11-1-2020

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Citation/Publisher Attribution
Krueger, Brian S., L. Hutchison, Emily C. Bodo, Kelly K. Orr, Jennifer DeAngelis, Aisling R. Caffrey, and Kerry L. LaPlante. "Science-based communication to decrease disparities in adult pneumococcal vaccination rates." *Journal of the American Pharmacists Association* 60, 6 (2020): 861-867. doi: 10.1016/j.japh.2020.05.020.

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Word Count: Manuscript: 2,743 (without references/tables/abstract)

Declaration of Interest: KL has received research funding from or is an advisor/consultant for: Merck, Pfizer Pharmaceuticals, Ocean Spray Cranberries, Inc., Nabriva Therapeutics US, Inc., Melinta Therapeutics, Inc., Tetraphase Pharmaceuticals and Paratek Pharmaceuticals. AC has received research funding from Pfizer, Cubist (Merck), and The Medicines Company.

Research funding: Pfizer Independent Grants for Learning and Change. They did not have any input in study design, data collection, analysis, interpretation of data, in the writing of the report, and in the decision to submit the article for publication.

Author Contributions:
Conception and design of the study: KL, MH, BK, KO, AC
Data generation: MH, BK
Analysis and interpretation of the data: BK, MH, KL, AC, EB
Preparation or critical revision of the manuscript: BK, MH, KL, KO, AC, EB

ABSTRACT

Objectives: The objective of our study was to determine effects of science-based communications on attitudes toward pneumococcal vaccination and understand how non-white racial and ethnic populations respond to these messages.

Design: Our team tested several science-based communications using a nationally representative survey and validated in a local community pharmacy as a field experiment.

Setting/Participants: The nationally representative sample phase was a survey of 3,276 participants, conducted by leading online survey firm YouGov. The field experiment was conducted at a community pharmacy in the northeastern United States and included 86 participants.

Outcome measures: In the national survey, participants were assigned to treatment groups or a control group to determine the effects of messaging strategies on influencing favorable views of pneumococcal vaccination. In the field experiment, participants were assigned to treatment or control groups to determine if the messaging strategies impacted intent to ask a medical professional about the vaccine.

Results: The nationally representative survey identified safety-focused vaccine messaging had statistically significant treatment effects towards increasing individuals' perception of personal importance to have the vaccine in the white population, but not in the non-white population (6.2% vs 2.7%). Messaging that focused on community and family duty demonstrated significant effects in both populations (8.8% vs 12.2%). These results were validated through the field experiment, which showed that a combination message emphasizing duty increased individual intent to vaccinate by 25% in a diverse ethnic population compared to the control.

Conclusions: Messaging focused on appeals to community and family duty produced significant increases in favorable attitudes toward pneumococcal vaccines and behavioral intent to seek medical advice about the vaccine in white and non-white populations across both the nationally representative survey and the field experiment. Medical professionals should highlight duty to

family and community when communicating with patients, as it may motivate vaccination in all populations.

Key Points: Pneumococcal Infection, Invasive Pneumococcal Disease, Pneumococcal Vaccine, Vaccination, Healthcare Disparities, Health Communication

BACKGROUND

Pneumococcal disease is a substantial public health burden among adults in the United States. National estimates for invasive pneumococcal disease in 2016 were 33,400 cases and 3,690 resultant deaths.[1] The major disparities in pneumococcal vaccination rates between non-white and white adult populations are troubling; in the 2017 National Health Interview Survey, vaccination coverage among black and Hispanic respondents ≥65 years old was at least 15 percentage points lower than white respondents.[2] The burden of pneumococcal disease in the non-white population is significant due to lower vaccination rates coupled with a high prevalence of pneumococcal risk conditions, such as asthma, diabetes, cardiovascular disease, and stroke.[3-6] Correcting for racial disparities in access and quality of health care does not eliminate the pneumococcal vaccination coverage gap.[7] Researchers need to consider other key factors, such as attitudes towards vaccination, when shaping efforts to close the gap in pneumococcal vaccination rates between racial and ethnic groups. The National Foundation for Infectious Diseases has called for approaches that identify and overcome attitudinal barriers to adult pneumococcal vaccination in racially and ethnically diverse subpopulations.[3] Many vaccine promotion materials currently utilize standard messaging in a “one size fits all” approach that is not sufficient for overcoming negative attitudes.[8-10] Therefore, to reduce vaccination disparities across racial and ethnic groups, researchers and healthcare providers need to ensure that messaging and communication intended to influence attitudes toward vaccines resonate among both white and non-white populations.

