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Major article

Occupational exposure to infection risk and use of personal protective equipment by emergency medical personnel in the Republic of Korea

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Background: Few studies of occupational exposure (OE) to infectious risk among emergency medical personnel (EMP) or their use of personal protective equipment (PPE) have been conducted in the Republic of Korea.
Objective: To determine the status of OE to infectious risks and use of PPE.
Methods: A convenience sample of 907 questionnaires (response rate, 88.5%) was collected from September 1, 2014, to January 31, 2015, in 5 metropolitan Korean cities.
Results: Respiratory diseases were significantly prevalent (44.5%) and influenza (29.5%) was the most frequently reported illness. An exposure report was only made in 19.5% of cases. The primary reason for OE report noncompletion was the complexity of the reporting process (23.9%). A total of 365 participants reported OE to body fluids and blood (40.2%) with needlestick injury being the most frequent OE type (17.6%). More than 5 years of job experience (47.8%) ($P < .001$) and region (city) ($P = .003$) significantly increased OE to body fluids and blood. Puncture-resistant containers (71.9%) and disposable gloves (68.9%) were used. Job training and education on infection risks and use of PPE were not uniformly conducted (77.5%). Anxiety about OE to risk of infection from patients was common among EMP (63.2%).
Conclusions: EMP experienced significant OE to infectious risk and use PPE inadequately. Surveillance and education programs regarding OE should be developed.

Prehospital health care providers, particularly emergency medical personnel (EMP), including emergency medical technicians (EMTs) and nurses, are exposed through their occupation to bloodborne pathogens, including hepatitis B virus, hepatitis C virus, HIV, and various other infectious hazards.[1,2] Unlike the characteristics of occupational exposure among other hospital health care workers (HCWs),[3,4] EMP are exposed more frequently to respiratory diseases[2] and blood via skin exposure rather than percutaneous exposure such as needlestick injury.[5-7] Thus, standard precautions, including the adequate use of personal protective equipment (PPE), are strongly recommended for EMP.[8,9] Blood exposure risks are more than doubled (odds ratio, 2.4) when not using appropriate PPE.[5]

In the Republic of Korea (hereafter Korea), prehospital health care providers as EMPs were mainly EMTs and nurses. As providers of prehospital emergency medical services (EMS), EMTs have 2 levels of certification: basic emergency medical technician (EMT-B) and paramedic (EMT-P). There are college- or university-based education systems for EMT-P and special authorized training organizations for EMT-B accredited by the Ministry of Health and Welfare, in which individuals are required to pass both written and practical examinations for the national EMS certification. Most EMTs are stationed at fire stations as prehospital EMS providers, whereas others are often positioned in the emergency department of hospitals. The duties of EMT-P include invasive medical treatments (including endotracheal intubation, initiating intravenous access, and injecting intravenous glucose for hypoglycemic shock), administering medication (sublingual nitroglycerin and bronchodilator for asthma attack), and performing cardiopulmonary resuscitation and ventilator support. The duties of EMT-B are limited to noninvasive procedures and basic life support.[10]

Few studies of occupational exposure to infectious risk among EMP and prehospital HCWs providing EMS and their adherence to the use of PPE in prehospital environments have been conducted

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Statement

There is no about any presentation of the data or findings in a preliminary report or abstract.

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in Korea. Moreover, during the Middle East respiratory syndrome outbreak from May 20-July 28, 2015, it was reported that 2 Middle East respiratory syndrome cases were caused by occupational exposure among EMP.[11] EMP should be included in occupational exposure prevention systems and systematically protected from occupational infectious risks as are other HCWs.[3] To achieve this, the status of their occupational exposure to infectious risk and infection prevention measures should be investigated and quantified, providing basic information of the status of occupational exposures to develop effective occupational exposure prevention systems for EMP.

Therefore, this study was conducted to determine the current status of occupational exposures among EMP to infectious risks and their use of PPE in prehospital environments, and to provide basic information about the occupational exposures of EMPs for the development of occupational exposure prevention programs.

METHODS

Design

A survey was conducted in the 5 largest and most representative metropolitan cities in Korea (referred to as locations A-E). A self-report, anonymous questionnaire about occupational exposure to infectious risks, use of PPE, and job training was administered to EMPs. The questionnaire took approximately 15 minutes to complete. The study was approved by the Institutional Review Board at Daejeon University.

