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Clinical characteristics of two human-to-human transmitted coronaviruses: Corona Virus Disease 2019 *vs.* Middle East Respiratory Syndrome Coronavirus

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Abstract. – OBJECTIVE: Subsequent to a global outbreak of the Middle East Respiratory Syndrome (MERS) in 2012, a novel human coronavirus, known as Corona Virus Disease 2019 (COVID-19) has caused a major disease outbreak. The aim of this study was to perform a systematic review to compare epidemiological, clinical, and laboratory features of COVID-19 and MERS-COV populations.

MATERIALS AND METHODS: We searched PubMed, EMBASE, and Cochrane Central Register of Controlled Trials database to identify potential studies that have reported COVID-19 or MERS-COV disease. Epidemiology, clinical, and laboratory outcomes, intensive care unit (ICU) admission rates, discharge rates, and fatality rates were evaluated using Graph-Pad Prism software.

RESULTS: A total of forty-two studies were included in our research, involving in 4,720 patients (COVID-19 = 2,012, MERS-COV = 2,708). The present study revealed that main clinical manifestations of both COVID-19 and MERS-COV populations are fever, cough and generalized weakness or myalgia, and Acute Respiratory Distress Syndrome (ARDS) is the main complication. The COVID-19 population has a lower rate of ICU admissions, discharges, fatalities, and shorter incubation periods than those of MERS-COV population.

CONCLUSIONS: The main clinical features of both COVID-19 and MERS-COV populations are fever, cough and generalized weakness or myalgia. ARDS is the main complication of both populations. COVID-19 cases have a shorter incubation period and lower rate of ICU admissions, discharges and fatalities compared to MRES-COV population.

Key Words:
COVID-19, MERS-COV, Clinical characteristics, ICU admission rates, Fatality rates.

Introduction

Coronaviruses are enveloped non-segmented positive-sense RNA viruses, causing respiratory and intestinal tract infections in humans and other mammals[1]. Despite the majority of patients who have presented with mild symptoms and good prognoses, the spread of two β-coronaviruses, Severe Acute Respiratory Syndrome Coronavirus (SARS-COV) and Middle East Respiratory Syndrome Coronavirus (MERS-COV), have resulted in thousands of infected individuals during past decades, with the fatality rate of 10% for SARS-COV population, and 37% for MERS-COV population[2-4]. By 2019, there was a total of six identified coronaviruses, but that might only be "the tip of the iceberg", with potentially more novel and terrible zoonoses to be presented.

Since December 8, 2019, a series of unexplained pneumonia cases linked to a Huanan seafood wholesale market were reported in Wuhan, Hubei, China[5,6]. Clinical characteristics of this pneumonia were very similar to those of viral pneumonia, such as MERS-COV, with an initial severe acute respiratory infection, followed by rapidly developing Acute Respiratory Distress Syndrome (ARDS) and even acute respiratory failure[7]. Sequencing data from throat swab samples of a patient indicated a novel coronavirus, subsequently named Corona Virus Disease 2019 (COVID-19) by the World Health Organization (WHO). So far, more than 80,000 confirmed cumulative cases have been reported in China and more than 500,000 confirmed cumulative cases in other countries, such as South Korea, Japan, Italy, Iran, and the USA.

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Although many previous studies have reported clinical characteristics of COVID-19 or MERS-COV diseases[8-11], a systematic comparison of clinical features between COVID-19 and MERS-COV diseases has not yet been published. Thus, the purpose of this study is to perform a systematic review of epidemiological, clinical, and laboratory characteristics of patients infected with COVID-19 or MERS-COV disease, and to compare COVID-19 and MERS-COV in the context of their incubation, laboratory features, admission rates of intensive care unit (ICU), and rates of discharges and fatalities, which will provide a comprehensive reference for clinical physicians to treat coronavirus diseases.

Materials and Methods

Search Strategy

A comprehensive and systematic search was performed using PubMed, EMBASE and Cochrane Central Register of Controlled Trials database up to 26 March 2020. Medical Subject Heading (MSH) terms and keywords were used to retrieve as many potential documents as possible (**Supplementary Table**). Terms for MERS-COV included: Middle East Respiratory Syndrome Coronavirus [Mesh] OR MERS-CoV OR MERS Virus OR MERS Viruses OR Virus, MERS OR Viruses, MERS OR Middle East respiratory syndrome-related coronavirus OR Middle East respiratory syndrome related coronavirus. They were combined with terms specifying COVID-19: [(Wuhan coronavirus) OR (Wuhan seafood market pneumonia virus) OR (SARS2) OR (COVID-19 virus) OR (coronavirus disease 2019 virus) OR (SARS-CoV-2) OR (2019-nCoV) OR (2019 novel coronavirus)]. When necessary, we also contacted corresponding author to obtain accurate data.

Eligibility Criteria

Studies that met following criteria were included: (1) reporting epidemiological, clinical, and laboratory characteristics of COVID-19 or MERS-COV disease, (2) minimum sample size of five, (3) confirmed COVID-19 or MERS-COV disease, and (4) English literature. Studies relating to the following criteria were excluded: duplicate publications, case report, meta-analysis, letters, reviews, technology reports, commentaries, animal trials, correspondence, predictive studies, guidance, radiology studies, and meeting reports.