Using both a nationally representative sample and a field experiment, our team tested several science-based communications on attitudes towards pneumococcal vaccinations, with an emphasis on understanding how non-white racial and ethnic populations respond to these messages.

OBJECTIVE

The objective of this study was to test science-based communications on attitudes toward pneumococcal vaccination to identify effective messaging in non-white racial and ethnic populations.

METHODS

Study Design

This research study was carried out in two stages. First, we conducted a randomized experiment embedded within a nationally representative opinion survey contrasting 5 different messages compared to no message in the control group. The findings from this nationally representative experiment were then used to develop a randomized field experiment undertaken in a community pharmacy. In the field study, there were 2 messages compared to an active control message based on responses from the opinion survey. Treatment messages were designed by utilizing language from the Centers for Disease Control (CDC), reviewing literature on traditional vaccine messaging, and conducting pre-testing of messages for clarity. This study was approved by the University of Rhode Island's Institutional Review Board.

National Survey Experiment

We contracted with YouGov (https://today.yougov.com, London, UK), a leading online survey firm, to conduct a nationally representative online survey from May 4th - 25th, 2017.[11] YouGov is a survey organization that draws on an online community of compensated users (aged 18+) who participate in surveys to voice their opinions. The data collected is utilized by organizations, institutions, campaigns, news media outlets, and companies. Participants are pre-screened to determine criteria they meet for specific surveys and polls. Our nationally representative online survey was conducted in English. The respondents were matched to an appropriate sampling frame on gender, age, race, education, party identification, political ideology, and political interest. The frame was constructed using the 2010 American Community

Survey, the 2010 Current Population Survey, and the 2007 Pew Religious Life Survey. YouGov distributed the survey to participants and 3,276 people completed the survey. They were then matched down to a sample of 3000 to produce the final dataset. Matching is a method designed to produce representative samples from respondent pools that are not selected randomly. The purpose of this methodology is to produce a respondent sample with the same characteristics and properties as a true random sample of the target population. YouGov matching procedures involve first identifying the target sample and then selecting respondents from the pool of opt-in participants that match members of the target sample. Drawing from an extensive number of variables drawn from voter and consumer databases, YouGov uses a proximity matching method which generates a distance function for each variable used to assess respondent similarity. Using this method, YouGov then identifies opt-in respondents who are most similar to each individual in the target sample. YouGov's online surveys and matching techniques compare favorably with older and more traditional survey methods.[12] The dataset includes a general population sample with a black and Hispanic oversample. The result is a near equal number of white and non-white respondents, which, unlike most studies, allows for the robust evaluation of the treatments effects within a non-white population.[a]

An experiment was embedded into the national survey, with survey respondents randomly assigned to one of five treatments or a control group (Table 1). Embedding randomized experiments in a nationally representative survey has distinct advantages. Because the experiments use a nationally representative sample for the subject pool, rather than a narrower pool of subjects (e.g., college sophomores), the results of the analysis display a high degree of external validity. All treatments began with the statement "Please read the following information carefully before answering the question" followed by the respective persuasive message below. The control group did not receive any message. After being randomly assigned to receive one

[a] The statistical power for tests using the national survey in this study is 99.6% which is well above the standard for statistical power (80%) (Cohen 1988).[14]

of the treatments or the control group (Table 1), respondents were asked the following, which represents the dependent variable:

"If allowed by your healthcare professional, how important is it for you to have the pneumococcal vaccine?" Responses included Very important; Somewhat important; Not very important; Not at all important; Don't know.

