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A computerized reminder strategy is effective for annual influenza immunization of children with asthma or reactive airway disease

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Background. **Influenza virus infection frequently triggers asthma exacerbation and hospitalization. Annual influenza immunization is recommended for children with chronic conditions, including those with asthma or reactive airway disease (RAD); however, <10% receive it each year.**

Methods. **In September, 1997, we instituted a computerized staged reminder strategy for annual influenza immunization of children with asthma/RAD at the Scott and White Pediatric Clinic in Temple. A reminder letter, followed six weeks later by an autodial recall telephone message, was sent to the parent/guardian of children with asthma/RAD using the Shared Medical Systems to identify children with asthma/RAD and the Integrated Client Encounter System to record immunizations. The effect of this computerized reminder system on the influenza immunization rate of a cohort of 925 Scott and White Pediatric Clinic children with asthma/RAD was examined for the 1996 to 1997 and 1997 to 1998 influenza seasons, before and after intervention.**

Results. **A significant increase in influenza immunization rate from 5.4% to 32.1% occurred in all age groups, regardless of the insurance status. The medically attended acute respiratory illness rate per 100 subjects was significantly higher in vaccinated than in unvaccinated children for each of the two influenza epidemics and in the period between the two epidemics.**

Conclusion. **A computerized reminder letter followed by an autodial recall telephone message is effective in increasing the influenza immunization rate of children with asthma/RAD. Children with significantly higher respiratory morbidity during and in between two influenza epidemics were more likely to be immunized after receiving written and telephone autodial reminders.**

INTRODUCTION

Asthma is a leading cause of illness in childhood, causes functional limitation in 6.4% of children ≤17 years of age and results nationally in 5 to 7 lost school days/year/child. Ten percent of children have asthma at some time during childhood, and the prevalence and mortality have increased during the last 3 decades. Asthma is the most frequent admitting diagnosis in children's hospitals, and the hospitalization rate for children with asthma is at least double that for the general population.[1–5] Children with asthma or reactive airway disease (RAD) are at an increased risk of influenza-related complications, especially pneumonia. Influenza infection frequently triggers asthma attacks that result in hospitalization.[6–9] In a 20-year retrospective cohort study of children <15 years with asthma enrolled in the Tennessee Medicaid program, Neuzil et al.[9] demonstrated excess hospitalization rates of 5.6 per 1000 in children 1 to 3 years old, which are comparable with those in adult high risk populations for whom influenza vaccine is recommended. In addition an estimated 10 to 20% of children <15 years old had an additional outpatient visit during an average influenza season, and ~14% received an additional antibiotic prescription.

A recent population-based retrospective cohort study of children with asthma 1 to 6 years of age from 4 large Health Maintenance Organizations showed protection from the trivalent inactivated influenza vaccine (TIV) against acute asthma exacerbation in a self-control analysis, after controlling for asthma severity.[10, 11] Annual administration of TIV to children with asthma is recommended by the Advisory Committee on Immunization Practices of the CDC and the Committee on Infectious Diseases of the American Academy of Pediatrics.[12, 13] Unfortunately children at high risk are not readily accessible within a short period of time, and

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<10% are vaccinated each year.[11, 14, 15] Lack of organized efforts to target children with asthma for influenza immunization probably is a major factor in their low immunization rate. Strategies are needed to achieve the national Healthy People 2010 goal of immunizing at least 60% of high risk persons <65 years old.[12, 14] Age-based strategy has been successful for influenza immunization in persons >65 years old and has contributed to the recent change in the recommendation in the United States to annually vaccinate all persons 50 years and older.[12]

Multiple barriers to annual influenza vaccination of children with asthma exist. Those that are common to all childhood vaccinations include lack of knowledge or problems with perception regarding vaccine efficacy and adverse effects, low parental education level, children with a single parent, large family size, difficulty accessing healthcare and missed opportunities by health care providers.[16–21] In addition there has been concern about the risk of asthma exacerbation with influenza vaccine in persons with asthma. However, most studies have concluded that the benefit outweighs the risk associated with influenza vaccine in this population.[22–26]

A targeted computerized staged influenza immunization strategy was developed for children with asthma in the setting of a pediatric clinic affiliated with a nonprofit health plan. Our goal was to vaccinate at least 60% of children with asthma or RAD. Targeting children with asthma for their annual influenza immunization with TIV could have an impact on the morbidity related to influenza epidemics. A significant decrease in medically attended illnesses and hospitalization could translate into decreased school and work absences for the families and cost savings to the health plan. This strategy could be further expanded to include all high risk persons <50 years of age with chronic high risk conditions.[12]

