The Costs of Registry-Based Immunization Interventions

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Background: Part of the payoff of immunization registries may be to lower costs of immunization intervention. However, registry-based intervention costs have not been evaluated in a community setting.

Methods: The purpose of this study was to prospectively measure the cost of three equally effective registry-based interventions, evaluate how the size of the targeted population affects cost estimates, and compare these results with previously reported studies. A total of 3050 children aged <12 months were randomized to one of four study arms: (1) computer-generated telephone messages (autodialer), (2) outreach worker, (3) autodialer with outreach worker backup, or (4) usual care. The cost data collected included capital equipment, supplies, travel, and personnel.

Results: Monthly costs of the three registry-based intervention types were (1) autodialer, $1.34 per child; (2) outreach worker, $1.87 per child, and (3) combination, $2.76 per child. Personnel costs represented the majority of incremental costs for all three interventions. Increasing the number of children targeted sharply decreased the cost per child for the autodialer but had only a modest effect on outreach costs. The monthly costs for outreach were substantially lower than previously reported for nonregistry-based interventions in part because of differences in the number of children who were followed up. Monthly costs for the autodialer intervention were slightly higher than previously reported, but several published studies excluded important costs.

Conclusions: By facilitating the management of a larger cohort of children, some registry-based immunization interventions appear to be less costly than nonregistry interventions. Further work is needed to establish whether registry maintenance costs may be recouped in part by these savings.

Medical Subject Headings (MeSH): costs and cost analysis, immunization, registries, vaccination (Am J Prev Med 2001;21(4):267–271)

Introduction

The Public Health Service's *Healthy People 2010* established a national goal for the year 2010 to completely immunize 90% of infants by age 24 months.[1] Results from the National Immunization Survey estimate that vaccination coverage in the United States on the 4:3:1 series was 79.9% in 1999,[2] with significantly lower rates for children living below the poverty level.[3] Scattered medical records; missed opportunities; and a lack of tracking, reminder, or recall systems all contribute to underimmunization.[4]

The medical and public health communities advocate the use of immunization registries to increase vaccination coverage rates.[5–9] Substantial public and private resources have been devoted to developing registries.[9,10] The specific capital investments required to develop and maintain registries have been studied elsewhere.[11–14] Part of the payoff of registry development may be the ability of registries to facilitate and lower the cost of traditional immunization interventions. There have been no previous studies of registry-based intervention costs outside of a health maintenance organization (HMO) setting.[15] If registry-based intervention costs are lower, then societal investments in registries may be offset by, for example, decreasing data entry or event capturing costs.

The purpose of this study was to (1) prospectively measure the costs of three different registry-based

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interventions implemented in an urban indigent population, and (2) evaluate how the size of the targeted population affects cost estimates. This study is the first cost evaluation of a regional registry-based immunization intervention. The actual costs expended were prospectively collected. The study evaluated the costs of automated reminder and recall messages and outreach workers both singly and in combination.

Methods

Setting

The study was implemented in an urban county with historically low immunization coverage rates.[16] It presents the economic component of a larger project evaluating the effectiveness of registry-based interventions to increase immunization rates. Approximately 75% of the children in the county receive their vaccinations through a network of 22 public health clinics. The county participates in the Metro Atlanta Team for Child Health (MATCH) immunization registry in Atlanta, Georgia. MATCH is a community-based partnership between two county health agencies, local nonprofit agencies, and federally qualified community health centers. The registry services provided include record lookups, real-time data interface or batch data entry interface, and the capability to generate reminder and recall notices through postcards or an autodialer.

Participants

A list of 3050 children aged <12 months who had been seen in a county public health clinic were randomly selected from the registry of immunization records between 1 September 1996 and 31 March 1998.

Intervention

The children were randomized to one of four study arms: (1) computer-generated telephone messages (AUTODIAL); (2) outreach worker (OUTREACH); (3) computer-generated telephone messages with outreach worker backup (COMBO); and (4) usual care (CONTROL). Usual care consisted of no intervention beyond normal clinic procedure.