Field Experiment

To address the concern that revealed attitudes about the importance of the pneumococcal vaccine in an online national survey may not correspond to real world preferences, we also conducted a field experiment at a community pharmacy. The field experiment assessed whether science-based communication could influence openness to vaccination if the messages were introduced in a typically occurring pharmacy practice. We selected a community pharmacy in the northeastern United States that primarily services diverse ethnic and racial communities to test the efficacy of the messages within this context. Corporate approval to conduct the field experiment was obtained. Customers of the community pharmacy were recruited, in English or Spanish, to voluntarily participate in the anonymous survey from April 2018 to May 2018. Qualtrics software version 04.2018 (Qualtrics, Provo, UT) was used to deliver the randomized messages, either the active control or one of two treatments (Table 2), and record the responses. The participant could select to take the survey in English or Spanish, which established greater external validity for the findings from the national survey experiment, especially for non-English speaking communities. The field experiment included 86 participants. After being randomly assigned to receive one of the above-mentioned conditions, subjects then were asked the following, which represents the dependent variable:

If you were to talk to your doctor or pharmacist today, would you ask about getting the pneumococcal vaccine? Yes; No

Analysis. Both the national survey experiment and field experiment had more than two conditions, therefore we used one-way analysis of variance (ANOVA) to determine whether the groups had significantly different attitudes about the pneumococcal vaccine. Two-sided hypothesis tests were used for all *P* values, and the $\alpha<0.05$ threshold was used to define statistical significance. Percentage point difference relative to the control group was calculated across treatments for those participants responding "Somewhat important" or "Very important" in the national survey experiment and those responding "Yes" in the field experiment. Results from the national survey experiment were differentiated by race (non-white, white) in order to identify messages that were effective in non-white populations and could then be tested in the field experiment. All analyses were conducted using STATA version 15 (StataCorp, College Station, TX).[13]

RESULTS

The demographic characteristics of the subjects in each treatment and control group for the national survey experiment and field experiment are described in Table 3. The groups were homogenous for all demographic characteristics, as none of the differences across treatments are significant at the $\alpha<0.05$ level. To alleviate any concerns that education and gender differences were significantly influencing our results in the field experiment, we conducted additional analyses using ANOVA and OLS regression controlling for education and gender (both separately and together) and found no substantive differences to the results presented below.

National Survey Experiment Results

The national survey experiment results are presented in Table 4. Among non-whites, treatment messages 1 (prevention), 2 (costs), and 3 (safety) did not significantly influence favorable views of pneumococcal vaccination in comparison to the control group, which received no message.

For non-whites, messaging that simply states the vaccine helps prevent pneumonia (T1), messaging that considers various costs including mortality, health, lost work, and expense of the vaccine (T2) as well as messaging that centers on assurances of vaccine safety (T3) do not appear to influence attitudes beyond baseline attitudinal predispositions as measured in the control group. Among non-whites, message treatments 4 (community and family duty) and 5 (combination message) did significantly influence favorable views of pneumococcal vaccination in comparison to the control group. These messages focusing on duty towards community and family (T4) and a combined message that involves the key elements from all of the other messages (T5) had significant effects on favorable vaccination attitudes (see Table 5). Results demonstrated 86.6% of subjects receiving the T4 message about duty to family and community responded that the pneumococcal vaccine was somewhat or very important, which was 12.2 percentage points higher than the control group. The combined message group showed a similar difference as compared with the control group, with 84.3% responding that the vaccine was somewhat or very important (9.9 percentage points higher than control).

Among whites, message treatments 1 (prevention) and 2 (costs) did not significantly influence favorable views of pneumococcal vaccination in comparison to the control group that received no message. In Table 5, we see that messaging that simply states the vaccine helps prevent pneumonia (T1) and messages that consider various costs (T2) did not influence attitudes beyond baseline predispositions. Among whites, message treatments 3 (safety), 4 (community and family duty), and 5 (combination message) did significantly influence favorable views of pneumococcal vaccination in comparison to the control group. These messages focusing on assurances of safety (T3), duty towards community and family (T4), and a combined message (T5) had similar substantive effects on favorable pneumococcal vaccination attitudes (see Table 3). Relative to the control group, the safety message (T3) and the combined message (T5) had a greater percentage of respondents responding that the vaccine was somewhat or very important, 6.2 and 6.3 percentage points higher respectively. The duty message (T4), relative to

the control group, also displayed more favorable vaccination attitudes, with an 8.8 percentage point difference. It should be noted that safety messages did have a treatment effect in non-white populations (2.7%), but the increase was not statistically significant (p-value of 0.628).

