

## Infection control measures for the prevention of MERS coronavirus transmission in healthcare settings

Jaffar A. Al-Tawfiq & Ziad A Memish

Middle East respiratory syndrome coronavirus (MERS-CoV) had caused multiple large health-care-associated infections and outbreaks.[1–7] The first outbreak was identified retrospectively in a hospital in Zarqa, Jordan, in April 2012.[4] In that outbreak, 2 of 13 people (including 10 health-care workers (HCWs)) tested positive for MERS-CoV based on polymerase chain reaction.[4] Furthermore, a serologic study showed an attack rate of 10% among exposed HCWs and 5% among family contacts.[5] The 2013 Al-Hasa outbreak in the Kingdom of Saudi Arabia occurred in four hospitals and 21 of 23 (91%) of cases were health-care acquired.[1] The rate of acquisition of MERS-CoV was less than 1% among 200 exposed HCWs.[1] The third outbreak took place in Jeddah, Saudi Arabia, in 2014 and occurred in 14 hospitals with a total of 128 cases.[2,3] Of 112 non-HCWs, 109 (97.3%) contracted infection within health-care settings.[3] Most recently on May 2015, an index case, 68-year-old male from South Korea visited many countries in the Middle East (Bahrain/Saudi Arabia/UAE/Qatar) and developed symptoms on 11 May 2015 and was subsequently seen in multiple hospitals in South Korea.[6] In about 2 weeks, he sparked an outbreak involving 5 health-care facilities and 63 cases.[7] There were 34 cases in hospital B, 18 cases in hospital D, 5 cases in hospital E, and 3 cases in hospital F.[7] According to the WHO as of 19 June 2015, the outbreak in the Republic of Korea involved 72 health-care facilities which have treated patients and 6 health-care facilities had nosocomial transmission.[8] The total number of cases as of 26 June 2015 was 182 cases with 31 deaths.[9,10] The index case in this outbreak eventually was responsible for a total of 185 infections during a 4-week period, mainly through in-hospital transmission.[11] Sequence analysis of isolates from four patients representing at least four generations of transmission showed no evidence of changes in the virus.[11]

HCWs in the various MERS outbreaks constituted 18% in South Korea outbreak[10] and 31% in the outbreaks in the Kingdom of Saudi Arabia.[1,12–14] In a recent review, the estimated percent of total symptomatic and asymptomatic HCWs who tested positive was 2%–67%.[14] There seems to be propensity of the MERS-CoV to be effectively transmitted within health-care facilities. The various factors facilitating such transmission had not been clearly elucidated except for that in all health-care facilities associated outbreaks; major breakdown in infection control procedures had occurred.[14] In Al-Hasa outbreak, one patient infected 20 other people.[1] Further genomic sequence analysis showed that the MERS outbreak was due to more than one introduction of the virus into the outbreak.[15] In that outbreak, one MERS patient was linked epidemiologically to seven secondary cases.[1] In an outbreak in Riyadh, Saudi Arabia, one patient contributed to 10 secondary cases.[16] In the recent outbreak in South Korea, of the initial 119 cases, 27 secondary cases in a single hospital were linked to the primary case and two secondary cases causing a second wave of the outbreak.[10] A total of 97 tertiary cases emerged.[10] The exact role of superspreader or a superspreading event in contributing to the different outbreaks is not well described.

Implementation of effective infection control measures in health-care setting is vital for the control of the transmission of microorganisms. The recommendations from the US and European Centers for Disease Control and Prevention call for the use of airborne infection isolation (AII) precautions for patients with suspected or confirmed MERS-CoV infection.[17,18] These recommendations rely on the fact that MERS is associated with high case fatality rate and the need to apply maximum

precautions.[19,20] The WHO recommends the use of All precautions when dealing with high-risk procedures or aerosol-generating procedures only.[21] The experience from the Al-Hasa outbreak indicates that basic infection control measures were effective for the control of the outbreak in the hemodialysis unit as well as other areas of the hospital.[1] The need to have many All rooms to accommodate a large number of patients puts a large burden on health-care organizations.

Overcrowding in the in-patient areas as well as in the emergency departments create a favorable situation where suspected patients could potentially spread respiratory viruses to other patients. And in almost all documented health-care facility outbreaks, overcrowding was cited by experts as one of the reasons for igniting the outbreak. Unpreparedness of HCWs and under-enforcement of health-care facility administration of preventative measures for viral respiratory infections has also been a common deficiency noted. It is important for HCWs to be vigilant and to elicit any patient's travel history every time they suspect MERS-CoV in countries outside the Arabian Peninsula. Effective triage system at the first encounter of patients with subsequent segregation of those with travel history and respiratory symptoms is of fundamental importance. It is also important to have systematic and effective infection prevention and control measures to effectively interrupt health-care transmissions.[22] To prevent intrahospital transmission of MERS-CoV infection, the Saudi Ministry of health implemented a set of prevention and control measures.[23] These measures included intensive education and training for HCWs in infection control and new standards for the surveillance and reporting of MERS-CoV.[23] Once a case of MERS-CoV is confirmed in a health-care facility, comprehensive contact tracing, extensive testing and follow up of all contacts, and quarantine/furlough of suspected HCWs, patients, visitors, and immediate family contacts are paramount for preventing any outbreaks from starting and spreading.

Specific patient characteristics leading to effective transmission of MERS-CoV to multiple secondary cases were not elucidated. A study from the Kingdom of Saudi Arabia in 2012–2013 utilizing nasopharyngeal swabs to screen 1695 HCWs contacts of MERS-CoV cases showed that 19 (1.1%) of the HCWs were positive for MERS-CoV by PCR.[24] The role of asymptomatic patients in the transmission of MERS-CoV was suggested. An asymptomatic HCW had positive PCR nasopharyngeal swab for MERS-CoV for about 6 weeks.[25] Further to this study, a large serological study of 10,000 blood samples in Saudi Arabia showed a positive MERS-CoV rate of 0.15% in the general population, 2.3% among camel shepherds, and 3.6% among slaughterhouse workers.[26] Those individuals who had asymptomatic or only mild MERS-CoV infections might act as vehicles to transmit the disease to others.[26]

To date, the contributing factors facilitating the spread and control of MERS-CoV within health-care settings are poorly elucidated. Multiple outbreaks within health-care settings are attributed to poor compliance with the basic infection control measures. Thus, proper infection control measures and practice would prevent the transmission of MERS-CoV within health-care settings.[13] To prevent spread of MERS-CoV within health-care settings, it is important to eliminate practice variation by adopting a respiratory screening program and to practice the best available infection control measures. Risk assessment and training of all HCWs on recognizing, isolating, and cohorting possible cases are of great importance to further decrease transmissions within the health-care facilities.

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