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Evaluation of respiratory protection programs and practices in California hospitals during the 2009–2010 H1N1 influenza pandemic

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Abstract

Background—Emergence of the novel 2009 influenza A H1N1 virus in California led to an evaluation of hospital respiratory protection programs (RPPs) and practices by the California Department of Public Health during the 2009–2010 influenza season.

Methods—Onsite evaluation of 16 hospitals consisted of interviews with managers and health care workers about RPPs and practices, review of written RPPs, and limited observations of personnel using respirators. Data were analyzed using descriptive statistics.

Results—All hospitals had implemented policies requiring the minimum use of N95 filtering facepiece respirators when working with patients with H1N1 virus infection; 95.5% of health care workers (n = 199) reported they would wear at least this level of protection when in close contact with a patient with confirmed or suspected H1N1 virus infection. However, evaluation of written RPPs indicated deficiencies in required areas, most commonly in recordkeeping, designation of a program administrator, program evaluation, employee training, and fit testing procedures.

Conclusions—Health care workers were aware of respiratory protection required when providing care for patients with confirmed or suspected H1N1 virus infection. Hospitals should improve written RPPs, fully implement written procedures, and conduct periodic program evaluation to ensure effectiveness of respirator use for health care worker protection. Increased accessibility of resources tailored for hospital respirator program administrators may be helpful.

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Keywords

N95 respirator; Aerosol transmissible disease; Hospital; Health care; Preparedness

The first 2 cases in the United States of human infection with the novel 2009 influenza A H1N1 virus were identified in April 2009 in California;¹ in June 2009 the World Health Organization declared a global pandemic.

Before the emergence of 2009 H1N1 pandemic influenza (pH1N1), the US government had committed substantial resources toward planning and preparedness for pandemic influenza. This effort included an assessment conducted by the Institute of Medicine (IOM) of the personal protective equipment (PPE), including respiratory protection, needed by health care workers in the event of an influenza pandemic.² The US Occupational Safety and Health Administration (OSHA) issued guidance in 2007 for workplace preparedness, including control measures appropriate for a pandemic influenza virus. For health care personnel working in close contact with infected patients, OSHA recommended the use of respiratory protection with an N95 or higher rated filter for most situations and higher levels of respiratory protection (supplied-air or powered air-purifying respirator) for procedures likely to generate bioaerosols.³

During May 2009, the California Department of Public Health issued infection control guidance consistent with OSHA pandemic influenza preparedness recommendations for the use of respiratory protection, and the Centers for Disease Control and Prevention took a similar position in its July 2009 guidance.⁴ On August 5, 2009, a new California occupational standard for the prevention of aerosol transmissible diseases (ATDs) became effective.⁵ The new ATD standard, which had been under development for several years by the California Division of Occupational Safety and Health (Cal/OSHA), was designed to make applicable public health guidance for worker protection measures legally enforceable in certain California workplaces where employees are at higher risk of infection, including acute care hospitals.

Under the Cal/OSHA ATD standard, employers are required to implement infection control practices, including the use of respiratory protection for aerosol transmissible infectious pathogens. Novel pathogens such as pH1N1 are included under the standard as requiring airborne precautions based on the recommendations of public health agencies. Therefore, the use of an N95 filtering facepiece respirator or equivalent (N95 respirator), or a higher level of respiratory protection, was required during 2009–2010 for health care workers providing care for patients with suspected or confirmed infection with pH1N1.

All respirator use in the workplace must be implemented through a comprehensive respiratory protection program (RPP) that is compliant with the applicable OSHA respiratory protection standard. The standard in California is essentially identical to the federal OSHA standard.⁶ RPPs must include written procedures and designation of a respirator program administrator (RPA), who is responsible for ensuring effective implementation of required elements such as respirator selection, medical clearance, fit testing, training, and program evaluation.

Despite the years of experience accumulated by health care workplaces in which respirators have been used to protect health care workers from tuberculosis and other ATDs, relatively little information exists to describe comprehensively acute care hospital implementation of RPPs. Investigations related to severe acute respiratory syndrome outbreaks have identified difficulties achieving compliance with PPE policies, especially for respiratory and facial protection.⁷⁻⁹ A more recent study of hospital nurses found poor adherence to respirator use policies, based on both self-report and observation, as well as low competence when asked to demonstrate respirator use. This study recommended that hospitals improve adherence by focusing on ready availability of equipment, training and fit testing, organizational support for worker health and safety, and good communication practices.¹⁰

In August 2009, the California Department of Public Health, in collaboration with the National Institute for Occupational Safety and Health, National Personal Protective Technology Laboratory, initiated a public health evaluation of a sample of California acute care licensed facilities with the aim of assessing the status of RPPs for the protection of health care workers during this pandemic involving a novel pathogen. The objectives of this evaluation, titled Respirator Use Evaluation in Acute Care California Hospitals, were to describe the extent to which hospitals implemented required elements of a RPP for pH1N1, assess the use of respiratory protection for pH1N1 among health care workers, and understand health care workers' knowledge and beliefs regarding the appropriate use of respiratory protection.

