

Original Article

## Changes in the vaccination rate among healthcare workers in response to hospital policies

Jin Young Lee<sup>1</sup>, Ji Young Park<sup>2</sup>, Young Hee Lee<sup>3</sup>, Je Hun Kim<sup>4</sup>, Jong Woo Park<sup>5</sup>

<sup>1</sup> Department of Internal Medicine, Kosin Medical College, Busan, Korea

<sup>2</sup> Department of Internal Medicine, Kosin University Gospel Hospital, Busan, Korea

<sup>3</sup> Department of Infection Control, Kosin University Gospel Hospital, Busan, Korea

<sup>4</sup> Department of Pulmonary and Critical care medicine, University of Ulsan college of Medicine, Asan medical center, Seoul, Korea

<sup>5</sup> Department of Emergency Medicine, Kosin University Gospel Hospital, Busan, Korea

### Abstract

**Introduction:** Vaccination is the most effective method of preventing infectious disease among healthcare workers (HCWs). Although HCWs are recommended to receive vaccination, the vaccination rates have been low. We sought to investigate the effect of HCWs' vaccination recommendation program by the types of enforcement and influencing factors on compliance, with the aim of enhancing their immunity.

**Methodology:** First and second interventions were carried out. During the first intervention, vaccinations were recommended through official documents. Hepatitis B vaccination was mandatory. Diphtheria toxoid, acellular pertussis (Tdap) and Hepatitis A vaccinations were recommended without financial support. MMR and varicella vaccinations were recommended with fees for the antibody test were covered by the hospital. One-to-one consultation (OC) regarding vaccination was held in the second intervention. Aside from the OC, the second intervention followed the same procedure as the first intervention for the antibody tests and vaccination, but differed in that pertussis vaccination fees were covered.

**Results:** The immunization rates for infectious diseases were greater after the second intervention than the first intervention. The rate of immunized HCWs with hepatitis B virus was 100% at the end of the second intervention. The greatest increase in immunization rates from the first to the second intervention was that for pertussis, and the second greatest was that for hepatitis A. Age and working units were influencing factors on hepatitis A vaccine compliance.

**Conclusions:** In order to increase vaccination rates, efforts must be made to deliver information to individual HCWs through OC as well as financial support including a mandatory policy.

**Key words:** vaccination; healthcare workers; compliance; one-to one consultation; financial support.

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### Introduction

Healthcare workers (HCWs) are at high risk of contracting various microbial infections [1]. Since most HCWs continue their jobs even when they have contacted an infectious disease, potentially transmitting pathogenic microorganisms to others, they may act as mediators that spread infectious diseases to other HCWs and patients; therefore, prevention of infectious diseases among HCWs is crucial [2]. Vaccination is the most effective method of preventing infectious diseases among HCWs [3]. Since healthcare-associated outbreaks can lead to fatal consequences for immunosuppressed patients, vaccination of HCWs has consistently been recommended [4]. The Advisory Committee on Immunization Practices has recommended HCWs to be vaccinated against influenza

on a yearly basis since 1984, and also to receive a single dose of tetanus toxoid, reduced diphtheria toxoid, acellular pertussis (Tdap) vaccine, and other recommended vaccines since 2005. Although these vaccines have been recommended for an extensive period of time, health institutions have not established policies yet [5]. In Europe, vaccination for HCWs has been recommended since 2000, but the vaccination rate has been less than 35% [6-8]. Similarly in Korea, while HCWs are recommended by the guidelines to receive vaccination [9], an individual HCW's awareness of vaccination and their own immunization status is poor. Furthermore, vaccination for HCWs at medical institutions is only at a recommendation level. HCWs who work in emergency departments (ED) or departments related to infectious diseases are especially

highly exposed to infectious diseases since they are required to direct contact with new patients even before they have sufficient information about the patients. The importance of vaccinations among HCWs, therefore, needs to be further emphasized. In this study, we implemented a vaccination recommendation program in accordance with vaccination guidelines for HCWs, with the aim of enhancing their immunity and managing infectious diseases among the HCWs. We also investigated the effects of the program on vaccination rates by the types of enforcement and influencing factors on compliance.

**Methodology**

This study was conducted between February and October 2016 at a single tertiary university hospital with 969 beds. This study was designed and initiated following the development of pertussis spontaneously in four patients at the university hospital between January and April 2016. Following the development of pertussis in the first patient in January 2016, chemoprevention (azithromycin) was administered to all HCWs contact with patients with pertussis. Following this, subsequent steps were taken that could be classified into two stages of action: first intervention and second intervention.

