff members for each practice for all activities in the major categories (ie, nursing, billing, registry use, non-

routine activities, and physician activities). We recorded the time spent on each activity and the job title of the staff member who performed the activity for each practice. To convert the time to cost, we used median salaries for the Denver metropolitan area for each job class (eg, receptionist, medical assistant, pediatrician, registered nurse, and billing clerk), as provided by the Bureau of Labor Statistics.[12] We calculated benefits on the basis of benefit percentages for each job class.[13]

To calculate practice time and costs associated with vaccination administration, we averaged the time reported for each major activity across all practices. We then calculated an average cost per injection by dividing the cost of each category across all practices by the total number of injections administered by all practices. This method takes into account any cost savings associated with administering multiple injections. It also allows the combined variable costs of multiple injections to be compared with the sum of vaccine administration payments for the initial and additional immunizations.

Variable Cost Measurement

Variable costs are those that vary with the amount of production, in this case, administration of vaccinations. Variable costs are those used in decision-making about whether to provide the service or to produce the product. Fixed costs (eg, rent and malpractice insurance) typically are not included in such decision-making because they do not change whether vaccinations are provided or not. If, by administering vaccinations, a practice can cover its variable costs and contribute something to fixed costs (ie, payments exceed variable costs), then the reasonable decision would be to deliver vaccinations. We also included supply costs and medical waste-disposal costs. Variable costs are expressed throughout the report as cost per injection (or oral administration). This analytic unit is used rather than antigen because there are combination vaccinations.

In addition to measuring variable costs, we took into account several other costs, including the cost of any new equipment and other expenditures such as vaccine insurance necessitated by the fact that more vaccines must be kept in stock. Refrigerators, generators, and other equipment usually are treated as fixed costs; however, because we wanted to portray all costs associated with the expansion of the immunization schedule, we collected data on the cost of those items.

Insurance Reimbursement for Immunization Administration

Different health plans pay different amounts for vaccine administration. Moreover, the same health plan may pay different amounts to different practices, depending on the agreements negotiated. We collected vaccine administration payment data from the practices for their largest payers (ie, the payers accounting for the most reimbursement, in aggregate, for each practice). These payments included Current Procedural Terminology codes 90465, 90466, 90471, and 90472.

Comparison With 2001 Vaccine Administration Costs, With Inflation Adjustment

We conducted a study in 2001 by using the methods we used in 2007.[10] In 2001, we analyzed vaccine administration costs for 4 pediatric practices. For the 2007 study, we analyzed costs for 10 practices, including the 4 that participated in 2001. Therefore, we were able to compare the costs for pediatric practices in 2001 with those for practices in 2007. To compare the cost data for 2007 with those for 2001, all cost data were adjusted to 2007 dollars by using the Consumer Price Index[14] for medical care for the United States.

Statistical Analyses

When estimates of the average cost of delivering vaccinations are based on a small number of observations, they may not represent the entire range of vaccine administration costs for pediatric practices. To compensate for the small number of practices in this study, we performed stochastic risk analyses by using Crystal Ball 7.3.1 (Oracle, Redwood Shores, CA), to estimate the range and probabilities of outcomes by randomly varying the cost variables about which there was uncertainty. These variables included costs of provider time, nursing time, billing time, registry time, and time for nonroutine activities. We modeled these costs as logarithmic-normal distributions on the basis of the distribution of the data we collected, by substituting in a Microsoft Excel (Microsoft, Redmond, WA) spreadsheet the appropriate, logarithmic-normally distributed, random variables for corresponding estimates for the practices, using the Crystal Ball program. To generate the random variables, we used Monte Carlo sampling to simulate values for the probability distributions contained in the spreadsheet. To find the range of possible outcomes and their probabilities, we recalculated the spreadsheet 1000 times. This is, in effect, a sensitivity analysis and is similar to that conducted in our previous study.

