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Parental Vaccine Acceptance: A Logistic Regression Model Using Previsit Decisions

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Abstract

This study explores how parents' intentions regarding vaccination prior to their children's visit were associated with actual vaccine acceptance. A convenience sample of parents accompanying 6-week-old to 17-year-old children completed a written survey at 2 pediatric practices. Using hierarchical logistic regression, for hospital-based participants ($n = 216$), vaccine refusal history ($P < .01$) and vaccine decision made before the visit ($P < .05$) explained 87% of vaccine refusals. In community-based participants ($n = 100$), vaccine refusal history ($P < .01$) explained 81% of refusals. Over 1 in 5 parents changed their minds about vaccination during the visit. Thirty parents who were previous vaccine refusers accepted current vaccines, and 37 who had intended not to vaccinate choose vaccination. Twenty-nine parents without a refusal history declined vaccines, and 32 who did not intend to refuse before the visit declined vaccination. Future research should identify key factors to nudge parent decision making in favor of vaccination.

Keywords

vaccines; vaccination; immunization; decision making

Introduction

Childhood vaccines reduce illness, morbidity, and mortality. In the United States, overall vaccination rates are high, but there remain areas where the health of children is at risk because of rising exemption levels.¹ Geographic clusters of parents who underimmunize or refuse to immunize their children undermine herd immunity and thus not only threaten their own child but also other families within their community.^{2,3}

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Author Contributions

All authors contributed to the initial design of the study. MRB and SBM contributed to data analysis. All authors reviewed and revised the manuscript, approved the final manuscript as submitted, and agree to be accountable for all aspects of the work.

Declaration of Conflicting Interests

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Despite overwhelming evidence of vaccine safety, previous studies note many reasons why parents choose to refuse or delay their child's vaccines, including concerns regarding vaccine safety, about providing multiple concurrent immunization, and/or whether their child needs vaccination.^{4–6} While prior studies have focused mainly on vaccine-refusers, there is scant information regarding decisions that parents make prior to the visit, and scant attention to unexpected outcomes such as parents changing their minds in favor of vaccine refusal.

Leask et al describe 5 parental groups in relation to vaccine acceptance: the unquestioning acceptor, the cautious acceptor, the hesitant parent, the late/selective vaccinator, and the refuser.⁷ The groups that theoretically have the most potential for intervention are the hesitant parent and the late/selective vaccinator.

Previous studies have described more vaccine refusal among parents who are white, who have higher income levels, and who have higher educational attainment.^{8,9} Underimmunization rates cluster geographically, in communities and neighborhoods with similar income, educational levels, and social norms.^{10–12}

In Brunson's decision model, parents assess and then choose.¹¹ Choosing can then be followed by stasis—the decision stands—or reassessment. Opel et al observed parent-provider immunization discussions and found that some parents who initially refused vaccines would change their minds after talking with the provider.¹³ Although the initial decision may have been made prior to the visit, that information was not reported. Gust et al also report that parents changed their mind and decided to receive vaccines as a result of provider recommendation, but further details regarding the timing of the refusal decisions are unclear.¹⁴

The objective of this study is to explore how vaccine decisions made by parents prior to their children's visits are associated with actual visit vaccine acceptance at a community-based practice and at a hospital-based academic pediatric practice.

Methods

Study Population

A convenience sample of parents were approached for study enrollment between October 2013 and March 2014, from 2 pediatric practices: a community-based, suburban practice with pediatricians and nurse practitioners serving families covered mostly by commercial insurance (40% Medicaid) and a large, urban-based academic hospital practice with pediatricians, nurse practitioners, and pediatric residents (81% Medicaid).

