

Statewide Pandemic Influenza Vaccination Reminders for Children with Chronic Conditions

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Shortly after the onset of the 2009 global pandemic of influenza A (H1N1)pdm09 virus (pH1N1),¹ the Advisory Committee for Immunization Practices released recommendations for vaccination that specifically identified 5 target groups, including persons at higher risk for infection or for severe influenza-related complications because of chronic medical conditions.² Although administration of a monovalent pH1N1 vaccine began throughout the United States in October 2009, initial vaccine supplies were very limited in many jurisdictions. As a consequence, numerous state and local health departments requested that providers focus vaccine administration on a smaller subset of the initial target groups,³ based on subgroups designated by the advisory committee as a priority in the event of a vaccine shortage.²

Early indications from the Centers for Disease Control and Prevention estimated that more than 1 million cases of pH1N1 influenza had occurred in the United States by August 2009⁴ and that pediatric deaths from pH1N1 influenza were more common among children with 1 or more chronic medical conditions (hereinafter referred to as “high-risk children”).⁵ Reminder–recall for pH1N1 vaccine represented a potential strategy for reaching parents of high-risk children. It had previously been demonstrated as an effective mechanism for increasing pediatric seasonal influenza vaccination among children with chronic conditions.^{6–8} In addition, during the 2009–2010 influenza season, a midseason report from the Advisory Committee for Immunization Practices urged health departments to consider implementing practices shown to increase influenza vaccination coverage, including reminder–recall.⁹

The Michigan Department of Community Health (MDCH) used the Michigan Care Improvement Registry (MCIR) to target pH1N1 vaccination reminders to children known to have a high-risk condition. MCIR has a high degree of provider participation with more

Objectives. We evaluated the use of a statewide immunization information system (IIS) to target influenza vaccine reminders to high-risk children during a pandemic.

Methods. We used Michigan’s IIS to identify high-risk children (i.e., those with ≥ 1 chronic condition) aged 6 months to 18 years with no record of pH1N1 vaccination among children currently or previously enrolled in Medicaid (n = 202 133). Reminders were mailed on December 7, 2009. We retrospectively assessed children’s eligibility for evaluation and compared influenza vaccination rates across 3 groups on the basis of their high-risk and reminder status.

Results. Of the children sent reminders, 53 516 were ineligible. Of the remaining 148 617 children, vaccination rates were higher among the 142 383 high-risk children receiving reminders than among the 6234 high-risk children with undeliverable reminders and the 142 383 control group children without chronic conditions who were not sent reminders.

Conclusions. Midseason reminders to parents of unvaccinated high-risk children with current or past Medicaid enrollment were associated with increased pH1N1 and seasonal influenza vaccination rates. Future initiatives should consider strategies to expand targeting of high-risk groups and improve IIS reporting during pandemic events. (*Am J Public Health.* 2014;104:e39–e44. doi:10.2105/AJPH.2013.301662)

than 95% of children age 6 years or younger having 2 or more vaccine doses entered.¹⁰ At the time of this reminder effort, all immunization providers in Michigan were required by state law to report school-exclusionary vaccinations administered to children to MCIR. In addition, pH1N1 vaccine providers were required to report to MCIR all pH1N1 doses administered during the pandemic.

Although using MCIR to target reminders to high-risk children had been demonstrated on a small scale,¹¹ the use of such notifications during an influenza pandemic was untested. With that in mind, our objective was to describe the feasibility and utility of this effort. To our knowledge, this is the first assessment of a statewide reminder–recall during an influenza pandemic.

METHODS

We collaborated with MDCH to retrospectively evaluate its use of pandemic influenza vaccine reminders during the 2009–2010

influenza season. These reminders were generated by a statewide immunization information system (IIS) and specifically targeted children having 1 or more high-risk conditions.

Mailed Reminder Notification

MDCH developed an influenza vaccination reminder letter for parents of high-risk children in Michigan who had not yet received a pH1N1 vaccination for the 2009–2010 influenza season. The reminder letter noted that the presence of a chronic condition placed their child at increased risk for complications from influenza and that the 2009 pH1N1 influenza virus could potentially cause more children to get sick than during a regular influenza season. The letter urged parents to contact the child’s health care provider or local health department to make an appointment to receive the pH1N1 vaccine and, if indicated, the seasonal influenza vaccine and provided the Web site address and telephone number to find a nearby influenza clinic. Reminder letters were mailed on December 7, 2009, using the US Postal Service and

were marked “return service requested” so that letters with changed, incomplete, or unknown addresses would be returned to MDCH.

