
Measuring Immunization Registry Costs

Promises and Pitfalls

Kimberly J. Rask, MD, PhD, Kristen J. Wells, BA, Susan A. Kohler, MPH, RN, Cynthia T. Rust, MD, Charles B. Cangialose, PhD

Introduction: The medical and public health communities advocate the use of immunization registries as one tool to achieve national goals for immunization. Despite the considerable investment of resources into registry development, little information is available about the costs of developing or maintaining a registry.

Methods: The objective of this study was to measure the direct costs of maintaining one immunization registry. Cost and resource-use data were collected by interviewing registry personnel and staff at participating pediatric practices, collecting available financial records, and direct observation.

Results: The estimated direct cost for maintaining the registry during the 3 calendar years 1995 through 1997 was \$439,232. In 1997, this represented an annual cost of \$5.26 per child immunized whose record was entered into the registry. In all years, personnel expenses represented at least three fourths of the total costs, with the majority of administrative effort donated. Yearly costs increased over time largely because of growing administrative personnel requirements as the registry became fully operational.

Conclusion: Considerable resources are required to establish and maintain immunization registries. Because personnel costs, particularly nontechnical personnel, represent a large portion of total registry costs, it is important to accurately account for donated effort. Recommendations for future registry cost studies include prospective data collection and focusing upon the costs of providing specific outreach or surveillance functions rather than overall registry costs. In addition, registry effectiveness evaluations are needed to translate registry costs into cost-effectiveness ratios.

Medical Subject Headings (MeSH): costs and cost analysis, immunization, registries, (Am J Prev Med 2000;18(3):262–267) © 2000 American Journal of Preventive Medicine

Introduction

The Public Health Service's *Healthy People 2000* established a national goal for the year 2000 to completely immunize 90% of infants by 24 months of age.¹ Results from the National Immunization Survey estimate that immunization coverage in the United States on the 4:3:1 series (four or more doses of diphtheria and tetanus toxoids and pertussis vaccine/diphtheria and tetanus toxoids, three or more doses of poliovirus vaccine, and one or more doses of measles-containing vaccine) was 78% in 1997.² Additionally, immunization coverage of all vaccines was significantly

lower for children living below the poverty level as compared with children living at or above poverty level.³

Medical and public health communities advocate the use of immunization registries as one tool.^{4–7} Immunization registries can consolidate scattered records,^{7–8} provide an immunization needs assessment for each patient, provide current immunization recommendations, promote automated recall of under-immunized children, and provide practice- and community-based immunization coverage assessments. Both the public and private sectors have funded the development and maintenance of immunization registries. Approximately \$142 million has been awarded by the U.S. Public Health Service through 317 grants since 1993 to develop and sustain immunization registries. In addition, the Robert Wood Johnson Foundation has provided more than \$20 million in grants since 1992 through the All Kids Count program.⁹

The National Vaccine Advisory Committee and the Centers for Disease Control and Prevention (CDC)

From the Division of General Medicine, Emory University School of Medicine (Rask, Kohler), Atlanta, Georgia; Department of Health Policy and Management, Rollins School of Public Health, Emory University (Wells), Atlanta, Georgia; Department of Pediatrics, Emory University School of Medicine (Rust), Atlanta, Georgia; Kerr L. White Institute for Health Services Research and Health Funding Authority (Cangialose), Wellington, New Zealand

Address correspondence and reprint requests to: Kimberly J. Rask, MD, PhD, Division of General Medicine, 1518 Clifton Road, N.E., Room 636, Atlanta, GA 30322. E-mail: krask@emory.edu.

reported that registries were being developed as part of 60 of the 64 (94%) national immunization projects and in an additional 255 communities.⁹ Despite the considerable investment of resources into registry development, minimal information is available regarding the costs of maintaining a registry. This paper will discuss some of the challenges of ascertaining the true costs of immunization registries. We will present a registry cost analysis that illustrates many of the difficulties and will outline some strategies to improve measurement of the costs incurred to develop and implement immunization registries. This effort is a necessary first step in analyzing the cost-effectiveness of registries and component registry activities.

