Visual Triage Contributes Toward Early Detection and Management of the Middle East Respiratory Syndrome Coronavirus (MERS-CoV)

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Abstract

Emerging viral infections particularly the Middle East Respiratory Syndrome Coronavirus (MERS-CoV) poses a significant public health threat in Saudi Arabia and several other Gulf countries. The virus is zoonotic in nature transmitted from camels to humans. Among humans respiratory secretion and aerial droplets released through sneezing and coughing are considered as a primary conduit for person to person viral transmission. Several reports are suggesting the transmission of the virus to health care professional particularly the first responders in the emergency departments (ED). Furthermore, the MERS symptoms resemble with several other respiratory ailments and infections and as such usually go unchecked thus posing a public health challenge as well as putting nurses and hospital staff at the risk of acquiring the infection. An early detection of MERS-CoV followed by appropriate treatment strategy can reduce the public health hazards associated with this infection. Toward this end, the Ministry of Health, Kingdom of Saudi Arabia "Infection Prevention and Control Guidelines for the Middle East Respiratory Syndrome Coronavirus (MERS-CoV) Infection" mandate usage of visual triage scoring for the people presenting respiratory symptoms. This visual triage score helps in isolating the patients potentially having MERS-CoV infection. This study reports usage of modified visual triage scoring matrix in the ED of King Fahd Medical City Hospital, Saudi Arabia. This strategy helped in quarantine of patients suspected of MERS-CoV infection. Further confirmation through molecular diagnostic evaluation of nasal lavage confirmed MERS-CoV in 2.31% of the patient. The study also confirmed that symptoms of MERS-CoV fever, cough, shortness of breath, runny nose, sore throat, body ache and previous exposure to the virus are a very strong predictor of the infection. The findings of this study suggest usage of visual triage scoring for MERS-CoV in the Saudi Arabia and other countries facing with this viral infections. Furthermore, visual triage was highly useful in the identification of patients having a viral infection that was further confirmed by molecular diagnostic and appropriate treatment. Although the number of patients having MERS-CoV was ~2%, however, early and appropriate quarantine can help in preventing further spread of the virus that has high morbidity and mortality.

Keywords: Middle East Respiratory Syndrome (MERS) Coronavirus; Visual Triage; Saudi Arabia; Nosocomial Infections

Introduction

The Middle East Respiratory Syndrome coronavirus (MERS-CoV) is a zoonotic infection transmitted from camels to humans. Among humans, the symptoms of this infection are similar to common cold like fever, cough, and sneezing. Several studies in the past manifested

Visual Triage Contributes Toward Early Detection and Management of the Middle East Respiratory Syndrome Coronavirus (MERS-CoV)

122

transmission of MERS-CoV to health professionals taking care of these patients mainly in the emergency EDs thus highlighting the potential risks involved [1,2]. To avoid the cross-infectivity of MERS-CoV among healthcare workers, several critical strategies have been delineated [3]. Among several others, visual triage scoring helps in isolating the patients suspected with MERS-CoV and taking appropriate measure during the clinical investigation. The Scientific Advisory Board of the Ministry of Health of the Kingdom of Saudi Arabia in January 2017 released "Infection prevention and control guidelines for the Middle East Respiratory Syndrome Coronavirus (MERS-CoV) infection" highlighting the importance of visual triage system particularly in the ED [4]. This visual triage system in based on numerical scoring of clinical symptoms/sign and risks of exposure to MERS. The triage is routinely used in the EDs for several other existing and emerging infections [5]. The ultimate benefits of implementing triage scoring system provide a hospital with the opportunity for early isolation of cases that may cause public health outbreaks of infectious diseases. Different hospitals use different protocols to divert suspected cases to the appropriate area of an emergency department for further care.

The Middle East Respiratory Syndrome-Coronavirus (MERS-CoV) is a novel coronavirus discovered in 2012 and is responsible for acute respiratory syndrome in humans [6]. According to the Center for Disease Control and Prevention (CDC), several countries in the Arabian Peninsula including Bahrain, Iran, Jordan, Kuwait, Lebanon, Oman and United Arab Emirates (UAE) have reported confirmed cases of MERS. This infection has crossed the geographic boundaries, and several other countries beyond the Middle East reported confirmed cases of MERS supposed to be travel-associated infection transfer [7]. Mortality among patients acquiring MERS-CoV infection has been reported to be 36% [8]. Besides travel-associated viral transmission of MERS, first healthcare responders in the ED are the primary target of acquiring infections mainly in the EDs.