Returned letters were considered undeliverable; each returned reminder letter was tracked and matched by name and address with the original reminder mailing list from MCIR.

Reminder Feasibility and Utility

Given the rapidly evolving nature of the 2009–2010 pandemic, the influenza reminder notifications were implemented by MDCH on an unprecedented scale, using methods that were largely untested. Consequently, we conducted our assessment from 2 perspectives, considering both the feasibility and the utility of using this outreach strategy.

Target population. MDCH staff requested that MCIR registry staff query the MCIR databases for children who resided in Michigan and had (1) at least 1 high-risk condition and (2) no pH1N1 vaccination doses entered into MCIR as of November 28, 2009. A customized query of the MCIR databases specifically for this initiative was necessary because the standard MCIR interface did not have a built-in feature to export cases for bulk mailing of reminder notifications. To identify children with high-risk conditions, the query used the MCIR high-risk indicator, which identifies children who have 1 or more conditions considered by the Advisory Committee for Immunization Practices to be associated with an increased risk for influenza-related complications (e.g., those with chronic conditions such as asthma). At the time of this reminder effort, the MCIR high-risk indicator was based on certain *International Classification of Diseases, Ninth Revision (ICD-9)*¹² diagnosis codes reported through Medicaid administrative claims data starting in calendar year 2005. Therefore, the children identified as high risk had at least 1 Medicaid claim with a chronic-condition diagnosis code and were either currently enrolled in the Michigan Medicaid program or had been, but were not currently, Medicaid enrolled at some point since 2005. Children never enrolled in Medicaid were not included in the reminder effort. Additional details of the MCIR high-risk indicator are described elsewhere.^{13–15} At the time of the reminder notification, 3.0 million children aged 6 months to 18 years were in MCIR; 49% of these children were currently or previously but not

currently enrolled in Medicaid. A total of 202 133 children were identified from the MCIR query as having at least 1 high-risk condition and no pH1N1 vaccination doses entered into MCIR as of November 28, 2009.

Feasibility. We applied several criteria to assess the degree to which the 202 133 children identified in the MCIR database query were eligible for this evaluation of pH1N1 vaccine reminders. Eligible children were those (1) with no pH1N1 vaccination administered before the MDCH query date; (2) flagged as high risk by the MCIR high-risk indicator before that date; and (3) aged 6 months to 18 years.

Utility. Our postpandemic evaluation of the utility of reminder notices for influenza vaccine focused on the population of children who were eligible to receive such notifications. We used a case-control study design for our analyses and compared children classified into 3 groups on the basis of high-risk and reminder notification status: (1) children with high-risk conditions mailed a deliverable reminder, (2) high-risk children subsequently determined to have an undeliverable reminder, and (3) a comparison group of children without an indication of a high-risk condition in MCIR and who were not mailed a reminder by MDCH. For the comparison group, we used MCIR to identify all children who were currently or previously but not currently enrolled in Medicaid; were not designated as having a high-risk condition (i.e., had no claims with a chronic-condition *ICD-9* diagnosis code); had not been mailed a MCIR pH1N1 vaccine reminder; and otherwise met our eligibility criteria for feasibility (n = 968 129). Using a case-control process for each eligible high-risk child with a deliverable reminder, we then randomly selected 1 non-high-risk child for each high-risk case, matching on birth month and year and Michigan county of residence; this process resulted in a 1-to-1 matched set of non-high-risk comparison children.

Data Analyses

To assess feasibility, we summarized the proportion of the targeted population that met each of the eligibility criteria for the high-risk reminder notifications. Primary outcomes measured for the utility of reminder notices were the receipt of 1 or more pH1N1 vaccine and 1 or more seasonal influenza vaccine after

notification. We defined receipt as having 1 or more dose of the respective influenza vaccine recorded in MCIR with an administration date between the reminder mailing date (December 7, 2009) and January 31, 2010 and calculated the median number of days from reminder date to receipt of the first dose of pH1N1 and seasonal vaccines. We compared child characteristics across the 3 groups using frequencies and the χ^2 test. These characteristics included Medicaid enrollment status (as of December 2009), age, gender, race/ethnicity, rural–urban designation (based on US Census Bureau metropolitan statistical area classification for county of residence), and prior history of seasonal influenza vaccination (in any previous season, for those aged 6 months or older in that season). In addition, we used multiple logistic regression to calculate odds ratios and confidence intervals for pH1N1 and seasonal influenza vaccination after reminder notification, including interaction models with prior seasonal influenza vaccination. We performed all analyses using SAS version 9.2 (SAS Institute, Cary, NC).

