

**Immunizing Children in Their
Medical Home —
Does it Make a Difference?**

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A report for the Immunize Kansas Kids project

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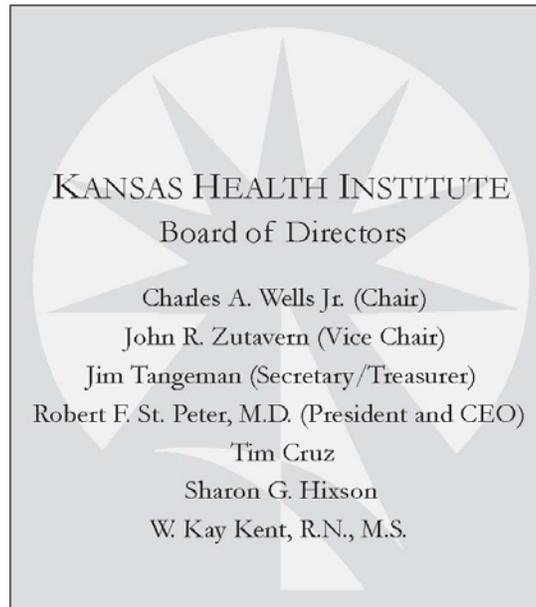
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EXECUTIVE SUMMARY

The low level of private sector participation in immunization activities, including the federal Vaccines for Children (VFC) program, appears to be one of the factors affecting Kansas' immunization rate. Only 65 percent of primary care providers in the state offer immunization services to their pediatric clients, and only half of the private clinics that provide immunizations are enrolled in the VFC program. The enrollment rate in VFC is lower in urban counties.

As a result, many Kansas children receive primary care at their doctor's office but are referred elsewhere, typically to a local health department, to receive immunizations. Results from some studies in other states suggest that children who are referred out of their medical homes may experience delays in receiving their immunizations. This study attempted to verify whether being referred for immunizations to a local health department (LHD) could affect the timeliness of the vaccinations received by the children who were referred.

A sample of private clinics that provide immunizations was identified from a database, generated by a previous IKK study, of private primary-care clinics in the state. Immunization records in those clinics were randomly selected and reviewed. Another sample of clinics that refer their patients elsewhere for immunizations also was identified and immunization records from the LHDs in the counties where those clinics are located (and where patients are presumably referred) were randomly selected and reviewed. Timeliness of immunizations for children in the first two years of life was compared in the two groups.

The results showed that timeliness varies substantially across the first two years of life. Statewide, children immunized in private clinics received more timely immunizations during the first year of life than those immunized in LHDs. After the first year, the gap between private clinics and LHDs narrows, and coverage rates at the age of 24 months tend to be higher in LHDs than in private clinics. In urban counties, however, vaccination coverage rates in private clinics are substantially higher than in LHDs across all ages, not just during the first year of life. For the children who did not receive their immunizations as early as recommended, over two-thirds had a history of at least one "missed opportunity," that is, instances in which a child received at least one dose of vaccine, but did not receive all the doses that the child was eligible for at that time.

In general, these findings suggest that there are no substantial structural differences that would make a LHD or a private clinic consistently a better place for children to receive their immunizations. However the findings confirm those from studies done in other states that indicate that referring children from their medical home to a LHD may cause delays in receiving immunizations, especially during the first year of life. The results also show that access to timely immunizations is more problematic in urban areas, where fewer physicians are available to participate in free vaccine programs and local health departments don't seem to be able to cope with the volume of children referred by private clinics.

This study identifies possible interventions to improve the timeliness of immunizations in Kansas. It confirms that effective solutions must include multiple strategies, be adapted to local circumstances, and involve coordinated efforts from private providers, public health agencies and communities at large.

BACKGROUND

For many years Kansas has experienced difficulty achieving and sustaining high immunization rates among children. And its progress towards the national goal of 90 percent coverage often has not matched that of other states. To address this long-standing problem, the Kansas Health Foundation is funding a multi-year project, Immunize Kansas Kids (IKK). The project is being administered by the Kansas Health Institute (KHI) and the Kansas Department of Health and Environment (KDHE), with support from a dozen other stakeholder groups. To support the IKK project, KHI is engaged in several research activities aimed at identifying possible barriers in the immunization delivery process and system. This report focuses on one of the research activities, a study of how referring children from their medical homes can affect the timeliness of immunizations.