The ED of any hospital has a crucial role in overcoming the existing or emerging infection. Primarily due to overcrowding of the EDs, early visual triage system provides an opportunity for the healthcare providers to confirm the infection through additional diagnostic and plan for therapeutic intervention. Effective triaging prevent nosocomial spread of MERS-CoV and other infectious diseases to adjacent patients, medical staff, and visitors [9]. This paper describes infection control measure through a visual triage system at the King Fahad Medical City Hospital, the Kingdom of Saudi Arabia emergency department. The study takes into consideration both the MERS-CoV and prevalent influenza in the region due to H1N1 strain. Data emanating from this study suggests that visual triage of patients presenting flu-like symptoms (fever, cough, shortness of breath) is highly effective public health measure to delineate and differentiate between common cold and MERS-CoV patients as well as protecting the healthcare workers in the ED with cross-infections that cause a significant morbidity and mortality. As the MERS-CoV infection is almost endemic to Arabian Peninsula, such studies strengthen the preparedness of healthcare facilities and strengthen the national health system to cope with future emergencies if any [10].

Literature Review

The MERS-CoV infection leads to symptoms like fever, cough, and shortness of breath followed by significant morbidity and mortality. Since its first report in the year 2012 from the Saudi Arabia, several outbreaks have been reported in the Arabian Peninsula and other parts of the world [11]. A rapid surge in the MERS-CoV infection in the kingdom during mid-March 2014; raised international concern for a global outbreak [12]. Several preparedness strategies were developed to cope with the MERS-CoV infections through the Ministry of Health and associated organizations. Among several others, the Saudi Arab Ministry of Health mandated for all the hospitals EDs to follow guidelines outlined in the "Infection prevention and control guidelines for the Middle East Respiratory Syndrome Coronavirus (MERS-CoV) infection" stressed the need for early detection followed by its clinical management [4]. These guidelines are in addition to existing universal infection control protocols and procedures in Saudi Arabia' hospitals [13]. Almost endemic nature of the MERS-CoV in the Saudi Arabia is due to camels, an animal considered as an intermediary in the transmission of this viral infection [14,15]. Human-to-human transmission of MERS-CoV occurs through droplets, direct contact with the infected patient, or by touching contaminated surfaces [16].

The comprehensive document prepared by the Saudi Arabia Ministry of Health has enhanced the ability of emergency departments of the country to control and prevent the possible spread of MERS in healthcare facilities [4]. This viral infection maybe symptomatic or

Visual Triage Contributes Toward Early Detection and Management of the Middle East Respiratory Syndrome Coronavirus (MERS-CoV)

123

asymptomatic. The emergency wards in the region having a prevalence of MERS have to be highly cautious and follow universal infection control measures along with the Ministry of Health guidelines. Furthermore, flu and MERS-CoV has common symptoms as well as initial prognostic and care should be adapted to every patient. The pathogenesis of MERS-CoV infection is also associated with extrapulmonary symptoms including diarrhea, nausea, and vomiting. In some cases, complications like kidney failure and pneumonia occur. People with weakened immune systems or with medical conditions such as diabetes, chronic lung cancer, heart disease or cancer have a greater chance of being infected with MERS-CoV [17].

Triage Systems and the MERS-CoV Patients

The ED of any hospital plays a significant role in an effective initial screening of patients followed by appropriate healthcare delivery. In Saudi Arabia, the Ministry of Health pays major attention to the enhancement of facilities in the ED and assures best possible facilities for patients. Due to overcrowding of ED, particularly during an outbreak of an infection ED visual triage has a crucial role in isolating patients that can potentially transmit infections to other patients or healthcare professionals. According to Fitzgerald., et al. [3], the purpose of the triage is to apply evidence from the objective observation of the patient's characteristics in order to prioritize emergency treatment. Highly trained nurses and medical staff plays a major role in the triage process thus categorizing patients who are presented for emergency care in order to sustain the patient's life. Healthcare professionals are always trained for the ED triage and is routinely utilized by military, civilian and disaster medicine [18,19].

