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Major Article

A Middle East respiratory syndrome screening clinic for health care personnel during the 2015 Middle East respiratory syndrome outbreak in South Korea: A single-center experience

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Background: Transmission of Middle East respiratory syndrome (MERS) to health care personnel (HCP) is a major concern. This study aimed to review cases of MERS-related events, such as development of MERS-like symptoms or exposure to patients.

Methods: A MERS screening clinic (MSC) for HCP was setup in the National Medical Center during the MERS outbreak in 2015. Clinical and laboratory data from HCP who visited the MSC were retrospectively reviewed. Additionally, these data were compared with the results of postoutbreak questionnaire surveys and interviews about MERS-related symptoms and risk-related events.

Results: Of the 333 HCP who participated in MERS patient care, 35 HCP (10.5%) visited the MSC for MERS-like symptoms. No one was infected with MERS, and the most common symptom was fever (68.6%) followed by cough (34.3%). However, 106 of 285 postoutbreak survey participants experienced at least 1 MERS-related symptom and 26 reported exposure to patients without appropriate personal protective equipment, whereas only 4 HCP visited the MSC to report exposure events.

Conclusions: Although a considerable number of HCP experienced MERS-related symptoms or unprotected exposure during MERS patient care, some did not take appropriate action. These findings imply that for infection control strategy to be properly performed, education should be strengthened so that HCP can accurately recognize the risk situation and properly notify the infection control officer.

BACKGROUND

The largest outbreak of Middle East respiratory syndrome (MERS) outside the Middle East occurred in South Korea in 2015. During the outbreak, 186 patients were confirmed to have MERS, of which 37 died.[1,2] Isolated strains were typed as clade B MERS-coronavirus (CoV) and were closely related to the viruses circulating in the Middle East.[3] The distinct feature of the MERS outbreak in South Korea was that the transmission was hospital-related, with transmission within the hospital and from hospital to hospital, resulting in the exposure of a high number of health care personnel (HCP) to MERS-CoV.[4] In general, HCP form a considerable proportion of confirmed MERS cases as observed during previous outbreaks. In the 2014 outbreak in Jeddah, Saudi Arabia, 81 of 255 patients (31%) were HCP.[5] In the 2015 MERS-CoV outbreak in South Korea, 30 of 166 confirmed patients (18%) were HCP.[6]

A number of HCP reported several symptoms compatible with CoV infection during a MERS outbreak[5,7,8]; this raises concerns about nosocomial spread and loss of competency in the medical service. Hospitals have instituted screening clinics for HCP with symptoms suggestive of CoV infection during outbreaks. The World Health Organization and U.S. Centers for Disease Control and Prevention

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developed a guide to determine who is eligible for MERS-CoV evaluation.[9,10] Typically, MERS-infected individuals seek medical care for symptoms such as fever, chills, cough, shortness of breath, and myalgia. However, several asymptomatic cases or patients with minimal symptoms have been reported.[11,12]

The National Medical Center (NMC) was a designated institution for MERS patient care during the 2015 outbreak in South Korea. A total of 30 of 186 confirmed MERS patients were referred to the NMC from May-July in 2015. During this period, the NMC instituted a screening clinic for HCP involved in MERS patient care to ensure rapid detection, isolation, and management of HCP who were possibly infected with MERS. The aim of this study was to review the HCP who visited the screening clinic for MERS-related symptoms or exposure events. Additionally, we compared the data of this HCP group with the results of the postoutbreak survey and interviews focusing on the overall HCP population that participated in MERS patient care.

MATERIALS AND METHODS

Study population

All HCP who participated in MERS patient care between May 20, and July, 31, 2015, were included in this study. We conservatively defined participation in MERS patient care as presence within 1 m of a patient with confirmed MERS, irrespective of use of personal protective equipment (PPE). During the MERS outbreak period, log data were filed for every HCP who entered the isolation unit, and eligible HCP were selected based on these data.

Infection control measures in the NMC

Patients with MERS were admitted to a negative pressure isolation room, and airborne transmission precautions were applied. The expected risk of exposure to MERS was considered when selecting PPE. In general, HCP wore gloves, a fluid-resistant coverall, a face shield that completely covered the face, and an N95 respirator. When the exposure risk was higher because of aerosol-generating procedures or mechanical ventilator care, HCP wore inner and outer gloves, an impermeable coverall, a powered air purifying respirator (PAPR) with external belt-mounted blower, a full face shield (hood), inner and outer boot covers, and an apron.[13] PPE was single-use and disposable, except some units of PAPR. Because only sparse data from Saudi Arabia were available regarding the transmission of MERS-CoV within health care facilities, the NMC adopted a higher infection precaution level than that generally recommended.