Questionnaire

The 2-part questionnaire was developed based on literature reviews.[4,6,12,13] Part I consisted of 12 questions assessing participants' demographic characteristics and the general characteristics of their workplaces, a majority of which were emergency fire stations. Part II included 18 questions measuring the extent of occupational exposure to infectious risks, job training and education, the use of PPE, and their concerns and suggestions. Detailed follow-up questions were used in several categories. Specific occupational exposure information included exposure experiences, types of occupational exposure, types of infectious diseases to which they were exposed, and previous reports of occupational exposure (if occupational exposure was not reported, the reasons for this were also collected). Specific PPE use information included use of PPE as a standard precaution (ie, wearing gloves and other PPE), manipulation of needles, use of sharps containers, types of PPE used during the transfer of patients with respiratory symptoms, and types of PPE used during transfer of patients with bleeding. Specific information about job training and educational experiences within the past year was collected, including the status of their training in occupational exposure to infection risks, use of PPE, and postexposure management (PEM). Information about participants' major concerns and suggestions about occupational exposure and prevention was also collected. The questionnaire was revised to increase validity following a pilot study of expert EMPs. The final questionnaire included 30 questions.

The Cronbach's alpha value of the final questionnaire was 0.788 (Cronbach's alpha based on standardized items, 0.782), indicating a good internal consistency.

Data collection and participants

The sample size required for a statistical power of 0.80, an effect size of 0.15, and an $\alpha < 0.05$ was N = 277. A total of 1,025 questionnaires were mailed to prehospital EMPs working at fire stations (questionnaire packages with cover letters were distributed with a return envelope). Participation was both voluntary and anonymous. Between the study period September 1, 2014-January 31, 2015, a total of 907 questionnaires (response rate, 88.5%) were collected via mail. Only EMPs indicating that they provide EMS as prehospital workers were enrolled in the study, excluding EMP working in hospital emergency departments.

Statistical analyses

The Kolmogorov–Smirnov test was used to analyze data distribution and normality. Descriptive statistics and multiple response analysis were used. Categorical variables were compared using the χ^2 test. Statistical analyses were performed using SPSS version 20.0 for windows (IBM-SPSS Inc, Armonk, NY). $P < .05$ was considered statistically significant.

RESULTS

General characteristics of participants (N = 907)

The average age of EMPs was 34.8 ± 15.0 years. Men (n = 795; 87.7%) were dominant in this sample. The job categories of the study population included EMTs (n = 646; 71.3%), nurses (n = 60; 6.6%), and nonspecified EMPs (n = 201; 22.1%). The educational attainment among the study population was college (or university) education (n = 808; 89.1%), followed by high school diploma (n = 87; 9.6%) and master's degree (n = 12; 1.3%). The median years at current workplace was ≤5 years (n = 551; 60.7%), followed by 6-10 years (n = 211; 23.3%) and ≥11 years (n = 145; 16.0%). Participation according to national representation was 181 from location A (20.0%), 241 from location B (26.6%), 134 from location C (14.8%), 108 from location D (11.9%), and 243 from location E (26.8%).

Occupational exposure to infections

Types of occupational exposure to infectious risks and management of sharps are listed in Table 1. Respiratory diseases were the most common occupational exposure (44.5%); influenza (29.5%), specifically, was the illness to which participants were most frequently exposed, followed by diarrhea, hepatitis, and HIV/AIDS. An exposure report was completed in only 19.5% of occupational exposure cases. The reasons for unreported exposure were the complexity of the process (23.9%), followed by being too busy, finding report completion annoying, and concerns regarding promotion and salary consequences.

A total of 365 participants reported occupational exposure to body fluids and blood (40.2%). Percutaneous exposures (ie, needlestick injury) were the most frequent route of exposure (17.6%), followed by mucocutaneous exposure and nonspecified. Needle and sharps manipulation were practiced by 34.9% of subjects. In particular, recapping (22.6%) and needle manipulation (10.9%) were the most frequently used procedures. Puncture-resistant containers for the disposal of needles and sharps were used by 71.9% (Table 1).

Length of experience on the job and city of employment had a statistically significant association with occupational exposure to body fluids and blood. Those with more than 5 years of job experience (170 out of 356; 47.8%) had significantly higher ($P < .001$) occupational exposure to body fluids and blood than those with 5 years or less (195 out of 551; 35.4%) experience. The rate of occupational exposures to body fluids and blood were 39.8% at location A (72 out of 181), 32.8% at location B (79 out of 241), 53.7% at location C (72 out of 134), 41.7% at location D (45 out of 108), and 39.9% at location E (97 out of 243). The differences among the cities were statistically significant ($P < .003$).