A factor potentially affecting Kansas' immunization rate is the low level of private-sector participation in immunization activities and in the federal Vaccines for Children (VFC) program, which provides free vaccine to eligible children from low-income families. A previous IKK study¹ revealed that:

- Only 65 percent of primary care providers in the state offer immunization services to their pediatric clients.
- Approximately half of the private clinics that provide immunizations are enrolled in the VFC program (the national average reported in 1997 was 81 percent of private clinics offering immunizations).
- Enrollment rate in VFC among private immunization clinics in Kansas is lower in urban counties.

As a result, many Kansas children receive primary care at their doctor's office but are referred elsewhere, typically to a local health department, to receive immunizations. The American Academy of Pediatrics and other groups recommend the use of a single medical home for the delivery of all primary care to children. Results from some studies in other states suggest that children who are referred from their medical homes may experience delays in receiving their immunizations.

The research question for this study was whether age-appropriate vaccination coverage rates during the first two years of life differ for children immunized in their medical homes compared to those referred to local health departments.

METHODS

SAMPLING FRAME

The sampling frame for this study was provided by a database, generated by a previous IKK study, of all private primary care clinics in the state. This list contains names and contact information for private clinics that provide primary care services for children. It is believed that the list includes almost all private clinics in the state and their physicians, although the completeness and the accuracy of the information in this database have not been formally evaluated. Two variables from the list were used for sampling purposes in this project:

1. Whether the clinic offers immunizations. This variable was used to classify clinics into two groups — those offering immunizations to some or all children, and those not offering immunizations.
2. The number and specialty of physicians practicing in each clinic. This variable was used to classify clinics into three groups — solo (one physician), medium (two to nine physicians), and large (ten physicians or more).

Table 1 shows the distribution of the 424 private primary care clinics in the database by clinic size and clinic policy on immunization services.

Table 1. Distribution of Private Clinics by Size and Policy on Immunization Services

Policy on Immunization Services	Clinic size							
	Solo		Medium		Large		Total	
	N	%	N	%	N	%	N	%
Offer immunization services	93	55.4	162	71.0	22	78.6	277	65.3
Do not offer immunization services	75	44.6	66	29.0	6	21.4	147	34.7
Total	168	100.0	228	100.0	28	100.0	424	100

Based on this distribution of clinics, the research team designed a study plan that called for quota sampling of private clinics of different sizes to achieve a comparable representation of subjects immunized in their private-sector medical home (the “private” group) and subjects referred to a local health department for immunizations (the “LHD” group). The quota sampling plan called for participation of three large clinics, 24 medium clinics, and 27 solo clinics in each of the private and LHD groups. To ensure a relatively even distribution of children across clinic size categories, without overrepresentation of any one clinic size, the plan called for random sampling of five records from solo clinics, 20 records from medium-sized clinics, and 35 records from large clinics, selected from the total pool of eligible children in each clinic.

The recruitment and sampling plans were carried out in a slightly different manner for the private and LHD groups. For the private group, in clinics that agreed to participate, subjects were selected directly from the list of eligible patients in each clinic. For the LHD group, the study team randomly selected private clinics that do not offer immunizations, according to the quota sampling plan. The study team did not attempt to contact these non-immunizing clinics, due to concern about the completeness of their immunization records and their willingness to participate in the study. Rather, the study team randomly selected the requisite number of records from the LHD in the same county where the non-immunizing private clinics are located. It was assumed that non-immunizing clinics refer patients to the closest LHD; this assumption is supported by well-established practices in the state and anecdotal evidence collected during the IKK project. In each LHD, a number of records were selected appropriate for the size of the non-immunizing private clinic. When multiple non-immunizing clinics in the same county were selected, the number of records sampled in the corresponding LHD was the total required for all selected non-immunizing clinics. Of note, there was no mechanism to consistently link LHD patients to a specific private clinic; therefore the LHD records included in the study were randomly selected from all eligible records, not limited to those of the selected non-immunizing clinics. In this respect, the LHD group represents a random sample of all children referred to LHDs for immunization, but cannot distinguish between those referred from solo, medium, or large private clinics.

Human subject protection assurance was obtained through the Institutional Review Board at the University of Michigan. The research team received a waiver of informed consent for the project.

