Using Administrative Claims to Identify Children With Chronic Conditions in a Statewide Immunization Registry

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Children with chronic conditions are especially vulnerable to complications from influenza.[1-5] Annual influenza vaccinations have long been recommended for this group of children.[6,7] More recently, the Advisory Committee on Immunization Practices (ACIP) adopted a universal recommendation of yearly influenza vaccination for healthy children aged 6 months to 18 years.[6,8] Despite this recommendation, vaccination rates for seasonal influenza remain low for children with chronic conditions.[9-15] Missed opportunities, where eligible children are seen by a practitioner but no vaccination dose is administered, have been documented among this population and may contribute to low vaccination rates.[9,11]

Immunization registries, also known as immunization information systems (IISs), are well established in the United States and provide reminder/recall functions that are effective in increasing vaccination rates.[16] However, IISs are not typically designed to track clinical information in addition to vaccinations and consequently cannot target reminder recall notices specifically to those with chronic conditions. Enhancing immunization registries with a high risk indicator may be a mechanism to promote increased vaccination rates among this population through the use of registry-based reminder/recall capability. In 2006, Michigan's IIS, known as the Michigan Care Improvement Registry (MCIR), was enhanced with a high risk indicator based on Medicaid administrative data to bolster vaccination rates among children with chronic conditions. This indicator has been demonstrated as being an effective mechanism to target reminder/recall notices,[17] although the benefits of that system have initially been limited to children enrolled in Medicaid.[18,19]

With that in mind, the objective of this study was to build on the success of the Medicaid-based MCIR high risk indicator by expanding it to include administrative data from 2 commercial health plans. First, we sought to demonstrate the feasibility of using administrative claims data from commercial health plans to establish a high risk indicator in a

Objectives
To demonstrate the feasibility and utility of using administrative claims data from commercial health plans to establish a high-risk indicator in a statewide immunization registry for enrollees with chronic conditions.

Study Design
Retrospective cohort analysis.

Methods
Administrative data were used to identify children with 1 or more chronic conditions enrolled in 2 commercial health plans during the 2008-2009 and 2009-2010 influenza seasons and matched with a statewide immunization registry. The proportion of cases that successfully matched and historical health services utilization, including influenza vaccinations and missed opportunities, were assessed.

Results
A total of 93% of children with chronic conditions identified through administrative claims were successfully matched with the statewide registry. Less than one-third of children received the seasonal influenza vaccine in either the 2008-2009 (29%) or 2009-2010 (32%) seasons; 30% of children received the H1N1 vaccination in 2009-2010. Most children in the 2008-2009 (63%) and 2009-2010 (63%) seasons had at least 1 missed opportunity for seasonal influenza vaccination. Younger children had the highest percentage of missed opportunities while adolescents had the lowest rate of missed opportunities for vaccination.

Conclusions
It is feasible to identify children with chronic conditions using administrative data and to link them with a statewide immunization registry. Low influenza vaccination rates and high occurrences of missed opportunities among children with chronic conditions suggest the utility of integrating administrative claims data with statewide registries to support various outreach mechanisms, including physician-focused and parent-targeted reminder/recall, based on target age to improve vaccination rates.

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statewide immunization registry for enrollees with an influenza-sensitive chronic condition (hereafter referred to as a "chronic condition"). We also sought evaluate the potential utility of this expansion of the MCIR high risk indicator by assessing historical influenza vaccination experiences among children with chronic conditions.

Take-Away Points

Administrative data from commercial health plans can be used to identify children with chronic conditions in a statewide immunization registry. Low influenza vaccination rates and high occurrences of missed opportunities among children with chronic conditions in our sample suggest the utility of integrating administrative claims data with statewide registries. This integration can:

■ Enable a population-based mechanism for identification of children with chronic conditions as priority cases during pandemic events or supply shortages.

■ Support various outreach strategies to improve influenza vaccination rates, including physician-focused and parent-targeted reminder/recall.