Table 1
Types of occupational exposure to infection risk and management of sharps (n = 907)

Variable	n	%
Type of infectious diseases		
Respiratory diseases	404	44.5
Influenza	268	29.5
Pulmonary tuberculosis	70	7.7
Pneumonia	66	7.3
Diarrhea	242	26.7
Hepatitis	180	19.8
HIV or AIDS	2	0.2
Nonspecified	79	8.7
Exposure report		
Yes	177	19.5
No	556	61.3
Reasons for nonreporting		
Complicated process	133	23.9
Busy	68	12.2
Annoying	53	9.5
Worry about some consequences	25	4.5
Nonspecified	277	49.8
No response	174	19.2
Body fluid and blood exposure		
Yes	365	40.2
No	542	59.8
Types of body fluid and blood exposure		
Percutaneous	192	21.1
Needlestick injury	160	17.6
Cut with potential contaminated materials	32	3.5
Mucocutaneous	136	15.0
Mucous membrane exposure	127	14.0
Mouth-to-mouth resuscitation without PPE	9	1.0
Nonspecified	37	4.1
Discarding needles and other sharps		
Without any manipulation	532	58.7
Manipulation	317	34.9
Recap	205	22.6
Scooping or handle	99	10.9
Nonspecified	13	1.4
Not used	58	6.4
Types of disposal containers for needles and other sharps		
Puncture-resistant containers	652	71.9
Waste containers in the hospital	211	23.3
Casual waste containers	22	2.4
Nonspecified	22	2.4

Table 2
The use of personal protective equipment (PPE)

Variable	n	%	Case %*
Types of commonly used PPE			
Disposable gloves	625	68.9	
Masks	224	24.7	
Face shields	26	2.9	
Eye protectors	15	1.7	
Gowns	4	.4	
Caps	2	.2	
Nonspecified	11	1.2	
Subtotal	907	100.0	
Adherence to use of PPE			
Always	761	83.9	
Not always	146	16.1	
Intermittently	71	7.8	
When infection risks detected	37	4.1	
Rarely used	17	1.9	
Nonspecified	14	1.5	
Nonuse	7	.8	
Subtotal	907	100.0	
Reasons for not always using PPE			
No need to use	24	16.4	
Annoying	23	15.8	
Insufficient PPE supply	18	12.3	
Busy	8	5.5	
Worry about patient comfort	4	2.7	
Nonspecified	69	47.3	
Subtotal	146	100.0	
Types of PPE used when transferring patients with respiratory symptoms			
Masks	841		93.8
Disposable gloves	523		58.3
Sterilized gloves	359		39.6
Goggles	229		25.5
Gowns	103		11.5
Face shields	92		10.3
Caps	63		7.0
Shoe covers	41		4.6
Nonspecified	15		1.7
Subtotal	2,266		
Types of PPE used when transferring trauma patients with bleeding			
Masks	761		86.0
Sterilized gloves	560		61.7
Disposable gloves	537		60.7
Goggles	336		38.0
Gowns	204		23.1
Face shields	108		12.2
Caps	102		11.5
Shoe covers	85		9.6
Nonspecified	5		0.6
Subtotal	2,698		

*Multiple response analysis.

Use of PPE

The most commonly used PPE item was disposable gloves (68.9%), followed by masks, face protectors, eye protectors, gowns, and caps. The proportion of participants who reported always using PPE when making contact with patients was 83.9%. The reasons for not always using PPE were no need to wear (16.4%), followed by annoying, insufficient supply, busy, and worry about making patients uncomfortable.

When transferring patients with respiratory symptoms, the most commonly used PPE was a mask (93.8%). When transferring trauma patients with bleeding, the most commonly used PPE was a mask (86.0%), followed by gloves, goggles, gowns, face shields, caps, and shoe covers (Table 2).

Job training and education

Among the participants, 703 (77.5%) had received on-the-job training and education about occupational exposure to infectious risks, use of PPE, and PEM within the past 12 months. Topics on bloodborne and infection-risk pathogens included the transmission route of bloodborne pathogens (n = 596; 65.7%), occupational blood exposures and other potential exposure pathogens (n = 573; 65.3%), infectious diseases and bloodborne diseases (n = 443; 47.7%), and the effects, safety, benefits, and cost of hepatitis B vaccine (390; 43.0%). Topics on PPE included how to select PPE (n = 623; 68.7%), how to use, operate, wear, and remove PPE as well as disinfection and disposal of PPE (n = 593; 65.4%). Topics on PEM included PEM of blood or other potential pathogen exposures (n = 532; 58.5%), process of report and postexposure treatments (n = 522; 57.6%), and information about evaluating the risk of exposure and PEM (n = 423; 46.6%). Training on topics of disinfection included ambulances and other materials (n = 662; 73.0%) and infection prevention planning for fire stations (n = 574; 63.3%).

