Immunization Registries: Costs and Savings

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SYNOPSIS

Objectives. The objectives of this study were to quantify the actual costs of developing, maintaining, and operating the Boston Immunization Information System (BIIS), an electronic registry and tracking system, and to compare the registry's costs with those of performing the same functions manually.

Methods. Cost data were obtained from 23 BIIS health care sites, the city health department, and 13 control sites. Actual costs of developing and operating BIIS in 1998 and projected 1999 costs for a hypothetical expanded registry were measured. Total costs of registry-supported immunization activities were compared with the costs of similar types and volumes of manual activities.

Results. The total annual cost of developing, maintaining, and operating BIIS in 1998 was $345,556. Annual total cost per record was $5.45 for all children aged <23 years and $10 when costs were distributed only among active users (children <8 years old). Operating BIIS saved $26,768 in 1998, compared with manual performance. The hypothetical projected total cost of an expanded BIIS in 1999 would have been $577,919, with a projected savings of $689,403 compared with manual costs.

Conclusions. Electronic immunization registries potentially offer an efficient tool for the delivery of immunization services. Registries can save substantial funds if their data are kept up-to-date, and if caregivers are willing and able to use the registries routinely.

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INTRODUCTION

Immunization registries have been promoted as an important tool to increase immunization levels, particularly for preschool children.[1] Between 1994 and 1999, an estimated $178.2 million in federal grants financed the design and implementation of immunization registries.[2] Private foundations have also supported registry development. Together, these efforts led to a proliferation of community and state-based registries.

The reported annual costs per child of registries ranges from $3.88 to $122, with most under $20.[3–6] Two reports estimated the cost of a fully functioning national registry at $67 to $123 million yearly.[3,7] Comparisons of costs are limited by differences in methods and definitions. Also, no study has provided a direct comparison of registry costs with those of activities performed manually. We measured the actual costs of developing, maintaining, and operating Boston's immunization registry and compared these with the costs of similar activities performed manually.

METHODS

Boston Immunization Information System (BIIS)

The BIIS was introduced as an electronic registry in October 1993. The system is used at 29 primary care facilities in Boston, including health centers, hospitals, and private practices. BIIS providers account for an estimated 77% of pediatric immunization services in the city. Data from the National Immunization Survey demonstrate a steady increase in the proportion of Boston children up-to-date (UTD) at 2 years of age for all recommended immunizations; Boston had the highest 1998 coverage level of any surveyed city.[8]

BIIS is a decentralized, but integrated system in which each site uses BIIS's customized software to develop and maintain its own database and track its own patients. Site-specific information is uploaded nightly to the central registry housed at the city health department, the Boston Public Health Commission (BPHC). When children transfer between BIIS sites, demographic and immunization information can be shared remotely by accessing the central registry.

BIIS's five output functions facilitate the delivery of immunization services. Some are data repository functions, and others are immunization promotion functions.

Data repository functions

- The immunization history report documents vaccinations and generates compliance statements that satisfy legal demands for proof of immunization.
- The vaccine usage report is produced monthly to track the quantity of vaccines administered at each site.
- The coverage level report is an annual immunization assessment of citywide and site-specific UTD status.

Immunization promotion functions

- The "behind" list is a summary report that identifies children who are not UTD.
- The immunization assessment sheet summarizes a child's immunization status and is prepared for a scheduled or walk-in appointment.

Study participants

Of the 29 BIIS sites, six were excluded from the study—five were recent participants without fully established immunization databases, and one had not implemented an immunization reminder and recall system for children not UTD. The 23 participating sites included 19 community health centers (CHCs), three hospitals, and one private practice. Controls were sites that had been randomly chosen for a manual immunization audit by the Massachusetts Department of Public Health during 1994 or 1998. Thirteen control sites—including five CHCs, two hospitals, and six private practices—agreed to participate in this project and provide cost data.