RESULTS

Of the initial 202 133 children identified to receive pH1N1 vaccine reminders, our retrospective feasibility analysis determined that 53 516 children (26%) were not eligible for evaluation of the reminder effort. The largest subgroup of ineligible children (n = 26 600 children; 13%) consisted of those who had already received 1 or more pH1N1 vaccine dose between September 1, 2009, and the reminder notification query date; the mean lag time between vaccine receipt and entry into MCIR was 17 days for this group. The other subgroups of ineligible children included children who were (1) aged 19 years or older as of the reminder mailing date (n = 22 871; 11%), (2) not designated with the MCIR high-risk indicator before the mailing date (n = 386; 0.2%), (3) determined to have an unknown or out-of-state address (n = 3270; 2%), or (4) otherwise marked in MCIR as ineligible for reminder–recall notifications (e.g., duplicate records, excluded by parent or provider; n = 389; 0.2%).

Among the 148 617 children (74% of the initial MDCH-identified population) eligible for the reminder evaluation, we assessed the utility

TABLE 1—Child Characteristics, Overall and by Evaluation Group: Michigan Care Improvement Registry; December 7, 2009

Characteristic	Total, No. (%)	High-Risk, Reminder, No. (%)	High-Risk, Undeliverable Reminder, No. (%)	Non-High-Risk, No Reminder, No. (%)
Overall	291 000	142 383 (49)	6234 (2)	142 383 (49)
Medicaid enrollment status				
Previously enrolled	69 636 (24)	20 003 (14)	981 (16)	48 652 (34)
Currently enrolled	221 364 (76)	122 380 (86)	5253 (84)	93 731 (66)
Age				
6–59 mo	64 311 (22)	31 532 (22)	1237 (20)	31 542 (22)
5–9 y	92 492 (32)	45 309 (32)	1886 (30)	45 297 (32)
10–14 y	73 790 (25)	36 007 (25)	1765 (28)	36 018 (25)
15–18 y	60 407 (21)	29 535 (21)	1346 (22)	29 526 (21)
Gender				
Female	135 665 (47)	61 615 (43)	2820 (45)	71 230 (50)
Male	155 201 (53)	80 708 (57)	3409 (55)	71 084 (50)
Unknown	134 (<0.5)	60 (<0.5)	5 (<0.5)	69 (<0.5)
Race/ethnicity				
White	163 083 (56)	77 402 (54)	3614 (58)	82 067 (58)
Black	102 230 (35)	54 534 (38)	2206 (35)	45 490 (32)
Other	17 476 (6)	7020 (5)	313 (5)	10 143 (7)
Unknown	8211 (3)	3427 (3)	101 (2)	4683 (3)
MSA				
Rural (MSA = no)	46 496 (16)	22 592 (16)	1312 (21)	22 592 (16)
Urban (MSA = yes)	244 504 (84)	119 791 (84)	4922 (79)	119 791 (84)
Ever received seasonal influenza vaccine ^a				
No	185 181 (64)	80 743 (57)	3905 (63)	100 533 (71)
Yes	105 511 (36)	61 492 (43)	2319 (37)	41 700 (29)

Note. MSA = metropolitan statistical area. Differences across evaluation groups for every child characteristic are significant at $P < .001$.

^aIncludes only those children aged ≥ 13 months ($n = 290\ 692$) and therefore eligible to have received an influenza vaccine in a prior season.

of the reminder notification by comparing influenza vaccine coverage rates among 3 groups: (1) high-risk children for whom the reminder was delivered ($n = 142\ 383$; 96% of reminders sent), (2) high-risk children for whom the reminder was returned as undeliverable ($n = 6,234$; 4%), and (3) the comparison group of non-high-risk children ($n = 142\ 383$). Combined, the total population for our analyses was 291 000 children. Table 1 describes the characteristics of each group and shows that the non-high-risk group had a lower proportion of children currently enrolled in Medicaid but was otherwise generally similar to the 2 groups of high-risk children. The undeliverable-reminder group had somewhat higher representation of children aged 10 years or older and from rural counties.