Study Selection

At the beginning, 5,067 potential publications were identified. We removed 969 duplicates and reviewed the titles and abstracts of remaining 4,098 publications. 4,044 publications were excluded for the following reasons: not involved research point (n = 1,376), reviews (n = 569), no English (n = 38), case report (n = 316), meta-analysis (n = 1), letters (n = 127), technology report (n = 196), commentaries (n = 81), animal studies (n = 1,107), correspondence (n = 29), predictive studies (n = 113), guidance (n = 28), meeting reports (n = 19) and radiograph studies (n = 44). Then, a comprehensive review of full-text was conducted for remaining 54 publications. Two reviewers independently screened eligible literature, and any argument was solved by discussion with a third reviewer. Finally, forty-two studies were included in this study[8-49]. The process is shown in Figure 1

Data Extraction

Two reviewers independently extracted common, clinical, and laboratory characteristics of included studies; disagreements were solved by discussion with a third reviewer. The extracted data included incubation time, white blood cell (WBC) count, lymphocyte count, creactive protein (CRP), alanine aminotransferase (ALT), aspartate aminotransferase (AST), creatinine, creatine kinase (CK), the admission rates of ICU, rates of discharges and fatalities, symptoms, comorbidities, complications and cure rate of drugs. For normality distribution data, outcomes were extracted directly. For skewness distribution data, outcomes were extracted after being converted[50].

Quality Assessment

The quality assessment of included studies was performed through the Newcastle-Ottawa Quality Assessment Scale (NOS), as recommended by Cochrane Non-Randomized Studies[51]. The NOS included three parts for risk of bias, with nine points in total: (1) selection of research groups (four points); (2) inter-group comparability (two points); and (3) ascertainment of exposure and outcomes (three points) for case-control and cohort studies, respectively. Yuhara et al[52] that scored 6 or more was qualified for systematic review. Assessment processes were completed independently by two reviewers. All debates were solved by discussion with a third reviewer.

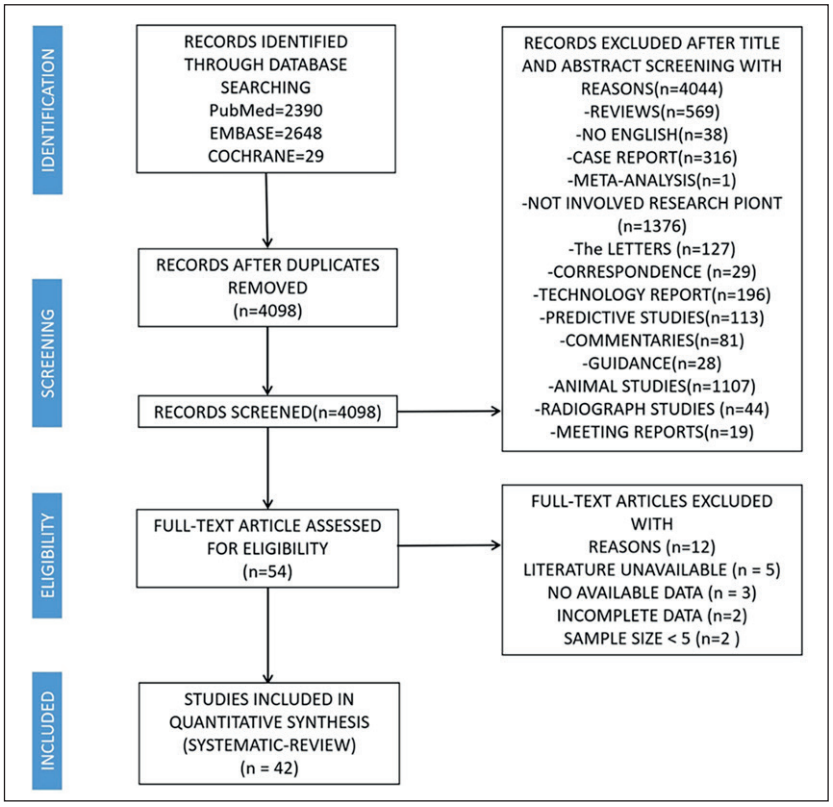

Figure 1. The flowchart shows the process of publication selection.

Statistical Analysis

All data analyses and graphs were generated and plotted using the Graph-Pad Prism version 7.00 software (GraphPad Software Inc, La Jolla, CA, USA).

Results

Study Characteristics

All included studies were retrospective[8-49]. Among the twenty studies reported for COVID-19, one trial was performed in the Netherlands[12], one trial was in Singapore[49], and the remaining eighteen trials were conducted in China[8,9,13-16,37-48]. The sample size ranged from 6 to 425 and had a total of 2,012 patients (male = 1066, female = 946). The trials were published in 2020. On the other hand, among the twenty-two studies reported for MERS-COV, fifteen studies were conducted in Saudi Arabia[11,17,18,20-23,27-30,32,34-36], five trials were performed in South Korea[24-26,31,33], one trial was performed in Iran[19], and one trial was conducted in Japan[10]. The sample size ranged from 5 to 883 and had a total of 2,708 patients. The years of publications ranged from 2013 to 2019. Clinical and laboratory characteristics of included studies are shown in Table I and Table II respectively.

Quality Assessment

Among the forty-two included studies, ten studies obtained 6 points of NOS[26,28,32,35,41-43,45,48,49] and the remaining thirty-two studies obtained 7 points of NOS or more[8-25,27,29-31,33,34,36-40,44,46,47]. The result of quality assessment is presented in Table III.

Clinical Symptoms

For COVID-19 population, the number of patients with fever was 1271 (63.%), cough was 895 (44.5%), generalized weakness or myalgia was 734 (36.5%), stuffy or rhinorrhea was 10 (0.5%), pharyngalgia was 86 (4.3%), chest pain was 20 (1%), diarrhea or anorexia was 226 (11.2%), dyspnea was 226 (11.2%) and dizziness or headaches was 136 (6.8%). For MERS-COV population, the amount of patients with fevers was 404 (14.9%), coughs was 424 (15.7%), generalized weakness or myalgia was 337 (12.4%), stuffy or rhinorrhea was 17 (0.6%), pharyngalgia was 47 (1.7%), chest pain was 27 (1%), diarrhea or anorexia was 128 (4.7%), dyspnea was 271 (10%) and dizziness or headaches was 131 (4.8%). The above results are shown in Table IV.

