Physician Communication Training and Parental Vaccine Hesitancy: A Randomized Trial


BACKGROUND AND OBJECTIVES: Physicians have a major influence on parental vaccine decisions. We tested a physician-targeted communication intervention designed to (1) reduce vaccine hesitancy in mothers of infants seen by trained physicians and (2) increase physician confidence in communicating about vaccines.

METHODS: We conducted a community-based, clinic-level, 2-arm cluster randomized trial in Washington State. Intervention clinics received physician-targeted communications training. We enrolled mothers of healthy newborns from these clinics at the hospital of birth. Mothers and physicians were surveyed at baseline and 6 months. The primary outcome was maternal vaccine hesitancy measured by Parental Attitudes on Childhood Vaccines score; secondary outcome was physician self-efficacy in communicating with parents by using 3 vaccine communication domains.

RESULTS: We enrolled 56 clinics and 347 mothers. We conducted intervention trainings at 30 clinics, reaching 67% of eligible physicians; 26 clinics were randomized to the control group. Maternal vaccine hesitancy at baseline and follow-up changed from 9.8% to 7.5% in the intervention group and 12.6% to 8.0% in the control group. At baseline, groups were similar on all variables except maternal race and ethnicity. The intervention had no detectable effect on maternal vaccine hesitancy (adjusted odds ratio 1.22, 95% confidence interval 0.47–2.68). At follow-up, physician self-efficacy in communicating with parents was not significantly different between intervention and control groups.

CONCLUSIONS: This physician-targeted communication intervention did not reduce maternal vaccine hesitancy or improve physician self-efficacy. Research is needed to identify physician communication strategies effective at reducing parental vaccine hesitancy in the primary care setting.

WHAT’S KNOWN ON THIS SUBJECT: Parental hesitancy about childhood vaccines is prevalent and related to delay or refusal of immunizations. Physicians are highly influential in parental vaccine decision-making, but may lack confidence in addressing parents’ vaccine concerns.

WHAT THIS STUDY ADDS: A physician-targeted communications intervention designed to reduce maternal vaccine hesitancy through the parent-physician relationship did not affect maternal hesitancy or physician confidence communicating with parents. Further research should determine the most effective approaches to addressing vaccine hesitancy.

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Dr Henrikson codesigned the study, directed all aspects of the trial, drafted all data collection instruments, wrote the first draft of the manuscript, and approved the final manuscript as submitted; Dr Opel refined the data collection instruments, assisted with analysis planning and interpretation of results, drafted portions of the manuscript, and reviewed and refined manuscript drafts; Mr Grothaus was responsible for clinic randomization, wrote the analysis plan, conducted all analyses, drafted portions of the manuscript, and critically reviewed the manuscript; Dr Nelson codirected the analysis plan, supervised final analyses and critically revised the draft manuscript; Mr Scrol oversaw the recruitment of hospitals, mothers, and clinics into the trial, led the day-to-day conduct and fidelity of data collection, and critically reviewed the manuscript; Dr Dunn led the intervention team, codesigned the intervention materials, contributed to study design, analysis planning, and interpretation of results, and critically reviewed the manuscript; Dr Faubion coordinated scheduling and conduct of trainings, served as the health educator on the intervention team, codesigned the intervention materials, and critically reviewed the manuscript;
Many parents in the United States delay or refuse vaccines recommended by the Centers for Disease Control and Prevention for young children. As public confidence in vaccines erodes, parents hesitate about vaccine decisions, vaccination rates may decrease, and outbreaks of vaccine-preventable disease may be more likely.

Physicians are highly influential on parental beliefs and attitudes about childhood vaccinations yet many feel unprepared to address questions from vaccine-hesitant parents. Improved physician communication with vaccine hesitant-parents could address parental hesitancy, but few evidence-based interventions are available. We conducted a randomized trial to test whether a novel communication intervention targeted at physicians could improve physician confidence in communication and reduce vaccine hesitancy among mothers of infants.

METHODS
We conducted a 2-arm clinic-level cluster randomized trial in pediatric and family practice outpatient clinics from March 2012 to December 2013. We hypothesized that training physicians would improve their self-efficacy in communicating with parents about vaccines, which would subsequently improve physician-parent communication and positively influence parental attitudes and beliefs about vaccines. All study protocols were approved by the Group Health Research Institute Institutional Review Board. Hospital recruitment activities were also approved by the Western IRB.

