

# Predictors of Influenza Virus Vaccination Status in Hospitalized Children

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**ABSTRACT.** *Objective.* To determine predictors of influenza virus vaccination status in children who are hospitalized during the influenza season.

*Methods.* A cross-sectional study was conducted among children who were hospitalized with fever between 6 months and 3 years of age or with respiratory symptoms between 6 months and 18 years of age. The 1999 to 2000 influenza vaccination status of hospitalized children and potential factors that influence decisions to vaccinate were obtained from a questionnaire administered to parents/guardians.

*Results.* Influenza vaccination rates for hospitalized children with and without high-risk medical conditions were 31% and 14%, respectively. For both groups of children, the vaccination status was strongly influenced by recommendations from physicians. More than 70% of children were vaccinated if a physician had recommended the influenza vaccine, whereas only 3% were vaccinated if a physician had not. Lack of awareness that children can receive the influenza vaccine was a commonly cited reason for nonvaccination.

*Conclusions.* A minority of hospitalized children with high-risk conditions had received the influenza vaccine. However, parents' recalling that a clinician had recommended the vaccine had a positive impact on the vaccination status of children. *Pediatrics* 2001;108(6). URL: <http://www.pediatrics.org/cgi/content/full/108/6/e99>; influenza, vaccination, hospitalized children.

Influenza virus causes febrile and respiratory illnesses in 20% to 40% of children each winter.<sup>1</sup> Although pediatric mortality from influenza infections is rare, morbidity is not. Influenza-related morbidity includes hospitalizations for suspected bacterial sepsis in neonates, respiratory illnesses, and rarely encephalitis. For children who are younger than 5 years, annual estimates of influenza-related hospitalization rates are 1 per 1000 children without high-risk conditions and 5 per 1000 children with high-risk conditions.<sup>2,3</sup>

Many hospitalizations of children with high-risk medical conditions are potentially avoidable. The Advisory Committee on Immunization Practices and

the American Academy of Pediatrics recommend influenza vaccination for children with high-risk conditions such as asthma and sickle cell anemia. Despite these long-standing recommendations, fewer than 30% of children with high-risk conditions receive the annual influenza vaccine.<sup>4-6</sup>

Almost all studies that analyze predictors of influenza vaccine acceptance focus on adult populations, particularly the elderly.<sup>7-11</sup> Factors that are predictive of adults' receiving the influenza vaccine include elderly age, perceived susceptibility to influenza illness, favorable perceptions about the vaccine, a previous vaccination, knowledge of risk factors for influenza infection, clinician recommendation, and chronic medical conditions.<sup>7-9,11-14</sup> Two pediatric studies analyzed predictors of influenza vaccinations in children with asthma. The first study found that mothers who worry about their children's asthma were more likely to have their children vaccinated after a mailed reminder than were mothers who worry about the side effects of the influenza vaccine.<sup>15</sup> The second study used an administrative database, which restricted the study to an evaluation of health care utilization patterns and prescribed treatments for children with asthma in a health maintenance organization. In a study population in which 10% of children with asthma were vaccinated, indicators of moderate to severe asthma predicted influenza vaccination. Of note, 61% of nonvaccinated children with asthma had an outpatient visit with a missed opportunity for vaccination.<sup>16</sup>

Reducing the gap between influenza vaccine recommendations and current vaccination status in children requires knowledge about factors that encourage families to vaccinate children. To expand our understanding of the influenza vaccination status and factors that might influence a family's decisions in a population of hospitalized children. Special emphasis was placed on understanding the motivation of parents whose children received the vaccine.

## METHODS

### Study Population

All children admitted to Vanderbilt Children's Hospital between January 10 and February 25, 2000, were eligible for inclusion if they 1) were younger than 3 years and had a history of fever or 2) were younger than 18 years and had any respiratory symptoms. All children with a primary admission diagnosis of an acute respiratory illness characterized by rhinorrhea, sore throat, cough,

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shortness of breath, or apnea were eligible. Broad inclusion criteria were chosen such that all children hospitalized with symptoms potentially related to influenza infections were eligible. For children with multiple qualifying admissions, only the first was included. Children younger than 6 months were excluded because the vaccine is not recommended for this age group. This effort was part of an ongoing Centers for Disease Control and Prevention surveillance study designed to calculate the burden of respiratory illness in hospitalized children.