Data collection

Data were collected between June and September 1998 at BIIS sites and the BPHC, and between August 1998 and May 1999 at control sites. Data collection included review of documents, interviews, and time and motion studies. For the 13 independently licensed CHCs, the Massachusetts Division of Health Care Finance and Policy provided staff salaries, operating budgets, and funding sources from state-mandated financial reports. Fiscal departments at the remaining 23 sites and the BPHC provided corresponding data. Interviews with technical support personnel identified the cost of the customized software.

Interviews with the BPHC program manager, who has overseen BIIS since 1992, provided information on development and maintenance cost. Structured interviews were conducted with clinical personnel at all sites and with data entry operators at BIIS sites. Site personnel described immunization activities and estimated the time to complete each of the five activities manually at control sites. Because no control sites were able to generate a "behind" list, comparable manual data were difficult to obtain. For the children at control sites, we estimated approximately three minutes

per visit to identify children who were not UTD. This is an imputed cost that reflects the actual time and effort required if these were done manually.

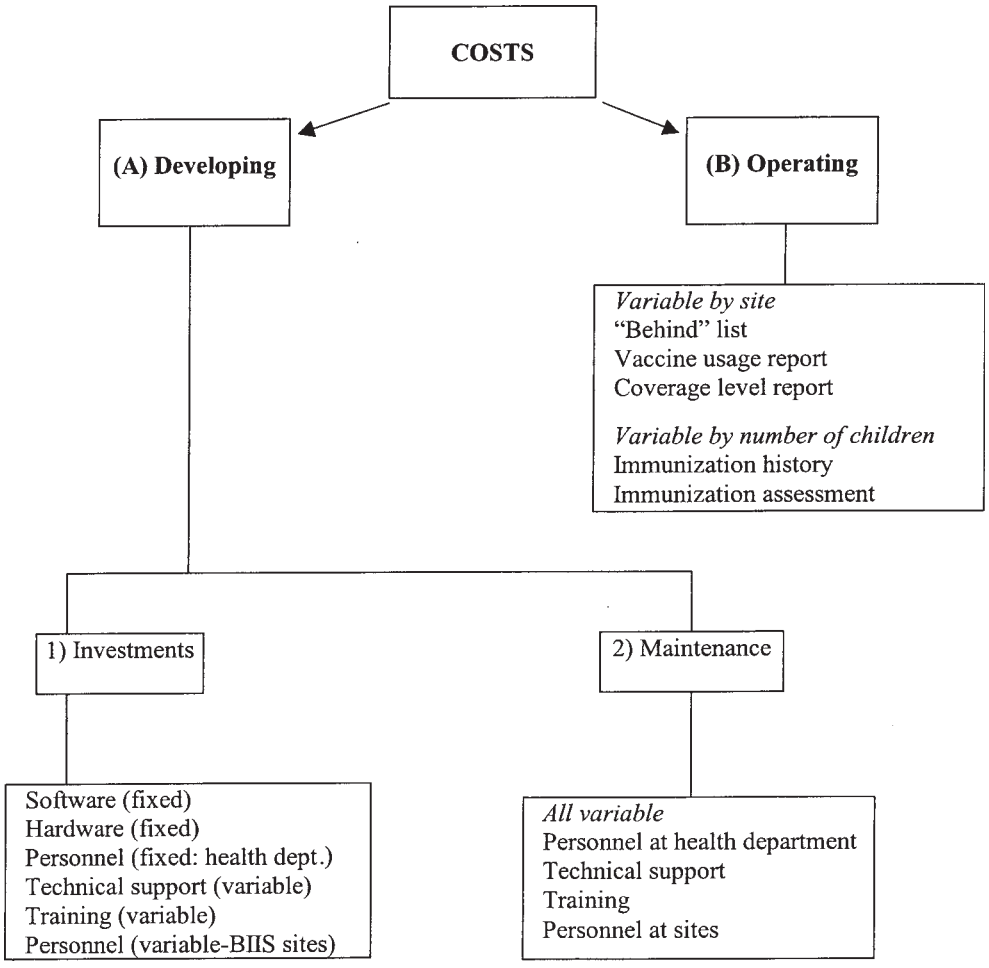
At BIIS sites, we directly observed the time required for registry-related activities. Project staff used a stopwatch to time the performance of immunization activities. Each activity was repeatedly monitored, and the average time per activity was calculated. For three months, BIIS site personnel manually recorded the frequency of immunization activities in logs. Also, BIIS software was programmed to automatically count frequency of use of registry functions. The same volumes were used to compare BIIS and control sites; thus, we held outputs constant and measured time and cost of performing the same activities in two different ways.

