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Evaluation of 2009 pandemic influenza A (H1N1) exposures and illness among physicians in training

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Abstract

Background—A cluster of influenza-like illness (ILI) among physicians in training during the 2009 influenza A (H1N1) pandemic (pH1N1) led to a health hazard evaluation.

Methods—We conducted a cross-sectional study to examine exposures, infection control practices, ILI prevalence, and transmission among physicians in training at 4 affiliated hospitals during the pandemic. We administered an electronic survey and met with physicians in training and hospital personnel.

Results—Of the 88 responding physicians, 85% reported exposure to pH1N1. Exposures occurred at work from patients or coworkers and outside of work from coworkers, household members, or the community. Thirteen cases of ILI were reported in May-June 2009; 10 respondents reported working while ill (duration, 1-4 days). Between 13% and 88% of respondents knew which personal protective equipment (PPE) was recommended when caring for influenza patients at the 4 hospitals. The most common reasons for not using PPE were not knowing that a patient had pH1N1 or ILI and not having PPE readily available.

Conclusions—Physicians in training have gaps in their knowledge of and adherence to recommended PPE and compliance with work restrictions. Our findings underscore the importance of installing isolation precaution signage, making PPE readily available near patients with influenza, and facilitating work restrictions for ill health care personnel.

Keywords

Health care-associated infection; Trainees; Residents; Fellows; Infection control; Personal protective equipment

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The 2009 pandemic influenza A (H1N1) virus (pH1N1) was first detected in humans in the United States in April 2009. In June 2009, the World Health Organization declared a pandemic of pH1N1. The Centers for Disease Control and Prevention (CDC) estimated that between April 2009 and April 2010, 43-89 million cases of pH1N1, 195,000-403,000 pH1N1-related hospitalizations, and 8,870-18,300 pH1N1-related deaths occurred in the United States.[1]

More than 13 million people are employed in health care settings in the United States, representing 9% of the total workforce.[2] Seasonal influenza has been shown to spread rapidly among patients and health care personnel (HCP) in health care settings.[3-5] HCP are among the occupational groups considered at highest risk for exposure to pandemic influenza virus,[6] and health care–associated pH1N1 infections were reported in HCP nationwide.[7] Strategies for prevention and control of seasonal influenza in health care facilities have included annual influenza vaccination of patients and HCP, standard and droplet precautions for infected patients, active surveillance for new illness cases, restriction of ill visitors and HCP, rapid administration of antiviral medications for treatment and prevention during outbreaks, and education and training of HCP in hand hygiene, respiratory hygiene, and cough etiquette.

Early in the 2009 pH1N1 pandemic, because of the uncertainty about pH1N1's virulence and potential transmission to HCP, the CDC issued an interim recommendation to use eye protection and a fit-tested N95 respirator[7] in addition to standard and contact precautions when caring for patients with confirmed or suspected pH1N1 infection. HCP use of personal protective equipment (PPE), antiviral prophylaxis after exposure, and adherence to work restrictions when ill are especially important in a comprehensive infection control strategy when vaccination is unavailable. If HCP are infected during an influenza pandemic, investigation of how and why transmission occurred could aid future prevention efforts.

A cluster of influenza-like illness (ILI) among physicians in training at a graduate medical education program occurred during June 2009, prompting a request to the CDC's National Institute for Occupational Safety and Health (NIOSH) to investigate. The state of Utah had widespread influenza activity at that time, with a total of 302 hospitalized cases of pH1N1 infection and 19 related deaths occurring in the spring and summer of 2009. A peak of pH1N1 activity occurred during the week ending June 26, 2009. Our investigation examined exposure, ILI prevalence, and transmission among physicians in training and assessed their knowledge, attitudes, and practices regarding influenza infection control during the early stages of the pH1N1 pandemic.

METHODS

Our evaluation had 2 components: a cross-sectional survey to examine pH1N1 exposure and infection control measures among internal medicine residents and fellows, and a site visit to 4 tertiary care medical centers affiliated with the residency training program to meet with physicians in training and learn about implementation of pH1N1 prevention and control strategies.

