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Clinical aspects and outcomes of 70 patients with Middle East respiratory syndrome coronavirus infection: a single-center experience in Saudi Arabia

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SUMMARY

Objectives: To report the experience with Middle East respiratory syndrome coronavirus (MERS-CoV) infection at a single center in Saudi Arabia.
Methods: Cases of laboratory-confirmed MERS-CoV occurring from October 1, 2012 to May 31, 2014 were reviewed retrospectively. Information sources included medical files, infection control outbreak investigations, and the preventive medicine database of MERS-CoV-infected patients. Data were collected on clinical and epidemiological aspects and outcomes.
Results: Seventy consecutive patients were included. Patients were mostly of older age (median 62 years), male (46, 65.7%), and had healthcare acquisition of infection (39, 55.7%). Fever (43, 61.4%), dyspnea (42, 60%), and cough (38, 54.3%) were the most common symptoms. The majority developed pneumonia (63, 90%) and required intensive care (49, 70%). Infection commonly occurred in clusters. Independent risk factors for severe infection requiring intensive care included concomitant infections (odds ratio (OR) 14.13, 95% confidence interval (CI) 1.58–126.09; $p = 0.018$) and low albumin (OR 6.31, 95% CI 1.24–31.90; $p = 0.026$). Mortality was high (42, 60%), and age ≥65 years was associated with increased mortality (OR 4.39, 95% CI 2.13–9.05; $p < 0.001$).
Conclusions: MERS-CoV can cause severe infection requiring intensive care and has a high mortality. Concomitant infections and low albumin were found to be predictors of severe infection, while age ≥65 years was the only predictor of increased mortality.

1. Introduction

Middle East respiratory syndrome coronavirus (MERS-CoV) is an emerging virus that was first isolated from a patient in Jeddah, Saudi Arabia, in June 2012.[1] Since then, there have been 699 cases of laboratory-confirmed MERS-CoV infection, including at least 209 deaths, reported in 21 countries from four continents.[2] Since its emergence in 2012, MERS-CoV infection has been diagnosed in sporadic cases and in family and healthcare clusters of infection.[3] The disease activity has recently appeared to increase, with a large healthcare-associated cluster in multiple hospitals in the western region of Saudi Arabia; 402 new cases were reported from Saudi

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Arabia alone during the period April 11 to June 9, 2014.[2] This in turn has raised concerns about the pandemic potential of MERS-CoV infection.

MERS-CoV is capable of causing a spectrum of illness ranging from asymptomatic infection to severe pneumonia requiring intensive care unit (ICU) admission.[4] While the infection is still associated with high mortality, specific antiviral therapy is lacking and management remains mainly supportive.[2,5]

The available literature describing the clinical and epidemiological features and outcomes of MERS-CoV infection is limited to case reports and descriptions of relatively small cohorts.[3,6–14]

We describe herein our clinical experience with 70 laboratory-confirmed MERS-CoV infection patients diagnosed at Prince Sultan Military Medical City (PSMMC) over a period of 20 months. PSMMC is a 1200-bed, tertiary medical center in Riyadh, Saudi Arabia, with around 40 000 annual admissions and 118 000 emergency room visits per year.

2. Methods

This was a retrospective study of all patients who were diagnosed with a laboratory-confirmed MERS-CoV infection at our center over the period October 1, 2012 to May 31, 2014. Patients were identified from the microbiology and infection control records. In addition to the medical file review, data were collected from infection control outbreak investigations and the preventive medicine database of MERS-CoV-infected patients. Demographic and clinical details, epidemiological exposures, laboratory investigations, and outcomes were collated. A consultant radiologist reviewed and summarized all radiological investigations. Patients were followed until discharge from the hospital or death. MERS-CoV infection was diagnosed by reverse transcriptase PCR (RT-PCR) testing of respiratory tract samples for the MERS-CoV upE, ORF 1b, and N genes.[15] All RT-PCR tests for MERS-CoV were performed at the Saudi Ministry of Health National Laboratories in Jeddah and Riyadh, Saudi Arabia. The study was approved by the institutional research ethics committee.