METHODS

Scott and White (S&W) is an integrated health care delivery system consisting of the S&W Health Plan (SWHP) with ~160 000 enrollees, a multispecialty clinic and a 483-bed teaching hospital located in Temple, Bell County in Central Texas. There are 19 regional clinics in the S&W system. Bell County has a population of 203 684 with 71.2% White (13.1% Hispanic), 18.9% Black and 9.9% other ethnic groups. Primary health care is provided for ~13 000 children in the S&W pediatric clinic (SWPC) in Temple. The SWPC is operated for extended hours, including evenings and weekends for urgent care. In addition to SWHP members, the Medicaid population and persons with other insurance comprise 40 to 50% of all patients. The patients receiving Medicaid represent the indigent population, and the SWHP members come from middle and upper income families. The local institutional review board approved the study protocol and informed consent was obtained before influenza vaccination.

Computerized staged reminder strategy. Influenza vaccination rate was examined in a cohort of children with asthma/RAD who received their medical care at SWPC before and after implementation of a computerized staged reminder strategy. Patients in the S&W system can be tracked by a single medical record number effective in all of the clinics and the hospital (Shared Medical Systems, (SMS). Using SMS, children ≥6 months and <19 years of age with asthma/RAD were identified by ICD-9-CM (International Classification of Diseases, 9th Revision, Clinical Modification) codes for asthma/RAD for the period of July, 1993, to September, 1997. All patients thus identified had their demographic information electronically entered into the Integrated Client Encounter System (ICES), a computerized immunization registration program developed by the Texas Department of Health (TDH). ICES can flag patients with a certain ICD-9-CM diagnosis codes, e.g. asthma/RAD, 493.9, can generate computerized reminder letters, autodial telephone messages in English or Spanish and reports of immunization rates for individual vaccines or combinations. Validation of the ICES and the clinic immunization records periodically, for a random sample of SWHP members, has shown >90% concurrence.

In September, 1997, computerized reminder letters were sent to the parent/guardian of 2009 children with ICD-9-CM diagnosis for asthma/RAD. There were 45 letters (2.2%) that could not be delivered. In early November, 1997, 6 weeks after the reminder letter, an autodial recall telephone message was delivered to 908 of 1793 (50.6%) households of children who had not been immunized by then. The reminder letter informed parents about study participation, provided education about flu-related complications in children with asthma and recommended annual influenza vaccination. The letter specified that a child should be 6 months of age to be eligible and that children age <9 years receiving their first influenza vaccine need 2 doses administered at least 1 month apart.[12, 13] A nurse-only visit by appointment during regular clinic hours, at no cost to the patient, was offered. A standing order to the SWPC nurses for influenza immunization of high risk children, including those with asthma, was placed. Free vaccine was available before and after the intervention. The Vaccines for Children program and SWHP covered the cost of TIV in 1996 to 1997 and 1997 to 1998. In 1997 to 1998 the study sponsor, Aventis Pasteur, also provided TIV.

The TIV for 1996 to 1997season included A/Wuhan/359/95-like (H3N2), A/Texas/36/91-like (H1N1) and B/Beijing/184/93-like influenza strains, and that for

1997 to 1998 included A/Wuhan/359/95-like (H3N2), A/Bayern/07/95-like (H1N1) and B/Beijing/184/93-like influenza strains.[27, 28] Children receiving short course corticosteroid as a "burst" therapy for acute exacerbation of asthma or for maintenance therapy, either by inhalation or by mouth, were included.[13, 29, 30] Children with a significant egg allergy or hypersensitivity reaction to a previous TIV were excluded.[12, 13] The immunization record was entered into ICES by the SWPC nurses. Primary care provider identified asthma/RAD patients who had not received the letter were also allowed to participate in the study and had their records flagged in ICES. Altogether 475 patients were enrolled after an informed consent. Additionally some children received influenza vaccine as a part of their medical care and were included in the analysis.

Influenza virus surveillance. Viral surveillance to define the influenza epidemic period was performed in the fall and winter of 1996 to 1997 and 1997 to 1998. Any child visiting outpatient pediatrics or hospitalized with a history of fever and any respiratory illness was eligible for a throat swab or a nasal wash (in young infants) for viral culture at no charge. The swabs were sent to the TDH virology laboratory in 1996 to 1997 and the TDH and S&W virology laboratory in 1997 to 1998. The S&W virology laboratory is one of the influenza surveillance sites for the CDC and the World Health Organization. The results of the viral cultures were reported to the health care providers. The weekly number of positive cultures from S&W Clinics and Hospital defined the influenza epidemic curve for each season.