Participants
Mothers
We recruited 4 hospitals with obstetric and newborn services in 2 western Washington counties (King and Snohomish). Deliveries at these hospitals constitute 44% of annual deliveries in the counties. Study staff approached mothers in the postpartum unit of these 4 hospitals, offered information about the study, and collected contact information for interested mothers. Eligibility criteria included planning to receive routine well-child care from a study clinic, age >18, English speaking, and pregnancy >35 weeks of gestation. Mothers were not approached if they or their newborns had medical complications.

Clinic Recruitment
All vaccines in Washington are obtained through a central ordering system administered by the Washington State Department of Health. Clinics in study counties that had ordered childhood vaccine from this program in 2010 comprised our clinic sampling frame. Clinic inclusion criteria included use of a study hospital newborn nursery and having ordered ≥1000 doses of childhood vaccine in 2010. Exclusion criteria included federally qualified health centers, naturopathic-only practices, or concurrent participation in other vaccine-related studies by study investigators. Physician investigators contacted clinic leaders directly to invite study participation. Clinic leaders provided the individual contact information for physicians at heir clinic providing pediatric care. Clinic leaders were asked to encourage physicians to participate in the study data collection and training. Providers did not receive payment for participation in the training or data collection.

Randomization and Blinding
We used the clinic as the unit of randomization. Randomization was blocked on medical group; single-site clinics were collectively considered a block. A biostatistician blinded to clinic name and location carried out randomization by using numeric clinic identifiers. Clinics could not be blinded to their randomization status, but clinics learned their status only after their clinic’s baseline data collection was complete. We did not share information about any mothers participating in the trial with any clinic staff.

Intervention
Intervention and Control Activities
Intervention clinics received training on a novel communication strategy developed by Vax Northwest, a partnership in Washington State. The strategy, "Ask, Acknowledge, Advise," was adapted from effective communication models and based on best practices in physician-patient communication adapted to vaccine conversations. This strategy had been shown to be feasible and well-received in initial evaluation. According to this strategy, the “ask” step cues physicians to invite parental vaccine questions and concerns, the “acknowledge” step reinforces communication of respect and empathy for the parent’s concerns and creation of a trusting environment, and the “advise” step prompts physicians to recommend immunization, educate about the benefits and risks of vaccines and vaccine-preventable disease, and end the consultation with a mutually agreed on action such as vaccinating or an appointment to discuss further.

The intervention was delivered by using a modified academic detailing format. The main component was a 45-minute training administered by a pediatrician immunization expert and a health educator. The entire clinic staff was invited to the training; food was provided. We tracked training attendance by sign-in sheets. We did not track the number of minutes physician attendees spent in the training.

The training included didactic presentation of data on vaccine hesitancy, the strong provider influence on parental vaccine decisions, and the importance of trust-building around vaccine decisions. Interactive components included facilitated discussion of videos modeling the method and how clinic
flow could be adjusted to improve vaccine hesitancy.

We considered intervention fidelity achieved if the training was successfully scheduled and carried out at its intended length and content.27 Immediately after the training, each attendee was invited to complete an anonymous 1-page written evaluation rating the following domains on a scale of 1(poor) to 7(excellent): how well the presentation met objectives, presentation quality, quality of written materials, practical value of the subject matter, value for practice, and overall impression. We conducted descriptive analyses of the results.

Second, training participants received paper materials with consistent branding (“Let’s Talk Vaccines”) detailing the framework. To reinforce training messages and reach nonattendees, each clinic received these materials plus branded leave-behind buttons, notepads, and parent-facing resources. The health educator visited each clinic 3 months after training and provided branded mugs and more supplies of training materials.

Third, each eligible physician, regardless of training attendance, received 6 months of monthly e-mail newsletters, a link to the study Web site that included a webinar version of the training, and technical assistance on request, such as responses to unusual parent questions about vaccine safety.

Control clinics did not receive any of these intervention components. After data collection concluded at each control clinic, the health educator delivered the training materials and offered study physicians access to online training materials via the study Web site.

