

The medical and biochemical knowledge of health care professionals regarding the management of MERS-CoV: lessons from 2019 pilgrimage season in Al-Madinah, Saudi Arabia: A cross-sectional study

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Abstract

Background: Middle East respiratory syndrome coronavirus (MERS-CoV) epidemic was a serious healthcare concern not responding to conventional anti-viral therapies between 2012 and 2017 with high fatality rates. Saudi Arabia is still among the best world examples in combating both MERS-CoV and COVID-19 pandemics.

Objectives: Investigating the medical and biochemical knowledge of healthcare professionals in Al-Madinah, Saudi Arabia on preventive, diagnostic and therapeutic measures against MERS-CoV epidemic.

Subjects and methods: In 2019, this cross-sectional study included 416 healthcare personnel of which 402 participants answered the questions with a response rate of 96.7%. Specialties of participants were medical students (1.4%), physicians (64.4%), nurses (23.6%) and others (10.7%).

Results: The vast majority of the investigated healthcare personnel gave the right answers. 96.7% of the participants answered that washing hands using water helps prevent MERS-CoV. 90.8% of the participants answered that wearing a clean non-sterile long-sleeved gown and gloves does helps prevent MERS-CoV infection. 94.7% of participants answered that using alcohol-based hand rub helps prevent MERS-CoV infection. 92.03% of the participants thought that wearing protective equipment does help preventing MERS-CoV infection. 86.1% answered that there is no vaccine available against MERS-CoV infection and 86.1% answered that taking vaccines is suitable for preventing MERS-CoV infection. 90.04% of the participants answered that MERS-CoV patients should be diagnosed using PCR and 84.3% thought that the highest levels of anti-CoV antibodies are in abattoir workers while 87.8% thought that isolation of suspected cases helps preventing MERS-CoV infection.

Conclusion: The investigated healthcare workers had a satisfactory knowledge on the preventive and therapeutic measures and biochemical knowledge against MERS-CoV epidemic at mass gatherings as pilgrimage season.

Keywords: MERS-CoV; Health care; Preventive measures; Vaccine; Health knowledge.

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Introduction

Middle East respiratory syndrome coronavirus (MERS-CoV) epidemic was a serious healthcare concern between 2012 and 2017 with high fatality rates (**Bai et al., 2013**) that preceded the emergence of COVID-19 pandemic. MERS-CoV is a respiratory illness that does not respond to conventional anti-viral therapies (**Bai et al., 2013**). It is diagnosed through RT-PCR, LAMP assay, and protein microarrays (**Straube et al., 2003**). Treatment is largely through the intravenous administration of antibodies against MERS-CoV (**Ashraf et al., 2011; Ismail et al., 2010**). There are no vaccinations or specific therapies for MERS-CoV, which causes severe and frequently fatal respiratory illnesses in humans. The MERS-CoV spike (S) glycoprotein binds to target cells' sialosides and dipeptidyl-peptidase 4 to start an infection (the attachment and entry receptors, respectively). The MERS-CoV virus binds to the sialoside receptors and identifies a region that may be vulnerable to viral entry inhibitors (**Park et al., 2019**). Hospitals have experienced an epidemic of MERS-CoV, which has led to increased MERS-CoV cases admissions and posed an increased risk of infectiousness among the medical staff. Droplet transmission and close contact transmission are the two methods of MERS-CoV transmission between humans. The year 2012 saw the initial MERS-CoV diagnosis in Saudi Arabia where 80% of cases of MERS-CoV originated, and it had later spread to 27 nations and areas in the Middle East, Asia, and Europe. When MERS-CoV first manifests, it causes a difficult-to-diagnose fever and respiratory symptoms. Within a week, MERS-CoV might proceed to cause severe pneumonia. Chills, myalgia, coughing, chest discomfort, dyspnea, vomiting, and diarrhea are other symptoms. Some people may not experience any of these. Pulmonary distress and abrupt renal failure are present

with double lung involvement. After one week, MERS-CoV primarily advances. People over 50 accounts for almost half of MERS-CoV cases. (**Liya et al., 2020**).