*First intervention*

In February 2016, each department was informed about vaccination guideline for HCWs through official documents. The occupational groups targeted for vaccination included physicians, nurses, and nursing assistants who worked in the ED, or departments and outpatient clinics of respiratory medicine, infectious diseases, and paediatrics. In this study, Tdap and Hepatitis A vaccinations were recommended without financial support. The presence of anti-HAV was tested by enzyme-linked immunosorbent assay (ELISA) and HCWs positive for IgG were classified as immune. MMR and varicella vaccinations were EIA recommended with fees for the antibody test were covered by the hospital. Measles and Varicella IgG antibodies were measured by the use of a commercial enzyme immunoassay (EIA). HCWs positive for IgG were classified as immune. Hepatitis B vaccination was mandatory and recommended according to Korean occupational safety and health acts. A mandatory anti-HBs test was performed for all HCWs at the beginning of their employment. The presence of anti HBs was tested by ELISA and HCWs positive for antibodies were classified as immune. The hospital covered the vaccination fees for the patients who showed negative results in an anti-HBs test. Meningococcus was not included in this study since the rate of exposure to the

**Table 1.** Comparison of first intervention and second intervention.

Recommendation form	First intervention	Second intervention
	Official documents	One-on-one consultation was done
Pertussis	Tdap vaccine once. HCWs with no history of receiving a vaccine were recommended. Vaccination fees were not covered by the hospital	Same as first intervention, but vaccination fees were covered by the hospital
Measles*	MMR vaccine twice in 1 month’s interval. HCWs with no history of measles, being vaccinated, and negative for IgG to measles were recommended. Fees for the antibody test were covered by the hospital	Same as first intervention
Varicella*	Varicella vaccine twice in 1 month’s interval. HCWs with no history of varicella, being vaccinated, and negative for IgG to varicella were recommended. Fees for the antibody test were covered by the hospital	Same as first intervention
Hepatitis A	Hepatitis A vaccine twice in 6 months’ interval. HCWs aged less than 30 years were vaccinated without undergoing a serologic test for anti HAV IgG, and those aged 30 years or older were vaccinated if their results were negative for IgG to hepatitis A virus. Serologic tests and vaccination fees were not covered by the hospital	Same as first intervention
Hepatitis B	Hepatitis B vaccine three times (0,1 <sup>st</sup> month and 6 <sup>th</sup> month) if anti-hepatitis B surface antigen antibody (anti-HBs) negative. HCWs underwent mandatory antibody testing on their first day of work at the hospital. All tests and vaccination fees were covered by the hospital	Same as first intervention

HCW: healthcare worker; MMR: mumps, measles, and rubella; Tdap: tetanus toxoid, reduced diphtheria toxoid, acellular pertussis; \* Since the HCWs were at high risk of infections, they were recommended to have their immunization status checked through a serologic test regardless of their age or of whether their medical records showed previous history of being vaccinated or of having measles or varicella.

bacteria was insignificant. The vaccination guideline was based on the Centres for Disease Control and Prevention (CDC) and on guidelines by the Korean Society of Infectious Disease (KSID). HCWs who were vaccinated before the start of the second intervention (earlier than 31<sup>st</sup> March 2016) were included in the counting of HCWs who acquired immunity during the first intervention.

### Second intervention

In April 2016, a second intervention was implemented to increase vaccination rates among HCWs. The same participants in the first intervention were targeted. One-to-one consultation (OC) regarding vaccination was held in outpatient clinics. Each HCWs was required to visit an infection control doctor within 2 weeks in their free time. The infection control doctor provided necessary vaccination information and emphasized the need for vaccination for their own safety, as well as the prevention of transmission of diseases to other patients and HCWs. In addition to the steps covered in the first intervention, we recommended the HCWs to attend an OC. Aside from the OC, the second intervention followed the same procedure as the first intervention for the antibody tests and vaccination. The two interventions differed in that pertussis vaccination fees were covered in the second intervention (Table 1). The immunization status was checked for all HCWs at an OC until the end of the first intervention. Unimmunized HCWs were recommended to be vaccinated. HCWs who were vaccinated until 30<sup>th</sup> June 2016 were considered as acquired immunity during the second intervention.