Measures

Our primary study outcome was maternal vaccine hesitancy at month 6, assessed by maternal score on the Parental Attitudes on Childhood Vaccines (PACV) survey. The PACV is a 15-item scale with high reliability and is associated with vaccine behavior.28–30 It assesses attitudes, beliefs, and past vaccination behaviors, and is scored from 0 (least hesitant) to 100 (most hesitant) with scores ≥50 considered “hesitant” and ≥70 “very hesitant.” Cronbach α for the items in the PACV scale was 0.85. The survey also included demographic items, vaccine information sources, family vaccine decision-maker, and duration of relationship with infant’s physician.

We contacted mothers by phone at infant’s age 4 to 6 weeks to confirm consent and administer the baseline survey; survey completion constituted enrollment in the study. A follow-up survey was conducted 6 months later. Surveys were administered by trained interviewers blinded to randomization status using Sawtooth C3 (Sawtooth Technologies, Inc, Northbrook IL) and WinCATI, a computer-assisted telephone interviewing software.

Our secondary outcome was physician confidence in communicating with parents about childhood vaccines. We developed 6 single-item self-efficacy questions about communicating with parents about childhood vaccines, by using a standard self-efficacy item format (“How confident are you in your ability to...”),31,32 adapted from those used previously by study investigators. We selected 3 items a priori as outcome measures (talking about the risks of vaccines, providing vaccine information resources, and answering difficult parent questions about vaccines), and 3 as hypothesis-generating (overall confidence about communicating about vaccines, establishing an ongoing dialogue, and discussing the benefits of vaccines). The survey also assessed pediatric practice volume, years in practice, frequency of parental vaccine concerns, and number of clinics in the medical group.

We e-mailed eligible physicians a unique link to a self-administered survey before clinic randomization status was revealed, with up to 2 reminders. Completion of the survey was considered to constitute the physician’s consent to participate in the study. Baseline data collection was terminated either before the training date (intervention clinics) or after 6 weeks (control clinics). Six months later, the follow-up survey was administered, by using the same procedures, to all eligible physicians regardless of whether they had completed the baseline survey or whether they had attended training.

Data Analysis

Prerecruitment power calculations assumed 50 clinics and 500 mothers and a 25% baseline hesitancy rate, representing 80% power to detect a 12.4% difference in the percentage of hesitant mothers at follow-up between intervention and control groups. To compare the baseline characteristics of both physicians and mothers in the 2 groups, we used a generalized estimating equation (GEE) version of a χ² test (for binary or categorical variables) or a GEE version of a t test (for ordinal or continuous variables) to account for within-clinic correlation. All multivariable models were selected a priori.

Maternal vaccine hesitancy at month 6, our primary study outcome, was analyzed in 2 ways: as a dichotomous measure as “hesitant” or “nonhesitant” and as an ordinal measure with 5 levels. We used GEE logistic regression to do unadjusted and adjusted analyses comparing hesitancy in the intervention and control groups. We also formed a 5-level ordinal version with PACV categories 0 to 20, 30 to 49, 50 to 59, 60 to 69, and 70 to 100. We used a random effects proportional odds model to estimate a common odds ratio (OR) comparing the likelihood of being at a higher hesitancy level in the 2 groups to account for within-clinic correlation. Because of sparse
Assessed for eligibility: Clinics in King/Snohomish County, WA (n = 253)

Excluded: not linked to study hospital (n = 32); FQHC (n = 28); naturopath (n = 1); enrolled in concurrent study (n = 11); vaccine doses <1000 (n = 97); closed or no longer offer primary care (n = 3)

Added on medical group request (doses 800–999) (n = 4)

Clinics approached (n = 83)

Part of medical groups (n = 55) Independent clinics (n = 30)

Unable to contact (n = 8); asked not to approach (n = 2); refused (n = 3); no response (n = 16)

Clinics randomized (n = 56)

Randomized to Intervention: (n = 30)

Randomized to control: (n = 26)

Excluded
no mothers enrolled (n = 5)

25 intervention clinics included in analysis

242 mothers consented

Physicians invited to survey
Baseline (n = 265)
Follow-Up (n = 257)

Mothers did not complete baseline survey (n = 49)

Mothers completing baseline survey (n = 193)

Mothers lost to follow-up (n = 20)

Mothers completing follow-up survey (n = 173)

Physicians completing baseline survey (n = 160)

Physicians completing follow-up survey (n = 171)