Data collection

NIOSH investigators and School of Medicine faculty developed a survey that was in part adapted from previous research applying the theory of planned behavior when examining PPE use for influenza control among critical care clinicians.[8,9] The survey included questions regarding personal characteristics, work history, history of exposure to pH1N1, and ILI symptoms. Knowledge, attitudes, and practices regarding influenza infection control measures, including previous seasonal influenza vaccination, hand hygiene, respirator training and fit testing, use of PPE, and adherence to recommended work restrictions, were examined. Knowledge and attitudes were examined by degree of agreement based on a 5-point Likert scale. Respondents were given a list from which to choose PPE included in precautions when caring for pH1N1-infected patients at each hospital and were asked to recall the frequency with which they used PPE when in close contact with patients. Internal medicine residents, cardiology fellows, and pulmonary and critical care fellows in the program at any time between May 1 and June 30, 2009, were invited to participate in the electronic survey administered during August and September 2009.

NIOSH investigators visited the School of Medicine and all 4 affiliated hospitals in September 2009 and convened in-person focus group sessions with residents and fellows to discuss their experiences and concerns regarding pH1N1. Meetings were held with representatives from graduate medical education, hospital and nursing administration, infection control and hospital epidemiology, employee health, safety and environmental health, and emergency management from all 4 hospitals. Medical records of hospitalized patients with confirmed or probable pH1N1 and of ill physicians in training were reviewed during the site visit. Exposure of physicians in training to infected patients was determined retrospectively by authorship of admission, progress, and discharge notes and signature of physician orders. Resident rotation schedule information and program social events were extracted from residency program records. Documentation of employee health program–administered antiviral prophylaxis to exposed physicians in training was reviewed. As a public health response, in accordance with the guidelines of US Title 45 Code of Federal Regulations Part 46, this evaluation was deemed to not require review by an Institutional Review Board.

Data analysis

Although the potential for aerosol generation during specific procedures is unknown, we conservatively defined intubation, suctioning, administration of nebulizing medications, bronchoscopy, acquisition of a nasopharyngeal sample, and ventilation with bilevel positive airway pressure or continuous positive airway pressure to be aerosol-generating procedures. We categorized respondents who rotated at a hospital during the study period or who reported close contact (<6 feet) with a patient with confirmed or probable pH1N1 or ILI as either knowing or not knowing the minimum recommended PPE when caring for such a patient at that hospital. Respondents who indicated a higher level of respiratory protection than the minimum recommendation specified in Table 1 were also classified as knowing the respiratory recommendations. We deemed that a respondent's selection of a full-facepiece powered air-purifying respirator (PAPR) did not necessarily demonstrate knowledge of an eye protection recommendation.

We analyzed survey responses to 4-point frequency scale questions on use of PPE components for those respondents reporting close contact with a patient with pH1N1 or ILI. Based on these responses and minimum hospital PPE recommendations, we categorized the respondents into high and low PPE adherence groups. Respondents indicating “never” or “some of the time” for use of any of the required PPE components composed the low adherence group, and those indicating “most of the time” or “always” for use of all required PPE components composed the high adherence group.

Respondents who reported using a higher level of protection than recommended (eg, use of an N95 respirator or PAPR when only a surgical mask was required or gowning when not required) were classified as high PPE adherence as long as the other required PPE components were used as well. Respondents who reported wearing a PAPR were categorized as wearing eye protection, because full-facepiece PAPRs were provided. Factors associated with high and low PPE adherence were determined.

Likert scale responses were categorized as “expressed agreement” if the respondent answered “agree” or “tend to agree,” and as “expressed disagreement” if the respondent answered “disagree” or “tend to disagree.” Bivariate analyses were conducted with the Student *t* test, Pearson's χ^2 test, and Fisher's exact test using SAS version 9.2 (SAS Institute, Cary, NC). Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated. Statistical significance was set at $P < .05$.