Two methods were used to measure the cost of data entry for BIIS in 1998. In the first method, data entry cost was equal to (data entry time per record) × (salary) × (number of records). For the second method, we determined the maximum number of immunizations a child should receive by 2 years of age.[9] Data entry cost was equal to (number of immunizations) × (number of children up to 2 years of age in each site's database) × (salary) × (data entry time per record). Because the two methods provided very similar estimates ($40,445 and $39,502), their average was used as the data entry cost.

Definitions: costs

Costs were divided into development and operating costs (Figure). Development costs were fixed or variable costs incurred in constructing and maintaining the registry. Fixed costs were defined as those that do not vary with the quantity of use or the number of records in the short run (such as software, equipment, and occupancy). Variable costs were those that vary

Figure. Costs associated with BIIS by type.



BIIS = Boston Immunization Information System

with changes in volume of activity (such as greater total data entry time for more patients).

Development costs were divided between investment and maintenance costs. Investments incurred in 1994 included hardware, training, and personnel (primarily for planning and the entry of historical data) at BIIS sites; and software, personnel, hardware, technical support, and training at the BPHC. (See Table 1 for description of specific costs included.) Additional investments made in 1998 included hardware upgrades at the BPHC and BIIS sites, and software modifications and personnel at the BPHC. Development investments were amortized over five years at the borrowing rate in effect in Boston when the actual costs were incurred (5.5% in 1994 and 4.5% in 1998). Maintenance costs in 1998 included personnel and training at all sites, and technical support at BPHC.

Total operating costs were those of operating the registry output functions, and were composed of direct and allocated indirect costs. Direct operating costs were the actual costs of operating the registry output functions for generating reports. The direct costs of performing each registry output function were equal to (hourly costs) × (time required to complete each function). Development costs were treated as indirect costs here and were allocated among the five registry functions in proportion to their direct operating costs. This allowed us to gauge the total costs (development and operating) of performing each registry output function. We compared the total costs of registry-supported functions with the cost of similar types and volumes of activities performed manually. Manual costs were derived from the findings of a survey conducted at control sites. In addition, BIIS sites were surveyed regarding performance of manual activity before the introduction of BIIS. These reports were very consistent. Personnel costs included fringe benefits.

Definitions: study cohort

On August 1, 1998, there were 91,566 records in BIIS. We excluded records with no immunization history ($n = 22{,}033$) and those from non-study sites ($n = 6{,}113$). The remaining 63,420 records were defined as the "all-children" group (aged <23 years). Active BIIS users were defined as children <8 years of age, who are likely to have the most immunization activity. There were 34,572 children in the "active user" group.

Projecting 1999 costs: an expanded registry

To project the costs of a hypothetical expanded registry in 1999, we made the following assumptions: (*a*) BIIS would expand to 59 sites citywide (includes all pediatric providers with >50 patients); (*b*) all sites would use BIIS to its full potential for children up to 10 years of age; (*c*) the annual city birth cohort would remain at approximately 8,000; and (*d*) expanded database management would be provided to keep data accurate and current. Because all 1994 costs were fully amortized by 1998, they were excluded from 1999 cost calculations. The 1995–1998 costs were not yet fully amortized, and they were included. We again compared projected costs of registry output functions with the cost of similar types and volumes of activities performed manually.