Investigating the health knowledge of healthcare workers and professionals involved in delivering care for Corona virus infection is vital to upgrade the delivered medical services. Raising the awareness of Saudi healthcare providers about MERS-CoV infection in public hospitals in Mecca (Makkah), was recently reported (**Al-Enazi, 2007; Sayed-Ahmed et al., 2010**). Likewise, Al-Madinah receives about 3 million pilgrims during the yearly pilgrimage season as Makkah. Investigating the readiness of healthcare professionals to manage such gatherings in the era of epidemics and pandemics is quite vital (**Khan et al., 2003; Salem & Hossain, 2000**). Several knowledge gaps may exist and health professionals need to fill such defective knowledge e.g. lack of knowledge of microbiology and virology (**Barakat et al., 2013**) and emerging infectious diseases (**Al-Johar et al., 2008**). Educational interventions for MERS-CoV management in Makkah, Saudi Arabia indicated the need for professional programs to enforce optimal levels of knowledge and improve the attitude of health workers to ensure gaining success in clinical practice (**El Daly, 1996; Fararh et al., 2004**).

Healthcare workers require prompt screening strategies (**Badary & AM, 2001**). MERS-CoV outbreak of 2014 in Jeddah is a good example of "healthcare-associated transmission" (**Nili-Ahmadabadi et al., 2011**). Preventive measures for the transmission of MERS-CoV among Healthcare workers are quite vital in reducing secondary transmission and in ensuring the continuity of care in healthcare settings (**Khader et al., 2010**). In primary healthcare settings, healthcare workers possess limited knowledge, largely due to a negative perception of knowledge transfer. Researchers highlighted the need for information

transfer in high-risk settings, and a higher level of awareness among primary healthcare workers (Hamed et al., 2013).

We previously reported the knowledge, attitudes, and practices of healthcare workers towards MERS-CoV Infection at primary health centers in Al-Madinah, Saudi Arabia during Hajj 1440 (Al-Ali et al., 2008).

In this study, we report on the knowledge, attitudes, and practices of the healthcare workers towards the management of MERS-CoV in Al-Madinah, KSA during the pilgrimage season (Hajj 1440 /2019 G calendar).

Subjects and Methods

This study was conducted via distributing a questionnaire to estimate the knowledge gaps of healthcare professionals in primary healthcare centers in Al-Madinah, Saudi Arabia. The time of the study was the Hajj season (1440 Hijri calendar) that lasted around six weeks between July 8th, 2019 to September 1st, 2019 and was corresponding to 15-11-1440 till 30-12-1440 in the Hijri Islamic calendar. The proposed questionnaire gathered information on some demographic, educational and health factors related to the investigated healthcare workers (table 1). Inclusion criteria included being a health carer (physicians, nurses and workers) in Al-Madinah city, Saudi Arabia and willingness to participate in the study. Exclusion criteria includes living outside Al-Madinah city, Saudi Arabia, not willing to participate or being non-health carers. This cross-sectional study included 416 healthcare personnel of which 402 participants answered the questions with a response rate of 96.7%.

Some statistical techniques were used in the data analysis to help the study achieve its goals. This study used the Cronbach's alpha coefficient, a measure of internal consistency, to

evaluate the overall validity of the measurement scale for each study construct.

The study is a cross-sectional screening for healthcare workers of primary healthcare centers in Al-Madinah, Saudi Arabia. The questionnaire was given to all participants followed. All questions and answers of the questionnaire are listed in (Tables 1-3).

Data gathering techniques

The study volunteers were native Arabic speakers, so an English version of a structured questionnaire was also translated into that language. To ensure uniformity, another individual back-translated it into English. Both data collection and supervision were assisted by the authors. The questionnaire was reviewed for completeness, sensitivity, and clarity.

Statistical analysis

International Business Machines Corporation's Statistical Package for the Social Sciences (IBM SPSS) version 20 was used for data analysis. The analysis was descriptive. Binary logistic regression analysis was used to identify the elements under investigation. A p-value of 0.05 or less was regarded as statistically significant when applied to variables from the bivariate analysis that had a p-value of less than 0.3.