Since the MERS-CoV disease was first discovered in Saudi Arabia, more than six hundred patients have died due to the disease [20]. Under such circumstances, visual triage scores could play a vital role in the detection of illness followed by appropriate clinical investigative measures. The symptoms of MERS-CoV include fever, cough, shortness of breath, runny nose, sore throat, body ache, nausea/vomiting, and diarrhea [21,22]. According to the Ontario Agency for Health Protection and Promotion [23], patients had presented these signs of the disease in 26 countries, where several hundred fatalities have been reported. Perhaps, early detection of the disease could have averted some of these deaths. The development of protocols for diagnosis of illness in ED based on signs and symptoms may improve the quality of healthcare. The ED visual triage scores play a significant role in early detection of MERS-CoV. Previous studies have explored the use of triage in early detection of various types of disease with positive outcomes. The triage process involves two stages: the assessment stage in which the triage category is allocated and processed, and the intervention phase which facilitates the provision of emergency care for the patient. The outcomes of triage may be categorized as correct, expected, over- and under triage. When the patient is examined within the correct timeframe, correct triage, which represents a positive health outcome, is obtained. Sometimes, triage can be deemed as over-triage or under-triage, representing a higher or lower acuity than required, respectively. Previous studies indicate that over-triage and under-triage can have costly outcomes for healthcare, resulting in the overextension of emergency department resources, longer patient waiting times and other associated complications [24].

There are pros and cons of triage system in the ED. For example, Gerdtz and Bucknall study revealed that over-triage and under-triage allocation leads to prolonged waits and can result in more complications due to the long waiting times [25]. This suggests that triage system should be implemented cautiously and its outcome should constantly be reviewed. However, the argument may not be so much about waiting times but rather about equitable redistribution of patient waiting times according to need in order to avoid the deleterious impacts of long waits. Along with similar lines, another study suggests the fair distribution of timings for each and every patient visiting the ED to avoid dissatisfaction among the patient population [26]. However, triage is an important process that needs to be embraced by both healthcare professionals and patients in order to improve satisfaction. The WHO recommended educational campaigns to educate health professionals, patients, and families about the importance of triage [17,27].

Materials and Methods

Study Design

This is an observational study involving assessment of all adult patients visiting the ED of King Fahad Medical City hospital during

Visual Triage Contributes Toward Early Detection and Management of the Middle East Respiratory Syndrome Coronavirus (MERS-CoV)

124

the 11 weeks' time frame (1st March - 24th June 2017). Both male and female adult individuals were asked to answer questions specific for Illness Checklist for MERS in Adults [4]. The questionnaire developed by the Ministry of Health, the Kingdom of Saudi Arabia was partially modified, and the threshold for MERS was reduced from the numeric value of 4 to 3. This triage visual scoring system takes into consideration disease symptoms suggestive of viral infection (fever, cough, shortness of breath, runny nose, sore throat, body aches nausea, vomiting or diarrhea, and patients previously exposed to MERS-CoV within 2 weeks and coming from an outbreak area). The study included all patients who walked into the King Fahad Medical City and were asked to answer the "visual triage scoring checklist for acute respiratory illness." The sample size of the patients having visual triage score above 3 was 397. All these individuals were isolated in a negative pressure room where all nurses and medical staff took full precautionary measure. In the first two hours, all patients were screened for complete blood count (CBC) and chest X-ray, followed by a clinical decision if the patient needed to be swabbed or not for MERS molecular diagnostic test. If the first swab was negative, they needed a second swab, and if the first swab was positive, they kept the patient in the isolation room.

Both adult male and female were included in the study and kept under surveillance if suspected for MERS infection. In addition, the following patients were included in the assessment.

1. A person with fever and community-acquired pneumonia or acute respiratory distress syndrome based on clinical or radiological evidence.
2. A hospitalized patient with healthcare-associated pneumonia based on clinical and radiological evidence.
3. A person with i) acute febrile (≥ 38°C) illness, AND ii) body aches, headache, diarrhea, nausea/vomiting, with or without respiratory symptoms, AND iii) unexplained leukopenia (WBC < 3.5 x 109/L) and thrombocytopenia (platelets < 150 x 109/L)
4. A person (including health care workers) who had protected or unprotected exposure to a confirmed or probable case of MERS-CoV infection and who present with upper or lower respiratory illness within 2 weeks of exposure.

