ORIGINAL ARTICLE

H1N1 Influenza Vaccine Compliance among Hospital- and Non-Hospital-Based Healthcare Personnel

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BACKGROUND. The 2009 pandemic H1N1 influenza vaccine had lower uptake compared to seasonal influenza vaccine, and most studies examining uptake of H1N1 vaccine focused on hospital-based healthcare personnel (HCP). Determinants of H1N1 vaccine uptake among HCP in all work settings need to be identified so that interventions can be developed for use in encouraging uptake of future pandemic or emerging infectious disease vaccines.

OBJECTIVE. To identify factors influencing nonhospital HCP H1N1 influenza vaccine compliance.

DESIGN AND SETTING. An H1N1 influenza vaccine compliance questionnaire was administered to HCP working in myriad healthcare settings in March–June 2011.

METHODS. Surveys were used to assess H1N1 influenza vaccine compliance and examine factors that predicted H1N1 influenza vaccine uptake.

RESULTS. In all, 3,188 HCP completed the survey. Hospital-based HCP had higher compliance than did non-hospital-based personnel ($\chi^2 = 142.2$, $P < .001$). In logistic regression stratified by hospital setting versus nonhospital setting, determinants of H1N1 vaccination among non-hospital-based HCP included extent to which H1N1 vaccination was mandated or encouraged, perceived importance of vaccination, access to no-cost vaccine provided on-site, no fear of vaccine side effects, and trust in public health officials when they say that the influenza vaccine is safe. Determinants of hospital-based HCP H1N1 vaccine compliance included having a mandatory vaccination policy, perceived importance of vaccination, no fear of vaccine side effects, free vaccine, perceived seriousness of H1N1 influenza, and trust in public health officials.

CONCLUSIONS. Non-hospital-based HCP versus hospital-based HCP reasons for H1N1 vaccine uptake differed. Targeted interventions are needed to increase compliance with pandemic-related vaccines.

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Emerging and reemerging infectious diseases pose a serious threat to US citizens' health. The propensity for influenza to undergo genetic reassortment has caused multiple pandemics, including the 2009 influenza A H1N1 pandemic (H1N1 pandemic), and led to higher than expected morbidity and mortality among vulnerable populations.[1] During emerging infectious disease outbreaks or pandemics, it is critical that prevention and control measures be implemented rapidly to decrease morbidity and mortality. One vital intervention during a pandemic is development of a vaccine against the emerging pathogen. The 2009 pandemic H1N1 influenza A vaccine (H1N1 influenza vaccine) was released in October 2009, and the World Health Organization (WHO)[2-4] and the Centers for Disease Control and Prevention (CDC)[5] identified healthcare personnel (HCP) as a primary priority group for vaccination. While HCP play a pivotal role by being at the forefront of patient care during pandemics, they can also be a major source of transmission to patients, family members, and other personnel.[6-10]

Both US and global studies have indicated that seasonal influenza vaccine uptake is low among HCP and was lower during the 2009 H1N1 pandemic.[11-13] Previous H1N1 vaccine uptake studies have focused primarily on hospital-based HCP,[14-17] yet 40% of registered nurses work in nonhospital care settings,[18] and many patients at high risk from influenza-related morbidity or mortality are provided care in nonhospital settings, such as long-term care. Seasonal influenza vaccination is recommended for HCP in all settings, and vaccinating HCP in nonhospital settings can decrease patient infection rates.[19] Researchers indicate that non-hospital-based personnel had higher H1N1 attack rates compared to hospital-based personnel during the early pandemic period be-

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fore vaccine was available,[20] providing additional evidence that immunization of non-hospital-based HCP could help lower morbidity and mortality. In order to develop targeted compliance interventions for a future emerging-pathogen vaccine, it is critical that non-hospital-based HCP attitudes and beliefs about H1N1 influenza vaccine be examined.

PURPOSE

The purposes of this study were to (*a*) determine immunization rates for H1N1 influenza vaccine among non-hospital-based personnel and (*b*) determine compliance predictors for H1N1 influenza vaccine.