Results

Specialties of participants and their knowledge source

Specialties of participants were medical students (5 participants with a valid percent of 1.4%), physicians (235 participants with a valid percent of 64.4%), nurses (86 participants with a valid percent of 23.6%) and others (39 participants with a valid percent of 10.7%) (Fig.1A). Valid percent for the participating age group (18-25 years) was 9.4, for the age group (26-35 years) was 58.6%, for the participating age group (36-45 years) was 31%, and for the

participating age group (46-55 years) was 1% (**Fig.1B**). Then, the questionnaire also investigated the health personnel knowledge regarding their knowledge source whether it comes from Scientific and medical courses, world health organization (WHO), ministry of health (MOH), news or others. 25 participants (valid percent 8.4%) acquired their

knowledge from courses, 166 participants (valid percent 55.9%) acquired their knowledge from WHO or MOH. 66 participants (valid percent 22.2%) acquired their knowledge from news, and 40 participants (valid percent 13.5%) acquired their knowledge from other sources (**Fig.1C**).

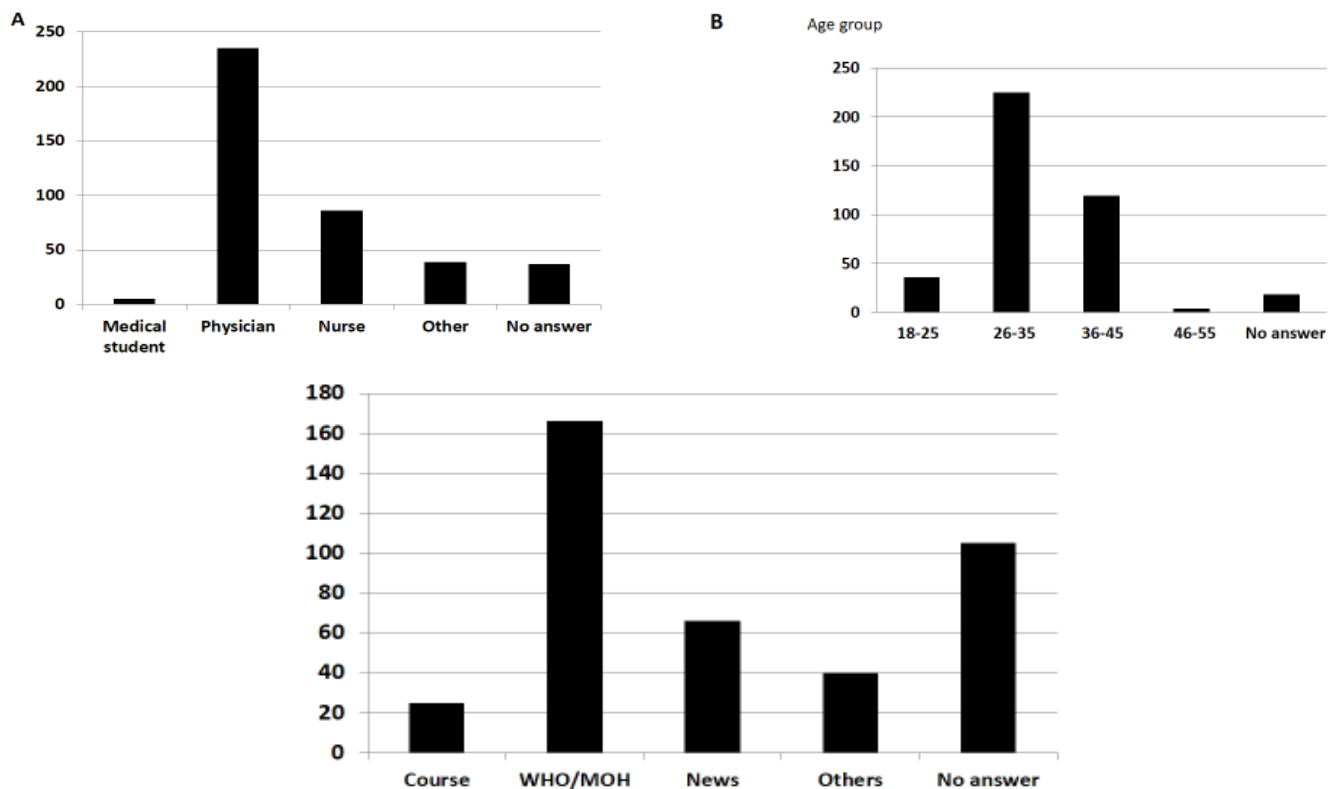


Fig. 1. Characteristics of the participants in the questionnaire; A. Majority of participants in the questionnaire were physicians in addition to medical students and nurses. **B.** Majority of participants in the questionnaire were young (26-35 years) age group. **C.** The source of participants’ knowledge on MERS-CoV.