Procedure

The protocol for the current study was approved by the institutional review board at University Hospitals of Cleveland Case Medical Center. Research assistants conducted pen-and-paper surveys. Survey questions related to parent/child demographics as well as parental previsit vaccine behaviors and decision making. Based on the available literature and information obtained from a pilot survey, the final survey asked participants if they had

decided to say “no” to certain vaccines prior to their visit or if they had decided to follow their provider’s vaccine advice prior to the visit.¹⁴

Parents were eligible to participate in the survey when accompanying their children (ages 6 weeks to 17 years) to any well, sick, injury, or follow-up medical appointment where the medical provider recommended vaccines. If more than one child in the family was offered vaccines that day, parents were instructed to answer questions about their eldest child. They were ineligible to participate in the study if the medical provider had not recommended vaccines for their child at the visit or if they had already participated in the study at a previous visit regarding any child in their household. If eligible, the medical provider gave parents an informational flyer explaining the study. Due to clinic flow constraints, surveys were completed after the provider visit. If interested, parents were directed to approach a study staff member in the waiting area who could be identified as individuals holding clipboards. Surveys took approximately 5 to 10 minutes to complete; parents received a \$5.00 gift card to a local grocery store for participating.

Statistical Analysis

Analyses were stratified by practice, when cell sizes were adequate; Pearson’s χ^2 test was used for bivariate comparisons. When individual cell sizes contained an expected count less than 5, Fisher’s exact test was implemented.¹⁵ *T* tests were used to compare means at the $P < .05$ level. Binary logistic regression analysis with hierarchical entry of variables was used to predict vaccine acceptance by parents on survey day. We used a nested, 2-block method: (1) primary independent variables were parents’ previsit vaccine intention and a history of vaccine refusal; (2) control variables were child’s age, number of parents in home, parent’s age and level of education, and reason for visit.

Differences in deviance test and Nagelkerke pseudo- R^2 were used to evaluate model fit.¹⁶ Using a significance level of .05 and a 2-tailed test, the study’s sample had 80% power to detect a medium effect size (Cramer’s $V = .30$).

Results

A total of 316 parents participated in the survey: 216 from the academic hospital practice and 100 from the community practice. The 2 practices differed from each other on child and parent age, race/ethnicity, number of parents in the home, parent education level, visit reason, and parents’ vaccine refusal at visit (Table 1). Children and parents in the academic hospital practice were younger than those in the community practice (both $P < .01$). Children in the academic hospital practice were predominantly African American (90%) and predominantly Caucasian in the community practice (68%).

Community practice children were less likely to live in single-parent homes (25% vs 53%, respectively, $P = .001$), and community practice parents were more likely to have attained at least a bachelor’s degree versus parents from the academic hospital practice (31% vs 6%, $P = .001$). Additionally, hospital practice parents as opposed to community practice parents (84% vs 69%, $P = .01$) were more likely to be attending a well-child visit versus a sick/follow-up visit. There were no significant differences between the practices on child gender,

the number of children in the home, whether parents expected vaccines to be recommended at the visit, history of vaccine refusal, or vaccine decisions made prior to visit.

Of the 316 parents who reported whether they accepted or refused vaccines in the survey, there were 63 parents who refused vaccines and 253 that accepted vaccines. Parents that refused versus accepted vaccines differed from one another in terms of child and parent race/ethnicity, practice, history of vaccine refusal, or whether they decided prior to the visit to refuse vaccines (Table 2). African American parents were more likely to be acceptors, making up 67% of the acceptor group versus 46% of the refusal group ($P < .01$). Parents in the community practice ($n = 30$; 67%) were more likely to be vaccine refusers than the academic hospital practice ($n = 33$; 33%; $P < .01$).

Parents who had made previsit decisions not to vaccinate were more likely to refuse vaccination than parents without previsit intentions to refuse ($P < .001$; Table 2). When only considering parents who were previous vaccine refusers, academic hospital practice parents were more likely to change their minds and agree to vaccinate after speaking with medical providers than parents from the community practice (33/50 [66%] vs 4/18 [22%], respectively). Fisher's exact test, $P < .01$, moderate effect size (.39).

Thirty parents who were previous vaccine refusers accepted vaccination, and 37 parents who had decided not to vaccinate prior to the visit changed their minds and opted for vaccination. However, 29 parents without a history of vaccine refusal refused vaccination, and 32 who had not made a decision against vaccination before the visit ultimately opted against vaccination.