Performing Cost Evaluations

Selecting the appropriate type of cost analysis is dependent upon the program to be evaluated and the target audience. In most public health effectiveness analyses, there are two target audiences—public policy decision-makers and program decisionmakers. Public policy leaders may use economic analyses to evaluate the potential impact of a broad range of public health initiatives, for example, primary prevention for heart disease and smoking cessation. For these purposes, the unit of outcome generally needs to be “lives saved” or “quality-adjusted life years gained.” A typical cost-utility ratio (CUR) might look like the following:

$$\text{CUR} = \frac{P - AM}{AQ}$$

where

- P = the total program costs
- A = the number of target diseases avoided
- M = the present value of the medical costs saved by avoiding one case of disease
- Q = the number of quality-adjusted life years saved by avoiding one case of disease

Two of the parameters are intervention specific—program costs (P) and the cases of disease avoided (A). The other parameters, medical costs averted and quality-adjusted life years gained, relate to the impact of the disease being prevented and not to the specific intervention.

Program directors at local public health agencies, for example, may use economic analyses to choose among alternative interventions with the same public health goal, such as different strategies to raise up-to-date immunization rates for 2-year-olds. Intermediate outcomes, such as the cost per additional child brought up to date on his or her immunizations, may be the most useful measure. In this case the ratio is a cost-effectiveness ratio (CER) expressed as:

$$\text{CER} = \frac{P}{A}$$

or in the case of registries, incremental registry costs divided by the number of additional children fully immunized. These same parameters then can be used in CURs to allow comparisons among a broader range of prevention interventions with different health outcomes. To fully evaluate an investment in registries, it is necessary to measure the cost of the registry and compare that cost with the additional benefit the registry provides, beyond what would have been achieved with existing community activities.

To measure registry costs, it is also necessary to define and standardize a program or program functions. Identifying and measuring intervention-related costs is challenging in public health interventions because of the need to separate ongoing public health initiatives from the specific intervention under evaluation. Often resources, personnel, space, and equipment are shared among programs or redirected from one program to another. Historically, immunization registries have been public health department-based with considerable in-kind support from local health departments or government agencies. Assigning a cost to in-kind donations is often difficult and arbitrary. Although all registries have the same overall goal of reducing immunization-preventable diseases, they differ in actual functions, with some concentrating on public health surveillance and others supporting outreach activities. Even registries that offer similar functions will provide these functions with greater or lesser degrees of comprehensiveness or intensity. For example, some registries will generate lists of overdue children to send to physicians whereas others will call families directly. The specific functions performed by the registry will affect total registry costs.

For replication purposes, it is useful to distinguish start-up costs from maintenance costs but, in practice, it is difficult to identify the start-up phase of registry development. Rather than being built *de novo*, registries evolve from public health clinic immunization-tracking programs to community-wide shared immunization records. An evaluator has to make the difficult judgment as to when registry functions are sufficiently implemented to be considered at a steady state. Despite these challenges, the need for accurate cost information regarding registry investments requires researchers to identify successful evaluation strategies. We describe one cost evaluation of an urban immunization registry.

Methods

Data were collected at the Metro Atlanta Team for Child Health (MATCH) immunization registry in Atlanta, Georgia. MATCH is a community-based partner-

Table 1. Immunization registry activities

Administrative

- Governance
- Creating and revising policies and procedures
- Advisory board
- Financial administration
- Personnel management—both staff and volunteers
- Community promotion
- Establishing and maintaining partnerships with providers
- Solicit funding

Technical

Equipment and start-up

- Designing record exchange system/duplicate record system
- Designing software and security features
- Designing system architecture
- Implementing security features
- Purchasing equipment or obtaining donated equipment

Bringing providers on-line

- Designing training materials
- Obtaining equipment
- Installing equipment
- Training users
- Telephone and on-site support

System maintenance

- Generating reports
 - Telephone and on-site technical support
 - Maintaining data quality
 - System upgrades
 - Update documentation and training materials
 - Training for new staff at provider sites
 - Updates for provider site staff
-

ship between two county health agencies, local non-profit agencies, and community health centers. The services that MATCH provides include record lookups, clinical data interface or batch data entry interface, and the capability to generate reminder and recall notices either through postcards or an autodialer. At the time of the study, participation in MATCH was limited to public provider sites (e.g., county health departments, public hospitals, and community health centers).