METHODS

We assessed the feasibility and utility of using commercial health insurance administrative data to identify children with chronic conditions in the MCIR statewide IIS. Administrative data were obtained from 2 Michigan-based commercial health plans and were matched with corresponding information in the MCIR. This study was approved by the University of Michigan institutional review board.

Study Population

The commercial health plan identified 48,936 children younger than 18 years who were enrolled in either health plan (health plan 1 or health plan 2) for calendar years 2008 and 2009 and had 1 or more claim for at least 1 chronic condition during this period. Chronic conditions were identified using *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* diagnosis codes (primary or secondary) reported on claims for conditions indicated as placing individuals at increased risk for influenza disease in the ACIP annual influenza vaccination recommendations.[8] Diagnosis codes for the specified conditions were assigned using the same methods as those employed in prior studies (**Appendix A**).[17,18] From this initial cohort, we excluded children who were younger than 6 months, had other insurance, or were not continuously enrolled (8246 [17%] in the 2008-2009 season; 7465 [15%] in the 2009-2010 season). Health plan enrollment and health services utilization were obtained for each subject for the period of 2008 to 2010; information was obtained for demographic characteristics and plan enrollment as well as claims for all outpatient office visits, including vaccine administrations.

Outcomes Measured

Feasibility. Among the commercially insured children 18 years or older who were identified as having 1 or more chronic condition (40,690 in the 2008-2009 season, 41,471 in the 2009-2010 season), we calculated the proportion of cases that could be successfully matched with their corresponding record in the MCIR. A common unique identifier was not available for linking the health plan members with the MCIR, requiring that matching be achieved using the child's name (first/last), date of birth, and gender. Health services utilization was then evaluated among eligible children who were matched successfully with the MCIR data to determine past influenza vaccination experiences as well as missed opportunities for influenza vaccination.

Utility. Three outcomes were measured for the 2008-2009 and 2009-2010 influenza seasons, defined to be September to February of each season: (1) primary care office visits (either ≥1 or ≥2 office visits); (2) vaccination for either seasonal or H1N1 influenza; and (3) missed opportunities for either seasonal or H1N1 influenza vaccinations. Primary care office visits were identified based on *Current Procedural Terminology* (CPT) procedural codes and/or *ICD-9-CM* diagnosis codes. Office encounters with a physician in a family practice, general practice, internal medicine, or pediatric setting were classified as a primary care visit. Immunization visits and other visits during each influenza season were identified using CPT procedure codes, and well child visits were classified using CPT procedure codes and *ICD-9-CM* diagnosis codes (**Appendix B**).

Vaccination records for children with chronic conditions that could be matched with the MCIR were obtained for influenza seasons 2008-2009 and 2009-2010. Healthcare providers are required by Michigan law to input in the MCIR all vaccination doses administered to persons younger than 20 years of age. Seasonal and H1N1 influenza vaccination rates were classified as the receipt of a dose as recorded in the MCIR or through administrative claims. In cases where more than 1 seasonal or H1N1 vaccination dose was administered during an influenza season, we considered the first date of influenza vaccination (from either administrative claims or MCIR data) as the vaccination date for our analysis. Missed opportunities for seasonal influenza vaccination were classified as the

initial office visit occurring during the influenza season (September-February) among children who remained unvaccinated throughout the entire influenza season. Since H1N1 influenza vaccine supply was limited from September to October 2009, missed opportunities for H1N1 influenza vaccination were classified as the initial office visit occurring from November 2009 through February 2010 among children who remained unvaccinated throughout the entire influenza season. Subsequent missed opportunities were not counted. The date of the missed opportunity was classified as the date of the initial office visit occurring between September and February for seasonal influenza vaccination and between November and February for H1N1 influenza vaccination in which the child remained unvaccinated. We calculated estimated seasonal and H1N1 influenza vaccination rates that could potentially be achieved if missed opportunities were successfully converted into influenza vaccination events.

