Using an Immunization Registry: Effect on Practice Costs and Time

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Introduction.—Immunization registries can consolidate immunization records scattered among different providers, allowing immunization documentation for legal purposes, generation of needed-immunization lists, inventory management, and outreach for underimmunized children. They have been endorsed by the Centers for Disease Control and Prevention and health professionals as a means of sustaining high immunization rates. However, some providers perceive the cost of registry use as a barrier to participation. We sought to determine the effects of registry use on cost and time.

Methods.—We used a pre-post design and a cost-accounting approach to measure labor costs and time for immunization-related activities possibly affected by registry use before development of a regional registry in Colorado and after the registry was being fully used. Two rural family practices, 2 rural community health centers (CHCs), 3 urban pediatric practices, and 2 rural public health agencies participated in both periods.

Results.—Cost per shot increased slightly in the postregistry period for private practices and CHCs ($0.56 per shot in 2001 dollars) and public health agencies ($0.38). Since costs can increase for several reasons, including salary increases above inflation, we analyzed time spent per shot and found that staff time decreased for private practices and CHCs but increased substantially for public health agencies.

Conclusions.—The study findings suggest to private practices that registry participation can provide a net benefit by making the vaccination process more efficient and, absent above-average salary increases, less costly. Public health agencies, however, would have to rely exclusively on the registry and eschew the use of paper vaccination records to realize efficiencies seen by other practice types.

KEY WORDS: cost analysis; immunization; registries; vaccination

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The National Vaccine Advisory Committee and public health professionals have promoted immunization registries as a method for improving and sustaining childhood immunization rates.[1] They have also been endorsed by the American Academy of Pediatrics.[2] The 2010 Health Objectives for the Nation specify that the proportion of children younger than 6 years participating in fully operational registries should increase to 95% by 2010.[3]

Immunization registries can consolidate multiple immunization records scattered among different providers into complete immunization histories, allowing documentation of immunizations for various legal purposes, generation of lists of children needing immunizations, management of vaccine inventory, and support of outreach for underimmunized children. With these capabilities, registries can address population-wide problems of underimmunization,[4,5] inappropriately timed immunizations,[6] overimmunization,[6,7] and erroneous measurement of immunization coverage.[8,9] At the provider level, registries provide data to assist in managing vaccine supplies, generate complete vaccination records for providers and parents for a variety of purposes, including those required for school, camp, and other activities, keep track of children needing to catch up on vaccinations in times of vaccine shortages, and prompt practices to remind patients when vaccinations are due.

Several studies have documented registry costs. Some have focused on development costs alone[10] or on development and maintenance costs from the point of view of registry developers and operators.[11] Others have measured the costs borne by provider participants and developers.[12–14] Rask et al,[15] however, focused on the cost to providers of registry participation and examined costs to public health clinics, community health centers (CHCs), and hospital-based pediatric clinics. An important limitation of this study is that private, office-based practices were not included.

Studies that addressed provider costs sometimes calculated offset costs, those costs avoided by virtue of participating in a registry.[12,13] These costs included prevention of overimmunization and not having to manually retrieve records for school entry or child care, generate ''behind'' lists, or produce vaccine use reports. In such studies, costs associated with performing these tasks manually were estimated separately by observation or interview.

The current study addresses providers' labor costs that could be affected by participation in a registry. We included public health agencies, CHCs, private rural family

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practices, and private urban pediatric practices. For registries to be successful, vaccinations provided by all immunization providers, public and private, in the area served must be captured. It is important to include private office-based physicians in registry cost studies, since the incentives facing private practitioners may differ from those of public health clinics, CHCs, and hospital clinics. Bordley et al[16] found that private physicians perceived costs to practices and staff time (also a direct cost) as important barriers to registry participation.

To determine the net cost of registry participation for providers, the current study examines the full range of immunization-related activities that occur during and in preparation for a child's office visit, including activities than could be affected by participation in a registry (eg, time spent reviewing the patient's medical record to determine immunization status). Hence, this study measures a wider range of visit-related costs and cost offsets for clinicians than have been included in other studies. Primarily societal offsets, such as avoidance of overimmunization, however, are not considered. This study also does not include costs associated with initial registry implementation.

METHODS

Participants

We were interested in differences in providers' cost of delivering vaccinations before participating in a registry and after registry implementation. We therefore used a pre-post experimental design, collecting cost data from rural sites participating in the Colorado Rural Immunization Services Project (CRISP), which tested methods of improving early childhood vaccination rates, principally the use of an immunization registry. We also collected cost data from 3 urban sites before registry development and again after the CRISP registry had been developed and was being used by these practices. On review of the proposed study, the Colorado Multiple Institutional Review Board deemed it exempt from oversight.