METHODS

Sampling strategy and recruitment

A list of all licensed hospitals in California was obtained from the Office of Statewide Health Planning and Development. From this list, acute care facilities located in the greater San Francisco area with an emergency department (ED) and at least 1 intensive care bed were eligible to participate. A sample of hospitals was selected to reflect the distribution of hospitals in California based on several characteristics: size (<200 beds vs ≥200 beds), rural status (rural vs nonrural), and type (city/county, district, nonprofit, for-profit, or university). The 14 counties surrounding the San Francisco Bay Area comprised the geographic area accessible to the project staff, and a stratified random sample of 16 facilities was selected from the 88 hospitals in the identified catchment area. The target goal of 16 facilities was based on available project staffing resources. Facilities were recruited by a project staff, who contacted the director of nursing or equivalent by telephone, explained the content and goals of the evaluation, and invited participation of the facility. Replacements for facilities declining to participate were selected randomly from the same stratum as the declining facility.

The California Department of Health and Human Services Committee for the Protection of Human Subjects determined that this evaluation was public health practice (ie, nonresearch). Participation of hospitals, individual managers, and health care workers was voluntary. Investigators first obtained facilities' approval to participate in the evaluation, including conducting observations of hospital units. Once onsite at a participating facility, project staff members explained to potential health care worker participants the purposes of the

evaluation and confidentiality of responses, and secured their consent for individual interviews. No identifying information was collected for nonmanagerial health care workers or unit managers.

Data collection and analysis

Separate evaluation instruments were designed by project staff for use in interviewing health care workers on specific units likely to care for patients with pH1N1 infection, managers of those units, and hospital managers with higher-level responsibilities related to the RPP. All 3 instruments were pilot tested with similar types of personnel at facilities not solicited for participation in the evaluation, and revised based on input obtained.

Questions for the 26-item health care worker interview instrument were developed to obtain demographic characteristics, information about respiratory protection practices (eg, what they would use when caring for a patient suspected or confirmed with pH1N1 infection), and knowledge and attitudes regarding use of respiratory protection (eg, protection afforded by N95 respirator vs surgical mask). Questions about use of respiratory protection when caring for patients with pH1N1 were modified from questions developed by Gershon et al¹¹ and Turnberg¹² as well as developed by the investigators.

A 1-page checklist was developed for use by project staff performing observations of respirator use by health care workers. The patient type, location of the observation, availability of respirators and hand hygiene facilities, and type of health care worker were noted. Essential components of respirator donning, use, and doffing were listed, as well as the duration of health care worker patient contact.

The unit manager interview instrument consisted of 50 questions developed by the investigators to identify each unit manager's roles and responsibilities in developing and implementing their facility's RPP; to assess various aspects of the RPP, including procedures and practices related to respirator use for pH1N1; and to determine knowledge and attitudes regarding respiratory protection.

The 39-item hospital manager instrument was similar to the unit manager instrument in design, but focused on identifying responsibilities for developing, implementing, and evaluating the RPP at the facility held by individual upper-level managers in employee or occupational health, infection control, or other key hospital functions.

Onsite hospital evaluations were performed in January and February 2010. Within each participating hospital, 15 to 21 interviews were performed using a tiered approach: 3 hospital managers, 3 unit managers, and 3–5 health care workers from each unit. The hospital managers interviewed were upper-level managers from nursing, employee health, and infection control. Three unit managers were selected by the hospital management from the ED, an intensive care unit (ICU), and pediatrics. When no pediatrics unit was present, a medical/surgical unit was substituted. These managers were interviewed, and each unit manager selected 3–5 health care workers from the unit for invitation to participate in the health care worker interview. Health care workers were selected based on availability to leave their current task for 5–7 minutes for completion of the interview; when fewer than 3

health care workers were available on a unit, 1 or 2 were interviewed. All interviews were performed in English.

After completing the health care worker interviews, investigators performed observations outside the rooms of patients with a suspected or confirmed ATD requiring the use of respiratory protection. Observers waited for up to 30 minutes outside the patient room in an area where health care workers could be observed donning and doffing respirators, or until 1 or more health care workers had entered the patient room. To avoid bias, silent observations were conducted using the checklist to record results.