RESULTS

Variable Cost Per Injection

The mean number of immunizations given at a well-child visit in the study was 2.45 (range: 1.86–3.03 immunizations). Table 2 shows the time and cost per category of immunization activity

TABLE 2 Time and Cost per Injection for Administration of Vaccinations in 10 Pediatric Practices in 2007

Category	Time per Injection, min	Cost per Injection, Mean, $	Cost Calculated With Simulation Model, $	
			Mean ± SD	Median
Personnel				
Nursing	3.87	1.71	1.79 ± 1.01	1.52
Billing	5.23	2.67	3.10 ± 1.81	2.75
Nonroutine[a]	3.78	1.64	1.64 ± 0.61	1.53
Registry	2.11	0.96	0.96 ± 0.46	0.89
Physician	2.62	4.05	4.30 ± 1.38	3.87
Total for personnel	17.61	11.03		
Supplies				
Syringe and needles		0.36		
Medical waste disposal		0.12		
Total variable costs		11.51	11.83 ± 2.52	11.55

[a] Nonroutine activities primarily include performing vaccine inventory and ordering, providing vaccination records to requesters, and answering parent telephone questions about vaccinations.

TABLE 3 Comparison of Time and Cost per Injection in Practices Participating in 2001 and Practices Participating in 2007

Category	Time per Injection, min		Cost per Injection, $[a]	
	2007 (10 Practices)	2001 (4 Practices)	2007	2001
Nursing	3.87	4.23	1.71	1.83
Billing	5.23	5.49	2.67	1.99
Nonroutine[b]	3.78	0.57	1.64	0.43
Registry	2.11	3.46	0.96	1.14
Physician	2.62	2.75	4.05	4.04
Total for personnel	17.61	16.5	11.03	9.44
Supplies			0.36	0.47
Waste disposal			0.12	c
Total per injection			11.51	9.90

[a] Costs are expressed in 2007 dollars.
[b] Nonroutine activities primarily include performing vaccine inventory and ordering, providing vaccination records to requesters, and answering parent telephone questions about vaccinations.
[c] Not measured in 2001.

for the 10 practices studied in 2007. The time of >17 minutes per injection spent by all office personnel in immunization activities accounted for $11.03 per injection; additional nonpersonnel costs amounted to less than $0.50.

Table 3 compares time and cost per injection for the 4 practices involved in the 2001 study and the 10 practices involved in the 2007 study. More time was spent in immunization-related activities in 2007 than in 2001. With adjustment for inflation, this amounted to a cost difference of $1.49 with the exclusion of waste disposal, which was not considered in 2001.

Table 4 compares immunization time and cost for the 4 practices that participated in both the 2001 and 2007 studies. In every category except nonroutine activities, time spent on vaccinations was less in 2007 than in 2001 for these 4 practices. The time spent on registry activities was sharply lower (59% lower). Efficient registry use can have effects on other activities, particularly nursing activities, in that it reduces the time spent examining medical records for immunization status. Overall, these 4 practices became more efficient (ie, spent less time per injection) between 2001 and 2007 and spent nearly 2 minutes, or 12%, less per injection.

Simulation Results

The results of our simulation analysis for total personnel time were close to the averages we calculated. The mean total cost after statistical analysis was $11.83, higher than our original mean of $11.51.

Nonvariable Costs

Other costs we investigated included equipment (refrigerators, generators, and other equipment necessitated by the expanded immunization schedule), vaccine insurance, and other related costs. Seven of 10 practices had purchased new refrigerators in the past 3 years. The prices ranged from $298 to $5535, and the median cost was $3175. Amortization of the cost of refrigerators over 5 years (estimated to be their useful clinical life) added pennies to

TABLE 4 Comparison of Time and Cost per Injection for Immunization Activities in 2001 and 2007 for 4 Practices Included in Both 2001 and 2007 Surveys

Category	Time per Injection, min		Cost per Injection, $[a]	
	2007	2001	2007	2001
Nursing	2.46	4.23	1.12	1.83
Billing	4.91	5.49	2.80	1.99
Nonroutine[b]	3.36	0.57	1.56	0.43
Registry	1.43	3.46	0.75	1.14
Physician	2.35	2.75	3.56	4.04
Total for personnel	14.51	16.5	9.79	9.44
Supplies			0.48	0.47
Waste disposal			0.12	c
Total per injection			10.39	9.90

[a] Costs are expressed in 2007 dollars.
[b] Nonroutine activities primarily include performing vaccine inventory and ordering, providing vaccination records to requesters, and answering parent telephone questions about vaccinations.
[c] Not measured in 2001.