2.1. Definitions

Infection was classified as healthcare-associated if the onset of MERS-CoV illness was more than 48 h after the current admission, or if the onset of illness was within 14 days of discharge from a clinical area where cases of MERS-CoV infection had been documented. A cluster was defined as two or more persons with onset of symptoms within the same 14-day period, and who were associated with a specific setting (healthcare or household).[4] Concomitant infections included all bacterial, fungal, and viral infections that occurred within 14 days of the diagnosis of MERS-CoV infection. Severe infection requiring care in an ICU and death were considered poor outcomes.

2.2. Statistical analyses

The Chi-square test or Fisher's exact test was used to compare categorical data, while the Student's *t*-test was used to compare continuous variables. All *p*-values were two-tailed and considered statistically significant at a cut-off of <0.05. Risk factors for a poor outcome were initially assessed in a univariate analysis. Those factors that were found to be significant were then entered into competing logistic regression (ICU care) or Cox regression (death) in order to determine the independent risk factors for a poor outcome. Graphical and statistical tests indicated that the proportional hazard assumption was not violated. A forward stepwise method was used to identify the determinants of a poor outcome, with the probability of entry set at ≤ 0.05.

Statistical analyses were performed using Microsoft Excel 2007 (Microsoft Corp., Redmond, USA) and IBM SPSS Statistics software, version 21.0 (IBM Corp., Armonk, NY, USA).

3. Results

3.1. Characteristics of the study patients

A total of 70 consecutive patients were included in the study. The majority of patients were males (46, 65.7%), of older age (median 62 years), residents of Riyadh (57, 81.4%), and of Saudi nationality (57, 81.4%). Comorbid conditions were documented in 57 (81.4%) patients, with a median age-adjusted Charlson comorbidity index (CCI) score of 5 (interquartile range (IQR) 0.25–6.0). Over half of MERS-CoV infections (39, 55.7%) were healthcare-associated. Only seven (10.0%) patients were obese and nine (12.9%) were smokers. A history of exposure to animals, including camels, within the 2 weeks preceding the onset of MERS-CoV infection was very uncommon (Table 1).

The majority of patients (67, 95.7%) with confirmed MERS-CoV infection were symptomatic. The most common symptoms were fever (43, 61.4%), shortness of breath (42, 60.0%), and cough (38, 54.3%). Non-respiratory symptoms were also relatively common, including generalized fatigue (29, 41.4%), vomiting or diarrhea (21, 30.0%), abdominal pain (17, 24.3%), confusion (18, 25.7%), and myalgia or arthralgia (14, 20%). Most patients had pneumonia (63, 90%). The most common radiological abnormality on chest X-rays was bilateral pulmonary infiltrates, which were reported in 53 (75.7%) patients. For patients with community-acquired MERS-CoV infection, the median time from onset of symptoms to hospital admission was 5.0 (IQR 3.0–8.5) days (Table 2). Overall, the median time from illness onset to diagnosis was 7 (IQR 3.0–13.8) days.

Table 1
Epidemiological characteristics of 70 patients with laboratory-confirmed MERS-CoV infection

Characteristic	Value
Total, *n* (%)	70 (100)
Age, years, median (range)	62 (1–90)
Age group, *n* (%)	
0–5 years	1 (1.4)
6–18 years	2 (2.9)
19–50 years	20 (28.6)
51–64 years	14 (20.0)
≥65 years	33 (47.1)
Gender, *n* (%)	
Male	46 (65.7)
Female	24 (34.3)
Nationality, *n* (%)	
Saudi Arabia	57 (81.4)
Philippines	9 (12.9)
Yemen	3 (4.3)
Egypt	1 (1.4)
City of residence, *n* (%)	
Riyadh	57 (81.4)
Al Kharj	6 (8.6)
Other	7 (10.0)
Occupation, *n* (%)	
Healthcare worker	10 (14.3)
Non healthcare worker	60 (85.7)
Age-adjusted Charlson comorbidity index, median (IQR)	5 (0.25–6.0)
Obese, *n* (%)	7 (10.0)
Pregnant, *n* (%)	1 (1.4)
Smoker, *n* (%)	9 (12.9)
Animal exposure within 2 weeks before illness onset, *n* (%)	
Camels	1 (1.4)
Cats	2 (2.9)
Acquisition of infection, *n* (%)	
Community-acquired	31 (44.3)
Healthcare-associated	39 (55.7)

IQR, interquartile range; MERS-CoV, Middle East respiratory syndrome coronavirus.