A hospital manager at each facility was asked to provide investigators with a copy of the facility's RPP, any written identification of activities that place workers at high risk of exposure to ATDs, program evaluation protocol or forms, any written plan for respirator conservation or prioritization, any policy or procedure for respirator re-donning, or infection control policy for pH1N1. These materials were collected and reviewed by an investigator and a staff industrial hygienist for comparison to the OSHA requirements for a written RPP.

Hospital characteristics were analyzed using Freeman and Halton's extension of the Fisher exact test to assess if the sampled facilities were representative of acute care facilities in California.¹³ Evaluation interview responses and observation results were summarized using descriptive statistics. Analyses were performed using Microsoft Excel 2003 or SAS version 9.2 (SAS Institute Inc, Cary, NC).

RESULTS

Participating hospitals and health care workers

Sixteen hospitals participated in the evaluation. Four of the initially selected hospitals declined participation, and a replacement facility was randomly selected from the same stratum as each declining facility, resulting in a participation rate of 16 out of 20 (80%). The sample of 16 participating facilities was similar to all 309 general acute care hospitals in California in terms of hospital size (50% <200 beds) and location (87% nonrural). Regarding type of ownership, university hospitals were slightly overrepresented (6% in sample vs 2% overall) and for-profit hospitals slightly underrepresented (12% in sample vs 21% overall).

Evaluation interviews were completed with 204 health care workers, 45 unit managers, and 48 hospital managers, as described below. No health care workers or managers declined participation when asked to be interviewed. Because individuals could choose not to answer any question, multiple responses were permitted for some questions, and some responses involved skip patterns, the total samples may vary for individual evaluation items.

Of the 204 health care workers interviewed, the majority (n = 145; 71.1%) were registered nurses. The language spoken at home was English for most respondents (n = 118; 92.6%), followed by Tagalog (n = 4; 2.0%) and Spanish (n = 2; 1.0%). More than half (n = 113; 55.4%) reported working in their present position for >5 years, and 53 (26.0%) reported working in their present position for 2–5 years. Sixty-five (31.9%) respondents worked in an

ED, 63 (30.9%) in an ICU, 55 (27.0%) in a medical/surgical unit, and 21 (10.3%) in a pediatrics unit. Only 8 (3.9%) respondents were contractors, with the remaining 196 (96.1%) being employees of the hospital. Thirty-one (15.2%) interviewees reported that they were at risk for complications from pH1N1 due to conditions such as pregnancy or asthma.

Among the 45 unit managers interviewed, 14 (31.1%) supervised an ED or ICU, 12 (26.7%) supervised a medical/surgical unit, and 5 (11.1%) supervised a pediatrics unit.

Among the 48 hospital managers interviewed, infection control was the most common department with 18 (37.5%), followed by nursing and employee/occupational health with 16 (33.3%) each, and environmental health and safety with 1 (2.1%); 2 (4.2%) reported management duties in another area (multiple responses were permitted for managers working in >1 department).

Health care worker interview responses

Selected responses from interviews of health care workers are summarized in Table 1. Of the health care workers who reported that they had or expected to have close contact with a patient with suspected or confirmed pH1N1 infection, nearly all (95.5%) stated that they would wear an N95 respirator or higher level of protection. When asked about the availability of their preferred size and model of respirator when needed, more than three-quarters reported that they were available “always.” Some health care workers (42.3%) reported that they had reused an N95 respirator when in close contact with a patient with pH1N1 infection; the most common reasons cited for reuse were “standard practice” and “shortage.” The most common way health care workers reported knowing that they were required to wear a respirator was a sign posted on the door of a patient’s room. Nearly all health care workers (94.1%) said they strongly agreed or agreed with the statement, “N95 respirators are more effective at protecting me from influenza than surgical masks.” The most commonly cited problem health care workers reported experiencing while wearing an N95 respirator was feeling uncomfortably warm; however, 34.7% of health care workers reported having no problems.

When health care workers were asked if they had received medical clearance to wear an N95 respirator, 182 (91.5%) said they had, 6 (3.0%) had not, and 11 (5.5%) did not know if they had received clearance. One hundred eighty-nine (95.0%) health care workers stated they had been fit tested for N95 respirator use within the past 2 years (the Cal/OSHA ATD standard has a temporary provision that allows employers to increase the interval for repeat fit testing to 2 years under certain circumstances, until January 1, 2014.). Most health care workers (n = 180; 90.9%) had received respirator training within the past year, 8 (4.0%) had received training >1 year ago, 4 (2.0%) said they had never received training, and 6 (3.0%) did not know when they had last received respirator training. Just less than half (n = 99; 49.5%) of health care workers had received training specifically on pH1N1, whereas 94 (47.0%) had not, and 7 (3.5%) did not know if they had received such training. When asked about their agreement with the statement, “I think my supervisor would correct me if I did not wear a respirator when it was required by my facility,” 138 (68.0%) strongly agreed with the statement, 51 (25.1%) agreed, 8 (3.9%) disagreed, 1 (0.5%) strongly disagreed, and 5 (2.5%) responded that they did not know.