Table 1. Investment costs of developing BIIS, an immunization registry ($ U.S.)

Costs		*BPHC*	*BIIS sites*	*Total*
1994 fixed costs	Software	94,000		94,000
	Personnel	73,188		73,188
	Hardware	15,165	62,192	77,357
1994 variable costs	Technical support	25,000		25,000
	Training	2,208	29,407	31,615
	Personnel		243,491	243,491
1994 total investment costs		209,561	335,090	544,651
1998 fixed costs	Software	9,667		9,667
	Personnel	35,869		35,869
	Hardware	6,325	15,811	22,136
1998 total investment costs		51,861	15,811	67,672

BPHC = Boston Public Health Commission

BIIS = Boston Immunization Information System

Table 2. Development and operating costs for BIIS in 1998 ($ U.S.)

Costs		*BPHC*	*BIIS sites*	*Total*
Investment	1994 amortized annual cost	48,057	76,843	124,900
	1998 amortized annual cost	11,606	3,539	15,145
Maintenance	Personnel	26,582	87,072	113,654
	Technical support	61,000		61,000
	Training	687	3,828	4,515
Total development costs				319,214
Operating	Immunization history		9,915	9,915
	Immunization assessment		13,085	13,085
	"Behind list"		130	130
	Coverage-level reports	675	—	675
	Vaccine usage reports		2,538	2,538
Total operating costs				26,343
Total costs				345,557

BPHC = Boston Public Health Commission

BIIS = Boston Immunization Information System

RESULTS

Development and maintenance costs

In 1994, a total investment of $544,651 was made to develop and build BIIS (Table 1). The yearly 1994 cost of amortizing this investment was $124,899. Equipment costs accounted for 31% of the 1994 investments. The personnel investment cost at the sites—$243,491—was primarily to enter data, with most (89%) for the entry of historical records.

The total annual cost of BIIS in 1998 was $345,557, of which 92% ($319,214) was for developing and maintaining the registry (Table 2). The total operating cost was $26,343. New investment costs ($67,672) in 1998 included computer upgrades and eliminating record duplication. The annual amortized cost was $15,145. At BIIS sites, personnel costs to maintain the registry decreased to $87,072, including $39,973 for data entry.

Operating costs

Of the $26,343 in total operating costs in 1998, 97% was incurred at BIIS sites. Operating costs varied by the usage level of the various output functions. Immunization histories required for school or camp were the most frequently used registry function. BIIS produced each immunization history in less than one minute, at a cost of $0.49 per report, compared with $14.70 per manual immunization history report (approximately 30 minutes).

1998 cost comparison

Operating BIIS accounted for a net overall savings of $26,768, compared with the costs of manually performing the same volume and type of immunization activities (Table 3). Most savings were related to the generation of immunization histories ($167,394). However, BIIS was not used to its full potential in 1998. Because of limited use and high development costs ($319,213), the BIIS costs for immunization assessments and vaccine usage reports were high, surpassing the costs of performing these activities manually in 1998 (Table 3).

Costs per child

For the "all-child" cohort (n = 63,420), the BIIS cost per child was $5.45. This cost varied widely among the sites ($2.50–$11.50) with the size of the patient population. Costs per child were lower at large sites, where site-specific development costs could be spread among more children. For the "active user" cohort (n = 34,572), the average cost per child was $10 per year.

Projected costs and savings of a hypothetical expanded registry in 1999

The total annual projected cost of a hypothetical expanded registry in 1999 was $577,919, including development costs ($359,068) and direct operating costs ($218,851). The amortized investments in 1999 were $26,387. Because the 1994 investments were fully paid

Table 3. Comparison of the costs of immunization activities with and without a registry in 1998 ($ U.S.)