Seasonal and H1N1 influenza rates for the 2008-2009 and 2009-2010 seasons were contrasted between our cohort of children with a chronic condition identified by the commercial health plan with a matched group not having a chronic condition. We used the MCIR to identify children who were not designated with the system's high risk indicator as the basis for our comparison group. However, at the time of our study, the MCIR high risk indicator process was limited to children with chronic conditions who were, or had previously been, enrolled in Medicaid. Children with only commercial insurance would not have chronic conditions identified through claims. As a result, the high risk status of children who were commercially insured in plans other than the 2 health plans used in this study was not known with certainty in the MCIR. To control for potential misclassification, we further categorized our comparison group of children without a MCIR high risk indicator into 2 subgroups: (1) children *currently* enrolled in Medicaid, not identified in the MCIR as having a chronic condition (since these children are or were previously enrolled in Medicaid, their claims were subject to queries to identify chronic conditions and therefore, absence of a high risk indicator in the MCIR is reflective of not having a chronic condition); and (2) children *never* enrolled in Medicaid, whose status in the MCIR was indicated as not high risk. While this group likely contains primarily children who did not have a chronic condition, it is possible that some may have had a chronic condition that was not detected in claims data queries, since this group had never been enrolled in Medicaid. Using this process, 1 comparison child was randomly selected for each commercially insured high-risk case, matching

on birth month and year, gender, and Michigan county of residence. This resulted in a 1:1 matched set of comparison children for each high risk case. Claims data were not available for children who had never been enrolled in Medicaid; as such, seasonal and H1N1 influenza doses were compared in this subanalysis across the 3 groups using doses reported in the MCIR.

Data Analysis

To assess feasibility, we summarized the proportion of cases in the commercial health plans that were successfully matched within MCIR. Primary outcomes measured for the utility of using administrative claims were the receipt of seasonal and H1N1 vaccination and either at least 1 or at least 2 office visits. Health utilization was compared between 1 health plans (health plan 1 and health plan 2) by child characteristics, including age, gender, and rural/urban designation (US Census Metropolitan Statistical Area classification). The proportion of children with a missed opportunity was assessed and compared by influenza season (2008-2009 and 2009-2010) by each child's age group. In addition, observed rates of seasonal and H1N1 influenza vaccinations as reported in MCIR were calculated and compared among the commercially insured high risk group and the 2 comparison groups described above. Estimated influenza vaccination rates were determined by classifying each child with a missed opportunity as a potential influenza vaccination event, and compared across seasons for the commercially insured children with chronic conditions. All analyses were conducted using SAS version 9.2 (SAS Institute Inc, Cary, North Carolina).

RESULTS

Characteristics for our study population are shown in **Table 1** contrasting children enrolled in health plan 1 with those in health plan 2 for the 2008-2009 and 2009-2010 influenza seasons. In 2008-2009, health plan 2 enrollees tended to exclude rural counties of residence (*P* <.0001) and were skewed toward young age groups (*P* <.0001); similar results were found for the 2009-2010 season. The sample of children enrolled in health plan 2 included a greater proportion of children under 6 years of age than children enrolled in health plan 1 for both the 2008-2009 (32% vs 24%; *P* <.0001) and 2009-2010 (29% vs 22%; *P* <.0001) influenza seasons.

We found a high degree of success in matching children with chronic conditions identified through administrative claims data with MCIR. Overall, 93% of the commercially

■ **Table 1.** Demographic Characteristics of the Study Sample

	Influenza Season			
	2008-2009 (N = 40,690)		2009-2010 (N = 41,471)	
	Health Plan 1 (n = 30,052)	Health Plan 2 (n = 10,638)	Health Plan 1 (n = 29,289)	Health Plan 2 (n = 12,182)
Characteristic	n (%)	n (%)	n (%)	n (%)
Age				
6-18 m	1571 (5)	732 (7)	1281 (4)	623 (5)
19-35 m	1811 (6)	842 (8)	1811 (6)	1029 (8)
36-71 m	4054 (13)	1812 (17)	3603 (12)	1986 (16)
6-10 y	7981 (27)	3113 (29)	7176 (25)	3347 (27)
11-18 y	14,635 (49)	4139 (39)	15,418 (53)	5197 (43)
Gender				
Female	14,253 (47)	4863 (46)	13,858 (47)	5539 (45)
Male	15,799 (53)	5775 (54)	15,431 (53)	6643 (55)
Residence				
Rural	3739 (12)	291 (3)	3680 (13)	362 (3)
Urban	21,184 (70)	10,319 (97)	2076 (71)	11,784 (97)
Unknown	5129 (17)	28 (0)	4842 (17)	36 (0)