Field Experiment Results. Table 6 displays the ANOVA for the field experiment undertaken at a northeastern U.S. pharmacy, which was selected because it serves a predominantly non-white population. The Treatment 1 message explains that pneumonia, bacteremia and meningitis are leading causes of death (fatality), that the pneumococcal vaccine helps prevents these diseases, and that the vaccine is safe and easy to get (safety). Relative to the control group message that simply states that the pneumococcal vaccine decreases the risk of pneumonia, bacteremia and meningitis, exposure to Treatment 1 did not significantly influence the intention of participants to ask their medical professional about the pneumococcal vaccine. The Treatment 2 message started with the same content as Treatment 1, but also added a duty to others component, which stated that getting the pneumococcal vaccine was a way to be responsible and protect the health and life of friends, family and the community. Unlike Treatment 1, exposure to the Treatment 2 duty message did significantly influence the intention of participants to ask their medical professional about the pneumococcal vaccine. Table 7 shows that 67.6% of the control group indicated an intention to ask their medical professional about the pneumococcal vaccine whereas 92.3% of Treatment 2 subjects declared an intention to ask their medical professional about the vaccine, a difference of 24.7 percentage points between the control and treatment 2.

DISCUSSION

From a national survey, we identified that effective messaging for pneumococcal vaccination in white and non-white populations included duty to family and community. The message was then adapted and tested in a predominantly non-white community pharmacy. Results from the

field test show that a combined message focused on fatality, safety, and duty to family and community was found to be highly effective, increasing intent to vaccinate by 25%. In Hispanic patients ≥65 years old, messaging about duty to family and community could help close the 22.2% vaccination gap compared to white patients identified in the National Health Interview Survey in 2017.[2]

In our national survey experiment, the safety focused message treatment shows the importance of conducting studies with a large non-white population rather than general populations. Treatment 3's safety-focused message demonstrated a statistically significant treatment effect of 6.2% in whites but a non-significant effect of only 2.7% in non-whites. These results convey that while safety messages positively influence vaccination attitudes for whites, they may not have as significant effects for non-whites. Though the vaccine safety debate is popular in the press and in some vaccine promotion campaigns, an exclusive focus on safety when communicating about the vaccine may actually exacerbate vaccination rate disparities unintentionally. The field experiment confirms the importance of including family and duty messaging when promoting vaccination in pharmacies that serve diverse populations. We were limited in what we could ask in the field experiment, so we used CDC messaging as a control, since that is typically encountered in a community pharmacy.

Recent research has shown that US clinicians view non-whites as less likely to follow health and medical recommendations, which may decrease the odds of clinicians communicating the types of messaging interventions considered in our study. But, our results show that non-whites targeted with messaging about the pneumococcal vaccine display large positive effects in vaccination attitudes, as demonstrated in the national survey experiment with messages that target duty to community and family (T4 and T5). At the practice level, particularly in areas that serve heterogeneous racial and ethnic populations, medical professionals should take the time to talk about vaccines with their patients. Specifically, targeting messaging of duty towards others can be especially efficacious in shaping attitudes in all people, but it may have the

greatest impact in non-white communities. A limitation of our study was that we only assessed intention to ask a healthcare professional about the vaccination and did not assess the actual action.

Ideally, multiple field experiments across the nation would capture a broader sample of non-white communities. According to 2010 census data, the pharmacy for the field experiment was conducted in an area with a higher level of racial diversity (60% non-white population) than the rest of the state (15% non-white population).