	With BIIS		Without BIIS (manual)		
Function	*Minutes/task*	*Total cost*[a]	*Minutes/task*	*Total cost*[a,b]	*Savings*
Immunization history	1	130,061	30	297,455	167,394
Immunization assessment	3	171,643	10	43,616	–128,027
"Behind" list	1	1,705	3	7,520	5,815
Vaccine usage reports	30	33,292	90	7,614	–25,678
Coverage level reports	1500	8,854	960	16,118	7,264
Total		345,555		372,323	26,768

[a]Total costs = direct operating costs + allocated indirect costs

[b]Without BIIS, the allocated indirect costs are equal to zero

BIIS = Boston Immunization Information System

off, total amortization costs decreased from $140,044 in 1998 to $41,532 in 1999. The projected maintenance costs increased from $179,169 in 1998 to $317,537 in 1999 to reflect the increased personnel, training, and technical support costs of improving the quality of BIIS data to encourage more frequent use. Operating costs also increased substantially, reflecting greater use per site and the addition of new sites (Table 4). Compared with costs of performing similar types and volume of functions without a registry ($1,267,322), savings of $689,403 would be realized by the expanded registry.

DISCUSSION

Our study suggests that use of Boston's immunization registry saved money in 1998. Operating BIIS to perform clinical and public health functions saved more than $26,000, compared with the cost of similar activities performed manually. These savings are projected to increase substantially with full use of the registry citywide.

Although substantial investments were needed to develop and maintain our registry, the incremental cost of actually operating it was relatively small. This is a strong argument for spreading fixed costs over a greater volume of use. A large proportion of BIIS development cost was related to data entry and management, including eliminating the duplication of records. More automated methods for data entry and management would decrease these costs.[10]

In our study, it cost $14.70 to manually complete one immunization history, close to the $14.50 reported in a study of costs related to pulling and manually reviewing records.[11,12] Compared with the direct cost of performing this activity with BIIS ($0.49 per report), use of the registry offers substantial savings. Our cost per child findings ($5.45; range $2.50–$11.50) were also similar to the cost of $3.91 (range $1.60–$6.23) arrived at in another study, and in the 1999 Centers for Disease Control and Prevention data collected from 24 registries that estimated an annual cost of $5.18 per child.[12,13]

We found that it cost $701 to complete a manual coverage-level assessment at a single control site, a figure substantially below the reported $1,320 needed to pull and review charts at a family practice clinic.[14] In contrast, operating the registry to perform this task for all 23 BIIS sites had a direct cost of only $675.

One of the most important public health functions of BIIS is generating the "behind" list to identify children overdue for immunizations. None of the control sites surveyed had an efficient method of identifying children who were not UTD, because the sites all relied on a record review at the time of an appointment only. There is no mechanism in place to routinely check immunization status of patients other than at time of appointment. This system, which fails to identify immunization status of children without an appointment who are most likely to be underimmunized, was estimated to cost $7,520. In contrast, generating the "behind" list using BIIS took approximately one minute at a direct cost of only $0.49. Clearly, the cost-effectiveness associated with this important function would be most obvious in areas with low immuniza-

Table 4. Childhood immunization-related costs in Boston, 1998–1999—registry vs. manual ($ U.S.)

	1998	*1999*
Registry	345,555	577,919
Manual	372,323	1,267,322

tion rates. This important function could target these populations and help to improve immunization rates.

Our study had several limitations. Because most registries have unique features and operate in particular environments, findings from our study may vary from those in other geographic areas.[6,15,16] Because all eligible BIIS sites participated, selection bias was minimal. Immunization coverage levels were similar at BIIS and control sites, suggesting that costs for similar endproducts were being evaluated. Participating controls had higher UTD immunization rates, compared with sites that refused. This may have been related to more intensive immunization activities and associated higher costs. This would have underestimated registry-related savings. Information bias may have occurred because study data collectors were not blinded. In addition, recall bias and providers' perceptions of the registry may have influenced our results. It is imperfect to directly compare manual registry functions determined by interview with time and motion assessments of registry costs. The use of fiscal documents, automated counts of registry activities, and direct observation probably minimized this bias. Finally, we were unable to adjust for possible confounders, such as provider characteristics or organizational structures.