This study focused on the direct costs, dollars and donated resources, expended to develop and maintain the registry. A comprehensive list of administrative and technical activities associated with operating the registry was developed after a review of the literature and repeated interviews with MATCH registry personnel. MATCH personnel provided the research team with a chart depicting the flow of immunization records between the provider sites and the registry. A taxonomy of immunization registry activities was produced with the identification of key personnel involved in each activity (Table 1). The operational processes were grouped into two major cost categories—administrative and technical activities. Subcategories relating to each of the main cost areas were created to classify detailed expenditures. Administrative activities could be either start-up or maintenance expenses, depending upon the focus of the activity. Equipment, start-up, and resources

Table 2. Sources of registry cost information

Financial records

- 1996 and 1997 monthly financial statements
- Bank account statements
- Detailed billing records
- Purchase orders
- Invoices from a computer consultant
- Other invoices

Interviews

- Interviews with registry personnel
- Interviews with provider site staff

Administrative records

- Minutes from registry community meetings
 - Registry manuals
-

required to bring providers on-line generally represented start-up costs, whereas system maintenance activities represented ongoing activities.

Cost data were collected from many different sources (Table 2). Financial statements were obtained from a grant provided to the registry for operational support. Records obtained from the registry treasurer included bank account statements, detailed billing records, purchase orders, and invoices dating back to 1995. Invoices from a computer consultant and cost data from an immunization intervention that used the registry were also available. Donated equipment and personnel were identified through interviews with registry staff, the computer consultant, and representatives from the provider sites. Financial information noted in minutes from registry community meetings was used to confirm expenditures and identify other expenditures or donations. Follow-up interviews were conducted with registry personnel to confirm the financial and operational information that was obtained.

Donated equipment and effort were valued in 1997 dollars. Financial expenditures from earlier years were inflated to 1997 dollars using the consumer price index for all urban consumers.¹⁰ After linking registry expenditures from financial statements to the appropriate cost areas, the costs for donated resources were estimated. Administrative cost estimates included volunteer time for the operations manager, other staff, rent, and office supplies. The operations manager's time was valued at the minimum of the 1997 annual salary range for a similar position (operating systems analyst/administrator, senior) as reported by a local university and included fringe benefits at 22.8%. The cost of office space was estimated based on 500 square feet of leased space at the commercial value of real estate in that location. Summary expenditures were used to calculate an average monthly cost for office supplies, telephone, and postage. Hardware costs (server and two computers) were also estimated, including the costs for donated computer equipment, based upon 1997 acquisition costs for comparable systems at a local university. Hardware costs were amortized over 5 years at a 5%

Table 3. Costs for maintaining the registry infrastructure by type of expense, 1995 through 1997, in 1997 dollars

Type of expense	Start-up costs		Maintenance costs	
	1995 (% of total)	1996 (% of total)	1996 (% of total)	1997 (% of total)
Administrative expenses	\$ 76,237 (60%)	\$ 77,929 (62%)	\$ 118,589 (63%)	
Staffing	\$ 62,232	\$ 62,232	\$ 104,432	
Donated effort	\$ 62,232	\$ 62,232	\$ 62,232	
Rent/supplies	\$ 14,005	\$ 15,697	\$ 14,157	
System design and maintenance	\$ 33,198 (26%)	\$ 37,136 (30%)	\$ 56,933 (30%)	
Equipment expenses	\$ 18,032 (14%)	\$ 9,823 (8%)	\$ 11,355 (6%)	
Total personnel costs	\$ 95,430 (75%)	\$ 99,368 (80%)	\$ 161,365 (86%)	
Total nonpersonnel costs	\$ 32,037 (25%)	\$ 25,520 (20%)	\$ 25,512 (14%)	
Total costs	\$ 127,467	\$ 124,888	\$ 186,877	
Average monthly cost	\$ 10,622	\$ 10,407	\$ 15,573	

discount rate with a 10% scrap value.¹¹ The costs for donated telephone lines were estimated using 1997 acquisition costs. The direct cost to the registry to bring a new community provider on-line was evaluated prospectively for a new user that was brought on-line during the study period. Software costs were estimated at acquisition cost, and registry personnel time was monitored with time and effort reports.

