Immunization Registries: Costs and Savings

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ABSTRACT

Objectives: The objective of this study was to quantify the actual costs of developing, maintaining, and using the Boston Immunization Information System (BIIS), an electronic registry and tracking system.

Methods: Cost data was obtained from 23 BIIS health care sites, the city health department, and 13 control sites. Actual costs of building and using 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 building, maintaining, and using 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). Using BIIS saved $26,768 in 1998 compared to manual performance. The projected total cost of an expanded BIIS in 1999 was $577,919, with a projected savings compared to manual costs of $689,403.

Conclusions: Electronic immunization registries offer an efficient tool for the delivery of immunization services.

Introduction

Immunization registries have been promoted as an important tool to increase immunization levels, particularly for pre-school aged 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 annual cost per child of immunization registries is reported to range from $3.88 to $122 with the majority under $20.[3-6] Two reports estimated the cost of a fully functioning national registry to range between $67-$123 million per year.[3,7] However, comparisons of available cost data are limited by differences in methods and non-standardized definitions. Also, no study has provided a direct comparison of registry costs with activities performed manually. We assessed the actual costs of developing, maintaining, and using Boston's immunization registry, compared to the cost 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 two years of age for all recommended immunizations. Boston had the highest 1998 coverage level of any surveyed city.[8]

BIIS is a decentralized system in which each site uses customized software to develop and maintain its own database and tracks its own patient population. Required and optional information is entered into the database either manually or electronically using a site's billing or medical record system. 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's call-up system.

BIIS has five output functions that facilitate the delivery of immunization services:

- The immunization history report documents vaccinations and provides a compliance statement that satisfies the legal demand for proof of immunization.
- The "behind" list is a summary report that identifies children who are not UTD.
- The immunization assessment sheet summarizes of a child's immunization status and is prepared for a scheduled or walk-in appointment.
- 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.

Study Participants

Of the 29 sites participating in BIIS, six were excluded from the study. Five sites were recent participants without a fully established immunization databases. One site had not implemented an immunization reminder and recall system for children not UTD. The 23 study participants included 19 community health centers (CHCs), three hospitals, and one private practice. These 23 sites provide immunization services to approximately 67% of the annual Boston birth cohort. 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, inclu ding 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 of 1998 at BIIS sites and 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 required financial reports. Fiscal departments at the remaining 23 sites and the BPHC provided corresponding data. The financial department at the BPHC provided invoices on equipment costs including computers, printers, and modems. Interviews with technical support personnel identified the cost of the customized software. Although outreach stemming from registry information is a critical activity, it was not considered a cost for this project.

Interviews with the BPHC program manager who has overseen BIIS since 1992 provided information on the cost of its development and maintenance. Structured interviews were conducted with clinical personnel at all sites and data entry operators at BIIS sites. Site personnel described immunization activities and estimated the time to manually complete each of the five activities at control sites. Because no control sites were able to generate a "behind" list, comparable manual data were difficult to obtain. Instead, clinical staff reported a record review for UTD status at the time of a scheduled visit at least yearly, and no method to identify children without a scheduled appointment. For the estimated 5,333 children at control sites, we approximated three minutes for one visit regardless of attendance to identify children who were not UTD.

We directly observed the time required at BIIS sites for registry-related activities. For three months, BIIS site personnel manually recorded the frequency of immunization activities in logs. Also, BIIS software was programmed to automatically count registry output functions. For comparison purposes, the same volume was used for BIIS and control sites.

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

Definitions: Cost

For this project, costs were divided into building and using costs (Figure 1). Building 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 number of records in the short run (such as software, equipment, and occupancy). Variable costs were those which vary with changes in volume of activity (such as data entry time for more patients).

Building costs were also categorized as either investment or maintenance costs. Investments incurred in 1994 included hardware, training, and personnel (primarily for planning and entry of historical data) at BIIS sites; and software, personnel, hardware, technical support, and training at BPHC. Additional investments made in 1998 included hardware upgrades at BPHC and BIIS sites, and software modifications and personnel at BPHC. Building investments were amortized over five years at Boston's borrowing rate in effect 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 using costs were defined as the costs of using the registry output functions, and were composed of direct and allocated indirect costs. Direct using costs were the actual cost of using the registry output functions for generating reports. The direct cost of performing each registry output function was equal to (hourly costs) x (time required to complete each function). Building costs were considered indirect using costs and were allocated among the five registry functions in proportion to their direct using costs. We compared the total costs of registry supported functions with the cost of similar types and volumes of activities performed manually. 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 0-22 years). Active BIIS users were defined as children up to and including age seven 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, four assumptions were made: 1) BIIS would expand to 59 sites citywide (includes all pediatric providers with > 50 patients); 2) all sites would use BIIS to its full potential for children up to ten years of age; 3) the annual city birth cohort would remain at approximately 8,000; and 4) expanded database management would be provided. Because all 1994 costs were fully amortized by 1998, they were excluded from 1999 cost calculations. We again compared projected costs of registry output functions with the cost of similar types and volumes of activities performed manually.

To determine the savings by practice size, the 59 sites were categorized as small (< 1500 patients), medium (1500 - 3000 patients) and large (> 3000 patients). BIIS records indicated that of the children up to ten years of age, 60% were at large sites, 29% at medium sites, and 11% at small sites. To determine per child using costs by individual output function, the frequency of each function was allocated by the proportion of children in each group. To determine per site using cost such as vaccine usage reports, we assumed 26 small, 20 medium and 13 large sites. The building costs were assigned to either BIIS sites or the city health department and were considered indirect using costs. They were allocated among the five registry functions in proportion to their direct using costs.