METHODS

This study consisted of a survey provided to HCP in the St. Louis region in April–June 2011, with recruitment focusing on non-hospital-based personnel. The survey was administrated through Qualtrics, an online program; paper surveys were also provided to subjects or agencies that did not have Internet access. Subjects were recruited using 2 methods: (*a*) 2 recruitment postcards (sent 2 weeks apart) were mailed to licensed HCP using addresses obtained from the Missouri Division of Professional Registration and (*b*) 2 recruitment e-mails (sent 2 weeks apart) were distributed to members of healthcare profession organizations and/or nonhospital agencies. In all, 69 organizations and agencies assisted with subject recruitment (list available on request). The Saint Louis University Institutional Review Board approved this study.

Instrument

Surveys used in earlier studies examining seasonal influenza vaccine compliance were used as the basis for this questionnaire.[21-24] In addition, questions were added that were specific to H1N1 influenza and this study's purposes. A group of 10 US influenza vaccine researchers provided feedback on content validity. The content validity index (CVI) was computed for each item;[25] no item had a CVI below 0.80, so none was deleted.[25] The final survey contained 12 questions plus demographic items. Twenty St. Louis–area HCP pilot tested the instrument. The survey assessed (*a*) H1N1 vaccine uptake, (*b*) employer's H1N1 influenza vaccination policy, and (*c*) attitudes and beliefs about H1N1 and seasonal influenza vaccines. Instrument temporal stability was assessed using a 2-week test/retest procedure among 163 HCP. The questionnaire had good temporal stability, with correlation coefficients varying from 0.74 to 0.94.

Data Analysis

SPSS 19.0 was used for all analyses. Descriptive statistics were computed for each question and used to describe H1N1 vaccine compliance, employer's policy on H1N1 influenza vaccination, and HCP attitudes and beliefs about H1N1 influenza vaccine. The χ^2 test was used to compare vaccine compliance rates when comparing dichotomous groups (eg, hospital-based worker vs non-hospital-based worker). A Kruskal-Wallis (KW) 1-way ANOVA test was used to evaluate the relationship between H1N1 influenza vaccine compliance by nonhospital work setting, past vaccination behavior, and occupation; significant findings were followed by Mann-Whitney *U* post hoc tests.

Hierarchical logistic regression, stratified by hospital work setting versus nonhospital work setting, was used to determine a predictive model for H1N1 influenza vaccination uptake behavior.[26] Good model fit, indicated by a nonsignificant χ^2 value, was calculated with the Hosmer and Lemeshow[27] goodness-of-fit test. Nonsignificant variables, such as patient contact versus no patient contact, were not included in the final models; only final models are reported.

RESULTS

In all, 3,188 HCP responded to the survey, although denominators for individual questions may vary due to missing data. The response rate was 43.8% among nonhospital agencies/organizations. The majority of respondents were female (81.3%, $n = 2{,}538$) and Caucasian (86.4%, $n = 2{,}701$) and had a bachelor's degree or less education (66.6%, $n = 2{,}183$). Although participants represented all healthcare worker groups, respondents were commonly nurses or nurse practitioners (43.8%, $n = 1{,}370$), physicians or physician assistants (9.1%, $n = 285$), or nonlicensed personnel (ie, those without a nursing or medical license; 15.1%, $n = 472$). About half reported that they work at a hospital at least 25% of the time (46.2%, $n = 1{,}506$). For the purposes of this study, non-hospital-based personnel were defined as HCP who reported that they never work in a hospital (53.9%, $n = 1{,}719$).

2009 Pandemic H1N1 Influenza Vaccine Compliance and Determinants of Uptake

More than half of all respondents reported getting the H1N1 influenza vaccine (63.3%, $n = 2{,}017$). Hospital-based personnel were significantly more likely ($\chi^2 = 142.2$, $P < .001$) to report receiving the H1N1 vaccine (74.3%, $n = 1{,}090$) compared to non-hospital-based personnel (53.9%, $n = 926$). Among the non-hospital-based personnel, significant differences were found in H1N1 vaccine uptake (KW = 47.7, $P < .001$) when comparing by work setting, with public health professionals being much more likely than personnel in all other nonhospital settings except ambulatory surgery centers to receive the vaccine (Table 1). HCP employed by pharmacies and/or industry were much less likely than personnel in all other nonhospital settings except urgent care, laboratory, and home health to report receiving the H1N1 vaccine (Table 1). HCP who report having direct patient contact (defined as having face-to-face contact within 3 feet of patients during clinical duties) were significantly more likely ($\chi^2 = 13.7$, $P < .001$) to receive the H1N1 vaccine (64.3%, $n = 1{,}846$)

