High Influenza Vaccination Coverage in Children With High-Risk Conditions During a Vaccine Shortage

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Objective: To assess whether pediatric practices with a system to identify and recall children with high-risk conditions (HRCs) could maintain high influenza vaccination coverage levels among these children during a vaccine shortage year.

Design: Observational study using data from a computerized billing database and an electronic immunization information system.


Participants: Children aged 24 to 72 months with and without HRCs.

Main Exposure: The vaccine shortage of the 2004-2005 influenza season.


Results: In the 2003-2004 season, 770 of 1166 children with HRCs (66.0%) were immunized and, in the 2004-2005 season, 656 of 1053 (62.3%) were immunized. Although vaccination coverage did not significantly decrease for children with HRCs during the 2004-2005 season (P = .07), coverage for healthy children decreased from 43.8% (4435/10 117) to 29.5% (3066/10 387) (P < .001). After the priority group recommendation in October 2004, the practices provided few vaccines to healthy children, whereas children with HRCs continued to receive the vaccine.

Conclusion: Pediatric practices with a system to identify and recall children with HRCs can target these children for receipt of the influenza vaccine and maintain high vaccination coverage, despite a vaccine shortage that may result in decreased vaccine coverage in healthy children.


For decades, the Advisory Committee on Immunization Practices (ACIP) and professional societies have recommended that children with high-risk conditions (HRCs) receive an annual influenza vaccine. More recently, recommendations for the influenza vaccine have been expanded to include children without HRCs. The ACIP recommended the influenza vaccine for all children aged 6 to 23 months in 2004, all children aged 6 to 59 months in 2006, and all children and adolescents aged 6 months through 18 years in 2008, with 2 doses of vaccine recommended for all children 8 years or younger if they have not previously been vaccinated. Despite these recommendations, influenza vaccination coverage among children remains low. Use of a reminder/recall system is a method proven to increase vaccination coverage in clinical settings. Because disruptions of the influenza vaccine supply and distribution are not uncommon, the ACIP and Centers for Disease Control and Prevention (CDC) have developed recommendations for the tiered use of influenza vaccine and have suggested that health care providers develop contingency plans to provide available vaccine based on these tiers in the event of a vaccine shortage. Similar vaccination tiers and target groups have been developed in the event of an influenza pandemic. The 2004-2005 influenza season was marked by a shortage of vaccine, during which the CDC recommended early and “aggressive” efforts to identify and vaccinate members of priority groups, including children with HRCs, while deferring vaccination of individuals not in priority groups.
practices can follow priority group recommendations during an influenza vaccine shortage. Therefore, we conducted an observational study to examine whether private pediatric practices with a system to identify and recall children with HRCs were able to target children with HRCs for influenza vaccination and to avoid a decrease in vaccination coverage for these children during the vaccine shortage of the 2004-2005 influenza season compared with healthy children in the same practices. A previous study in the same pediatric practices during the 2002-2003 season showed that the practices’ system could be used to identify children with HRCs by diagnosis, to remind these children to receive their influenza vaccine, and to increase vaccination coverage to 42%.14 We hypothesized that, in the case of a vaccine shortage, the practices would be able to maintain high vaccination coverage among children with HRCs, whereas coverage would decrease among the healthy children.

**STUDY METHODS AND POPULATION**

The study protocol was reviewed and approved by local and CDC human subjects review boards. Our study was conducted in 4 private pediatric practices in the metropolitan Denver area. The population served by these practices is 80% non-Hispanic white, with 72% of families having an annual income of more than $30,000 and 68% of parents having a college education.15

**PRACTICES’ IDENTIFICATION AND RECALL SYSTEM**

The 4 practices use a regional immunization information system (IIS) and share a common billing system.13 The data from the IIS and billing system can be linked. As described in a previous study of identification and recall of children with HRCs in the same pediatric practices, children were classified as being at high risk on the basis of ACIP recommendations and the consensus of physicians in the participating practices.14 Each year the billing database was searched using codes from the *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)*,16 to identify all eligible children aged 24 to 72 months who had had an encounter for an HRC in the previous 2 years. The previous study found that the billing database correctly identified 90% of the children whose medical records indicated the presence of an HRC.14

During the 2003-2004 and 2004-2005 influenza seasons, the practices identified all children with HRCs and sent reminder/recall letters to these children, but they did not send reminder/recall letters to healthy children. In addition to the letters, all 4 practices implemented “flu clinics” to increase vaccine delivery. In the 2004-2005 season, the 4 practices also distributed a brochure about the importance of the influenza vaccine to children with HRCs.