Knowledge of participants on preventive measures against MERS-CoV infection

The questionnaire also investigated the health personnel's knowledge regarding preventing MERS-CoV infection via washing the hands with water. 389 of the participants (96.7%) reported that washing hands using water does help preventing MERS-CoV. 9 participants (2.1%)

reported that washing hands using water does not help preventing MERS-CoV infection. The questionnaire also investigated their health knowledge regarding wearing clean non-sterile long-sleeved gowns and gloves for preventing MERS-CoV infection. 365 participants (90.8%) thought that wearing clean non-sterile long-sleeved gowns and gloves does

help preventing MERS-CoV infection while 26 participants (6.4%) denied that and gave wrong answers. 392 participants (97.5%) reported that wearing a clean non-sterile long-sleeved gown and gloves helps preventing MERS-CoV infection while 9 participants (2.1%) denied that and gave wrong answers. The questionnaire also investigated the health personnel's knowledge regarding a possible prevention and control of MERS-CoV infection. 362 (90.04%) participants answered that

wearing a regular mask does prevent MERS-CoV infection. 26 (6.4%) participants thought that wearing a regular mask does not prevent MERS-CoV infection. The questionnaire also investigated the health personnel's knowledge regarding using a medical mask for preventing MERS-CoV.. 381 participants (94.7%) thought that wearing a medical mask helps preventing MERS-CoV infection while 26 participants (6.4%) gave wrong answers (Table. 2).

Table.1. Points of investigating the health knowledge of healthcare workers in Al-Madinah, Saudi Arabia and their correct answers

<ul style="list-style-type: none"> • Medical profession • Age group • Source of participants' knowledge • Investigating health knowledge on: <ul style="list-style-type: none"> ➤ Highest anti-MERS-CoV antibodies (among abattoir workers) ➤ Causes of Mortality in MERS-CoV (Respiratory failure) ➤ Suitable treatments for patients with MERS-CoV (Supportive treatment) ➤ How to confirm MERS-CoV diagnosis (PCR) ➤ Availability of a vaccine against MERS-CoV (Not available) ➤ Most suitable therapies for MERS-CoV (supportive treatment) ➤ Role of a vaccine in prevention and treatment of MERS-CoV (None) ➤ Necessity of isolating suspected cases having MERS-CoV (Yes) • Necessity of hand washing to combat MERS-CoV (Yes) 1. Necessity of alcohol-based hand rub to combat MERS-CoV (Yes) 2. Necessity of wearing protective personal equipment to combat MERS-CoV (Yes) 3. Necessity of wearing medical masks to combat MERS-CoV (Yes) • Necessity of wearing regular masks to combat MERS-CoV (Yes) • Necessity of wearing a clear non-sterile long-sleeved gown and gloves (Yes) • Sources of their medical knowledge
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Table 2. Investigating the health knowledge of healthcare professionals on preventive measures against MERS-CoV. That was done through answering the following questions:

Questions investigating the knowledge of healthcare on MERS-CoV prevention	Correct Answers	% of correct answers	% of wrong answers	% of “no answer”	p value
A. Does washing hands using water help the prevention of MERS-CoV?	Yes	389 (96.7%)	9 (2.1%)	4 (0.99%)	<0.05
B. Does using a clear non-sterile long-sleeved gown and gloves help the prevention of MERS-CoV infection?	Yes	365 (90.8%)	26 (6.4%)	11 (2.7%)	
C. Is it important to wear a regular mask to help prevent MERS-CoV infection?	Yes	392 (97.5%)	9 (2.1%)	1 (0.24%)	<0.05