insured children with chronic conditions were successfully matched with their respective MCIR record; this result was consistent across both seasons in our study period. There were no differences between the matched and unmatched groups by age, gender, or county of residence. Children enrolled in health plan 2 had a higher degree of match success than did children enrolled in health plan 1 for the 2008-2009 (98% vs 90%) and 2009-2010 (98% vs 91%) influenza seasons. Match rates were consistent across plans by gender and age, but were substantially lower for children from unknown counties of residence (44% for health plan 2 vs 83% for health plan 1).

Less than one-third of children received the seasonal influenza vaccine during either the 2008-2009 (29%) or 2009-2010 (32%) influenza seasons; 30% of children received the H1N1 vaccination in 2009-2010. The proportion of children with influenza vaccination or office visits during the 2008-2009 and 2009-2010 influenza seasons varied within health plans (**Table 2**). For both the seasonal and H1N1 vaccines, younger children were more likely to be vaccinated than older children; this was true for children enrolled in health plan 1 (P <.0001) and health plan 2 (P <.0001) across both influenza seasons. Vaccination rates did not differ by gender. For health plan 1, children residing in rural counties were more likely to receive the seasonal vaccination during both the 2008-2009 and 2009-2010 seasons (P <.0001) and H1N1 vaccination in the 2009-2010 season (P <.0001) compared with children

from urban or unknown settings. Vaccination rates did not differ by county of residence for children enrolled in health plan 2.

Overall, 71% of all children were seen by a provider at least once in either season; nearly half had at least 2 provider visits in 2008-2009 (44%) and 2009-2010 (45%). Rates of office visits were highest among younger children across both influenza seasons and plans (P <.0001); adolescents (aged 11-18 years) were the least likely to be seen by a provider in both the 2008-2009 and 2009-2010 influenza seasons. Vaccination rates and office visits differed across health plans (Table 2). Compared with children enrolled in health plan 1, children enrolled in plan 2 had higher seasonal vaccination and office visits across both influenza seasons as well as H1N1 vaccination rates in the 2009-2010 season. Patterns among each plan remained consistent across influenza seasons.

Missed opportunities for influenza vaccination were commonplace among children each season and varied substantially across age groups (**Figure 1**). Among all children in our sample, 71% remained unvaccinated for influenza during the 2008-2009 season, 68% remained unvaccinated during the 2009-2010 season, and 70% remained unvaccinated for H1N1 in the 2009-2010 season. Among those who remained unvaccinated, nearly two-thirds (63%) of children during both the 2008-2009 and 2009-2010 seasons had at least 1 missed opportunity for seasonal influenza vaccination; 50% of children had a

■ **Table 2.** Health Services Utilization, 2008-2009 and 2009-2010 Influenza Seasons

	Influenza Season													
	2008-2009 (N = 40,690)						2009-2010 (N = 41,471)							
	Health Plan 1 (n = 30,052)			Health Plan 2 (n = 10,638)			Health Plan 1 (n = 29,289)				Health Plan 2 (n = 12,182)			
	Seasonal Vaccination	Office Visit (≥1)	Office Visit (≥2)	Seasonal Vaccination	Office Visit (≥1)	Office Visit (≥2)	Seasonal Vaccination	H1N1 Vaccination	Office Visit (≥1)	Office Visit (≥2)	Seasonal Vaccination	H1N1 Vaccination	Office Visit (≥1)	Office Visit (≥2)
	%[a]	%	%	%	%	%	%	%	%	%	%	%	%	%
Total	27	68	42	36	78	52	30	29	66	41	37	31	82	56
Age														
6-18 m	57	92	83	62	97	88	58	46	92	80	61	40	96	86
19-35 m	46	86	65	51	89	65	52	44	85	65	52	38	90	73
36-71 m	39	78	54	44	86	61	44	39	78	53	46	38	89	67
6-10 y	27	68	40	36	76	49	34	34	67	41	39	34	81	56
11-18 y	17	60	32	25	71	41	20	22	58	32	27	25	76	46
Gender														
Female	26	68	42	34	78	51	29	29	67	41	35	30	82	57
Male	27	68	42	38	78	52	31	30	65	40	39	33	82	56
Residence														
Rural	28	67	41	31	78	49	33	42	65	42	32	35	85	60
Urban	29	69	43	36	78	52	32	31	68	42	38	31	82	56
Unknown	16	63	37	39	68	57	17	12	60	36	39	22	83	67

