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Major article

Impact of hospital policies on health care workers' influenza vaccination rates

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Key Words:
Hospital employees
Influenza vaccine
Mandated vaccination

Background: Overall annual influenza vaccination rate has slowly increased among health care workers but still remains below the national goal of 90%.
Methods: To compare hospitals that mandate annual health care worker (HCW) influenza vaccination with and without consequences for noncompliance, a 34-item survey was mailed to an infection control professional in 964 hospitals across the United States in 4 waves. Respondents were grouped by presence of a hospital policy that required annual influenza vaccination of HCWs with and without consequences for noncompliance. Combined with hospital characteristics from the American Hospital Association, data were analyzed using χ^2 or Fisher exact tests for categorical variables and *t* tests for continuous variables.
Results: One hundred fifty hospitals required influenza vaccination, 84 with consequences (wear a mask, termination, education, restriction from patient care duties, unpaid leave) and 66 without consequences for noncompliance. Hospitals whose mandates have consequences for noncompliance included a broader range of personnel, were less likely to allow personal belief exemptions, or to require formal declination. The change in vaccination rates in hospitals with mandates with consequences (19.5%) was nearly double that of the hospitals with mandates without consequences (11%; $P = .002$). Presence of a state law regulating HCW influenza vaccination was associated with an increase in rates for mandates with consequences nearly 3 times the increase for mandates without consequences.
Conclusion: Hospital mandates for HCW influenza vaccination with consequences for noncompliance are associated with larger increases in HCW influenza vaccination rates than mandates without such consequences.

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Over the decades since the Centers for Disease Control and Prevention (CDC) first included health care workers (HCWs) among those for whom annual influenza vaccination is recommended, interventions to improve vaccination rates based on voluntary uptake have met with limited success. In recent studies, HCW influenza vaccination rates have ranged from 40% to 87.4% in facilities using such strategies as free influenza vaccine offered at the work site, education, publicity, incentives, mass vaccination clinics, mobile carts, feedback, reporting vaccination rates to administrators, vaccination champion, and signed declinations.[1-6] Only since 2006 has the concept of mandatory influenza vaccination of HCWs been promoted among professional infection control, clinical, and patient safety organizations.[7-9] In addition, a number of states have adopted laws requiring HCW influenza vaccination. Concomitantly, overall US HCW influenza vaccination has increased from 44.4% in 2006-2007[10] to 63.5% in 2011[11] but remains below the national goal of 90%.[12] Hospitals that mandate HCW influenza vaccination report vaccination rates >90%.[5,13-15]

In an effort to better understand mandated HCW influenza vaccination policies, a national sample of acute care hospital infection control professionals was surveyed following the 2010-2011 influenza season. This study examined the prevalence of mandatory influenza vaccination policies, vaccination rates before and after implementation of the policies, and factors associated with the implementation of these institutional requirements.

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METHODS

Selection of survey recipients

The American Hospital Association provided a database of member hospitals. After excluding those hospitals previously surveyed by CDC on the same topic, a random sample of 1,000 hospitals was drawn. This list was sent to the Association for Professionals in Infection Control and Epidemiology (APIC) to match with their member database. Because multiple APIC members were matched to some hospitals, an algorithm was developed to reduce the number of multiple contacts, based on complete contact information and work e-mail and mailing addresses, and to select only 1 contact per hospital.

Survey

A questionnaire regarding hospital regulations and policies for HCW influenza immunization was designed based on a similar survey developed by the CDC.[16] Selected APIC members were sent a 34-question survey in June 2011. The cover letter provided informed consent language and was signed by the principal investigators and the president of APIC. The cover letter also offered the following incentives for participation: 1 of 10 chances to win $50 worth of APIC merchandise or membership or conference fees or 1 of 2 chances to win an Apple iPad. The study was approved by the University of Pittsburgh Institutional Review Board.

A secure link with an identification number for each person was included so that he or she could complete the questionnaire online. Surveys were to be returned by mail within 1 week in self-addressed stamped envelopes or answered online. When the responses from the first mailing trailed off, approximately 1 month later, the survey was remailed to nonresponders. When responses to the second mailing were negligible, a third and fourth wave of surveys was sent via e-mail. These surveys could be answered online or downloaded, answered on paper, and returned by mail.

Individuals whose questionnaires were returned without having reached them because of bad addresses, no longer being employed at the hospital, or otherwise, were removed from the denominator. Returned paper surveys were keyed into a database and verified by double data entry and comparison. Data from paper surveys and online responses were combined with hospital characteristics from the American Hospital Association Annual Survey database into a SAS release 9.3 (SAS Institute, Cary, NC) database for data management. SPSS release 19.0 (2010; SPSS, Inc, Chicago, IL) statistical software was used to analyze the data. Comparisons were performed using χ^2 or Fisher exact tests for categorical variables and t tests for continuous variables. Statistical significance for all analyses was set at an α equal to .05.

RESULTS

Removing those with bad contact information resulted in a final sample of 964 hospitals from which 433 infection control professionals returned surveys for a response rate of 45%. This analysis was limited to hospitals reporting mandatory influenza vaccination and providing pre- and postmandate vaccination rates (n = 150). Hospitals reporting mandates for HCW influenza vaccination did not differ from those without such policies by bed size, region, ownership, admissions, inpatient-days, Medicare discharges, full-time registered nurses, or full-time personnel (data not shown).

Among hospitals that required influenza vaccination, there were 84 hospitals with consequences for noncompliance and 66 hospitals without consequences for noncompliance. Consequences included a requirement to wear a mask (66.7%), termination (28.5%), additional education (14.3%), restriction from patient care duties (6.0%), and temporary suspension or unpaid leave (3.6%; multiple responses were possible). Table 1 shows some of the basic aspects of the vaccination requirement for hospitals with and without consequences. Hospitals whose mandates have consequences for noncompliance were more likely to include noncredentialed employees, students, and volunteers; were less likely to allow exemptions on the basis of personal beliefs; and were less likely to require a formal declination. The requirements for declination statements did not vary by type of mandate because most required that the declination statement include some education such as the rationale for offering the influenza vaccine, risks to patients and HCW for vaccine refusal, a signature, and the reason for declination.