Complications

For COVID-19 population, the main complications included shock, arrhythmia, ARDS, acute

Table I. Epidemiological and clinical characteristics of included studies.

Study ID	Study design	Country	Confirmed Disease	Number of patients	Patients age (y) mean ± SD or (range)	Male/Female	Incubation period (d) mean ± SD or (range)	Temperature (°C) mean ± SD or (range)	ICU Rate (%)	Discharge Rate (%)	Fatality Rate (%)
Backer et al[12]	Retrospective	Netherlands	COVID-19	88	(2-72)	57/31	6.4 ±6.7	NA	NA	NA	NA
Chan et al[13]	Retrospective	China	COVID-19	6	46.2 ± 22.5	3/3	4.5 ± 1.3	37.7 ± 1.4	NA	NA	NA
Song et al[14]	Retrospective	China	COVID-19	51	49 ± 16	25/26	NA	NA	NA	NA	NA
Huang et al[8]	Retrospective	China	COVID-19	41	49 ± 12.6	30/11	NA	NA	13/41	35/41	6/41
Wang et al[9]	Retrospective	China	COVID-19	138	56 ± 19.3	75/63	NA	NA	36/138	47/138	6/138
Liu et al[15]	Retrospective	China	COVID-19	12	53.7 ± 18	8/4	5.6 ± 4.2	NA	6/12	NA	NA
Chen et al[39]	Retrospective	China	COVID-19	99	55 ± 13.1	67/32	NA	NA	23/99	31/99	11/99
Xu et al[37]	Retrospective	China	COVID-19	62	41 ± 14.8	36/27	4 ± 1.5	NA	1/62	1/62	0/62
Zhang et al[38]	Retrospective	China	COVID-19	140	57 ± 15.5	71/69	NA	NA	NA	NA	NA
Li et al[16]	Retrospective	China	COVID-19	425	59	238/187	5.2	≥ 38	NA	NA	NA
Yang et al[40]	Retrospective	China	COVID-19	52	59.7 ± 13.3	35/17	NA	NA	52/52	8/52	32/52
Chen et al[41]	Retrospective	China	COVID-19	9	29.9 ± 4.8	0/9	NA	(37.8-39.3)	NA	NA	0/9
Han et al[42]	Retrospective	China	COVID-19	108	45 ± 17.3	38/70	NA	NA	NA	NA	NA
Tian et al[43]	Retrospective	China	COVID-19	262	47.5 ± 19.8	127/135	6.7 ± 5.2	NA	NA	45/262	3/262
Xu et al[44]	Retrospective	China	COVID-19	50	43.9 ± 16.8	29/21	NA	NA	13/50	NA	NA
Xu et al[48]	Retrospective	China	COVID-19	90	50 ± 17	39/51	NA	NA	NA	NA	NA
Liu et al[45]	Retrospective	China	COVID-19	137	55 ± 15.8	61/76	NA	NA	NA	44/137	16/137
Mo et al[46]	Retrospective	China	COVID-19	155	54 ± 17.8	86/69	NA	≥ 38	NA	NA	NA
Wang et al[47]	Retrospective	China	COVID-19	69	42 ± 20	32/37	NA	> 38	55/69	18/69	5/69
Young et al[49]	Retrospective	Singapore	COVID-19	18	47 ± 31.1	9/9	NA	(36.1-39.6)	6/18	NA	0/18
Alfaraj et al[17]	Retrospective	Saudi Arabia	MERS-COV	314	48 ± 17.3	NA	NA	NA	NA	236/314	78/314
Arabi et al[18]	Retrospective	Saudi Arabia	MERS-COV	144	57.5 ± 17	101/43	NA	NA	NA	37/144	107/144
Ahmadzadeh et al[19]	Retrospective	Iran	MERS-COV	107	50 ± 17	80/27	NA	NA	NA	89/107	18/107
Habib et al[20]	Retrospective	Saudi Arabia	MERS-COV	63	59.7 ± 18.2	47/16	NA	NA	NA	NA	16/63
Al-Baadani et al[11]	Retrospective	Saudi Arabia	MERS-COV	82	61.6 ± 21	53/29	NA	NA	23/82	45/82	37/82
Hwang et al[10]	Retrospective	Japan	MERS-COV	7	43 ± 28.2	5/2	8.1 ± 6.8	≥ 37.8	NA	NA	NA
Ahmed et al[21]	Retrospective	Saudi Arabia	MERS-COV	883	54.3 ± 17.6	610/273	(2-14)	NA	NA	NA	323/883
Garout et al[22]	Retrospective	Saudi Arabia	MERS-COV	52	15-85	40/12	NA	NA	52/52	13/52	39/52
Shalhoub et al[23]	Retrospective	Saudi Arabia	MERS-COV	32	39	16/16	NA	≥ 38	32/32	24/32	8/32
Kim et al[24]	Retrospective	South Korea	MERS-COV	186	55	111/75	NA	NA	NA	148/186	38/186
Kang et al[25]	Retrospective	South Korea	MERS-COV	171	54.4 ± 16.2	99/72	7.1 ± 4.5	≥ 38.5	36/171	140/171	31/171
Kim et al[26]	Retrospective	South Korea	MERS-COV	23	46 ± 7.5	14/9	7 ± 2.8	NA	6/23	19/23	4/23
Garbati et al[27]	Retrospective	Saudi Arabia	MERS-COV	25	60 ± 16.3	9/16	NA	NA	21/25	9/25	16/25
Khalid et al[29]	Retrospective	Saudi Arabia	MERS-COV	14	54 ± 14	9/5	NA	>38	14/14	5/14	9/14
Alraddadi et al[30]	Retrospective	Saudi Arabia	MERS-COV	39	40 ± 19	21/18	NA	NA	27/39	28/39	11/39
Choi et al[31]	Retrospective	South Korea	MERS-COV	186	55 ± 17.5	110/76	NA	NA	45/186	158/186	28/186
Oboho et al[32]	Retrospective	Saudi Arabia	MERS-COV	255	45 ± 21.5	174/81	NA	NA	93/255	62/255	93/255
Cha et al[33]	Retrospective	South Korea	MERS-COV	30	54 ± 20.7	17/37	NA	NA	15/30	12/30	5/30
Al-Hameed et al[28]	Retrospective	Saudi Arabia	MERS-COV	8	56.5 ± 17	6/2	NA	38.4 ± 0.8	8/8	2/8	6/8
Saad et al[34]	Retrospective	Saudi Arabia	MERS-COV	70	62 ± 22.3	46/24	NA	NA	49/70	19/70	42/70
Arabi et al[36]	Retrospective	Saudi Arabia	MERS-COV	12	59 ± 11.75	8/4	NA	NA	12/12	5/12	7/12
Al-Tawfiq et al[35]	Retrospective	Saudi Arabia	MERS-COV	5	57.6 ± 20.8	3/2	NA	NA	5/5	0/5	5/5