22 control clinics included in analysis

246 mothers consented

Physicians invited to survey
Baseline (n = 206)
Follow-Up (n = 206)

Physicians completing baseline survey (n = 125)

Physicians completing follow-up survey (n = 119)

Physicians completing both baseline and follow-up survey (n = 96)

Mothers completing follow-up survey (n = 174)

Mothers completing baseline survey (n = 198)

Mothers lost to follow-up (n = 24)

Mothers included in final analysis
Baseline (n = 145)
Follow-up (n = 121)

Mothers included in final analysis
Baseline (n = 118)
Follow-up (n = 90)

FIGURE 1
Study flow diagram.
data, we adjusted for only the baseline value of the PACV (coded by using 2 dummy variables for 0–30 vs 30–49 vs 50+) and race, which was correlated with hesitancy and differed in the 2 treatment groups.

Only physicians who reported seeing infants in the previous 6 months were included in the analysis. We compared control and intervention physicians reporting high self-efficacy at follow-up, defined as 4 or 5 on a 1 to 5 scale. We used GEE $\chi^2$ tests (unadjusted analysis) and GEE logistic regression for adjusted analyses. We controlled for baseline self-efficacy, physician gender, specialty (pediatrics versus family practice), number of children seen in the previous 6 months, and reported frequency of parental vaccine concerns. We also conducted a per-protocol analysis comparing self-efficacy of physicians in the control group with only physicians in the intervention group attending a training.

**RESULTS**

We approached 85 clinics, including 30 single-site practices and 55 that were part of multisite medical groups (Fig 1). We enrolled and randomized 56 clinics (65.9%). We conducted trainings of intended length and content in all 30 clinics randomized to the intervention group. Of the 265 physicians seeing pediatric patients in the 30 clinics, 179 (67.5%) attended a training session, along with 198 others (18 midlevel providers, 54 nurses, and 126 other staff). The median number of total attendees was 16.5 (range 4–22) and of physician attendees was 6 (range 2–19). Among attendees, 278 (74%) completed posttraining evaluations. The proportion rating the training as 6 or 7 (7-point scale) ranged from 89.6% (value of training for my practice) to 96% (presentation quality).

A total of 471 physicians received invitations to the baseline survey, and 285 (60.5%) completed surveys. We sent 463 follow-up surveys; 290 (62.6%) were completed. The final analysis set included 263 baseline surveys (118 control; 145 intervention) and 211 month-6 surveys (90 control, 121 intervention). We excluded 9 clinics from analysis because no mothers could be linked to the clinics.

We approached 700 mothers and enrolled 488 (69.7%). Of these, 391 (80.1%) completed the baseline survey and 347 mothers (71.1%) completed the follow-up survey.

