The Regional Immunization Registry as a Public Health Tool for Improving Clinical Practice and Guiding Immunization Delivery Policy

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Objectives. We assessed the distribution of immunization records among 3 health care delivery sectors and the impact of a regional immunization registry on "up to date" rates.

Methods. Immunization registry records in 2 regions were categorized as having originated in private practices, community health centers, or public health clinics. "Up to date" rates were calculated after we sequentially added immunization records from the 3 sectors.

Results. The percentage of children with immunizations documented in multiple sectors increased with age from 7 to 24 months, and children who were seen in multiple sectors were more likely to be up to date. There were relative increases in "up to date" rates of 50% for children aged 24 months.

Conclusions. The regional immunization registry is a powerful public health tool for increasing documented "up to date" rates and providing insights into patterns of immunization delivery. (*Am J Public Health.* 2004;94:967–972)

The National Immunization Program of the Centers for Disease Control and Prevention advocates the use of computerized immunization registries as an integral part of efforts to increase immunization rates.[1] Immunization registries allow providers to monitor immunization records and to generate reminder and recall notices for underimmunized children.[2–10] When such registries are population-based and include all patients in a given area, they consolidate immunization records that are scattered among multiple providers, which facilitates the targeted recall of children who are truly underimmunized and decreases the chances of a child's being overimmunized.[2]

Record scatter is a significant barrier to accurate assessment of immunization "up to date" rates, especially in rural areas.[11–14] In fact, the problem of record scatter and the burden of trying to track immunizations are significant deterrents to rural primary care physicians' participation in immunization delivery.[11] The resultant practice of referring patients to public health clinics for immunization undermines the concept of the "medical home," defined by the American Academy of Pediatrics as "accessible, comprehensive, continuous and coordinated health care delivery by a provider that is known to the family."[15]

There has been limited previous assessment of the extent of the record scatter problem at a population level. In our study, we approximated a population-based analysis of record scatter in 2 rural regions of Colorado. Our specific objectives were to (1) assess the distribution of immunization records in 3 sectors of the health care delivery system (private practices, community health centers, and public health clinics that deliver immunizations but provide no other primary care), (2) assess the relationship between "up to date" rates and having records exclusively in any 1 sector, and (3) assess the impact of a regional immunization registry on documented "up to date" rates.

METHODS

Study Sites

The Colorado Rural Immunization Services Project (CRISP) was a Centers for Disease Control and Prevention–funded demonstration project conducted in 2 rural, medically underserved regions: the northeast section of the state (6 counties) and the south-central region of the state, which is referred to as the San Luis Valley (6 counties). As shown in Table 1, both regions have large Hispanic populations. The population of the San Luis Valley region has more Hispanics, lower per capita personal income, and higher rates of uninsured adults and unemployed adults than the northeast region.[16]

Beginning in 1997, CRISP staff worked with immunization providers in these 2 regions to develop a regional immunization registry. Our study analyzed immunization data from all the major immunization providers for children in both regions, including private practices, community health centers, and public health clinics. Public health centers included nursing services that provide immunizations but do not provide comprehensive primary care and immunization clinics at public health departments. Private practices were included in the project if they provided 20 or more immunizations per month to children. The registry in the northeast region included 10 private practices (22 physicians and 13 mid-level providers), 1 community health center (3 physicians), and 1 large public health department. The registry in the San Luis Valley region included 5 private practices (8 physicians and 6 mid-level providers), 6 community health centers (7 physicians, 12 mid-level providers), and 6 public health nursing services. The final registry database included immunization records from 100% of the public health clinics and community health centers and 94% (33 of 35) of the private practices that provided immunizations to children in the 2 regions. We did not have data regarding the number of children who were cared for by the 2 family medicine providers that were not included, but they reported providing

TABLE 1—Population Demographics of the Northeast and San Luis Valley Regions: Colorado, 2000

