Family Characteristics Associated with Likelihood of Varicella Vaccination

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ABSTRACT

Context: The introduction of the varicella vaccine as a routine pediatric immunization in the US, in 1995, provided an opportunity to assess factors associated with uptake of new vaccines in the member population of the Kaiser Permanente Northwest (KPNW) Health Plan.

Objective: Identify factors associated with varicella vaccination in the KPNW population in the first five years after varicella vaccine was introduced.

Design: A retrospective cohort of children under age 13 years between June 1995 and December 1999, without a history of varicella disease was identified using KPNW automated data. Membership records were linked to vaccine databases. Cox regression was used to estimate likelihood of varicella vaccination during the study period in relation to age, sex, primary clinician's specialty, and Medicaid eligibility. For a subset whose parents answered a behavioral health survey, additional demographic and behavioral characteristics were evaluated.

Main Outcome Measure: Varicella vaccination.

Results: We identified 88,646 children under age 13 years without a history of varicella; 22% were vaccinated during the study period. Varicella vaccination was more likely among children who were born after 1995, were not Medicaid recipients, or had pediatricians as primary clinicians. In the survey-linked cohort, positively associated family characteristics included smaller family size; higher socioeconomic status; and parents who were older, were college graduates, reported excellent health, and received influenza vaccination.

Conclusion: Understanding predictors of early varicella vaccine-era vaccine acceptance may help in planning for introduction of new vaccines to routine schedules.

INTRODUCTION

The introduction of the varicella vaccine as a routine pediatric immunization in the US, in 1995, provided an opportunity to assess factors associated with uptake of new vaccines in the member population of the Kaiser Permanente Northwest (KPNW) Health Plan. For the first few years after its introduction, the varicella vaccine was available to Health Plan members, but it was not consistently promoted by clinicians, particularly for older children. During this time, parent choice was a major determinant of whether a child was vaccinated against varicella.

After the varicella vaccine was introduced, vaccination coverage increased more slowly than expected across the US (34% among children 19-35 months of age in 1997-1998), with wide geographic variation.[1] Parents' concerns, lack of information about the vaccine, and beliefs that clinical varicella was not an illness to be concerned about are thought to have influenced vaccine acceptance.[2-4]

Several nonfamilial factors undoubtedly influenced the likelihood of varicella vaccination in the KPNW pediatric population. In 1995, the US Centers for Disease Control and Prevention (CDC) recommended that the vaccine be routinely administered to children between 12 and 18 months of age and to older children lacking a history of varicella infection. In 1998, varicella vaccination of 1-year-olds was incorporated into the childhood immunization status measure of the national Healthcare Effectiveness Data and Information Set (HEDIS), and in 1999, varicella vaccination for 2-year-olds was adopted as a regional performance measure for KPNW. Also in 1999, the State of Oregon Health Division announced that varicella vaccination would be required for school entry to kindergarten and seventh grade in Fall 2000. Therefore, the period of highest parental influence on likelihood of varicella vaccination was probably from 1995 to 1999; thereafter, state regulations and Health Plan policies were more influential.

During the early and mid-1990s, KPNW annually surveyed its adult members to collect information on demographics and health behaviors; a 2% to 3% random sample of the member population was mailed a questionnaire to gather information on health status, medical history, health services utilization, and behavioral risk factors. We linked this parent-provided survey information with automated vaccination data on the survey respondents' children to identify demographic and parental factors associated with varicella vaccination from 1995 to 1999. This project was undertaken as a part of the CDC's Vaccine Safety Datalink, a project that studies the safety, effectiveness, and use of vaccines.[5]

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METHODS

Study Population

Using automated membership records, we identified 114,865 Health Plan members who were under age 13 years on June 1, 1995, or who were born after that date and were at least 1 year old by the last day of 1999. Of these, 3447 had at least 1 parent who had completed a Health Plan member survey from 1991 to 1996; if both parents responded to the survey, we randomly selected data from one parent. For each child, we defined an observation period that began at the child's first birthday, date of entry into the Health Plan, or date of first vaccine availability (June 1, 1995), whichever was later, and extended through December 31, 1999, date of leaving the Health Plan, date of varicella diagnosis, or date of varicella vaccination, whichever was earlier. Children with varicella disease or varicella vaccination before this period were excluded (Table 1), leaving 88,646 total study members. Of these, 2300 members were in the cohort linked to the membership survey information.