Hospitals that mandated HCW influenza vaccination frequently utilized other common strategies for increasing vaccination rates such as providing multiple opportunities and locations for receiving the vaccine, tracking rates, incentives for vaccination, and education (data not shown). The only significant difference between hospitals with mandates with and without consequences was that 100% of those with consequences provided feedback on rates to administration compared with 92% of those without consequences ($P = .015$).

Respondents were asked to indicate which factors led to implementation of the vaccination mandate. The most frequently cited factors were previous vaccination rates, which were thought to be suboptimal and the H1N1 influenza pandemic (Table 2). Other common factors varied by whether the mandate included consequences or not. Those without consequences significantly more often cited state law or statutes, and Joint Commission recommendations, whereas those with consequences significantly more often cited experience of similar policies at other facilities.

Figure 1 shows vaccination, declination, and exemption rates in hospitals with the 2 types of vaccination mandates. Hospitals with mandates with consequences had significantly higher average vaccination rates both prior to the mandate and during the first season after implementation of the policy. The change in vaccination rates in hospitals with mandates with consequences was double that of the hospitals with mandates without consequences (21.9% vs 10.6%, respectively; $P < .001$). Among the 97 facilities for which the first year of the mandate was before 2010-2011, the change in HCW influenza vaccination rate between premandate and 2010-2011 was 25.5% for hospitals with mandates with consequences versus 15% for hospitals with mandates without consequences for noncompliance ($P = .004$). Significantly lower declination rates were associated with mandates with consequences (17.6% vs 30.1%, respectively; $P = .001$), compared with mandates without consequences. Adoption and enforcement of the policy in all or almost all units was higher among hospitals with mandates with consequences than those without (84.1% vs 62.1%, respectively; $P = .025$).

Hospitals were then grouped according to the reported impetus for establishing a vaccination mandate. Vaccination rates did not differ between hospitals with mandates with and without consequences except when the presence of a state law regulating HCW influenza vaccination for implementing the mandate was cited. In this case, mandates with consequences were associated with an increase in rates nearly 3 times the increase for mandates without consequences (Fig 1). Additionally, among hospitals reporting that all or nearly all units had adopted and enforced the policy (n = 110), those facilities whose mandates included consequences for noncompliance had significantly higher increases in vaccination rates from the premandate period to 2010-2011 (21.3% mandates with consequences vs 13.2% mandates without consequences; $P = .014$).

Table 1
Features of hospital health care worker influenza vaccination mandates

Variables	Percent of respondents in hospitals with HCW influenza vaccination mandates: Without consequences, n = 66	With consequences, n = 84	*P* value
In addition to employees, mandate applies to:			
Credentialed nonemployees	39.4	54.8	.061
Other nonemployees	25.8	41.7	.042
Students	33.3	70.2	<.001
Volunteers	53.0	84.5	<.001
Exemptions allowed in the mandate			
Medical	90.9	91.7	.870
Religion	75.8	72.6	.664
Personal belief	77.3	46.4	<.001
Mandate requires formal declination	98.5	90.5	.040
Declination requirements (total, n = 141)			
Rationale for offering vaccine	84.6	78.9	.387
Risk to patients for vaccine refusal	81.5	78.9	.701
Risk to self for vaccine refusal	78.5	81.6	.644
Required signature	95.4	92.1	.427
Reasons for declination	87.7	85.5	.707
Tracks influenza vaccination outside facility	69.2	63.2	.448

Table 2
Factors leading to implementation of the HCW influenza vaccination mandate

Factor	Percent of respondents in hospitals with HCW influenza vaccination mandates: Without consequences, n = 66	With consequences, n = 84	*P* value
Resource expenditure of a previous policy	3.0	2.4	.806
Other (eg, quality improvement, APIC/CDC recommendations)	3.0	10.7	.073
Corporate policy	6.1	15.5	.071
Experience of similar policies at other facilities	15.2	35.7	.005
Other nonstatutory, large-scale, or statewide initiative	21.2	28.6	.304
State law or statute	31.8	7.1	<.001
H1N1 pandemic influenza	34.8	41.7	.395
The Joint Commission (JCAHO) recommendations/standards	40.9	11.9	<.001
Suboptimal vaccination rates	45.5	47.6	.792
The extent to which the policy has been adopted and/or enforced			.025
All or almost all units	62.1	84.1	
About 75% of units	19.7	8.5	
About 50% of units	15.2	6.1	
≤25% of units	3.0	1.2	

DISCUSSION

Long stagnant HCW influenza vaccination rates have led to increasingly aggressive strategies to increase uptake to the Healthy People 2020 goal of 90%.[12] States have begun passing legislation regulating HCW influenza vaccination, and an increasing number of hospitals have begun implementing policies that require HCWs to receive the seasonal influenza vaccine.[16] These policies have resulted in significant progress with some facilities reporting vaccination rates >90%.[5,13-15] Policies mandating HCW influenza vaccination vary with regard to the individuals and group to which the mandate applies, the consequences for noncompliance, ability for HCWs to decline, acceptable reasons for declination, and other concurrent efforts to bolster influenza vaccination uptake. This study examined several of these factors among hospitals reporting mandatory influenza vaccination with and without consequences for noncompliance.

Significant increases in average HCW vaccination rates were observed in hospitals requiring influenza vaccination of its employees. However, the change in vaccination rate was significantly larger (almost twice) among hospitals whose mandates included consequences for noncompliance in spite of the fact that hospitals with consequences had higher vaccination rates prior to implementation of the mandate. These findings are similar to those of Miller et al, who reported the largest increase in vaccination among hospitals that terminated noncompliant HCWs (24%), an intermediate increase among those with less drastic consequences (18%), and the smallest improvement (10%) among those without consequences for noncompliance with the mandate.[17]

This difference in vaccination rates between facilities whose mandates include and do not include consequences for noncompliance may be in part explained by the fact that hospitals with mandates with consequences also more frequently included other nonemployees, students, and volunteers in their policy; less frequently allowed for exemptions based on personal beliefs; and more frequently provided feedback on rates to hospital administration. Including more groups in the mandate may increase vaccination rates by relegating noncompliers to a potentially small group, thus decreasing social support for nonvaccination. Several behavioral theories account for the effect of social support in changing health behavior.[18,19]

Declinations were significantly lower in hospitals with mandates with consequences than those with mandates without consequences for noncompliance in the first influenza season after implementation of the mandate. This difference was also observed in the 2010-2011 season in respondent hospitals whose first year of reporting was earlier (data not shown). Policies that stipulate consequences for noncompliance seem to convey a sense of the gravity with which the hospital administration views this aspect of patient safety. It follows, then, that declinations in facilities with such mandates would be less tolerated and hence less frequently observed as shown in the current study. Furthermore, this factor may explain the increased level of adoption/enforcement observed in hospitals with consequences for noncompliance.