COVID-19: Corona Virus Disease 2019, MERS-COV: Middle East Respiratory Syndrome-Coronavirus, SD: Standard Deviation, ICU: Intensive Care Unit, NA: Not Available.

Table II. Laboratory outcomes of included studies.

Study ID	Study design	Country	Confirmed Disease	Number of patients	WBC (x 10^9 cells/L) mean ± SD or (range)	Lymphocyte count (x 10^9 cells/L) mean ± SD or (range)	CRP (mg/L) mean ±SD or (range)	ALT (U/L) mean ±SD or (range)	AST (U/L) mean ± SD or (range)	Creatinine (umol/L) mean ± SD or (range)	Creatine kinase (U/L) mean ± SD or (range)
Backer et al[12]	Retrospective	Netherlands	COVID-19	88	NA	NA	NA	NA	NA	NA	NA
Chan et al[13]	Retrospective	China	COVID-19	6	6.1 ± 2.7	1.7 ± 1	23.4 ± 24.6	19.2 ± 5	24.2 ± 4.2	67.7 ± 18.3	93.2 ± 43.3
Song et al[14]	Retrospective	China	COVID-19	51	NA	NA	NA	NA	NA	NA	NA
Huang et al[8]	Retrospective	China	COVID-19	41	6.2 ± 4.7	0.8 ± 0.4	NA	32 ±21.5	34 ± 32.6	74.2 ± 20.9	132.5 ± 116.3
Wang et al[9]	Retrospective	China	COVID-19	138	4.5 ± 2.1	0.8 ± 0.4	NA	24 ± 17.8	31 ± 20	72 ± 20	92 ± 54.8
Liu et al[15]	Retrospective	China	COVID-19	12	6 ± 2.6	1.4 ± 1	41.1 ± 27.5	31.6 ± 12.3	40 ± 22.4	85.6 ± 49.5	219.7 ± 322.7
Chen et al[39]	Retrospective	China	COVID-19	99	7.5 ± 3.6	0.9 ± 0.5	51.4 ± 41.8	39 ± 7.8	34 ± 5.5	75.6 ± 25	85 ± 33.3
Xu et al[37]	Retrospective	China	COVID-19	62	4.7 ± 1.7	1.0 ± 0.5	NA	22 ± 14.8	26 ± 8.9	72.0 ± 17	69.0 ± 44.8
Zhang et al[38]	Retrospective	China	COVID-19	140	4.7 ± 0.8	0.8 ± 0.1	34.2 ± 13.7	NA	NA	NA	72.5 ± 15.7
Li et al[16]	Retrospective	China	COVID-19	425	NA	NA	NA	NA	NA	NA	NA
Yang et al[40]	Retrospective	China	COVID-19	52	NA	NA	NA	NA	NA	NA	NA
Chen et al[41]	Retrospective	China	COVID-19	9	7.8 ± 2	1.2 ± 0.8	NA	253.8 ± 690	170 ± 410.4	NA	NA
Han et al[42]	Retrospective	China	COVID-19	108	NA	NA	NA	NA	NA	NA	NA
Tian et al[43]	Retrospective	China	COVID-19	262	NA	NA	NA	NA	NA	NA	NA
Xu et al[44]	Retrospective	China	COVID-19	50	NA	NA	NA	NA	NA	NA	NA
Xu et al[48]	Retrospective	China	COVID-19	90	NA	NA	NA	NA	NA	NA	NA
Liu et al[45]	Retrospective	China	COVID-19	137	NA	NA	NA	NA	NA	NA	NA
Mo et al[46]	Retrospective	China	COVID-19	155	4.4 ± 2	0.9 ± 0.3	33 ± 43	23 ± 16.3	32 ± 17.8	71 ± 20	93 ± 58.5
Wang et al[47]	Retrospective	China	COVID-19	69	3.82 ± 1.9	1.2 ± 0.5	13.2 ± 31.3	25 ± 17	28 ± 14.8	66.4 ± 16	NA
Young et al[49]	Retrospective	Singapore	COVID-19	18	4.6 ± 3.4	1.2 ± 0.7	16.3 ± 71.6	NA	NA	NA	NA
Alfaraj et al[17]	Retrospective	Saudi Arabia	MERS-COV	314	NA	NA	NA	NA	NA	NA	NA
Arabi et al[18]	Retrospective	Saudi Arabia	MERS-COV	144	NA	NA	NA	NA	NA	114.9 ± 177.8	NA
Ahmadzadeh et al[19]	Retrospective	Iran	MERS-COV	107	NA	NA	NA	NA	NA	NA	NA
Habib et al[20]	Retrospective	Saudi Arabia	MERS-COV	63	NA	NA	NA	NA	NA	NA	NA
Al-Baadani et al[11]	Retrospective	Saudi Arabia	MERS-COV	82	NA	NA	NA	NA	NA	NA	NA
Hwang et al[10]	Retrospective	Japan	MERS-COV	7	5.9 ± 2.8	NA	2.6 ± 4.1	25.4 ± 5.3	32.9 ± 5.6	NA	181.3 ± 195
Ahmed et al[21]	Retrospective	Saudi Arabia	MERS-COV	883	NA	NA	NA	NA	NA	NA	NA
Garout et al[22]	Retrospective	Saudi Arabia	MERS-COV	52	NA	NA	NA	NA	NA	NA	NA
Shalhoub et al[23]	Retrospective	Saudi Arabia	MERS-COV	32	NA	NA	NA	49.6	NA	69	NA
Kim et al[24]	Retrospective	South Korea	MERS-COV	186	NA	NA	NA	NA	NA	NA	NA
Kang et al[25]	Retrospective	South Korea	MERS-COV	171	NA	NA	NA	NA	NA	NA	NA
Kim et al[26]	Retrospective	South Korea	MERS-COV	23	NA	NA	NA	NA	NA	NA	NA
Garbati et al[27]	Retrospective	Saudi Arabia	MERS-COV	25	7.5 ± 3.9	NA	NA	NA	NA	170.1 ± 222.4	104.5 ± 253.2
Khalid et al[29]	Retrospective	Saudi Arabia	MERS-COV	14	9.1 ± 3.6	NA	NA	27 ± 272.3	53 ± 184.8	90 ± 240.8	NA
Alraddadi et al[30]	Retrospective	Saudi Arabia	MERS-COV	39	NA	NA	NA	NA	NA	NA	NA
Choi et al[31]	Retrospective	South Korea	MERS-COV	186	4.3 ± 7.4	NA	25.2 ± 169.7	29 ± 72	39 ± 95	80 ± 374.8	NA
Oboho et al[32]	Retrospective	Saudi Arabia	MERS-COV	255	NA	NA	NA	NA	NA	NA	NA
Cha et al[33]	Retrospective	South Korea	MERS-COV	30	NA	NA	NA	NA	NA	NA	NA
Al-Hameed et al[28]	Retrospective	Saudi Arabia	MERS-COV	8	4.3 ± 4.9	0.48 ± 0.2	NA	60.5 ± 1820	92.5 ± 1041	84 ± 55.8	123.5 ± 1502
Saad et al[34]	Retrospective	Saudi Arabia	MERS-COV	70	7.4 ± 4.1	0.9 ± 0.4	NA	29 ± 22.4	59 ± 43	106.5 ± 95.9	NA
Arabi et al[36]	Retrospective	Saudi Arabia	MERS-COV	12	8.9 ± 4.9	0.9 ± 0.6	NA	49 ± 37.8	72 ± 52.3	162 ± 269.3	NA
Al-Tawfiq et al[35]	Retrospective	Saudi Arabia	MERS-COV	5	13.3 ± 10.9	NA	NA	41 ± 27.5	59.6 ± 59.5	3.3 ± 2.5	NA