Table 2
Clinical characteristics, outcomes, and time course of clinical progression of 70 patients with laboratory-confirmed MERS-CoV infection

Characteristic	Value
Total, *n* (%)	70 (100)
Clinical symptoms, *n* (%)	
Fever	43 (61.4)
Cough	38 (54.3)
Sputum production	23 (23.9)
Hemoptysis	6 (8.6)
Shortness of breath	42 (60)
Fatigue	29 (41.4)
Myalgia or arthralgia	14 (20)
Abdominal pain	17 (24.3)
Vomiting or diarrhea	21 (30)
Headache	9 (12.9)
Confusion	18 (25.7)
Type of infection, *n* (%)	
Asymptomatic	3 (4.3)
Upper respiratory infection	4 (5.7)
Pneumonia	63 (90)
Radiological findings, *n* (%)	
Normal	3 (4.3)
Unilateral infiltrates	10 (14.3)
Bilateral infiltrates	53 (75.7)
Not done	4 (5.7)
Clinical outcome, *n* (%)	
Required hospital admission	64 (91.4)
Required ICU care	49 (70)
Required assisted ventilation[a]	49 (70)
Died in hospital	42 (60)
Currently hospitalized	3 (4.3)
Discharged home alive	19 (27.1)
Cases with concomitant infections, *n* (%)	
All cases	30 (42.9)
Cases with multidrug-resistant organisms	22 (31.4)
Complications related to MERS-CoV infection, *n* (%)	
Acute lung injury/ARDS	28 (40)
Acute kidney injury	30 (42.9)
Liver dysfunction	22 (31.4)
Rhabdomyolysis	10 (14.3)
Pneumothorax	5 (7.1)
Arrhythmias	11 (15.7)
DIC	10 (14.3)
Seizures	6 (8.6)
Time from illness onset to hospital admission[b], days, median (IQR)	5.0 (3.0–8.5)
Time from illness onset to diagnosis, days, median (IQR)	7.0 (3.0–13.8)
Time from illness onset to death, days, median (IQR)	20.5 (11.8–28.0)
Time from illness onset to discharge from hospital, days, median (IQR)	27.0 (20.0–31.5)

ARDS, acute respiratory distress syndrome; DIC, disseminated intravascular coagulation; ICU, intensive care unit; IQR, interquartile range; MERS-CoV, Middle East respiratory syndrome coronavirus.
[a] Invasive or non-invasive ventilation.
[b] Only for patients with community-acquired infections.

Acute lung injury (28, 40%), acute kidney injury (30, 40.9%), and hepatic dysfunction (22, 31.4%) were the most common complications. Cardiac arrhythmias, including variable tachyarrhythmias and severe bradycardia requiring temporary pacemaker insertion, occurred in 11 (15.7%) cases (Table 2).

Of the patients with MERS-CoV infection, 10 were healthcare workers; one was an ICU nurse, six were non-ICU nurses, two were physicians, and one was a radiology technician. Interestingly, three (30%) had only mild upper respiratory symptoms and three (30%) were asymptomatic. Only one healthcare worker had a community-acquired MERS-CoV infection.

There were 58 episodes of concomitant infection in 30 (42.9%) patients with MERS-CoV infection. Types of infection included bacteremia (16 episodes), bacterial pneumonia (18 episodes), urinary tract infection (nine episodes), skin and soft tissue infection (12 episodes), candidemia (two episodes), and *Clostridium difficile* infection (one episode). Multidrug-resistant bacteria were isolated in 22 (31.4%) patients, including carbapenem-resistant *Acinetobacter baumannii* (17 episodes), vancomycin-resistant enterococci (three episodes), and methicillin-resistant *Staphylococcus aureus* (one episode). Infection with respiratory viruses other than MERS-CoV was not documented in any of the patients.

Laboratory abnormalities that were commonly present at the time of diagnosis included low hemoglobin (median 10.7 g/dl; IQR 9.1–13.4), lymphopenia (median 0.85×10^9/l; IQR 0.6–1.2), low albumin (median 27 g/l; IQR 24.5–33.5), and elevated aspartate aminotransferase (median 59 IU/l; IQR 29–87). Several abnormal laboratory parameters were commonly observed during the hospital course of the MERS-CoV infection (Table 3).