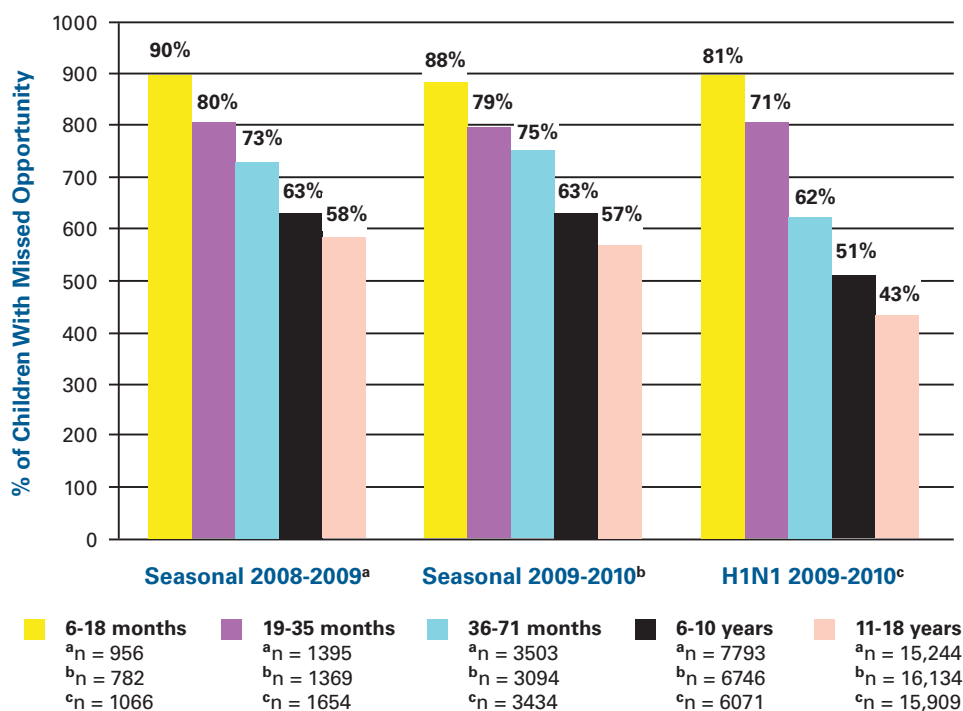[a]Percentages represent the proportion of children with service utilization.

H1N1 missed opportunity in 2009-2010. Children aged 6 to 18 months were most likely to have at least 1 missed opportunity for H1N1 vaccination (81%) and seasonal vaccination in the 2008-2009 (90%) and 2009-2010 (88%) seasons. The proportion of children with chronic conditions having a missed opportunity decreased sharply among older children. Given their lower numbers of office visits, adolescents had the lowest rate of missed opportunities for the seasonal influenza vaccine during 2008-2009 (58%) and 2009-2010 (57%) and the H1N1 vaccine during 2009-2010 (43%). Importantly, Figure 1 also illustrates the population that was unvaccinated for influenza and had no office visit; ranging from a minority of unvaccinated children 18 months or younger (≤10%) to nearly 50% of adolescents.