Data Sources

Vaccination dates were obtained from KPNW's automated vaccination database. In addition to vaccines administered by KPNW, this database captured non-KPNW vaccinations for which written documentation was available. In a study of the reliability of the KPNW automated vaccination data, Mullooly et al[6] found 83% to 92% agreement between automated vaccination data and vaccine information abstracted from medical records for common childhood vaccines. History of varicella disease was recorded in the automated vaccination database as a contraindication for varicella vaccine, although this information was incomplete. Varicella diagnoses for the years 1995 to 1999 were obtained from the Health Plan's electronic medical record system and from inpatient, Emergency Department, and telephone advice databases. This project was approved by the KPNW institutional review board.

Analysis

We used Cox regression survival analysis models to estimate the likelihood of varicella vaccination. Follow-up was measured in days after cohort entry. Start of follow-up was June 1, 1995, for Health Plan members 12 months of age or older on that date; the child's first birthday (eligible age for the vaccine) for children younger than 12 months on June 1, 1995; or date of entry into the Health Plan for children aged 2 years and older who were not in the Health Plan on June 1, 1995. Subjects without vaccination were removed from the analysis on the date of varicella diagnosis, Health Plan termination, or end of the study period (December 31, 1999), whichever was earlier. The maximum follow-up interval was 4 years, 7 months (June 1, 1995-December 31, 1999).

Covariates available for both the linked and unlinked cohorts included age group, sex, clinician specialty (Family Practice vs Pediatrics), and Medicaid eligibility (a surrogate for socioeconomic status [SES]). The cohort linked to the Health Plan membership survey had additional categorical variables available to analyze, including race; number of children in family; family income; self-reported SES; and parent's age, education, marital status, self-reported health status, history of depression, and current cigarette smoking.

To perform the Cox regression models, we created the following analytic variables to examine demographics: race (nonwhite vs white), number of children in the family (1, 2, or 3 or more), self-reported lower SES vs middle or higher SES, annual family income (less than $20,000; $20,000 to 49,999; or $50,000 or more per year), parent education

Table 1. Number of study subjects by age group and medically identified varicella and varicella vaccination during observation period

Age group		Survey-linked and unlinked cohorts combined				Survey-linked cohort only			
Group no.	Birth date range[a]	No. after exclusions[b]	Median observation time, days	No. with varicella	No. with varicella vaccination	No. after exclusions[b]	Median observation time, days	No. with varicella	No. with varicella vaccination
1	Born June 1, 1998-December 31, 1998	1916	23	15	1276	22	54	0	14
2	Born June 1, 1997-May 31, 1998	4027	45	89	3144	67	28	2	57
3	Born June 1, 1996-May 31, 1997	4633	102	170	2777	114	88	4	87
4	Born June 1, 1995-May 31, 1996	5474	194	344	2458	124	139	13	81
5	Born June 1, 1994-May 31, 1995	6322	252	489	2338	156	208	13	89
6	Born June 1, 1993-May 31, 1994 (1 year old on June 1, 1995)	6601	365	667	1972	181	389	29	82
7	Born June 1, 1991-May 31, 1993 (2-4 years old on June 1, 1995)	19,564	443	2065	3476	539	610	102	163
8	Born June 1, 1986-May 31, 1990 (5-9 years old on June 1, 1995)	25,594	548	1786	1867	650	878	88	106
9	Born June 1, 1983-May 31, 1985 (10-12 years old on June 1, 1995)	14,515	730	523	506	447	1368	38	29
Total		88,646	395	6148	19,814	2300	605	289	708

[a] Includes relationship to date of first availability of varicella vaccine on June 1, 1995.

[b] Subjects with varicella disease or varicella vaccine before observation period were excluded: 26,219 in survey-linked and unlinked cohorts combined and 1147 in survey-linked cohort only.

(high school graduate or less, some college, or college graduate), parent age (30 years or more vs younger than 30 years), and single-parent marital status (divorced/widowed/never-married) vs married. We also created variables to describe parental health status and health behaviors: parent's influenza vaccine ("flu shot") in previous year (yes vs no), parent's health status (less than excellent health vs excellent heath), parent's current cigarette smoking (yes vs no), and parent's history of depression (yes vs no).