TABLE 5 Reimbursement Ranges for Vaccine Administration Codes for 5 Major Insurers and Medicaid

Insurer	Reimbursement Range, $	
	Initial Vaccine Administration	Subsequent Vaccine Administrations
1	9.18–16.04	4.53–18.54
2	15.00–24.26	11.00–14.28
3	9.70–23.47	6.59–24.73
4	8.00–24.42	6.00–21.67
5	9.70–22.26	6.59–25.44
Medicaid	6.50	6.50

the cost per injection; the range of additional costs was $0.005 to $0.11. None of the practices bought back-up generators. Only 2 practices bought specific vaccine insurance policies. Most others said that vaccine loss was covered under their general property insurance.

Vaccine wastage was reported as negligible by all practices. The number of doses wasted per year ranged from 0 (2 practices) to 150 (the largest practice in the study), and the median was 10. Of all wasted doses, 33% were wasted because of vaccine expiration. Wastage amounted to ~0.1% of the number of injections given by the practices in 2007.

Payment for Vaccine Administration

The range of vaccine administration payment rates for the first vaccine and subsequent vaccines was large, even with the same insurance company. Table 5 shows the ranges in reimbursement for the practices participating in the study. Many of the lower reimbursement levels were less than the variable costs of providing vaccinations.

Examining the reimbursement data from the 8 health plans mentioned by ≥2 practices is quite complicated. Among the 7 practices that provided us with payment data, 8 health plans were mentioned by ≥2 practices. There were 37 different agreements between these health plans and practices for vaccine administration payments. With $11.51 as the variable cost for the first vaccine administration code, 1 health plan paid less than the variable cost in every practice, 1 paid less in 29% of practices, 2 paid less in 14% of practices, and 4 paid more than the variable cost in every practice. Overall, 63% of health plans paid less for the first vaccine administered in ≥1 practice. It was more common to underreimburse for the second or greater vaccine administration code. For instance, 1 health plan paid less than the variable cost in every practice, 2 paid less in ≥50% of practices, 2 paid less in 33% of practices, 1 paid less in 29% of practices, and 2 paid more than the variable cost in every practice. Overall, 75% paid less for additional vaccines in ≥1 practice. When 2 vaccines were administered, we compared the sum of the 2 payments with the sum of the 2 variable costs ($23.02). In this scenario, 1 health plan paid less than the combined variable costs in every practice, 1 paid less in 50% of practices, 1 paid less in 43% of practices, 1 paid less in 29% of practices, 1 paid less in 14% of practices, and 3 paid more than the variable cost in every practice. More than one third of the agreements (13 of 37 agreements) paid the practices less for 2 immunizations.

Inventory

Virtually all practices used some type of "just-in-time" inventory method. All practices said that they performed inventory frequently and ordered what they needed for an ~2-week period. All also said that they took advantage of manufacturers' special pricing. One practice examined its patients needing vaccinations in the near term and ordered specific types of vaccine on the basis of those needs.

Vaccine Refusal

With adverse vaccine publicity, there is uncertainty about the frequency of parents refusing vaccines for their children. Because of this concern, we asked pediatricians to estimate the proportions of refusals they encountered in visits. Eleven estimates were between 1 and 5%, 16 were 5%, and 3 were 10%.