	Northeast	San Luis Valley
Total births (1/1998–12/1999)	2083	1334
Birth rate (per 1000 population)	15.1	14.7
Race/ethnicity of births, %		
White/non-Hispanic	64.8	45.2
White/Hispanic	34.1	53.0
African American	0.0	0.0
Other/multiracial	1.0	1.8
Total population	70 042	46 429
Race/ethnicity of total population, %		
Caucasian/non-Hispanic	78.7	50.6
Caucasian/Hispanic	17.8	42.8
African American	0.8	0.5
Other/multiracial	2.7	6.1
Per capita personal income, $	23 945	18 268
Unemployment rate in 2000, %	2.9	6.6
Estimated uninsured adults during 1998–2000, %	19.2	30.5
Public health facilities	1 department with multiple sites	6 individual county-run offices
Community health centers	1 site	1 system with multiple sites

Source: US Census Bureau.[16]

fewer than 20 immunizations per month to children.

Regional Immunization Registry

As part of the development of a regional registry, site-specific computerized immunization databases were established in each participating office in the 2 regions during 1999 and early 2000. To initiate the site-specific immunization databases, each private practice and community health center enumerated all children aged 0 to 30 months who had been seen for any reason at least once at that site, regardless of whether or not they had received immunizations at that site. Trained CRISP personnel used the enumeration data to abstract immunization information from the medical charts directly into the CRISP immunization software. For the public health clinics, all data from existing immunization tracking software were migrated into the site-specific computerized immunization database. Office staff were trained to create registry records for new patients and to enter all immunizations—whether recorded in an immunization history from other sites or given by the office—into their immunization database in a timely manner.

Study Population

A data set of children aged 7 to 30 months on a specific cutoff date (January 31, 2000, in the San Luis Valley region and April 30, 2000, in the northeast region) was downloaded from each site-specific database for our analyses. To maximize the accuracy of these databases, trained CRISP personnel verified each site-specific data set by medical record abstraction. Medical records for all children from the registries in both regions were re-reviewed; if any immunizations were missing, they were added to the data sets, which were then merged to create a single record for each child. The study population, therefore, consisted of children who had any record at participating provider sites and who were aged 7 to 30 months on the cutoff dates in the 2 regions. The total sample (n=1548) included 426 infants aged 7 to 11 months, 565 children aged 12 to 23 months, and 557 children aged 24 to 30 months.