RESULTS

PPE recommendations by hospital

Initially, all 4 hospitals followed the CDC's interim guidance for PPE use by HCP when caring for patients with pH1N1.[7] However, beginning in June 2009, 3 hospitals deviated from this guidance because of an insufficient supply of N95 respirators, limited HCP respirator fit testing in a region with a low prevalence of *Mycobacterium tuberculosis*, and differing guidance at the state level. At these 3 hospitals, a surgical mask was considered appropriate protection. Table 1 presents minimum PPE recommendations when caring for patients with confirmed or suspected pH1N1 or ILI by hospital, as of September 2009. All hospitals required gloves, gown, either a fit-tested N95 respirator or PAPR, and eye protection for aerosol-generating procedures.

Physician in training characteristics and exposures

Of 210 current and recently graduated residents and fellows, 88 (42%) completed the electronic survey. The median age of the respondents was 30 years (range, 25-53 years), and 57 (65%) were male. The 88 respondents included 75 internal medicine residents, 7 cardiology fellows, and 6 pulmonary and critical care fellows.

Respondents reported the following exposures: 56 (65%) had close contact with a patient with pH1N1 or ILI (defined as temperature ≥100°F and cough and/or sore throat) while working, 45 (52%) had close contact with a coworker with pH1N1 or ILI (henceforth referred to as ill) at work, 28 (32%) had close contact with an ill coworker outside of work, and 12 (14%) had close with an ill person in their household or in the community. Thirteen

respondents (15%) reported no close contact with any of the foregoing possible sources of exposure.

Between May 1 and June 30, 2009, 13 of the 88 respondents (15%) reported symptoms of ILI (defined as fever and sore throat and/or cough). Seven of these 13 sought medical care, 5 of whom had laboratory confirmation of influenza A by viral culture or direct immunofluorescence assay; none were hospitalized. The first onset of ILI in a responding physician was on May 10, and the second onset was on May 30. The next onset of ILI was not until June 13. A cluster of 8 ILI cases occurred within a 96-hour period after an internal medicine residency program dinner held on June 19; 6 of these individuals reported attending the dinner. Prophylactic antiviral agents were prescribed to 68 residents on June 23-24, 2009, and no further cases of ILI were reported. Figure 1 shows an epidemic curve illustrating the number of cases of ILI and influenza A infection among respondents in June 2009.

Among the 13 survey respondents with ILI, the following close contacts in the 7 days before symptom onset were reported: only an ill patient (n = 2), only an ill coworker while at work (n = 2), only an ill coworker outside of work (n = 1), only an ill household or community case (n = 1), and multiple ill sources (n = 5). Two respondents with ILI reported no known contact with a potential source.

Ten of the 13 respondents (77%) who reported ILI worked while ill, with duration ranging from 1 day to 4 days. The following reasons for working while ill (respondents could cite more than one reason) were reported: having a professional obligation to coworkers (n = 4) or to patients (n = 4), not thinking that they were putting their patients (n = 3) or fellow coworkers at risk (n = 2), not thinking that they were contagious (n = 2), and not wanting to admit they were sick (n = 2).

Knowledge and attitudes regarding influenza infection control measures

Twenty-five of 59 respondents (42%) at hospital A, 7 of 55 (13%) at hospital B, 28 of 32 (88%) at hospital C, and 3 of 5 (60%) at hospital D were categorized as knowing the minimum PPE recommendations when caring for patients with influenza at the time. Eye protection was the component most often misunderstood by respondents; for example, 41 of 55 respondents (75%) at hospital B believed that eye protection was not recommended or did not know whether it was recommended. Table 2 summarizes the survey results regarding infection control knowledge and attitudes. Most respondents expressed agreement that proper hand hygiene and use of PPE protected both themselves and patients against acquiring influenza.

Influenza infection prevention practices

Seventy-nine respondents (90%) reported receiving the 2008-2009 seasonal influenza vaccination. Sixty-eight respondents (77%) reported always washing their hands before patient encounters, and 71 (81%) reported do so after patient encounters. Thirty-eight respondents (43%) reported receiving training on the use of N95 respirators, 29 (33%) reported receiving training on the use of PAPRs since the start of their program, and 19

(22%) reported undergoing respirator fit testing between the start of their program and June 2009.