COVID-19: Corona Virus Disease 2019, MERS-COV: Middle East Respiratory Syndrome-Coronavirus, WBC: White Blood Cell, CRP: C-Reactive Protein, ALT: Alanine aminotransferase, AST: Aspartate aminotransferase, SD: Standard Deviation NA: Not Available.

Table III. Quality Assessment of Included Studies.

Study	Selection	Comparability	Outcome	Total scores
Backer et al[12]	4	1	2	7
Chan et al[13]	4	2	2	8
Song et al[14]	4	2	2	8
Huang et al[8]	4	2	2	8
Wang et al[9]	4	2	2	8
Liu et al[15]	4	1	2	7
Li et al[39]	3	2	2	7
Chen et al[37]	4	1	2	7
Xu et al[38]	4	1	2	7
Zhang et al[16]	4	1	2	7
Yang et al[40]	4	1	2	7
Chen et al[41]	3	1	2	6
Han et al[42]	3	1	2	6
Tian et al[43]	3	1	2	6
Xu et al[44]	3	1	3	7
Xu et al[48]	3	1	2	6
Liu et al[45]	3	1	2	6
Mo et al[46]	3	1	3	7
Wang et al[47]	3	1	3	7
Young et al[49]	3	1	2	6
Alfaraj et al[17]	4	2	2	8
Arabi et al[18]	4	2	2	8
Ahmadzadeh et al[19]	4	2	2	8
Habib et al[20]	4	1	2	7
Al-Baadani et al[11]	4	2	2	8
Hwang et al[10]	4	2	2	8
Ahmed et al[21]	4	2	2	8
Garout et al[22]	4	2	2	8
Shalhoub et al[23]	4	1	2	7
Kim et al[24]	4	1	2	7
Kang et al[25]	4	2	2	8
Kim et al[26]	3	1	2	6
Garbati et al[27]	4	1	2	7
Khalid et al[29]	4	1	2	7
Alraddadi et al[30]	4	1	2	7
Choi et al[31]	4	1	2	7
Al-Hameed et al[32]	3	1	2	6
Oboho et al[33]	3	1	2	6
Cha et al[28]	4	1	2	7
Saad et al[34]	4	1	2	7
Arabi et al[36]	4	1	2	7
Al-Tawfiq et al[35]	3	1	2	6

Table IV. Description of clinical symptoms in COVID-19 and MERS-COV populations.