Each day, potential subjects were identified by reviewing admission logs to all of the pediatric inpatient services. We reviewed the charts of children with admission diagnoses potentially consistent with febrile or respiratory illnesses to verify that history during this illness. A research team member approached eligible children and their parents within 24 hours of admission. Discharge logs were reviewed to verify that all eligible patients had been identified. The study was reviewed and approved by the Vanderbilt University Institutional Review Board.

## Questionnaire

After consent was obtained, we administered a questionnaire to parents. The questionnaire, which had been created and revised after pilot testing, elicited information regarding the child's routine vaccinations and the 1999 to 2000 influenza vaccination status, factors that might influence the influenza vaccination status, the parent's reasons for the influenza vaccination status, and the child's medical history.

Influenza vaccination status was determined by whether the child had received at least 1 dose of influenza vaccine after September 1, 1999. To validate the influenza vaccine history, we asked when the vaccine was given. All parents who stated that their child received the influenza vaccine reported that the first dose was given between September and December, except for 1 child, who received it in January after having received a diagnosis of cystic fibrosis.

Gender and race information was collected from the medical record. All other variables were determined by parental responses to the questionnaire. If parents reported that a physician had recommended the influenza vaccine for their child within the past year, then it was coded as physician recommended. A family member was considered vaccinated if at least 1 person who lived with the child had received the influenza vaccine after September 1, 1999.

To understand the reasons for children's vaccination status, we asked several questions. All parents were asked whether a physician had recommended the influenza vaccine for their child within the past year. Parents of unvaccinated children were asked, "What were the reasons your child did not get a flu shot this year?" Potential responses included lack of awareness, concern about side effects, inconvenience, or other. Parents of vaccinated children were asked, "What were the reasons your child got a flu shot this year?" Potential responses included protection of an elderly family member, previous influenza-like illness, physician recommendation, or other. Parents could report multiple responses for the child's vaccination status. Explanations for any response including "other" were documented.

To determine which children had high-risk conditions, parents were asked whether the child had a history of asthma, kidney disease, heart disease, sickle cell anemia, diabetes mellitus, bronchopulmonary dysplasia, or other medical problems. To screen further for high-risk conditions, we ascertained the child's daily medicines. For parents who reported asthma, we validated the diagnosis with a detailed asthma history and a review of the medical chart. High-risk conditions were restricted to those for which the influenza vaccine is explicitly recommended in the *2000 Red Book*.<sup>17</sup> They include 1) asthma or other chronic pulmonary diseases, 2) hemodynamically significant cardiac disease, 3) immunosuppressive disorder or therapy, 4) human immunodeficiency virus infection, 5) sickle cell anemia and other hemoglobinopathies, 6) diseases requiring long-term aspirin therapy, 7) chronic renal dysfunction, and 8) chronic metabolic disease.

## Statistical Analysis

The primary outcome, influenza vaccination status in 1999 to 2000, and all variables, except for age, were coded as dichotomous variables. Age was classified as a categorical variable with 3 age groups: 6 months to younger than 18 months, 18 months to

younger than 5 years, and 5 years to 18 years. Odds ratios and 95% confidence intervals were calculated by univariate and multivariate logistic regression analyses. Because interactions between age group and physician recommendation, age group and high-risk condition, and high-risk condition and physician recommendation were insignificant, these interactions were excluded from the final analyses. Nine children (5%) whose caregivers reported uncertainty about whether a physician had recommended the influenza vaccine were classified in the "not recommended" category. Because inclusion or exclusion of these 9 children from the analyses did not change the results, they were included in the final analyses. STATA, Version 6.0 (STATA, College Station, TX) was used for all analyses.