Talbot et al reported significant improvements in HCW influenza vaccination rates in hospitals that reported those rates to the highest levels of their administration.[4] In Iowa, a statewide reporting system for HCW influenza vaccination, with public reporting of rates, resulted in an 87% mean vaccination rate among hospitals without a policy mandating influenza vaccination,[5] thus demonstrating the powerful effect of such feedback. In the current study, feedback to administration was the only vaccination improvement strategy that differed between the 2 groups of hospitals.

It is also possible that hospitals that implemented mandates with consequences had already tried a similar policy without mandates and were dissatisfied with the results. These data were not collected in this study. However, hospitals with mandates with consequences reported more frequently that the motivation for implementing the policy was their observation or knowledge of similar policies at other facilities. Conversely, hospitals with mandates without consequences were more often driven by the presence of a state law or statute or adherence to Joint Commission's recommendations or standards. This difference may indicate a willingness among no consequences hospitals to adhere to the "letter of the law" rather than to the "spirit of the law." It may also reflect the fact that mandatory HCW influenza vaccination is not

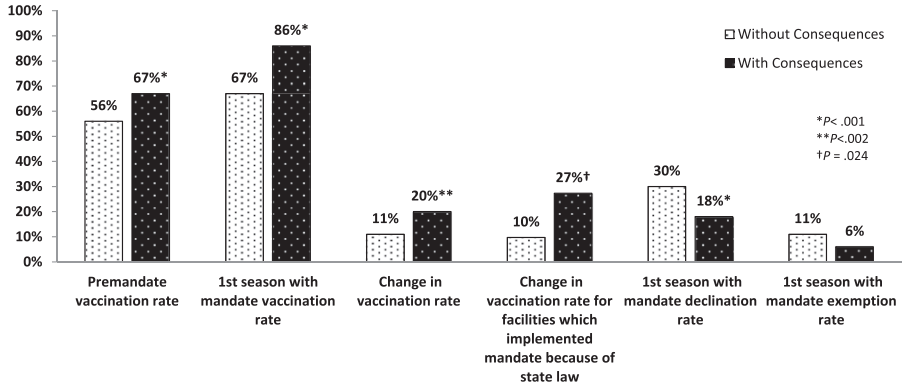

Fig 1. Vaccination, declination, and exemption rates for hospitals with mandates for health care worker influenza vaccination with and without consequences for noncompliance.

universally supported. Some labor unions representing both clinical and nonclinical personnel and others oppose such mandates, and implementation of the mandate has been modified in at least 1 health system because of collective bargaining agreements already in place.[13] Furthermore, objections are frequently based on lack of evidence for significant reductions in influenza disease among hospitalized patients.[20] Evidence supports influenza vaccination for HCWs in long-term care facilities because it has been associated with lower mortality among residents.[21,22]

Poland,[23] Stewart,[24] and Ottenberg et al[25] argue that mandated HCW influenza vaccination is ethically, morally, legally, and financially founded, whereas McLennan and Wicker[26] recommend opt-out declinations and HCW reassignments, and Pavia[27] suggests setting a 90% vaccination goal and using whatever strategies are necessary to achieve it. In fact, the National Vaccine Advisory Committee has recommended that hospitals consider mandatory HCW influenza only if they have implemented a "comprehensive influenza infection program" and fail to reach a goal of 90% of HCWs vaccinated.[20]

Strengths and limitations

We surveyed infection control professionals who may have been instrumental in developing the policy and thus have more knowledge of the vaccination policy and its implementation than the mixture of infection control professionals and administrators who were surveyed by Miller et al.[16] It is unknown whether this potential stake in the policy influenced their estimates of its success in raising HCW vaccination rates. Moreover, in selecting the recipient of the survey, we had no information to determine which of the multiple APIC members matched to the hospitals in the list was most knowledgeable about the hospital's influenza policy.

Our response rate was lower than a previous, similar survey.[16] The methods used for soliciting survey responses were different between the 2 studies, and previous research has shown that government surveys tend to elicit higher response rates.[28]

CONCLUSION

The CDC and several medical professional groups are strongly encouraging health care employers and HCWs to take proactive steps to improve HCW influenza immunization rates. Hospital mandates with consequences such as termination for noncompliance with influenza vaccination policies have been successfully implemented in hospitals and are associated with a larger increase in HCW influenza vaccination rates than vaccination mandates without personal consequences.

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APIC Position Paper: Influenza Vaccination Should Be a Condition of Employment for Healthcare Personnel, Unless Medically Contraindicated

Influenza is a serious disease that is associated with high rates of morbidity and mortality. In the United States, an estimated 5% to 15% of the population is affected by the virus each year.[1] Influenza infections result in approximately 150,000 hospital admissions and 24,000 deaths annually.[2] A recent study estimated that annual influenza epidemics account for 610,660 life-years lost, 3.1 million days of hospitalization and 31.4 million outpatient visits.[3]

The most efficient method of preventing annual influenza epidemics and their associated morbidity and mortality, is through pre-exposure vaccination.[4] In addition to their risk for exposure to influenza from community sources, healthcare personnel (HCP) are at an increased risk for acquiring influenza due to their exposure to ill patients. Conversely, those patients who are at greatest risk of developing severe complications of influenza are themselves more likely to be exposed to potentially infectious HCP. Therefore, one of the most important strategies to decrease influenza transmission to or from high risk persons is to immunize healthcare personnel.[5]

Despite long standing recommendations by the Association for Professionals in Infection Control and Epidemiology (APIC), the Centers for Disease Control and Prevention (CDC) and other national healthcare organizations, the response to voluntary programs has failed to increase immunization rates to acceptable levels required to substantially reduce healthcare-acquired influenza.[6,7] Annual influenza vaccination for HCP has been recommended by the CDC since 1981; however national survey data from 2010 demonstrated only marginal increases in HCP seasonal influenza vaccination coverage levels (61.9 %).[8]

As a profession dedicated to the prevention of infection, we have an ethical responsibility to protect those individuals entrusted to our care. We must do a better job of immunizing HCP every year to ensure patient safety and protect those individuals at high risk of developing complications of influenza.