3.2. Distribution and clustering of cases

The distribution of new cases was variable during the study period, with peaks of increased activity in September 2013 and April 2014. The increased disease activity in the community was associated with an increase in healthcare transmission of infection and overall testing of suspected cases (Figure 1).

Cases of laboratory-confirmed MERS-CoV infection occurred sporadically and in clusters. There were three documented family clusters, each involving two to four individuals. Infected family members within those clusters received treatment in more than one hospital, including four cases in our hospital. Furthermore, a total of eight clusters of healthcare-associated MERS-CoV infection were documented; these ranged in size from two to 15 and involved patients in more than one clinical area. The largest cluster, which involved 15 individuals, occurred in the emergency department and included 10 cases who had apparently acquired the infection from a single patient (Figure 2). In addition, Figure 2 documents multiple occurrences of secondary transmission of infection in the healthcare-associated clusters. However, tertiary transmission of infection was only observed once – in the healthcare-associated cluster in March 2014.

3.3. Outcomes

Severe infection requiring ICU care occurred in the majority (49, 70.0%) of patients; 46 (65.7%) of these patients required invasive mechanical ventilation and three (4.3%) required non-invasive ventilation. In the univariate analysis, factors associated with severe infection requiring ICU care were age ≥65 years (odds ratio (OR) 9.47, 95% confidence interval (CI) 2.45–36.56; $p = 0.001$), male gender (OR 3.05, 95% CI 1.05–8.84; $p = 0.04$), higher age-adjusted CCI score (OR 1.35, 95% CI 1.11–1.65; $p = 0.003$), the presence of bilateral pulmonary infiltrates on chest X-ray (OR 4.89, 95% CI

Table 3
Laboratory abnormalities in 70 patients with laboratory-confirmed MERS-CoV infection at the time of diagnosis

Parameter	At MERS-CoV diagnosis, median (IQR)	Maximum variation, median (IQR)
Hemoglobin (g/dl)	10.7 (9.1–13.4)	7.6 (6.7–9.9)
White blood cell count ($\times 10^9$/l)	7.4 (4.9–10.4)	4.9 (3.3–6.7)
Absolute lymphocyte count ($\times 10^9$/l)	0.9 (0.6–1.2)	0.5 (0.3–0.8)
Absolute neutrophil count ($\times 10^9$/l)	5.4 (3.4–8.6)	3.2 (1.8–4.6)
Platelets ($\times 10^9$/l)	180 (127.3–246)	118 (83–152.8)
Creatinine (μmol/l)	106.5 (76.3–205.8)	251.5 (143.5–427)
Albumin (g/l)	27 (24.5–33.5)	21 (19–26)
Alanine aminotransferase (IU/l)	29 (19–49.3)	54 (35–115)
Aspartate aminotransferase (IU/l)	59 (29–87)	112 (52–218)
Bilirubin, total (μmol/l)	9.5 (6–16)	17 (10–42)
Alkaline phosphatase (IU/l)	94 (66–151.8)	145 (100.5–262.3)

IQR, interquartile range; MERS-CoV, Middle East respiratory syndrome coronavirus.

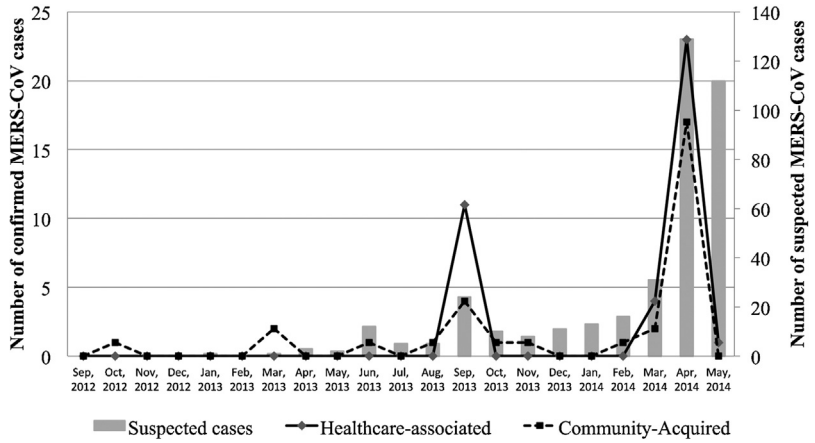

Figure 1. Distribution of laboratory-confirmed cases of MERS-CoV (primary axis) and suspected cases (secondary axis) by month of diagnosis.

