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# 2009 H1N1 influenza infection in Korean healthcare personnel

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**Abstract** Healthcare personnel (HCP) can acquire influenza and transmit it to patients and other hospital staff. The aim of this study was to evaluate the attack rate of HCP by the 2009 H1N1 influenza virus during the 2009 pandemic influenza season in Korea. HCP infected with H1N1 virus were asked to fill out a questionnaire, which included job type, method of diagnosis, facility type, history of contact with patients infected by H1N1 virus, vaccination status, and use of personal protective equipment. A total of 328 HCP (female 68.6%, 225/328) were infected with H1N1 virus at the nine study centers. The highest attack rate was in physicians, followed by nurses and nurses' aides. Transmission occurred

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primarily after contact with outpatients (27.8%), followed by contact with inpatients (21.6%). Most (77.3%) of the infected HCP never used an N95 mask during contact with patients. Surgical masks were always used by 29.4% of the subjects and usually or intermittent used by 46.9%. The peak incidence of the H1N1 infection among HCP preceded that among the general population. Among HCPs, physicians, nurses, and nurses' aides were at the greatest risk of H1N1 infection. HCP should be more vigilant and protect themselves with appropriate personal protective equipment during the influenza season.

## Introduction

Healthcare personnel (HCP) infected with influenza, either symptomatic or asymptomatic, can transmit influenza to vulnerable patients and other employees in the hospital [1]. Many HCP continue to work despite being ill with influenza, increasing the potential of exposure to patients and coworkers [2, 3]. Healthcare-associated influenza outbreaks are well documented [1, 4]. The infectivity of 2009 H1N1 influenza virus among humans appears to be higher than that of seasonal influenza [5]. Complications of nosocomial influenza infection in the elderly, the immunocompromised, the critically ill, and children can result in severe illness, increased length of hospital stays, and death [6, 7].

In healthcare settings, routine infection control recommendations for a decrease in the risk of transmission of seasonal influenza to HCP include vaccination, isolation of infected patients in single rooms, and the use of standard and droplet precautions [1, 8]. The successful management of an outbreak depends on keeping susceptible HCP safe from patients shedding droplet and airborne influenza particles [8].

In this study, we investigated an attack rate of infection, mode of transmission, usage rate of personal protective equipment, and isolation of HCP infected with H1N1 virus during the 2009 pandemic H1N1 influenza season in Korea. We also evaluated the time relationship of peak incidence of the H1N1 virus infection between HCP and the general population.

## Materials and methods

### Study design

This study was conducted during the 2009 H1N1 influenza season from September to December 2009 at nine university-affiliated hospitals in Korea. HCP were defined as employees, contractors, and clinicians whose activities involved contact with patients in healthcare or laboratory settings [1]. Infection

of HCP with H1N1 virus was confirmed by real-time or multiplex reverse transcriptase polymerase chain reaction (RT-PCR). All of the subjects were interviewed by well-trained nurses or physicians using a same standard protocol. The study subjects of HCP were classified into four groups based on job type: Group I (physicians), Group II (nurses and nurses' aides), Group III (technicians, therapists, emergency paramedical service personnel, laboratory personnel, and pharmacists), and Group IV (administrative workers and others employees not directly involved in patient care but having the potential of being exposed to infectious agents, i.e., clerical, dietary, and maintenance workers).

From 27th October 2009, vaccine for H1N1 virus became available in Korea. All of the participating hospitals completed a vaccination program for HCP by early December 2009. The attack rate of H1N1 virus was calculated by comparing the infected HCP versus entire HCP as the denominator because we did not evaluate the daily vaccination status of HCP. We used pandemic H1N1 infection status in Korea with daily average anti-viral agent consumption because most infected individuals did not undergo confirmatory tests after the Korean health authorities recommended anti-viral agent for all patients with any influenza-like illness on 21st October 2009 [9]. The study protocol and questionnaire were approved by the Institutional Review Boards of each institution.