**Baseline Characteristics**

**Mothers**

Mean maternal age was 32.2 years (SD 4.9), 90% were married or

<table>
<thead>
<tr>
<th>TABLE 1 Baseline Characteristics: Mothers</th>
<th>Overall n = 391</th>
<th>Control Group n = 198</th>
<th>Intervention Group n = 193</th>
<th>$P^a$</th>
</tr>
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<tbody>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>&lt;30</td>
<td>113 (29)</td>
<td>64 (32)</td>
<td>49 (25)</td>
<td>.15</td>
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<tr>
<td>30–34</td>
<td>149 (38)</td>
<td>72 (38)</td>
<td>77 (40)</td>
<td></td>
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<tr>
<td>≥35</td>
<td>129 (33)</td>
<td>62 (31)</td>
<td>67 (35)</td>
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<tr>
<td>Marital status</td>
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<td></td>
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<tr>
<td>Single/widowed</td>
<td>38 (10)</td>
<td>21 (11)</td>
<td>17 (9)</td>
<td>.62</td>
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<tr>
<td>Married/partnered</td>
<td>352 (90)</td>
<td>177 (99)</td>
<td>175 (91)</td>
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<tr>
<td>Education</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>High school or less</td>
<td>39 (10)</td>
<td>15 (8)</td>
<td>24 (12)</td>
<td>.41</td>
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<tr>
<td>Some college</td>
<td>66 (17)</td>
<td>36 (18)</td>
<td>30 (16)</td>
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<td>4-year college</td>
<td>146 (37)</td>
<td>77 (39)</td>
<td>69 (36)</td>
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<td>Postgraduate</td>
<td>139 (36)</td>
<td>70 (35)</td>
<td>69 (36)</td>
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<td>Household income</td>
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<tr>
<td>&lt;$25 000</td>
<td>26 (7)</td>
<td>11 (5)</td>
<td>15 (8)</td>
<td>.94</td>
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<td>$25–50 000</td>
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<td>24 (12)</td>
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<td>31 (16)</td>
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<td>$75–100 000</td>
<td>81 (21)</td>
<td>42 (22)</td>
<td>39 (21)</td>
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<td>&gt;$100 000</td>
<td>176 (46)</td>
<td>87 (45)</td>
<td>89 (48)</td>
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</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Asian</td>
<td>59 (15)</td>
<td>42 (21)</td>
<td>17 (9)</td>
<td>.01</td>
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<tr>
<td>African American</td>
<td>18 (5)</td>
<td>11 (6)</td>
<td>7 (4)</td>
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<td>Pt/hi/other</td>
<td>15 (4)</td>
<td>9 (5)</td>
<td>6 (3)</td>
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<tr>
<td>White</td>
<td>297 (76)</td>
<td>135 (69)</td>
<td>162 (84)</td>
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<tr>
<td>Hispanic origin</td>
<td>23 (6)</td>
<td>8 (4)</td>
<td>115 (8)</td>
<td>.04</td>
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<tr>
<td>No. children, mean (SD)</td>
<td>1.80 (0.88)</td>
<td>1.76 (0.83)</td>
<td>1.94 (0.93)</td>
<td>.30</td>
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<tr>
<td>First-time parent</td>
<td>181 (46)</td>
<td>92 (47)</td>
<td>89 (48)</td>
<td>.98</td>
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<tr>
<td>Vaccine decision-maker</td>
<td></td>
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<td></td>
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<tr>
<td>Mom only</td>
<td>82 (21)</td>
<td>44 (22)</td>
<td>38 (20)</td>
<td>.82</td>
</tr>
<tr>
<td>Mom and someone else</td>
<td>307 (79)</td>
<td>153 (77)</td>
<td>154 (80)</td>
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<tr>
<td>Other person</td>
<td>2 (0.5)</td>
<td>1 (0.5)</td>
<td>1 (0.5)</td>
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<tr>
<td>Duration of relationship with infant's doctor</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>&lt;1 mo</td>
<td>62 (16)</td>
<td>38 (20)</td>
<td>24 (13)</td>
<td>.08</td>
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<td>1 to 12 mo</td>
<td>132 (34)</td>
<td>64 (33)</td>
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<td>1 to 5 y</td>
<td>133 (35)</td>
<td>68 (35)</td>
<td>65 (34)</td>
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</tr>
<tr>
<td>&gt;5 y</td>
<td>58 (15)</td>
<td>23 (12)</td>
<td>35 (18)</td>
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<tr>
<td>Vaccine information source (main)</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Child's doctor</td>
<td>288 (74)</td>
<td>144 (73)</td>
<td>144 (75)</td>
<td>.35</td>
</tr>
<tr>
<td>All other sources</td>
<td>71 (18)</td>
<td>34 (17)</td>
<td>37 (19)</td>
<td></td>
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<tr>
<td>Internet</td>
<td>32 (8)</td>
<td>20 (10)</td>
<td>12 (6)</td>
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<tr>
<td>Vaccine hesitant (PACV)</td>
<td>44 (11.3)</td>
<td>25 (12.6)</td>
<td>19 (9.8)</td>
<td>.43</td>
</tr>
<tr>
<td>PACV score, mean (SD)</td>
<td>21.7 (18.0)</td>
<td>22.8 (18.7)</td>
<td>20.6 (17.3)</td>
<td>.34</td>
</tr>
</tbody>
</table>

HI, Hawaiian; Pt, Pacific Islander.

$^a$ P value compares means in control and intervention group using a GEE $t$ test; percentages are compared by using a GEE $\chi^2$ test.

$^b$ Race $P$ value compares % white.

