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Major Article

Middle East respiratory syndrome coronavirus transmission among health care workers: Implication for infection control

Sarah H. Alfaraj MD ^{a,b}, Jaffar A. Al-Tawfiq MD, FRCP (Edin), FRCP (London) ^{c,d},
 Talal A. Altuwajri MD ^e, Marzouqa Alanazi MD ^f, Nojoom Alzahrani MD ^a,
 Ziad A. Memish MD, FRCPC, FRCPE, FRCPL, FPH ^{g,h,i,*}

^a Corona Center, Infectious Diseases Division, Department of Pediatric, Prince Mohamed Bin Abdulaziz Hospital, Ministry of Health, Riyadh, Saudi Arabia

^b University of British Columbia, Vancouver, BC, Canada

^c Indiana University School of Medicine, Indianapolis, IN

^d Johns Hopkins Aramco Healthcare, Dhahran, Saudi Arabia

^e Department of Surgery, Prince Mohamed Bin Abdulaziz Hospital, Ministry of Health, Riyadh, Saudi Arabia

^f Department of Emergency, Prince Mohamed Bin Abdulaziz Hospital, Ministry of Health, Riyadh, Saudi Arabia

^g College of Medicine, Alfaisal University, Riyadh, Saudi Arabia

^h Infectious Diseases Division, Department of Medicine, Prince Mohamed Bin Abdulaziz Hospital, Ministry of Health, Riyadh, Saudi Arabia

ⁱ Hubert Department of Global Health, Rollins School of Public Health, Emory University, Atlanta, GA

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Background: Many outbreaks of Middle East respiratory syndrome coronavirus (MERS-CoV) have occurred in health care settings and involved health care workers (HCWs). We describe the occurrence of an outbreak among HCWs and attempt to characterize at-risk exposures to improve future infection control interventions.

Methods: This study included an index case and all HCW contacts. All contacts were screened for MERS-CoV using polymerase chain reaction.

Results: During the study period in 2015, the index case was a 30-year-old Filipino nurse who had a history of unprotected exposure to a MERS-CoV-positive case on May 15, 2015, and had multiple negative tests for MERS-CoV. Weeks later, she was diagnosed with pulmonary tuberculosis and MERS-CoV infection. A total of 73 staff were quarantined for 14 days, and nasopharyngeal swabs were taken on days 2, 5, and 12 postexposure. Of those contacts, 3 (4%) were confirmed positive for MERS-CoV. An additional 18 staff were quarantined and had MERS-CoV swabs. A fourth case was confirmed positive on day 12. Subsequent contact investigations revealed a fourth-generation transmission. Only 7 (4.5%) of the total 153 contacts were positive for MERS-CoV.

Conclusions: The role of HCWs in MERS-CoV transmission is complex. Although most MERS-CoV-infected HCWs are asymptomatic or have mild disease, fatal infections can occur and HCWs can play a major role in propagating health care facility outbreaks. This investigation highlights the need to continuously review infection control guidance relating to the role of HCWs in MERS-CoV transmission in health care outbreaks, especially as it relates to the complex questions on definition of risky exposures, who to test, and the frequency of MERS-CoV testing; criteria for who to quarantine and for how long; and clearance and return to active duty criteria.

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Since the emergence of Middle East respiratory syndrome coronavirus (MERS-CoV) in September 2012, the largest and most documented outbreaks to date have occurred in health care settings.¹⁻⁶

* Address correspondence to Ziad A. Memish, MD, FRCPC, FRCPE, FRCPL, FPH, College of Medicine, Alfaisal University, PO Box 54146, Riyadh 11514, Saudi Arabia.
 E-mail address: zmemish@yahoo.com (Z.A. Memish).

Conflicts of interest: None to report

As of June 26, 2017, there have been 2,029 cases, including a total of 704 deaths, reported to the World Health Organization.⁷ The recent outbreaks of MERS-CoV infection highlight the importance of the emergency departments in being the initial site of the spread of this virus.⁸⁻¹² In addition, hemodialysis units were also highlighted as the focus of multiple documented and undocumented outbreaks in Al-Hasa and Taif, Saudi Arabia (SA).^{5,13} From April 2014–November 2016, a total of 295 confirmed cases were admitted to Prince Mohamed Bin Abdulaziz Hospital (PMAH), Ministry of Health, Riyadh,

SA. Of those cases, 98 (33%) were diagnosed at PMAH, whereas the rest were transferred to PMAH from other Riyadh hospitals, because it is the reference coronavirus center for the central region of SA. Here, we describe a detailed investigation of an outbreak of MERS-CoV among health care workers (HCWs) in a MERS-CoV referral hospital with key learning points to be highlighted.