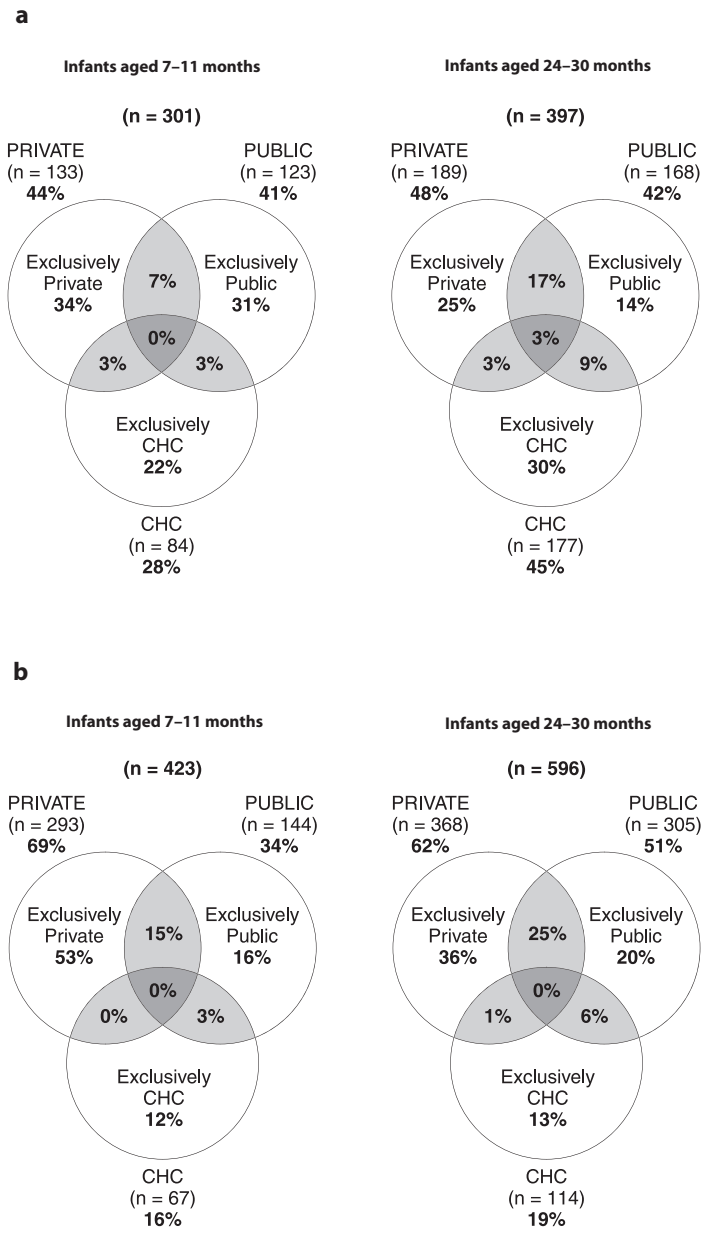
Outcomes

The registry allowed us to ascribe documentation of records to specific sites, but we were not able to ascribe the site of delivery of immunizations. As a result, if records existed at a site, it could be assumed to be a site of care but could not be assumed to have provided that vaccination. The up-to-date criteria for each age group reflect the recommendations of the joint Advisory Committee on Immunization Practices/American Academy of Pediatrics/American Academy of Family Physicians harmonized schedule.[17] An infant was considered to be up to date at 7 months if he or she had received at least 3 diphtheria-tetanus-pertussis (DTP), 2 polio, 2 hepatitis B, and 2 *Haemophilus* influenzae type B (Hib) immunizations. At 12 months, the requirement was 3 DTP, 2 polio, 2 hepatitis B, and 3 Hib immunizations; at 24 months it was 4 DTP, 3 polio, 1 measles-mumps-rubella, 3 hepatitis B, and 3 Hib immunizations.

Data Analysis

Each immunization delivery site and the immunizations recorded at those sites were assigned to 1 of the 3 health care delivery sectors (private practice, community health center, or public health clinic). Therefore, 3 separate but partially overlapping cohorts of children were defined, which permitted assessment of "up to date" rates from the perspective of a practitioner in each of the 3 sectors. To assess the benefit of "up to date" rates accrued by the registry, we created 3 data sets: (1) private-practice data only, (2) private-practice data *plus* community health center data, and (3) private-practice data *plus* community health center data *plus* public health clinic data for children who had any immunizations documented in the private-practice sector. Rates of up-to-date children were then calculated for each data set, and the rates of private practice alone and the rates of private practice plus the rates of all sectors were compared statistically with McNemar's tests.

We conducted a similar analysis beginning with the cohort of children who were identified at community health centers and sequentially adding data from private practices and public health clinics. These additional analyses were performed because the cohorts who were defined by having records at private practices or by having records at community health centers, although overlapping, were different cohorts of children. Because the public health clinics in these regions do not provide compre-



Note. CHC = community health center.

FIGURE 1—Immunization records from 3 health care delivery sectors in (a) the San Luis Valley region and (b) the northeast region of Colorado, 2000.

hensive primary care, we did not repeat these analyses beginning with children who were identified by having records at public health clinics. Statistical comparisons of "up to date" rates between health care delivery sectors and between regions were performed with χ^2 analyses. All analyses were conducted with SAS software (SAS Institute Inc, Cary, NC).

RESULTS

Distribution of Immunization Records Among 3 Health Delivery Sectors

The proportion of infants who were aged 7 months in each health sector and who had records exclusively in that sector was in the range of 75% to 80%, with the exception of the public health clinic sector in the northeast region, where only 46% of the infants who had records in the public health clinic sector had records exclusively in that sector. By 24 months of age, the proportion of children who had records exclusively in 1 sector dropped markedly for all 3 sectors in both regions. In the San Luis Valley region, the greatest drop occurred in the proportion of children who had records exclusively in the public health clinic sector (75% to 33%; $P<0.0001$), and in the northeast region, the greatest drop occurred in the proportion who had records exclusively in the private-practice sector (77% to 58%; $P<0.0001$).