$^c$ Scored 0–100 (>50 considered "hesitant").
partnered, and 73% were college graduates or higher. Nearly half (46%) reported a household income of ≥$100 000. The intervention group was more likely to report White race (84% vs 69%, \( P = .01 \)) and less likely to report Hispanic ethnicity (4% vs 8%, \( P = .04 \)). Nearly half of the sample was first-time parents (46%); the mean number of children was 1.80 (SD 0.88) (Table 1). Most (79%) reported joint decision-making about vaccines with another person. Sixteen percent reported they had known their infant’s doctor for <1 month; an additional one-third, for <1 year but >1 month. The most common source of vaccine information was the infant’s doctor (74%).

Eight mothers (2%) had PACV scores in the very hesitant range.

**Clinic and Physician Characteristics**

Most clinics were part of medical groups with ≥6 sites and were family medicine clinics (Table 2). These clinics represented a total of 526 study-eligible physicians. Of the participating physicians (\( n = 263 \)), nearly all had a Doctor of Medicine degree and two-thirds were women.
Nearly half (48%) of physicians in the control group reported a family medicine specialty compared with 67% of the intervention group \((P = .16)\). Intervention clinic physicians reported slightly fewer years since medical school graduation \((P = .07)\). At baseline, both control and intervention group physicians reported that parents in their practice “always,” “frequently,” or “sometimes” voiced vaccine concerns in the previous 6 months (82% and 75%, respectively).

**Primary Outcome: Maternal Vaccine Hesitancy**

The intervention had no effect on maternal vaccine hesitancy (Table 3). At follow-up, 8.0% (13) of the control group and 7.5% (14) of the intervention group were vaccine hesitant \((P = .78)\). Adjusting for baseline PACV score and race showed similar results \((OR 1.22, 95\% confidence interval [CI] 0.47–2.68; OR >1.0 indicates greater hesitancy in the intervention group). Summarizing the PACV as an ordinal measure showed similar results (Fig 2). The percentage of mothers at lower levels of hesitancy (PACV score <.30) was similar between groups at both baseline and follow-up: 70.7% and 74.6% of mothers in the control and intervention groups, respectively, and 79.9% and 79.8% at follow-up. Adjusting for baseline PACV and race had little effect on the ordinal results \((OR 1.13, 95\% CI 0.61–2.10, P = .60)\).

**Secondary Outcome: Physician Self-Efficacy**

Baseline physician self-efficacy was lower in the intervention group (Table 4). Compared with the control group, fewer physicians in the intervention group reported high confidence in talking about risks (58% vs 70%, \(P = .06\)), providing information (69% vs 81%, \(P = .03\)), and answering difficult parent questions (54% vs 69%, \(P = .01\)). After adjusting for baseline self-efficacy, the intervention had no effect on physician self-efficacy at month 6 on any of the 3 items; fully adjusted models showed similar results. The 3 exploratory items suggested similar results. Per-protocol analysis of physicians in the intervention group attending a training showed no difference in self-efficacy for any of the 6 items (data not shown).

### DISCUSSION

We conducted a cluster randomized controlled trial to test the impact of a novel intervention to address parental hesitancy by improving physician-parent communication about early childhood vaccines. Both unadjusted and adjusted results indicate that the intervention neither reduced maternal hesitancy nor improved physician confidence in addressing parental hesitancy.

Vaccine hesitancy continues to be a difficult problem to address.33 A systematic review found limited evidence for the impact of any intervention on improving vaccine acceptance, and none focused on the physician-patient relationship pathway.18 This study is, to our knowledge, the first randomized trial to test an intervention aimed at improving hesitancy about early childhood vaccines by working directly with physicians.

Our study had a strong design. We identified and approached a large, community-based sample of clinics. We had high consent, response, and follow-up rates. The Ask, Acknowledge, Advise communication framework, the centerpiece of our intervention, was based on best practices, pretested, delivered in a format known to change physician behavior, carried out as intended, and well-received.