Though the final question on the instrument identified if participants would ask their doctor or pharmacist about getting the pneumococcal vaccine, it is unknown if they actually did speak to these health professionals, or ultimately receive the vaccination. Due to small numbers, the field experiment did not assess treatment effect by race.

CONCLUSION

In this study, it was found that in both white and non-white populations combined messaging emphasizing appeals to communal and family duty produced substantively significant differences in favorable attitudes toward pneumococcal vaccines in the nationally representative survey and behavioral intent to seek medical advice about the pneumococcal vaccine in a field experiment at a northeastern U.S. pharmacy. Medical professionals should use vaccine messaging that emphasizes duty to family and community when communicating with patients, as it reduces attitudinal and behavioral disparities. Our results indicate that some popular vaccine messaging interventions increase openness to receiving pneumococcal vaccination *only* among white populations while other messaging interventions have positive effects on both white and non-white populations.

Future research will need to confirm results in broader representations of non-white communities. In addition to marketing messages, there is an opportunity for development of

230 visuals that include appeals to family and community duty as part of public health marketing
231 strategy. Lastly, clinical outcomes demonstrating increased adult pneumococcal vaccination
232 coverage in non-white communities are needed to confirm the impact of this messaging.
233
234 **Acknowledgements:** Carmen Oquendo, PharmD, Claudia Valenzuela, PharmD, and Walgreens
235 Pharmacy

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Table 1. Messages used in the national survey experiment

Treatment Messages		
Treatment Group Number	**Focus Area**	**Message**
Treatment 1	Pneumonia Prevention	*The pneumococcal vaccine is highly effective at preventing pneumonia.*
Treatment 2	Costs	*In the United States, pneumonia is a leading cause of death, with over 50,000 people dying from pneumonia each year. Pneumonia also causes severe sickness leading to bed rest, hospitalization and missing work. Cigarette smokers, older adults, those with asthma or COPD are most susceptible to pneumonia. Fortunately, pneumonia can be prevented by the highly effective pneumococcal vaccine. Even if you are currently healthy, had pneumonia in the past, or had the flu shot you still need the pneumococcal vaccine to be protected. It is free, quick and easy to get the pneumococcal vaccine from most health providers.*
Treatment 3	Safety of Vaccine	*The pneumococcal vaccine is highly effective at preventing pneumonia and the pneumococcal vaccine has been thoroughly tested for safety by independent medical doctors and scientists. Years of evidence strongly show that sickness and side effects from the pneumococcal vaccine are incredibly rare. The pneumococcal vaccine is considered very safe.*
Treatment 4	Community & Family Duty	*It is everyone's duty to eliminate contagious disease from our communities. Those receiving the pneumococcal vaccine contribute to everyone's good health by helping to eradicate pneumonia. This simple act of getting the pneumococcal vaccine protects family, friends and our community because vaccinated individuals will be less likely to infect others with pneumonia. Being responsible and caring for those around you means getting vaccinated.*

Treatment 5	Combined Message	*In the United States, pneumonia is a leading cause of death, with over 50,000 people dying from pneumonia each year. Pneumonia also causes severe sickness leading to bed rest, hospitalization and missing work. Cigarette smokers, older adults, those with asthma or COPD are most susceptible to pneumonia. Fortunately, pneumonia can be prevented by the highly effective pneumococcal vaccine. Even if you are currently healthy, had pneumonia in the past, or had the flu shot you still need the pneumococcal vaccine to be protected. It is free, quick and easy to get the pneumococcal vaccine from most health providers. The pneumococcal vaccine has been thoroughly tested for safety by independent medical doctors and scientists. Years of evidence strongly show that sickness and side effects from the pneumococcal vaccine are incredibly rare. The pneumococcal vaccine is considered very safe.It is everyone's duty to eliminate contagious disease from our communities. Those receiving the pneumococcal vaccine contribute to everyone's good health by helping to eradicate pneumonia. This simple act of getting the pneumococcal vaccine protects family, friends and our community because vaccinated individuals will be less likely to infect others with pneumonia. Being responsible and caring for those around you means getting vaccinated.*

Table 2. Messages used in the field experiment.