TABLE 1. 2009 Pandemic H1N1 Influenza Vaccine Compliance by Work Setting, Past Behavior, and Occupation

	N	Mean (SD)*	Kruskal-Wallis
Work setting (nonhospital only)			
Public health	60	0.80 (0.40)	47.7**
Ambulatory surgery center	49	0.69 (0.47)	
School/university	238	0.66 (0.48)	
Outpatient clinic or diagnostics	396	0.62 (0.49)	
Physician's office	608	0.58 (0.49)	
Long-term care or skilled nursing	250	0.56 (0.50)	
Urgent care	59	0.54 (0.50)	
Laboratory	41	0.51 (0.51)	
Home health	172	0.50 (0.50)	
Pharmacy or industry	220	0.44 (0.50)	
Other	134	0.55 (0.50)	
Past vaccination behavior			
Received Sept 2010 and Oct 2011 seasonal influenza vaccines	2,251	0.79 (0.41)	1,074.4**
Received Sept 2010 or Oct 2011 seasonal influenza vaccine	391	0.54 (0.50)	
Received no seasonal influenza vaccine in past 2 years	541	0.04 (0.19)	
Worker groups/occupation			
Physicians and physician assistants	287	0.84 (0.37)	223.6**
Nurses and nurse practitioners	1,376	0.68 (0.47)	
Administrators	396	0.62 (0.49)	
Nonlicensed personnel	475	0.48 (0.50)	
Chiropractors	69	0.03 (0.17)	
All other worker groups	584	0.63 (0.48)	

NOTE. 0, no; 1, yes; SD, standard deviation.

* Significant differences (as determined by the Mann-Whitney *U* test): work setting: differences between public health and all groups except ambulatory surgery, between ambulatory surgery and home health, between ambulatory surgery and pharmacy, and between pharmacy or industry and all groups except urgent care, lab, and home health; past vaccination behavior: differences between received both vaccines and all other groups and between received no vaccines and all other groups; worker groups/occupation: differences between physicians and physical assistants and all other groups, between nurses and nurse practitioners and all other groups, between administrators and all other groups except all other worker groups, between nonlicensed personnel and all other groups, and between chiropractors and all other groups.

** $P < .001$.

compared to those who reported having no patient contact (53.8%, $n = 171$). Physicians and physician assistants and nurses and nurse practitioners were more likely than other worker groups to receive the vaccine; chiropractors were least likely of any occupation to receive the vaccine (KW = 223.6, $P < .001$; Table 1). When comparing HCP by licensure status, licensed personnel were significantly more likely to receive the H1N1 influenza vaccine compared to nonlicensed personnel ($\chi^2 = 57.7$, $P < .001$). HCP who reported receiving seasonal influenza vaccine during the past 2 years (either both the 2009/2010 and 2010/2011 vaccines or only 1 of the vaccines) were significantly more likely to receive the 2009 H1N1 vaccine compared to those who had not received seasonal influenza vaccine (KW = 1,074.4, $P < .001$; Table 1).

For hierarchical logistical regression, subjects were stratified by hospital work setting versus nonhospital work setting due to the significant uptake rate difference between the 2 groups. After controlling for gender, age, and race, determinants of 2009 pandemic H1N1 influenza vaccination among non-hospital-based HCP were as follows (in order of decreasing importance): extent to which H1N1 vaccination was mandated or encouraged, perceived importance of vaccination, access to no-cost vaccine provided on-site, no fear of vaccine side effects, and trust in public health officials when they say that influenza vaccine is safe (see Table 2). After controlling for gender, age, and race, determinants of 2009 pandemic H1N1 influenza vaccination among hospital-based HCP were as follows (in order of decreasing importance): extent to which H1N1 vaccination was mandated or encouraged, perceived importance of vaccination, no fear of vaccine side effects, access to free vaccine, perceived seriousness of H1N1 influenza, and trust in public health officials when they say that the influenza vaccine is safe (see Table 2). The final models correctly classified 50.8% of the non-hos-