The null effect we observed may have been due to intervention reach. Only 67% of the target physician population attended training, but all were given access to an online version of the training and resources and e-mailed repeatedly with information, technical support, and reinforcement of intervention messages. We do not know how many intervention physicians used the online training or whether physicians attended only partial in-person training. Therefore, mothers could have encountered an “untrained” physician. However, the intervention

### TABLE 3 Maternal Vaccine Hesitancy: Results

<table>
<thead>
<tr>
<th>Vaccine hesitant, %</th>
<th>Control, n (%)</th>
<th>Intervention, n (%)</th>
<th>OR* (P)</th>
<th>Adjusted OR(^b) (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PACV(^a)</td>
<td>Baseline</td>
<td>Month 6</td>
<td>Baseline</td>
<td>Month 6</td>
</tr>
<tr>
<td>50–100</td>
<td>25 (12.6)</td>
<td>19 (9.8)(^d)</td>
<td>13 (7.5)</td>
<td>0.93 (.78) 1.22(^a) (0.47–2.68)(^a)</td>
</tr>
<tr>
<td>Vaccine hesitant, ordinal PACV(^a)</td>
<td>140 (70.7)</td>
<td>144 (74.6)(^d)</td>
<td>138 (79.8)</td>
<td>0.95 (.86) 1.13 (.61–2.10)(^d)</td>
</tr>
<tr>
<td>0–29(^h)</td>
<td>133 (65.7)</td>
<td>131 (64.2)</td>
<td>97 (51.7)</td>
<td>1.01 (.97) 1.05 (.99–1.12)</td>
</tr>
<tr>
<td>30–49</td>
<td>33 (16.7)</td>
<td>30 (15.5)</td>
<td>20 (10.7)</td>
<td>1.00 (.81) 1.13 (.69–1.80)</td>
</tr>
<tr>
<td>50–59</td>
<td>15 (7.6)</td>
<td>13 (6.7)</td>
<td>8 (4.2)</td>
<td>1.01 (.78) 1.26 (.85–1.89)</td>
</tr>
<tr>
<td>60–69</td>
<td>5 (2.5)</td>
<td>3 (1.6)</td>
<td>2 (1.2)</td>
<td>1.00 (.75) 1.27 (.85–1.91)</td>
</tr>
<tr>
<td>70+</td>
<td>5 (2.5)</td>
<td>3 (1.6)</td>
<td>3 (1.7)</td>
<td>1.00 (.74) 1.28 (.86–1.90)</td>
</tr>
</tbody>
</table>

\(^a\) OR for difference in month 6 hesitancy between intervention and control groups.

\(^b\) Adjusted for baseline PACV hesitancy score and race (2 indicator variables for white, Asian, and all other races).

\(^d\) OR >1.0 corresponds to a higher hesitancy rate in the intervention group.

\(^h\) PACV, scores 0–100; where 100 is most hesitant; ≥50 indicates vaccine hesitancy.
was designed to translate meaningfully into practice and thus may reflect realistic implementation of interventions of this type. Another reason for our null finding may be insufficient intervention intensity. Despite 6 months of reinforcement of the training messages, our intervention in effect was a 1-dose, 45-minute training. Physician behavior is difficult to change and may require a higher-intensity activity.34 Also, more recent data suggest that a strong physician recommendation may influence parents’ vaccine choices in the short term.35 Our intervention stressed the importance of physician recommendation, but focused more on long-term relationship building. Finally, the intervention and study design relied on having improvement in provider-parent communication lead to subsequent improvement in maternal vaccine attitudes. Communication is increasingly recognized as a possible determinant of health outcomes, by increasing trust, patient knowledge, satisfaction, and patient-centered experience.36 Maternal trust in vaccine information, trust in the child’s physician, and ability to discuss vaccine concerns openly with the physician were all measured in the PACV. Given the null effect on maternal vaccine hesitancy, we have limited ability to assess where the intervention may have fallen short in its implementation without other measures of physician attitudes or behavior in clinical interactions with the study parent.

We acknowledge several limitations. The prevalence of maternal vaccine hesitancy was less than expected, and decreased in both the intervention and control groups. During the study period, a highly publicized pertussis epidemic that involved infant deaths37 and a new state law requiring a health care provider’s signature to claim vaccine exemption for school entry38 may have altered vaccine hesitancy in the study population, but it is unlikely the

![PACV scores (ordinal)](chart)

**FIGURE 2**

Vaccine hesitancy at baseline and month 6.