**STUDY POPULATION**

Our study population included all children aged 24 to 72 months as of October 1, 2003 (for the 2003-2004 season), or October 1, 2004 (for the 2004-2005 season), who had had an office visit in the preceding 18 months and who had a record in the billing database and IIS. The practices chose October 1 as the cut-off date for identification of children because they typically received their influenza vaccine by October and began their immunization efforts after October 1. Children aged 6 to 23 months were also identified by the practices and received outreach efforts. Children older than 72 months were not included in the study because the IIS was initially implemented only for children younger than 72 months and therefore data were incomplete for older children.


For the 2003-2004 season, 3 practices had received all of their influenza vaccine supply by September 30, 2003, whereas the fourth practice had received all of its supply by October 15, 2003. For the 2004-2005 season, the practices had received about one-quarter of their requested vaccine supply by September 30, 2004, and received additional vaccine throughout the influenza season.

**DATA SOURCES**

The primary data sources were a computerized billing database and an Internet-based IIS. The billing database included the sex, age, and dates of office visits with associated ICD-9-CM and Current Procedural Terminology codes.12 Per the IIS protocol, the staff at the 4 pediatric practices routinely entered immunization information into the system within 24 hours of vaccine administration. As previously described, a quality assessment review of the IIS at the pediatric practices showed a completeness rate of 97.4% (the percentage of children in the practices who were included in the IIS) and an error rate of 7.2% (the percentage of all immunizations not recorded or recorded incorrectly in the IIS).13 Immunization status was determined using data in the IIS and the billing database. Because influenza immunizations were not routinely entered into the IIS before 2002, we were unable to accurately determine influenza immunization histories prior to 2002 and were unable to determine which children needed 1 vs 2 doses. Therefore, we included only the first immunization given each season in our analysis.

**RESULTS**

As shown in Table 1, children with HRCs did not differ by age, sex, or insurance status between the 2003-2004 and 2004-2005 seasons. In both seasons, more than 90% of the children with HRCs had a primary diagnosis of asthma (92.9% in the 2003-2004 and 91.0% in the 2004-2005 seasons). Healthy children did not differ between the 2003-2004 and 2004-2005 seasons except that slightly
more healthy children were privately insured in the 2004-2005 season.

Overall, 1483 fewer immunizations were given in the 2004-2005 season. For children with HRCs, influenza immunization coverage did not show a significant change between the 2003-2004 and 2004-2005 seasons (66.0% vs 62.3% [P = .07]). However, for healthy children, the proportion of immunized children decreased from 43.8% to 29.5% (P < .001). As shown in Table 2, more children with HRCs and more healthy children received their immunizations by the end of October in the 2004-2005 season compared with the 2003-2004 season, but fewer healthy children were immunized after October in the 2004-2005 season compared with the 2003-2004 season. The Figure shows the cumulative percentages of children with HRCs and healthy children receiving influenza vaccine by week for the 2003-2004 and 2004-2005 seasons. The slope of the line reflects the immunization rate. After the first half of October 2004, when the ACIP made its priority-group announcement, the slope flattens for healthy children, indicating that fewer immunizations were given to these children. The slope does not flatten for children with HRCs, indicating that they continued to be immunized.

**COMMENT**

Despite a national vaccine shortage, private pediatric practices with a system to identify children with HRCs and to recall them achieved a high level of vaccination coverage among these children in the 2004-2005 season. These practices immunized more than 60% of the children with HRCs during both the 2003-2004 (when there was no shortage) and 2004-2005 influenza seasons. Moreover, most of these vaccinations were given before the influenza season started.