Regarding the question, "What most concerns you related to occupational exposure to infection risks?" participants showed highest concern about infection from patient exposure (63.2%), followed by contamination of uniforms (11.0%), and other concerns. Regarding the question, "What are your comments or suggestions to prevent occupational exposures?" the majority of participants suggested a need for greater support for employee health (36.5%), followed by

Table 3
Major concerns and suggestions about infection control

Variable	n	%
Major concerns		
Being infected by patients	573	63.2
Contamination of uniform	100	11.0
Deficit in knowledge	90	9.9
Transmitting infection to other patients	66	7.3
Decontamination of ambulances	42	4.6
Disinfection or sterilization methods	16	1.8
Nonspecified	20	2.2
Subtotal	907	100.0
Suggestions		
Support employee health (ie personal protective equipment and vaccination)	331	36.5
Support knowledge and information about decontamination process	252	27.8
Increase supply of disposable items for patient care	203	22.4
Increase job training and education	76	8.4
Cooperate with other hospitals	27	3.0
Nonspecified	18	2.0
Subtotal	907	100.0

educational support that provides information on decontamination processes (27.8%) and other (Table 3).

DISCUSSION

The majority of participants (EMPs as prehospital EMS providers) were men, as in a previous study.[6] Respiratory diseases were a major occupational exposure infectious risk, with influenza being the disease to which EMPs were most frequently exposed. This finding corresponds with previous study results. El Sayed et al[2] reported that EMPs were exposed most frequently to respiratory diseases such as possible meningitis (32.9%) followed by tuberculosis (17.1%) and viral respiratory infections (15.4%). An occupational exposure report was completed by a small proportion of participants and the proportion of unreported cases of exposure was easily correctable with adequate education and information about occupational exposure infection reporting systems.

Datta et al[1] reported that first responders have high rates of exposure to blood via skin contact (174 per 100 person-years) but few via mucosal or needlestick exposures (1 and 0 per 100 person-years, respectively). Marcus et al[6] reported that individual EMS workers have a mean of 1.25 blood contacts, including 0.02 percutaneous exposures, per 100 patients attended. Unlike the previous studies,[1,6] our study revealed that EMP percutaneous exposure in Korea (ie, needlestick injury) was the most frequent route of occupational exposure to body fluids and blood. This result was likely related to the high rate of recapping and manipulation of needles, and to participants' dissatisfaction with their use of puncture-resistant containers for disposal of needles and sharps (shown in Table 1). Therefore, job training and education about blood and body fluid exposure prevention should be encouraged. In addition, supplies of sharps containers should be increased in all areas of the work environment.

In this study, the magnitude and the types of occupational exposure could be measured only in an approximate manner. The first step toward establishing effective programs for occupational exposure prevention is accurately and practically quantifying the size and characteristics of occupational exposure, which should include measuring the incidence density. This will be valuable for determining the effects of subsequent occupational exposure prevention programs. Next, an occupational exposure infectious risk surveillance system should be developed.

Occupational exposure to body fluids and blood was higher among EMP with more than 5 years of job experience and in specific regions. Exposure prevention education and training should be targeted toward senior EMP, with regular support and ongoing training throughout their careers. Furthermore, national occupational exposure prevention programs should be developed to address regional disparities.

Adherence to the use of PPE as a standard precaution was low. Among the types of PPE, gloves were used most frequently. However, percentage of EMPs wearing gloves was lower than in previous studies (where 2.4%[12] and 17%[13] did not wear gloves). Our participants' use of PPE did not satisfy the standards.[9,14] Therefore, additional efforts should be made to improve adherence to routine PPE use. When EMPs transfer patients with respiratory symptoms and open trauma with bleeding, the most commonly used PPE was a mask; however, the use of other PPE was very low. Therefore, job training and education about PPE use according to transmission-based and exposure types should be included to decrease exposure risk. Leiss[5] reported that the risk of nonintact skin blood exposure and not being provided with appropriate PPE increased the risk of occupational exposure (odds ratio, 2.4; 95% confidence interval, 1.6-3.3).

In this study, on-the-job education and training status did not satisfy the recommendations.[9,14] Therefore, job training and education should be developed to improve the use of PPE and prevent occupational exposure more effectively. Moreover, because EMP reported being preoccupied with worry about infection transmission risk, adequate information about occupational exposure and prevention should be delivered.

This study had some limitations inherent to self-report studies; for example, recall bias of occupational blood exposures, using a gross measurement of occupational exposure, and a lack of incidence density assessment.

However, this study measured the status of occupational infection control programs among EMP in terms of types of occupational exposure to infectious risks and use of PPE among a nationally representative sample working in 5 large cities in Korea.

CONCLUSIONS

Significant occupational exposure risks, the lack of adherence to PPE protocols among EMPs, and on-the-job training was reported. Therefore, the following should be developed: surveillance programs for occupational exposure, employee health programs for occupational exposure prevention and PEM, and effective job training and education programs for PPE use and occupational exposure prevention.

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