Respirator use observations

A total of 18 observations of health care workers using respiratory protective equipment were performed. Of these, 7 (38.9%) occurred in an ICU or medical/surgical unit, 2 (11.1%) in a pediatric unit, 1 (5.6%) in an ED, and 1 (5.6%) in another area of the hospital. Eleven (61.1%) patients receiving care at the time of the observation had suspected or confirmed pH1N1 infection; the other 7 (38.9%) were suspected or confirmed to have another ATD requiring airborne precautions. The majority of observed health care workers (55.6%) were registered nurses; other job titles included nursing assistant, respiratory therapist, technician, and phlebotomist. All of the observed health care workers donned an N95 respirator. The elements of proper respirator use most commonly lacking were user seal check (performed for 3 of 15 observations; 20.0%) and correct doffing (performed for 1 of 14 observations; 7.2%). Most of the health care workers touched the front of the respirator when doffing, rather than handling it only by the straps, and 8 (47.1%) did not perform hand hygiene after doffing the respirator. Waste receptacles were available in the immediate area for 71.4% of observations, and hand-washing facilities or alcohol-based hand rub for 94.1% of observations.

Hospital unit manager interview responses

Of the 45 unit managers interviewed, all reported having responsibilities related to administering the RPP. The most common responses were that they communicated hospital policies and procedures regarding the RPP to health care workers on their unit (n = 44; 97.8%), reported problems with the RPP to the hospital management (n = 42; 93.3%), and that they observed health care workers to see if they were wearing respiratory protection when required by the RPP (n = 41; 91.1%). Forty (88.9%) unit managers reported that they were asked to provide input on the RPP at their facility. Almost all unit managers (n = 43; 95.6%) reported that respirators were located close to the point of use in their unit. Twenty-eight (62.2%) unit managers reported that they had an employee on their unit who could not be fitted with an N95 respirator; of these, 23 (82.1%) stated that powered air purifying respirators were available for these staff members.

Unit managers commonly reported informing their staff of changes to the RPP via meetings (n = 42; 93.3%), verbally 1-on-1 (n = 40; 88.9%), and by signs and/or e-mail (n = 36; 80% for both) (multiple responses permitted). Most unit managers did not report performing formal observation of respirator use on their unit (n = 32; 71.1%) as a component of respirator program evaluation; however, all but 1 reported informally observing use of respirators by their staff (n = 44; 97.9%). All unit managers (n = 45; 100%) reported that they would counsel health care workers who repeatedly violated the RPP requirements. Thirty-eight (84.4%) unit managers reported that a patient with confirmed pH1N1 infection had been treated on their unit, and 34 (75.6%) reported that they would be notified if a pH1N1 case occurred among their staff. Most unit managers (n = 42; 93.3%) reported that airborne precautions (including use of an N95 respirator or better) were required for close contact with patients with suspected or confirmed pH1N1, and the remaining 3 (6.7%) said that droplet precautions (which calls for use of a surgical mask) were required.

Hospital manager interview responses

OSHA requires each worksite to have 1 RPA with primary responsibility for the RPP, although other employees may assist with some parts of the program. At some facilities more than 1 hospital manager claimed to be the RPA, and 1 hospital was unable to provide an RPA to respond. A limitation of our design (identified in hindsight) is that the hospital manager interview questions were asked of 3 managers at each facility and the responses combined, rather than focusing questions on the 1 person with primary responsibility for the RPP (if 1 was identified).

All but 1 of 48 managers reported having a written RPP at their facility; however, 1 of 16 hospitals failed to produce a written RPP for review. When asked which department at their facility decided on respirator policies (multiple responses permitted), 48 (100%) managers responded that the infection control department made these decisions. Other commonly named responsible parties were unit managers (n = 45; 93.8%) and the materials management department (n = 43; 89.6%). Forty (85.1%) hospital managers reported that their RPP included written identification of high-risk activities for exposure to ATDs, 1 (2.1%) reported that it did not, and 6 (12.8%) did not know.