### Questionnaire

The questionnaire consisted of items including job type, method of diagnosis, facility type, contact history with patients with known H1N1 infection, vaccination status, isolation, and use of personal protective equipments (N95 mask, surgical mask, gloves, goggles, and gown). The questionnaire specifically asked about the use of personal protective equipment during the week before clinical symptoms appeared.

### Statistical analysis

Descriptive statistics (mean and standard deviation) were employed to describe the study subjects. The chi-square test and Fisher's exact test were used for the univariate analysis of categorical variables, and analysis of variance (ANOVA) was used for continuous variables. SPSS software (version 15.0) was used for all analyses, and a $p$-value of less than 0.05 was considered to be statistically significant.

## Results

A total of 15,018 HCP were registered at the nine participating hospitals. Of these, 328 HCP (2.2%, 328/

**Table 1** General characteristics of confirmed influenza A (H1N1) 2009 infections in Korean healthcare personnel

|  | | Total (n=328) | Group I (n=90) | Group II (n=159) | Group III (n=32) | Group IV (n=47) | p-value |
|---|---|---|---|---|---|---|---|
| Age | | 31.6±8.1 | 30.6±6.4 | 30.4±7.6 | 33.5±8.2 | 36.5±10.3 | <0.001* |
| Sex | Female | 225 (68.6%) | 25 (27.8%) | 154 (96.9%) | 18 (56.3%) | 28 (59.6%) | <0.001** |
|  | Male | 103 (31.4%) | 65 (72.2%) | 5 (3.1%) | 14 (43.8%) | 19 (40.4%) | |
| Attack rate*** (95% CI) | | 2.2 (2.0-2.4). | 2.9 (2.3-3.5) | 2.8 (2.4-3.2) | 2.1 (1.4-2.9) | 1.0 (0.7-1.3) | <0.001** |
| Interval between first symptom(s) and diagnostic testing | | 2.2±2.1 | 2.1±2.3 | 2.2±2.1 | 2.4±1.9 | 2.1±2.1 | 0.950* |
| Interval between initial symptom(s) and diagnosis | | 2.5±3.7 | 2.3±2.7 | 2.5±4. 5 | 2.5±2.1 | 2.6±3.7 | 0.974* |

CI, confidence interval; NA, not available

*Analyzed by analysis of variance (ANOVA)

**Analyzed by chi-square test or Fisher's exact test

***Calculated by dividing the confirmed cases by the total persons during September to December 2009, ignoring vaccine recipients

15,018; female 68.6%, 225/328) were infected with H1N1 virus. The mean age of the subjects was 31.6±8.1 years. There were no statistical differences among the nine hospitals concerning the attack rate of H1N1 virus (data not shown, p=0.067). The attack rate of infection was highest in Group I (2.9%, 95% confidence interval [CI] 2.3–3.5), followed by Group II (2.8%, 95% CI 2.4–3.2), Group III (2.1%, 95% CI 1.4–2.9), and Group IV (1.0%, 95% CI 0.7–1.3) (Table 1). The mean interval between exposure to a patient with suspected H1N1 and the onset of clinical symptoms was 3.3±2.5 days (group difference p=0.303 by ANOVA). The mean interval between initial clinical symptoms and diagnosis was 2.5±3.7 days (p=0.567) (Table 1).

The general ward (35.7%) was the most common place where HCP worked during the week before symptoms appeared, followed by the outpatient department (25.0%), emergency room (10.4%), and others (29.0%). Groups I and II were in contact with patients during the majority of their workdays; however, groups III and IV spent less time with patients compared with Groups I and II (Table 2). Twenty-two percent of infected HCP reported that they worked in a specialized outdoor flu ward (data not shown).

The main sources of H1N1 virus exposure were outpatients (25.8%), inpatients (19.9%), family members (15.0%), other HCP (14.1%), and unknown origin (32.6%) (Table 3).

The usage rate of N95 masks was very low, with 77.3% of respondents reporting that they did not use them. Surgical masks, on the other hand, were used relatively often, with 29.4% of respondents reporting that they always used surgical masks. Gloves were always used by only 8.6% of respondents, while goggles were not used 98.9% of the time. Gowns were always used by only 20.6% of respondents (Table 4).