Recommendation:

Therefore, APIC recommends that acute care hospitals, long term care, and other facilities that employ healthcare personnel* require annual influenza immunization as a condition of employment unless there are compelling medical contraindications. This requirement should be part of a comprehensive strategy which incorporates all of the recommendations for influenza vaccination of HCP of the Healthcare Infection Control Practices Advisory Committee (HICPAC) and the Advisory Committee on Immunization Practices (ACIP) for influenza vaccination of HCP.[9] An essential part of this comprehensive strategy includes strict attention to important infection prevention practices such as hand

hygiene and respiratory etiquette. Individuals exempted from annual vaccination due to medical contraindications must be educated on the importance of careful adherence to **all** of the non-vaccine related HICPAC prevention strategies, including hand hygiene and cough etiquette. Further, they may be required to wear a surgical mask when contact with patients or susceptible employees is likely. Additionally, strong leadership commitment that takes into account and collaboratively addresses concerns by employees and the organizations representing them is essential to providing the necessary support and resources to implement such a comprehensive program.

Rationale:

- Multifaceted mandatory vaccination programs have been tried and tested and have been found to be the single most effective strategy to increase HCP vaccination rates, with multiple facilities and systems achieving vaccination coverage of more than 95%[10]

- The vaccine is most effective in younger, healthier individuals. Patients at highest risk including the elderly and the immunocompromised are least likely to develop an adequate response to the vaccine.[11] Several studies now demonstrate that HCP influenza vaccination reduces patient mortality.[12] Therefore vaccination of those individuals who come in contact with our vulnerable population is the most effective strategy for prevention.

- The virus can be transmitted to patients by both symptomatic and asymptomatic HCP. Multiple studies show that 70% or more of HCP continue to work despite being ill with influenza, thus exposing patients to the virus.[13]

- Institutions that have implemented a mandatory policy have dramatically reduced employee absenteeism as well as healthcare associated influenza, thereby improving patient safety and reducing healthcare costs.[14]

- Influenza vaccine is safe. The most common side effects of the injectable (inactivated) influenza vaccine include soreness, redness, or swelling at the site of the injection. These reactions are temporary and occur in 15%–20% of recipients.[15]

- Immunization requirements are effective in increasing vaccination rates. HCP policies requiring demonstrable vaccination for measles, mumps and rubella have been successful in achieving near universal compliance. Requiring influenza vaccine should similarly be highly effective.[16]

Positions on mandatory vaccination have been endorsed by the Infectious Diseases Society of America (IDSA), the American Academy of Pediatrics (AAP), and the Society for Healthcare Epidemiology of America (SHEA).

Conclusion:

Seasonal influenza vaccination of HCP offers an important method for preventing transmission of influenza to high-risk patients. Evidence supports the fact that influenza vaccine is effective, cost efficient and successful in reducing morbidity and mortality. Evidence also demonstrates that the current policy of voluntary vaccination has not been effective in achieving acceptable vaccination rates. As healthcare providers, we have an obligation to ensure that all HCP are vaccinated against influenza. As a profession that relies on evidence to guide our decisions and actions, we can no longer afford to ignore the compelling evidence that supports requiring influenza vaccine for HCP. This is not only a patient safety imperative, but is a moral and ethical obligation to those who place their trust in our care.

"[T]he term HCP includes: all paid and unpaid persons working in health-care settings who have the potential for exposure to patients with influenza, infectious materials, including body substances, contaminated medical supplies and equipment, contaminated environmental surfaces or contaminated air. HCP might include (but are not limited to) physicians, nurses, nursing assistants, therapists, technicians, emergency medical service personnel, dental personnel, pharmacists, laboratory personnel, autopsy personnel, students and trainees, contractual staff not employed by the health-care facility, and persons (e.g., clerical, dietary, housekeeping, maintenance, and volunteers) not directly involved in patient care but potentially exposed to infectious agents that can be transmitted to and from HCP. The recommendations in this report apply to HCP in acute care hospitals, nursing homes, skilled nursing facilities, physician's offices, urgent care centers, and outpatient clinics, and to persons who provide home health care and emergency medical services." [Source MMWR August 28, 2009)

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Major article

Predicting influenza vaccination uptake among health care workers: What are the key motivators?

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Background: Health care worker (HCW) vaccination was critical to protecting HCW during the H1N1 pandemic. However, vaccine uptake rates fell below recommended targets. This study examined motivators and barriers influencing HCW pH1N1 vaccination to identify modifiable factors that can improve influenza vaccine uptake.

Methods: A cross-sectional survey was conducted at a large Canadian tertiary care hospital. HCW (N = 3,275) completed measures of demographics, vaccination history, influenza risk factors, and attitudes toward pH1N1 vaccination. Self-reported vaccination was verified with staff vaccination records. Of the total sample, 2,862 (87.4%) HCW received the pH1N1 vaccine. Multiple logistic regression analyses were used to predict HCW vaccination.

Results: HCW attitudes toward vaccination significantly predicted vaccination, even after adjusting for demographics, vaccine history, and influenza risk factors. This model correctly predicted 95% (confidence interval [CI]: 0.93-0.96) of HCW vaccination. Key modifiable factors driving HCW vaccination include (1) desire to protect family members and patients, (2) belief that vaccination is important even if one is healthy, (3) confidence in vaccine safety, and (4) supervisor and physician encouragement.

Conclusion: This research identified fundamental reasons why HCW get vaccinated and provides direction for future influenza vaccination programs. To enhance vaccine uptake, it is important to target HCW attitudes in influenza vaccine campaigns and create a culture of vaccine promotion in the workplace, including strong messaging from supervisors and physicians.