Identification of SWPC patients with asthma. Because the S&W Hospital is a tertiary referral center and the S&W system has several regional clinics, we identified a subset of patients who received the reminder letter who received their medical care at SWPC in Temple. SWPC patient was defined as one with at least two pediatric clinic visits between July, 1993, and September, 1997. A cohort of SWPC patients that had an ICD-9-CM diagnosis of asthma/RAD before September, 1996 (beginning of the control period) was included in the analysis (n = 925).

Extraction of immunization and acute respiratory morbidity data. In May, 1998, influenza immunization data for 925 SWPC patients with asthma were collected from ICES and charge code entries in the S&W Clinic and Health Plan databases for 1996 to 1997 and 1997 to 1998. The morbidity data for these 925 SWPC patients with asthma were collected from SMS using ICD-9-CM codes for medically attended acute respiratory illnesses (MAARI) for clinic and emergency room visits, during and in between the influenza epidemics in 1996 to 1997 and 1997 to 1998. We compared the influenza immunization rate of the cohort of 925 SWPC children with asthma who were identified before September, 1996, before and after implementation of our computerized reminder strategy (the 1996 to 1997 and 1997 to 1998 influenza seasons, respectively).

Outcome measures. Outcome measures were: (1) the immunization rate before (control) and after (study) implementation of the intervention strategy, stratified by insurance status and age; and (2) the rate of medically attended acute respiratory illnesses (MAARI) during the influenza epidemic and in the period between the 2 epidemics in vaccinated and unvaccinated children with asthma.

Statistical analysis. The vaccination rates during the control and study period were compared with the McNemar test for correlated proportions. Vaccination rates between independent groups of patients were compared with the chi square test. MAARI rates per 100 subjects were compared using a Poisson regression model. Data were analyzed with SAS Version 7 (SAS Institute Inc., Cary, NC). P values <0.05 indicated statistically significant effects.

RESULTS

Figure 1 gives the comparison of immunization rates for the 925 SWPC asthma patients before and after implementation of the computerized reminder strategy. There was a significant increase in the overall influenza immunization rate from 5.4% to 32.1%, and the improved rate was similar for both SWHP and Medicaid/other insurance group. Table 1 compares immunization rate by age before and after the intervention. The responses were similar for each age group.

Table 2 shows the chronologic response of the 925 SWPC patients to the letter and of the 654 patients to a subsequent autodial reminder. The reminder letter was successful in immunizing 220 of 925 children (24%). For the remaining 705 children, an autodial

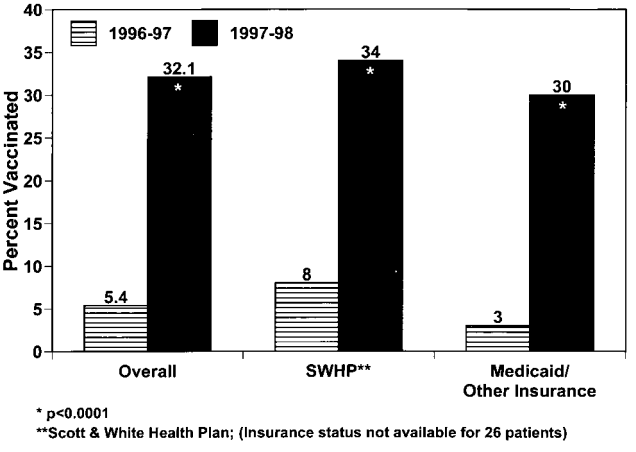

FIG. 1. Influenza vaccination rate for children with asthma or RAD before and after intervention, 1996 to 1997 and 1997 to 1998, respectively.

TABLE 1. Influenza vaccination rate by age before and after intervention, 1996 to 1997 and 1997 to 1998, respectively

Age Group (yr)	1996–1997	1997–1998	*P*
<5	15/385 (4)*	104/385 (27)	<0.0001
5–11	24/365 (7)	136/365 (37)	<0.0001
12–19	11/175 (6)	57/175 (33)	<0.0001

* Numbers in parentheses, percent.

TABLE 2. Chronologic response to reminder letter with or without follow-up autodial message for influenza vaccination in children with asthma or RAD

Group	No. of Children	No. Vaccinated
I. Reminder letter (before autodial)	925	220 (24)*
II. Reminder letter followed by autodial	654	285 (43.6)†
III. Reminder letter only (autodial unsuccessful)	271	12 (4)†
Final total	925	297 (32.1)

* Numbers in parentheses, percent.
† $P < 0.0001$ for Groups II and III.

message was delivered to parent/guardian of 434 children (62%). Thus the computerized staged strategy of a reminder letter, followed by autodial message in 6 weeks (if not yet immunized), was implemented in 654 (71%) of these 925 children. Of 654 with autodial telephone follow-up, 285 (43.6%) were immunized. The subsequent autodial telephone message resulted in vaccination of 15% of those contacted. This was significantly higher ($P < 0.0001$) than the 4% vaccination rate in the 271 remaining children not contacted by autodial.