Fifty-three of the 88 respondents (60%) reported close contact with a patient with pH1N1 or ILI and provided sufficient information on PPE adherence. Of these 53 respondents, we classified 19 (36%) as having high adherence to the PPE recommendations and 34 (64%) as having low adherence. Reported adherence to recommendations for the use of individual PPE components (Table 1) was 82% (46 of 56) for gloves, 58% (11 of 19) for gowns, 36% (16 of 45) for eye protection, 83% (15 of 18) for N95 respirator or PAPR, and 88% (42 of 48) for surgical mask or higher levels of protection. Fifty-two respondents reported using all recommended PPE when in close contact with a patient with pH1N1 or ILI; 40 (77%) reported not always wearing recommended PPE. The most common reasons given for not using recommended PPE are listed in Table 3.

We found no statistically significant differences in demographic characteristics or rotation hospital between respondents in the high adherence group and those in the low adherence group. Expressing either agreement or disagreement with other infection control knowledge and attitudes statements (listed in Table 2) was not significantly associated with either high or low PPE adherence. In addition, knowledge of the correct, recommended PPE at 3 of the 4 hospitals was not significantly associated with classification into either high or low PPE adherence. At hospital A, knowledge of the correct recommended PPE was associated with high PPE adherence (OR, 3.80; 95% CI, 0.98-14.67; $P = .047$).

Those recorded as being on an intensive care unit (ICU) rotation during the study period (OR, 3.43; 95% CI, 1.02-11.56) and those present at an aerosol-generating procedure on a patient with pH1N1 (OR, 5.20; 95% CI, 1.54-17.55) were more likely to be in the high adherence group. Those recorded as being on an inpatient ward rotation were less likely to be classified as high adherence (OR, 0.22; 95% CI, 0.06-0.80).

Discussion

HCP are at increased risk of acquiring and transmitting influenza to their patients and fellow HCP.[3-6] The fact that HCP represent an estimated 9% of the entire US workforce[2] further magnifies the importance of preventing influenza in HCP to protect both themselves and their patients. Information on comprehensive prevention strategies for HCP during pandemics, when effective vaccination or treatment might not be available, is important. We had the opportunity to evaluate the attitudes and actual infection prevention practices of physicians in training in an internal medicine residency training program at the height of the 2009 pH1N1 pandemic.

The majority of responding physicians reported having close contact with patients with pH1N1 or ILI while working. Significant exposures to ill coworkers and individuals from the community were reported as well, and many of the ILI cases reported appeared to be temporally associated with exposure to ill coworkers. Influenza prevention strategies at the 4 affiliated hospitals emphasized PPE use when caring for patients with influenza, respiratory hygiene and cough etiquette, prophylactic antiviral therapy for those with known workplace

exposure, and work restrictions for ill HCP. However, there were differences in the minimum recommended PPE for non-aerosolizing procedures, the training provided, and in how suspect patients were identified and confirmed across hospitals. We found high rates of adherence to certain influenza infection prevention practices, including hand hygiene and seasonal influenza vaccination, by residents and fellows.

Most of the responding physicians expressed agreement that PPE use protected themselves (90%) and patients (80%) from acquiring influenza. Our findings regarding attitudes toward PPE use are comparable to those reported by Daugherty et al,[9] who found that 79% of residents expressed agreement that PPE use kept them and patients from acquiring influenza during a previous influenza season. Nonetheless, we found gaps in the knowledge of and adherence to PPE recommendations among our responding physicians. We classified 36% of our responding physicians as having high adherence to PPE recommendations; this percentage is lower than that reported by Daugherty et al,[9] who found that 62% of critical care HCP reported high PPE adherence. Their classification of adherence differed from ours; their respondents were asked to report a percentage of time adhering to PPE use, and those with a value >80% were classified as having high adherence. In addition, their survey pertained to an influenza season in which a lower level of respiratory protection was recommended. In our study, the PPE component with the lowest reported rate of use was the eye protection recommended by 3 affiliated hospitals, which might help explain our lower rate of adherence. Moreover, the study population of Daugherty et al included only critical care HCP at 2 hospitals, who may have had higher-than-average PPE adherence rates, as suggested by the increased odds of adhering to PPE use in physicians recorded as being on an ICU rotation in our study.