TABLE 2. Determinants of Healthcare Worker 2009 Pandemic H1N1 Influenza Vaccination from Logistic Regression

	Hospital-based personnel		Non-hospital-based personnel	
Variable	OR (95% CI)	*P*	OR (95% CI)	*P*
Male vs female	1.8 (1.1–2.8)	<.05	1.2 (0.86–1.7)	NS
Age ≤ 30 vs older HCP				
31–40	2.0 (1.2–3.3)	<.05	0.72 (0.47–1.1)	NS
41–50	1.8 (1.1–3.0)	<.05	1.2 (0.78–1.8)	NS
51–60	2.4 (1.5–3.9)	.001	1.5 (1.0–2.2)	.05
≥61	3.0 (1.5–6.1)	<.01	1.8 (1.1–2.8)	<.05
No enforcement or mention of vaccination vs intervention				
Mandatory vaccination policy	66 (33.3–130.8)	<.001	18.5 (9.1–37.4)	<.001
Vaccination highly encouraged	5.6 (3.6–9.8)	<.001	3.7 (2.7–5.1)	<.001
Informed about vaccine only	1.0 (0.54–1.8)	NS	0.81 (0.56–1.2)	NS
Perceived importance of vaccination	4.3 (2.4–7.5)	<.001	3.2 (2.1–4.8)	<.001
No fear of influenza vaccine side effects	3.5 (2.1–5.6)	<.001	2.5 (1.6–3.8)	<.001
Would take vaccine if free of charge	2.4 (1.4–4.4)	<.01	NIM	...
Perceived seriousness of H1N1 influenza	2.0 (1.2–3.4)	<.01	NIM	...
Trust public health regarding vaccine safety	1.6 (1.1–2.4)	.01	2.4 (1.8–3.2)	<.001
Would take vaccine if offered on-site and free of charge	NIM	...	3.0 (2.0–4.5)	<.001

NOTE. Determinants were controlled for gender, age, and race; race is not included in the table because it was nonsignificant in the final model. OR, odds ratio; CI, confidence interval; NS, nonsignificant; NIM, not included in model because it was NS.

pital-based respondents and 54.9% of the hospital-based personnel (see Table 2).

Mandatory Vaccination Policy

Less than one-quarter (20.4%, $n = 642$) reported that their employer had a mandatory vaccination policy related to the 2009 H1N1 influenza vaccine. Hospital-based HCP were significantly more likely ($\chi^2 = 297.5$, $P < .001$) to report that their employer mandated vaccination (76.3%, $n = 490$) compared to non-hospital-based HCP (23.7%, $n = 152$). HCP who reported that their employer had a mandatory vaccination policy were asked to describe the extent to which this policy was enforced. Despite indicating that the policy was "mandatory," most (65.6%, $n = 421$) reported that the mandatory vaccination policy was not enforced. Among HCP who reported an enforced mandatory vaccination policy ($n = 221$), the following types of enforcement were reported (participants could select multiple ways in which enforcement occurred): 22.4% ($n = 144$) fired staff for noncompliance, 17.3% ($n = 111$) required that nonvaccinated staff wear a mask during all patient care activities during influenza season, 2.7% ($n = 13$) held paychecks until compliance was proven, and 1.9% ($n = 12$) required nonvaccinated staff to attend an influenza counseling session. There was no difference between vaccine compliance rates when comparing those whose employer enforced the mandatory vaccination policy versus those whose policy was not enforced.

HCP who did not have mandatory vaccination policies ($n = 2,498$) were asked to report the extent to which they were informed of or encouraged to receive the H1N1 influenza vaccine. About half of these HCP (48.2%, $n = 1,537$) reported that the vaccine was encouraged, 19.2% ($n = 480$) were informed about the vaccine but not encouraged to receive it, and 19.3% ($n = 481$) were neither encouraged to get immunized nor informed about the vaccine.