In 1997, before registry development, 6 rural private practices, 4 rural public health departments or county nursing services, and 3 rural CHCs participated in the cost study. These were the only practices that served children in the 4 CRISP study communities. In 2001, the postregistry period, only 2 of these private practices and 2 CHCs participated in the cost study. Among the health departments or county nursing services, 2 participated in the study. Of the 4 private practices that did not participate, 1 had closed before 2001, and 3 declined to participate. One CHC also declined. The time commitment for participating in the study was substantial; this was the reason given by practices for not participating in 2001. Two health department or nursing services did not participate in this analysis because they were using a registry in the earlier period. Therefore, any data they provided in that period could not be considered to be preregistry data. The rural CRISP practices implemented the registry in mid-2001 and provided cost data during October 2001.

In addition to collecting cost data from CRISP practices in 1997, we collected cost data for immunization-related activities from 3 urban pediatric practices in the Denver metropolitan area during the same year. These practices implemented the CRISP registry in early 2002 and provided cost data in late August 2002 with the same data collection forms as those used by the rural practices.

Data Collection

Historical charges have often been used to estimate physician practice costs, but they may not reflect actual costs of rendering services.[17,18] To estimate actual costs of delivering vaccinations, we therefore used a cost-accounting approach to measure variable practice costs (ie, labor) in both periods.[19]

Forms on which office staff and nonphysician providers recorded time spent on vaccination-related activities were developed in conjunction with participating practices, pilot-tested, and modified. With identical forms, public health agency, CHC, and rural private practice staff kept track of time spent on vaccination-related activities for one calendar month during 1997 and 2001; urban practices kept such records with identical forms for one calendar month in 1997 and a calendar week during 2002. The 1997 data were collected from urban practices in December, a ''slow'' time of year for immunizations but a busy time for other visits, since it was the middle of the flu season, whereas the 2002 data were collected just before the school year, a busy time for vaccinations. Our primary concerns in the postregistry period were collecting data for a period sufficient for the practice to provide at least 50 immunizations and at a time several months after implementing the registry to allow for each practice to become familiar with its use and to begin using it for all pediatric patients. One new data collection form for measuring time spent on registry-related activities was completed by practices in the postregistry period. It was designed to elicit information regarding time spent on registry activities after the registry was fully operational within the practice. Much of this time involved updating the registry with patient demographic data (primarily for new patients) and vaccinations given.

Data collection forms for practice staff specifically asked for time spent on vaccination-related activities that occurred during and before each visit in which a vaccination was administered (Table 1). For nonphysician staff, actual hourly salary and benefits costs were obtained. To determine cost per shot, time spent by each health professional and staff member involved in giving vaccinations was multiplied by applicable salary and benefits; the products of this operation were then summed, and the total divided by the number of shots provided.

Physicians did not keep track of time spent on vaccination-related activities. Instead, a CRISP project nurse interviewed each physician once during each study period (preregistry and postregistry periods) with a standard interview form about vaccination activities performed during a typical well-child visit, including reviewing the record; completing the ''superbill,'' immunization logs, and

Table 1. Vaccination-Related Activities Recorded by Staff of Participating Medical Practices During the Preregistry and Postregistry Periods

Nonroutine Activities Related to Providing Vaccinations*	Routine Nursing Activities†	Immunization Registry Activities‡
Order vaccine	Obtain parental consent	Screen registry data to prepare for upcoming appointments
Inventory vaccine	Provide vaccine information to parent	Enter shots into registry database
Provide vaccination records to requesters	Review medical or registry record for vaccination history	Enter history and demographic data for new patients
Answer telephone questions about vaccinations	Complete vaccination log in chart	Solve registry technical problems
Attend vaccination-related continuing education	Fill out patient's shot record	
	Draw and give vaccine	

*These occur at times other than when vaccinations are given.
†These occur each time a vaccination is given.
‡Postregistry period only; these do not include registry start-up activities.

shot records; providing vaccine information to parents; and obtaining parental consent. The interview form required physicians not only to estimate the time they spent on each activity, but also to reevaluate their answers based on the sum of time spent on all activities relative to the amount of time available in a well-child visit. To estimate physician cost, we obtained salary and benefit data from a national database[20] and applied average salary and benefits for family practitioners or pediatricians, whichever was appropriate, in the county in which the practices were located to their time estimates.