D. Is it important to wear a medical mask to help the prevention of MERS-CoV infection?	Yes	362 (90.04%)	26 (6.4%)	16 (3.9%)	
E. Does using an alcohol-based hand rub important to prevent MERS-CoV infection?	Yes	381 (94.7%)	19 (4.7%)	2 (0.49%)	<0.05
F. Is wearing personal protective equipment important to help the prevention of MERS-CoV infection?	Yes	370 (92.03%)	21 (5.2%)	11 (2.7%)	<0.05
G. Is there currently a vaccine against MERS-CoV infection?	Not available	346 (86.1%)	44 (10.9%)	12 (2.9%)	
H. Can prevention and control of MERS-CoV be through taking vaccines?	No. As there are no available vaccines	346 (86.1%)	44 (10.9%)	12 (2.9%)	

The questionnaire also investigated the health personnel’s knowledge regarding using alcohol-based hand rub for preventing MERS-CoV. 381 participants (94.7%) answered that using alcohol-based hand rub does help preventing MERS-CoV infection. 19 participants (4.7%) thought wrongly that using alcohol-based hand rub does not help preventing MERS-CoV infection. The questionnaire also investigated the health personnel’s knowledge regarding wearing protective equipment for preventing MERS-CoV infection. 370 participants (92.03%) thought that wearing protective equipment does help preventing MERS-CoV infection while 21 participants (5.2%) reported wrongly that using wearing a protective equipment does not help preventing MERS-CoV infection (**Table. 2**).

The questionnaire also investigated the health personnel’s knowledge regarding the availability of a vaccine against MERS-CoV infection. 346 participants (86.1%) gave the correct answer that there is no currently available vaccine against MERS-CoV infection while 44 participants (10.9%) gave the wrong answer that there is an available vaccine against MERS-CoV infection. The questionnaire also investigated the health personnel’s knowledge regarding the prevention and control of MERS-CoV

infection. 346 participants (86.1%) gave the correct answer that a suitable vaccine cannot be taken (as it is not available) for preventing MERS-CoV infection (**Table. 2**).

Knowledge of healthcare professionals on diagnosis and immunity related to MERS-CoV infection

The questionnaire also investigated the health personnel’s knowledge regarding how to confirm the diagnosis of MERS-CoV infection. 362 participants (90.04%) gave the correct answer that the diagnosis should be done using PCR. 30 participants (7.4%) thought wrongly that patients should be diagnosed using other investigations as ELISA or sputum culture. Regarding the question where is the highest levels of anti-CoV antibodies whether in the general population, camel owners or abattoir workers. 339 participants (84.3%) gave the correct answer that the highest levels of anti-CoV antibodies existed in abattoir workers. The remainder 52 participants (12.9%) gave wrong answers and chose “the general population” or “camel owners and shepherds” (**Table. 3**).

Knowledge of healthcare professionals on the management and prognosis related to MERS-CoV infection

The questionnaire also investigated the health personnel’s knowledge regarding the effects of isolation of suspected cases

for preventing MERS-CoV. 353 participants (87.8%) answered correctly saying that isolation of suspected cases helps preventing MERS-CoV. 46 participants (11.44%) answered wrongly saying that isolation of suspected cases does not help preventing MERS-CoV infection and they should be admitted to wards or be referred to a higher centre (Table. 3).

The questionnaire also investigated the health personnel’s knowledge regarding the treatment of MERS-CoV infection and how it should be. 348 participants (86.56%) answered correctly that MERS-CoV patients should be treated by supportive management. 337 participants (83.8%) thought correctly that MERS-CoV patients should be given a symptomatic

and supportive treatment rather than antiviral drugs and antibiotics. 62 participants (15.4%) wrongly chose antibiotics as cephalosporins and antivirals as acyclovir as the suitable management drugs for MERS-CoV infection. Finally, the health knowledge about the causes of mortality in MERS-CoV whether it is due to respiratory failure, associated comorbidities, delayed diagnosis or lack of effective therapies. 346 participants (86.06%) answered correctly saying that MERS-CoV-induced mortality is due to respiratory failure. 42 participants (10.44%) thought wrongly of other causes (as delayed diagnosis or associated comorbidities) to induce MERS-CoV mortality.

Table 3. Investigating the health knowledge of healthcare professionals on best diagnostic investigation and some measures to combat MERS-CoV?