Children randomized to the AUTODIAL arm received an automated telephone call or postcard to remind their families 7 calendar days before the child was due to be immunized. If there was no phone number for a family, or if the autodialer determined that the number listed was a nonworking number, an automated postcard was mailed. If the autodialer was unable to successfully reach the family via phone within 2 days, an automated postcard was printed and mailed. The autodialer calculated each child's immunization schedule from the child's date of birth and the date of the last immunization received. Children were defined as being up to date if they received the diphtheria, tetanus toxoids, and pertussis (DTP); *Haemophilus influenzae* type B (Hib); polio; and measles, mumps, and rubella (MMR) shots recommended for a child their age. The autodialer delivered a recorded message from health department medical staff. If a child was not immunized by the date that he or she was due, the family received an automated phone call explaining that the child was behind in his or her immunization schedule. If the child still failed to be immunized, the family received a phone call on 4 successive days. Postcards were mailed to families without a phone, families with nonworking numbers, and families who failed to respond to the phone calls.

Children randomized to the OUTREACH arm who missed an immunization were contacted by the outreach worker following a standardized protocol initiated by a phone call within 1 week. If the appointment time was known, the outreach worker made a reminder call before the appointment. If a child remained behind the next month, a home visit was attempted monthly until personal contact was made.

Children in the COMBO arm first received the automated reminders and recalls according to the protocol described above for AUTODIAL. If they remained behind schedule after the last scheduled phone call or postcard, the OUTREACH protocol was implemented.

The immunization registry provided monthly updates of the study cohort. Children in the study cohort were followed up until they reached 24 months of age. The human investigations committee at Emory University, the participating health department, the registry, and the Centers for Disease Control and Prevention approved the study design.

Intervention effectiveness. In aggregate, the three interventions significantly raised series completion by 5% compared to the usual-care arm ($p=0.021$). Differences in the impact among the intervention arms (4% to 6%) were not statistically significant ($p=0.67$).

Costs Included

Costs were calculated from the perspective of program replication and represented direct program-related costs. The program cost data collected included capital equipment, supplies, travel, and personnel. Study personnel, including supervisory personnel, kept daily activity logs of the time allocated to specific intervention arms. The effort logs tracked the amount of time spent in specific activities, some of which related directly to an intervention, some of which represented general support functions, and some of which represented effort directed toward other projects. In this way actual effort expended, rather than budgeted effort, could be evaluated. Equipment and supplies were valued at wholesale acquisition costs, while travel and personnel costs were valued at actual expenses and wages over the 22-month intervention period.

Costs Excluded

No downstream costs, revenues, or opportunity costs were included. Research-specific costs were excluded.

Cost Allocation

The cost of personnel time for each intervention was calculated by multiplying the total time spent by the hourly compensation rate and benefits for the staff member. Capital equipment costs included the acquisition costs of one computer and one autodialer. Equipment purchases were valued at acquisition cost and were amortized over 5 years with a 10% scrap value.[17] The cost of the computer was divided between the two intervention arms—OUTREACH and COMBO—that

Table 1. Total annualized intervention costs (1997 dollars)

Resource	Autodialer intervention	Outreach intervention	Combined autodialer and outreach intervention
Personnel	$10,732 (88.8%)	$13,976 (82.9%)	$20,877 (84.1%)
Facilities	$ 283 (2.3%)	$ 2,164 (12.8%)	$ 2,446 (9.9%)
Supplies and equipment	$ 1,074 (8.9%)	$ 352 (2.1%)	$ 1,252 (5.0%)
Travel	$ 0 (0.0%)	$ 376 (2.2%)	$ 251 (1.0%)
Total	$12,089	$16,868	$24,826

utilized it. The cost of the autodialer was divided between the AUTODIALER and COMBO intervention arms. Supply costs included postage, autodialer software, and copying expenses. Both the outreach worker and the autodialer required a telephone line. The outreach worker also incurred travel expenses while performing home visits. It was assumed that the autodialer alone would not require space or utility allocations beyond that generally provided by the supporting organization. It was also assumed that an outreach worker would require 100 square feet of office space for telephone contacts, reviewing registry records, and storing client contact records.

Cost Analyses

Because the study had a control arm and three intervention arms, incremental costs were calculated. The incremental cost for each intervention was defined as the total cost of the intervention minus the project management cost of following the usual care cohort. All cost analyses were conducted using Microsoft Excel. Because all three interventions were equally effective, the primary outcome measure for the cost evaluation is monthly cost per child.