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Maintaining the health and availability of health care workers (HCW) is an essential component of pandemic preparedness.[1,2] A key to protecting HCW during the H1N1 influenza pandemic was vaccination.[1-3] Vaccination of HCW against pandemic H1N1 (pH1N1) was prioritized as essential for outbreak management and health care pandemic response.[3,4] However, despite the vaccine's proven effectiveness and the highly visible nature of the pH1N1 vaccine campaign, HCW vaccine uptake rates fell well below recommended targets.[5]

Some researchers have reported on factors influencing HCW pH1N1 vaccine uptake; however, the majority of this research focused on intent to be vaccinated (as opposed to actual vaccination status) and did not investigate the impact of HCW attitudes and beliefs on their vaccine uptake.[6] Thus, existing literature is limited in its capacity to enhance the current understanding of HCW influenza vaccination behavior. This study seeks to address this gap in the literature through the examination of a broad array of factors (including HCW attitudes and beliefs) that predict *actual* pH1N1 vaccine uptake among a large multiprofessional sample of Canadian HCW. Furthermore, by applying the Health Belief Model framework,[7] a well-established theory of health behavior change, we sought to identify *modifiable* factors that predict vaccine uptake in our sample. Such modifiable factors could be influenced in future vaccine campaigns.

The overall goal of this study was to identify the motivators and barriers to pH1N1 vaccine uptake among HCW to inform the future

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Table 1
Sociodemographic, influenza risk factors, and vaccine history predictors of health care worker pH1N1 vaccine uptake

Characteristics	Did not receive pH1N1 vaccine (n = 413)	Received pH1N1 vaccine (n = 2,862)	*P* value
Sociodemographics			
Mean age, yr	40.24 ± 11.67	43.32 ± 11.14	.023
Sex: Female	83.7%	81.0%	.196
Ethnic background: white	87.7%	89.6%	.02
Formal religious belief	64.9%	75.8%	<.001
In a relationship	70.8%	76.6%	.013
Dependent children <21 years of age	41.6%	49.8%	.002
Children living at home	43.6%	52.3%	.001
Type of work: full-time	61.4%	73.2%	<.001
Occupation classification, %			
Nursing	30.5	35.9	<.001
Physician	1.2	5.8	<.001
Allied HCW	7.3	11.6	<.001
Administrative/clerical	31.0	20.7	<.001
Health care technicians	5.3	7.7	<.001
Research and laboratory	9.4	8.3	<.001
Facilities and logistics	7.7	6.4	<.001
Other nonclinical	7.5	3.6	<.001
Influenza vaccine risk factors, %			
Regular contact with children	50.1	62.8	<.001
Regular contact with elderly patients	46.2	59.6	<.001
Living with someone with a chronic illness	9.2	14.1	.004
Family member has a chronic illness	18.17	27.6	<.001
Personally has a chronic illness	10.5	14.1	.029
Influenza history, %			
Past adverse effects to influenza vaccination	26.1	23.8	<.001
Egg allergy	3.2	0.6	<.001
Allergy to vaccine components	10.9	0.8	<.001
Previous influenza infection	41.5	41.0	.84
Perceived self-health, %			
Poor	0.7	0.2	.078
Fair	3.7	2.6	.078
Good	23.5	23.0	.078
Very good	43.3	41.8	.078
Excellent	28.9	32.4	.078
Vaccine uptake			
2008/2009 Seasonal influenza vaccination	24.1	81.7	<.001
2009/2010 Seasonal influenza vaccination	9.8	60.2	<.001

design and implementation of a more effective vaccination campaign, thereby increasing HCW vaccine uptake. Understanding the fundamental reasons why a core group of HCW failed to receive the pH1N1 vaccination despite an aggressive campaign, perceived vaccine shortage, and national media coverage may help us develop a successful vaccination campaign to enhance uptake among the most recalcitrant HCW.

METHODS

Study participants and design

This cross-sectional observational study was conducted at a large bilingual teaching hospital in Ontario, Canada. Following the conclusion of the hospital's pH1N1 vaccination campaign in June 2010, all hospital HCW (N = 10,464) were invited to complete a bilingual study questionnaire through a mass mailing. The study package included an informed consent form, a questionnaire package, and a stamped, self-addressed return envelope. Participants returned their completed questionnaires to Occupational Health and Safety (OCHS). OCHS de-identified the questionnaires, and only de-identified responses were analyzed by the research team.

OCHS housed a list of employees who received the pH1N1 vaccine and those who did not. These records were used to verify the self-reported vaccination status of HCW responding to the survey, thus allowing the prediction of *actual* vaccine uptake. All aspects of the study were approved by the Institution's Research Ethics Board.

Measures

HCW completed measures of (1) sociodemographics, (2) influenza infection risk factors, (3) influenza vaccine history, and (4) pH1N1 vaccine attitudes. The pH1N1 Vaccine Attitude Scale, a 34-item measure, was adapted from questionnaires developed to measure behavioral determinants associated with influenza vaccine uptake among HCW.[8,9,10] This scale surveys the 5 constructs of the Health Belief Model (HBM),[7] including perceived (1) susceptibility to influenza, (2) severity of influenza, (3) benefits of accepting vaccination, (4) barriers to accepting vaccination, and (5) cues to action (ie, internal and external stimuli that motivate vaccine uptake). The scale also assesses general attitudes of HCW toward pH1N1 vaccination. Participants indicated on a 5-point Likert scale the extent to which they agree or disagree with scale items. The HBM provides a valuable theoretical framework for understanding attitudes and beliefs driving various health behaviors, including seasonal influenza vaccination,[7-13] suggesting these constructs may also explain pH1N1 vaccine uptake.

Statistical analysis

All analyses were conducted using SPSS/PASW v.17 statistical package (SPSS Inc, Chicago, IL). Data were initially screened, and statistical assumptions were evaluated. Descriptive and frequency statistics were used to evaluate the responses to individual scale items of the questionnaires. The distribution of key sociodemographic variables and pH1N1 vaccine uptake of the study sample was compared with the overall HCW population (ie, staff at the institution) to assess external study validity. HCW reported level of agreement with the pH1N1 Vaccine Attitudes Scale items was dichotomized into agree and disagree statements.

The χ^2 analyses and independent samples *t* tests were used to examine differences between vaccinated and nonvaccinated HCW in terms of sociodemographics, vaccine history, and influenza risk factors. Univariate analysis was used to examine differences between vaccinated and nonvaccinated HCW in their responses to pH1N1 Vaccine Attitudes Scale items, and odds ratios (OR) (with 95% confidence intervals [95% CI]) were calculated to examine the items' association with vaccination and nonvaccination. Multivariate logistic regression analysis, using forward stepwise selection of variables, was used to model factors predictive of HCW pH1N1 vaccination. Inclusion of factors in the multivariate regression analysis was based on a systematic review of HCW pH1N1 vaccine uptake literature,[6] as well as univariate predictors of pH1N1 vaccination ($P < .1$).