Symptom	COVID-19, No. (n/total %)	MERS-COV, No. (n/total %)
Fever	1271 (63.2 %)	404 (14.9%)
Cough	895 (44.5 %)	424 (15.7%)
Generalized weakness and myalgia	734 (36.5 %)	337 (12.4%)
Stuffy and Rhinorrhea	10 (0.5 %)	17 (0.6%)
Pharyngalgia	86 (4.3 %)	47 (1.7%)
Chest pain	20 (1 %)	27 (1%)
Diarrhea or Anorexia	226 (11.2 %)	128 (4.7%)
Dyspnea	226 (11.2 %)	271 (10%)
Dizziness or headache	136 (6.8 %)	131 (4.8%)

COVID-19: Corona Virus Disease 2019, MERS-COV: Middle East Respiratory Syndrome-Coronavirus Disease.

Table V. Distribution of main complications in COVID-19 and MERS-COV populations.

Complication	COVID-19, No. (n/total %)	MERS-COV, No. (n/total %)
Shock	17 (0.8 %)	22 (0.8%)
Arrhythmia	28 (1.4 %)	11 (0.4%)
ARDS	86 (4.3 %)	83 (3.1%)
Acute cardiac injury	23 (1.1 %)	10 (0.4%)
Acute kidney injury	25 (1.2 %)	30 (1.1%)
Acute liver injury	17 (0.8 %)	22 (0.8%)
Neurological symptoms	0	4 (0.1%)

COVID-19: Corona Virus Disease 2019, MERS-COV: Middle East Respiratory Syndrome-Coronavirus Disease, ARDS: Acute Respiratory Distress Syndrome.

cardiac injury, acute kidney injury, and acute liver injury, and the amounts of which were 17 (0.8%), 28 (1.4%), 86 (4.3%), 23 (1.1%), 25 (1.2%) and 17 (0.8%) respectively. For MERS-COV population, the number of individuals who presented shock was 22 (0.8%), arrhythmia was 11 (0.4%), ARDS was 83 (3.1%), acute cardiac injury was 10 (0.4%), acute kidney injury was 30 (1.1%), acute liver injury was 22 (0.8%) and neurological symptoms was 4 (0.1%). The results are shown in Table V.

Comorbidity

Among COVID-19 population, 94 (4.7%) patients had diabetes mellitus, 178 (8.8%) patients had hypertension, 118 (5.9%) patients had cardiovascular disease, 26 (1.3%) patients had chronic obstructive pulmonary disease (COPD), 36 (1.8%) patients had malignancy, 32 (1.6%) patients had chronic liver disease, 27 (1.3%) patients had cerebrovascular disease and 11 (0.5%) patients had chronic kidney disease. Among MERS-COV population, the number of patients with diabetes was 247 (9.1%), hypertension was 244 (9%), cardiovascular disease was 161 (5.9%), COPD was 83 (3.1%), malignancy was 70 (2.6%), chronic liver disease was 28 (1%), cerebrovascular disease was 47 (1.7%), chronic kidney disease was 167 (6.2%) and obesity was 42 (1.6%). Those results are shown in Table VI.

Clinical and Laboratory Characteristics of COVID-19 and MERS-COV

Systematic review was performed for clinical and laboratory outcomes of coronavirus disease. The reduced lymphocyte counts were found in both COVID-19 and MERS-COV populations (1.1 ± 0.1 and 0.8 ± 0.1 respectively). Increased CRP (30.4 ± 5.2 and 13.9 ± 11.3), ALT (52.2 ± 25.3 and 37.3 ± 5.1), and AST (46.6 ± 15.5 and 58.3 ± 7.6) were found in both COVID-19 and MERS-COV populations. There was no abnormal was found in WBC (5.5 ± 0.4 and 7.6 ± 1), creatinine (73.1 ± 2.1 and 101.4 ± 18.5), and CK (107.1 ± 17.5 and 136.4 ± 23.1) in both COVID-19 and MERS-COV populations. The ages of both populations were 48.9 ± 1.7 and 53.6 ± 1.5 respectively. The incubation times of both populations were 5.4 ± 0.5 and 7.4 ± 0.4 respectively. The results are shown in Table VII.

Table VI. Distribution of comorbidities in COVID-19 and MERS-COV populations.

Comorbidity	COVID-19, No. (n/total %)	MERS-COV, No. (n/total %)
Diabetes mellitus	94 (4.7 %)	247 (9.1%)
Hypertension	178 (8.8 %)	244 (9%)
Cardiovascular disease	118 (5.9 %)	161 (5.9%)
Chronic obstructive pulmonary disease	26 (1.3 %)	83 (3.1%)
Malignancy	36 (1.8 %)	70 (2.6%)
Chronic liver disease	32 (1.6 %)	28 (1%)
Cerebrovascular disease	27 (1.3 %)	47 (1.7%)
Chronic kidney disease	11 (0.5 %)	167 (6.2%)
Obesity	0	42 (1.6%)

COVID-19: Corona Virus Disease 2019, MERS-COV: Middle East Respiratory Syndrome-Coronavirus.

Table VII. Clinical and laboratory characteristics of COVID-19 and MERS-COV populations.