Estimating Both Cost and Time

Examining costs for the 2 periods of interest is not an adequate method of measuring the effect of registry participation because costs can be affected by other factors. For instance, salaries of staff delivering immunizations could have changed in real terms. Also, lower salaried workers could have been substituted for highly paid workers or vice versa, resulting in lower or higher costs. Some activities formerly performed by physicians could have been delegated to nursing staff, thereby lowering costs. Such actions would be reflected in cost figures and would mask the effects of a registry on the use of practice resources. To isolate the effects of registry participation on resource use, we compared the time spent on each immunization-related activity for the preregistry and postregistry periods.

Adjusting for Inflation

To compare cost data gathered in different years, it was necessary to adjust for inflation. To adjust salary and benefits data for private practices and CHCs, we used the average increase in total compensation during 1997–2001 for private industry.[21] The rationale for applying this index to CHCs is that they are in competition with private practices for physicians and nursing staff and must pay comparable salaries. For urban practices, we adjusted 2002 cost data to 2001 dollars. For public health agencies, we used the average increase in compensation for state and local government to adjust for inflation, since these agencies are not in competition with private practices (most employees are registered nurses, not usually employed by private family practices) and are an arm of local government. All cost figures are expressed in 2001 dollars.

Statistical Analysis

Estimates of the average cost or time spent delivering vaccinations, when based on a small number of observations, may not represent the entire range for each type of practice.[22] To compensate for the small number of practices in our study, we performed stochastic risk analyses with Crystal Ball 2000 (Decisioneering Inc, Denver, Colo) to estimate the range and probabilities of outcomes that resulted from randomly varying the costs and time for activities about which there was uncertainty. These included physician, nursing, registry, and nonroutine activities. We modeled these costs as lognormal distributions based on the distribution of our data by substituting, in a Microsoft Excel (Microsoft Corp, Redmond, Wash) spreadsheet, the appropriate lognormally distributed random variables for corresponding estimates for the participating practices by the Crystal Ball program. To generate the random variables, we used Monte Carlo sampling. In this way, we simulated values for probability distributions contained in the spreadsheet. To find the range of possible outcomes and their probabilities, we recalculated the spreadsheet 1000 times. Separate simulations were performed for each practice type.

RESULTS

Data Collected

The participating practices provided information on 1335 shots given to 610 children in the preregistry period and 2244 given to 991 children in the postregistry period (Table 2).

Cost of Providing Immunizations

The average variable cost of delivering vaccinations, after adjusting for inflation and excluding vaccine cost, increased between 1997 and 2001 for private practices, CHCs, as well as for public health agencies (Table 3). The increase was $0.56 per shot for private practices and CHCs and $0.38 per shot for public health agencies. Postregistry figures include the cost of registry-related activities performed by practice personnel ($0.87 for private practices and CHCs and $1.09 for public health agencies).

Private Practices and CHCs

The small increase in average cost of providing vaccinations for private practices and CHCs from the preregis-

Table 2. Number of Vaccinations and Number of Children Receiving Vaccinations Reported by Participating Practices in the Preregistry and Postregistry Periods

Type of Practice	Preregistry		Postregistry	
	No. of Shots	No. of Children	No. of Shots	No. of Children
Urban practices	624	279	1095	440
Rural private practices or community health centers	301	133	507	203
Rural public health agencies	410	198	642	348
Total	1335	610	2244	991

try period to the postregistry period is not explained by increases in the average time spent on immunization-related activities. In the postregistry period, nursing time spent on vaccinations (both immunization-related and nonroutine activities) declined markedly (4.8 minutes or 40%), more than making up for the average of 3.4 minutes per shot spent on registry-related activities, thereby reducing total time spent on immunization (Table 4).

Public Health Agencies

Public health agencies saw a small increase in the variable cost of providing immunizations similar to that for private practices and CHCs. The reasons for this, however, were different from those for private practices and CHCs. Salaries for providers in these agencies either decreased or stayed the same; they began to substitute medical assistants for registered nurses to provide vaccinations to some extent, thereby reducing their costs. However, on average, time spent on immunization activities increased by an average of 6 minutes. Registry activities themselves took nearly 6 minutes per shot, 67% more than the time spent by private practices and CHCs. Immunization administration time remained about the same as in the preregistry period, suggesting that registry participation did not improve efficiency of immunization administration, as it appeared to do in private practices and CHCs.

