

# Exploring the risk of Middle East Respiratory Syndrome- coronavirus among expatriate healthcare workers. A comparative epidemiological study of Saudi Arabian and South Korean healthcare workers

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## Research article

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# Abstract

**Background** In comparison to South Korea, which was able to contain the outbreak of Middle East respiratory syndrome corona virus (MERS-CoV) in 2015, new cases are still emerging in the Kingdom of Saudi Arabia. The Saudi Arabian healthcare sector, which is dependent on the expatriate workforce to cater to its growing local healthcare demands, has been reporting multiple healthcare-associated MERS-CoV outbreaks since 2012. In this paper, we compare the epidemiology of MERS-CoV among healthcare workers (HCWs) in Saudi Arabia and South Korea and to ascertain the risks of MERS-CoV among expatriate HCWs.

**Methods** Data were collected from publicly available resources such as World Health Organization and health department websites. A line list of all reported cases of MERS-CoV among HCWs in Saudi Arabia and South Korea was prepared and analysed.

**Results** Among the total infected HCWs in Saudi Arabia, 84.6% (n=192/227) were expatriates. The mean age of infected HCWs in both settings was similar (Saudi Arabia 38 years, South Korea 39 years). Female HCWs were more likely to be infected, while male HCWs were more likely to die. In Saudi Arabia, 36.5% (n= 68/186) of HCWs with MERS-CoV were asymptomatic, compared to 7% (n=2/28) HCWs in South Korea. Most of the expatriate HCWs in Saudi Arabia were asymptomatic (78%, n=53/68) to MERS-CoV. Unlike South Korea, in Saudi Arabia, a diversity of HCWs other than doctors, and nurses were also infected with MERS-CoV.

**Conclusions** A high proportion of expatriate HCWs were infected with MERS-CoV in Saudi Arabia which highlights the need for adequate training and education in this group about emerging infectious diseases and the appropriate strategies to prevent acquisition. Also, we did not find any policy statements restricting the contact of HCWs, vulnerable to MERS-CoV like pregnant HCW, HCWs over the age 60, HCWs with underlying comorbidity etc, from getting in proximity with a suspected or potential MERS-CoV infected patient. Policy development in this regard should be a priority, to contain healthcare-associated transmission of emerging and reemerging infectious diseases like MERS-CoV. Further studies should be conducted to determine social, cultural and other factors contributing to high infection rate among expatriate HCWs.

## Introduction

Healthcare-associated transmission of Middle East respiratory syndrome coronavirus (MERS-CoV) has been reported in several countries since 2012, including Kingdom of Saudi Arabia, Jordan, the United Arab Emirates, France, the United Kingdom (UK), and South Korea with varying caseloads per outbreak (2-180 per outbreak) [1]. Compared to South Korea, which had a one large outbreak of healthcare-associated MERS-CoV in 2015, Saudi Arabia, has had continuous but intermittent healthcare-associated outbreaks of MERS-CoV across the country since 2012 [2-6]. According to the WHO, out of total MERS-CoV infected cases reported between 2012-2018 from Saudi Arabia, 19.2% were healthcare workers (HCW) [7].

Globally, around 20% of the cases reported between the year 2012-2018 have been of HCWs [8], whilst a second study reported that around 10% of critically ill patients with MERS-CoV were HCWs [9].

The spread of healthcare-associated MERS-CoV amongst HCWs is now well documented [9]. In summary, it was first observed in Jordan in April 2012, but it was until 2013, that Saudi Arabia reported the first two laboratory confirmed cases of MERS-CoV infected HCWs, following exposure to laboratory confirmed MERS-CoV patients [10, 11]. This was followed by seven female HCWs being affected in subsequent months in 2013 with MERS-CoV in Saudi Arabia, four of whom were expatriate HCWs (nationality of the rest three not available)[12]. While there have been numerous reports about the burden of infection and the factors contributing to the risk, what hasn't been given attention is the burden of infection amongst expatriate staff members.