In our survey, there was a wide range (13%-88%) of physicians who knew the minimum PPE recommendations when caring for patients with pH1N1 or ILI across hospitals. In another published survey of residents during the pH1N1 pandemic, May et al[10] found that 59% of residents would wear gloves, 44% would wear a surgical mask, and 35% would wear an N95 respirator before entering the room of a patient with ILI. Although our respondents reported higher rates of adherence to the use of gloves (82%) and surgical mask or higher level of protection (83%-88% depending on the hospital), fewer responding physicians used other forms of required PPE that were not evaluated in the survey of May et al, including eye protection (36%) and gowns (58%).[10]

Lack of awareness of patients' pH1N1 or ILI status and unavailability of PPE near patient rooms were the most common reasons cited for not using recommended PPE. These findings demonstrate the importance of early identification of patients requiring isolation precautions and the administrative responsibilities of installing isolation precaution signage and ensuring the appropriate stock of supplies on each floor. Differences in diagnostic testing for confirming influenza across the affiliated hospitals, as well as in the ability to stock supplies because of national shortages at that time, likely limited the use of PPE by physicians when rotating across hospitals. Overall, we found that efforts to educate residents and fellows about recommended PPE and its proper use should be strengthened, and that affiliated hospitals may need to consolidate practices when possible or else clarify the specific differences to HCP who rotate across facilities.

Surprisingly, knowledge of minimum PPE recommendations and attitudes toward PPE were not significantly associated with adherence to PPE use at 3 of the 4 study hospitals. In contrast, presence at an aerosol-generating procedure on a patient with pH1N1 and rotation in an ICU during the study period were significantly associated with higher adherence to PPE recommendations. It is possible that HCP perceive increased risk in certain settings, which can lead to different thresholds of PPE use. Our findings suggest the need for further efforts to emphasize PPE use when caring for both non–critically ill and critically ill patients with influenza.

HCP are at risk of influenza transmission not only from their patients, but also from ill colleagues and from the community. We found gaps in adherence to recommendations to avoid working while ill. We also found that ill HCP exposed their colleagues in nonwork settings as well. The majority of ill physicians in training in our evaluation continued to work despite the recommendation against it, citing professional obligations to coworkers and patients as the most common reasons. These results are similar to those of a study of another graduate medical education program, in which 58% of responding physicians in training reported working while ill.[11] A cluster of ILI among physicians in training closely followed a residency program social gathering attended by some ill trainees, which might have been partly controlled by widespread antiviral prophylaxis as well as increased awareness of nonpatient routes of transmission. Education should emphasize the importance of all modes of influenza transmission and isolation of all individuals with ILI. Hospital administration and program directors should remove barriers and facilitate ill HCP staying home and avoiding contact with other HCP in nonwork settings.

Our study has some limitations. Our response rate was only 42% despite multiple e-mail reminders to the physicians in training, but it is comparable to rates in other physician surveys, which generally are lower than survey response rates in the general population.[12,13] Nevertheless, our results might not be representative of all physicians in these programs, although residents in all years of training in the internal medicine residency and fellows from selected programs were represented in our sample. Although the period of interest was May-June 2009, NIOSH did not learn about the ILI cluster until August 2009. Thus, respondents' recall ability might have had some affect on our results. Our classification of adherence to hand hygiene and the minimum PPE recommendations was based on self-reported behaviors by survey respondents, and might be an overestimation based on previous studies comparing self-reported adherence to external observed adherence.[14,15] However, observed rates of hand hygiene adherence by local infection prevention staff were in the range of the responding physicians self-reports. Finally, our evaluation was exploratory, many analyses were performed, and some findings may be due to chance.