Simulation Results

The average preregistry variable cost per shot obtained in the simulation model was $4.41 for private practices and CHCs; the postregistry cost was $4.98 (Table 5). These figures are slightly larger for both periods than the averages we computed for private practices and CHCs ($4.37 and $4.93, respectively), but the differences between the 2 periods are virtually the same ($0.56 vs $0.57).

For public health agencies, the simulation model calculated average preregistry costs of $3.82 per shot and postregistry costs of $4.18, slightly more than the figures we computed. Again, the differences between the 2 periods were virtually the same for both analyses ($0.38 and $0.36, respectively).

The simulation model found that the average preregistry time spent per shot for private practices and CHCs

Table 3. Average Cost Per Shot in Private and Public Practices Before and After Participation in a Regional Immunization Registry

Practice Type	Cost (Range), $*										Difference (Before and After Registry)
	Nonroutine Immunization Activities		Immunization Administration (Nursing)		Physician Activities		Registry Activities		Total Variable Costs		
	Preregistry	Postregistry	Preregistry	Postregistry	Preregistry	Postregistry	Preregistry	Postregistry	Preregistry	Postregistry	
Private practices and community health centers	0.82 (0.27–1.55)	0.64 (0.13–1.48)	1.95 (0.73–4.17)	1.64 (0.65–2.61)	1.59 (0.79–2.39)	1.77 (0.24–4.29)	0	0.87 (0.49–1.44)	4.37 (2.88–5.95)	4.93 (3.00–7.81)	0.56
Public health agencies	1.06 (0.30–1.81)	1.12 (0.64–1.59)	2.73 (2.18–3.28)	1.96 (1.36–2.56)	0	0	0	1.09 (0.99–1.19)	3.79 (2.48–5.09)	4.17 (3.94–4.39)	0.38

*Costs are expressed in 2001 US dollars.

Table 4. Average Time Spent per Shot in Private and Public Practices Before and After Participation in a Regional Immunization Registry

Practice Type	Time (Range), min										Difference (Before and After Registry)
	Nonroutine Immunization Activities		Immunization Administration (Nursing)		Physician Activities		Registry Activities		Total		
	Preregistry	Postregistry	Preregistry	Postregistry	Preregistry	Postregistry	Preregistry	Postregistry	Preregistry	Postregistry	
Private practices and community health centers	3.1 (1.4–6.3)	2.3 (0.3–5.6)	8.8 (2.5–22.2)	4.8 (2.4–7.0)	2.0 (1.2–3.4)	1.8 (0.3–3.3)	0	3.4 (1.8–4.6)	13.8 (9.6–25.8)	12.2 (8.0–16.0)	−1.6
Public health agencies	1.9 (1.1–2.6)	2.7 (1.8–3.6)	7.7 (6.2–9.2)	7.4 (4.4–10.3)	0	0	0	5.7 (4.6–6.7)	9.5 (7.3–11.8)	15.7 (12.7–18.8)	+6.2

was 13.5 minutes; the postregistry time per shot was 12.2 minutes. The preregistry time figures we computed were slightly higher than those produced by the model, but the postregistry figures were identical. The difference found by the simulation model between the periods was therefore smaller than those we computed (1.3 minutes less time in the postregistry period vs the 1.6 minutes we calculated).

The pattern for public health agencies was different from that for private practices and CHCs. The simulation model's figures for both periods were virtually identical to those we calculated, resulting in an increase of 6.1 minutes per shot between the preregistry and postregistry periods.

The similarity of the simulation results to our calculated averages bolsters our confidence in the data we collected, even though it was gathered from a small sample of practices. Our results should therefore represent a similar population of practices.

DISCUSSION

It appears that the concerns of private physicians with respect to the cost of participating in an immunization registry[16] may be unwarranted. Our findings show that the principal component of immunization cost, personnel time, declined on average between the preregistry and postregistry periods, from 13.8 minutes per shot to 12.2 minutes. Although we cannot be certain whether participation in the registry was the cause of the decline in time spent per shot, the fact that we included in our analysis only activities that could conceivably be affected by registry use suggests that it plays a part in the time reduction. For instance, the time required for giving vaccinations could be affected by registry participation because of ready electronic availability of each child's immunization record for appointments and consequent elimination of the need to search the medical record for immunization information at the time of the visit, as well as the ability to immediately retrieve complete immunization records for purposes such as day care center and school inquiries (often responded to by nursing staff).