Field Experiment Messages		
Group	**Focus**	**Message**
Control	Risk	*The pneumococcal vaccine is highly effective at decreasing the risk of pneumonia, bacteremia and meningitis.*
Treatment 1	Fatality & Vaccine Safety	*Pneumonia, bacteremia and meningitis are leading causes of serious disease and death. Fortunately, the pneumococcal vaccine decreases the risk of pneumonia, bacteremia and meningitis. The vaccine is safe, quick and easy to get.*
Treatment 2	Fatality, Safety, and Duty	*Pneumonia, bacteremia and meningitis are leading causes of serious disease and death. Fortunately, the pneumococcal vaccine decreases the risk of pneumonia, bacteremia and meningitis. The vaccine is safe, quick and easy to get.Getting the pneumococcal vaccine also protects your family, friends and community because you will be much less likely to infect others. Vaccination is one of the best ways to be responsible and care for the health and life of those closest to you.*

Table 3. Demographic comparisons across experimental groups

	Treatment Group: National Survey Experiment							Treatment Group: Field Experiment			
	Overall	Control	T1	T2	T3	T4	T5	Overall	Control	T1	T2
Age (mean)	46.1	46.9	45.5	46.9	45.1	46.2	46.3	45.4	43.1	46.8	46.8
Gender (% female)	55	56	57	54	54	57	53	69	74	58	73
Education (% college or more)	23	23	24	22	22	22	23	20	15	19	27
Income (% $50,000-99,999)	27	24	27	26	26	28	28				
Rural (%)	20	21	19	20	20	20	20				
N	3000	513	520	496	482	482	507	86	34	26	26

Note: None of the differences across treatments are significant at $p < .05$ based on a one-way analysis of variance.

Table 4. National survey experiment analysis of variance of the effect of messaging on pneumococcal vaccination importance, stratified by race

	Non-Whites Main effects			Whites Main effects		
Treatment Conditions	**N**	**F**	**p**	**N**	**F**	**p**
Control	211	N/A	N/A	186	N/A	N/A
Pneumonia Prevention	219	0.13	0.716	240	0.07	0.791
Costs	208	1.1	0.295	238	1.69	0.193
Safety of Vaccine	205	0.23	0.628	225	4.32	0.038
Community & Family Duty	209	7.31	0.007	203	4.34	0.037
Combined Message	229	11.32	0.001	235	4.07	0.044

Table 5. National survey experiment treatment effects of messaging on pneumococcal vaccination importance, stratified by race

	Non-Whites			Whites		
Treatment Conditions	**N**	**% Important**	**Treatment Effect**	**N**	**% Important**	**Treatment Effect**
Control	211	74.4%	N/A	186	72.0%	N/A
Pneumonia Prevention	219	71.2%	-3.2%	240	71.7%	-0.3%
Costs	208	80.3%	5.9%	238	77.3%	5.3%
Safety of Vaccine	205	77.1%	2.7%	225	78.2%	**6.2%**
Community & Family Duty	209	86.6%	**12.2%**	203	80.8%	**8.8%**
Combined Message	229	84.3%	**9.9%**	235	78.3%	**6.3%**

Note: **Bold** indicates a statistically significant effect in the analysis of variance (Table 4).
% Important includes all "Somewhat Important" and "Very Important" responses.

Table 6. Field Experiment Analysis of Variance of the Effect of Messaging on Pneumococcal Vaccination Intent

		Main effects	
Treatment Conditions	**N**	**F**	**p**
Control	34	N/A	N/A
Fatality & Vaccine Safety	26	1.58	0.212
Fatality, Vaccine Safety, & Duty	26	5.58	0.021

Table 7. Field experiment treatment effects of messaging on pneumococcal vaccination importance

Treatment Conditions	N	% Agree to Ask	Treatment Effect
Control	34	67.6%	N/A
Fatality and Vaccine Safety	26	80.8%	13.2%
Fatality, Vaccine Safety, and Duty	26	92.3%	**24.7%**
Note: **Bold** indicates a statistically significant effect in the analysis of variance (Table 6).			