The major cost areas correspond to Table 1, with the addition of rent and supplies, and were organized as (1) administrative (i.e., rent, financial administration, and operations management); (2) equipment (i.e., computers, printers, and telephone lines); (3) system development and maintenance (i.e., personnel time involved in system design and maintenance, system and manual upgrades, and addressing data quality issues); and (4) registry outreach functions (i.e., reminder and recall activities, and report generation). At the time of our study, the registry supported no outreach or surveillance functions, and therefore no costs were allocated to that category.

The registry's start-up period (1995) was distinguished from its maintenance period (1996 through 1997) through interviews with registry staff. The registry was considered to be operational (1996) after the hardware and software had been configured and the initial provider sites brought on-line.

Results

The estimated direct cost for maintaining the registry during the 3 calendar years 1995 through 1997 was \$439,232. Estimated yearly costs ranged from \$124,888 to \$186,877 and increased during 1997 largely because administrative personnel requirements increased from 1.5 to 3 full-time equivalents (FTEs) (Table 3). Personnel expenses were by far the largest cost category, representing 75% to 86% of yearly registry costs. Two thirds (1 to 2 FTEs) of the personnel expenses were for administrative or operational tasks (e.g., management, community promotion, provider relationships), while

only one third (0.5 to 1.0 FTEs) were for technical support functions (e.g., help desk, troubleshooting, system maintenance). The majority of administrative and operational personnel effort was either donated by volunteers or subsidized by other public health agencies.

Additionally, registry personnel spent approximately 56 hours over 8 months bringing a new hospital-based primary care clinic on-line (Table 4). Included in this estimate is the time personnel spent installing the software, providing user training and support, and traveling to and from the clinic. The estimated total cost to the registry is \$2212.

To calculate the registry costs per child immunized, we reviewed registry activity reports from 1997 and validated data entry from a sample of provider sites. An estimated 35,550 children received immunizations in 1997 who were entered into the registry, resulting in an annual cost of \$5.26 per child.

Discussion

This study was designed to examine the costs of maintaining an immunization registry. Registry records were reviewed to ascertain the financial and organizational history of the registry. To obtain information that was not included in written records and to clarify existing written information, the research team conducted in-depth interviews with registry personnel. The largest

Table 4. Registry costs incurred to bring a provider online, October 1997 through May 1998

Resource	Number of hours	Total cost
Personnel		
Computer consultant	17.5	\$1050
Operations manager	38.5	\$1152
Equipment and Supplies		
Software manual		\$ 10
Total		\$2212

Table 5. Comparison of expenditures at the study site and the Sheps Center study sites¹²

Type of expenditure	% of study site costs	% of Sheps sites costs
Personnel Expenditures		
Administrative tasks	64%	11% to 48%
Computer and technical tasks	36%	45% to 76%
Registry outreach tasks	0%	0% to 45%
Nonpersonnel Expenditure		
Computer and technical	47%	74% to 80%
Other	53%	20% to 26%

registry cost category was personnel expenses, and administrative tasks were often performed by volunteers. To the extent that donated or volunteer effort was overlooked, our study underestimates the personnel effort required to maintain a registry. Increasing personnel costs over time may represent increased effort or better ascertainment of effort contributed closer to the time of the evaluation.