Private Clinic Recruitment

A letter of recruitment was mailed to all private clinics in the database that provide immunizations, inviting them to participate in the study. A minimum of three telephone calls were placed to each clinic. Additional written information about the study was provided via fax and/or e-mail, as requested. All clinics providing immunizations that agreed to participate were included in the study. After agreeing, private clinics were asked to designate an individual who would be responsible for overseeing the patient selection and record procurement process.

Local Health Department Recruitment

General information about the study was distributed to all health departments in Kansas via letter and at public health meetings. For the 45 LHDs included in the study, the team placed telephone calls to the immunization coordinator inviting the LHD to participate. Additional written information about the study was provided via fax and/or e-mail, as requested.

Record Selection and Exclusion Criteria

Participating private clinics and LHDs were asked to generate a list of all patients between 19 and 35 months of age, as of January 1, 2007. Patient lists were generated through an electronic billing system, if one existed. Excluded were children who did not have a Kansas home address.

The study team tried to identify the population of children in each setting for whom providers could reasonably be held responsible for immunization delivery. This approach facilitated comparability across these two unique settings of immunization delivery, and ensured that participating clinics felt they were receiving fair treatment in the assessment of their immunization patterns.

In this regard, private clinics were asked to exclude children who had not made a visit to the clinic in the preceding 12 months, since children of this age would be expected to have an office

visit at least once a year, either for sick or well care; therefore those with no visit in 12 months were considered inactive. In contrast, for the LHDs, there was no comparable exclusion, for several reasons. First, LHDs may not offer sick and well visits; there may be no records of office visits; and there is no expectation of visit frequency, beyond scheduled immunizations. Second, many LHDs had implemented immunization practices to administer recommended doses as soon as possible, such as after a child's first birthday; thus, for those born on the earlier end of this study's age range (children 25–35 months), excluding children who had not received an immunization in the preceding 12 months would unfairly eliminate those who received all doses of the 4:3:1:3:3 series by 13 months of age and had no further need of immunizations.

For both private clinics and LHDs, children were excluded if their records were deemed to be incomplete. For private clinics, these comprised children who transferred to the practice and/or those who received immunizations elsewhere; in almost all cases, the immunization records carried a notation about the record being incomplete. For LHDs, excluded were children with recorded immunizations on one date only, suggesting another site for immunization delivery. Without an immunization registry or other means to complete the immunization history, the study team felt that it was appropriate to exclude these children. For both the private and LHD groups, exclusions due to incomplete records represented less than 0.5 percent of the eligible patient population.

The remaining list of eligible patients represented potential subjects for the record abstraction.

RECORD ABSTRACTION

From each clinic's sampling frame, the research team used random number generation to select the requisite number of patients (based on clinic size), and communicated to clinic staff which patient records to pull. In instances where a clinic did not have sufficient eligible patients for that stratum's target, all were selected for participation. Selected patients were assigned a unique study identification number, to facilitate anonymity of research records. Clinic staff pulled the records for selected children, photocopied the immunization history, redacted

identifying information, and sent the record to the research team. Only the date of birth and the date and type of immunizations on the records were transmitted to the study team.

DATA MANAGEMENT

For each record, research staff entered date of birth, as well as vaccine administration dates and type into the Centers for Disease Control and Prevention's (CDC) CoCASA software. The study team implemented logic checks and verification procedures to ensure data accuracy and consistency. To facilitate analyses of clinic demographic factors, each site was categorized by clinic setting (private clinic versus local health department) and county type (urban, semi-urban and rural). In addition, private clinics were categorized by clinic size (solo, medium and large) and clinic type (pediatric, family practice and general practice).

VACCINATION MEASURES

Vaccination measures used in the study parallel those used by the CDC's National Immunization Survey. Vaccination coverage rates represent the proportion of children "up-to-date" for a specific set of vaccine doses.

The study's overall outcome measure is the vaccination coverage rate for the 4:3:1:3:3 series for children 19–35 months of age. The 4:3:1:3:3 series includes four doses of diphtheria-tetanus-pertussis vaccine (DTaP); three doses of Haemophilus influenzae type b vaccine (HiB); one dose of measles-mumps-rubella vaccine (MMR); three doses of inactivated polio vaccine (IPV); and three doses of hepatitis B vaccine (HepB). We did not include varicella vaccine, which had not been widely recommended in Kansas at the time, and pneumococcal conjugate vaccine, due to prolonged national shortages.