Figure 1 shows the overall distribution of immunization records among the 3 health delivery sectors for children aged 7 and 24 months in both regions. In the San Luis Valley region, approximately one third of the infants younger than 1 year had immunization records exclusively in either the private-practice or public health clinic sectors, while only 22% had records exclusively in the community health center sector. The amount of overlap between sectors more than doubled from the 7-month to 24-month age groups (13% to 31%; $P<0.0001$), with most of the increase occurring in the community health center sector (28% to 45%) and higher rates of overlap occurring between the private-practice and public health clinic sectors. In the northeast region, a higher percentage of infants younger than 1 year had records exclusively in the private-practice sector, with 12% having records only in the community health center sector and 16% having records only in the public health clinic sector. The overlap between the sectors increased among the older age groups (18% to 32%; $P<0.0001$), with higher rates of overlap occurring between the private-practice and public health clinic sectors. Data for children aged 12 months in both regions showed similar trends, and values were intermediate between the other age groups (data not shown).

In both regions, children who had immunizations recorded at a private practice were more likely to also have immunizations recorded at a public health clinic than were children who had immunizations recorded at a community health center. For example, in the San Luis Valley region, the number of children who had immunizations recorded at both private practices and

TABLE 2—Documented Immunization "Up to Date" Rates (%) for Children Seen in 3 Health Care Delivery Sectors in the Northeast and San Luis Valley Regions, by Age Group: Colorado, 2000

	Overall "Up to Date" Rate	More Than 1 Sector	Exclusively Private Practice	Exclusively Community Health Center	Exclusively Public Health Clinic
7–11 mo					
San Luis Valley	34	54	56	15***	13***
Northeast	50	43	57*	52	30
24–30 mo					
San Luis Valley	49	64	23***	57	44**
Northeast	57	72	53***	42***	49***

Note. Comparisons of "up to date" rates for children in 1 sector versus more than 1 sector.
*$P<0.05$; **$P\leq0.01$; ***$P\leq0.0001$.

public health clinics as a proportion of children who had immunizations recorded at private practices was 42% (79 of 189) for children aged 24 to 30 months. Conversely, the proportion who had immunizations recorded at both community health centers and public health clinics as a proportion of all children who had immunizations recorded at community health centers was only 26% (46 of 177). Similar findings were observed in the northeast region.

Relationship Between "Up to Date" Rates and Health Care Delivery Sector

As shown in Table 2, among children aged 24 months in both regions, immunization rates were higher for children who had immunization records in multiple sectors than for those who were seen in only 1 health sector. In the northeast region, "up to date" rates were lowest for children who had records exclusively in the private-practice sector, while in the San Luis Valley region, the "up to date" rates were lowest for children who had records only in the community health center sector. The comparison between exclusively private practice (23% up to date) and more than 1 sector (64% up to date; $P<0.0001$) for children aged 24 months in the San Luis Valley region was particularly striking, as was the falloff in "up to date" rates between the first and second years for children who had immunizations exclusively at private practices (56% vs 23%; $P<0.0001$).

Impact of the Regional Registry on Overall "Up to Date" Rates

Table 3 shows the benefit on overall "up to date" rates of sequentially adding immunization records from community health centers and public health clinics to records of the cohort of children who had any immunization records at private practices. The absolute increases shown translate to relative increases in the overall "up to date" rate in the range of 9% for infants aged 7 months to 50% for children aged 24 months. The greatest incremental increases in "up to date" rates were seen with the addition of records from public health clinics for children older than 12 months. Similar calculations beginning with the cohort of children who had records at community health centers and adding immunization records first from private practices and then from public health clinics yielded similar overall "up to date" rates and overall incremental changes in the northeast region. However, in the San Luis Valley region, if the beginning cohort was defined by having community health center records, final "up to date" rates after the addition of all other records were lower than final "up to date" rates for the cohort of children who had private-practice records: 24% versus 56% at 7 months, 70% versus 79% at 12 months, and 60% versus 41% at 24 months. These rates were not compared statistically, because the populations were partially overlapping and, therefore, not independent.