Multivariable Analysis

Academic Hospital Practice—The multivariable regression model for the academic hospital practice explained 87% of the cases of vaccine refusals. History of vaccine refusal (odds ratio [OR] = 4.77; 95% confidence interval [CI] = 1.64–13.8; $P < .01$) and vaccine decision made prior to the visit (OR = 2.81; 95% CI = 1.04–7.07; $P < .05$) were predictors of current refusal, when controlling for other covariates (Table 3).

Community Practice—The multivariable regression model for the community practice explained 81% of the cases (Table 4). History of vaccine refusal was the only significant predictor of current vaccine refusal (OR = 7.0; 95% CI = 1.52–32.1; $P < .01$).

Discussion

We found that, in both the academic hospital and community practices, a history of vaccine refusal was the key predictive factor as to whether parents refused vaccines at the current visit for their child. Contrary to previous studies, parental education level did not appear to have an independent effect on vaccine refusal; within-practice parent education levels may have been too similar in our study to be able to show these differences.^{17,18}

Over 1 in 5 parents changed their minds about vaccination during the visit; unfortunately, almost as many changed their minds against versus in favor of vaccinating. While the net

result of the visit for these switchers was that more parents changed their minds in favor of vaccinating, the impact of the clinician encounter on vaccine decisions was disappointing. Ascertaining the characteristics of these children, their parents, their clinicians, and/or the interactions between the factors underlying these decision switches, for better or for worse, is key for understanding how to improve vaccine acceptance.

Providing vaccine information and education has not been shown to be a consistently effective strategy for improving vaccine uptake.¹⁴ In a review of 30 studies that attempted interventions to decrease parental vaccine hesitancy and refusal, Sadaf et al found none to be sufficiently effective.¹⁹ Indeed, Nyhan et al found that education about the MMR and autism paradoxically increased intention to refuse vaccination, particularly in parents who were initially reluctant to vaccinate.²⁰ The parent decision-making process is clearly complex and also involves social pressures and emotions that were not directly addressed by this study.²¹ Opel et al suggested that parents are less likely to refuse vaccination if clinicians take a more presumptive approach (“your child needs these shots today”) rather than a participatory approach (“we can discuss some options for your child’s shots today”).¹³

This study had several limitations. The racial and educational distributions of our practice sites were not balanced, limiting our ability to make comparisons between the 2 practices, and perhaps limiting the generalizability of results; our results can inform hypothesis generation for future studies. We did not track parents who declined to enroll in the study, which could have introduced selection bias. Differences in parental vaccine decisions related to child age were beyond the scope of this study. Due to time constraints and clinic flow limitations, only postvisit surveys were given, and no previsit data were collected to assess attitudes and decisions. Future work should include both pre- and postvisit information. Finally, parents gave a self-report of vaccines received. Dorell et al reported that parents may over- or underestimate the vaccination status of young children and that parents are likely to underreport recently recommended vaccines.²² Parental report of children’s vaccine reception may have also been affected by a social desirability bias.

In conclusion, while prior vaccine refusal was the largest predictor of vaccine acceptance by parents, a large proportion of parents changed their minds—either toward or against vaccination during the clinician visit. Further studies to identify key actionable factors are needed to develop novel effective interventions to foster immunization acceptance.

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Table 1

Sample Characteristics by Practice^a.