Results

Annualized incremental intervention costs in 1997 dollars are presented in Table 1. The most expensive arm was the combined autodialer and outreach intervention. The autodialer intervention was least expensive. Personnel costs represented a large majority (83% to 89%) of the incremental costs in all three interventions. The majority of personnel costs in the autodialer arm were for technical support for both the registry-autodialer interface and autodialer programming (160 annual hours, 0.1 full-time equivalent [FTE]). The majority of personnel expenses in the outreach intervention arm (1036 hours annually, 0.5 FTE) were for the outreach worker. The outreach worker effort (0.4 FTE) was lower for the combination cohort since a smaller number of the study cohort required outreach intervention. The outreach worker attempted contact with 58% of the children in the COMBO arm at some point during the intervention. These annualized costs translate to a monthly cost of $1.34 per child for the autodialer intervention, $1.87 per child for the outreach worker intervention, and $2.76 per child for the combination intervention.

The actual costs measured in this study were used to project the costs that might be expected for delivering the same interventions to a larger cohort of 1500 children. A cohort of 1500 was feasible for a single outreach worker based on her management of two of the study arms. The autodialer was not used to capacity, and most of the autodialer expenses were fixed and would not increase with a larger cohort size as long as the cohort was recruited from clinics currently participating in the registry. Based on these projections, the monthly cost to deliver the autodialer intervention to 1500 children would be $0.85 per child. The outreach intervention required additional outreach worker time for each child not up to date. Thus, increasing the size of the cohort only slightly decreased the cost per child to $1.72 per month. The cost of the combination intervention also decreased, but it remained the most expensive intervention with a monthly cost of $2.25 per child, even with the larger cohort size.

Discussion

A registry-based vaccination intervention using an autodialer for reminder/recall was considerably less expensive than recall by an outreach worker with no significant difference in impact on vaccination rates. Although the autodialer intervention required a higher initial investment for equipment and technical support, lower ongoing costs made it the least expensive intervention.

Technical support for the autodialer intervention represented the bulk of the study arm expenditures. New adopters of this technology should be aware that it does require an up-front investment in both equipment and programming, although ongoing costs are minimal. After the initial programming, the majority of technical support was devoted to managing the registry–autodialer interface. Programming or software changes at the registry and the addition or removal of participating clinic sites required modifications to the autodialer software. The effectiveness of autodialers is also limited by the availability of accurate phone numbers. In this study of an indigent urban population, 6% of patients did not have a phone number listed in the registry, and an additional 15% had an incorrect number listed when contact was attempted. The autodialer used in this study had significant functionality. A less

Table 2. Comparisons of average monthly costs to deliver immunization interventions

Study	Number of children	Average monthly cost per child
Outreach (registry based)		
Current study	750	$ 1.87
Current study (projected)	1500	$ 1.72
Outreach (not registry based)		
Wood et al. 1998[20]	185	$132.25
Rodewald et al. 1999[18]	200	$ 5.27
Hoekstra et al. 1999[19]	324	$ 29.32
Autodialer (registry based)		
Current study	750	$ 1.34
Current study (projected)	1500	$ 0.85
Lieu et al. 1998[21]	10000	$ 0.08[a]
Autodialer (not registry based)		
Dini et al. 2000[23]	215	$ 0.69[b]
Franzini et al. 2000[22]	314	$ 1.13[c]
Combination (registry based)		
Current study	750	$ 2.76
Current study (projected)	1500	$ 2.25

[a]Excluded capital costs and programming costs were amortized over 10 years.
[b]Excluded programming or maintenance costs.
[c]Included capital costs.

expensive autodialer would lower intervention costs further, but might also affect intervention effectiveness.

Table 2 compares the results of this study to previously published studies on intervention costs. The average reported monthly cost per child for immunization interventions varies widely, ranging from $0.08 to $132.25. The interventions differ in intensity and are not directly comparable. Several trends, however, can be noted. Automated reminders are consistently less costly than outreach interventions, and the cost per child decreases as the cohort size increases. The registry-based outreach interventions were considerably less costly than nonregistry-based interventions. A previous study using social worker outreach measured a cost of $5.27 per child per month.[18] An intensive, personalized, and linguistically appropriate reminder and recall intervention in a Special Supplemental Program for Women, Infants, and Children (WIC) population cost $29.32 per child per month.[19] An intensive intervention aimed at inner-city African-American children was even more costly.[20] Our study identified a registry-based intervention cost of $1.87 per child per month. The cost difference is attributable mainly to differences in case load and intervention intensity. To the extent that a registry facilitates the management of a larger cohort, registry-based interventions are likely to be less costly.