Overall Influenza Vaccine Receipt

For the period after reminder notification (December 7, 2009–January 31, 2010), the overall vaccination rate for the 291 000 children in the evaluation population was 5.4% for pH1N1 vaccine and 3.7% for seasonal influenza vaccine. Among those vaccinated ($n = 20\ 186$), almost half received only the pH1N1 vaccine (46%), a third received both pH1N1 and seasonal influenza vaccines (32%), and the remainder received only seasonal influenza vaccine (22%).

Of the 291 000 children in the evaluation population, 290 692 children were age eligible (i.e., ≥ 6 months) in a prior season to receive influenza vaccine. Among these children, receipt of seasonal influenza vaccine in any prior

season was associated with a higher likelihood of vaccination for either pH1N1 or seasonal influenza vaccines during the 2009–2010 season. Children receiving seasonal influenza vaccine in any prior influenza season were almost 3 times as likely (odds ratio [OR] = 2.70; 95% confidence interval [CI] = 2.61, 2.79) to receive pH1N1 vaccine during the 2009–2010 season and more than 3 times as likely (OR = 3.26; 95% CI = 3.13, 3.39) to receive a seasonal influenza vaccine than those without a seasonal influenza vaccine in any prior season. Similarly, children currently enrolled in Medicaid were substantially more likely than those previously but not currently enrolled to receive either the pH1N1 (OR = 2.31; 95% CI = 2.20, 2.42) or the seasonal influenza (OR = 3.06; 95% CI = 2.86, 3.26) vaccines. Child age, race/ethnicity, and metropolitan statistical area were also associated with pH1N1 and seasonal influenza vaccination after reminder notification, whereas gender was not.

Influenza Vaccine Receipt Across Evaluation Groups

High-risk children who received a mailed reminder were more likely to be vaccinated with both pH1N1 (OR = 1.54; 95% CI = 1.49, 1.59) and seasonal influenza (OR = 1.79; 95% CI = 1.72, 1.87) vaccines than the 2 groups of children who did not receive a reminder (Table 2). Among the 2 groups of children who did not receive a reminder, high-risk children with an undeliverable reminder were less likely to receive pH1N1 vaccine (OR = 0.83; 95% CI = 0.73, 0.95) and more likely to receive seasonal influenza vaccine (OR = 1.21; 95% CI = 1.04, 1.39) than the non-high-risk, no-reminder group. Note that although the differences between these 2 groups were statistically significant, the absolute difference in vaccination rates may be of marginal practical significance. The median time to receive the first pH1N1 vaccine dose (14 days) or seasonal influenza dose (16 days) from the reminder date did not vary by evaluation group.

To further explore the relationship between influenza vaccination, reminder notification, and child characteristics, we developed multivariate logistic regression models of the interaction between prior influenza vaccine status and evaluation group (Table 3). In this

TABLE 2—pH1N1 and Seasonal Influenza Vaccination Across Evaluation Groups: Michigan Care Improvement Registry; December 7, 2009–January 31, 2010

Evaluation Group	No.	pH1N1 Vaccine Receipt		Seasonal Influenza Vaccine Receipt	
		No. (%)	Unadjusted OR (95% CI)	No. (%)	Unadjusted OR (95% CI)
High-risk, reminder	142 383	9280 (6.5)	1.54 (1.49, 1.59)	6786 (4.8)	1.79 (1.72, 1.87)
High-risk, undeliverable reminder	6234	227 (3.6)	0.83 (0.73, 0.95)	203 (3.3)	1.21 (1.04, 1.39)
Non-high-risk, no reminder	142 383	6175 (4.3)	1.00 (Ref)	3869 (2.7)	1.00 (Ref)

Note. CI = confidence interval; OR = odds ratio.

model, all comparisons were relative to children without a high-risk condition, with no reminder sent, and with no history of prior influenza vaccination. We adjusted for confounding child characteristics (i.e., Medicaid enrollment status, age, race/ethnicity, and metropolitan statistical area); gender was not statistically significant and therefore was not included. We found that prior influenza vaccination was strongly associated with influenza vaccine receipt for all evaluation groups and was consistent for both pH1N1 and seasonal influenza vaccination. However, we found the strongest association among high-risk children with a history of prior influenza vaccination who received a reminder; pH1N1 vaccination (OR = 3.00; 95% CI = 2.86, 3.14) and seasonal influenza vaccination (OR = 3.81; 95% CI = 2.59, 4.04) were most likely among this group. Similarly, reminders were also associated with higher likelihood of influenza vaccination among high-risk children with no prior