Characteristic	Practice Group		χ^2/it	P	ES
	Academic Hospital (n = 215)	Community (n = 100)			
Child demographic characteristics					
Gender, n (% female)	128 (60)	51 (51)	2.03	.18	.08
Age (in months), mean (SD)	51 (57)	76 (68)	3.2	<.01	.03
Race/ethnicity, n (%)					
African American	192 (90)	4 (4)	FET = 231.0	<.001	.86
Caucasian	3 (1)	69 (68)			
Other (Hispanic, Asian, multiracial)	19 (9)	26 (26)			
Single-/double-parent home, n (% single)	114 (53)	25 (25)	21.2	<.001	.26
Number of children in home (<18 years old)	2 (1)	2 (1)	1.0	.77	.01
Parent demographic characteristics					
Relationship to the child, n (%)					
Mother	195 (90)	84 (84)	FET = 3.49	.20	.11
Father	16 (7)	14 (14)			
Other	6 (3)	2 (2)			
Age (in years), mean (SD)	29 (9)	35 (10)	5.7	<.001	.11
Race/ethnicity, n (%)					
African American	191 (89)	5 (5)	227	<.001	.85
Caucasian	6 (3)	78 (78)			
Other (Hispanic/Latino, multiracial)	17 (8)	17 (17)			
Level of education, n (%)					
Less than bachelor's degree	203 (94)	68 (69)	38.0	<.001	.35
Bachelor's degree or higher	12 (6)	31 (31)			
Parent expectations that doctor/nurse would be recommending vaccines at visit					
Did not expect vaccines to be recommended	25 (12)	16 (16)	1.19	.28	.06
Expected vaccines to be recommended	189 (88)	83 (84)			
Reason for visit, n (%)					
Well-child	169 (84)	63 (69)	7.93	<.01	.16

Characteristic	Practice Group		χ^2/df	P	ES
	Academic Hospital (n = 215)	Community (n = 100)			
Sick/follow-up	33 (16)	28 (31)			
Parents' vaccine decisions made prior to the visits					
History of vaccine refusal for children					
No	176 (82)	76 (76)	1.68	.22	.07
Yes	38 (18)	24 (24)			
Vaccine decision to refuse made prior to visit					
No	166 (77)	82 (82)	1.07	.31	.06
Yes	50 (23)	18 (18)			
Parents' vaccine refusal at visit, n (%)					
Did not refuse (accepted vaccines)	183 (85)	70 (70)	9.28	.003	.17
Refused	33 (15)	30 (30)			

^aChi-square tests of independence for categorical and *t* tests with independent groups for continuous variables. Child/parent race excluded from logistic regression model. FET (Fisher's exact test) is implemented when at least one expected cell count in a χ^2 test of independence is <5. ES = effect size (Cramer's *V* for χ^2 test of independence where magnitude of .10 = small, .3 = medium, and .5 = large). For continuous variables, Cohen's *d* was calculated where magnitude of .2 = small, .5 = medium, and .8 = large. Sample size varies due to missing data.

Table 2

Sample Characteristics by Parents That Accepted Versus Refused Vaccines^a.

Characteristic	Parents' Vaccine Decision		χ^2/t	P	ES
	Accepted Vaccines (n = 253)	Refused Vaccines (n = 63)			
Child demographic characteristics					
Gender, n (% female)	143 (57)	35 (56)	.04	.89	.01
Age (in months), mean (SD)	47 (54)	72 (69)	1.9	.06	.03
Race/ethnicity, n (%)					
African American	166 (67)	29 (46)	9.33	<.01	.40
Caucasian	52 (21)	20 (32)			
Other (Hispanic, Asian, multiracial)	31 (12)	14 (22)			
Single-/double-parent home, n (% single)	110 (80)	29 (20)	.18	.78	.02
Number of children in home (<18 years old)	2 (1)	2 (1)	.88	.38	.01
Parent demographic characteristics					
Relationship to the child, n (%)					
Mother	222 (88)	56 (89)	FET = .14	NS	NS
Father	24 (10)	6 (10)			
Other	7 (2)	1 (2)			
Age (in years), mean (SD)	28 (9)	30 (9)	1.00	.37	.22
Race/ethnicity, n (%)					
African American	166 (66)	29 (46)	11.5	<.01	.19
Caucasian	63 (25)	21 (33)			
Other (Hispanic/Latino, multiracial)	21 (8)	13 (21)			
Level of education, n (%)					
Less than bachelor's degree	217 (32)	54 (54)	.30	.68	.03
Bachelor's degree or higher	34 (14)	7 (46)			
Practice group, n (%)					
Academic hospital	183 (72)	33 (33)	9.28	<.01	.17
Community	70 (28)	30 (67)			
Parent expectations that doctor/nurse would be recommending vaccines at visit, n (%)					
Did not expect vaccines to be recommended	34 (14)	7 (12)	.18	.67	.02