Due to increasing local healthcare demand, many high income economies are more than ever reliant on expatriate HCWs, many of whom come from low and middle income countries including Asia [13, 14]. For instance, a 2015 report from the Organisation for Economic Co-operation and Development points out that UK is the most dependent of all major EU countries on foreign doctors (35.4%) and nurses (21.7%) [15]. Likewise, a 2011 census found that 52.3% HCWs in Australia were born and educated in other countries. And also, out of 15,168 additional HCWs in Australia between the 2006 and 2011 censuses, 68.9% were foreign-born, which saved the Australian government US\$1.7 billion in medical education costs[16, 17]. In fact, the United States (US) health care system also, relies very heavily on HCWs from other countries with one in four doctors in the US being born and educated in another country [14]. Correspondingly a high-income country like Saudi Arabia is no different, expatriate HCWs constitute about two thirds of the physicians, nurses and pharmacists employed [18].

With WHO estimating a shortage of more than 2 million doctors, nurses and midwives to meet the minimum global recommended density [19] expatriate HCWs are bound to play a big role in filling this demand and supply gap. Therefore, the aim of this study was to compare the epidemiology of MERS-CoV among HCWs in Saudi Arabia and South Korea, particularly focusing on the risk amongst expatriate HCWs.

## Methods

### Data Collection

Publicly available data were used to create a database of MERS-CoV infected HCWs from the first reported HCW patient in May 2013 through to December 2018 in Saudi Arabia and South Korea. For the purposes of this study, a HCW was defined as any person, paid and unpaid, working in a hospital whose activities potentially place him or her at risk for exposure to MERS-CoV. The laboratory confirmed cases of MERS-CoV infected HCWs in both countries were sourced from reports published by WHO. Moreover, in order to further investigate the cases, and gather more information to improve the dataset, additional data was sourced from various online portals like FluTracker, Promed Mail and Figshare. In addition to this, wherever possible, data was cross checked from reports published by government health

departments, as well as from online news portals like Arab News, Onaiza today, Aljazeera. A line list of all reported cases of MERS-CoV among HCWs was prepared. The data collected included date of notification, reporting country, city of residence, age, gender, nationality, job category of HCW, comorbidity, location of exposure, contact history (exposure to camel, bats or any other animal; camel milk consumption; exposure to MERS-CoV patients), clinical manifestation (symptomatic or asymptomatic to MERS-CoV) and status (deceased or alive). The MERS-CoV infected HCWs were categorized into six age groups, as per WHO categorization: <30 years, 30–39 years, 40–49 years, 50–59 years, 60–69 years and ≥70 years. The job categorization of healthcare workers was classified into, doctors, nurses, others (healthcare support staff, receptionist, respiratory therapist, pharmacist, ambulance driver, X-ray technician, cleaner) and in case no job specification of HCW was specified, it was categorized as per WHO job categorization and other reporting sources as ‘healthcare worker’. The location of exposure was classified into hospital-linked, either hospital or home, ambulance.

## Statistical Analysis

Descriptive analysis was conducted to calculate the mean and frequencies of all the HCWs infected with MERS-CoV in Saudi Arabia and South Korea from 2013 to 2018. T-test was used to compare the mean values of age and Chi-square test, Fishers exact test, was used to compare proportions of categorical variables (e.g., gender, healthcare worker, comorbidity, contact history) based on nationality of infected HCWs. A p-value < 0.05 was considered statistically significant and data was analysed using SPSS version 25.

## Results

Of the cases reported in Saudi Arabia, 246/1901 (13%) were HCWs, while 29/187 (15.5%) South Korean cases were HCWs. The comparison of demographics and other characteristics between the two focus countries are outlined in Table 1, and Fig. 1. HCW MERS-CoV related data were not available for various variables including age (5 cases), gender (6 cases), comorbidity (125 cases), symptomatic/asymptomatic (61 cases), nationality (19 cases).

Table 1

Demographics and other characteristics of HCWs with laboratory confirmed MERS-CoV infection, in Saudi Arabia (year 2013 – year 2018) and South Korea (year 2015 – year 2018).