Viral surveillance cultures of children with acute febrile respiratory illness in 1996 to 1997 and 1997 to 1998 revealed 32 (9.8%) of 326 and 59 (12.9%) of 456, respectively, to be positive for influenza. In 1996 to 1997, all 32 viral isolates were influenza A H3N2, and in 1997 to 1998, 56 were influenza A H3N2 and 3 were influenza B/Beijing/184/93-like. The influenza epidemic period for each year was defined by the occurrence of positive influenza cultures and included the weeks around the peak during which ~80% of the positive cultures were obtained (Fig. 2). For 1996 to 1997 this period was from December 8, 1996, to February 1, 1997 (Week 50 through Week 5, includes 8 weeks), and for 1997 to 1998 it extended from January 11, 1998, to February 28, 1998 (Week 2 through Week 8, includes 7 weeks).

During the influenza epidemics of 1996 to 1997 and 1997 to 1998, the clinic visit rate for acute respiratory illness for the vaccinated group was significantly higher each year than for those unvaccinated the same year (Table 3). Among the 875 patients unvaccinated in 1996 to 1997, those vaccinated in 1997 to 1998 also had a significantly higher visit rate in the interim between

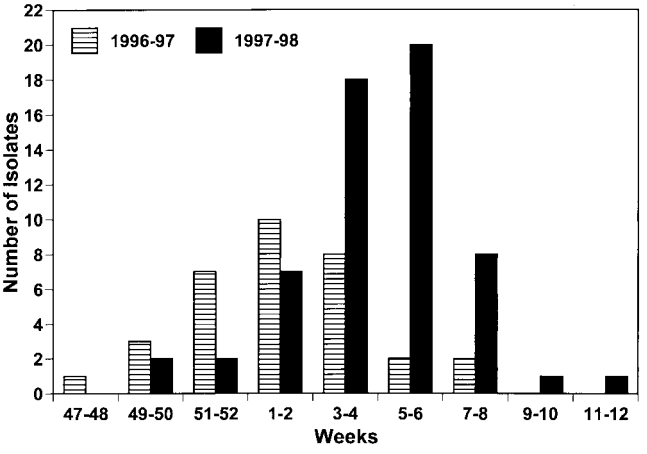

FIG. 2. Influenza virus surveillance in 1996 to 1997 and 1997 to 1998.

TABLE 3. MAARI rate per 100 subjects during influenza epidemics by vaccination status for 1996 to 1997, during the period between influenza seasons in 1997 for 875 patients unvaccinated in 1996 to 1997 by vaccination status in 1997 to 1998, and for 1997 to 1998, respectively

Year	MAARI Rate/100		*P*
	Vaccinated	Unvaccinated	
1996–1997	196.0 ($n = 50$)	116.1 ($n = 875$)	<0.0001
1997	218.7 ($n = 260$)	162.4 ($n = 615$)	<0.01
1997–1998	78.8 ($n = 297$)	52.7 ($n = 628$)	<0.0001

* Based on Poisson regression model.

the 2 epidemics as shown in Table 3. Conversely patients with at least 1 clinic visit for an acute respiratory illness in the interim between the 2 epidemics had a significantly higher vaccination rate in 1997 to 1998 than those with no visits during this period (33.5% *vs.* 23.8%, $P = 0.001$).

DISCUSSION

As seen in our study before the intervention, underimmunization with influenza vaccine has been consistently documented in children with asthma.[14, 31–33] Kramarz et al.[14] found that only 9 to 10% of asthmatic children enrolled in 2 to 4 large health maintenance organizations were vaccinated for influenza for the 1995 to 1996 and 1996 to 1997 influenza seasons. Overall 61% of unvaccinated asthmatic children had outpatient clinic visits during the months when influenza vaccination would have been appropriate, representing many missed opportunities. In a cross-sectional survey of 117 children age 6 to 48 months attending an allergy-immunology clinic at an urban tertiary care center, only 25% of children with moderate to severe asthma received influenza vaccination.[31]