### Analysis of differences between two interventions compared with influenza vaccination

We investigated the immunization status of the HCWs against each infectious disease after the first and second interventions, and compared vaccination rates. Vaccination with the MMR and varicella zoster vaccine were deemed complete after the second dose was given, hepatitis A vaccination after the first dose was given, and hepatitis B vaccination after the second dose was given, with the vaccination interval for each vaccine taken into account.

We compared the final immunization rates with the influenza vaccination rate performed in accordance with the hospital policies in October 2016. All HCWs are required to be vaccinated against influenza since 1997 in this hospital. The HCWs were notified by the heads of their departments and through social media to be vaccinated. Vaccination fees were covered by the

hospital. In cases where HCWs did not acquire immunity against certain infectious diseases even after second intervention, we investigated factors that may have contributed to such a result. Thus, we retrospectively investigated sex, age, employment period, designated ward, and types of occupation of the HCWs through their medical records.

Statistical analysis was performed using IBM SPSS Statistics for Windows, version 23.0 (IBM Corp., Armonk, NY, USA). Correlations between categorical variables were evaluated using chi-square test. Independent factors of vaccination rates were analyzed using logistic regression analysis, and a p-value less than 0.05 was considered statistically significant.

### Ethics statement

This study was approved by the Institutional Review Board of Kosin University Gospel Hospital.

### Results

A total of 88 HCWs were included in this study. None of the HCWs involved in this study had been traveling during the period. The demographic characteristics are followed by Table 2. The immunization rates for pertussis, measles, varicella, hepatitis A, and hepatitis B were greater after the second intervention than the first intervention. The greatest increase in immunization rates from the first to

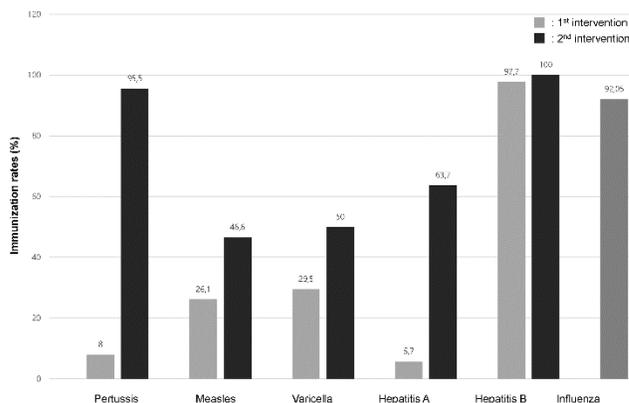
**Table 2.** Baseline characteristics of healthcare workers in this study (N=88).

Characteristics	Total (%)
Sex	
Female	63(71.6%)
male	25(28.4%)
Age (years)	
20-29	49(55.7%)
30-39	25(28.4%)
40-49	8(9.1%)
≥ 50	6(6.8%)
Length of experience in hospital (years)	
< 10	65(73.9%)
10-19	17(19.3%)
20-29	5(5.7%)
≥ 30	1(1.1%)
Hospital unit	
Emergency room	60(68.2%)
Respiratory wards, outpatient clinics	28(31.8%)
Occupation	
Medical doctor	23(26.1%)
Nurse	60(68.2%)
Nursing assistant	5(5.7%)

the second intervention was that for pertussis. The rate of Tdap vaccination was 8% after the first intervention, and 95.5% after the second intervention. The rates of immunization against measles and varicella, for which only the serologic tests for antibodies, and not the vaccination fees, were covered by the hospital were 26.1%, and 29.5% after the first intervention, respectively, and it increased to 46.5% and 50.0% after the second intervention. In the case of hepatitis A, the antibody test and vaccination rate was 5.8% after the first intervention, and 63.7% after the second intervention. The second highest increase in the immunization rate between the first and second interventions was observed for hepatitis A. Although questionnaires were not used in this study, we interviewed each HCW and found a tendency among the HCWs to perceive the risk of hepatitis A, which is a direct contact infection, as higher than that of airborne infections such as varicella and measles due to the nature of their occupation, which requires them to wear protective masks.

The rate of positive anti HBs test results and vaccination upon negative results was 97.7% after the first intervention, and 100% at the end of the second intervention. The HCWs who acquired immunity against hepatitis B included hepatitis B carriers. Among the HCWs included in this study, the number of HCWs who received the influenza vaccine annually in accordance with the hospital policies was 81 (92.1%) (Figure 1).