Secondary outcome measures were age-appropriate vaccination rates at 3, 7, 13, 19 and 24 months of age. The criteria for these age-appropriate rates, shown in Table 2, are the specific doses recommended by the CDC's childhood immunization schedule at key points in time. A one-month grace period is allowed, to allow for problems with scheduling or minor illnesses.

Table 2. Analysis of Children’s Age-Appropriate Vaccination Status

Assessment at	Up-to-date defined as
3 months	1 DTaP, 1 Hib, 1 IPV, 1 HepB
7 months	3 DTaP, 2 Hib, 2 IPV, 2 HepB
13 months	3 DTaP, 2 Hib, 2 IPV, 2 HepB
19 months	4 DTaP, 3 Hib, 1 MMR, 3 IPV, 3 HepB, 1 VAR
24 months	4 DTaP, 3 Hib, 1 MMR, 3 IPV, 3 HepB, 1 VAR

DATA ANALYSIS

Differences in vaccination coverage rates between groups were assessed and tested for statistical significance using logistic regression. Comparisons were studied by clinic setting, county type, clinic size, and clinic specialty. P-value for significance was set at 0.05. Results were adjusted for the effect of clustering inherent in the study design (intra-cluster correlation).

An analysis of missed opportunities for vaccinations also was performed. For this study, missed opportunities were defined as instances (dates) when a child received at least one vaccine dose, but did not receive all eligible doses at that time. In other words, there is evidence from the immunization records that the child was in the clinic or health department for vaccination, but did not receive all vaccines that could have been given on that date, based on the child’s age. At each assessment point, the missed opportunity rate was calculated by identifying, out of the number of children who were not up-to-date, the proportion of children who had at least one missed opportunity to that point.