Results

Building 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 the majority (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 building and maintaining the registry (Table 2). The total using cost was $26,343. New investment costs ($67,672) in 1998 included computer upgrades and record de-duplication; amortized cost was $15,145. At BIIS sites, personnel costs to maintain the registry decreased to $87,072, including $39,973 for data entry.

Using Costs

Of the $26,343 total using costs in 1998, 97% occurred at BIIS sites. Using 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 to $14.70 per manual immunization history report (approximately 30 minutes).

Using BIIS accounted for net overall savings of $26,768 compared to 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. The “behind” list was always used at all 23 sites; however, five sites never used BIIS to generate immunization histories. Because of limited use and large building costs ($319,213), the proportion of allocated indirect cost for immunization

assessments and vaccine usage reports was high and surpassed the costs of performing these activities manually in 1998 (Table 3).

Cost per Child

For the "all child" cohort (n=63,420), the cost per child was $5.45. However, this cost varied widely among the sites ($2.50-$11.50) because of the size of the patient population. Costs per child were lower at large sites, where site-specific building 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 building costs ($359,068) and direct using costs ($218,851). The amortized investments in 1999 were $26,387. Because the 1994 investments were fully paid off, total amortization costs decreased from $140,044 in 1998 to $41,532 in 1999. However, the projected maintenance costs increased from $179,169 in 1998 to $317,537 in 1999 to reflect increased personnel, training, and technical support. Using costs also increased substantially, reflecting maximum use and the addition of new sites (Figure 2). Compared to costs of performing similar functions without a registry ($1,267,322), savings of $689,403 would be realized by the expanded registry.

With maximum usage and citywide coverage, all participating health care sites would save money (Table 4). Annual projected savings increased with the size of the site's patient base. Small sites (<1500 patients) were estimated to save $60,264; whereas, large sites (>3000 patients) would save $526,386. The health department would incur a loss of $119,780 since it heavily supported the registry but used only one BIIS output function (coverage level reports).

Discussion

Our study suggests that usage of Boston's immunization registry saved money in 1998. Using BIIS to perform clinical and public health functions saved over $26,000 compared to the cost of similar activities performed manually. Projected costs with optimal use of an expanded registry suggest that these savings would increase. All sites would save money, with the amount varying in proportion to site size. In contrast, the health department would incur a loss of $119,780 related to large indirect costs and use of only one output function (coverage level report). Practice size and training needs should be considered in the development and implementation of registries in order to maximize savings.

Although substantial investments were needed to build and maintain our registry, the incremental cost of actually using it was relatively small. A large proportion of BIIS building costs was related to data entry and management, including de-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. This figure closely approximates the $14.50 reported in a study of costs related to pulling and manually reviewing records.[11] Compared to the direct cost of performing this activity with BIIS ($0.49 per report), use of the registry offers substantial savings. 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.[12] In contrast, using 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 to identify children who

were not UTD since all relied on a record review at the time of an appointment. This system, which fails to identify children without an appointment who are most likely to be under immunized, 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.

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, 13,14] Since all eligible BIIS sites participated, selection bias was minimal. Immunization coverage levels were similar at BIIS and control sites, suggesting that costs for similar end products were being evaluated. However, parti cipating controls had higher UTD immunization rates compared to sites that refused. This may have been related to more intensive immunization activities and associated higher costs. However, 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 difficult to directly compare manual registry functions determined by interview with time and motion assessment 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 and 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. A well-designed, user-friendly registry with accurate data can offer a valuable tool for helping to ensure that all children are immunized as cost efficiently as possible.

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Table 1. Investment costs of building BIIS, an immunization registry

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**

Table 2. Building and using costs for BIIS in 1998.

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 Building Costs				**$319,214**
Using	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 Using Costs				**$26,343**
TOTAL COSTS				**$345,557**

Table 3**.** Comparison of the costs of immunization activities with and without a registry in 1998.

Function	With BIIS		Without BIIS (manual)		Savings
	Minutes/task	Total cost[1]	Minutes/task	Total cost[1,2]	
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	30	$33,292	90	$7,614	-$25,678
Coverage level	1500	$8,854	960	$16,118	$7,264
Total		**$345,555**		**$372,323**	**$26,768**

[1]Total costs = direct using costs + allocated indirect costs.

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

Table 4. Projected costs and savings of a hypothetical expanded registry in 1999 by site size.

	With BIIS[1]	Without BIIS (manual)[1]	Savings
Small sites: < 1500 patients (n=26)			
Immunization history	$6,299	$61,137	$54,838
Immunization assessment	$63,972	$68,992	$5,020
"Behind" list	$473	$1,294	$821
Vaccine usage report	$14,174	$13,759	-$415
TOTAL	$84,918	$145,182	**$60,264**
Medium sites: 1500-3000 patients (n=20)			
Immunization history	$11,369	$161,186	$149,817
Immunization assessment	$115,460	$181,888	$66,428
"Behind" list	$250	$3,410	$3,160
Vaccine usage report	$7,465	$10,584	$3,119
TOTAL	$134,544	$357,068	**$222,524**
Large sites: >3000 patients (n=13)			
Immunization history	$17,357	$333,470	$316,113
Immunization assessment	$176,284	$376,320	$200,036
"Behind" list	$119	$7,056	$6,937
Vaccine usage report	$3580	$6,880	$3,300
TOTAL	$197,340	$723,726	**$526,386**
Heath Department (n=1)			
Coverage level report	$161,127	$41,347	**-$119,780**

[1]Total costs = direct using costs + allocated indirect costs.

Legends

Figure 1. Costs associated with BIIS by type.

Figure 2: Childhood immunization related costs in Boston, 1998-99: Registry versus manual