Although the ACIP and professional societies have long-standing recommendations that children with HRCs receive a yearly influenza vaccine,1,18-19 immunization rates in this group remain low. Recent estimates of influenza vaccination coverage in children with HRCs range from 21% to 42%.20-24 Specialty clinics serving children with HRCs have been able to immunize large proportions of their patients. For example, a regional cystic fibrosis center immunized 79% of its pediatric patients by staging a “flu-shot party.”25 The level of vaccination coverage among children with HRCs in our study is higher than has been documented previously in primary care settings.

National survey data reported by the CDC show that coverage among adults with HRCs has been consistently low (<35%) and that coverage among adults with HRCs decreased by about 8% during the 2004-2005 season compared with the 2003-2004 season.22 No comparable national data are available to examine influenza vaccination coverage among children with HRCs between the 2004-2005 and 2003-2004 seasons. Previous studies during pneumococcal vaccine shortages have shown that vaccination coverage decreased in healthy children and those with HRCs.26,27 In the study practices, influenza vaccination coverage might have been expected to decrease in children with HRCs during the shortage year, especially because coverage in the 2003-2004 season was high and potentially difficult to maintain. However, a decrease did not occur in our study practices. Despite the shortage, the practices were able to maintain influenza vaccination coverage of greater than 60% in their children with HRCs.

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| Table 1. Characteristics of Children Aged 24 to 72 Months With and Without High-Risk Conditions (HRCs) From 4 Denver, Colorado, Private Pediatric Practices in 2 Influenza Seasons |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Children With HRCs | Healthy Children |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **2003-2004 Season** (n=1166) | **2004-2005 Season** (n=1053) | **P Value** | **2003-2004 Season** (n=10117) | **2004-2005 Season** (n=10387) | **P Value** |
| Age, mean (SD), mo | 46 (13) | 48 (14) | .30 | 46 (14) | 47 (14) | .20 |
| % Male | 62.0 | 62.3 | .90 | 50.0 | 50.7 | .40 |
| Insurance, % |  |  |  |  |  |  |
| Private | 89.5 | 89.5 |  | 88.9 | 90.7 | <.001 |
| Public | 7.7 | 8.1 | .90 | 7.4 | 6.4 |  |
| Uninsured | 2.7 | 2.5 | .90 | 3.7 | 2.9 |  |

| Table 2. Proportion of Immunizations Given by Month to Children Aged 24 to 72 Months With and Without High-Risk Conditions (HRCs) During 2 Influenza Seasons |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Children With HRCs | Healthy Children |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **2003-2004 Season** (n=1166) | **2004-2005 Season** (n=1053) | **P Value** | **2003-2004 Season** (n=10117) | **2004-2005 Season** (n=10387) | **P Value** |
| Immunizations, No. (%) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| All immunizations | 770/1166 (66.0) | 656/1053 (62.3) | .07 | 4435/10117 (43.8) | 3066/10387 (29.5) | <.001 |
| By October 31 | 362/770 (47.0) | 524/1053 (50.0) | <.001 | 1508/4435 (34.0) | 1993/3066 (65.0) | <.001 |
| By November 30 | 647/770 (84.0) | 610/1053 (58.0) | <.001 | 3371/4435 (76.0) | 2177/3066 (71.0) | <.001 |
| By December 31 | 762/770 (98.9) | 637/1053 (60.0) | .01 | 4302/4435 (97.0) | 2606/3066 (85.0) | <.001 |