During the MERS outbreak, tympanic temperature measurements using a digital thermometer and checkups for MERS-like symptoms were conducted by clinical staff twice a day for every HCP who was engaged in patient care inside the isolation room.

Screening and management of HCP with suspected MERS-CoV infection

During the MERS outbreak in Korea, the NMC managed the isolation and treatment of confirmed MERS patients referred from other hospitals nationwide, and suspected MERS cases identified at a community or medical facility other than the NMC were referred to other medical facilities designated for MERS diagnosis. Therefore, the MERS screening clinic (MSC) in the NMC was operated solely for HCP with MERS-related symptoms. Few non-HCP visitors for MERS-like symptoms were managed in a separate section of the emergency room. Retrospective chart review of clinical and laboratory data was performed for HCP who visited the MSC because of MERS-like symptoms or accidental exposure to MERS patients without appropriate PPE. As previously mentioned, tympanic temperature measurements and checkups for MERS-like symptoms were performed regularly. When an HCP developed clinical features suggestive of MERS (fever ≥37.5°C or respiratory symptoms) and had contact with MERS patients within 2 weeks before symptom onset, the chief infection control officer quarantined the HCP to their home or an isolated room in the hospital according to the guidelines of the Korea Centers for Disease Control and Prevention. Droplet precaution was applied during the quarantine, and a nasopharyngeal swab specimen was sent to the Korea National Institute of Health for MERS-CoV reverse-transcription polymerase chain reaction testing. If the first test result was negative, a second test was performed 48 hours later. If both consecutive tests were negative, the quarantine was released.

Asymptomatic HCP reporting unprotected exposure (ie, without appropriate PPE) to a patient with MERS were self-quarantined at home for 14 days. Surveillance was maintained during quarantine with self-measurement of tympanic temperature twice a day and telephonic checkups for MERS-like symptoms. The HCP was also instructed to report immediately to the infection control officer in case of development of MERS-like symptoms.

Analysis of the characteristics of HCP who participated in MERS patient care

Although there was no documented MERS case among the HCP of the NMC, a serosurvey was performed to measure subclinical infections among the HCP after the end of the MERS outbreak; there was no evidence of MERS among HCP in the NMC.[13] A questionnaire survey was performed during the serosurvey regarding the risk factors related to MERS acquisition and the presence of subjective symptoms (ie, fever, general weakness, cough, sore throat, myalgia, diarrhea, chill, sputum, abdominal pain, dyspnea, nausea, vomiting) during the MERS outbreak. These questionnaire survey data were used in this study. Informed consent was obtained from all HCP who agreed to participate in the serosurvey. To investigate the risk factors for exposure to MERS, HCP participants were asked to answer the questionnaire covering the following items: type and length of contact with confirmed MERS patients, places of duty within the hospital, PPE status, exposure events without appropriate PPE, and symptoms possibly related with MERS infection that developed during the care of MERS patients. If the subject answered that they had been exposed without appropriate PPE in the questionnaire, and the HCP had not visited the MSC during the outbreak, we conducted a detailed questionnaire on the exposure events. The in-depth interview included the type and time of exposure, reasons for the exposure without appropriate PPE, and reasons for not notifying the exposure event to the infection control officer.

Ethical review

The study was approved by the NMC Institutional Review Board. We conducted this study in compliance with the principles of the Declaration of Helsinki.

RESULTS

Characteristics of HCP at the MSC

In total, 46 HCP visited the MSC during the MERS outbreak. Of these, 5 HCP confirmed that there had been no contact with MERS patients and 4 HCP visited the clinic for exposure to confirmed MERS patients without appropriate PPE regardless of MERS-like symptoms. Two visits were a repeat from the same HCP. Therefore, 35 individual HCP visits were made to the MSC for newly developed MERS-like symptoms.

Table 1
Characteristics of health care personnel who visited the MERS screening clinic for MERS-like symptoms (n = 35)

Characteristics		Value
Age, y		28 (26-31)
Female		29 (82.9)
Occupation	Registered nurse	31 (88.6)
	Medical doctor	2 (5.7)
	Radiologist	2 (5.7)
Symptom	Fever	24 (68.6)
	Cough	12 (34.3)
	Dyspnoea	2 (5.7)
	Sputum	5 (14.3)
	Sore throat	9 (25.7)
	Diarrhea, chills, headache, or myalgia	8 (22.9)
Interval between MERS care involvement and symptom onset, d		9 (3-21)
Level of PPE used during MERS care		
Fluid-resistant coverall with N95 respirator		11 (31.4)
Impermeable coverall with PAPR		17 (48.6)
Use of both levels of PPE		7 (20.0)

NOTE. Values are n (%) or median (interquartile range).
MERS, Middle East respiratory syndrome; *PAPR*, powered air purifying respirator; *PPE*, personal protective equipment.