We divided the children in our study population into age groups relative to the date of first availability of varicella vaccine and computed risk ratios for each age group before combining age groups where appropriate. Because vaccine receipt was much more common among younger children, we used dummy variables to adjust for age group in all regression models. We also used a time-dependent covariate for Calendar Year 1998 (yes/no) and another time-dependent covariate for Calendar Year 1999 (yes/no) to take into account increased clinician influence on likelihood of varicella vaccination (because of changes in guidelines and staff evaluation criteria). Because factors influencing vaccination for children turning 1 year old after the vaccine was introduced might be different from factors influencing vaccination in older children, we created the following groups: children turning 1 year old after the date of vaccine introduction (Groups 1-5—the younger stratum), children 12 to 23 months old on the date of vaccine introduction (Group 6), and children 2 years of age and older on the date of vaccine introduction (Groups 7-9—the older stratum). We then ran 2 separate multivariable models. Group 6 was the reference group for both models.

Table 2. Family characteristics related to likelihood of varicella vaccination, survey-linked and unlinked cohorts combined

Population	Characteristic	Risk ratio[a]	95% CI
Age Groups 1-6[b] (N = 28,973)	Age Group 6	1.0	Reference
	Age Group 1	11.9	11.0-12.8
	Age Group 2	8.6	8.1-9.1
	Age Group 3	4.1	3.9-4.4
	Age Group 4	2.2	2.0-2.3
	Age Group 5	1.5	1.4-1.6
	Male vs female child	1.0	0.96-1.0
	Family practitioner vs pediatrician	0.56	0.48-0.66
	Medicaid vs other insurance	0.81	0.78-0.84
Age Groups 6-9[b] (N = 66,274)	Age Group 6	1.0	Reference
	Age Group 7	0.52	0.49-0.55
	Age Group 8	0.18	0.17-0.19
	Age Group 9	0.07	0.06-0.08
	Male vs female child	0.99	0.94-1.0
	Family practitioner vs pediatrician	0.36	0.31-0.41
	Medicaid vs other insurance	0.79	0.75-0.84

[a] Adjusted for age group and time-dependent covariates for the years 1998 and 1999.
[b] See Table 1 for age group characteristics.
CI = confidence interval.

RESULTS

In the total subject population (linked plus unlinked cohorts), the child's age group was strongly associated with likelihood of vaccination. Using children 12 to 23 months old on June 1, 1995, as the reference group (Age Group 6), the relative likelihood of vaccination during the observation period increased to 1.5 for children turning 1 year old during the following year (Age Group 5), and to 2.2, 4.1, 8.6, and 11.9 respectively, in the subsequent 1-year age groups (Table 2). Children less than 1 year old on June 1, 1995, were the most likely to be vaccinated. Children older than 1 year on June 1, 1995, were much less likely than the 1-year-olds to be vaccinated during the study period; 2- to 4-year-olds (Age Group 7) were only half as likely to be vaccinated, whereas 5- to 9-year-olds (Age Group 8) were only one-fifth as likely, and the oldest age group (Age Group 9) was less than one-tenth as likely. The child's sex was not associated with vaccination status.

Family and clinician characteristics also affected the likelihood of child vaccination in the total subject population. Medicaid eligibility was associated with lower rates of vaccination in both the younger and older age strata (risk ratio [RR] = 0.8 for Age Groups 1-6 and Age Groups 6-9) and in every age group (results not shown). Children with family practitioners as their primary care clinicians were much less likely to receive the vaccine than were children with pediatricians as primary clinicians; this was more pronounced among older children (RR = 0.36, 95% confidence interval [CI] 0.31-0.41) than among younger children (RR = 0.56, 95% CI 0.48-0.66).

We were able to examine additional family characteristics in the cohort linked to the member survey. In this cohort, family factors were more strongly related to risk of vaccination in the older age stratum than in the younger (Table 3); however, the larger number of subjects in this stratum improved statistical power for comparisons. In both the older and younger age strata, the presence of 3 or more children in the family was associated with a lower likelihood of vaccination compared with families with only 1 child. Before multivariable adjustment, self-reported low SES and Medicaid eligibility were associated with lower likelihood of vaccination than higher SES and no Medicaid eligibility in both age strata. Children with parents aged 30 years or older and with parents who were college graduates were more likely to be vaccinated than were children of younger and less well-educated parents. If the parent did not get a flu shot in the year before the member survey, the child's likelihood of receiving the varicella vaccine was lower than in families in which the parent did get a flu shot. In the older age stratum, vaccination was more likely if family income was high and less likely if the parent was currently single or reported less than excellent health status, current cigarette use, or history of depression.