## RESULTS

Of the children who were hospitalized during the study period, the cohort enrolled in the study is depicted in Fig 1. Of 245 eligible children, 26 were identified after 24 hours of admission, 27 declined participation, and 3 had an unknown vaccination status. The remaining 189 children (77%) were enrolled. The study children were more frequently male, predominantly white, and had approximately equal distributions among the 3 age groups (Table 1). Of the study population, 48% had high-risk conditions; the most common were asthma, malignancy, congenital heart disease, and cystic fibrosis (Table 2). Of the 55 children with asthma, 100% used albuterol at home, 26 (47%) used prophylactic medications, and 45 (82%) had taken oral steroids for an asthma exacerbation within the past year.

Overall, only 42 children (22%) were vaccinated (Table 1). Univariate analysis revealed that being vaccinated for influenza was associated with increasing age, having a high-risk condition, recalling a physician recommendation, and having a vaccinated family member. For all enrolled children, more parents reported that at least 1 family member was vaccinated (41%) than recalled a physician recommendation (29%). However, of all of the potential predictors assessed, physician recommendation had the most significant impact on a child's vaccination status. For children with and without high-risk conditions, 69% and 73%, respectively, were vaccinated when parents recalled a physician recommendation compared with 2% and 4%, respectively, when parents did not. The vaccination rate for each high-risk condition with at least 4 patients is displayed in Table 2.

To analyze the importance of each factor adjusting for all the others, we performed a multivariate logistic regression analysis (Table 1). Physician recommendation was the only independent predictor of influenza vaccination. Although increasing age was not significant in the adjusted model, the increasing proportion of children with and without high-risk conditions vaccinated for influenza by age group is shown in Fig 2. In addition, the proportion of parents who recalled that a physician had recommended the vaccine increased by age group.

To elicit additional insight from the analyses, we evaluated factors that reportedly influenced the decision about vaccinating the child for influenza. For vaccinated children, parental explanations other than physician recommendation included that the child had had an influenza-like illness in the past and that

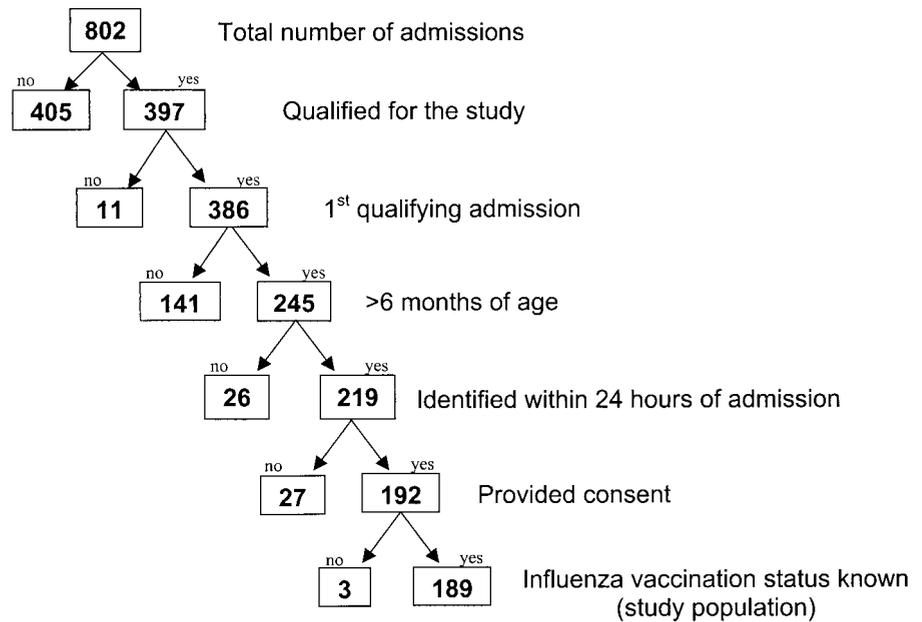


Fig 1. Identification of the study population.