1.16–20.47; $p = 0.03$), concomitant infections (OR 12.66, 95% CI 2.65–60.46; $p = 0.001$), and serum albumin <35 g/l at the time of MERS-CoV diagnosis (OR 8.0, 95% CI 1.97–32.46; $p = 0.004$) (Table 4). Of note, neutropenia was found to be associated with a lower risk of severe MERS-CoV infection in the univariate analysis (OR 0.24, 95% CI 0.07–0.82; $p = 0.02$) (Table 4). However, in the multivariate regression analysis, the only independent risk factors for severe infection requiring ICU care were the presence of a concomitant infection (OR 14.13, 95% CI 1.58–126.09; $p = 0.018$) and a low serum albumin (OR 6.31, 95% CI 1.24–31.90; $p = 0.026$) (Table 5).

Overall, 42 (60%) patients with MERS-CoV infection died. The median time from illness onset to death was 20.5 (IQR 11.8–28.0) days. All patients who died, except one, had severe MERS-CoV infections requiring ICU care and were placed on mechanical ventilation. Among those who died, 33 (78.6%) had a progressive disease course until death, while nine (21.4%) patients had an initial clinical improvement before they eventually died. Univariate analysis showed that mortality was increased in patients aged ≥65 years (OR 4.39, 95% CI 2.13–9.05; $p < 0.001$), those with a higher age-adjusted CCI score (OR 1.27, 95% CI 1.12–1.44; $p < 0.001$), and those with concomitant infections (OR 3.15, 95% CI 1.60–6.18; $p = 0.001$) (Table 4). However, multivariate analysis showed age ≥65 years to be the only independent risk factor for associated with increased mortality (OR 4.39, 95% CI 2.13–9.05; $p < 0.001$) (Table 5).

Among the healthcare workers with MERS-CoV infection, two developed severe infections and required ICU care; one died due to a progressive MERS-CoV infection. Interestingly, in the univariate analyses of risk factors for both severe infection requiring ICU care and death, healthcare profession was associated with a lower risk of a poor outcome (Table 4).

4. Discussion

We report herein our experience with 70 consecutive cases of laboratory-confirmed MERS-CoV infection at a single tertiary medical center. There are several important findings of this study that need to be highlighted.

In this study, MERS-CoV was shown to have a tendency to infect males and older patients. We could not find any obvious epidemiological risk to explain this finding. Healthcare exposure to infection was the most important risk factor for the development of MERS-CoV infection. However, in the ICU setting, where more strict infection control measures were applied (single rooms, dedicated 1:1 nurses, and more compliance with hand hygiene and isolation precautions), only one healthcare worker acquired the infection, while no patient-to-patient transmission occurred. These findings highlight the importance of applying infection control measures in healthcare facilities where patients with suspected MERS-CoV infection are admitted.

Healthcare transmission of infection is well-documented herein, with peaks of increased disease activity correlating with increased healthcare transmission. Nevertheless, healthcare transmission was preceded by an increased influx of patients with MERS-CoV infection from the community, as observed in the spikes of September 2013 and April 2014. Therefore, there appears to be a true variation in the distribution of cases over the year that should