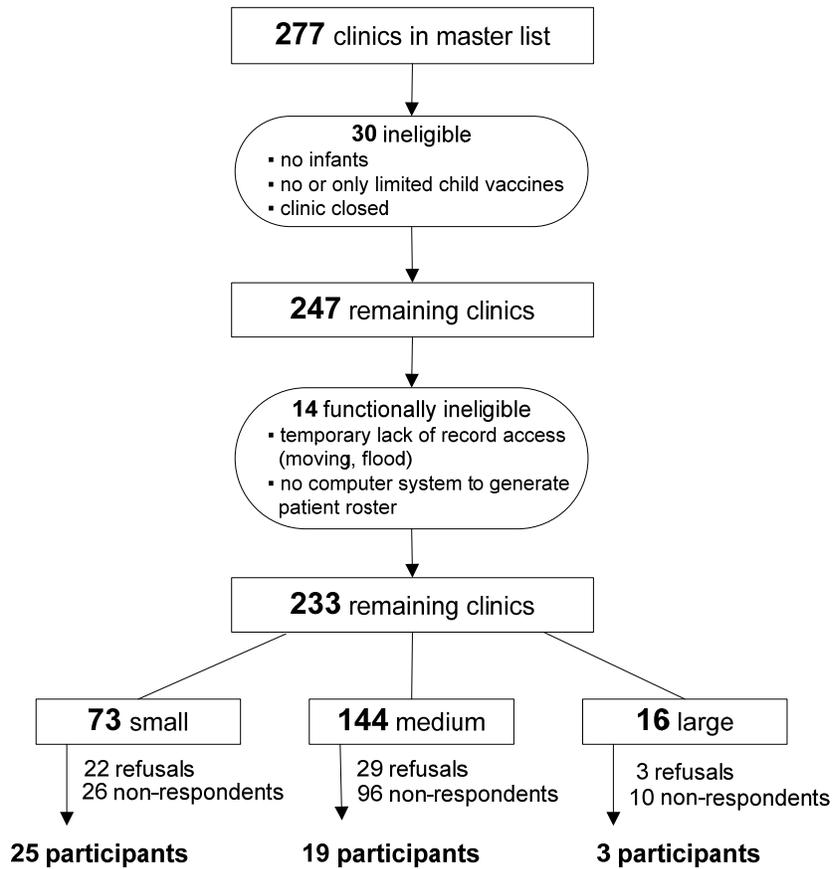
RESULTS

As shown in Figure 1, 30 of the initial 277 private clinics in the sampling frame had been closed or were no longer providing childhood immunizations. For the remaining 247 clinics that provide immunizations and were eligible to be included in the study, 14 were unable to participate due to functional or technological difficulties. All the other 233 eligible clinics were invited to participate in the study, and a total of 47 accepted: 25 solo clinics, 19 medium clinics, and three large clinics. These private clinics included 16 pediatric clinics, 30 family practice clinics, and one general practice clinic. The study’s private clinic participation rate was 20 percent (47 of 233 invited clinics). The study included a number of clinics just short of the quota sampling target of 27 solo, 24 medium and three large clinics.

Among local health departments, 44 of the 45 selected LHDs participated in the study, for a participation rate of 98 percent.

The 47 private clinics and 44 LHDs yielded records from 1,194 children (600 from private clinics and 594 from LHDs).

Figure 1. Private Clinic Eligibility and Participation



4:3:1:3:3 VACCINATION COVERAGE RATE

The overall 4:3:1:3:3 vaccination coverage rate for children 19–35 months of age was 76.5 percent (95% confidence interval [CI] 72.4% – 80.2%). Comparing by clinic setting, the

4:3:1:3:3 coverage rate was 73.7 percent for private clinics versus 79.1 percent for LHDs. These differences were not statistically significant.

AGE-APPROPRIATE VACCINATION COVERAGE RATES

Age-appropriate coverage rates for the 1,194 children included in the analysis are shown in Table 3 for the overall sample and comparing private versus LHDs. Up-to-date rates varied substantially across the first two years of life, which is consistent with established patterns observed elsewhere.

Table 3. Up-To-Date Rates at Key Ages

	3 months*	7 months*	13 months	19 months	24 months
Overall	81.3%	60.0%	86.2%	65.1%	74.4%
Private	84.0%	67.6%	88.2%	63.6%	71.6%
LHDs	78.6%	52.4%	84.3%	66.7%	77.2%

* The difference is statistically significant.

As shown in Table 3, children immunized in private clinics have higher up-to-date rates at 3 and 7 months. After the first year of life, the gap between private clinics and LHDs narrows, and coverage rates at the age of 24 months are actually higher in LHDs than in private clinics, although this difference is not statistically significant.

In Table 4, the comparison of private and LHD vaccination rates are broken down further by county population density. These data show that in urban counties, vaccination coverage rates in private clinics are substantially higher than in LHDs across all ages, and the differences are statistically significant.

Table 4. Vaccination Coverage Rates by County Type

	3 months	7 months	13 months	19 months	24 months
Urban*					
Private	86.7%	74.8%	90.5%	68.0%	75.8%
LHDs	71.3%	46.8%	66.5%	49.5%	55.7%
Semi-urban					
Private	79.4%	57.9%	83.4%	58.3%	68.1%
LHDs	83.0%	57.6%	86.9%	63.2%	75.8%
Rural					
Private	85.2%	64.9%	86.0%	63.1%	70.3%
LHDs	79.5%	52.1%	89.2%	74.5%	85.2%

* The difference is statistically significant.

Among private clinics, vaccination coverage rates did not vary by clinic size across the first year of life. At 19 and 24 months, children immunized in large clinics tended to be more up-to-date, though the differences were not statistically significant.

However, the type of private clinic had a significant effect on vaccination coverage rates. Consistently, children immunized at pediatric clinics had higher vaccination coverage rates than children immunized at family/general practice clinics (Table 5).

Table 5. Vaccination Coverage Rates by Private Clinic Type

	3 months	7 months	13 months	19 months*	24 months*
Pediatric	87.8%	73.1%	89.4%	73.9%	81.5%
Family/General	81.9%	64.1%	86.5%	58.1%	66.7%

* The difference is statistically significant.

MISSED OPPORTUNITIES FOR VACCINATION

Table 6 presents the prevalence of missed opportunities during the first two years of life. Each column represents the proportion of children not up-to-date with at least one missed opportunity from birth to the age indicated in the column. Missed opportunities occur more frequently in private clinics than LHDs; this gap is particularly pronounced at 3 months of age. For the 4:3:1:3:3 series, for children who were not up-to-date, 72 percent in the private group and 51 percent in the LHD group could be brought up-to-date with one additional visit.