We estimated maximum vaccination rates potentially achievable if missed opportunities were successfully converted into administered influenza doses for children with chronic conditions enrolled in the commercial health plans (**Figure 2**). By converting initial missed opportunities into influenza vaccination events, cumulative gains of 45% (2008-2009) and 44% (2009-2010) were estimated for seasonal influenza vaccinations and 35% for H1N1 influenza vaccinations. If missed opportunities

were eliminated, the commercially insured children with chronic conditions could potentially have experienced seasonal influenza vaccination rates that were markedly higher than the observed vaccination rates. If all missed opportunities were converted to vaccination events, seasonal vaccination rates in February would have been 74% versus 29% (2008-2009) and 75% versus 32% (2009-2010). H1N1 vaccination rates could have reached 65% by the end of the influenza season in 2010, versus the rate of 30% that was observed at that time.

Seasonal and H1N1 influenza rates for the 2008-2009 and 2009-2010 seasons as reported in MCIR only were contrasted between our cohort of children with chronic conditions identified by the commercial health plans with 2 matched groups of non–chronic condition children. Less than one-third of the enrollees with chronic conditions identified by the commercial plans received the seasonal influenza vaccine in either the 2008-2009 (26%) or 2009-2010 (29%) influenza seasons; 31% of children received the H1N1 vaccination in 2009-2010. In contrast, children enrolled in Medicaid without a chronic condition had sharply lower vaccination rates for seasonal (17% during 2008-2009 and 19% during 2009-2010) and H1N1 (18%) vaccinations. Similarly, children never enrolled in

■ **Figure 1.** Missed Opportunities for Influenza Vaccination Among the Unvaccinated Population, by Age and Year

■ **6-18 months**	■ **19-35 months**	■ **36-71 months**	■ **6-10 years**	■ **11-18 years**
[a]n = 956	[a]n = 1395	[a]n = 3503	[a]n = 7793	[a]n = 15,244
[b]n = 782	[b]n = 1369	[b]n = 3094	[b]n = 6746	[b]n = 16,134
[c]n = 1066	[c]n = 1654	[c]n = 3434	[c]n = 6071	[c]n = 15,909

Medicaid without a chronic condition indication in the MCIR had comparably low seasonal vaccination rates during both seasons (16% in 2008-2009 and 18% in 2009-2010), and 20% for H1N1.