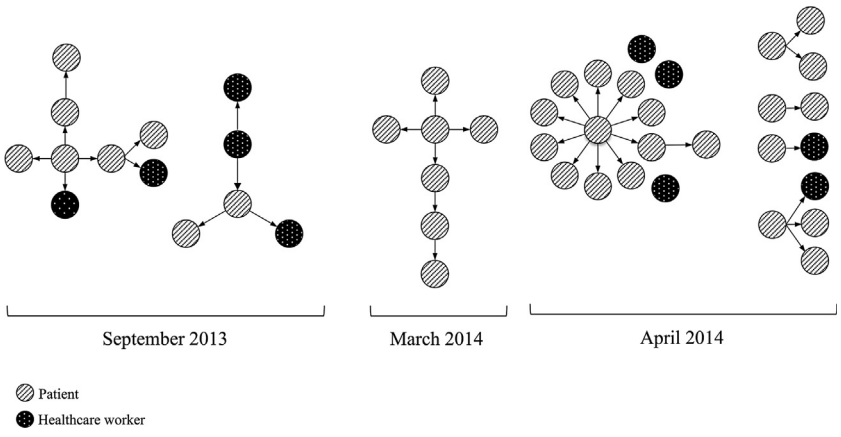

Figure 2. Transmission graph of healthcare-associated clusters in 70 patients with laboratory-confirmed MERS-CoV infection.

Table 4
Risk factors associated with severe infection requiring ICU care and death in 70 patients with laboratory-confirmed MERS-CoV infection; univariate logistic regression

Characteristic	ICU care		Univariate logistic regression			In-hospital mortality		Univariate logistic regression		
	Yes	No	OR	95% CI	*p*- Value	Yes	No	OR	95% CI	*p*- Value
Age ≥65 years	30	3	9.47	2.45–36.56	0.001	27	6	4.39	2.13–9.05	<0.001
Gender, male	36	10	3.05	1.05–8.84	0.040	28	18	1.12	0.57–2.17	0.737
Occupation, healthcare worker	2	8	0.07	0.13–0.36	0.002	1	9	0.13	0.02–0.98	0.048
Acquisition of infection, healthcare-associated	24	14	0.48	0.16–1.39	0.177	21	17	1.32	0.69–2.53	0.398
Age-adjusted Charlson comorbidity index, median (IQR)	5 (3–7)	0 (0–4)	1.35	1.11–1.65	0.003	5 (3–7.5)	1 (0–5)	1.27	1.12–1.44	<0.001
Radiological findings at diagnosis, bilateral infiltrates	44	9	4.89	1.16–20.47	0.030	38	15	2.76	0.83–9.15	0.097
Concomitant infections	28	2	12.66	2.65–60.46	0.001	25	5	3.15	1.60–6.18	0.001
Laboratory abnormalities at diagnosis										
Leukocytosis (WBC count $>11\times10^9$/l)	10	1	4.16	0.49–35.49	0.192	9	2	1.17	0.55–2.49	0.683
Neutropenia (ANC $<0.5\times10^9$/l)	16	11	0.24	0.07–0.82	0.020	12	15	0.75	0.37–1.50	0.420
Lymphopenia (ALC $<1\times10^9$/l)	30	6	3.12	0.96–10.17	0.058	25	11	1.35	0.68–2.64	0.383
Elevated creatinine (>110 μmol/l)	25	5	2.62	0.78–8.74	0.118	21	9	0.93	0.48–1.79	0.834
Decreased albumin (<35 g/l)	40	7	8.00	1.97–32.46	0.004	34	13	3.09	0.92–9.84	0.068
Elevated ALT (>3× ULN)	4	1	1.77	0.18–16.93	0.617	3	2	1.19	0.56–2.53	0.644

ALC, absolute lymphocyte count; ALT, alanine aminotransferase; ANC, absolute neutrophil count; CI, confidence interval; ICU, intensive care unit; IQR, interquartile range; MERS-CoV, Middle East respiratory syndrome coronavirus; OR, odds ratio; ULN, upper limit of normal; WBC, white blood cell.

not be attributed merely to increased healthcare transmission. Indeed, other factors, such as seasonal variation, should be evaluated carefully to explain this observation.

Another interesting observation in our study is the occurrence of multiple healthcare-associated clusters of MERS-CoV infection. Moreover, a single patient transmitted the infection to 10 others. Isolated incidents of high-level MERS-CoV transmission have been reported previously.[8,16] However, the scale of transmission remains small compared with the super-spreader events that were described in association with the outbreak of severe acute respiratory syndrome coronavirus (SARS-CoV) in 2003.[17] Furthermore, nosocomial transmission was promptly interrupted with the application of effective infection control measures. This is consistent with previous reports that have suggested the potential for self-sustained MERS-CoV transmission to be low, especially once appropriate infection control is implemented.[18,19]

Several studies have focused on the possible role of camels in the transmission of MERS-CoV infection to humans.[20–22] In this study, animal exposure was rare and only one patient had had recent exposure to camels. In our opinion, this observation does not rule out the possible role of camels; instead, there may be a missing link in the transmission of MERS-CoV infection from camels to humans.