Characteristics	COVID-19 Mean ± SEM	MERS-COV Mean ± SEM
Age (y)	48.9 ± 1.7	53.6 ± 1.5
Incubation time (d)	5.4 ± 0.5	7.4 ± 0.4
WBC (× 10^9 cells/L)	5.5 ± 0.4	7.6 ± 1
Lymphocyte count (× 10^9 cells/L)	1.1 ± 0.1	0.8 ± 0.1
CRP (mg/L)	30.4 ± 5.2	13.9 ± 11.3
ALT (U/L)	52.2 ± 25.3	37.3 ± 5.1
AST (U/L)	46.6 ± 15.5	58.3 ± 7.6
Creatinine (μmol/L)	73.1 ± 2.1	101.4 ± 18.5
Creatine kinase (U/L)	107.1 ± 17.5	136.4 ± 23.1

COVID-19: Corona Virus Disease 2019, MERS-COV: Middle East Respiratory Syndrome-Coronavirus WBC: White Blood Cell, CRP: C-Reactive Protein, ALT: Alanine aminotransferase, AST: Aspartate aminotransferase SEM: Standard Error of Mean.

Incidence of ICU Admission, Discharge and Fatality

The ICU admission rates of both COVID-19 and MERS-COV populations were 37.9% and 43.6% respectively (Figure 2). The discharge rates of both populations were 26.6% and 59.9% (Figure 3). The fatality rates of both populations were 8.9% and 34.1% (Figure 4).

Cure Rate of Drugs for MERS-COV

67 (74.2%) of the 93 patients who were treated by a combination of ribavirin and interferon were cured. 27 (69.2%) of the 39 patients who were treated by oseltamivir were cured. 47 (67.1%) of the 70 patients who were treated by antivirals were cured. 5 (62.5%) of the 8 patients who were treated by intravenous immunoglobulin were cured. 4 (44.4%) of the 9 patients who were treated by a combination of ribavirin and lopinavir/ritonavir were cured. 7 (38.9%) of the 18 patients who were treated by corticosteroids were cured. The results are shown in Figure 5.

Discussion

Coronavirus is an important pathogen causing respiratory and intestinal infection. Of seven identified coronaviruses, the two very pathogenic viruses, SARS-COV and MERS-COV, cause severe ARDS and even acute respiratory failure, with a mortality rate of over 10% and more than 35% respectively[53,54]. The four other human coronaviruses (HCoV-OC43, HCoV-229E, HCoV-

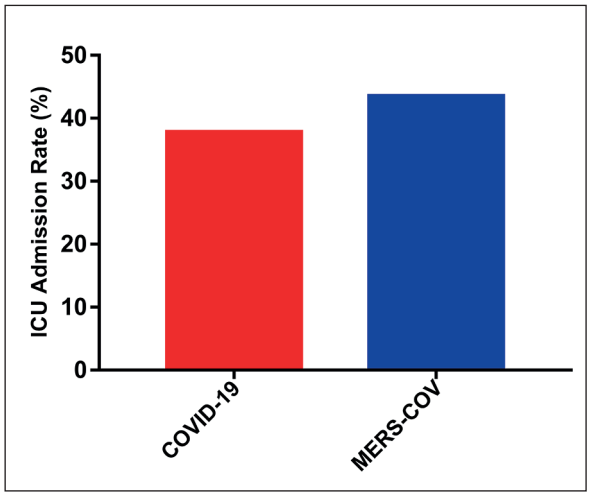

Figure 2. The histogram shows the ICU admission rates of both COVID-19 and MERS-COV populations. COVID-19 = Corona Virus Disease 2019, MERS-COV = Middle East Respiratory Syndrome Coronavirus, ICU = Intensive Care Unit.

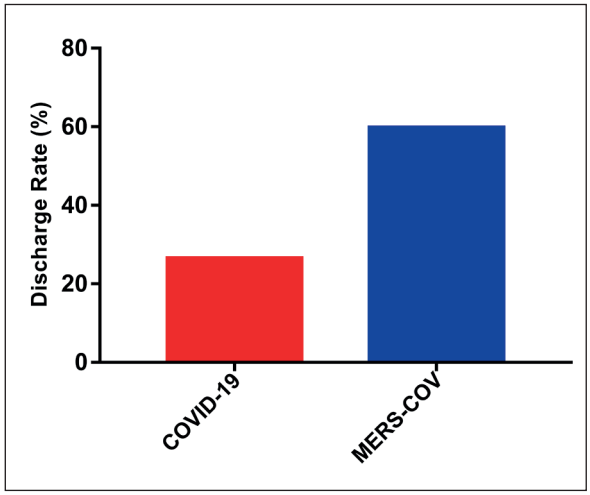

Figure 3. The histogram shows the discharge rates of both COVID-19 and MERS-COV populations. COVID-19 = Corona Virus Disease 2019, MERS-COV = Middle East Respiratory Syndrome Coronavirus.

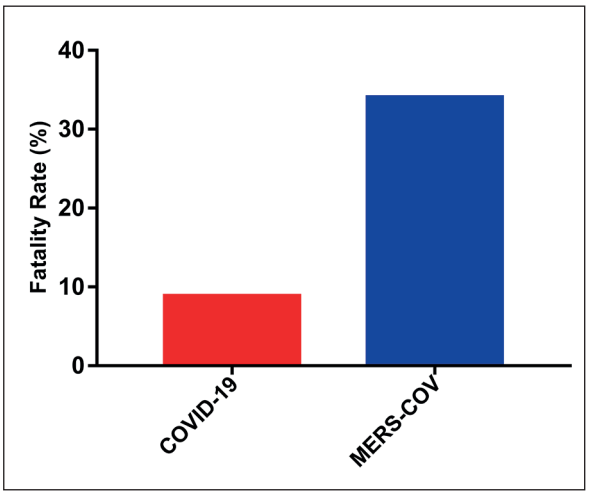

Figure 4. The histogram shows the fatality rates of both COVID-19 and MERS-COV populations. COVID-19 = Corona Virus Disease 2019, MERS-COV = Middle East Respiratory Syndrome Coronavirus.