For comparison purposes, the study registry is similar in terms of level of implementation and target population to some of the sites described in a report of four All Kids Count immunization registries (Sheps Center study).¹² The Sheps Center cost evaluation was based on a mailed survey and limited in-person interviews. In the sites that are similar to MATCH, 5-year registry development costs ranged from \$2,583,000 to \$6,948,000, although none of these registries was considered to be fully implemented.¹² The percent of total costs attributed to personnel expenditures at the Sheps Center sites were slightly lower than at our study site, but personnel expenses did represent the largest cost category, ranging from 54% to 76% (Table 5).¹² In this study, registry personnel expenditures were predominantly (64%) for administrative tasks, whereas in the Sheps Center study sites, the majority of personnel costs were attributed to computer and technical tasks or outreach (e.g., reminder, recall, and outreach functions). The majority of nonpersonnel expenditures at the Sheps Center study sites were for computer and technical expenditures,¹² whereas at the study registry, rent and supplies represented a larger percentage. These differences may represent true differences among registries or better ascertainment of those costs through observation and prospective data collection at the study site. The costs incurred to bring new providers on-line in the Sheps Center study sites ranged from \$245 to \$3704, with computer programming being the largest cost component.¹²

The Sheps Center reported that the 5-year cost per child with a record in the registry, with or without an immunization history, ranged from \$35 to \$217.¹² We examined costs and records entered for 1 year, choosing the most recent year (1997) to increase the likeli-

hood of accurately capturing both the costs and number of immunizations entered into the registry. Our estimate of the yearly cost per child may have been lower for several reasons, including differences in registry functionality. Our study registry supported no outreach functions, whereas three of the four registries in the Sheps Center study performed those functions. Second, only a small percentage of the target population was included in the MATCH registry at the time of our study. The most comprehensive registry in the Sheps Center study, which included almost 100% of the target population and had a high level of participation from both public and private providers, has the highest cost per child immunized (\$217).¹²

Although labor-intensive, we found it necessary to collect cost data through repeated in-depth interviews. Even with the interviews, it can be difficult to verify the accuracy of the cost information reported by registry staff. Interviewed staff members might have limited knowledge about specific donations of equipment and effort because of personnel changes. The staff's inability to confidently estimate both the length of the effort and the specific activities performed by volunteers complicated estimation of cost for donated effort. Estimating the costs of donated computers and software was somewhat arbitrary given changes in computer costs and functionality over time.

These evaluations suggest that it is difficult to compare the total costs of different registries with the goal of identifying the most efficient systems. Registry development has been idiosyncratic, and registries differ in terms of size of the database, size and location of the target population, number of participating providers, and type and intensity of outreach functions. Only a small number of registries meet the minimum functional criteria of maintaining records on 95% of all eligible 2-year-old children in the target population and of providing an electronic immunization record that is accessible to providers.¹³ With few registries fully implemented, it is difficult and somewhat arbitrary to distinguish start-up from maintenance costs.¹⁴ Using objective criteria, such as the CDC-designated 12 core functions or the All Kids Count quantitative and qualitative indicators of registry development, will allow more standardized comparisons of registry development costs.¹³

Despite these challenges, the need for accurate comparable cost information remains. Implementation costs are real, they need to be enumerated, and the magnitude of these costs will determine the likelihood of long-term registry success. To this end, we have identified several recommendations for future studies. To ensure that the data collection process is complete and accurate, evaluators must become familiar with the registry infrastructure, operational processes, and record exchange systems. Personnel and administrative tasks account for the majority of registry costs and are

commonly performed with volunteer or donated personnel. Not accounting for donated effort would seriously underestimate the resource costs of implementing a similar registry structure. Prospective data collection allows evaluators to more accurately estimate the cost of donated resources, supplies, and equipment. Direct observation can provide a picture of the day-to-day activities of registry staff members and volunteers and can allow the allocation of resource costs to different registry functions. By isolating and analyzing specific function costs, similar components of otherwise disparate registries can be compared. This can be accomplished by evaluating standardized registry outreach functions and developing cost estimates for that specific function.