TABLE 3—Contributions of Records (%) From 3 Health Care Delivery Sectors to Documented Immunization "Up to Date" Rates in the Northeast and San Luis Valley Regions, by Age Group: Colorado, 2000

	Private Practices	Plus Community Health Centers (Incremental Change)	Plus Public Health Clinics (Incremental Change)	Overall Change
7–11 mo				
Northeast (n = 293)	48	48 (0)	53 (5)	5
San Luis Valley (n = 133)	51	51 (0)	56 (5)	5
12–23 mo				
Northeast (n = 378)	69	70 (1)	78 (8)	9
San Luis Valley (n = 187)	70	73 (3)	79 (6)	9
24–30 mo				
Northeast (n = 368)	48	48 (0)	62 (14)	14
San Luis Valley (n = 189)	20	24 (4)	40 (17)	21

DISCUSSION

The development of regional immunization registries has been advocated as a means of improving immunization delivery by consolidating immunization records from multiple sources, which thereby eliminates record scatter, reduces the frequency of missed opportunities, and facilitates reminder and recall notices for immunizations. Our study quantifies the extent of record scatter within the different health care sectors for nearly complete populations of children who received health care in 2 rural geographic regions. This allowed us to examine the benefit that a regional registry can confer to providers in an entire region. Our findings show a significant beneficial effect of the registry, with a doubling of documented "up to date" rates for children aged 24 months. Additionally, our study suggests that a regional registry can be a valuable public health tool for delineating patterns of care that have direct implications for health care planning and policy.

Our study expands on several previous studies that examined the potential benefit of consolidating records in immunization registries from the perspective of individual practices or the public health clinic versus private-practice sectors.[18–20] The results of our study, which included nearly complete data from all health delivery sectors in 2 regions, were similar to those previously reported for more limited populations, with increases in "up to date" rates in the range of 14% to 21% for children aged 24 months. The largest incremental increases in "up to date" rates resulted from the addition of records from the public health clinic sector for children older than 1 year who also had been seen at private practices.

Our data also provide insight into patterns of immunization delivery among the 3 health delivery sectors that have important public health policy implications. In both regions, there was a clear temporal trend for children to move into the public health clinic sector after the first year of age, and these children often received both private and public sector health care. Indeed, our data contradicted the perceptions of many of our participating providers in each of the health care sectors, who believed they provided almost all of the immunizations for the children who were seen at their practices. This perception was a major hurdle to overcome during the initial implementation of the CRISP registry and during the continued involvement of some providers in the 2 regions. At 24 months of age, about one third of the children who were seen in the public health clinic sector were seen exclusively in that sector, only slightly over half of the children who were seen in the private-practice sector were seen exclusively in that sector, and about two thirds of the children who were seen in the community health center sector were seen exclusively in that sector. Additionally, our data also demonstrate that children who received primary care in either the private-practice or community health center sectors were more likely to have documented up-to-date records if they also had records in multiple sectors. In these regions, children who utilized more than 1 sector appear to have better documentation and higher "up to date" rates.

These data illustrate the special challenges posed by immunization delivery in rural areas. From the point of view of rural private-practice physicians, most of whom are family physicians, it is difficult and expensive to maintain adequate supplies of a variety of vaccines, especially when the volume of children in their practice is low. Underinsurance for vaccines also is a common problem, because the parents of many children either do not have any coverage for vaccines through their insurance or they have to pay out-of-pocket when their deductible has not been met. Additionally, children often shift between public insurance programs and being uninsured because of seasonal changes in income and because of loss of continuous Medicaid eligibility after 12 months of age. Families must navigate the 3 immunization delivery systems as they experience shifts in their insurance status, financial status, deductible limits, access to primary care services, and transportation. As a result of all these factors, practitioners in rural areas frequently refer uninsured children, children with public insurance, and children with private insurance who have co-payments or deductibles to public health nursing services or clinics for immunizations.[11,12]