The goals of BIIS include supporting clinical management, population assessment, and education. By enabling active and targeted recall of children who are overdue for immunizations, by giving clinicians clear data on immunization status at time of visit, and by providing practice-based and citywide coverage estimates, immunization registries such as BIIS can offer important public health benefits that would be difficult to attain without a registry. Our data indicate that immunization registries can save money; such savings could be increased substantially by ensuring that registries are well-designed and user-friendly, with accurate data. Registries can offer a valuable tool for raising immunization rates inexpensively. The National Vaccine Advisory Council (NVAC) has recommended that registries should be simple to use and should capitalize on data already collected by providers for billing or other purposes.[13] As health care systems begin to invest in on-line medical record systems, integrating them with registries is one way to increase data reliability, cost savings, and ease of use.

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REFERENCES

1. Varrasso DA. Immunization registries emerging as fact of practice life. Am Acad Pediatr News 1997 Dec 13.
2. All Kids Count. Sustaining financial support for immunization registries. Decatur (GA): All Kids Count; Sept 1999.
3. Horne PR. Testimony on resource issues relevant to immunization registries. Presented at the National Immunization Registry Initiative public meeting; 1998 Jul 17; Atlanta, GA.
4. Slifkin RT, Freeman VA, Biddle A, Faherty KM, Guild P, Musselman D, et al. The cost of immunization registries: four case studies. Chapel Hill, North Carolina: Cecil G. Sheps Center; Apr 1998.
5. Urquhart GA. Testimony of resource issues related to state and community-based immunizations. Presented at The Initiative on Immunization Registries public meeting; 1998 May 13; Washington, DC.
6. Rask KJ, Wells KJ, Kohler SA, Rust CT, Cangialose CB. Measuring immunization registry costs. Promises and pitfalls. Am J Prev Med 2000;18:262-7.
7. The National Vaccine Advisory Committee. Development of community- and state-based immunization registries. 1999 Jan 12 [cited 1999 Aug 3]. Available from: URL: http://www.cdc.gov/nip/registry/i_recs.htm
8. Notice to readers: national vaccination coverage levels among children aged 19–35 months—United States, 1998. MMWR Morb Mortal Wkly Rep 1999;48:829-30.
9. Recommended Childhood Immunization Schedule, United States, January–December 1999. American Academy of Pediatrics website [cited 1999 Feb 11]. Available from: URL: http://www.aap.org/family/parents/immunize.htm
10. All Kids Count (AKC). De-duplication program: a success for New York registry [snapshot]. 1999 Jul 5; p. 28.
11. Horne PR, Saarlas KN, Hinman AR. An All Kids Count cost study on immunization registries. Paper presented at the All Kids Count Immunization Registry Conference; 1999 Apr 27–29; St. Paul, MN.
12. Horne PR, Saarlas KN, Hinman AR. Costs of immunization registries: experiences from the All Kids Count II Projects. Am J Prev Med 2000;19:94-8.
13. Development of community- and state-based immunization registries: CDC response to a report from the National Vaccine Advisory Committee. MMWR Morb Mortal Wkly Rep 2001;50(No. Rr-17):1-17.
14. Chapman RW, Hacker TW. Calculating a clinic's childhood immunization rate: costs and returns. Arch Fam Med 1995;4:625-7.
15. Fairbrother G, Troob C, Friedman S, Butts GC. Design issues for a big city immunization registry. Am J Prev Med. 1997;3(2S):26-31.
16. Baker BJ, Appelbaum D, Hinds W, Carson K, Korolak K, Bibus D, et al. CHILD profile: development of an immunization registry. Am J Prev Med 1997;13(2S):42-5.