Each of these strategies can improve the ability to produce consistent and accurate cost estimates across immunization registries, which is the numerator (P) of a cost-effectiveness ratio (CER). However, to take the next step and to evaluate the cost-effectiveness of registries, more information is required. Cost-effectiveness analyses require an estimation of changes in clinical outcomes (A), such as changes in up-to-date rates or immunization-preventable disease rates.^{11,15} At this time there is no information available about the efficacy of registries in decreasing immunization-preventable disease. Evidence shows that sharing immunization records increases the apparent immunization rate and identifies excess immunizations.⁸ Future studies could use stable registries with standardized program functions to measure community changes in actual up-to-date rates. As these effectiveness evaluations are performed, cost evaluations could then be used to estimate the cost-effectiveness of specific registry functions. This information will be more useful to program directors and policymakers than are the currently available estimates of total registry costs or registry costs per eligible child.

This research was supported by grant number UIW/CCU414706-01 from the National Immunization Program of the Centers for Disease Control and Prevention (CDC). The contents are solely the responsibility of the authors and do not necessarily represent the official views of the CDC. The

authors wish to thank Gene Downing, David Shields, and the MATCH registry participants for their invaluable help in illuminating the challenges faced when implementing public health goals in the real world.

References

1. U.S. Department of Health and Human Services. Healthy People 2000: national health promotion and disease prevention objectives (pub no PHS91-50212). Washington, DC: U.S. Government Printing Office, 1991.
2. Centers for Disease Control and Prevention. National, state, and urban area immunization coverage levels among children aged 19–35 months—United States, July 1996–June 1997. *MMWR Morb Mortal Wkly Rep* 1998;47:108–16.
3. Centers for Disease Control and Prevention. Vaccination coverage by race/ethnicity and poverty level among children aged 19–35 months—United States, 1997. *MMWR Morb Mortal Wkly Rep* 1998;47:956–9.
4. Gostin LO, Lazzarini Z. Childhood immunization registries: a national review of public health information systems and the protection of privacy. *JAMA* 1995;274:1793–9.
5. Codero JF, Orenstein WA. The future of immunization registries. *Am J Prev Med* 1997;13(suppl 1):122–4.
6. Sinn JS, Kronenburg MA, Morrow AL. The purpose and functions of immunization information systems within health care organizations. *Arch Pediatr Adolesc Med* 1997;151:615–20.
7. Linkins RW, Feikema SM. Immunization registries: the cornerstone of childhood immunization in the 21st century. *Pediatr Ann* 1998; 27:349–54.
8. Yawn BP, Edmonson L, Huber L, et al. The impact of a simulated immunization registry on perceived childhood immunization status. *Am J Managed Care* 1998;4:185–92.
9. National Vaccine Advisory Committee. Development of community- and state-based immunization registries: findings and recommendations for action, Washington, DC: U.S. Department of Health and Human Services, 1999.
10. U.S. Department of Labor, Bureau of Labor Statistics. Consumer price index for all urban consumers. Washington, DC: U.S. Department of Labor, 1998.
11. Haddix AC, Teutsch SM, Shaffer PA, Duñet DO. Prevention effectiveness: a guide to decision analysis and economic evaluation 1st ed. New York: Oxford University Press, 1996.
12. Slifkin RT, Freeman VA, Biddle A, et al. The cost of immunization registries: four case studies. A report prepared for the Robert Wood Johnson Foundation. Chapel Hill, NC: Cecil G. Sheps Center for Health Services Research, University of North Carolina at Chapel Hill, 1998.
13. Wood D, Saarlans KN, Inkelas M, Matyas BT. Immunization registries in the United States: implications for the practice of public health in a changing health care system. *Ann Rev Public Health* 1999;20:231–55.
14. DeFriesse GH, Faherty KM, Guild PA, et al. All Kids Count National program evaluation project report: implementation year three, November 1, 1995–October 31, 1996. A report prepared for the Robert Wood Johnson Foundation. Chapel Hill, NC: Cecil G. Sheps Center for Health Services Research, University of North Carolina at Chapel Hill, 1997.
15. Krahn M, Guasparini R, Morris S, Detsky AS. Costs and cost-effectiveness of a universal, school-based hepatitis B immunization program. *Am J Pub Health* 1998; 88:1638–44.