Of the total infected subjects, 99.1% of cases were isolated for 5.8±1.4 days. Isolation was either at home (97.8%) or in the hospital (2.2%). Figure 1 shows that the peak incidence of the H1N1 infection among HCP preceded that among the general population. There were no deaths among HCP who were infected with the H1N1 virus.

**Table 2** The location of work during the week before initial symptoms

|  | Total (n=328) | Group I (n=90) | Group II (n=159) | Group III (n=32) | Group IV (n=47) |
|---|---|---|---|---|---|
| General ward | 117 (35.67 | 48 (53.3) | 65 (40.9) | 2 (6.3) | 2 (4.3) |
| Outpatient department | 82 (25.0) | 16 (17.8) | 47 (29.6) | 9 (28.1) | 10 (21.3) |
| Emergency room | 34 (10.4) | 12 (13.3) | 20 (12.6) | 0 (0.0) | 2 (4.3) |
| Other (contact*) | 40 (12.2) | 9 (10.0) | 14 (8.8) | 6 (18.8) | 11 (23.4) |
| Other (non-contact*) | 55 (16.8) | 5 (5.6) | 13 (8.2) | 15 (46.9) | 22 (46.8) |

*Contact; contact with patients

"Other" included laboratory department, endoscopic department, pharmacy department, elevator, reception for hospital, office for administration, etc.

**Table 3** The possible modes of transmission of influenza A (H1N1) 2009 virus*

|  | Total (%) | Group I (%) | Group II (%) | Group III (%) | Group IV (%) |
|---|---|---|---|---|---|
| CH, RH-outpatient | 122 (27.8) | 27 (23.5) | 65 (29.8) | 17 (38.6) | 13 (21.0) |
| CH, RH-inpatient | 95 (21.6) | 31 (27.0) | 46 (21.1) | 6 (13.6) | 12 (19.4) |
| CH, RH-HCP | 53 (12.1) | 18 (15.7) | 28 (12.8) | 6 (13.6) | 1 (1.6) |
| In family-confirmed, RS | 50 (11.4) | 6 (5.2) | 29 (13.3) | 5 (11.4) | 10 (16.1) |
| Unknown | 119 (27.1) | 33 (28.7) | 50 (22.9) | 10 (22.7) | 26 (41.9) |

CH, confirmed patient in hospital; RH, patient with respiratory symptoms in hospital; RS, respiratory symptoms

*Calculated by multiple response, %; applicable number/total number in each group

## Discussion

Knowing the incidence of infection for each job type of HCP in the hospital during influenza or other infectious pandemics would provide important information and allow for more effective management and control of influenza dissemination. However, no reports have focused on the incidence of infection according to each type of HCP during influenza seasons. In the present study, the attack rate of HCP was highest in physicians, nurses, and nurses' aides. The attack rates in the first three professional groups were similar, while Group IV was significantly lower than the other groups. These groups represent the most likely HCP to be in contact with infected patients. Our findings are similar to those of previous studies assessing the incidence of severe acute respiratory syndrome (SARS) infection of HCP [10, 11], in which physicians, nurses, and nurses' aides were determined to be at the highest risk for infection. Given these findings, physicians, nurses, and

nurses' aides should wear appropriate protective equipment and should be the first among HCP to be vaccinated.

A risk of infection in HCP also exists in the outpatient setting [12]. Many contacts between HCP and infected patients likely occur in ambulatory-care settings during the week preceding symptom onset [12]. In our study, infections were the most common in general wards (35.6%), followed by the outpatient department (25.0%), and emergency room (10.4%). Twenty-two percent of HCP reported that they worked in a flu ward, which was the outpatient department.