Questions investigating the knowledge of healthcare on MERS-CoV prevention	Correct Answers	% of correct answers	% of wrong answers	% of “no answer”	p value
A. How to confirm MERS-CoV diagnosis? (nasal swab, PCR, sputum culture, or ELISA)	Using PCR	362 (90.04%)	30 (7.4%)	10 (2.4%)	<0.05
B. Highest anti-MERS-CoV antibodies are among whom? (General population, camel owners& shepherds, or abattoir workers)	Among Abattoir workers	339 (84.3%)	52 (12.9%)	11 (2.7%)	
C. Where MERS-CoV patients should be treated? (admit to ward, refer to higher centers, isolate patients, or give symptomatic treatment and send to home)	Isolate patients	353 (87.8%)	46 (11.44%)	3 (0.7%)	
D. What are the suitable measures for treating patients with MERS-CoV?	Supportive treatments	348 (86.56%)	42 (10.44)	12 (2.9%)	
E. What are the suitable agents to treat MERS-CoV infection? (antiviral agents e.g., acyclovir, antibiotics e.g., cephalosporins, or supportive management)	Supportive management	337 (83.8%)	62 (15.4%)	3 (0.74%)	
F. What are the causes of mortality due to MERS-CoV infection? (respiratory failure, associated co-morbidities or delayed diagnosis)	Respiratory failure	346 (86.06%)	42 (10.44%)	14 (3.4%)	

Discussion

Available research evidences indicate that the current level of knowledge, attitudes, and practices (KAPs) among healthcare workers requires targeted educational interventions to help decreasing the infection transmission in clinical settings. Our previously published study evaluated the general understanding of medical personnel regarding the virology of MERS-CoV coronaviruses, including the kind of nucleic acids (DNA or RNA), viral envelopes, viral strains, and viral genus. The effects of close contact on corona transmission, the risk of infection to recent travellers from the Arabian Peninsula, the risk of infection to close contacts of a confirmed MERS-CoV case, the risk of infection to people exposed to camels, and the risk of infection that may affect healthcare workers who were also assessed as a part of our health knowledge assessment. We also evaluated the medical knowledge regarding the seasons and species involved in MERS-CoV transmission, as well as whether camels and bats are involved. Our previously published study also assessed the health knowledge on MERS-CoV infectivity, infectiousness and health impacts (Al-Ali et al., 2008). However, this study focused on completing the assessment of the basic health knowledge on the prevention, control and treatment of MERS-CoV. This hopefully may decrease the risk of morbidity and mortality rates. The current study places significant emphasis on the MERS-CoV-related events occurring in Saudi Arabia at the time of Hajj when infection transmission rates are significantly higher.

The current study was carried out in 2019 Hajj (pilgrimage) season in the Kingdom of Saudi Arabia where healthcare workers face extreme workload. Primary health centers account for the first point of contact with the patient and face the highest risk regarding the possibility of acquiring MERS-CoV infection from the patient. Given that the probability of

infection transmission is significantly higher in the Hajj season (Hamed et al., 2013), research has the potential to explore and quantify the attitudes and practices of Healthcare workers working in primary health centers in the context of effective prevention and management of MERS-CoV. The “One Health approach” is recommended for zoonotic outbreaks as MERS-CoV where one health working group was established in Qatar to conduct a survey in the Gulf Cooperation Council countries, Egypt, and Jordan to monitor the preparedness of public health and veterinary health authorities in response to the MERS-CoV epidemic as health framework to mitigate the risk for Middle East respiratory syndrome and other emerging zoonotic diseases (Abdel-Hamid et al., 2013; Dollah et al., 2013; Hassan, et al., 2012).

Almutairi et al. (2018) recorded the traumatic experiences of healthcare workers at a 1000-bed Saudi hospital in terms of providing care, associated prejudice and stigma, feeling of fear, trauma, despair, and denial, and how these factors adversely affect their performance (Sayed et al., 2013). In this study, the majority of participants in the questionnaire were physicians in addition to medical students and nurses. Also, the majority of participants in the questionnaire belonged to the young people age group (26-35 years) with variable sources of knowledge.