In an attempt to quantify the ability of pH1N1 Vaccine Attitudes Scale items to predict pH1N1 influenza vaccination behavior, 2 independent regression models were generated. All factors found to be statistically significant predictors of HCW pH1N1 vaccination ($P < .05$) were included in the final models: (1) Base model: includes key sociodemographics, occupation, influenza infection risk factor, and vaccination history related variables but excludes pH1N1 Vaccine Attitudes Scale items; and (2) Base model plus pH1N1 Vaccine Attitudes Scale items: includes all variables in base model

Table 2
HCW pH1N1 Vaccine Attitudes Scale item predictors of health care worker pH1N1 vaccine uptake

Factor	Did not receive pH1N1 vaccine (n = 407), %*	Received pH1N1 vaccine (n = 2,849), %†	Odds ratio (95% CI)
Perceived susceptibility to influenza			
I am at high personal risk for getting pH1N1‡	12.4	40.6	4.81 (3.54-6.51)
It is very likely that I can infect patients with pH1N1 if I don't get the pH1N1 vaccine‡	13.7	47.2	5.63 (4.21-7.53)
I am likely to get pH1N1 if I do not get the pH1N1 vaccine‡	5.4	27.6	6.70 (4.33-10.38)
The pH1N1 vaccine IS required for a healthy person‡,§	27.6	78.5	9.60 (7.60-12.14)
HCW are at greater risk than general public of catching pH1N1‡	59.8	81.7	3.02 (2.42-3.75)
I am at risk of catching pH1N1 from hospital patients‡	38.1	69.2	3.64 (2.94-4.52)
Perceived severity of influenza			
pH1N1 is dangerous for me‡	24.9	55.7	3.78 (2.99-4.79)
pH1N1 is dangerous for the patients in the hospital at which I work‡	71.2	87.9	2.94 (2.31-3.74)
pH1N1 is a bad disease‡	77.8	90.1	2.61 (2.01-4.0)
If I were to get pH1N1, it would significantly interfere with my regular daily activities‡	68.9	88.0	3.29 (2.60-4.18)
Other health problems that I have may become worse if I get pH1N1‡	33.7	44.3	1.56 (1.26-1.94)
The thought of getting pH1N1 scares me‡	22.5	48.0	3.18 (2.50-4.06)
Perceived benefits of vaccination in preventing influenza			
If I get vaccinated against pH1N1, then I will be more certain that I will not infect patients‡	26.5	75.8	8.68 (6.86-11.00)
If I get vaccinated against pH1N1, then I will be more certain that I will not infect family members‡	29.7	80.9	10.04 (7.96-12.66)
Getting the pH1N1 vaccine will prevent me from getting pH1N1‡	17.1	56.0	6.16 (4.72-8.05)
Prevent spread of pH1N1‡	30.6	80.4	9.30 (7.39-11.71)
The pH1N1 vaccine can NOT cause pH1N1‡,§	52.0	79.5	3.58 (2.89-4.44)
I do not expect any side effects (eg, local tenderness or infection) from the pH1N1 vaccine‡	11.0	26.7	2.93 (2.13-4.04)
I do not expect an allergic reaction or autoimmune disease after getting the pH1N1 vaccine‡	28.5	64.1	4.47 (3.56-5.62)
I believe the pH1N1 vaccine is safe‡	14.7	69.6	13.23 (9.94-17.59)
Perceived barriers to accepting vaccination			
I have time to get the pH1N1 vaccine‡,§	60.9	91.0	6.48 (5.11-8.21)
pH1N1 vaccine is NOT painful‡,§	38.1	58.1	2.25 (1.82-2.79)
Getting the pH1N1 vaccine does NOT interfere with daily activities‡,§	54.8	82.2	3.80 (3.06-4.72)
I am NOT worried about the side effects of getting the pH1N1 vaccine*,§	20.8	56.5	4.94 (3.84-6.34)
The pH1N1 vaccine will NOT make me sick‡,§	28.7	73.7	6.95 (5.52-8.75)
Cues to action			
People close to me think that it is important for me to get vaccinated against pH1N1‡	17.9	61.6	7.33 (5.63-9.54)
My colleagues think it is important for me to get the pH1N1 vaccine‡	28.7	60.7	3.82 (3.04-4.80)
My doctor encouraged me to get the pH1N1 vaccine‡	14.7	48.0	5.34 (4.02-7.10)
My supervisors thought it was a good idea for me to get the pH1N1 vaccine‡	45.2	75.0	3.63 (2.93-4.49)
General attitudes			
All HCW should be vaccinated against pH1N1‡	14.7	76.0	18.40 (13.81-24.52)
It is important that HCW have freedom of choice in vaccination‡	92.4	69.0	0.18 (0.13-0.27)
I believe in immunizations‡,§	47.7	86.9	7.30 (5.84-9.12)

*Data missing for 6 participants from the total sample.
†Data missing for 13 participants from the total sample.
‡$P < .001$.
§Reverse code for ease of odds ratio interpretation.

plus the pH1N1 Vaccine Attitudes Scale items ($P < .05$). The discriminative power of both models to correctly classify HCW pH1N1 vaccination was assessed using area under the receiver operating curve (AUC).

RESULTS

Study sample characteristics

A total of 10,464 survey packages was distributed to hospital staff, and 3,301 packages were completed and returned, yielding a response rate of 31.5%. Of these, 3,275 surveys were included in the data analysis (26 surveys were excluded because HCW self-reported vaccination status could not be verified with staff vaccination records housed by OCHS). The distribution of this study sample's sex, pH1N1 immunization status, and occupation group was found to be comparable with that of the overall HCW population when verified with administrative staffing records.

In the overall sample (N = 3,275), 2,862 (87%) HCW received the pH1N1 vaccine, whereas 413 (13%) did not receive the pH1N1 vaccine. Of the total sample, the majority was female (81%), white (89%), in a relationship (76%), reported formal religious beliefs (76%), and working full-time (72%). Study sample characteristics are presented in Table 1.