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Although we do not have a comparison group of practices without a system to identify and recall children with HRCs, we suspect that maintenance of high vaccination coverage among children with HRCs was facilitated by the study practices’ system. First, the ability to identify children with HRCs was likely an important factor. A survey of adults after the 2004-2005 influenza shortage found that those who identified themselves as being at high risk were more likely to be immunized than those who did not think they were at high risk, and surveys of health care providers regarding influenza vaccine delivery suggest that practices’ inability to identify individuals with HRCs is a barrier during a shortage. Second, outreach efforts via reminder/recall letters are known to increase influenza immunization rates. In addition to the identification and recall of children with HRCs, the practices used a variety of other measures during both seasons that may have contributed to the high vaccination coverage. They advertised the importance of the influenza vaccine with brochures and posters hung in the clinics’ waiting rooms. The practices also used mass influenza immunization clinics to immunize a large proportion of the clinic population efficiently rather than relying on health care providers to remember to immunize at patients’ scheduled well-child or sick visits. Other methods of encouraging vaccination included offering the vaccine outside of regular work hours on Saturdays and in the evenings, using themes for immunization clinics such as “Boo the Flu” during which providers and patients could wear Halloween costumes, and offering the vaccine to parents as well as children.

A higher proportion of healthy children were also immunized in the study practices compared with national estimates. These children were not among the groups recommended to receive the influenza vaccine by the ACIP during the study seasons. Although the level of vaccination coverage among healthy children in the study practices decreased from 43.8% to 29.5% during the shortage in the 2004-2005 season, national estimates of vaccine coverage among healthy children are consistently less than 30%. The younger age of the children and higher level of education in our study population compared with those of previous study populations may partly explain the higher vaccination coverage, even among healthy children. Additional explanations may include differences in the providers’ knowledge and adherence to recommendation.
titudes about the influenza vaccine and a pro–influenza vaccine culture in the study clinics because of their previous involvement with studies of reminder/recall for children aged 6 to 23 months and children with HRCs.\textsuperscript{14,15} Finally, media coverage of the early and severe 2003-2004 influenza season in Colorado may have increased parents’ demand for the influenza vaccine.

The ability to prioritize groups for immunization is important any time the vaccine supply is delayed or limited and is even more important now that policy makers have adopted a universal influenza immunization strategy.\textsuperscript{33} To plan for appropriate vaccine distribution, practices must be able to quantify the amount of vaccine required for the population in each priority tier. If the population in the highest priority tiers can be identified and immunized as soon as the initial vaccine supply becomes available, the remainder of the vaccine supply can then be distributed to the population in the lower priority tiers. Our data suggest that this is what occurred in the 4 pediatric practices during the 2004-2005 vaccine shortage. More than 60% of children with HRCs received vaccine, and 80% of these immunizations were administered before November. These practices immunized few healthy children after the ACIP priority-group announcement.

This study has several limitations. Because it was observational rather than experimental, we cannot definitively attribute the practices’ success in following priority group recommendations to the practices’ system. Besides the practices’ ability to identify and recall children with HRCs, other factors such as media coverage of illness and deaths due to influenza, parents’ attitudes regarding influenza vaccine, and the timing or the severity of the influenza season may have influenced the immunization rates that we observed.\textsuperscript{34-36} Some children may have needed 2 doses of influenza vaccine to be fully immunized; however, we included only the first immunization each season in our analysis as described in the methods section. Finally, the study sites were metropolitan private practices serving a mostly privately insured and middle– to high–socioeconomic status population; therefore, our results may not be generalizable to other populations. Our study also has several strengths, which include our ability to compare immunization delivery between seasons by analyzing data from the same practices and our ability to assess immunization rates by using data from the IIS and a shared billing database.

Our results show that practices with a system to identify and recall children with HRCs were able to follow the ACIP priority group recommendations during the 2004-2005 influenza vaccine shortage. An electronic billing database or an electronic medical record is an important tool to efficiently identify and quantify children with HRCs in a practice. The billing or medical record databases can be linked to electronic IISs so that children’s medical records can be flagged and the children can be recalled. Practices can also use data from databases and IISs to rapidly assess their performance on immunization measures and to help with quality improvement efforts. Electronic systems integrating billing databases, medical records, and immunization information may prove to be an extremely valuable tool that enables providers to identify and recall their highest-priority patients quickly in the face of a vaccine shortage or an outbreak situation.

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