Most patients with MERS-CoV infection in our cohort were symptomatic; nonetheless, a significant proportion of patients had atypical presentations. This, coupled with the lack of known exposures in most of the community-acquired cases, led to the diagnosis being elusive, and several cases went undiagnosed until a cluster of infection became apparent. Assiri et al. reported higher percentages with classical symptoms in their cohort of 47 patients with MERS-CoV infection. However, all of their patients presented with pneumonia.[3] In a case–control study, Al-Tawfiq et al. found only a few differences in the clinical presentation of MERS-CoV-infected patients compared to controls.[6] Combined with our results, these observations highlight the limitations of the clinical presentation in differentiating MERS-CoV infection from other causes of pneumonia.

MERS-CoV-related complications were frequently observed in our cohort of patients. The lungs, liver, and kidneys were the most commonly affected organs. Serious cardiac complications were not uncommon and were mainly in the form of arrhythmias. These observations may reflect the systemic nature of the MERS-CoV infection with its tendency to cause multi-organ involvement.

Concomitant infections were commonly observed in our patients. Unlike the study by Assiri et al. in which only admission cultures were reported,[3] we included all infections within 14 days of the diagnosis of MERS-CoV infection. The majority of concomitant infections were healthcare-associated and reported in patients who required ICU care. Indeed, we found concomitant infections to be an independent risk factor for severe MERS-CoV infection requiring ICU care. The reason behind this observation is not clear, but it underscores the vulnerability of patients with severe MERS-CoV infection and emphasizes the importance of infection prevention measures. However, an immunosuppressive effect of MERS-CoV infection cannot be entirely excluded.

Albumin, in our analysis, was observed to be an independent risk factor for the development of severe MERS-CoV infection. Although there is no clear explanation for this observation, albumin may reflect the nutritional status and the general well-being of the patient.

Finally, the overall case fatality rate was high in our cohort of patients, but similar to that reported by Assiri et al.[3] Similarly, high mortality rates were reported by Arabi et al. (58%) and Assiri et al. (65%).[7,8] In contrast, the overall case fatality rate reported by the World Health Organization (WHO) was 30%.[2] The main difference between the patients in our cohort and the overall cases reported by the WHO is age; the median age of our cohort was 62 years compared to 47 years in the WHO report.[2] Furthermore, we found age ≥65 years to be the only independent risk factor for mortality. This underscores the importance of age, not only as a risk factor for acquiring MERS-CoV infection, but also as an important predictor of MERS-CoV-related mortality. Our finding is similar to that reported by Breban et al.,[18] but different from the report of Assiri et al.,[3] who found no association between older age and the risk of mortality.

Table 5
Risk factors associated with severe infection requiring ICU care and death in 70 patients with laboratory-confirmed MERS-CoV infection; multivariate regression model

	OR	95% CI	*p*-Value
ICU care			
Concomitant infection	14.13	1.58–126.09	0.018
Decreased albumin (<35 g/l)	6.31	1.24–31.90	0.026
Mortality			
Age ≥65 years	4.39	2.13–9.05	<0.001

CI, confidence interval; ICU, intensive care unit; MERS-CoV, Middle East respiratory syndrome coronavirus; OR, odds ratio.

Our study has several limitations inherent to its design. First, this was a retrospective study with the potential of incomplete and possible variation of data recording according to the primary care providers. We minimized this limitation by collecting the data from the patients' medical files in addition to the infection control and preventive medicine records. Second, the virus was not isolated for further genotyping and viral kinetic studies were not done for most of the patients. Therefore viral shedding was not assessed, and clusters of infection were only investigated epidemiologically.

In conclusion, in our cohort of patients, MERS-CoV infection caused a spectrum of disease ranging from asymptomatic to severe infection requiring ICU care. Severe infection developed in the majority of patients. Concomitant infections and low albumin were predictors of severe infection. Age ≥65 years was the only predictor of mortality.

Conflict of interest: No conflict of interest to declare.

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