Similar to the results of previous studies [12], most infections in this study occurred in the healthcare setting (outpatients, inpatients, and HCP). This was followed by exposure to infected family members and infection due to unknown origin. In a previous report, 46% of cases were due to contact with patients with either H1N1 infection or an undiagnosed respiratory illness [12]. Meanwhile, 23.0% of HCP infections were due to contact with a friend or

**Table 4** Use rates of protective equipment in H1N1 cases among healthcare personnel during the week before initial symptoms

|  |  | Total (n=328) | Group I (n=90) | Group II (n=159) | Group III (n=32) | Group IV (n=47) | p-value* |
|---|---|---|---|---|---|---|---|
| N95 | Always | 13 (4.0) | 2 (2.3) | 9 (5.8) | 1 (3.1) | 1 (2.1) | 0.285 |
|  | Usually or intermittent | 60 (18.7) | 23 (26.1) | 27 (17.5) | 5 (15.6) | 5 (10.6) |  |
|  | Never | 248 (77.3) | 63 (71.6) | 118 (76.6) | 26 (81.3) | 41 (87.2) |  |
| Surgical mask | Always | 96 (29.4) | 15 (16.7) | 57 (36.3) | 13 (40.6) | 11 (23.4) | 0.007 |
|  | Usually or intermittent | 153 (46.9) | 50 (55.6) | 70 (44.6) | 14 (43.8) | 19 (40.4) |  |
|  | Never | 77 (23.6) | 25 (27.8) | 30 (19.1) | 5 (15.6) | 17 (36.2) |  |
| Gloves | Always | 28 (8.6) | 1 (1.1) | 18 (11.4) | 2 (6.3) | 7 (14.9) | <0.001 |
|  | Usually or intermittent | 101 (30.9) | 35 (38.9) | 50 (31.6) | 13 (40.6) | 3 (6.4) |  |
|  | Never | 198 (60.6) | 54 (60.0) | 90 (57.0) | 17 (53.1) | 37 (78.7) |  |
| Goggles | Usually or intermittent | 4 (1.2) | 2 (2.3) | 1 (0.6) | 1 (3.1) | 0 (0) | NA |
|  | Never | 320 (98.8) | 86 (97.7) | 157 (99.4) | 31 (96.9) | 46 (100.0) |  |
| Gown | Always | 67 (20.6) | 32 (35.6) | 24 (15.3) | 8 (25.0) | 3 (6.4) | <0.001 |
|  | Usually or intermittent | 36 (11.0) | 16 (17.8) | 14 (8.9) | 4 (12.5) | 2 (4.3) |  |
|  | Never | 223 (68.4) | 42 (46.7) | 119 (75.8) | 20 (62.5) | 42 (89.4) |  |

NA, not available

*Analyzed by the chi-square test or Fisher's exact test

**Fig. 1** The number of infected healthcare personnel with influenza A (H1N1) 2009 virus at nine university-affiliated hospitals and daily antiviral agent consumption from September to December 2009 in Korea. H1N1 vaccinations were started for healthcare personnel on 27th October 2009 (*arrow 1*), students in elementary, middle, and high schools on 11th November 2009 (*arrow 2*), young children under 6 years of age on 7th December 2009 (*arrow 3*), and pregnant women on 21st December 2009 (*arrow 4*)
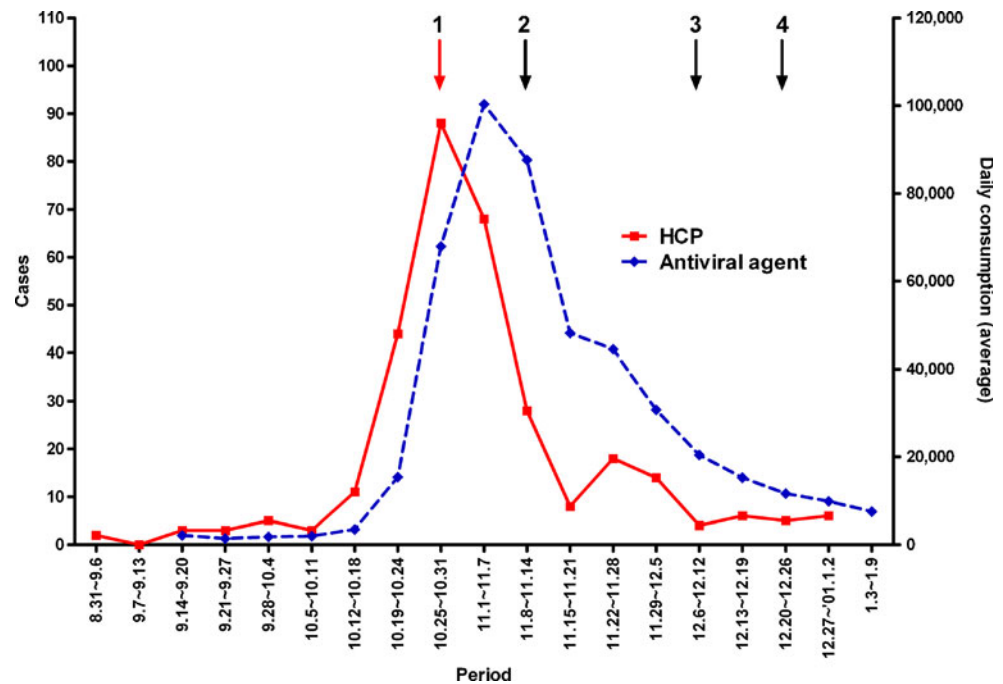