The confirmation of MERS viral infection was done by taking a nasopharyngeal swab from the posterior nasopharynx. If the patients were confirmed (MERS-CoV), they were transferred to Prince Mohammed Bin Abdulaziz Hospital, but, if not, they were sent for a second swab after 48 hours, then a swab every three days. If they were found to be still positive but clinically improving and stable, home isolation was discussed with the patient/family, and the Ministry of Health was informed for follow up.

Data Collection and Analysis

The chart review was conducted for all ED patient files that proceeded to the respiratory zone area suspected of MERS-CoV infection during the study period. Data collected from the charts included medical record number (MRN), age, the outcome of a nasal swab, visual triage score, date of swabs, and visit date. Those patients who were swabbed were then compared with the patient's chart, and the number of patients that met the case definition criteria was recorded. Data collected were subjected to statistical analyses using Statistical Package for the Social Science (SPSS) version 18.0

Results

This study approved by the Ethical Review Board spanning over a period of eleven weeks evaluated the benefits of visual triage in the ED for isolating the patients suspected of MERS-CoV infection in the King Fahd Medical City, Saudi Arabia. Based on our visual triage scoring matrix the number of patients suspected for the viral infections were 397. In this cohort, demographically, 48.8% (n = 189) were female and 51.2% (198) were male. The average age of the patients was 54 years (SD = 21.624).

Visual Triage Contributes Toward Early Detection and Management of the Middle East Respiratory Syndrome Coronavirus (MERS-CoV)
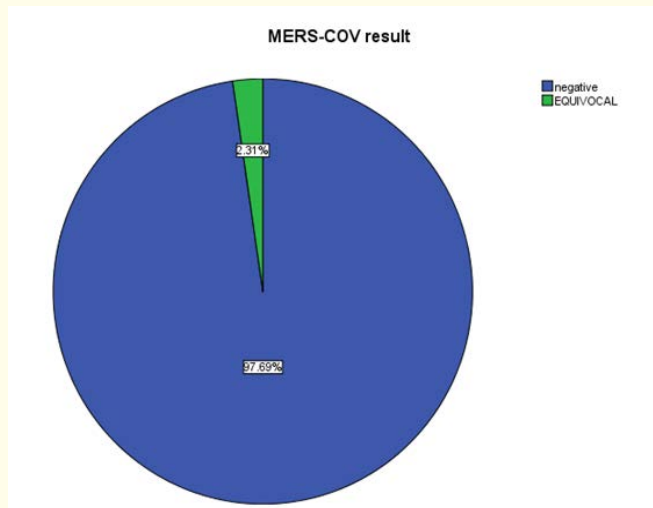
125

Figure 1: *The percentage of patients detected of MERS-COV in the sample population after recording the visual triage scores and subsequent swabbing. Upon analysis, the results show that 2.3% of the patients tested positive for MERS-CoV.*

Paired sample tests were performed to find any significant relationships between various predictors of the Canadian Triage and Acuity Scale (CTAS) and their respective scores (Table 1). The findings show that all independent variables (fever, cough, shortness of breath, runny nose, sore throat, body ache, nausea, vomiting, and diarrhea as well as exposure to MERS-COV) are significantly associated with the visual triage score (p < 0.05).

Paired Sample Test		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	The patient has fever	-3.417	2.155	.123	-3.659	-3.175	27.786	306	.000
Pair 2	Cough	-3.166	2.066	.118	-3.397	-2.934	-26.889	307	.000
Pair 3	shortness of breath	-3.198	2.242	.128	-3.449	-2.947	-25.036	307	.000
Pair 4	Runny nose	-4.153	2.499	.142	-4.433	-3.872	-29.158	307	.000
Pair 5	sore throat	-4.062	2.433	.139	-4.335	-3.789	-29.294	307	.000
Pair 6	body ache	-3.899	2.443	.139	-4.173	-3.625	-28.015	307	.000
Pair 7	nausea vomiting and diarrhea	-4.020	2.586	.148	-4.311	-3.729	-27.189	305	.000
Pair 8	exposed to MERS-CoV	-4.248	2.595	.148	-4.540	-3.957	-28.643	305	.000

Table 1: *The relationship between independent predictors and the CTAS scores.*

After ascertaining the relevance of these variables, correlation, and regression statistics were performed to determine the association between the use of the visual triage scores and diagnosis of MERS-CoV in patients. The visual triage scores were rescored in order to complete this analysis. The following tables present the visual triage scores after rescoring.