Table 6. Cumulative missed opportunities to provide age-appropriate vaccinations

	3 months* N=223	7 months N=477	13 months N=166	19 months N=402	24 months N=295
Overall	8.3%	12.8%	35.4%	49.6%	68.8%
Private	14.7%	14.8%	41.0%	54.5%	71.7%
LHDs	3.5%	11.5%	30.9%	44.1%	65.3%

* The difference is statistically significant.

DISCUSSION

For stakeholders interested in improving the vaccination rates of children in Kansas, findings from this study point to several target areas and confirm the existence of important differences in the delivery of primary care between rural and urban areas in the state. Based on results from this and previous studies, it appears that the immunization delivery system is weaker in urban areas than in rural areas.

Primary care physicians in urban areas carry patient loads about twice those of their counterparts in rural areas. Also, private physicians in urban areas are less likely than those in rural areas to enroll in the VFC program. As a result, the LHD often is the only viable immunization option for low-income children. However, public health agencies in urban areas appear to be struggling to cope with the number of hard-to-reach children in need of immunizations. The results of this study show that in urban areas, children immunized at LHDs were far behind their counterparts who were immunized in private clinics in terms of age-appropriate vaccination. The discrepancy began with the first series of vaccines (at 3 months, vaccination coverage rates are 86.7 percent private and 71.3 percent LHD) and continued through age 2 years (75.8 percent private and 55.7 percent LHD). Moreover, at 7 and 19 months, less than half of the children immunized at urban LHDs were up to date. Of all subgroups analyzed for this study, urban LHDs had the lowest vaccination coverage rates.

Numerous studies show the strongest predictor of a child being up-to-date on vaccinations at age 2 is whether the child's first doses are administered in a timely fashion. Therefore, solutions aimed at improving immunization rates in urban areas should be focused on ensuring that

children receive their initial vaccinations on time.²⁻⁹ A key question is whether children who fall behind during their first year of life — many of whom are likely to be enrolled in Medicaid — are taken in for a primary care visit within their first month of life. Early access to primary care, a longstanding problem with Medicaid programs across the country, enhances age-appropriate immunization; the primary care provider lays out a schedule for well-child visits that corresponds to immunization requirements. For children immunized at urban LHDs who do not have an early well-child visit with a private primary care provider, interventions need to address the overall extent of Medicaid participation in urban areas, as well as timeliness of assigning primary care providers after birth, in order to ensure that infants receive appropriate medical care (including immunizations) from the earliest ages. Improved referral mechanisms for newborn babies to a primary care provider at the time of discharge from the hospital have been recommended by the IKK steering committee.

For children immunized at urban LHDs who have had an early well-child visit with a private primary care provider, interventions should focus on increasing participation in the Kansas Vaccines for Children (VFC) program among urban primary care sites. This would allow more children to be immunized in their medical homes, avoiding the need for parents to visit two different locations (a private clinic for well-child or other type of primary care, then a health department for immunizations).

Outside of urban areas, differences in vaccination coverage rates among private clinics and LHDs were less pronounced. Rates in LHDs tend to be lower during the first year of life, probably reflecting the fact that the vaccine schedule from birth to 12 months of age requires multiple doses at short intervals, a schedule that may not give parents and LHDs enough time to complete the referral process. In the second year of life, the intervals between vaccinations are greater and rates observed tended to be higher for LHDs than private clinics. In general, these findings suggest that there are no substantial structural differences that would make a LHD or a private clinic a consistently better place for children to receive their immunizations. However, they indicate that referring children from their medical homes to LHDs may cause delays in receiving immunizations, especially during the first year of life.

Still, the vaccination rate in Kansas does not meet the national immunization goal of 90 percent coverage, and data from this study highlight several aspects of immunization delivery that could be improved. For example, vaccination coverage rates for children of all ages were higher for those immunized at private pediatric clinics than at family or general practice clinics. This is consistent with the published literature on immunizations and appears to be related to several factors. Pediatricians are more likely than family physicians to adopt new immunization recommendations.¹⁰⁻¹² Moreover, childhood immunization comprises a much larger portion of routine practice in a pediatric office than in a family practice setting; thus, pediatric practices have opportunities to gain critical experience and expertise in immunization delivery. Findings related to clinic type offer opportunities for intervention; state and/or local public health officials may target family/general practice clinics for educational interventions, incentives and tracking activities.