Characteristic	Parents' Vaccine Decision		χ^2/t	P	ES
	Accepted Vaccines (n = 253)	Refused Vaccines (n = 63)			
Expected vaccines to be recommended	217 (86)	54 (88)			
Reason for visit, n (%)					
Well-child	188 (81)	44 (72)	2.53	.15	.09
Sick/follow-up	43 (19)	17 (28)			
Parents' vaccine decisions made prior to the visits, n (%)					
History of vaccine refusal for children					
No	222 (88)	29 (48)	50.8	<.001	.40
Yes	30 (12)	32 (52)			
Missing	1	2			
Vaccine decision to refuse made prior to visit					
No	215 (85)	32 (51)	35.5	<.001	.34
Yes	37 (15)	31 (49)			
Missing	1	0			

^aChi-square tests of independence for categorical and *t* tests with independent groups for continuous variables. Child/parent race excluded from logistic regression model. FET (Fisher's exact test) is implemented when at least one expected cell count in a χ^2 test of independence is <5. ES = effect size (Cramer's *V* for χ^2 test of independence where magnitude of .10 = small, .3 = medium, and .5 = large. For continuous variables, Cohen's *d* was calculated where magnitude of .2 = small, .5 = medium, and .8 = large). Sample size varies due to missing data.

Table 3

Summary of Logistic Regression Analysis for Variables Predicting Parents' Vaccine Refusal for Children Receiving Care at Academic Hospital Practice Only (n = 187), Controlling for Background Variables.

Predictor	OR	SE	95% CI	P
History of vaccine refusal ^a	4.77	0.54	1.64–13.8	<.01
Vaccine decision was made prior to visit ^b	2.81	0.51	1.04–7.57	<.05
Child's age (months) ^c	1.00	0.01	0.99–1.01	.80
Number of parents in home ^d	1.15	0.46	0.46–2.82	.77
Parent's age (years) ^e	0.98	0.03	0.93–1.04	.55
Parent's education level ^f	1.97	0.86	0.34–10.6	.40
Reason for visit ^g	0.92	0.61	0.28–3.03	.89

Abbreviations: OR, odds ratio; SE, standard error; CI, confidence interval.

^aFor history of vaccine refusal, *No, I did not refuse vaccines in the past* (= 0) is the reference category.

^bFor vaccine decision made prior to visit, *No, I did not make a vaccine decision prior to the visit* (= 0) is the reference category.

^cChild's age is a continuous variable (in months).

^dFor number of parents in the home, *one/single parent* (= 0) is the reference category.

^eParent's age (in years) is a continuous variable.

^fFor parents highest level of education, *less than a bachelor's degree is the reference category* (= 0).

^gFor reason for visit, *well-visit* (= 0) is the reference category.

Table 4

Summary of Logistic Regression Analysis for Variables Predicting Parents' Vaccine Refusal for Children Receiving Care at Community Practice Only (n = 91), Controlling for Background Variables.

Predictor	OR	SE	95% CI	P
History of vaccine refusal ^a	7.00	0.78	1.52–32.1	.01
Vaccine decision was made prior to visit ^b	3.94	0.87	0.72–21.2	.11
Child's age (months) ^c	0.99	0.01	0.98–1.00	.13
Number of parents in home ^d	2.86	0.67	0.76–10.7	.12
Parent's age (years) ^e	1.07	0.04	0.98–1.16	.14
Parent's education level ^f	0.58	0.65	0.16–2.08	.40
Reason for visit ^g	1.04	0.61	0.31–3.42	.96

Abbreviations: OR, odds ratio; SE, standard error; CI, confidence interval.

^aFor history of vaccine refusal, *No, I did not refuse vaccines in the past* (= 0) is the reference category.

^bFor vaccine decision made prior to visit, *No, I did not make a vaccine decision prior to the visit* (= 0) is the reference category.

^cChild's age is a continuous variable (in months).

^dFor number of parents in the home, *one/single parent* (= 0) is the reference category.

^eParent's age (in years) is a continuous variable.

^fFor parents highest level of education, *less than a bachelor's degree is the reference category* (= 0).

^gFor reason for visit, *well-visit* (= 0) is the reference category.