METHODS

We describe the transmission pattern and contact tracing of a MERS-CoV-infected HCW, resulting in an outbreak in PMAH in SA. All suspected HCWs were tested for MERS-CoV using real-time polymerase chain reaction.¹⁴ The target upstream of MERS-CoV was *upE* and *ORF1a*.¹⁴

The first case who initiated the outbreak was designated as the index case with all her positive contacts designated as primary transmissions. As described previously, subsequent cases resulting from the first-generation cases were called second-generation transmission, and infected HCWs from those were designated as third-generation cases and so on.¹⁵

RESULTS

Index case

The case was confirmed on August 12, 2015 (from the first screening swab), and the patient was a 30-year-old Filipino nurse who had a history of unprotected exposure to a MERS-CoV-positive case on May 15, 2015. She was normal weight (weight, 58 kg). At that time and as per hospital protocol, she was quarantined for 14 days.¹⁶ MERS-CoV swab was documented on days 2, 5, and 12 to be negative (May 17, 23, and 27). On June 26, she went on vacation to the Philippines. Two weeks after her arrival to the Philippines, she manifested symptoms of dry cough and shortness of breath. She self-medicated herself with amoxicillin with no significant improvement. On August 7, she came back to SA, and on August 10, she was seen at the employee health clinic for evaluation. Given her recent arrival from a nonendemic country, screening for MERS-CoV was not considered. On August 11, she was allowed to resume work despite being symptomatic with dry cough and shortness of breath. On August 12, she was admitted as a suspected tuberculosis vs MERS-CoV infection. On the following day, MERS-CoV test was positive (cycle threshold [Ct] values of *upE* gene = 35, and *ORF1a* gene = 34), and she also tested positive for tuberculosis.¹⁷

Contacts of the index case

A comprehensive contact tracing was done, with a total of 73 staff quarantined for 14 days, and nasopharyngeal swabs taken on days 2, 5, and 12 postexposure. All quarantined HCW contacts had daily monitoring for fever and respiratory symptoms. Of those contacts, 3 (4%) were asymptomatic and confirmed positive for MERS-CoV by nasopharyngeal swabs (on first swab). An additional 18 new HCW contacts were quarantined and had MERS-CoV swabs as previously indicated. A fourth case was asymptomatic and tested negative on days 2 and 5 but was confirmed positive on day 12. Therefore, an additional 7 staff were quarantined (the fourth case's flatmates). A fifth staff member had fever and sore throat and was confirmed positive on first swab, and she came into contact with 15 additional staff. A sixth case had cough and sore throat and was confirmed positive on third swab. This sixth case had 21 additional contacts. Of those, 1 nurse was diagnosed with MERS-CoV (seventh case). The staff member was asymptomatic and was positive on the first swab. The seventh case had an additional 22 exposed staff, but

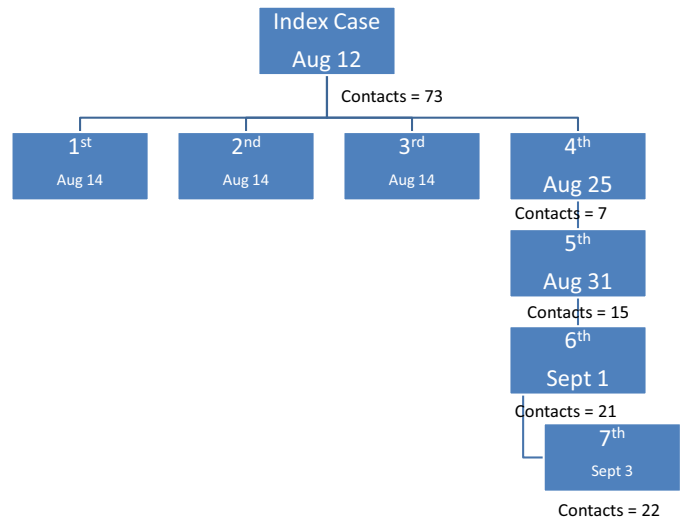


Fig 1. Graphical representation of the evolution of the outbreak.

none of them were positive (Fig 1). Therefore, only 7 (4.5%) of the total 153 contacts were positive for MERS-CoV.

All confirmed cases were nurses, and 2 of the 7 subsequent cases were thought to acquire the infection through an exposure within the housing compound. Detailed questioning on the significance of the contact with the positive cases revealed the following: 3 (43%) had contact <1.5 m, 4 (57%) had contact for <10 minutes, 3 (43%) had contact <1.5 m and >10 minutes, and the remaining had contact >1.5 m and <10 minutes (Table 1). Only the index case had an abnormal chest radiograph, and the laboratory evaluations of all positive cases are shown in Table 2. All positive cases were positive on the first swab except for 2 who were positive on the second and third swabs. The mean time to negative swab was 4.8 days (range, 2–14 days).

DISCUSSION

In this outbreak investigation, we report 4 generations of transmission of MERS-CoV among HCWs. The transmission dynamics suggest that the transmission occurred within the setting of the hospital and in the housing environment. These findings highlight the importance of continued vigilance and detailed systematic screening of exposed HCWs whether they are symptomatic or not. Such an activity is very complex, and often it is difficult to elucidate the exact contact pattern between HCWs because of the extensive social interaction within the hospital and housing among different HCWs from different units. In addition, there are difficulties in relying on HCW's memory of exact contacts and infection control precautions taken during that contact.

The index case was initially identified as a contact of a MERS-CoV patient, and she had multiple swabs that were negative. She then went to the Philippines and started to have symptoms. Later, she was diagnosed with both MERS-CoV and pulmonary tuberculosis. Because the diagnosis of MERS had occurred many weeks after several negative MERS swabs, the exact source of the infection could not be determined. In the South Korean MERS-CoV outbreak, 5 patients with MERS-CoV had unclear infection sources.¹⁵ During the outbreak investigation, there were 4 spreaders (transmitting MERS to ≥ 1 individuals), and 1 possibly was a superspreader (transmitted the virus to 4 HCWs). In the South Korean outbreak, superspreader was arbitrarily defined as transmission of MERS-CoV to ≥ 5 cases.¹⁵ However, the exact definition of superspreader is not well established.¹⁸ The characteristics of the index case of an

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