Predictors of pH1N1 vaccine uptake among HCW

Sociodemographic, influenza risk factors, and vaccine history predictors

Compared with nonvaccinated HCW, vaccinated HCW were older, in a steady relationship, and living with their dependent children at the time of the pandemic ($P < .05$). HCW who received the pH1N1 vaccine were also more likely to have received previous seasonal influenza vaccines ($P < .001$). In addition, vaccinated HCW were working in full-time clinical positions ($P < .001$) and reported more frequent contact with children, elderly patients, and loved ones living with a chronic health condition compared with unvaccinated HCW ($P < .05$). A higher proportion of nonvaccinated HCW cited adverse effects to eggs or vaccine components when compared with vaccinated HCW ($P < .001$). Neither perceived self-health nor a self-reported previous influenza infection was found to be predictive of vaccination status.

Table 3
Multivariate regression analysis, modeling factors predictive of health care worker pH1N1 vaccination

	Base model*			Base model + Attitudes Scale items†		
Predictor variables	OR	95% CI	*P* value	OR	95% CI	*P* value
Sociodemographics						
In a relationship	1.50	(1.04-2.16)	.029	-	-	-
Formal religious belief	1.82	(1.28-2.58)	.001	1.52	(1.00-2.30)	.051
Type of work: full-time	1.85	(1.31-2.62)	<.001	2.16	(1.41-3.30)	<.001
Occupation classification						
Physician	1	Reference	.006	1	Reference	.028
Nursing	0.31	(0.07-1.31)	.110	0.46	(0.07-2.82)	.401
Allied HCW	0.43	(0.09-1.98)	.281	0.64	(0.10-4.24)	.644
Administrative/clerical	0.23	(0.05-1.01)	.052	0.33	(0.05-2.03)	.233
Health care technicians	0.47	(0.09-2.21)	.337	1.09	(0.16-7.51)	.928
Research and laboratory	0.43	(0.09-1.98)	.277	0.41	(0.06-2.74)	.359
Facilities and logistics	0.23	(0.05-1.09)	.064	0.62	(0.09-4.27)	.624
Other, nonclinical	0.12	(0.02-0.55)	.006	0.17	(0.02-1.21)	.076
Influenza risk populations						
Regular contact with children	1.43	(1.02-2.00)	.036	-	-	-
Family member has a chronic illness	1.56	(1.04-2.36)	.033	-	-	-
Influenza vaccine history						
Past side effects to influenza vaccination	0.58	(0.41-0.83)	.003	-	-	-
Allergy to vaccine components	0.14	(0.06-0.31)	<.001	0.04	(0.01-0.12)	<.001
2008/2009 Seasonal influenza vaccination	3.10	(2.19-4.40)	<.001	1.48	(0.95-2.31)	.084
2009/2010 Seasonal influenza vaccination	5.40	(3.48-8.38)	<.001	3.43	(2.06-5.71)	<.001
pH1N1 Vaccine Attitudes Scale items						
It is very likely that I can infect patients with pH1N1 if I don't get the pH1N1 vaccine	-	-	-	2.47	(1.49-4.10)	<.001
The pH1N1 vaccine IS required for a healthy person‡	-	-	-	1.73	(1.12-2.66)	.013
The thought of getting pH1N1 scares me				1.88	(1.20-2.93)	.006
If I get vaccinated against pH1N1, then I will be more certain that I will not infect family members	-	-	-	2.38	(1.56-3.65)	<.001
I believe the pH1N1 vaccine is safe	-	-	-	2.45	(1.50-4.01)	<.001
I have time to get the pH1N1vaccine‡	-	-	-	1.94	(1.25-3.00)	.003
The pH1N1 vaccine will NOT make me sick‡	-	-	-	1.54	(1.01-2.35)	.046
People close to me think that it is important for me to get vaccinated against pH1N1	-	-	-	1.83	(1.14-2.95)	.012
My doctor encouraged me to get the pH1N1 vaccine	-	-	-	2.10	(1.20-3.65)	.009
My supervisor thought it was a good idea for me to get the pH1N1 vaccine	-	-	-	1.86	(1.23-2.81)	.003
All HCW should be vaccinated against pH1N1	-	-	-	2.90	(1.73-4.86)	<.001
Area under the receiver operating curve	0.84	(0.81-0.87)	<.001	0.95	(0.93-0.96)	<.001

*Base model: includes key sociodemographic, influenza infection risk factor, and vaccination history related variables but excludes pH1N1 Vaccine Attitudes Scale items.
†Base model plus pH1N1 Vaccine Attitudes Scales items: includes all variables in base model (ie, sociodemographic, risk factor, vaccination history) and the pH1N1 Vaccine Attitudes Scale items (P <.05).
‡Reverse code for ease of odds ratio interpretation.

HCW pH1N1 Vaccine Attitudes Scale predictors: HBM constructs

The OR with 95% CIs, as well as the proportions of vaccinated and nonvaccinated HCW who agree with each of the scale items, are presented in Table 2.

Perceived susceptibility

Overall, perceived personal susceptibility to pH1N1 infection was significantly associated with pH1N1 vaccine uptake ($P < .05$). Compared with nonvaccinated HCW, those who received the vaccine were more likely to agree that a person requires the pH1N1 vaccine even if they are healthy. Vaccine acceptors were more likely to perceive they were (1) at high personal risk of pH1N1 influenza, (2) at risk of being infected by patients, and (3) at greater overall risk of pH1N1 infection than the general public. Additionally, vaccinated HCW were more likely to believe that their vaccine uptake would not only reduce personal susceptibility to pH1N1 infection but also reduce infection transmission to their patients.

Perceived severity

Compared with nonvaccinated HCW, HCW who received the pH1N1 vaccine were more likely to perceive that (1) pH1N1 is personally dangerous, (2) pH1N1 infection would interfere with their daily activities, (3) pH1N1 infection is scary, and (4) pH1N1 is dangerous to their patients. Nonvaccinated HCW tended *not* to perceive pH1N1 as personally dangerous or scary.

Perceived benefits of pH1N1 vaccination

HCW perception that the pH1N1 vaccine is safe was the most important perceived benefit that predicted vaccine uptake. Additional benefits motivating HCW to receive the pH1N1 vaccine include (1) protection of self, patients, and family members from being infected and (2) preventing the spread of pH1N1. Of note, the associations between vaccination and the desire to protect family members and patients were stronger than the association between vaccination and the desire to protect self. Nonvaccinated HCW were more concerned about vaccine adverse effects and vaccine allergies than vaccinated HCW.