The effectiveness of a reminder letter for annual influenza vaccination of children with asthma has been

inconsistent in previous studies. Szilagyi et al.[32] identified 124 children with moderate to severe asthma at a pediatric clinic in an urban teaching hospital and randomly assigned them to the study group who were sent a personalized reminder letter or the control group who received no reminder. Similar to our study, they found that the intervention group had received significantly higher immunizations (30%) than the control group (7%). However, lack of effectiveness of a letter reminder for annual influenza immunization of asthmatic children was reported in a pediatric practice even with the addition of Saturday clinics.[33]

Our study is the first to document the effectiveness of a subsequent recall autodial telephone message for influenza vaccine and a computerized staged reminder strategy. Investigators from a semirural family practice residency program sent a reminder letter to 475 noninstitutionalized Medicare beneficiaries >65 years old and similar to our experience had a 28% response rate within 1 month.[34] Almost one-half of the patients who had not received influenza vaccine at the clinic were directly contacted on the telephone for a reminder and were interviewed about their vaccination status. Unlike our experience no additional immunizations could be attributable to the telephone intervention; however, 35% reported receiving influenza vaccine elsewhere.[34]

A successful implementation of a computerized reminder strategy for annual influenza vaccination has been previously reported. Hak et al.[35] showed significant improvement in the influenza vaccination rate of the elderly and the high risk age <65 years from 71% in 1995 to 76% in 1996, in a Dutch General Practice network covering 36 000 patients using computerized medical records, reminder letters and an online (physician-monitored) indication tag. Physician-monitored online indication tags may be effective provider reminders that could decrease the missed opportunities. However, the vaccination rate was significantly higher in persons ≥65 years old with cardiac, lung or other disease (not diabetes mellitus or renal insufficiency) than in those with similar conditions who were <65 years of age.

We found that children with asthma who had one or more clinic visits for acute respiratory illnesses between the two influenza epidemics are more likely to get their influenza immunization. This suggested that the parent/guardian of children with higher respiratory morbidity during the previous year were more likely to respond to the influenza vaccine reminders. The higher MAARI rate during each influenza season in the vaccinated children was probably related to not controlling for severity of underlying illness. Kramarz et al.[14] reported that children who were hospitalized, had an emergency room visit for asthma or a prescription for a beta-agonist before the influenza season were more likely to be vaccinated. Similarly Chung et al.[31] found that influenza vaccine recipients were more likely to have been hospitalized than nonrecipients.

Physician variability in knowledge, attitude and behavior in relation to influenza vaccination of high risk children has been reported. A survey of three physician groups in Toronto, Canada, showed that community pediatricians were more likely than community family physicians or hospital subspecialists to recommend vaccination for all but one of the high risk conditions including for children with asthma on maintenance inhaled steroids. Pediatricians (54%) were also the most likely to use active strategies to contact families of high risk children as compared with the latter two (23% each). Over one-half of the pediatricians and family physicians recommended influenza vaccine in children with a history of hospitalization or prednisone use for asthma. However, only 44% of all physicians were themselves vaccinated with no difference between the groups.[36]

In 1996 to 1997 influenza A/Wuhan/359/95-like (H3N2) peaked in late December and early January (Week 50 of one year through Week 1 of the next) and influenza B/Beijing/184/93-like in late February (Week 9).[27, 37] The influenza vaccine was very well-matched to the circulating strains in 1996 to 1997, but only a minority of children with asthma had received the vaccine, which is reflected in high clinic visit rates overall for 1996 to 1997. In 1997 to 1998 Influenza A/Sydney/5/97 (H3N2) peaked in late January and early February (Weeks 3 to 8), and the vaccine provided limited protection against the new variant.[28, 38] The emergence of this new variant did not result in a severe epidemic overall in our study population. However, it is apparent from the higher interepidemic MAARI rates that children brought for vaccination probably had more severe underlying conditions.

There are a few limitations to our study. The severity of asthma was not considered for the reminders and probably resulted a in lower than expected vaccination rate. Also we did not attempt to find out which children <9 years old were being vaccinated for the first time and required two doses of TIV for either season. The effectiveness of the TIV in preventing influenza-associated asthma exacerbation or other complications and the cost effectiveness of our reminder strategy was not evaluated.

Thus to achieve optimal annual influenza vaccination for the high risk persons <50 years including children with asthma, a multicomponent strategy, including physician and patient education, computerized letter and autodial telephone reminders, healthcare provider reminders, nurse-only visits and standing orders, convenient locations and times and availability

of free vaccine, is needed. A cold-adapted, trivalent, live attenuated influenza vaccine has been shown to be safe and efficacious in a multicenter, double blind, placebo-controlled trial in healthy children 15 months to 71 months old.[39, 40] The safety and effectiveness of this vaccine in children with asthma and other high risk conditions should to be evaluated.

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