history of influenza vaccination, for both pH1N1 (OR = 1.30; 95% CI = 1.24, 1.37) and seasonal influenza vaccination (OR = 1.45; 95% CI = 1.36, 1.54). We observed the strength of this association even among those with no high-risk condition or reminder notification; in this group, receipt of either pH1N1 or seasonal influenza vaccine was sharply higher among those with a history of prior influenza vaccination. By contrast, high-risk children with no prior history of influenza vaccination with an undeliverable reminder had a lower likelihood of vaccination for both the pH1N1 (OR = 0.74; 95% CI = 0.60, 0.91) and seasonal influenza vaccination (OR = 0.93; 95% CI = 0.73, 1.19).

DISCUSSION

This evaluation demonstrates the feasibility of using a population-based IIS to conduct influenza vaccination outreach during a pandemic and illustrates important opportunities

for public health preparedness. To our knowledge, this demonstration is the first use of a statewide IIS during an influenza pandemic for a large-scale vaccine reminder campaign. This effort specifically targeted children with chronic conditions and current or past Medicaid enrollment who were unvaccinated at midseason, enabling public health officials to emphasize the importance of influenza vaccination among this vulnerable group of children.

Our findings indicate that a reminder notice underscoring the importance of influenza vaccination and the elevated risk among children with chronic conditions can be a sufficient prompt for parents to seek out an influenza vaccination for their child. Parents of children with high-risk conditions receiving reminder notices had the highest likelihood of having their child vaccinated, for both the pH1N1 and the seasonal influenza vaccines. Of note, we observed these gains among a group of children considered to be at high risk for vaccine-preventable infection yet who were still unvaccinated midseason during a pandemic. Although the observed increase in influenza vaccination rates among children receiving notices was somewhat modest in absolute terms (2%–3%) compared with children not receiving such notices, the effect was nonetheless meaningful. This gain is relatively large, considering that during the entire 2009–2010 pandemic, MCIR data indicate that only 16% of children in Michigan received a seasonal influenza vaccine and only 17% received a pH1N1 vaccine.¹⁶ The estimate of the increase in rates associated with the reminder may be underestimated for the seasonal influenza vaccine because the reminder notifications evaluated here were not generated on the basis of a child's seasonal influenza vaccination status. In addition, the reporting of seasonal influenza vaccine doses to MCIR was not required, further diminishing the likelihood that those doses would be recorded in MCIR. Despite these findings, the fact remains that the vast majority of parents of children with high-risk conditions did not respond to the reminder notification. Follow-up reminders or perhaps notifications made through other mechanisms could possibly yield a higher response given the interest of some subgroups of parents in e-mail, text message, or phone reminders.¹⁷

Our findings also provide important insights regarding future efforts to target influenza

TABLE 3—pH1N1 and Seasonal Influenza Vaccination by Evaluation Group and Prior Influenza Vaccination Status: Michigan Care Improvement Registry; December 7, 2009–January 31, 2010

Evaluation Group	Prior Seasonal Influenza Vaccine ^a	No.	AOR (95% CI) ^b	
			pH1N1 Vaccine Receipt	Seasonal Influenza Vaccine Receipt
High-risk, reminder	Yes	61 492	3.00 (2.86, 3.14)	3.81 (2.59, 4.04)
	No	80 743	1.30 (1.24, 1.37)	1.45 (1.36, 1.54)
High-risk, undeliverable reminder	Yes	2319	1.71 (1.43, 2.05)	2.96 (2.47, 3.55)
	No	3905	0.74 (0.60, 0.91)	0.93 (0.73, 1.19)
Non-high-risk, no reminder	Yes	41 700	2.50 (2.37, 2.64)	2.74 (2.57, 2.93)
	No	100 533	1.00 (Ref)	1.00 (Ref)

Note. AOR = adjusted odds ratio; CI = confidence interval.

^aIncludes only those children aged ≥ 13 mo old ($n = 290\ 692$).

^bOdds ratios adjusted for Medicaid enrollment, age, race/ethnicity, and metropolitan statistical area; gender was not a significant confounder, and therefore was not included in the model.

vaccination reminder notices. Although overall we found the highest likelihood of influenza vaccination among those who received reminders, our findings also indicate that children with a history of prior influenza vaccination were highly likely to receive influenza vaccine in a subsequent season, consistent with prior findings.^{18,19} Consequently, efforts to target influenza reminders among those with no prior history of influenza vaccination may be an effective strategy to efficiently focus reminders using limited resources. IIS-based reminder systems could be designed to take into account all available influenza vaccination history to sharpen the focus of reminder notices on those to whom the prompt is likely to have the most benefit.