In the linked cohort, as in the total subject population, use of a family practitioner rather than a pediatrician as the primary clinician was associated with a reduced relative likelihood of vaccination. There were only 16 subjects in the

younger age stratum who regularly visited family practitioners, so statistical power for that comparison was poor, but the risk ratio was similar to that of the larger group.

When covariates of interest were combined into a multivariate regression model, the factor most strongly related to vaccination in the younger age stratum, other than age group, was number of children in the family (Table 3). The primary clinician's specialty was also strongly related, although statistical power was poor because of small numbers in the family practitioner category. Income, education, and SES were less influential in the multivariate model than in the univariate models. Medicaid status was not included in this model because it was highly correlated with SES.

In the multivariate model for the older age stratum, as in the younger age stratum, the primary clinician's specialty and the number of children in the family were strongly related to vaccination (Table 3). In addition, vaccination was positively associated with high family income, excellent parental health status, and parent's receipt of a flu shot and was negatively associated with parental history of depression. Variables that were less influential in the multivariate model than the univariate models included single-parent status, history of cigarette smoking, parent's education level, and self-reported SES.

DISCUSSION

We found several factors to be related to the likelihood of varicella vaccination in our pediatric population. One consistent relationship was with clinician specialty; children cared for by family practitioners were only about half as likely to be vaccinated as were patients of pediatricians. A large retrospective cohort study previously reported a similar finding for compliance with the routine second varicella vaccination dose among four- to six-year-olds.[7] A 1996 survey of physicians in Rochester, NY, found that the physicians most likely to offer the varicella vaccine were pediatricians.[8] Our results are also consistent with those of parent surveys conducted by Taylor and Newman[3] and Freeman and Freed,[4] in which clinicians powerfully influenced parental decisions to accept the varicella vaccine.

Clinician specialty differences in vaccination practices could be addressed by a systemwide vaccine in-reach strategy such as a nurse reviewing the child's immunization record at every medical or dental office visit and flagging the chart for the clinician with immunizations needed. Another helpful tool is access to the routine childhood immunization schedules, either electronically or as a pocket card, for each clinician seeing children.

Family demographics and health factors were also related, especially in children older than 1 year on date of vaccine introduction. For the older children particularly, lower vaccination rates were associated with poorer parent health as reflected in reporting depression, less than excellent health, or lack of health awareness as reflected in cigarette smoking or not getting a flu shot. The consistently inverse relationship between number of children in the family and immunization, independent of family income or parent education, may be related to parental experience with uncomplicated varicella; the highly contagious nature of varicella makes it likely that children in larger families had more opportunities for

Table 3. Age group and family characteristic related to likelihood of varicella vaccination, survey-linked cohort only

	Age Groups 1-6[a] (N = 664)		Age Groups 6-9[a] (N = 1817)	
Characteristic	Risk ratio (95% CI)[b]	Multivariable adjusted risk ratio (95% CI)[c]	Risk ratio (95% CI)[b]	Multivariable adjusted risk ratio (95% CI)[c]
Family practitioner vs pediatrician	0.46 (0.19-1.1)	0.35 (0.12-1.1)	0.35 (0.18-0.67)	0.35 (0.17-0.71)
Nonwhite vs white	1.4 (0.99-1.9)	1.1 (0.73-1.6)	0.97 (0.70-1.4)	0.88 (0.60-1.3)
2 children in family vs 1	0.81 (0.62-1.1)	0.87 (0.64-1.2)	1.0 (0.82-1.3)	1.1 (0.81-1.4)
3 or more children in family vs 1	0.76 (0.56-1.0)	0.65 (0.46-0.91)	0.75 (0.58-0.98)	0.68 (0.50-0.92)
Self-reported low socioeconomic status	0.85 (0.69-1.0)	1.0 (0.74-1.3)	0.77 (0.61-0.97)	1.2 (0.86-1.6)
Medicaid recipient	0.76 (0.56-1.0)	Not in model	0.79 (0.58-1.1)	Not in model
Family income < $20K vs $20K-$49K	1.1 (0.76-1.5)	1.3 (0.85-2.0)	0.97 (0.67-1.4)	1.1 (0.72-1.8)
Family income ≥ $50K vs $20K-$49K	1.2 (0.93-1.5)	1.1 (0.84-1.5)	1.5 (1.2-2.0)	1.4 (1.0-1.8)
Parent college graduate vs high school or less	1.3 (1.0-1.7)	1.2 (0.85-1.6)	1.3 (1.0-1.7)	0.96 (0.70-1.3)
Parent aged 30 years or older vs < 30 years	1.2 (0.99-1.5)	1.2 (0.93-1.5)	1.3 (1.0-1.7)	1.2 (0.93-1.7)
Parent flu shot previous year (no vs yes)	0.80 (0.61-1.0)	0.83 (0.61-1.1)	0.72 (0.56-0.91)	0.66 (0.50-0.87)
Parent health (not excellent vs excellent)	0.95 (0.85-1.1)	0.91(0.80-1.0)	0.83 (0.74-0.92)	0.82 (0.72-0.93)
Parent smokes cigarettes	0.88 (0.67-1.2)	1.1 (0.79-1.5)	0.74 (0.56-0.99)	0.91 (0.65-1.3)
Parent history of depression	0.85 (0.59-1.2)	0.88 (0.59-1.3)	0.51 (0.31-0.81)	0.55 (0.32-0.94)
Single parent	0.95 (0.74-1.2)	0.98 (0.70-1.4)	0.69 (0.52-0.93)	0.89 (0.60-1.3)