TABLE 1. Characteristics of Children Hospitalized for Febrile or Respiratory Illnesses Between January 10 and February 25, 2000, and Odds Ratios for the Association of These Characteristics With Receipt of Influenza Vaccination

Characteristic	Children Not Receiving Influenza Vaccine (N = 147; %)	Children Receiving Influenza Vaccine (N = 42; %)	Odds Ratio (95% Confidence Interval)	Adjusted Odds Ratio* (95% Confidence Interval)
Gender				
Female	60 (41%)	21 (50%)	Reference	Reference
Male	87 (59%)	21 (50%)	0.7 (0.3–1.4)	1.1 (0.3–3.3)
Race				
Black	32 (22%)	15 (36%)	Reference†	Reference†
Hispanic	5 (3%)	0 (0%)	Reference†	Reference†
White	110 (75%)	27 (64%)	0.6 (0.3–1.3)	1.0 (0.3–3.5)
Age group				
0.5–<1.5 years	63 (43%)	8 (19%)	Reference	Reference
≥1.5–<5 years	49 (33%)	7 (17%)	1.1 (0.4–3.3)	0.2 (0.1–1.3)
≥5–18 years	35 (24%)	27 (64%)	6.1 (2.5–14.8)‡	3.3 (0.8–13.1)
High-risk condition				
No	85 (58%)	14 (33%)	Reference	Reference
Yes	62 (42%)	28 (67%)	2.7 (1.3–5.6)‡	0.4 (0.1–1.70)
Physician recommended				
No	131 (89%)	4 (10%)	Reference	Reference
Yes	16 (11%)	38 (90%)	77.8 (24.5–246.5)‡	131.4 (28.7–602.3)‡
Family member vaccinated				
No	95 (65%)	17 (40%)	Reference	Reference
Yes	52 (35%)	25 (60%)	2.1 (1.1–4.0)‡	2.9 (0.9–9.1)

\* Multivariate logistic regression analysis of all of the characteristics in the table.

† Black and Asian/Hispanic are combined as the reference group for race in the analyses.

‡ Statistically significant result.

family members recalled good experiences with receiving the vaccine. A school health class discussion influenced the decision for 2 teenagers. Although no parent reported that a child was vaccinated to protect a high-risk family member, having a vaccinated family member may have influenced the influenza vaccination status of children. The proportion of children with a vaccinated family member was 60% for vaccinated children and 35% for unvaccinated children.

For the 147 unvaccinated children, 11% of parents recalled that a physician had recommended the influenza vaccine. Many of these parents reported that they did not proceed with vaccination because the

child was ill at that visit ( $n = 8$ ) or because they were concerned about the side effects of the vaccine ( $n = 12$ ), specifically that the child would get “the flu” from the vaccine itself ( $n = 7$ ). For all nonvaccinated children, the 3 most common reasons (Table 3) were lack of knowledge about the influenza vaccine for children (29%), lack of physician recommendation (27%), and not thinking or forgetting about it (8%).

## DISCUSSION

Within our study population, only 31% of children who had high-risk medical conditions and were hospitalized with fever or respiratory symptoms during the influenza season had received the influenza vac-

**TABLE 2.** Frequency of Influenza Vaccination Rates for High-Risk Children

High-Risk Conditions	Total (N)	Vaccinated (N %)
Asthma	55	16 (29%)
Malignancy	8	0 (0%)
Congenital heart disease	7	2 (29%)
Cystic fibrosis	6	6 (100%)
Metabolic disorders*	4	2 (50%)
Sickle cell disease	4	2 (50%)
Other†	12	3 (25%)

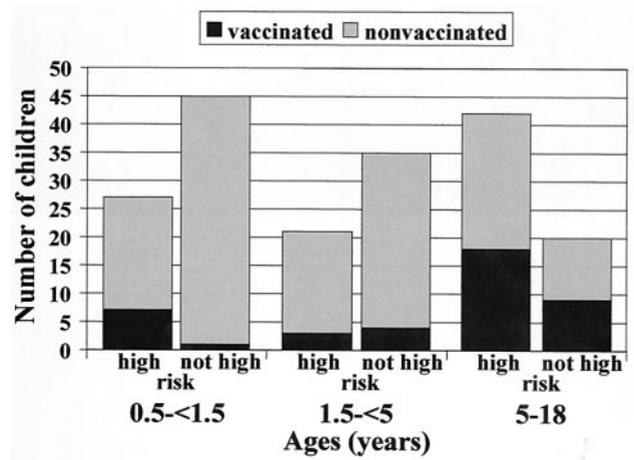
\* One diabetes without cystic fibrosis, 2 chronic renal disorders, 1 panhypopituitary syndrome.