The hospitals' respiratory protection policies and practices as described by interviewed managers are summarized in Table 2. Nearly all hospital managers reported that all staff were medically evaluated (95.8%) and always fit tested (93.8%) before being permitted to use an N95 respirator. Fit testing was most frequently performed by in-house personnel, and a qualitative fit testing method was most often used. When asked about frequency of fit testing, 83.3% of managers reported that fit testing was conducted at hire and then annually; 6.3% said fit testing was done at hire and then "as needed." Most hospital managers (91.7%) reported that their facility offered respirator training, and most reported (79.6%) requiring training at hire and then annually thereafter. In-person training was the most frequently cited type of training offered (77.1%), and the majority of managers (79.2%) reported having offered training specific to pH1N1. Less than half of managers responded that their facility had a formal mechanism or method for evaluation of their respirator program and, of these, only 57.1% obtained input from employees as part of evaluation (as required by the OSHA respiratory protection standard). For health care workers in close contact with a patient with suspected or confirmed pH1N1 infection, 85.4% of hospital managers reported that an N95 respirator was the minimum level of protection required.

Most hospital managers (n = 40; 83.3%) reported their facility formally documented respirator supplies and use. Half of hospital managers (n = 24) reported that they had experienced a shortage of respirators during the pandemic. The most common reasons given for a shortage being experienced (multiple responses permitted) were higher patient loads (n = 22; 91.7%), orders not filled by suppliers (n = 20; 83.3%), and allotment from suppliers* (n = 16; 66.7%). For facilities that did not experience a shortage, the presence of respirators stockpiled by the facility (n = 12; 54.6%) was the most common reason given for a shortage being prevented. More than half of hospital managers (n = 23; 53.5%) reported that their

*In allotment, suppliers allow hospitals to order only a certain number of respirators, based on their order quantities in the past.

facility had received a brand or model of respirator that had not previously been used by their employees. Of these, 47.8% (n = 11) said that all employees were fit tested with the new respirators before use, whereas 47.8% (n = 11) acknowledged that some employees were fit tested before use.

Most respondents (n = 45; 93.8%) reported having a plan to conserve N95 respirators in the event of a shortage, with the most common methods (multiple responses permitted) being redonning (81.3%, n = 39), cohorting of patients (52.1%, n = 26), and extended use (12.5%, n = 6). Fewer hospital managers (n = 37; 77.1%) reported having plans to prioritize use of respirators; the most common methods (multiple responses permitted) were to prioritize respirators for health care workers performing high-hazard (aerosol-generating) procedures (n = 32; 66.7%), for tuberculosis or other patients on airborne precautions (n = 29; 60.4%), and for staff at high risk for complications of pH1N1 infection (n = 12; 25.0%). Thirty-four (70.8%) hospital managers said that their facility had a written policy for redonning of respirators by health care workers in close contact with patients with pH1N1 infection, and of these the most common method for storing respirators between uses was in a paper bag (n = 28; 58.3%).

Evaluation of written respiratory protection programs

The assessment of written RPP documents provided by each facility is summarized in Table 3, including the presence (complete or partial) or absence of elements required under the OSHA respiratory protection standard (ie, designated program administrator, medical evaluation of respirator users, fit testing of respirator users, recordkeeping, training and information, respirator selection, use of respirators, maintenance and care of respirators, and program evaluation). Most (93.8%) of the facilities had a written RPP including at least 1 of the required elements; only 1 facility was completely lacking a written RPP. Four facilities (25%) did not name a RPA. The most problematic element, considering both partial and absent elements, was recordkeeping. Nine (56.3%) facilities only partially addressed the recordkeeping requirements, and 3 (18.8%) did not include this element at all. Considering completely absent elements, the most common omission was program evaluation, with 37.5% of facilities failing to include a written procedure addressing program evaluation.

DISCUSSION

The emergence of pH1N1 in 2009 provided an opportunity to evaluate hospital preparedness for a widespread novel influenza virus where, in the absence of a vaccine or knowledge about its health consequences, the use of N95 filtering facepiece respirators or equivalent had been widely recommended by public health officials as a minimum level of respiratory protection for health care workers performing patient care. Transmission of pH1N1 was documented among health care workers who treated the initial cases identified in California and associated with inadequate use of personal protective equipment.¹⁴ Once the novel pathogen was recognized, hospitals were expected to quickly implement their pandemic influenza plans for comprehensive infection control measures, including the early identification of suspected cases and use of respiratory protection by exposed workers. This onsite evaluation assessed respiratory protection programs and practices in a randomly

selected set of hospitals several months after pH1N1 had spread throughout California, public health guidance on infection control measures had been widely disseminated, and a new state OSHA standard on ATDs had become effective.