Variable	Kingdom of Saudi Arabia (n = 246) <sup>††</sup>	South Korea (n = 29)	P-value
Mean age* (range) Standard Deviation ( $\sigma$ )	38 (23–64) years $\sigma = 10.46$	39 (24–70) years $\sigma = 14.59$	0.67
Gender <sup>†</sup>			
Male	101/239 (42.2%)	10/29 (34.5%)	0.465
Female	138/239 (57.8%)	19/29 (65.5%)	
Gender-specific fatalities <sup>‡</sup>			
Male	6/101 (5.9%)	1/10 (10%)	0.417
Female	1/138 (0.7%)	1/19 (5.3%)	
Comorbidity <sup>§</sup>			
Male	13/21 (62%)	2/5 (40%)	0.61
Female	8/21 (38%)	3/5 (60%)	
Contact history			
Exposure to Camel, Bats or any other animal	1/246 (0.4%)	0/29 (0%)	NA
Camel milk consumption	1/246 (0.4%)	0/29 (0%)	NA
Exposure to MERS-CoV case	171/246 (69.5%)	29/29 (100%)	< 0.001
No exposure/Unknown exposure	75/246 (29.2%)	0/29 (0%)	NA
Location of exposure			
Hospital	145/246 (58.9%)	26/29 (89.6%)	< 0.001
Either hospital or home	100/246 (40.6%)	1/29 (3.4%)	< 0.001
Ambulance	1/246 (0.4%)	2/29 (6.9%)	< 0.001
Clinical manifestation			
Symptomatic <sup>¶</sup>	118/186 (63.4%)	26/28 (92.3%)	< 0.001
Asymptomatic	68/186 (36.5%)	2/28 (7.1%)	

Variable	Kingdom of Saudi Arabia (n = 246) <sup>††</sup>	South Korea (n = 29)	P-value
Nationality <sup>#</sup> of HCWs			
Citizen HCW	35/227 (15.4%)	29/29 (100%)	< 0.001
Expatriate HCW	192/227 (84.6%)	0/29 (0%)	
Job category			
Healthcare workers	213/246 (86.6%)	17/29 (58.6%)	< 0.001
Doctor	10/246 (4.1%)	4/29 (13.8%)	
Nurse	17/246 (6.9%)	5/29 (17.2%)	
Others <sup>§§</sup>	6/246 (2.4%)	3/29 (10.3%)	
Note: †† Saudi Arabia: Includes 5 MERS-CoV infected healthcare workers (HCWs) reported by USA (2), Lebanon (1), Philippines(2) after arriving from Saudi Arabia.			
*Age: 5 cases of HCWs in Saudi Arabia were unavailable.			
†Gender: 6 cases of HCWs in Saudi Arabia were unavailable.			
‡Gender-specific fatalities: 1 case of HCW in Saudi Arabia were unavailable.			
§Comorbidity: 122 cases of HCWs in Saudi Arabia and 3 in South Korea were unavailable.			
¶Symptomatic/Asymptomatic: 60 cases of HCWs in Saudi Arabia and 1 in South Korea were unavailable.			
#Nationality:19 cases HCWs in Saudi Arabia were unavailable			
§§Others: includes ambulance driver, receptionist, pharmacist, healthcare support staff, X-ray technician, Cleaner			

Insert Table 1

Insert Fig. 1. Percentage of MERS-CoV infected HCW in Saudi Arabia (year 2013 – year 2018) and South Korea (year 2015 – year 2018), age group wise.

The overall case fatality rate (CFR) in HCWs was 3.25% (8/246 cases) in Saudi Arabia and 6.9% in South Kora (2/29 cases). In Saudi Arabia the odds of a male HCW dying of MERS-CoV were 9.6 times greater than female HCWs and in case of South Korea the odds were 2 times greater than that of female HCWs. As far as age specific CFR in Saudi Arabia is concerned, equal number of deaths were reported in the age

group of < 30, 40–49 and 50–59 (2 each) and one death was reported in the age group of 30–39 years. Both South Korean HCWs who died were aged 70 years and above.

Due to the nature of the outbreaks, it is perhaps not surprising that the odds of HCWs being infected at hospital in Saudi Arabia were less (odds ratio 0.056) compared to HCWs in South Korea. Nevertheless, the differences in the rates of location of exposure to MERS-CoV between Saudi Arabia and South Korea was found to be statistically significant ( $P < 0.001$ ). The rate of asymptomatic MERS-CoV cases was also low in South Korea compared to Saudi Arabia (odds ratio .133). In Saudi Arabia for every MERS-CoV infected doctor there were 1.7 MERS-CoV infected nurses, while as in South Korea for every MERS-CoV infected doctor there were 1.2 MERS-CoV infected cases of nurses.