† Infrequent high-risk conditions not otherwise described.

cine. Of hospitalized children without high-risk conditions, only 14% had been vaccinated. For all children, parental recall of a physician recommendation increased the odds of influenza vaccination 130-fold. For children with high-risk conditions, the proportion of parents who reported that a physician had recommended the vaccine increased from 21% for children younger than 18 months to 43% for children 5 to 18 years. This study, to our knowledge, is the first to describe the influenza vaccination status of hospitalized children and the importance of a physician recommendation on the influenza vaccination status of children.

Although school-aged children, children with high-risk conditions, and children with a vaccinated family member were more likely to receive the influenza vaccine, these factors were not independent predictors of vaccination in the multivariate analysis. Several factors may explain why age and high-risk conditions were not predictors in our study but were in adult studies.<sup>7,12,18,19</sup> First, physicians in our study were more likely to recommend influenza vaccination for older children with high-risk conditions, which reduced the power to detect age as an independent predictor. Second, physician recommendation was an overwhelming predictor in our model. Third, only 42 children (22%) were vaccinated, so the power to detect factors that may influence the influenza vaccination status was limited.

This study reinforces the importance of physician recommendations in promoting vaccine acceptance. Unfortunately, many parents of children with high-risk conditions did not recall physicians' having discussed or recommended the influenza vaccine. Our data, like studies in high-risk adults, suggest that physician recommendation is a strong predictor of vaccination acceptance.<sup>8,9,13,20,21</sup> We determined physician recommendation by whether the parent of a hospitalized child recalled that a physician had recommended the vaccine. Physicians were not interviewed, nor were charts reviewed, to confirm whether the physician had recommended the vaccine. Because parents of vaccinated children, who may have ruminated about the vaccine's apparent lack of effectiveness, may remember a physician recommendation more often than parents of nonvaccinated children, recall bias is possible. Although lack of a reported physician recommendation does not necessarily indicate that a physician failed to mention or discuss the influenza vaccine, it does indicate



**Fig 2.** Influenza vaccination by age groups and by high-risk group status.

**TABLE 3.** Reasons That Parents Reported as to Why Their Children Did Not Receive the Influenza Vaccine

Reason	Number (%; N = 154)*
Lack of awareness of an influenza vaccine for children	45 (29%)
Lack of a physician recommendation	41 (27%)
Not thinking about it or forgetting it	12 (8%)
Parental concern about side effects	12 (8%)
Perceiving that a physician discouraged the vaccination	11 (7%)
Deciding the influenza vaccine was not necessary	11 (7%)
Illness at the time the vaccine could be given	8 (5%)
Time or inconvenience	5 (3%)
Family member had a bad experience with the vaccine in the past	3 (2%)
Lack of a doctor	2 (1%)
Parental opposition to another shot	2 (1%)
Parental confusion that it is an annual vaccination	1 (1%)
Egg allergy	1 (1%)

\* Of 147 unvaccinated children, 8 parents had no reported response and 15 parents reported 2 responses.

that the message was not received. Hence, clinicians should be able to increase the vaccination rate by improving communication about the influenza vaccine, recommending its use, and confirming that the message was received.

This study has other potential limitations. Selection bias was minimized by enrolling 77% of eligible children and by defining broad inclusion criteria. The inclusion criteria were designed so that all children admitted with potential influenza infections were eligible. Because young children with influenza infections can present with only fever, children who younger than 3 years and were admitted with fever and without respiratory symptoms were eligible.<sup>22</sup> Because respiratory symptoms are present in 92% of children with influenza infections, all children with respiratory symptoms were eligible.<sup>23</sup> Although misclassification bias remains possible, other studies of high-risk children in outpatient settings have reported similar vaccination rates.<sup>4-6</sup> Because the pneumococcal conjugate vaccine received Food and Drug Administration approval 9 days before the end

of the study period and because the 23-valent pneumococcal vaccine is infrequently administered to children, it is unlikely that parents would have confused the pneumococcal and influenza vaccines. Parents who reported safety concerns about the influenza vaccine mentioned getting "the flu" from the vaccine. No parent mentioned a concern about risks associated with any component of the influenza vaccine, such as trace amounts of thiomersal.