Healthcare Worker Attitudes and Beliefs regarding H1N1 and Seasonal Influenza Vaccine

HCP attitudes and beliefs regarding H1N1 and seasonal influenza vaccines are reported in Table 3. HCP attitudes and beliefs toward influenza vaccines differed significantly when comparing H1N1 vaccine uptake among vaccinated non-hospital-based HCP versus nonvaccinated non-hospital-based HCP (see Table 3). Vaccinated HCP were significantly more likely than nonvaccinated personnel to agree that H1N1 influenza A was a serious disease ($\chi^2 = 191.4$, $P < .001$), that annual influenza vaccination is important to them ($\chi^2 = 795.0$, $P < .001$), that they would receive the seasonal influenza vaccine every year if it was offered free of charge ($\chi^2 = 699.1$, $P < .001$) and/or free and on-site ($\chi^2 = 692.2$, $P < .001$), and that public health officials can be trusted to produce a safe vaccine ($\chi^2 = 435.0$, $P < .001$; see Table 3). Non-hospital-based HCP who received the H1N1 vaccine were significantly less likely than nonvaccinated personnel to agree that their immune system has become built up from years of working in healthcare ($\chi^2 = 83.8$, $P < .001$) and that they are afraid of seasonal influenza vaccine side effects ($\chi^2 = 310.8$, $P < .001$; see Table 3).

TABLE 3. Attitudes and Beliefs of Vaccinated Personnel versus Nonvaccinated Personnel about H1N1 and Seasonal Influenza Vaccines

			Nonhospital personnel only (N = 1,719)				
	All respondents (N = 3,188)		Vaccinated (N = 926)		Unvaccinated (N = 793)		Vaccinated vs nonvaccinated
Statement	Strongly agree or agree, %	n	Strongly agree or agree, %	n	Strongly agree or agree, %	n	P[a]
2009/2010 H1N1 influenza A was a serious disease that could cause death	87.1	2,741	93.9	1,861	75.5	880	<.001
It is important to me to receive the influenza vaccine every year	71.0	2,233	78.5	1,753	25.0	228	<.001
I would receive the influenza vaccine every year if it was free	73.0	2,296	76.8	1,764	25.6	217	<.001
I would receive the influenza vaccine every year if it was free and on-site	74.1	2,330	76.4	1,779	24.6	200	<.001
I am afraid of seasonal influenza vaccine side effects	15.0	472	26.9	127	69.4	1,853	<.001
I trust public health authorities when they say influenza vaccine is safe	62.4	1,962	76.2	1,510	38.9	452	<.001
My immune system is built up; I am not likely to get influenza	10.7	336	6.8	135	17.3	201	<.001

NOTE. "Vaccinated" indicates that personnel received the 2009 pandemic H1N1 vaccine; "unvaccinated" indicates that personnel did not receive the 2009 pandemic H1N1 vaccine.

[a] Determined by the χ^2 test.

DISCUSSION

Similar to other research examining uptake of seasonal influenza vaccine,[28] this study found that hospital-based HCP were more likely to receive the H1N1 influenza vaccine compared to personnel in nonhospital settings. Findings from this study indicate that higher vaccine uptake among hospital-based personnel may be explained in large part due to the higher frequency of a mandatory H1N1 vaccination policy in hospital settings compared to nonhospital settings. Among nonhospital agencies, public health professionals had the highest compliance with H1N1 vaccine, and pharmacy or industry settings had the lowest compliance. The reasons for these differences are not entirely clear but may be due to increased awareness among public health professionals regarding the importance, efficacy, and safety of vaccination. Because influenza can spread in nonhospital settings, it is likely that H1N1-associated morbidity and mortality could have been lowered if there had been higher staff compliance with H1N1 vaccine. Public health interventions needed to increase vaccine compliance are essential and should be implemented for every influenza season as well as during pandemics. This study and others[29-31] have found that having a mandatory vaccination policy is a very strong factor in increasing healthcare worker vaccine compliance. An interesting finding from this study is that the existence of a mandatory vaccination policy was associated with significantly higher vaccine uptake rates, regardless of whether the policy was actually enforced. While this casts some doubt on whether these policies are truly "mandatory" if there are no associated consequences of noncompliance, it appears that the term "mandatory vaccination policy" may be sufficient to increase vaccine compliance. Healthcare administrators should consider implementing such a policy in their agencies.