Our findings have important policy implications. Despite the success of the federal Vaccines for Children (VFC) program in increasing the numbers of vaccines administered in private practices nationally, our data suggest that public health nursing services and clinics continue to play a major role in immunizing children in rural areas. If the policy priority is to increase the involvement of private-practice physicians in immunization delivery in rural areas, with the benefits of a single medical home, stronger financial incentives for participation in immunization delivery need to be instituted. At present, certain VFC policies—including inadequate administrative fees and regulations that prohibit use of VFC for underinsured children in private practices—undermine children who receive immunizations at their primary care site. As summarized in a recent publication, overall reimbursement is currently less than total delivery costs for the majority of vaccines among private practices in these rural areas.[21] Liberalizing the regulations regarding use of VFC vaccine among underinsured children, providing an economic incentive for covering administration costs for physicians who participate in the VFC program, and increasing reimbursement for immunizations in general might arrest the observed trends to refer children to the public health sector for immunizations. Unless these needed changes are instituted, cutting federal support for public health immunization infrastructure is likely to result in lower immunization "up to date" rates in rural areas.

Our data also have implications for local health care delivery planning and policy. For example, in both regions, the registry identifies a portion of children who had records only in the public health clinic sector during their first year of life. In most cases, these children received shots but did not receive comprehensive preventive care from nursing services or immunization clinics. Our data indicate that by 2 years of age, many of these children appeared in the private-practice or community health center sectors, which suggests that they were accessing comprehensive primary care, although this care may have been significantly delayed. If it is linked to the public health department, the regional registry can serve an important role by identifying this at-risk group and by focusing local efforts to determine eligibility for Medicaid or the State Child Health Insurance Plan. Furthermore, the regional registry can promote early enrollment and access to primary care sites for this group of at-risk children.

Observed differences between the regions also raise interesting questions that are relevant to local policy makers. For example, why were children aged 24 months in the San Luis Valley region who had records exclusively in the private-practice sector less than half as likely to be up to date by available documentation when compared with children in the northeast region who had records exclusively in the private-practice sector? The regions differ substantially with respect to the structural organization of their community health centers and public health clinics, the sociodemographic characteristics of their populations, and their geography. Although our data do not supply definitive reasons for the observed regional differences in immunization documentation, they can focus the efforts of the communities to understanding the observed patterns and instigating positive change. This potential to use a regional registry to better

understand patterns of health care delivery has not previously been explored.

Our findings have some important limitations. Although we attempted to approximate a population-based approach, our study did not include children aged 24 months who did not access any provider, who migrated into the area and had not yet accessed a provider, or the small percentage of children who accessed 2 practices that were not included because they provided too few immunizations. As previously noted, our registry was populated from medical records alone and did not include a concerted effect to enter hand-held records that were not part of the medical record at the time. Although the registry did markedly increase documented "up to date" rates, particularly for older infants, the overall "up to date" rates may be lower than those obtained if there was more aggressive collection of all historical data, including hand-held records.[22] Finally, our data reflect regional patterns of documentation of immunizations, but they do not precisely map patterns of immunization delivery.

Regional immunization registries can help clinicians and public health officials increase immunization "up to date" rates by better tracking patients, by helping to target and carry out recall and reminder efforts, and by preventing overimmunization. Additionally, as this study shows, a regional registry also is a valuable public health tool that offers insight into immunization delivery and documentation on a population level. Data from a regional registry that demonstrate the extent of overlap in the delivery of preventive care at different ages can help persuade health care providers of the importance of a statewide registry. Also, patterns of immunization delivery within a region can reveal deficiencies in the delivery of care and can have important policy implications. Such data will be useful for increasing cooperation among different sectors of the health care delivery system within a community in focusing on the common goal of improving immunization delivery to children. ■

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Contributors

A. Kempe conceived the study design, supervised all aspects of the analysis, synthesized the analysis, and led the writing. B. Beaty assisted with the design, led the analysis, and assisted with synthesis of the analysis and writing the article. J. Steiner assisted with the design, synthesis of the analysis, and writing the article. K. Pearson assisted with the design, implementation of the study, synthesis of the analysis, and writing the article. N.E. Lowery assisted with the design, was responsible for all aspects of implementation of the study, and assisted with synthesis of the analysis and writing the article. M. Daley and L. Crane assisted with the design, synthesis of the analysis, and writing the article. S. Berman assisted with the design, synthesis of the analysis, policy implications, and writing the article.

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Human Participant Protection

No protocol was needed for this study.

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