Influenza infections may cause more pediatric illnesses and hospitalizations than previously recognized. Estimates of annual influenza-related hospitalization rates for healthy children younger than 2 years are comparable to high-risk groups for whom the vaccine is explicitly recommended.<sup>3</sup> Influenza illness also accounts for an estimated 6 to 15 and 10 to 20 outpatient visits annually for healthy and high-risk children younger than 15 years, respectively.<sup>2,24</sup> Thus, influenza has a significant impact on the health of children.

To reconcile that influenza virus causes many winter illnesses and that few children are vaccinated for influenza, we explored some of the potential reasons. One possibility is that the low vaccination rate among patients with asthma reflects an interpretation that only children on prophylactic medications need the influenza vaccine. The rate of vaccination among patients who have asthma and are taking prophylactic medication (39%) was higher than the rate for patients who have asthma and are not taking prophylactic medications (21%). Another possibility is the complexity of the influenza vaccine recommendations. Of 441 general practices in England, 71% to 82% of practitioners reported always offering the influenza vaccination to high-risk adults, but only 33% to 43% of the same practitioners reported always offering the influenza vaccine to high-risk children.<sup>25</sup> Although the influenza vaccine is strongly recommended for children with high-risk conditions and their families,<sup>17</sup> the recommendation of vaccination for everyone who wishes to avoid influenza illness is ambiguous and may be interpreted as "not recommended." Varying dosages and number of doses recommended based on age and on past influenza vaccination status may also contribute to the tendency not to recommend it. Simplifying and clarifying the recommendations may improve uptake.

Another barrier to vaccination is the lack of parental knowledge about the influenza vaccine for children. Public health efforts to vaccinate the elderly have been impressive. The public health initiatives included educational campaigns targeting both health care providers and the elderly and recommending clinic-based standing orders for adults older than 65 years. These initiatives paralleled the increase in the influenza vaccination rate of the elderly to 50% to 67%.<sup>26-32</sup>

Health beliefs of the family probably play an important role in determining the influenza vaccination status of children. Having a vaccinated family member increased the likelihood that a child had received the influenza vaccine. This association is consistent with pediatric studies that report that the health beliefs of the family have an impact on the vaccina-

tion status of children. For example, Szilagyi et al<sup>15</sup> reported that mothers who are very worried about their child's asthma are more likely to vaccinate their children for influenza after receiving a mailed reminder. Another study indicated that the health beliefs of a maternal grandmother significantly influence the 2-month and 6-month vaccination status of children in an underserved population.<sup>33</sup> The impact of the health beliefs of the family on the influenza vaccination status of children is an important area of additional exploration.

In this study, three quarters of the reasons cited for failing to vaccinate children can be addressed by improving parent education about influenza. Our data suggest that physicians have the potential to improve influenza vaccination rates by informing families about the vaccine recommendations and by reducing missed opportunities. To increase compliance with the recommendations, clinicians need to understand the reasons that children are not vaccinated. Identifying barriers to vaccination can highlight system issues that are likely to have an impact on the influenza vaccination status.<sup>34</sup> In our study, the only high-risk condition for which all of the children were vaccinated was cystic fibrosis (Table 2). The cystic fibrosis clinic attributed its exemplary vaccination rate to a strong consensus statement from the Cystic Fibrosis Foundation and several efforts in the clinic. They include 1) educating children and parents about influenza and its prevention, 2) a computerized registry, and 3) designing the clinic so that it is conducive to administering the influenza vaccine, even for children who come to the clinic without an appointment. As advocates for children, it is time for us to identify and eliminate system barriers that interfere with the health of children.

## CONCLUSION

Many high-risk children are not receiving the annual influenza vaccine. Because we found that parents' recalling that a clinician had recommended the vaccine significantly influenced the vaccination status of children, clinicians should consider evaluating the systems they use to recommend the vaccine.

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