Visual Triage Contributes Toward Early Detection and Management of the Middle East Respiratory Syndrome Coronavirus (MERS-CoV)

126

As shown in Table 1 the Sig. (2-tailed) value in our example is 0.000 is lesser than 0.05 for various parameters indicative of MERS-CoV infection including fever, cough, shortness of breath, runny nose, sore throat, body ache and previous exposure to MERS-CoV. These findings suggest a strong association of the above-described parameters with MERS-CoV infection.

Table 2 describes the correlation between visual triage scores and MERS-CoV. An F value of 5.364 by keeping visual triage score as a constant and MERS-CoV dependent variable allude to the benefits of visual triage for screening purposes of patients manifesting symptoms of the viral infection. The logistic regression results further affirm these findings.

ANOVA					
Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	.778	1	.778	5.364	.031[a]
Residual	3.048	21	.145		
Total	3.826	22			
a. Predictors: (Constant), visual triage rescore					
b. Dependent Variable: MERS-COV result					

Table 2: *Correlation between visual triage scores and MERS-CoV.*

Coefficients					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
B	Std. Error	Beta			
1 (Constant)	-.286	.179		-1.592	.126
visual triage rescore	.095	.041	.451	2.316	.031
a. Dependent Variable: MERS-CoV result					

Table 3: *Logistic Regression Results.*

According to our findings, fever, cough, and runny nose are significant predictors of MERS-CoV. This is consistent with what is reported elsewhere in the literature. The World Health Organization suggested that fever, cough, and dyspnea are the significant predictive factors for the MERS-CoV disease [28]. The Center for Disease Control and Prevention further identifies shortness of breath as well as other early symptoms including body aches, sore throat, headache, diarrhea, and nausea/vomiting as possible symptoms [29]. The present study found these factors to be highly significant to early detection of the disease.

Discussion

The MERS-CoV shows a wide variety of symptoms such as fever, cough, shortness of breath, runny nose, sore throat, body ache, nausea, vomiting, and diarrhea. Several other ailments also have symptoms resembling this viral infection. Patients who come to the hospital for various reasons but have these symptoms are likely to have MERS-CoV, especially in countries where the disease has been reported. As of April 2016, the disease had been described in 26 countries where it had caused hundreds of deaths [14,20]. In this paper, visual triage scoring was used based on these symptoms for the detection of MERS-CoV infection. The MERS-CoV is an emerging viral infection in the Arabian Peninsula and poses a severe public health threat to public and health care professional. Earlier quarantine measures in the region prone to this viral infection can curtail its further spread.

This study suggests that low-cost and quick screening through visual triage is a highly effective measure in controlling further spread of MERS-CoV, particularly in the ED the first responders to take care of sick patients. Previous studies have explored the use of triage in early detection of various types of disease with positive outcomes. However, its usage in curbing MERS is still at an earlier stage. The triage process involves two steps: the assessment stage in which the triage category is allocated and the patient processing and inter-

Visual Triage Contributes Toward Early Detection and Management of the Middle East Respiratory Syndrome Coronavirus (MERS-CoV)

127

vention phase which facilitates the provision of emergency care to the patient. The outcomes of triage may be categorized as correct, expected, over- and under-triage. When the patient is examined within the right timeframe, the proper triage, which represents a positive health outcome, is obtained. Sometimes, triage can be deemed as over-triage or under-triage representing a higher or lower acuity than required, respectively. Previous studies indicate that over-triage and under-triage can have costly outcomes to healthcare, such as over-allocation of hospital resources, longer patient waiting times, and other associated complications [23,24].