This evaluation also illustrates the value of existing IIS infrastructure for targeting reminder notifications to children with chronic conditions. This initiative was feasible during the 2009–2010 influenza pandemic only because prior initiatives had established the chronic condition indicator in MCIR; implementing this capability during the pandemic would not otherwise have been possible. Developing such an indicator would allow other IISs to strengthen the population-based influenza reminder infrastructure to further public health preparedness for a pandemic event. However, establishing a chronic disease indicator in a statewide IIS is time consuming and may require coordination across numerous agencies.^{13–15}

Because many of the ineligible notifications resulted from delays in entering administered influenza vaccine doses into MCIR in a timely and complete manner, future initiatives should consider strategies to improve the timeliness and completeness of influenza dose reporting to IISs during a pandemic event. One such strategy may include ongoing initiatives to foster more seamless interoperability between practices' electronic health records and IISs,²⁰ which could substantially improve the timeliness of reporting during pandemics. Given meaningful use requirements for electronic health records to flag patients with chronic conditions,²¹ they could become a tool used by IISs to target immunization coverage assessments or reminder–recall efforts. Although at the time of this reminder effort, the MCIR chronic condition indicator was representative of a majority (77%) of children in Michigan

(33% currently enrolled in Medicaid, 43% previously but not currently enrolled), efforts to expand identification of children with chronic conditions to include those enrolled in private health plans could be achieved through enhanced electronic health record–IIS interoperability. In addition, a pilot test has been conducted in Michigan to evaluate the potential expansion of the high-risk indicator to additional children using commercial health plan claims data.

The need to target high-risk groups for influenza vaccination remains relevant despite the continued expansion of influenza vaccination recommendations to include all children aged 6 months to 18 years.²² Influenza vaccination coverage remains suboptimal—even among the most vulnerable children, including the very young and those with high-risk conditions.²³ In addition, periodic influenza vaccine supply shortages do occur and can have substantial impacts.^{3,24,25} In these situations, the Advisory Committee for Immunization Practices generally recommends that groups at high risk for influenza-related complications, including children with chronic conditions, be given priority for immunization.²³ However, absent a population-based mechanism to identify children with chronic conditions, the recommended prioritization approach would rely on the varying capabilities of providers to identify children with chronic conditions in their panels of patients and then conduct the necessary outreach. Attempts thus far to implement reminder–recall among private providers has been challenging and difficult to sustain.^{26,27}

Many of the mailed influenza vaccination reminders were undeliverable and therefore unable to prompt these parents to seek influenza vaccination for their child. Our findings from an earlier pilot study indicate that postal mail addresses may often be out of date or missing in an IIS¹¹ and may be particularly problematic among adolescents.²⁸ Our observed undeliverable rates in this study were substantially lower than those in prior studies and may be reflective of ongoing efforts to improve the accuracy of MCIR contact information. It is important to note that the notification methods used to deliver immunization reminder messages are evolving beyond postal mail. Mechanisms such as e-mail or text messaging may expedite large-scale, rapid notification,²⁹ although these technologies have only

been tested on a limited basis for influenza vaccination reminders.³⁰

Limitations

This evaluation has several limitations. One important limitation of this evaluation is that, although providers were required to report pH1N1 doses administered to MCIR, evidence indicates that some doses may not have been entered. On the basis of MCIR data, vaccination rates among the entire MCIR population of children 6 months to 18 years, for those with chronic conditions (pH1N1 24%; seasonal 24%) and no chronic conditions (pH1N1 16%; seasonal 15%) were low compared with rates shown in national data sources.^{9,31} This difference may partially reflect incomplete dose recording in MCIR and suggests a limited ability to target midseason reminders to unvaccinated children and to measure the effectiveness of such reminders during influenza pandemics. To help address this limitation, immunization providers should receive continued education and training on the importance and use of IISs. To improve reporting of seasonal influenza vaccinations in Michigan, immunization providers are now required (as of August 2012) to report to MCIR all doses of all vaccines given to all persons younger than 20 years. Because reporting seasonal influenza vaccination to MCIR was not required during the study period, data on prior influenza vaccination were underestimated and may reflect unknown biases that could not be quantified in this study (e.g., provider-level reporting differences).