DISCUSSION

Our findings demonstrate the feasibility of using administrative claims data from commercial health plans to identify children with chronic conditions and subsequently match them within a statewide immunization registry to enable a high risk indicator. This study extends previous findings that document accuracy in using Medicaid administrative data to identify children with chronic conditions in a statewide IIS.[18] To our knowledge, this is one of only 2 studies that link billing-based identification data with statewide immunization registries[17]; however, previous studies have utilized similar approaches to identify chronic conditions from administrative data,[18,20-22] including variations of the Healthcare Effectiveness Data and Information Set (HEDIS) methodology.[23-26]
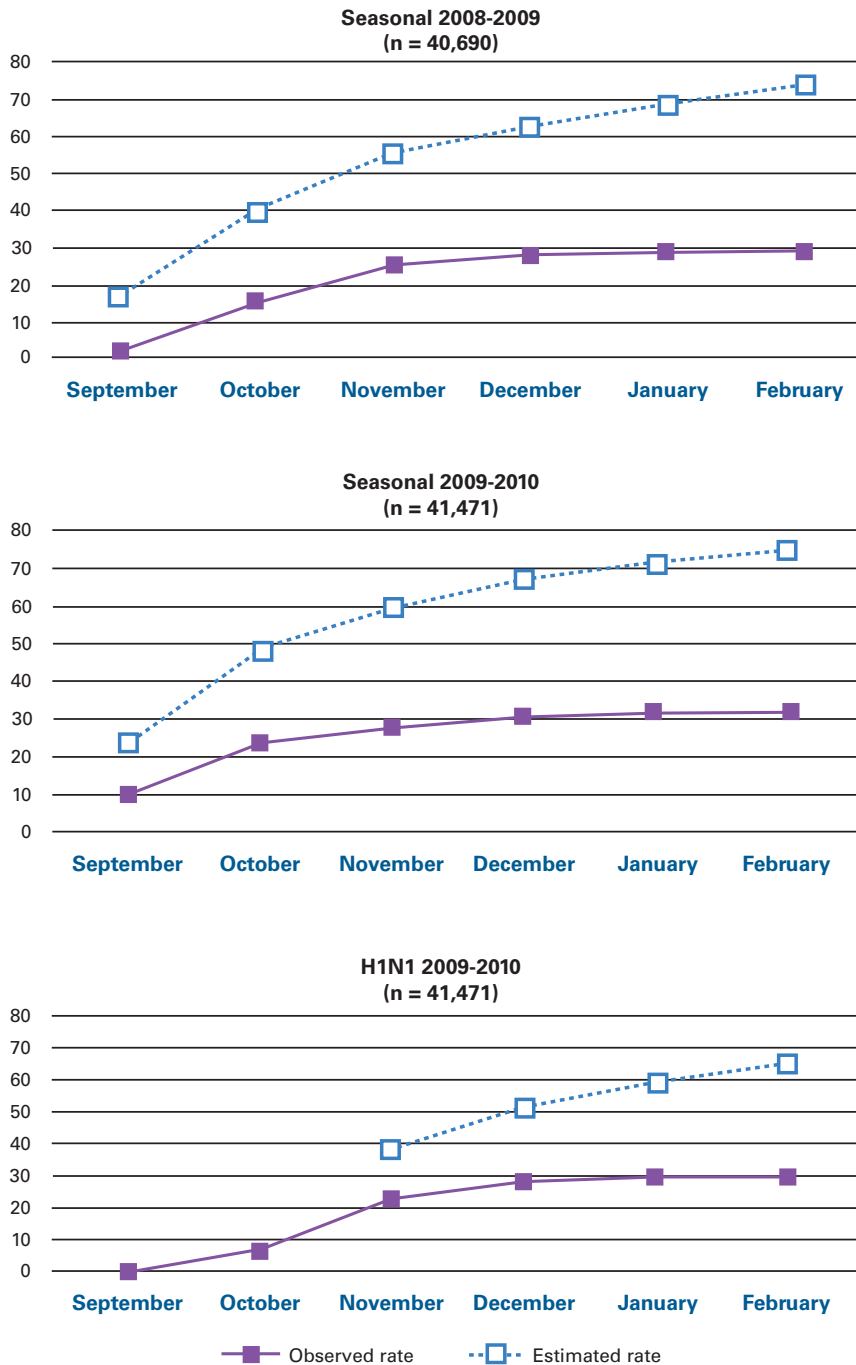
These findings have important implications for promoting vaccination among children with chronic conditions. Despite the progressive expansion of the influenza vaccination recommendations for all children younger than 18 years during the past decade,[6] the ability to quickly identify children with chronic conditions remains

important. Although universal influenza vaccination recommendations for children aged 6 months to 18 years have been adopted, this does not equate to universal vaccination. Influenza vaccination rates remain low for children with chronic conditions,[9,10,14] even during times of pandemic.[27] Integrating administrative claims with a statewide registry could enable a population-based mechanism for the identification of children with chronic conditions as priority cases either during pandemic events or supply shortages.

Although our study found a high degree of success in matching administrative claims with the statewide registry, ample opportunities to improve linkages exist. Establishing a common identifier unique to each child between systems would greatly improve methods of information exchange among registries and electronic health records (EHRs). In order to establish unambiguous linkages without a common identifier, a minimum set of demographic data on each child should be present prior to information sharing between systems as recommended by American Immunization Registry Association (AIRA), an organization that helps establish uniform standards to advance IIS and immunization programs.[28]

The ability to link administrative claims with statewide registries is only the first step in identification and prioritization of children with chronic conditions. Given the rapid adoption of EHRs by providers, mechanisms to

■ **Figure 2.** Cumulative Observed and Estimated Seasonal and H1N1 Influenza Vaccination Rates for Children With Chronic Conditions Enrolled in 2 Commercial Health Plans, 2008-2009 and 2009-2010