We found that all participating hospitals had implemented policies requiring the use of N95 respirators as the minimum level of protection for health care workers in close contact with suspected or confirmed pH1N1 patients, consistent with guidance from state and federal public health agencies as well as the enforceable requirement of the Cal/OSHA ATD standard. Responses from unit and hospital managers indicated a high level of knowledge of this policy (93.3% and 85.4%, respectively). Health care workers from those units overwhelming (95.5%) stated they would select an N95 respirator or a more protective PAPR when caring for a patient with suspected or confirmed pH1N1, demonstrating a high level of knowledge of the policy even if it may not have been consistently followed in practice. We did not assess awareness of the Cal/OSHA ATD standard; thus it is not possible to determine whether or not having an applicable new state regulation was a key factor in promoting the implementation of these policies in California. In contrast, a survey of medical students and residents at a Washington, DC, hospital (November–December 2009) showed that only 13% of medical students and 21% of residents would wear an N95 respirator when caring for a patient with influenza symptoms.¹⁵ Another study conducted at a New York City hospital identified 277 unprotected health care worker exposures related to 44 patients with pH1N1 infection (May–July 2009), explained by suboptimal adherence to PPE recommendations in addition to other factors.¹⁶

In general, the basic elements required with respirator use (eg, medical clearance, fit testing, and employee training) were in place in all hospitals, as demonstrated by consistent responses across health care workers, unit managers, and hospital managers. Because onsite evaluation visits were conducted in January–February 2010, we are unable to report on the extent of N95 respirator readiness in these facilities at the start of the pandemic. Jaeger et al¹⁴ found that 52% of health care workers exposed to the earliest California patients with pH1N1 infections after admission to the hospital were “N95 ready,” defined as having been fit tested within the past year and knowing the appropriate size and location of N95 respirators. Data collected from 22 states on 48 health care workers with clinical care duties who had been infected with pH1N1 showed that 69% had ever been fit tested, another assessment of respirator readiness.¹⁷ A National Institute for Occupational Safety and Health survey of internal medicine residents and fellows at 4 Utah hospitals conducted August–September 2009 showed a lower level of training on N95 respirator use (43%) and lower level of fit testing (22% between the beginning of their training and June 2009) than found among this California health care worker sample.¹⁸

Interviewed health care workers overwhelmingly (94%) believed that N95 respirators would be more effective than surgical/medical masks at protecting them from pH1N1 infection. Given that clearly understanding the differences in protection and appropriate use between respirators versus surgical/facemasks had been cited as a potential challenge for the health care field in pandemic influenza preparedness,² our results may reflect progress made in this area. In contrast, 24% of respondents in the Utah study believed that surgical masks and N95 respirators provided equal protection.¹⁸ The heightened awareness among California health

care workers about the role of respiratory protection against pH1N1 may have been due to publicity regarding the new ATD standard, and/or employer or union-based educational efforts. Thirty-five percent of health care workers reported experiencing no problems while wearing respirators, and of those who did experience problems, feeling uncomfortably warm was the most frequent issue mentioned (49%), followed by interference with eyeglasses (21%).

We had difficulty drawing conclusions about how health care workers know when to wear a respirator, because multiple responses to this question were permitted. Signage on patient doors, information from coworkers and shift reports, and the health care worker's patient assessment were common responses. Future investigations could look more closely at how hospital respirator policies address this topic, particularly for the earliest health care worker-patient contacts in the hospital, before diagnosis, and for nonclinical staff who may not be included in communications about suspected or confirmed disease status. The New York City hospital study cited earlier, which identified almost 5 unprotected health care worker exposures for each patient with pH1N1 infection who presented with influenza-like illness, highlighted the need to better understand how to more effectively implement screening protocols as well as to achieve adherence to respirator use requirements.¹⁶

In the limited number of observations of respirator users, we did not observe health care workers failing to don a respirator when appropriate; however, frequently identified problems were failure to perform user seal checks, touching the outside of the respirator during doffing, and failure to perform hand hygiene after doffing. Since reuse of filtering facepiece respirators was fairly common (42% of health care workers reported ever reusing a respirator), these latter practices could result in disease transmission due to contamination of the respirator. Further training may be warranted in these facilities on how to properly don and doff respirators, as well as how to conduct user seal checks (which should be spelled out in the manufacturers' instructions). These deficiencies in proper respirator use are significant, as they may result in a failure of the respirator to provide its intended level of protection. A recent study with 100 observations of N95 respirator users showed that 76% failed to perform a user seal check and 60% touched the outside of the respirator while removing it.¹⁰ Another observational study performed in 11 hospitals showed deficiencies in proper sequence of PPE removal and only 57% of health care workers performing hand hygiene after removal of respiratory or facial protection.¹⁹