An additional limitation is that, because we were conducting an evaluation of a public health program, our comparison groups were limited to those that could be determined retrospectively. As a consequence, our comparison groups may reflect other underlying differences. For example, children with undeliverable reminders may be a marker for those with a high degree of mobility resulting from economic or other social stressors; additional information to control for these potential differences was not available. Finally, because the MCIR high-risk indicator is populated on the basis of prior years' claims, younger children with chronic medical conditions may be underrepresented in the group identified as being at high risk.

Conclusions

An IIS-based reminder effort conducted during the 2009–2010 influenza season and targeted to high-risk children was associated with increased influenza vaccination rates. Future initiatives should consider strategies to expand the ability to identify high-risk groups for targeted immunization outreach and to improve the timeliness and completeness of influenza dose reporting during pandemic events. ■

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Contributors

K. J. Dombkowski led the study conceptualization and design, supervised the data analyses, and contributed substantially to the interpretation of data and the writing and editing of the article. R. C. Potter contributed to the study conceptualization and design, data collection and interpretation, and critical review of the article. A. E. Cowan collaborated on the interpretation of data and the writing and editing of the article. S. Dong conducted data analyses and article review. M. Kolasa collaborated on the study design and critical review of the article drafts. S. J. Clark contributed to study conceptualization and design, drafts of the article, and critical reviews. All authors approved the final version of the article.

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Note. The findings and conclusions are those of the authors and do not necessarily represent an official viewpoint of the Centers for Disease Control and Prevention.

Human Participant Protection

This evaluation was focused on assessing and improving the quality of public health practices and, consistent with Michigan Department of Community Health policy, was not subject to institutional review board review.