The cost per child to deliver the registry-based autodialer intervention was higher than previously reported cost estimates. Most of these studies, however, excluded important costs and, thus, underestimated the resources required to deliver the intervention. One study in an HMO setting assumed that there were no equipment expenses, amortized programming expenses over 10 years rather than the recommended 5 years, and estimated a client load of 10,000 children over which costs were spread.[21] Computer-generated reminder systems can attempt as many as 100 calls per hour. Given the capacity of an autodialer, increasing the target population will decrease the cost per child. Another study in private provider offices calculated an annual cost of $1.12 per child to deliver an autodialer intervention.[22] However, the study excluded all autodialer hardware and maintenance costs, thus substantially underestimating actual costs. The prorated annual cost of the autodialer added an additional $1.04 per child per month to the cost of the intervention, resulting in a total monthly cost of $1.13. The costs observed for the registry-based autodialer study were also higher than those reported for a Denver study performed in four public health clinics that shared computerized databases linked to one main office.[23] However, no personnel costs for autodialer programming, training, or maintenance were measured. In the study reported here, public health clinics, community clinics, and hospitals with either manual or computerized records are linked to the registry. As a result, more technical support was required to both program and maintain autodialer function. Registries that accommodate a diverse assortment of equipment data–transferring capabilities and levels of computer savvy have found that successfully connecting participants is more complex and expensive than originally anticipated.[24]

If registries do lower vaccination intervention costs, to what extent can registry maintenance costs be offset? No published studies have directly addressed this question, but based on existing work, some preliminary estimates can be made. Two studies have examined the cost of maintaining immunization registries. A review of 16 *All Kids Count* registries reported an average yearly cost of $3.91 (range $1.60 to $6.23) per child to maintain a fully operational registry.[14] A prospective cost evaluation of the registry used for the registry-based vaccination interventions reported an average yearly cost per child of $5.26, and 1997 total estimated registry maintenance costs were $186,877. Replacing a traditional outreach effort ($5.27 per month per child)[18] with registry-facilitated outreach ($1.72 per month per child) for a cohort of 1500 children would save $63,900 yearly. Thus, 34% of registry infrastructure costs could potentially be recouped by replacing traditional outreach efforts with registry-facilitated outreach for a cohort of 1500 children. The ability to replace outreach efforts with automated reminders would generate even larger cost offsets.

There are several limitations that must be noted. First, it is difficult to determine the reliability of the time estimates provided by the staff members. However,

time and effort logs are an improvement over previous studies that recorded only budgeted time. Another limitation is the reliability of the estimates for donated resources. Costs were measured prospectively in order to maximize cost identification. This study evaluated the costs of one specific intervention in an urban underserved community, and the results may not be generalizable. This population, however, is at high risk of being underimmunized and is the target of many public health interventions. Comparisons to cost estimates from other studies are limited by the range of interventions evaluated and the use of different cost methodologies. Using standardized cost measurement techniques is key to producing generalizable estimates.[17] Autodialer interventions and outreach can be implemented with or without an immunization registry. A randomized trial is needed to directly address whether registry-based interventions are less costly than community- or practice-based interventions. Until such information is available, program directors will need to use their own experiences and the published literature to select the optimal vaccination strategy.

Cost-effective interventions are key to reaching immunization goals, particularly in underserved communities. A potential payoff for investing in regional registries may be lower intervention costs. Automated telephone messages have cost advantages over outreach worker interventions, particularly for large client cohorts, and regional registries can facilitate the use of lower-cost automated reminders. Our study suggests that registry costs may be recouped in part by savings with some vaccination interventions. However, these savings may not be realized for all interventions. It appears unlikely that intervention savings can entirely offset registry costs. Further research is needed to examine the benefits of registries on immunization coverage.

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