DISCUSSION

There has been an increase in the time spent by office staff members on vaccination-related activities since the expansion of the immunization schedule. We did not document an increase in the time pediatricians spend counseling parents regarding vaccines. However, this may vary depending on attention to concerns about vaccines in the national media. Our impression, which was supported by the data we collected, is that practices have become more efficient in most immunization-related activities.

The greatest difference in time spent on vaccination-related activities occurred in the time spent on nonroutine activities (more than sixfold difference). Activities in this category included inventory control and purchasing and answering telephone questions from parents about which vaccinations are due. Inventory control has become a high priority in pediatric practices. None of the practices reported keeping vaccine for long periods. The wastage attributable to vaccine expiration reported in the study indicates effective inventory and buying practices. Previous time-motion studies of vaccine administration documented 1 to 2 minutes of nursing time directly related to drawing up and administering vaccines.[15–17] However, this study considered a broader range of staff vaccine-related activities (Table 1) that should be included in calculations of total variable costs per injection.

Our data show that vaccine administration payments in both the private and public sectors often do not cover variable costs or fixed costs. There was large variability in the rates of payments to different practices in the same health plan, as well as among health plans. One plan, for instance, reimbursed 1 practice 75% more than another practice, whereas there was a threefold range of payments with another plan. This study did not explore reasons for this variability. Possible reasons include the effectiveness of practice documentation of specific costs, practice size and prestige, and negotiation abilities.

The principal limitation of this analysis was the small sample size; only 10 practices participated. Mitigating this to some extent was the fact that data were collected for 1789 injections. Moreover, the extensive sensitivity analysis we conducted helped to compensate for the small sample size; it found both median and mean costs close to the mean we calculated. Although the results are applicable only to the Denver metropolitan area, the usefulness of these data would be enhanced if similar studies in different regions of the country documented similar findings. Another limitation is that we did not observe practice staff members in immunization activities, to determine the time spent on each activity. This is the gold standard method for estimating the time spent on any activity, but this level of data collection was not realistic, given the resources available. We relied on self-reports for estimations of the time spent on each activity. Although this approach is imperfect, it is better than other methods, such as interviews or questionnaires asking respondents to estimate times. Also, the use of detailed forms to collect data on the frequency and length of time for immunization activities likely minimized errors. We interviewed physicians and asked them to estimate the time they spent on immunization activities during an office visit. We thought that it was unrealistic to ask physicians to record the time spent on immunization activities during office visits. Again, the use of the Crystal Ball analysis helped to compensate for this limitation and should reassure readers about the use of self-reports.

Practices may be more willing to accept lower administration payments from health plans if they can shift this expense to higher reimbursements for vaccine purchases. Some insurers may be reimbursing pediatricians for purchasing vaccines at rates that include the costs of ordering, inventory control, and newly purchased equipment. The variable costs presented here could be adjusted to reflect such payments. Because a number of vaccines actually save money that otherwise would be spent on treating illnesses, it is not in the interests of health plans/insurers or the public that this particular service be underfunded.

CONCLUSIONS

This analysis documents the variable costs of vaccine administration and finds that public and private health plans/insurers often are not covering these variable costs. This should inform discussions of vaccination policy with public and private health plans within the context of a public discourse about the importance of immunization and its adequate funding.

ACKNOWLEDGMENTS

This study was funded by a grant from the American Academy of Pediatrics.

We thank the pediatric practices that spent considerable time participating in this study. They made a very important contribution to the understanding of vaccine financing in the United States.