Table 2
Demographic characteristics and MERS patient care activity of health care personnel who participated in the postoutbreak MERS questionnaire survey (n = 285)

Characteristics		Value
Median age (interquartile range), y		30 (26-36)
Female		171 (60.0)
Occupation	Registered nurse	178 (62.5)
	Medical doctor	56 (19.6)
	Radiology technician	18 (6.3)
	Infection control nurse	2 (0.7)
	Patient transporter	2 (0.7)
	Others	29 (10.2)
Main workplace	General ward	157 (55.1)
	Intensive care unit	52 (18.2)
	Outpatient clinic	13 (4.6)
	Emergency department	14 (4.9)
	Other	49 (17.2)
No. of confirmed MERS patients under the care of the health care worker		
1		14 (4.9)
2-5		71 (24.9)
6-10		49 (17.2)
≥11		100 (35.1)
Not available		55 (19.3)
Mean duration of MERS patient care ± SD, d		42.8 ± 14.8
Subjective symptom experience during MERS outbreak		
Fever (≥37.5°C)		52 (18.2)
General weakness		47 (16.5)
Cough		33 (11.6)
Sore throat		32 (11.2)
Myalgia		29 (10.2)
Diarrhea		22 (7.7)
Chill		20 (7.0)
Sputum		19 (6.7)
Abdominal pain		6 (2.1)
Dyspnea		5 (1.8)
Nausea		2 (0.7)
Vomiting		1 (0.4)
Asymptomatic		176 (61.8)
Exposure to MERS patient without proper PPE		26 (9.1)
Simple exposure without PPE		11(3.9)
Aerosol-generating procedure without PAPR		15 (5.3)

NOTE. Values are n (%) or as otherwise indicated.
MERS, Middle East respiratory syndrome; *PAPR*, powered air purifying respirator; *PPE*, personal protective equipment.

The characteristics of the symptomatic HCP with suspected MERS-CoV infection are summarized in Table 1. Most of them were female nurses (88.6%), and the median age was 28 years (interquartile range [IQR], 26-31 years). The most common symptom was fever (68.6%) followed by cough (34.3%). The median interval between participation in MERS patient care and symptom onset was 9 days (IQR, 3-21 days). All were quarantined until 2 consecutive MERS-CoV reverse-transcription polymerase chain reaction tests, repeated with a 48-hour interval, returned negative results.

There were 4 cases of accidental exposure without adequate PPE during the outbreak, as previously described.[13] Briefly, 3 HCP were exposed to MERS patients without adequate PPE, such as PAPR circuit disconnection, and 1 HCP reported exposure to blood on bare skin from a patient with active pneumonia. All the involved HCP were quarantined and monitored for 14 days, and none of them developed symptoms or any other positive findings during the quarantine.

Postoutbreak survey and interviews

Baseline characteristics of HCP who participated in MERS patient care

A total of 333 HCP participated in MERS patient care within 1 m of confirmed MERS patients. Of these, 285 HCP consented to participate in the serosurvey and answer the questionnaire.[13] Characteristics of the enrolled 285 HCP are summarized in Table 2. The median age was 30 years (IQR, 26-36 years), and 60% were women. Most of them were registered nurses (62.5%) or medical doctors (19.6%). The most common workplace was the general ward (55.1%), followed by the intensive care unit (18.2%). The mean duration of MERS patient care was 42.8 ± 14.8 days. About one third of HCP (35.1%) answered that they participated in the care of >11 MERS patients.

Subjective symptoms and exposure history: Questionnaire survey and interviews

Overall, 109 (38.2%) of 285 eligible HCP reported that they experienced at least 1 MERS-related symptom during the MERS outbreak. The most frequently reported symptoms were fever (18.2%), followed by general weakness (16.5%), cough (11.6%), sore throat (11.2%), and myalgia (10.2%).

Exposure to the patients without appropriate PPE was reported by 26 HCP (9.3%) (Table 2). Of these, we conducted an in-depth interview for 24 HCP, excluding 2 HCP who already had been registered to the MSC as exposure cases, with detailed questions about the exposure events; 21 HCP responded to this interview and 3 refused to participate in the interview. In the interview, 7 individuals (33.3%) denied exposure without appropriate PPE. Frequent reasons for exposure in the remaining HCP were as follows: PAPR malfunction (n = 3), exposure to bare skin by blood or bodily fluid of MERS patients (n = 3), use of an N95 mask instead of PAPR during an aerosol-generating procedure (n = 2), transient dislocation of a facial shield (n = 2), and participation in infectious waste disposal procedure without PPE (n = 1). Among 14 participants, 12 replied that the reason for not notifying the exposure event to the infection control officer was that according their judgment, the patient was not likely to be infectious at the time of exposure.