Seasonal 2008-2009
(n = 40,690)

Seasonal 2009-2010
(n = 41,471)

H1N1 2009-2010
(n = 41,471)

─■─ Observed rate   ·-□-· Estimated rate

identify individuals with chronic conditions on a population basis will likely continue to evolve. Current federal programs, including the Meaningful Use Incentive Program, will foster mechanisms to identify children with chronic conditions in EHRs. This program, which provides incentives for medical practices to establish EHRs, sets the stage for categorization of children with chronic conditions by tying funding to a practice's ability to generate a list of patients by specific conditions using an EHR. Ongoing efforts to establish interoperability between EHR and statewide registries will expedite real-time reporting of influenza immunization doses administered by

healthcare providers and could enable the exchange of information regarding chronic conditions, if allowed by the registry.[29] Ultimately, improved interoperability with EHRs may introduce opportunities to identify chronic conditions from the source, with chronic condition lists being maintained by practices' clinical and billing systems in conjunction with the Meaningful Use program objectives.

Our study also provides insight into the utility of a high risk indicator. Although the commercially insured children with chronic conditions were more likely to be vaccinated for seasonal influenza and H1N1 than their counterparts without a chronic condition, their observed influenza rates were low and missed opportunities were frequent. Similar to other studies, we found that only a minority of children with chronic conditions received the seasonal influenza or H1N1 vaccination[30] and missed opportunities were commonplace among this group of high risk children.[11] Low vaccination rates, combined with high rates of missed opportunities, suggest that multiple outreach strategies may be necessary to improve influenza vaccination rates among this group of children. Not surprisingly, adolescents had the lowest rate of vaccination among our sample and were the least likely to have been seen by a provider throughout both influenza seasons. Reminder/recall is one strategy to improve influenza vaccination among children with chronic conditions, where parents are notified by mail, telephone, or other mechanisms to serve as a prompt to vaccinate their children.[30,31] For this group, vaccination reminders prompting parents of adolescents to schedule an appointment with vaccination providers, either public or private, may be an effective mechanism to increase office visits and influenza vaccination rates.

In contrast, reminder/recall may have limited impact on increasing vaccination rates among children experiencing missed opportunities since they, by definition, had 1 or more office visit during the flu season, yet remained unvaccinated throughout the season. We found that younger children had greater missed opportunities than older children, suggesting that outreach strategies could differ by age group. Most of the unvaccinated children younger than 3 years in our sample had at least 1 missed opportunity and were seen by a provider throughout the 2008-2009 and 2009-2010 influenza seasons. Consequently, parent reminders alone might not be effective in reducing missed opportunities for this group. Implementing provider-focused reminder systems in combination with mailed reminders for parents of younger children may be 1 strategy to convert missed opportunities to vaccination events.

Our findings should be considered in light of several limitations. We were unable to evaluate the accuracy and completeness of the commercial healthcare claims data used to populate the high risk indicator in MCIR. Consequently, we were therefore unable to verify the accuracy of using the administrative claims data from the commercial health plans in identifying children with chronic conditions. Additionally, although this study examined missed opportunities among children with chronic conditions, we are unable to determine why missed opportunities occur. Furthermore, because our study intended to demonstrate the feasibility of using administrative data to identify children with chronic conditions, children were included in our sample if they had at least 1 claim for a chronic condition regardless of the number of provider encounters, severity, or duration of the condition. Future studies examining the accuracy, feasibility, and utility of using administrative claims data should also take into account the severity of chronic condition by subdividing children with chronic conditions into complexity groups. Finally, it should be noted that substantial time lags were encountered with respect to executing the data-use agreements required for this study. Such delays should be considered in future studies or applications of these methods to public health practice.

In conclusion, our study found that administrative claims data can be used to identify children with chronic conditions in a statewide registry. Low vaccination rates and a high rate of missed opportunities among the children with chronic conditions in our sample suggests the utility of integrating administrative claims data with statewide registries for use of various outreach strategies, including reminder/recall aimed at parents and provider-focused reminders.

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