Our study suggests that visual triage is effective in implementing public health quarantine measures and saving the lives of patients as well as healthcare professionals. Whether to apply visual triage in emerging viral infections control or not is an active area of investigation. There are both proponents and opponents of the visual triage implementation in the EDs. Among several others, the most prominent objection for implementing visual triage is the delaytion in receiving the medical care. It has been observed that over-triage and under-triage allocation leads to prolonged waiting times and can result in more complications due to the long waiting times [25]. This issue can be resolved through proper education of the public and decrease dissatisfaction of patients visiting the EDs [24].

Another important aspect associated with the implementation of visual triage is a lack of consensus among the EDs nurses and medical staff. In their study of the effect of visual cues, vital signs and protocols on triage, Salk, and colleagues found the knowledge of nurses of critical data as well as the level of agreement among nurses was quite limited [30]. Another study strengthened the non-implementation of triage in the EDs of hospitals [31]. Doubts have also been raised about the variability of triage scales and measurements [23-25]. In spite of all these issues the benefits reported in this study and several in the past strengthen implementing visual triage for protecting the public as a whole from the infectious diseases including MERS-CoV. It is not the issue with the triage rather the need for further refinements and research for developing very sophisticated measures. A study focusing on the triage refinements suggest that the psychometrics of a triage scale with five categories has better reliability than those with fewer classes [32]. However, increased training on the use of triage is likely to improve the reliability of triage scales since some of the sources of unreliability could emanate from the nursing and medical staff rather than the protocol itself. Besides, fewer interruptions and less workload are likely to increase the effectiveness of triage processes. Behavioral change of patients' through appropriate training could also affect the reliability of a triage scale. In Saudi Arabia, the Ministry of Health has compiled a triage protocol within the greater nursing guideline manual. The guidance is comprehensive, outlining set policies and objectives, levels of triage processes, and the materials, personnel, equipment, and protocols required for the emergency department. These guidelines are particularly significant for Saudi Arabia which is among the twenty-six countries affected by MERS-CoV.

The present study indicates that visual triage scores can be a handy tool for the early detection of suspected cases with MERS-CoV. Through visual observations alone, we were able to detect the MERS-CoV infection among 2.3% of patients subjected to screening. The patient's age and gender were not significant factors in this study. This is important given the sex of a patient should not be used to determine medical priority.

Conclusion

The findings of this study point to the effectiveness of visual triage scores in detecting MERS-CoV patients. The symptoms of MERS-CoV which include fever, cough, shortness of breath, runny nose, sore throat, body ache, nausea, vomiting, and diarrhea can be used to predict suspected cases of MERS-CoV. As the disease spreads in countries where camels are part of the community's lifestyle, such public health measures are likely to become increasingly useful in the detection of the disease, especially since one of the primary goals is to prevent deaths associated with the MERS-CoV disease. More importantly, visual triage scores will assist in coping with emergency situations, whether in the emergency room or ambulatory settings, where the signs might help healthcare practitioners to detect the disease as early as possible.

Early detection of infection is a necessary exercise that can help to prevent the further advancement of the disease in the patient as well as to take precautionary measures to avoid the spread of the disease to others. Despite some of the limitations highlighted in the

Visual Triage Contributes Toward Early Detection and Management of the Middle East Respiratory Syndrome Coronavirus (MERS-CoV)

128

discussion above (reliability issues, prolonged waiting times, and inconsistencies in the application of triage scales), visual triage scores remain a potentially useful tool for detecting suspected cases of MERS-CoV.

The limitation of this study is that it included a sample of patients in the ED unit. Future studies need to expand the scope to include psychiatric emergency and ambulatory settings to explore the effectiveness of visual triage scores in detecting MERS-CoV disease in those settings. Also, the study used a CTAS system, so its reliability relative to other triage systems is not known. Overall, the study provides evidence for the usefulness of visual triage in the diagnosis of the disease under study.

Ethical Approval

This study was approved by the King Fahd Medical City, Ministry of Health, Kingdom of Saudi Arabia Institutional Review Board registered with KACST, KSA and OHRP/NIH, USA.

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Visual Triage Contributes Toward Early Detection and Management of the Middle East Respiratory Syndrome Coronavirus (MERS-CoV)

129

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Visual Triage Contributes Toward Early Detection and Management of the Middle East Respiratory Syndrome Coronavirus (MERS-CoV)

130

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