**Figure 1.** Cumulative immunization rates (%) in health care workers at the first and second intervention compared with influenza vaccination rate performed in October 2016.



Eighty-four (95.5%) HCWs attended an OC in the second intervention in this study. There was no HCW who could not be vaccinated due to contraindications or religious reasons. The final rate of immunization against each infectious disease among the 84 HCWs who attended an OC was 100% for Tdap and hepatitis B, but not for measles and varicella, for which partial financial support was given, and for hepatitis A, for which no financial support was given.

We investigated the factors that contributed to the development of immunity against measles, varicella, and hepatitis A, against which the HCWs were not

**Table 3.** Determinants associated with healthcare workers immunized for measles and varicella.

	All N = 84	Vaccinated or showed positive antibody results for measles and varicella (%) N = 40
Factors		
Gender		
Female	61	32(52.5%)
Male	23	8(34.8%)
Age (years)		
20-29	48	27(56.3%)
≥ 30	36	13(36.1%)
Length of experience in hospital (years)		
<10	62	31(50.0%)
10-19	16	9(56.3%)
≥ 20	6	0(0%)
Hospital unit		
Emergency room	56	30(53.6%)
Respiratory wards, outpatient clinics	28	10(35.7%)
Occupation		
Medical doctor	21	9(42.9%)
Nurse	58	29(50.0%)
Nursing assistant	5	2(40.0%)

immunized even after the second intervention, unlike pertussis and hepatitis B. A higher proportion of HCWs who were vaccinated or showed positive results in the antibody test for measles and varicella, was women (52.5%). The number of HCWs aged less than 30 years was higher than that of those aged 30 years or older; however, the difference was not statistically significant. In regards to the length of employment period, HCWs employed for 10-19 years had the highest proportion (56.3%). In regards to hospital departments, the proportion of HCWs in the ED (53.6%) was higher compared to the department of respiratory medicine and outpatient clinics; however, the difference was not statistically significant (Table 3) In the case of hepatitis A, for which no financial support was given, positive for anti HAV IgG or vaccination rate was significantly higher among the HCWs aged less than 30 years (n = 38, 79.2%) compared to those aged 30 years or older in the univariate analysis (p < 0.05). The proportion of HCWs who worked less than 10 years was the highest (74.2%). The proportion of HCWs who worked in the ED (76.8%) was significantly higher than of those who worked in the department of respiratory medicine or outpatient clinics (p < 0.05). In the multivariate analysis, the final immunization rates was higher among the HCWs aged less than 30 years compared to those aged 30 years or older (adjusted odds ratio [aOR] = 3.52 (95% Confidence Interval [CI] 1.297–9.555)),

and among the HCWs who worked in the ED than those who worked in the department of respiratory medicine and in outpatient clinics (aOR = 3.434 (95% CI 1.244–9.480)) (Table 4).

**Discussion**

We found differences in immunization rates according to the vaccination policies that were in effect. The mandatory vaccination policy was the most effective in increasing immunization rates among HCWs. Financial support and OC also contributed to the increase. In addition, HCWs’ awareness of different types of vaccines contributed to the increase in immunization rates.

The immunization rate against hepatitis B, for which vaccination was mandatory, and the mandatory antibody test and vaccination fees were covered by the hospital, was the highest after both the first and second interventions in this study. As a result of low compliance of HCWs, a mandatory vaccination program for HCWs has been drawing attention, and the compliance rate has been drastically improving [10,11]. Mandatory vaccination for HCWs was performed for the first time in 2005 against influenza in United states, and vaccination rates reached 98% [12,13]. While the mandatory vaccination policy was the most effective in improving vaccination rates, it was associated with ethical and legal issues related to HCWs’ autonomy

**Table 4.** Determinants associated with healthcare workers immunized for hepatitis A: univariate analysis and multivariate analysis

	All N=84	Vaccinated or showed positive antibody results for hepatitis A (%) N=57	P-value (univariate analysis)	Multivariate analysis	
				Odds ratio (95% CI)	P-value
Sex					
Female	61	43 (70.5%)	0.403		
Male	23	14 (60.9%)			
Age (years)					
20-29	48	38 (79.2%)	0.011	3.52 (1.297 - 9.555)	0.014
≤30	36	19 (52.8%)			
Length of experience in hospital (years)					
<10	62	46 (74.2%)	0.007	Ref. 0.822 (0.183-3.698)	
10-19	16	10 (62.5%)			
≤20	6	1 (16.7%)			
Hospital unit					
Emergency room	56	43 (76.8%)	0.014	3.434 (1.244-9.480)	0.017
Respiratory wards, outpatient clinics	28	14 (50.0%)			
Occupation					
Medical doctor	21	15 (71.4%)	0.949		
Nurse	58	38 (65.5%)			
Nursing assistant	5	4 (80.0%)			

CI: confidence interval.