The ratio of Saudi Arabia MERS-CoV infected expatriate HCW (183/214 cases, 85.5%) to Saudi HCW (31/214 cases, 14.5%) was 5.9:1. All MERS-CoV infected South Korean HCWs were citizens. Furthermore, in Saudi Arabia the percentage of MERS-CoV infected Saudi male HCWs were more (25/31, 80.6%) than Saudi female HCWs (6/31, 19.4%), i.e. 4.2:1 male/female ratio. This contrasts with expatriate HCWs where the percentage of MERS-CoV infected expatriate female HCWs were more (121/186, 65.0%) as compared to MERS-CoV infected expatriate male HCWs (65/186, 35.0%), i.e. 0.5:1 male/female ratio. Most of the expatriate HCWs in Saudi Arabia were asymptomatic 78% ( $n = 53/68$ ) to MERS-CoV. However, the percentage of asymptomatic expatriate female HCWs were more (39/47, 83.0%) as compared to asymptomatic expatriate male HCWs (8/47, 17.0%), i.e. 0.2:1 male/female ration. Also, 89.4% ( $n = 17/19$ ) Saudi Arabia expatriate HCWs had comorbidity, out of which, 23.5% ( $n = 4/17$ ) Saudi Arabia expatriate HCWs were above the age of 60. In addition to this, 2 out of 3 male expatriate HCWs who died due to MERS-CoV had underlying comorbidity. In Saudi Arabia for every Saudi MERS-CoV infected doctor there were 0.3 MERS-CoV infected Saudi nurses, while as for every expatriate MERS-CoV infected doctor there were 2.1 MERS-CoV infected cases of nurses. The comparison of demographics and other characteristics between Saudi and non-Saudi HCWs are outlined in Table 2.

Table 2

Demographics and other characteristics of laboratory confirmed MERS-CoV infection amongst Saudi Arabia HCWs (year 2013 – year 2018): Nationality Wise\*

Variable	Saudi (n = 35)	Non-Saudi (n = 192)	P-value
Mean age <sup>¶</sup> (range) Standard Deviation ( $\sigma$ )	35.8 (24–60) $\sigma = 11.90$	38.7 (23–64) $\sigma = 10.20$	0.09
Gender <sup>†</sup>			
Male	25/31 (80.6%)	65/186 (35.0%)	< 0.001
Female	6/31 (19.4%)	121/186 (65.0%)	
Gender-specific fatalities <sup>‡</sup>			
Male	3/31 (9.6%)	3/186 (1.6%)	NA
Female	0	1/186 (0.5%)	
Comorbidity <sup>§</sup>			
Male	1 / 2 (50.0%)	11/17 (64.7%)	1
Female	1 / 2 (50.0%)	6/17 (35.3%)	
Clinical Manifestation <sup>#</sup>			
Symptomatic	17/24 (70.8%)	94/147 (64%)	0.64
Asymptomatic	7/24 (29.2%)	53/147 (36%)	
Job category <sup>**</sup>			
Healthcare workers	28/35 (80.0%)	168/192 (87.5%)	< 0.001
Doctor	3/35 (8.5%)	7/192 (3.6%)	
Note: *Data (gender & nationality) of 32 cases of HCWs were unavailable			
<sup>¶</sup> Age: 1 case of Saudi HCW & 2 cases of non-Saudi HCW were unavailable.			
<sup>‡</sup> Gender-specific fatalities: 1 case of non-Saudi HCW in Saudi Arabia were unavailable.			
<sup>§</sup> Comorbidity: 20 cases of Saudi HCWs and 85 cases of non-Saudi HCWs were unavailable.			
<sup>#</sup> Clinical Manifestation: 75 cases of HCWs were not available nationality wise.			
<sup>**</sup> Nationality:19 cases of HCWs were unavailable.			
<sup>§§</sup> Others: includes ambulance driver, receptionist, pharmacist, healthcare support staff, X-ray technician, Cleaner			

Variable	Saudi (n = 35)	Non-Saudi (n = 192)	P-value
Nurse	1/35 (2.9%)	15/192 (7.9%)	
Others §§	3/35 (8.5%)	2/192 (1.0%)	
Note: *Data (gender & nationality) of 32 cases of HCWs were unavailable			
¶Age: 1 case of Saudi HCW & 2 cases of non-Saudi HCW were unavailable.			
‡Gender-specific fatalities: 1 case of non-Saudi HCW in Saudi Arabia were unavailable.			
§Comorbidity: 20 cases of Saudi HCWs and 85 cases of non-Saudi HCWs were unavailable.			
#Clinical Manifestation: 75 cases of HCWs were not available nationality wise.			
**Nationality: 19 cases of HCWs were unavailable.			
§§Others: includes ambulance driver, receptionist, pharmacist, healthcare support staff, X-ray technician, Cleaner			