Other results from this study point to the importance of missed opportunities. Prior studies have shown that underimmunized children — children whose vaccinations are not up to date — often had encounters with providers when vaccines could have been administered, but were not.¹³⁻¹⁴ In this study, the rate of missed opportunities was substantial in both private and public settings. This could be related to the reluctance of some parents and physicians to allow multiple doses at early ages, as documented in other studies.¹⁵⁻¹⁶ Other factors may involve vaccine supply problems and lack of accurate immunization history. State immunization officials can address the problem of missed opportunities in their ongoing educational activities with both private and public immunization providers.

LIMITATIONS

This study is subject to several limitations. The clinic participation rate of 20 percent means that one in five private clinics were included in the study's data collection. It is unclear how the private clinics that agreed to participate are different from the non-participating clinics. It would be reasonable to hypothesize that participating clinics may have greater interest in childhood immunization, or feel they have higher vaccination rates, which could lead to an overestimation of results. However, it is important to note that records were randomly selected from the population of eligible patients in the participating clinics, which would mitigate (even though not

eliminate) any participation bias. In addition, the vaccination coverage rates found in this IKK study are very similar to other published rates. Specifically, in the CDC's 2006 National Immunization Survey (NIS),¹⁷ which targeted the same cohort of children included in this study, the 4:3:1:3:3 vaccination coverage rate was 79.2 percent (CI 74.1%–84.3%). In comparison, for this IKK study, which included children born between February 2004 and June 2005, the 4:3:1:3:3 rate was 76.5 percent (CI 72.4%–80.2%). These rates are very similar and are not statistically different, as evidenced by the overlapping confidence intervals, which supports the validity of findings for this study.

Study methods did not allow for collection of immunization data beyond the participating clinics and LHDs to complete children's immunization history with records from other providers and clinics. This could result in an underestimation of the rates, if additional vaccinations were delivered that are not included in the records. In contrast, the CDC protocol used for the NIS includes data collection from all parent-reported sites of immunization delivery. This difference likely explains the slightly higher CDC rates described above; still, the vaccination coverage rates are very comparable, suggesting that the effect of this limitation is minimal. Also, in this IKK study, children whose records were noted to be incomplete were excluded from the study. Although this exclusion accounted for less than 0.5 percent of the eligible population, study results cannot be said to reflect all children who visit multiple settings for immunization.

Another limitation of this study is that immunization records of children whose private medical homes do not offer immunizations were not studied directly; records from LHDs were used as a proxy instead. This precluded collection of data on primary care visits, and the subsequent calculation of the time delay between well-child visits in the private sector and subsequent LHD immunizations. It also prohibited analysis of the extent of early access to primary care. While this limitation does not affect the study's vaccination coverage rates, it does constrain the search for underlying causes of the low rates among the urban LHD group.

CONCLUSION

Kansas has some unique challenges in delivering immunizations to all the children in a timely manner. It is a predominantly rural state, yet most of its citizens live in urban areas where the problems of delivering immunizations to children are different than those in rural areas. The state also suffers from a long-standing shortage of primary care doctors, and physicians in the state have been traditionally more reluctant than their counterparts in other states to provide vaccinations.

Findings from this study provide ideas for several possible areas for improvement. In urban areas, across all points in the first two years of life, children immunized at local health departments have substantially lower vaccination coverage rates than their peers who are immunized in private clinics, and physicians are more reluctant than their colleagues in rural areas to enroll in the VFC program. Improving access to timely immunizations in urban areas, primarily through the recruitment of more private clinics in the VFC program, could have an important effect in boosting those immunization coverage rates.

Outside of urban areas, results of this study show that in general immunization delivery can be equally well done in LHDs and private clinics, especially after the first year of life. However, some delays occur in the first year of life, and missed opportunities to vaccinate children on time are widespread. In these areas, educational efforts may be useful in both private and public sites to help reduce the number of missed opportunities for vaccination and ensure a more efficient mechanism of referral between private and public clinics.

In summary, this study reinforces the notion that effective solutions to improve and sustain a high immunization rate in our state must include multiple strategies, be adapted to local circumstances, and involve coordinated efforts from private providers, public health agencies and communities at large.

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