Another important finding from this study is that nonlicensed HCP are less likely to receive the H1N1 vaccine compared to licensed personnel. In this study, less than half of all nonlicensed personnel received the H1N1 vaccine. Nonlicensed personnel make up a large portion of the healthcare workforce, and these individuals work closely with high-risk patients during patient care duties. Nonvaccinated personnel increase the risk of influenza spread among patients and personnel as well as their families and community contacts. Increasing vaccine compliance among nonlicensed personnel is an important public health intervention to decrease influenza-related morbidity and mortality.

This study also found that trust in public health was an important determinant of H1N1 vaccine uptake among both hospital-based HCP and non-hospital-based HCP. HCP who reported trusting public health officials when they say that influenza vaccine is safe were much more likely to be vaccinated than those who did not report this belief. Research indicates that many HCP believed that the 2009 H1N1 influenza vaccine was either not approved by the US Food and Drug Administration in the usual manner or that testing was accelerated, resulting in a less safe vaccine.[32,33] Researchers also report that HCP who examined evidence-based information about the H1N1 vaccine were significantly more likely to receive the vaccine compared to personnel who relied only on information from the media regarding the vaccine's safety and efficacy.[32] Increasing HCP trust in public health in the development of a safe vaccine will be critical during a future outbreak of an emerging infectious disease or pandemic. Integrating evidence-based information into education campaigns is one way to increase workforce trust in vaccine safety and efficacy to improve compliance.

Previous research has indicated that HCP who had received seasonal influenza vaccine in the past were more likely to receive seasonal influenza vaccine in subsequent seasons.[21] This study found that past uptake of seasonal influenza vaccine was a strong predictor for receiving the 2009 H1N1 vaccine during the pandemic. Because of this, it is imperative that public health agencies promote seasonal influenza vaccination among HCP groups identified as having low influenza vaccination rates, since this would increase the likelihood that HCP will receive future seasonal and pandemic influenza vaccines.

One final important finding from this study is that the determinants of H1N1 vaccine uptake and personnel attitudes and beliefs about H1N1 vaccine differed between hospital-based personnel versus non-hospital-based personnel and between those who received the H1N1 vaccine and those who did not. Vaccine education campaigns should be targeted to different work settings to ensure that personnel attitudes and beliefs are addressed. In addition, it is vital that misconceptions, such as HCP being less or not susceptible to influenza, be addressed in vaccine campaigns. Because perceived importance of vaccine was found to be a strong determinant of uptake behavior, it is vital that public health officials and healthcare administrators stress the professional responsibility that HCP have in protecting themselves and their patients from influenza by getting vaccinated. Vaccine education campaigns should also include information about vaccine safety to address personnel fears of vaccine side effects. Last, it is critical that hospital and nonhospital agencies provide no-cost vaccine on-site to increase healthcare worker compliance with influenza vaccine, as vaccine access and cost were identified as important barriers to vaccine uptake.

A few limitations of this study must be noted. Limitations include the potential issues of responder and/or social desirability biases. Responders are likely more interested in influenza vaccination compared to nonresponders, and this could bias the results toward higher than accurate vaccination uptake rates. Social desirability could also have biased the results if respondents believed that vaccine uptake was the preferred answer/response; however, given that the survey was anonymous, this bias should be minimized. Findings from this study may not be generalizable to laboratory personnel, given the low response rate among these professionals. One final limitation is that only St. Louis–based HCP were included in

this study; thus, the findings may not be generalizable to all HCP nationwide or even to all HCP in St. Louis. Studies reporting similar findings (ie, hospital-based personnel reported higher compliance rates compared to non-hospital-based personnel) provide evidence that these results can be considered generalizable outside of St. Louis and outside of Missouri.[34,35]

CONCLUSION

Healthcare worker vaccination is an essential intervention to decrease disease transmission during routine times as well as during a disaster. The 2009 pandemic H1N1 influenza vaccine was safe and efficacious, yet more HCP were reluctant to get vaccinated compared to those who receive the seasonal influenza vaccine. Vaccination during the pandemic was believed to be one of the best protective measures against illness, and vaccine uptake during a future outbreak of an emerging infectious disease or pandemic will be vital to controlling disease spread. Mandating vaccination and implementing targeted educational campaigns should maximize healthcare worker vaccine uptake. Findings from this study should be used to develop an education campaign for hospital and non-hospital healthcare settings that can be used during a future pandemic or outbreak of an emerging infectious disease.

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