Insert Table 2

## Discussion

We compared the characteristics of laboratory-confirmed MERS-CoV infected Saudi Arabian HCWs and South Korean HCWs, that were reported from 2013 to 2018. To our knowledge this is the first study to show high proportion of MERS-CoV infection among expatriate HCWs. Despite our best efforts to retrieve information through various publicly available resources including reports published by WHO, the data still contained gaps. Incomplete and incorrect information available on online portals hinders the ability to undertake these types of epidemiology reviews. Comprehensive data regarding emerging and re-emerging infectious diseases like MERS-CoV should be made publicly available and accessible by WHO, so that contradictions could be avoided in the general interest of public health.

In both countries' hospital acquired transmission of MERS-CoV amongst HCWs was found to be the main reason for the transmission of this disease. This finding is consistent with other studies conducted on the transmission of this disease among HCWs within healthcare facilities, as well as, WHO MERS global summary and assessment of risk [6, 20–23]. We found that most of the South Korean HCWs were symptomatic to MERS-CoV, which contradicts with other studies that report asymptomatic characteristic of MERS-CoV infected patients. In Saudi Arabia, however > 36% of MERS-CoV infected HCWs, remained asymptomatic to the disease, of which the majority were expatriate HCWs. Saudi Arabian HCWs, especially expatriate HCWs being asymptomatic to MERS-CoV is consistent with other studies [24, 25]. Considering this, serologic testing should be extended to HCWs, especially expatriate HCWs who do not

show symptoms of MERS-CoV but work in the healthcare facilities where patients with MERS-CoV are being treated.

The CFR among HCWs (Saudi Arabia & South Korea) was 3.6% (10/275) compared with overall CFR of 35.5% [26]. It was 3.2% (8/246) in case of expatriate HCWs. Low CFR could be due to younger age, lesser comorbidity and perhaps ease of access to healthcare services, leading to early detection or suspicion of MERS-CoV among HCWs. However, the age-specific CFR were different for South Korea and Saudi Arabia. While two MERS-CoV infected South Korean HCWs over the age of 70 died, no death of infected Saudi Arabian HCW above the age of 60 was reported. Although more than a quarter of Saudi Arabian expatriate HCWs who had underlying comorbidity were above the age of 60. Also, 2 out of 3 male expatriate HCWs who died due to the infection had underlying comorbidity.

Most of the MERS-CoV infected HCWs in Saudi Arabia and South Korea were found to be listed under the job category 'healthcare workers. This could include any employee working in a healthcare setting. Subsequently, more nurses were infected than doctors with MERS-CoV both in Saudi Arabia and South Korea, which may be due to higher nurse-doctor ratio in both the countries [27, 28]. Unlike South Korea, in Saudi Arabia, a diversity of HCWs other than doctors, and nurses were also infected with MERS-CoV. A pharmacist with comorbidity (male, 53 years old), a receptionist (expatriate, male, 47 years old), a cleaner (expatriate, female, 29 years old) and two male HCWs (Saudi, 28 years and 50 years old) were among HCWs being infected with MERS-CoV in Saudi Arabia. This highlights, the need for delivery of infection prevention and control training programs to HCWs, especially to expatriate HCWs, who are working in non-clinical roles in healthcare facilities.

The main difference between the two countries included higher percentage of expatriate HCWs being infected with MERS-CoV in Saudi Arabia. Despite more than 60% of HCWs employed by MOH Saudi Arabia being Saudi nationals, 85% of MERS-CoV infected HCWs were expatriates. In spite of greater number of expatriate HCWs being infected with MERS-CoV, no information is available about country specific training being delivered to new non-Saudi HCWs arriving from different countries, acclimatizing them to the challenge of prevention and control of an emerging disease like MERS-CoV. In South Korea due to stringent recruitment policies for hiring foreign HCWs, there are few non-South Korean staff members [29, 30]. Infection prevention and control guidelines of South Korea and Saudi Arabia, do not specifically include a section on expatriate HCWs, which would highlight the need for country specific training programs being delivered in order to fill MERS-CoV knowledge gap between local and expatriate HCWs, if any. Thus, country specific guidelines and safety training programs against the transmission of MERS-CoV among HCWs, should be provided to the newly appointed expatriate HCWs joining the global healthcare workforce.