[a] See Table 1 for age group characteristics.

[b] Each model contained dummy variables for all age groups except the reference group (Age Group 6) and time-dependent covariates for calendar years 1998 and 1999 (both yes/no).

[c] Each model contained dummy variables for all age groups except the reference group (Age Group 6), time-dependent covariates for calendar years 1998 and 1999 (both yes/no), and the other variables listed in the table.

CI = confidence interval; flu shot = influenza vaccination; K = 000.

exposure to the disease. The more often that parents observe uncomplicated varicella in the family, the less likely they may be to contact the medical system for care or advice about varicella or to immunize their children to prevent disease. Parental perception that varicella is a mild disease is common; a phone survey about varicella vaccination of 14- to 17-month-olds performed 18 months after Canada licensed the vaccine revealed that 90% of parents perceived varicella as a benign disease.[9] The inverse relationship between family size and varicella immunization was also described in a study from a health care organization in Israel; investigators reported that children in families with 3 or fewer children were significantly more likely to be vaccinated than those in larger families.[10]

Studies of public acceptance of other pediatric vaccines have found that likelihood of vaccination is lower in single-parent families,[11,12] families with larger numbers of children,[13,14] families with young primary caregivers,[11] and families of lower SES.[15] These studies' results are similar to ours, although only one was conducted in a prepaid Health Plan.[13] A strategy to improve immunization uptake among these families could include a text message or e-mail appointment reminder sent to parents with information including which immunizations are due. Offering to immunize siblings who accompany their patients at the office visit may also help clinicians encourage more parents to vaccinate their children.

… understanding parental factors related to vaccine acceptance will help focus educational efforts with the introduction of new routine immunizations in the future.

A limitation of this study is that a fairly large proportion of varicella disease is not reported to the medical system (approximately 30% in this Health Plan), and so some children who were not candidates for varicella vaccination because of a history of varicella are included in this analysis. For the analyses linked to the membership survey, we had educational and health information on 1 parent only. Some of the survey information was old (up to 8 years old) and may not have accurately described the current situation of the family during the study period. These member surveys were designed to collect information on demographics, health behaviors, and satisfaction with health services, but they did not ask specific questions about knowledge and attitudes on vaccines. Because our study population belonged to a prepaid Health Plan, the weak association we found between family income and vaccination may not translate to families in the fee-for-service medical system.

Strengths of this study include the large number of subjects, the relatively complete automated immunization database, and the access to self-reported personal information on the family that was collected separately from information on vaccine status.

The incorporation of varicella vaccination into KPNW's clinical guidelines and performance measures, combined with state requirements for varicella vaccination for school entry (Oregon in 2000 and Washington in 2008) have likely reduced parental reluctance to vaccinate in this population. However, understanding parental factors related to vaccine acceptance will help focus educational efforts with the introduction of new routine immunizations in the future. In addition, identification of clinician specialty differences in vaccination practices will help health care organizations improve procedures and staff education to increase vaccine coverage. ❖

Disclosure Statement

The author(s) have no conflicts of interest to disclose.

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