Public health agencies experienced a substantial increase in time spent on vaccinations (6.2 minutes or a 65% increase). Most of this increase is attributable to their registry operations, on which they spent 67% more time than did private practices and CHCs; time required for other vaccination-related activities remained unchanged from the preregistry period. There may be several reasons for the difference in registry experiences between private practices and CHCs and public health agencies. First, private practices used the registry alone for determining vaccinations needed by children at their visits, thereby reducing time needed for other immunization-related activities, whereas public health agencies used both the registry and paper files to determine needed immunizations, pulling paper records and printing registry reports for each appointment (Pat Perry, Rio Grande County Nursing Service, and Pat Radford, Alamosa County Nursing Service, oral communication, March 2002). After vaccinations are

Table 5. Results of Simulations of Variable Costs and Time for the Preregistry and Postregistry Periods

Practice Type	Total (SD) Variable Costs, $*			Total (SD) Time, min		
	Preregistry	Postregistry	Difference	Preregistry	Postregistry	Difference
Private practices and community health centers	4.41 (1.40)	4.98 (1.90)	+0.57	13.5 (7.0)	12.2 (3.2)	−1.3
Public health agencies	3.82 (1.23)	4.18 (1.1)	+0.36	9.5 (2.4)	15.6 (4.3)	+6.1

*Costs are expressed in 2001 US dollars.

given, data are entered in both the registry and the paper record. In these cases, the registry is substituting for virtually no time spent on other tasks. Another reason for spending more time on registry activities is slow network connection time in the rural areas we studied (the CRISP registry is Internet based). An examination of the reasons for public health agencies' dependence on multiple sources of immunization information and methods for reducing it appears to be warranted.

Although real variable costs per shot for both types of practices increased from the preregistry period to the postregistry period, we found that factors other than registry participation likely accounted for the change. Salary increases beyond inflation accounted for most of the cost increase for private practices and CHCs. Public health agencies kept their real variable cost increase low, even while spending more time on vaccinations, by substituting lower-cost personnel, such as medical assistants, for more highly paid registered nurses.

These findings extend the research into the effects of registry participation on medical practices by analyzing the entire range of immunization-related activities that occur during an office visit that could be affected by immunization registry use. This allows understanding of the likely substitution effects of registry participation. For instance, it appears from our data that, in private practices, nursing time in preparation for and provision of vaccinations was substantially reduced after practices began participation in the registry. Moreover, unlike most other studies, private practices were included, an important feature, since they are more likely than other types of practice to perceive cost of participation as a barrier to registry use.

Limitations

A principal study limitation is the small number of practices studied and consequent concern that they may not represent the entire population of practices. To compensate for this, we performed a sensitivity analysis that included 1000 recalculations of the cost and time data by random variables generated by Monte Carlo sampling. The similarity between the simulation results and the cost and time figures we calculated should reassure the reader about the representativeness of the data collected.

All data were collected in rural Colorado and the Denver metropolitan area. Generalizability of the cost results may be limited if labor costs are different from those in the study areas.

The differential timing of data collection for urban practices, during a relatively slow period for immunizations in 1997 and a busy period in 2002, could account for differences in time spent on immunization activities, since work likely proceeds at a faster pace during busy times. These practices saw 58% more patients receiving vaccinations in the postregistry study period than in 1997. We cannot be certain, however, that practices were busier overall during the latter period, since the cold and flu season had not yet begun.

Another limitation of the study is the use of self-report for determining time spent on immunization-related activities. Although we believe the use of detailed forms to collect both frequency and length of time for immunization activities minimized error in the data collected, we cannot, without independent observation, be certain that this was so. Physicians were asked to reevaluate their interview responses about time spent on immunization activities when the interviewer added all time estimates for particular activities and asked if the total was correct, given the amount of time devoted to well-child visits. Although we acknowledge this limitation, we should also mention that these practices, with mostly the same personnel, participated in the study in both periods and that there is no reason to believe that any tendency to underestimate or overestimate time varied between periods.

This study did not take into account any possible differences among practices with respect to quality of information entered into the registry. It is possible that such differences exist, but they were not measured here.

CONCLUSION

Public health agencies are committed to registry participation, which is seen as an important way to improve the vaccination process and sustain high rates of immunization, a public health priority. They face different incentives from those of private practices, which are often small businesses that must meet payroll and expense demands each month. These practices must carefully weigh the benefits of each new activity they are asked to perform against the time (cost) required to perform it. The findings of this study suggest to private practices that registry participation can provide them a net benefit by making the vaccination process more efficient and therefore less costly.

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