References

- Chan M. World now at the start of 2009 influenza pandemic. 2009. Available at: http://www.who.int/mediacentre/news/statements/2009/h1n1_pandemic_phase6_20090611/en/index.html. Accessed May 22, 2013.
- Centers for Disease Control and Prevention. Use of influenza A (H1N1) 2009 monovalent vaccine: recommendations of the Advisory Committee on Immunization Practices (ACIP), 2009. *MMWR Recomm Rep*. 2009;58(RR-10):1–8.
- Centers for Disease Control and Prevention. The 2009 H1N1 pandemic: summary highlights, April 2009–April 2010. 2010. Available at: <http://www.cdc.gov/h1n1flu/cdcreponse.htm>. Accessed May 22, 2013.
- Centers for Disease Control and Prevention. Update: influenza activity—United States, April–August 2009. *MMWR Morb Mortal Wkly Rep*. 2009;58(36):1009–1012.
- Centers for Disease Control and Prevention. Surveillance for pediatric deaths associated with 2009 pandemic influenza A (H1N1) virus infection—United States, April–August 2009. *MMWR Morb Mortal Wkly Rep*. 2009;58(34):941–947.
- Daley MF, Barrow J, Pearson K, et al. Identification and recall of children with chronic medical conditions for influenza vaccination. *Pediatrics*. 2004;113(1 pt 1):e26–e33.
- Gagliani M, Riggs M, Kamenicky C, Glezen WP. A computerized reminder strategy is effective for annual influenza immunization of children with asthma or reactive airway disease. *Pediatr Infect Dis J*. 2001;20(12):1155–1160.
- Szilagyi PG, Rodewald LE, Savageau J, Yoos L, Doane C. Improving influenza vaccination rates in children with asthma: a test of a computerized reminder system and an analysis of factors predicting vaccination compliance. *Pediatrics*. 1992;90(6):871–875.
- Centers for Disease Control and Prevention. Interim results: state-specific seasonal influenza vaccination coverage—United States, August 2009–January 2010. [Erratum appears in *MMWR Morb Mortal Wkly Rep*. 2010;59(18):561] *MMWR Morb Mortal Wkly Rep*. 2010;59(16):477–484.
- Centers for Disease Control and Prevention. Progress in immunization information systems—United States, 2010. *MMWR Morb Mortal Wkly Rep*. 2012;61(25):464–467.
- Dombkowski KJ, Harrington LB, Dong S, Clark SJ. Seasonal influenza vaccination reminders for children with high-risk conditions: a registry-based randomized trial. *Am J Prev Med*. 2012;42(1):71–75.
- International Classification of Diseases, Ninth Revision, Clinical Modification*. Hyattsville, MD: National Center for Health Statistics; 1980. DHHS publication PHS 80–1260.
- Clark SJ, Lamarand K, Dombkowski KJ. Identifying children with chronic conditions for influenza vaccination using a statewide immunization registry: initial experiences of primary care providers. *J Public Health Manag Pract*. 2012;18(3):204–208.
- Dombkowski KJ, Lamarand K, Dong S, Perng W, Clark SJ. Using Medicaid claims to identify children with asthma. *J Public Health Manag Pract*. 2012;18(3):196–203.
- Dombkowski KJ, Leung SW, Clark SJ. Provider attitudes regarding use of an immunization information system to identify children with asthma for influenza vaccination. *J Public Health Manag Pract*. 2007;13(6):567–571.
- Boulton ML, Grossman AM, Potter R, Vranesich PA, Clayton J. Assessing the relationship between seasonal and H1N1 influenza vaccination status in Michigan children, 2009–2010. *Public Health Rep*. 2011;126(suppl 2):70–77.
- Clark SJ, Butchart A, Kennedy A, Dombkowski KJ. Parents' experiences with and preferences for immunization reminder/recall technologies. *Pediatrics*. 2011;128(5):e1100–e1105.
- Centers for Disease Control and Prevention. Characteristics associated with seasonal influenza vaccination of preschool children—Oregon, 2006–2008. *MMWR Morb Mortal Wkly Rep*. 2011;60(29):981–984.
- Fiks AG, Hunter KF, Localio AR, et al. Impact of electronic health record-based alerts on influenza vaccination for children with asthma. *Pediatrics*. 2009;124(1):159–169.
- Centers for Disease Control and Prevention. Progress in immunization information systems—United States, 2009. *MMWR Morb Mortal Wkly Rep*. 2011;60(1):10–12.
- US Department of Health and Human Services. Health Information Technology: Standards, Implementation Specifications, and Certification Criteria for Electronic Health Record Technology, 2014 Edition; Revisions to the Permanent Certification Program for Health Information Technology. *Fed Regist*. 2012;77(171):54163–54292.
- Fiore AE, Shay DK, Broder K, et al. Prevention and control of seasonal influenza with vaccines: recommendations of the Advisory Committee on Immunization Practices (ACIP), 2009. *MMWR Recomm Rep*. 2009;58(RR-8):1–52.
- Fiore AE, Uyeki TM, Broder K, et al. Prevention and control of influenza with vaccines. Recommendations of the Advisory Committee on Immunization Practices (ACIP), 2010. *MMWR Recomm Rep*. 2010;59(RR-8):1–62.
- Zimmerman RK, Tabbarah M, Nowalk MP, et al. Impact of the 2004 influenza vaccine shortage on patients from inner city health centers. *J Urban Health*. 2007;84(3):389–399.
- Schade CP, Hannah KL. Impact of the 2004 influenza vaccine shortage on repeat immunization rates. *Ann Fam Med*. 2006;4(6):541–547.
- Dombkowski KJ, Harrington LB, Allred NJ, Hudson E, Clark SJ. Feasibility of initiating and sustaining registry-based immunization recall in private practices. *Acad Pediatr*. 2012;12(2):104–109.
- Saville AW, Albright K, Nowels C, et al. Getting under the hood: exploring issues that affect provider-based recall using an immunization information system. *Acad Pediatr*. 2011;11(1):44–49.
- Dombkowski KJ, Reeves SL, Dong S, Stevenson J, Clark SJ. Assessing the burden of undeliverable immunization reminder and recall notifications. *Prev Med*. 2011;53(6):424–426.
- Dombkowski KJ, Harrington L, Hanauer D, Kennedy A, Clark S. Current and potential use of new technologies for reminder notifications. *Clin Pediatr (Phila)*. 2012;51(4):394–397.
- Stockwell MS, Kharbanda EO, Martinez RA, Vargas CY, Vawdrey DK, Camargo S. Effect of a text messaging intervention on influenza vaccination in an urban, low-income pediatric and adolescent population: a randomized controlled trial. *JAMA*. 2012;307(16):1702–1708.
- Centers for Disease Control and Prevention. Interim results: state-specific influenza A (H1N1) 2009 monovalent vaccination coverage—United States, October 2009–January 2010. [Erratum appears in *MMWR Morb Mortal Wkly Rep*. 2010;59(18):561] *MMWR Morb Mortal Wkly Rep*. 2010;59(12):363–368.

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