<table>
<thead>
<tr>
<th>PACV scores (ordinal)</th>
<th>70–100 (most hesitant)</th>
<th>60–69</th>
<th>50–59 (hesitant)</th>
<th>30–49</th>
<th>0–29 (least hesitant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Baseline</td>
<td>70%</td>
<td>50%</td>
<td>20%</td>
<td>10%</td>
<td>0%</td>
</tr>
<tr>
<td>Intervention Month 6</td>
<td>60%</td>
<td>40%</td>
<td>30%</td>
<td>20%</td>
<td>10%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Control %</th>
<th>Intervention %</th>
<th>Model 1a OR (P)</th>
<th>Model 2b OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline, n = 118</td>
<td>Month 6, n = 90</td>
<td>Baseline, n = 145</td>
<td>Month 6, n = 121</td>
</tr>
<tr>
<td>How confident are you in your ability to…?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. talk about the risks of vaccines?</td>
<td>70</td>
<td>78</td>
<td>58d</td>
</tr>
<tr>
<td>2. provide vaccine information resources?</td>
<td>81</td>
<td>79</td>
<td>69e</td>
</tr>
<tr>
<td>3. answer difficult parent questions about vaccines?</td>
<td>69</td>
<td>74</td>
<td>54f</td>
</tr>
<tr>
<td>Exploratory items:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communicate with parents about vaccines?</td>
<td>91</td>
<td>91</td>
<td>81f</td>
</tr>
<tr>
<td>Establish an ongoing dialogue about vaccines?</td>
<td>86</td>
<td>85</td>
<td>79f</td>
</tr>
<tr>
<td>Talk about the benefits of vaccines?</td>
<td>97</td>
<td>94</td>
<td>95f</td>
</tr>
</tbody>
</table>

a Adjusted for baseline self-efficacy only.
b Adjusted for baseline self-efficacy, gender, specialty, number of children seen per week.
c Self-efficacy stem; 4–5 on 5-point scale considered high self-efficacy.
d Baseline difference between groups (P = .06).
e Baseline difference between groups (P = .03).
f Baseline difference between groups (P = .01).

We acknowledge several limitations. The prevalence of maternal vaccine hesitancy was less than expected, and decreased in both the intervention and control groups. During the study period, a highly publicized pertussis epidemic that involved infant deaths37 and a new state law requiring a health care provider’s signature to claim vaccine exemption for school entry38 may have altered vaccine hesitancy in the study population, but it is unlikely the
intervention and control groups were differentially exposed to these events. There were also baseline differences in the racial and ethnic distribution of mothers, perhaps related to our use of block randomization of clinics. Although we adjusted for this in our analyses, there may be other unmeasured differences between the intervention and control groups. Finally, vaccination behavior would have been the ideal primary outcome, but it was logistically infeasible. Because overall early childhood vaccine coverage still exceeds 90% in most areas, detecting further improvement in vaccination rates would require a sample size of nearly 300 clinics. Thus, we chose an intermediate measure that correlates with vaccination behavior, but we cannot assess if the intervention had any impact on actual vaccination behavior through any other, unmeasured intermediate pathway.

We offer several recommendations for future research. First, work in identifying and targeting interventions at hesitant parents may be warranted. The relative impact of vaccine hesitancy on vaccine coverage compared with other factors, including access and beliefs specific to cultural groups, deserves further study. Increasing intervention intensity through multiple levels of influence may yield better results; for example, communication training combined with clinic, systems, peer-to-peer, or policy-level interventions may have a greater collective impact on maternal confidence in vaccines. Also, more foundational and conceptual work is needed on the optimal approaches to communicating with vaccine-hesitant parents, and delivering feasible, high-dose communications interventions with physicians where the ultimate target is parent behavior.

CONCLUSIONS
A physician-targeted communications intervention was not effective in changing maternal vaccine hesitancy from birth to 6 months or in improving physician confidence in communicating with parents.

ABBREVIATIONS
CI: 95% confidence interval
GEE: generalized estimating equation
OR: odds ratio
PACV: Parental Attitudes on Childhood Vaccines

Ms Roberts contributed to study design, codesigned the intervention materials, facilitated the identification of eligible study clinics, and critically reviewed the manuscript; Dr Marcuse contributed to study design, analysis planning, and interpretation of results, assisted with clinic recruitment, codesigned intervention materials, and critically reviewed the manuscript; and Dr Grossman conceptualized the study design, codesigned all data collection instruments, participated in analysis planning and interpretation of results, and critically reviewed all manuscript drafts.

This trial has been registered at www.clinicaltrials.gov (identifier NCT01667354).

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