Review of written respiratory protection programs revealed instances where written procedures for 1 or more program elements were lacking or incomplete. Of the 16 hospitals, only 1 had a program that was considered to be complete, and 1 hospital failed to provide a written program. Achieving an effective level of protection from respirator use relies on having comprehensive written procedures for all of the required elements, implementing those procedures, regularly evaluating the implementation of each element (with respirator user input), and making necessary improvements. Such an effort is required under the OSHA respiratory protection standard for any workplace where respirators are used. The most frequently missing program element in the hospitals' written RPPs was program evaluation, followed by the designation of a program administrator. These results suggest that, although hospitals have made substantial progress in implementing the use of

respiratory protection, it may be necessary to assign clearer responsibility for overall oversight of the program. Conducting periodic program evaluation, including observations of health care workers using respirators and soliciting input from respirator users, should be broadly implemented. Other areas for improvement of written programs include delineating required recordkeeping procedures, and specifically how fit testing and training are conducted. We are not aware of any other published assessments of written hospital respiratory protection programs.

Given California's specific OSHA requirement for the use of respiratory protection by health care workers in close contact with a patient with suspected or confirmed pH1N1 infection, we were aware of hospitals' concerns regarding the potential for respirator shortages. Our results provide some insight on how hospitals planned for a potential shortage, most commonly through having employees reuse respirators and store them in a paper bag between uses. Half of interviewed hospital managers reported experiencing a shortage of respirators; they cited increased demand due to higher patient loads and supplier inability to fill orders as the key reasons for a shortage. Those facilities that did not experience a shortage stated that stockpiling respirators helped them maintain adequate supply levels. Most facilities formally documented their respirator supplies and use, as encouraged by Cal/OSHA; this information could be useful for their future pandemic influenza planning efforts. Due to respirator supply issues, some hospitals were forced to use alternate respirator brands or models, and some managers acknowledged an inability to fit test all employees with the new respirator before use.

Several limitations should be taken into consideration when generalizing the results of this public health evaluation. First, California was in a unique position regarding pH1N1 because the first cases occurred here, and California enacted the nation's first occupational standard for aerosol transmissible diseases in August 2009 during the peak of the pandemic. Hospitals in California may have been faster to mobilize respirator use because they had been preparing to meet the new standard. Because our evaluations were conducted later in the pandemic, hospitals may have had earlier deficiencies in respirator use that we could not have documented. Another consequence of the timing of our evaluation (influenza activity in California had moved from widespread to sporadic by early 2010) was that some hospital units no longer had any patients on airborne precautions, seriously limiting the number of respirator use observations we could conduct. Therefore, our results and conclusions based on interview data assess knowledge and intended practices, rather than observed practices. Our sample of 16 facilities was small, comprising 5.2% of acute care California hospitals. Hospitals that declined participation (4 out of 20 invited) may have been less successful at implementing respirator use. Although we obtained a sample that was generally representative in terms of size, rural versus nonrural, and type of ownership, generalizing the findings to all facilities in the state should be done with caution. This small sample size precluded analysis of the data by hospital characteristics. Finally, our aim was to evaluate a sample of California hospital RPPs and health care worker respiratory protection practices during a novel pandemic, and the findings are likely not applicable to seasonal influenza or other ATDs.

Studies conducted during pH1N1 documented transmission to health care workers in both inpatient and outpatient environments^{14,17,20} as well as unprotected exposures.¹⁶ However, available studies lacked the ability to evaluate the effectiveness of respiratory protection. One problem identified in the assessment of the use of PPE^{14,17} was that questions did not distinguish between respondents' use of N95 respirators versus surgical/medical masks. Improved surveillance of PPE use in health care workplaces has been recommended by the IOM.²¹ Observational studies of actual practice during a pandemic, as well as of respiratory protection use during more usual circumstances, could further help to inform efforts to protect health care workers from aerosol transmissible diseases. The IOM has made numerous recommendations regarding the role of respiratory protection in preventing the transmission of pandemic influenza and other viral respiratory diseases to health care workers, and continues to track the nation's progress in this important area of occupational health and safety.²¹

CONCLUSIONS

We found that California hospitals evaluated during pH1N1 were able to implement many of the required elements of respiratory protection programs. However, several deficiencies were commonly noted. To provide a comprehensive occupational infection control program, hospitals should ensure that they have a written respiratory protection program, fully implement programs and procedures, and conduct periodic program evaluation to ensure the effectiveness of respirator use for health care worker protection. Increased accessibility of information and resources tailored for hospital respirator program administrators may be helpful in this regard.