Nevertheless, we conclude that HCP have significant gaps in knowledge of and adherence to some important infection prevention practices. Addressing these gaps will require a multi-disciplinary approach to address and better prepare for future pandemics. Our findings underscore the importance of (1) educating and training residents and fellows on the importance of staying home when ill and on recommended PPE and proper use, (2) readily identifying patients requiring isolation precautions, (3) making PPE more readily available near patient rooms, (4) emphasizing PPE use when caring for both critically ill and non–

critically ill patients with influenza, and (5) increasing awareness of all modes of influenza transmission, including transmission from ill HCP.

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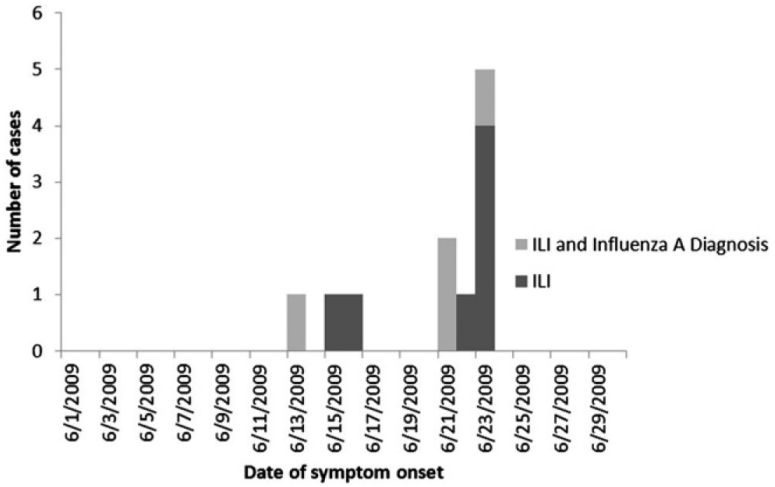

Fig 1.

Graph illustrating the number of cases of ILI and influenza A among responding physicians by date of symptom onset in June 2009.

Table 1

Minimum PPE recommendations when caring for patients with influenza (excluding aerosol-generating procedures) by hospital as of September 2009

PPE component	Hospital A	Hospital B	Hospital C	Hospital D
Gloves	Yes	Yes	Yes	Yes
Gown	No	Yes	No	Yes
Surgical mask	Yes	No	Yes	Yes
Fit-tested N95 respirator	No	Yes	No	No
Powered air-purifying respirator	No	Yes	No	No
Eye protection	Yes	Yes	No	Yes

Table 2

Respondents' knowledge and attitudes regarding infection control

Knowledge or attitude statement	Respondents expressing agreement, n (%) (N = 87-88)*
Proper handwashing by me keeps me from getting flu.	81 (92)
Proper handwashing by me keeps patients from getting flu.	80 (91)
My PPE use keeps me from getting flu.	79 (90)
My PPE use keeps patients from getting flu.	70 (80)
I feel confident that I know how to use PPE.	59 (67)
All recommended influenza PPE is available near rooms of patients in isolation.	57 (65)
The charge nurse or attending would remind me if I did not use PPE when caring for patients with flu.	49 (56)
Using recommended influenza PPE interferes with patient care.	27 (31)
Surgical masks and N95 respirators are equal in protecting me from getting flu.	21 (24)

* Sample size was either 87 or 88 due to missing values.

Table 3

The most common reasons cited by respondents for not using recommended PPE

Reason cited*	Respondents, n (%) (N = 40)†
I didn't know the patient had pH1N1 or ILL	22 (55)
The recommended PPE was not available near my patients' rooms.	12 (30)
I didn't think I needed it for the activity I was performing.	8 (20)
The facility ran out of the recommended PPE.	7 (18)
I just entered the room for a brief time.	5 (13)
I didn't touch the patient.	5 (13)
The facility didn't provide the recommended PPE.	4 (10)
I didn't come within 6 feet of the patient.	4 (10)
I was too busy to wear PPE.	4 (10)
Inconvenient to use recommended PPE when caring for patients with flu.	4 (10)

*Respondents could cite more than one reason and cited up to 7 reasons each.

†Respondents comprised those who reported close contact with a patient with confirmed or probable pH1N1 or ILI and self-reported not always wearing recommended PPE.