[14,15]. In this regard, a policy-oriented approach, including tasks like educating HCWs through OC and providing free vaccines may increase vaccination rates more effectively than implementing mandatory policies. Accurate information regarding types of vaccines needed, routes of infection transmission, and vaccination methods and benefits for HCWs is lacking. Nicole *et al.* reported that only 21.9% of HCWs were aware of current vaccination guidelines [16]. We found the benefits of OC as a second intervention, the increase in vaccination rates among HCWs due to the promotion of awareness on the side effects of vaccination, benefits of vaccinations and the danger of not being vaccinated. In previous studies, group education alone had limited effects in improving vaccination rates, and phone interviews and OC were found to result in a meaningful improvement in vaccination uptake [17-19].

The importance of financial support in increasing immunization rates was confirmed in this study when the rate of vaccination against influenza, for which the fees are covered by the hospital, reached over 90%. Of course, the influenza vaccination differed from other vaccinations in that it has been taken before the flu season during similar periods every year since 1997. Measles and varicella were also supported partial financial support in the form of antibody test fee coverage in the first intervention. By the end of the first intervention, the immunization rates were the highest after that for hepatitis B, for which mandatory vaccination was conducted.

In the case of the Tdap vaccine, for which both OC and financial support were provided in the second intervention, the vaccination rate was merely 8% in the first intervention, but was the second highest after the vaccination rate for hepatitis B by the end of the second intervention.

As can be seen, vaccination education via OC and financial support effectively improved vaccination rates among the HCWs. Despite the fact that only OC was conducted and no financial support was provided, the final immunization rate for hepatitis A was higher than those for varicella and measles, for which partial financial support was given. This may be a reflection of the changes in the level of awareness of each HCW on vaccination. HCWs are aware of hepatitis A which transmitted by contact is more risky than airborne diseases preventable by wearing a mask. In other studies that used a questionnaire, HCWs' main reason for getting vaccinated was for self-protection rather than preventing transmission of infectious diseases to patients and other HCWs [20]. We evaluated influencing factors on hepatitis A vaccine compliance

recommended without mandatory policy or financial support. In the multivariate analysis, the final immunization rate of hepatitis A was higher among the HCWs who were aged less than 30 years, and those who worked in the ED. Previous studies have also reported decreasing vaccination compliance with increasing age due to a common misconception about side effects of vaccination, and because HCWs tended to believe that they were healthy and did not need any vaccinations [21,22]. In most other studies, concerns regarding side effects of vaccination were the major reason for HCWs refusing vaccination [23,24]. Similarly, in our study, most HCWs explained during the OC that their reason for not getting vaccinated was due to their concerns about side effects. Many HCWs working in the ED perceived a high risk of infection in their workplace since it is in the ED that the HCWs meet new patients before they have sufficient information about the patients. Their compliance rate significantly increased after they received one-to-one education on infectious diseases.

This study had a number of limitations. First, it was conducted in a single hospital for 8 months, and the intervention used in this study may not produce the same results in other institutions. Second, questionnaires were not used to record the responses from participants obtained during the OC; therefore, it was difficult to ascertain the exact reasons why the HCWs decided to be vaccinated or not. Lastly, only HCWs in the ED, and departments with high risk of infectious diseases were included in this study. These limitations need to be addressed in future research.

## Conclusion

In conclusion, vaccination is the most effective method of preventing infections among HCWs. In order to increase vaccination rates, efforts must be made to deliver information regarding infectious diseases to individual HCWs through OC and to educate them about the benefits of vaccination and dangers of not maintaining their immunity against infectious diseases as well as financial support.

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### Corresponding author

Ji Young Park  
 Department of Internal Medicine, Kosin University Gospel Hospital, 262, Gamcheon-ro, Seo-gu, Busan, Korea 49267  
 Phone: 051-990-6157  
 Fax: 051-990-3049  
 E-mail: aiteitel@naver.com

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