Perceived barriers to pH1N1 vaccination

The most important barrier to vaccine uptake in this study was the perception that the vaccine could cause illness. In comparison with nonvaccinated HCW, vaccine accepters were more likely to agree that the vaccine would NOT make its recipients sick. In comparison with vaccine accepters, nonvaccinated HCW were

more likely to cite additional barriers to vaccine uptake, including (1) lack of time to be vaccinated, (2) concerns regarding vaccine adverse effects, and (3) vaccination interfering with daily activities. Interestingly, fear of needles and disliking injections were not statistically significant barriers to vaccination.

Cues to action

Vaccine uptake was higher among HCW who perceived pH1N1 vaccination is important to their friends, family, and colleagues. In addition, compared with nonvaccinated HCW, those who received the vaccine were more likely to report that their physicians and supervisors encouraged them to get vaccinated.

Attitudes toward vaccination

Belief that all HCW should be vaccinated against pH1N1 was the strongest predictor of pH1N1 vaccination. Conversely, nonvaccinated HCW were more likely to agree that HCW should have freedom of choice in vaccination compared with their vaccinated colleagues.

Modeling factors predictive of pH1N1 vaccine uptake

The OR with 95% CIs and statistical significance of factors included within the final multivariate logistic regression models are presented in Table 3.

Base model excluding pH1N1 Vaccine Attitudes Scale items

AUC, indicative of the model's discriminative power, was 0.84 (95% CI: 0.81-0.87). That is, the base model of factors correctly predicted 84% of HCW pH1N1 vaccination.

Base model plus pH1N1 Vaccine Attitudes Scale items

The purpose of this model was to examine whether the addition of the pH1N1 Vaccine Attitudes Scale items to the base model increased the model's ability to predict pH1N1 vaccination. As seen in Table 3, HCW attitudes and beliefs were predictive of vaccination, even with the base model predictors included. The AUC of this model was 0.95 (95% CI: 0.93-0.96). This combined model of factors correctly predicted 95% of HCW pH1N1 vaccination behavior, which is an increase over the base model.

DISCUSSION

This study identified key factors predictive of *actual* pH1N1 vaccination in a large sample of Canadian multiprofessional HCW to improve future vaccine campaigns and pandemic preparedness. This is one of the few studies that examined HCW attitudes towards pandemic vaccination using attitudinal constructs grounded in a validated theoretical framework.[6] We were especially interested in modifiable attitudes and motivators driving HCW to accept the vaccine because these factors can be influenced through vaccination strategies to improve vaccine coverage.

Our study identified highly predictive multivariate models of HCW pH1N1 vaccine uptake and demonstrated the important role that modifiable HCW attitudes and beliefs play in such uptake. Our multifactorial model correctly predicts 95% of HCW pH1N1 vaccination behavior. The addition of attitudinal factors increased the model's ability to discriminate between vaccinated and nonvaccinated HCW. In comparison with nonvaccinated HCW, vaccine accepters were more likely to be in a relationship, work full-time, have regular contact with at-risk populations, and have received influenza vaccines in the past. Key modifiable attitudes and beliefs driving vaccine uptake included the following: (1) desire to protect family members and patients from pH1N1, (2) the belief that vaccination is important even if one is in good health, (3) confidence in vaccine safety, and (4) supervisor and physician encouragement. HCW pH1N1 vaccine uptake was also motivated by fear and inhibited by misperceptions regarding vaccine safety and the belief of allergy to vaccine components.

Past research supports our findings because it shows that HCW are more likely to receive (or intend to receive) influenza and pH1N1 vaccinations if they (1) perceive that they are susceptible to the infection, (2) perceive the infection is severe, (3) perceive the benefits of vaccination outweigh barriers, and (4) are influenced by positive external cues to action.[6,8,9] Our findings extend this research by developing a model to quantify and determine the key attitudes predictive of HCW vaccination.

Similar to our findings, past research has also cited fear of vaccine safety and allergy as a vaccination deterrent.[5,14,15] However, the incidence of vaccine allergies is greatly inflated among nonvaccinated HCW compared with vaccinated HCW, and the prevalence of reported vaccine allergies among nonvaccinated HCW was greater than that of other HCW populations.[16] Thus, nonvaccinated HCW may be misinformed about their true risk of vaccine-related allergies, and helping them rule out their perceived allergy may help reduce their fears about such safety concerns.

Limitations

The following study limitations should be considered when interpreting the findings. There was a time lag between the time of the survey and the peak of the pandemic, which may have influenced HCW recall of their responses to the questionnaire items. Although HCW were assured confidentiality in their questionnaire responses, some HCW may have decided not to participate in the study or be forthcoming, fearing negative consequences if their identity was revealed. Furthermore, this was a single-center study. These factors may limit the external validity (ie, generalizability) of the study results. Furthermore, our results illustrate a predictive model of vaccine uptake and do not imply causation. Finally, there is an unequal distribution of HCW in each of the occupational subgroups (ie, higher proportion of administrative/clerical staff than physicians), which could limit the generalizability of the study results to all HCW groups. Future research should evaluate the efficacy of novel interventions designed to influence these key HCW modifiable attitudes toward vaccination to examine if they improve vaccine uptake.

CONCLUSION

Protecting HCW and patients from acquiring a transmissible infectious disease is a core value of the Canadian health care system as seen in the efforts placed on patient safety and in the quality measures that have been developed. Vaccination is the best way to prevent infectious diseases and has had the greatest impact worldwide in reducing disease and mortality. The persistent attitudinal barriers to influenza vaccination has been an ongoing quandary. One response is to impose a mandatory HCW vaccination requirement, which has been considered unpalatable to some employee groups. Therefore, the search for interventions to improve voluntary HCW participation in vaccination continues. Our results suggest that future influenza vaccine campaigns should target HCW attitudes and perceptions to improve vaccination uptake in both pandemic and nonpandemic scenarios. Furthermore, a culture of vaccine promotion in the workplace, characterized by strong consistent messaging from HCW supervisors and colleagues to enhance vaccine uptake, is important. Finally, physicians play an important role in driving HCW vaccine uptake; thus, strong physician support, encouragement, and

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leadership will likely be important in the success of future vaccine campaigns.

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