family member with H1N1 infection or undiagnosed respiratory illness.

In the healthcare setting, personal protective equipment are used to protect patients from healthcare-associated infections and to protect HCP from occupational exposure through droplet or airborne spread [8, 13–16]. Face masks (N95 or surgical masks) are crucial for the successful management of an outbreak of pandemics, keeping susceptible HCP safe from hospitalized patients and outpatients shedding droplet and airborne influenza particles [8, 17, 18]. In this study, the usage rate of N95 was very low (77.3% of HCP did not use an N95 mask, Table 4). Surgical masks, on the other hand, were used relatively often (29.4% of HCP always used a surgical mask). Gloves were not used 60.6% of the time, and goggles were used only 1.2% of the time. Gowns were not used 68.4% of the time. These results are very similar to those of other studies of behavior in the hospital setting [12].

The Advisory Committee on Immunization Practices (ACIP) recommends that vaccination efforts should focus initially on healthcare and emergency medical service personnel whose members are at higher risk for influenza or influenza-related complications and those who are likely to come in contact with the influenza virus as a part of their occupation [13]. Persons in all of these groups should be vaccinated as soon as the vaccine is available. The World Health Organization (WHO) Strategic Advisory Group of Experts recommended that each country secures a supply of 2009 H1N1 influenza vaccine sufficient to vaccinate all HCP in order to protect those at greatest risk and to minimize any disruption of healthcare services [19].

In this study, we found that the peak of H1N1 infection in HCP preceded the peak in the general population. The vaccination of HCP was a top priority in Korea, and after vaccination of the high-risk population, the number of patients with H1N1 influenza decreased rapidly. Early vaccination of these groups including HCP may have attributed to the decline of transmission. There were no deaths among the infected HCP surveyed in this study. Most infected HCP were young and were diagnosed soon after symptoms began. We believe that young age, early diagnosis, and rapid treatment were the main reasons for the lack of deaths occurring in this study.

However, there are several limitations. First, we did not calculate attack rates with full-time equivalent (FTE), which gives a rate controlled for different intensities of exposure to source patients. The proportion of part-time workers in the tertiary hospital is very low (<1.0%) in Korea. Even if we could use FTE in analysis, the attack rates associated with exposure to source patients would be similar to the results reported in this investigation. Second, we compared the HCP infection with all patients receiving anti-viral therapy. Therefore, there is a possibility of an overestimation of influenza patients. However, during the 2009–2010 pandemic influenza season in Korea, the total number of the isolated influenza viruses reported by the influenza sentinel surveillance was 3,852 (A/H3N2, 2; A (2009 H1N1), 3,842; B, 8) [20]. Among the 3,852 isolates, 99.7% were 2009 H1N1, suggesting that the estimation of influenza patients in this report is slightly over the actual number.

In conclusion, this is the first report indicating that HCP were at the greatest risk and these facts should be taken into

consideration when creating a strategy for dealing with future influenza epidemics.

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