This study also investigated the knowledge of healthcare professionals on preventive measures against MERS-CoV. That was done by answering many questions about the roles of washing hands (using water) in the prevention of MERS-CoV infection. Moreover, the questionnaire asked about the role of a clear non-sterile long-sleeved gown, gloves, regular mask, medical mask, alcohol-based hand rub, and personal protective equipment in the prevention

of MERS-CoV infection. Then, the questionnaire asked about the importance of wearing protective equipment to help the prevention of MERS-CoV infection. Then, the questionnaire asked about whether there is a currently available vaccine against MERS-CoV infection and asked about the possibility of prevention and control of MERS-CoV via taking vaccines.

Moreover, this study also investigated the knowledge of healthcare professionals regarding the best diagnostic investigations for MERS-CoV infection regarding the best test to confirm MERS-CoV diagnosis and where the highest anti-MERS-CoV antibodies can be found. Then, this study investigated the knowledge of healthcare professionals on some measures to combat MERS-CoV infection, whether it is important to isolate MERS-CoV cases, what are the suitable measures for treating MERS-CoV patients and what are the suitable agents to treat MERS-CoV infection. Finally, the study investigated the knowledge of healthcare workers on the causes of mortality due to MERS-CoV infection.

The answers were collected and reported in the results section and indicated by the supporting figures and clearly demonstrate that there is a need for continuous medical education regarding epidemics management particularly against MERS-CoV infection. Workshops, training courses and public awareness campaigns are strongly recommended to increase the knowledge of healthcare professionals.

Based on the current knowledge and attitudes of the health carers in Al-Madinah (Saudi Arabia), the authors are assured and satisfied with the current knowledge in this respect. Our own views are promising with the magnitude of positive attitudes in sharing in the answers of this questionnaire and also with the satisfactory quantity of knowledge exhibited by the healthcare participants.

The shortcomings of this study are quite promising. We expect a better level of healthcare giving in the future. The promising participation and the level of healthcare awareness and medical knowledge reflect on improving the medical services provided to the public. We expect a better management of any recurrent or emerging epidemics or pandemics in the future. Saudi Arabia does have an excellent healthcare system that upgrades continuously and reflects a continuously improving human factor in delivering a high standard of medical care and services.

It is quite important for healthcare personnel to have a biochemical knowledge regarding PCR in diagnosing MERS-CoV. When a person is suspected of having MERS-CoV infection based on clinical symptoms and connections to MERS-affected areas, molecular testing is done to confirm the diagnosis of active infection. Molecular tests such as real-time reverse-transcription polymerase chain reaction (rRT-PCR) assays can be used to identify viral RNA in clinical samples. The current case criteria for laboratory confirmation of MERS-CoV infection, as defined by the American center for disease control (CDC), calls for the sequencing of a second target in addition to a positive rRT-PCR result for at least two distinct genomic targets. The majority of state laboratories in the US are authorized to use the CDC-developed rRT-PCR assay to test for MERS-CoV. The reason this test is conducted under Emergency Use Authorization is that there aren't any FDA-approved or authorized tests available in the US for this use.

The effectiveness of rRT-PCR testing is contingent upon multiple aspects, such as the level of experience and skill possessed by laboratory personnel, the laboratory environment (such as the prevention of contamination), and the nature and state of the specimens under examination. The CDC advises gathering a variety of specimens for this rRT-PCR

assay, such as serum, feces, and lower (bronchialveolar lavage, sputum, and tracheal aspirates) and upper (nasopharyngeal and oropharyngeal swabs) respiratory samples.

Once rRT-PCR test on the suggested specimens yields a negative result, the CDC deems the subject of the investigation to be negative for an active MERS-CoV infection. In rare cases, several specimens may be analyzed because a single negative result does not totally rule out MERS-CoV infection.

After two consecutive negative rRT-PCR tests on all samples, the CDC considers a known MERS patient to be negative for an active MERS-CoV infection.

Conclusion

The investigated healthcare workers had a significant knowledge on preventive and therapeutic measures against MERS-CoV epidemics particularly at mass gatherings as pilgrimage season. However, minor knowledge gaps are still present and need to be covered via workshops, training courses and public awareness campaigns.

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