REFERENCES

1. Szilagyi PG, Humiston SSG, Shone LP, Barth R, Kolasa MS, Rodewald LE. Impact of vaccine financing on vaccinations delivered by health department clinics. *Am J Public Health*. 2000;90(5):739–745
2. Zimmerman RK, Medsger AR, Ricci EM, Raymund M, Mieczkowski TA, Grufferman S. Impact of free vaccine and insurance status on physician referral of children to public vaccine clinics. *JAMA*. 1997;278(12):996–1000
3. American Academy of Pediatrics, Committee on Practice and Ambulatory Medicine. Implementation of the immunization policy (S94–26). *Pediatrics*. 1995;96(2):360–361
4. Stokley S, Rodewald LE, Maes EF. The impact of record scattering on the measurement of immunization coverage. *Pediatrics*. 2001; 107(1):91–96
5. Szilagyi PG, Humiston SSG, Shone LP, Barth R, Kolasa MS, Rodewald LE. Decline in physician referrals to health department clinics for immunizations: the role of vaccine financing. *Am J Prev Med*. 2000;18(4): 318–324
6. Zimmerman RK, Mieczkowski TA, Mainzer HM, et al. Effect of the Vaccines for Children program on physician referral of children to public vaccine clinics: a pre-post comparison. *Pediatrics*. 2001;108(2): 297–304
7. Forgione DA, Galbraith KS, Galbraith KH. Incentivising appropriate care: the case of immunizations. *J Health Care Finance*. 2000; 27(1):21–28
8. Bordley WC, Margolis PA, Lannon CM. The delivery of immunizations and other preventive services in private practices. *Pediatrics*. 1996;97(4):467–472
9. Rodewald LE, Szilagyi PG, Holl J, Shone LR, Zwansiger J, Raubertas RF. Health insurance for low-income working families: effect on the provision of immunizations to preschool-age children. *Arch Pediatr Adolesc Med*. 1997;151(8):798–803
10. Glazner JE, Beaty B, Pearson K, Berman S. The cost of giving childhood vaccinations: differences among provider types. *Pediatrics*. 2004;113(6):1582–1587
11. Luce BR, Manning WG, Siegel JE, Lipscomb J. Estimating costs in cost-effectiveness analysis. In: Gold MR, Siegel JE, Russel LB, Weinstein MC, eds. *Cost-effectiveness in Health and Medicine*. New York, NY: Oxford University Press; 1996:176–213

12. Bureau of Labor Statistics. Occupational Employment Statistics: May 2008 National Employment and Wage Estimates, United States. Available at: www.bls.gov/oes/current/oes_nat.htm. Accessed July 10, 2008
13. Salary.com. Salary wizard. Available at: http://swz.salary.com/salarywizard/layoutscripts/swzl_selectjob.asp?op=salswz_psr&hdSearchByOption=0&hdLocationOption=0&hdKeyword=health+care+practicioners&hdJobCategory=&hdZipCode=80220&hdStateMetro=&hdNarrowDesc=&rdbSearchByOption=0&txtKeyword=health+care+practicioners&rdbLocationOption=0&txtZipCode=80220. Accessed July 10, 2008
14. US Bureau of Labor Statistics. Consumer Price Index. Databases: Consumer Price Index-All Urban Consumers. Available at: http://data.bls.gov/PDQ/servlet/SurveyOutputServlet;jsessionid=a2301144b081a1067647. Accessed July 15, 2008
15. Pellissier JM, Coplan PM, Jackson LA, May JE. The effect of additional shots on the vaccine administration process: results of a time-motion study in 2 settings. *Am J Manag Care.* 2000;6(9):1038–1044
16. LeBaron CW, Rodewald L, Humiston S. How much time is spent on well-child care and vaccinations? *Arch Pediatr Adolesc Med.* 1999;153(11):1154–1159
17. Szilagyi PG, Iwane MK, Humiston SE, et al. Time spent by primary care practices on pediatric influenza vaccination visits: implications for universal influenza vaccination. *Arch Pediatr Adolesc Med.* 2003;157(2):191–195

Cost of Vaccine Administration Among Pediatric Practices

Judith E. Glazner, Brenda Beaty and Stephen Berman

Pediatrics 2009;124;S492
DOI: 10.1542/peds.2009-1542H

PEDIATRICS®
OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

Cost of Vaccine Administration Among Pediatric Practices

Judith E. Glazner, Brenda Beaty and Stephen Berman

Pediatrics 2009;124;S492
DOI: 10.1542/peds.2009-1542H