DISCUSSION

In this study, 35 of 333 HCP visited the MSC for MERS-like symptoms when caring for 30 patients with confirmed MERS. In the postoutbreak questionnaire survey, however, 52 of 285 (18.2%) HCP answered that they experienced fever during the MERS outbreak. Additionally, 24 HCP did not take any action, despite unprotected exposure to MERS patients. Although there may have been a recall bias about exposure events as has been previously reported,[14] our

study findings imply that HCP may not behave as they are instructed by the hospital authority during an outbreak situation.

As previously mentioned, none of the MSC visitors was infected with MERS during the outbreak. The serosurvey conducted after the end of the MERS outbreak, targeting all HCP who participated in MERS patient care, revealed no positive cases, despite one third of HCP answering that they experienced MERS-related symptoms during the MERS outbreak. A previous study conducted in Saudi Arabia reported that even though respiratory symptoms developed in 10 (21%) of 48 HCP who were exposed to MERS patients, none of them showed evidence of MERS-CoV infection; the number of symptomatic HCP exposed to MERS was lower than the number of symptomatic HCP without reported exposure (33%).[15] Similarly, in a contact investigation of the first imported MERS patient into the United States, all 61 identified contacts had negative test results for MERS-CoV, even though some had face-to-face interactions or prolonged exposure to the index patient, including aerosol-generating procedures.[14]

Other than the studies targeting groups who had contact with MERS patients, a study of 490 cases of suspected MERS in the United States confirmed 2 (0.4%) cases of MERS infection, and both of them were HCP from MERS-prevalent areas.[16] The most common detected pathogens in the 490 suspected cases were influenza A virus and rhinovirus-enterovirus. However, a recent study reported by another centwe in South Korea revealed that 4 of 58 symptomatic HCP contracted MERS (6.9%) and 3 of 196 asymptomatic HCP (1.5%) were infected with MERS; this was despite the HCP being aware of the patient's infection with MERS-CoV and wearing PPE (ie, surgical gloves, surgical gown, eye shield, N95 respirator).[17]

Specifically for the MERS outbreak in South Korea, most transmissions happened from patients with active pneumonia while they were staying in the hospital for treatment, rather than in the community setting.[4] Early identification of patients with an infection risk and vigilant monitoring are crucial to minimize the risk of transmission. Our institution focused on instructing HCP to notify the infection control officers as soon as they experienced MERS-like symptoms or exposure to a patient without appropriate PPE during the MERS outbreak. However, a substantial proportion of HCP did not take appropriate action, such as visiting the MSC, despite experiencing MERS-related symptoms or potential exposure. During the in-depth interview about exposure events, most HCP stated that the reason for not notifying the infection control officer was that by their judgment, the patient was not infectious when the exposure occurred. Although the actual risk of infection was very low in most exposure events, it is not recommended that the HCP determine the infectivity of a quarantined patient by themselves. In addition, one HCP replied that she tried to obtain a sputum sample through oropharyngeal catheter suction from a patient with poor sputum expectoration capacity. Although she was aware that it might provoke coughing, she only wore an N95 respirator against the recommendation of using PAPR during the procedure, which may cause aerosol generation. During the in-depth interview, she replied that she was reluctant to notify the event to the hospital authority worried about the limited HCP capacity during the outbreak situation. Although abiding by the infection precaution is most important, HCP should be educated to notify hospital authorities promptly if unprotected exposure occurs.

There are several limitations in our study. First, the NMC was designated as a referral institution and closed for general patient management besides MERS management. Therefore, the risk of unrecognized exposure may have been minimal and the actual situation may be different according to the role of an institution during the outbreak situation. Second, our data regarding the MSC are based on the HCP who visited the MSC. As observed in our postoutbreak survey, some HCP may not have visited the MSC even though they had experienced MERS-related symptoms. Third, although most HCP replied that the reason for not notifying their exposure event to the infection control officer was that they judged the patient as not infectious, we could not determine the actual infectivity because most HCP could not recall the involved patients. However, despite these limitations, there was no evidence in the postoutbreak serosurvey that HCP had been infected with MERS during patient care in the NMC. We think our experience may be helpful for developing strategies in the situation of an emerging infectious diseases outbreak.

CONCLUSIONS

A considerable number of HCP experienced MERS-related symptoms or potential exposure events during MERS patient care. Although there was no evidence that HCP at the NMC were infected with MERS-CoV, a postoutbreak survey revealed that a substantial proportion of HCP did not take appropriate action while infection-related events occurred during patient care. Because HCP are a group at high risk for MERS-CoV infection, it is important to develop and institute an effective screening plan to ensure prompt detection and management of HCP with MERS-related events. This plan may be achieved by educating HCP to accurately recognize the risk situation and immediately notify the hospital authorities regarding symptom occurrence or potential exposure.

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