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Table 1

Respiratory protection practices and beliefs of health care workers (HCWs)

	n	%
Mask or respirator HCW would wear for close contact with patient with suspected or confirmed pH1N1 (n = 199)		
Surgical mask	4	2.0
Surgical mask or N95 respirator	5	2.5
N95 respirator	183	92.0
N95 or powered air purifying respirator	2	1.0
PAPR	5	2.5
Availability of preferred size and model of N95 respirator when needed (n = 198)		
Always	155	78.3
Most of the time	30	15.2
Sometimes	9	4.6
Never	0	0.0
Not applicable (does not use N95 respirator)	4	2.0
How HCW knows wearing an N95 respirator is required (n = 201)*		
Sign on door of patient room	194	96.5
Respirators located near patient room	118	58.7
Supervisor informs	68	33.8
Coworkers inform	155	77.1
Told during shift report	165	82.1
HCW decides based on patient assessment	156	77.6
Another method	35	17.4
Don't know	0	0
Agreement with the statement, "N95 respirators are more effective at protecting me from influenza than surgical masks" (n = 203)		
Strongly agree	133	65.5
Agree	58	28.6
Disagree	7	3.5
Strongly disagree	0	0.0
Not applicable or don't know	5	2.5
Problems when wearing N95 respirator (n = 193)*		
Feel uncomfortably warm	76	39.4
Interferes with eyeglasses normally worn	41	21.2
Trouble speaking or being understood	39	20.2
Difficulty breathing	30	15.5
Bothered by moisture buildup inside respirator	25	13.0
No problems reported	67	34.7

pH1N1, pandemic influenza A H1N1 virus; *PAPR*, powered air purifying respirator.

* More than 1 response permitted; therefore percentages may sum to >100%.

Table 2

General respiratory protection policies and practices as reported by hospital managers (n = 48 unless otherwise noted)

	n	%
All staff medically evaluated before use of close-fitting respirator is allowed		
Yes	46	95.8
No	0	0.0
Don't know	2	4.2
All staff fit tested before use of close-fitting respirator is allowed		
Yes - always	45	93.8
Yes - sometimes	3	6.3
No - never	0	0.0
Don't know	0	0.0
If yes, who conducts fit testing*		
Hospital personnel	42	87.5
Respirator manufacturer	2	4.2
Contracted service	15	31.3
Other	1	2.1
If yes, type of fit test administered		
Quantitative	0	0.0
Qualitative	44	91.7
Don't know	1	8.3
Minimum level of respiratory protection required for close contact with patient with suspected or confirmed pH1N1		
Surgical mask	5	10.4
N95	41	85.4
Don't know	2	4.2
Facility offers respirator training		
Yes	44	91.7
No	2	4.2
Don't know	2	4.2
If yes, what kind of training is offered (n = 44)*		
Lectures	12	25.0
In-person	37	77.1
Videos	8	16.7
Written materials	14	29.2
Quizzes	9	18.8
Online training	14	29.2
Other	2	4.2
Don't know	1	2.1
Facility performs formal program evaluation (n = 47)		
Yes	21	44.7
No	15	31.9

	n	%
Don't know	11	23.4
If yes, does evaluation include input from respirator users (n = 21)		
No	8	38.1
Yes	12	57.1
Don't know	1	4.8

* More than 1 response permitted; percentages sum to >100%.

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Table 3

Assessment of written hospital respiratory protection programs

Program element required by OSHA	REACH facility number																Totals	% +		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16				
Written respiratory protection program present	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	+	*	0	
Designated program administrator	*	+	+	+	+	+	+	+	0	0	0	0	*	*	+	+	9	3	4	56.3
Medical evaluation	+	*	+	+	+	+	+	*	+	0	0	0	+	*	+	*	10	4	2	62.5
Fit testing	*	*	+	*	+	+	+	*	*	*	*	0	+	+	*	*	6	9	1	37.5
Recordkeeping	0	*	*	*	+	*	*	*	0	*	*	0	+	*	+	+	4	9	3	25.0
Training and information	*	*	+	+	+	+	+	*	+	0	0	0	+	*	+	*	8	5	3	50.0
Respirator selection	*	+	+	+	+	+	+	0	+	*	+	0	+	+	+	*	11	3	2	68.8
Use of respirators	*	+	+	+	+	+	+	0	+	*	*	0	+	+	+	0	10	3	3	62.5
Maintenance and care of respirators	*	+	+	+	+	+	+	0	+	*	*	0	+	+	+	+	11	3	2	68.8
Program evaluation	0	*	+	+	+	+	+	0	0	+	0	0	+	0	+	+	9	1	6	56.3

+, present; *, partial/incomplete; 0, missing; N, No; OSHA, Occupational Safety and Health Administration; REACH, Respirator Use Evaluation in Acute Care California Hospitals program; Y, yes.