There is also an issue regarding expatriate staff member travelling while potentially exposed. For example, a 37-year-old Filipina female nurse, working in a hospital in Dammam, travelled to Philippines on August 29, 2014. This was four days after she was tested for MERS-CoV. She did not wait for the results to come and flew out of Saudi Arabia. On Sept. 2, she was notified by her supervisor from Saudi

Arabia that she tested positive for MERS-CoV. The nurse then notified the DOH Philippines, prompting government health personnel to take appropriate action [31]. Just like her, another Filipina female nurse (31 year old, pregnant) working in a Riyadh, Saudi Arabia, who developed symptoms on 26 January 2015, travelled to Philippines, and sought medical care at a local private hospital, where she was admitted on 2 February 2015. Following laboratory confirmation of MERS-CoV infection, on 10 February 2015, the patient was transferred to the Research Institute for Tropical Medicine (RITM) [32]. In the case of 37-year-old Filipina nurse, MOH Saudi Arabia instead of also informing the MOH Philippines, it was left to the individual judgement of the MERS-CoV infected HCW to follow infection control protocol, if any. There are also four other instances of Saudi Arabian MERS-CoV infected HCWs, who travelled abroad. No travel restrictions were imposed on the suspected MERS-CoV infected HCWs and/or presumably, the HCWs were also not trained on taking safety precautions once suspected of having been infected with MERS-CoV. The case of, 37-year-old Filipina nurse, was not found listed on the MERS-CoV WHO disease outbreak news case list, which shows loopholes in crisis communication and co-ordination between healthcare different stakeholders.

This study has limitations, as it is based on publicly available data. For many variables like age, gender, contact history of the patient, location of exposure, comorbidity etc data is listed as being not available by WHO, MOH Saudi Arabia, MOH South Korea and other supporting websites like, Flutracker, Promed Mail and Figshare. The current status (deceased or alive) of the MERS-CoV infected HCW's had not been updated as well. There could be many possible reasons for not being able to update the case list of MERS-CoV patients by WHO, including compromised information sharing by the host country. Also, while undertaking our review, a research paper was published that reported that there were 99 Saudi Arabian nationals and 5 South Korean nationals amongst the 415 HCWs infected with MERS-CoV since 2012 to 2018 [33], while according to our findings it is 35 and 29 for Saudi Arabia and South Korea, respectively. We cannot account for the differences between the two studies, unless the other authors had access to classified information. However, incomplete and incorrect information complicates the development of qualitative researches in the field of emerging and re-emerging infectious disease like MERS-CoV.

## Conclusions

MERS-CoV infected HCWs from Saudi Arabia and South Korea showed epidemiological similarities and differences. In Saudi Arabia a large proportion of MERS-CoV infected HCWs are asymptomatic to MERS-CoV, have unknown exposure and a majority of them are expatriate HCWs. There is a need for training and education of HCWs, especially expatriate HCWs, about emerging infectious diseases, the appropriate strategies to prevent acquisition and transmission. For instance, expatriate HCWs who are potentially exposed to MERS-CoV should take necessary precautions before travelling from an outbreak affected country to prevent worldwide transmission of the disease. Also, there are currently contradictory national and international guidelines, which further complicates the issue of managing HCWs, especially asymptomatic expatriate HCWs exposed to MERS-CoV in healthcare facilities. Thus, there is a need for dissemination of transparent communication and delivery of adequate training to HCWs about their safety and prevention from a susceptible viral infection like MERS-CoV, which in turn, would facilitate

HCWs wellbeing in healthcare facilities at the time of an outbreak and ultimately mitigate the spread of healthcare-associated infectious diseases.

## Abbreviations

CFR  
Case fatality rate  
HCW  
Healthcare worker  
MERS-CoV  
Middle East respiratory syndrome  
MOH  
Ministry of health  
RITM  
Research Institute for Tropical Medicine  
RT-PCR  
Reverse transcription-polymerase chain reaction

## Declarations

### *Ethics approval and consent to participate*

Not required

### *Consent for publication*

Not applicable

### *Availability of data and materials*

The database which supports this study is available upon request.

### *Competing interests*

Dr Holly Seale is a section editor for BMC Infectious Diseases. The author(s) declare(s) that there are no other competing interest.

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### *Authors' contributions*

All the authors contributed equally and all authors read and approved the final manuscript.

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