NL63, HCoV-HKU1) only cause mild respiratory or intestinal infection, despite having certain pathogenicity for infants, young children, and the elderly with weakened immune systems[55,56]. The newest one is COVID-19. The sequencing analysis has indicated that COVID-19, like SARS-COV and MERS-COV, belongs to β-coronavirus. Both SARS-COV and MERS-COV originated in bats, but the source of COVID-19 remains to be further

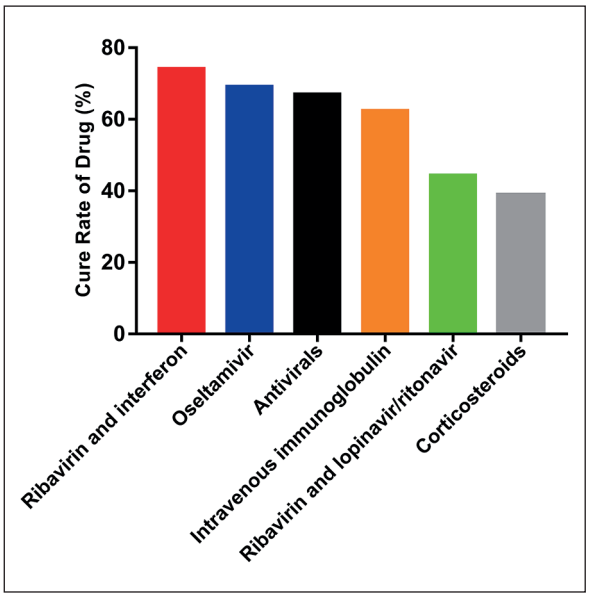

Figure 5. The histogram shows the cure rate of drugs for MRES-COV population. MERS-COV = Middle East Respiratory Syndrome Coronavirus.

investigated. Although recent studies[8,9,17,18] have reported the clinical and laboratory features of COVID-19 or MERS-COV infections, there is no systematic comparison between COVID-19 and MERS-COV diseases. Therefore, the aim of this study was to perform the first systematic review to compare epidemiological, clinical and laboratory characteristics of COVID-19 and MERS-COV populations. Our results suggested that fever, cough and generalized weakness or myalgia were the main clinical manifestations of both COVID-19 and MERS-COV, and ARDS was the main complication. Compared with MERS-COV population, COVID-19 population had lower incubation time and rate of ICU admissions, discharges and fatalities.

Similarities of clinical characteristics between COVID-19 and MERS-COV have been found. In our current study, the majority of COVID-19 patients presented with fever, cough and generalized weakness or myalgia, which bear some resemblances to MERS-COV infections. Moreover, both COVID-19 and MERS-COV patients hardly developed upper respiratory tract infections, such as rhinorrhea or pharyngalgia, indicating that their target cells might be located in lower respiratory areas. However, 11.2% of patients with COVID-19 infections had diarrhea or anorexia, and only 4.7% of patients with MERS-COV infections exhibited those symptoms. Thus, feces and urine samples from COVID-19 patients should be tested to exclude a potential alternative way of transmission that is unknown at present.

In addition, we found that the number of males was more than that of females in either COVID-19 or MERS-COV populations. The possible reason for reduced susceptibility of females to viral infections is that females have a lot of X chromosome and estrogen that are vital components in development of innate and adaptive immunity[57]. Additionally, a number of patients with COVID-19 infections had chronic comorbidities, mainly hypertension, diabetes, and cardiovascular disease, which is similar to MERS-COV population. Those results indicated that older adult males with chronic underlying disease might have more susceptibility to COVID-19 or MERS-COV disease.

In terms of laboratory testing, reduced lymphocytes and increased CRP were found in both COVID-19 and MERS-COV populations. Those results indicated that COVID-19 might be associated with cellular immune responses, mainly acting on lymphocytes, similar to MERS-COV[58].

Cells infected by viruses induce the release of numbers of pro-inflammatory cytokines and inflammation storms in the body. Moreover, increased cytokines might damage related organs, such as the liver[59]. Our results showed that an abnormal value of AST was found in both MERS-COV and COVID-19 populations. This result indicated that COVID-19 might damage the liver of patients. However, a long follow-up time study is needed to confirm this result. On the other hand, our results suggested that MERS-COV population had a higher rate of ICU admissions and fatalities than COVID-19 population, indicating that compared with MERS-COV, COVID-19 was less toxic and more easily cured. However, a lower discharge rate was found in COVID population than in MERS-COV population. A possible explanation is that most of COVID-19 patients remained hospitalized at the time of manuscript submission, and data on those patients could not be obtained in time. Thus, careful interpretation is urgently needed for this result.

Until now, no effective strategy has been found for treatment of COVID-19 infection[60]. Currently, to control COVID-19, determining the source of infection, taking personal protective measures to reduce the risk of transmission, and early diagnosis, isolation and supportive treatment for confirmed patients are crucial courses of action. In our present study, systematic cure rate results for drug to treat MERS-COV infections indicated that ribavirin and interferon combinations, oseltamivir, antivirals and intravenous immunoglobulin all had been effective for MERS-COV infections; they were 74.2%, 69.2%, 67.1% and 62.5% respectively. Thus, we assume that those drugs might also be effective for COVID-19 infections. However, further studies are needed to confirm this presumption.

This study had several limitations. First, many patients infected by COVID-19 remained hospitalized at the time of manuscript submission, leading to unavailable data. Second, the follow-up time of COVID-19 population is too short to get related data from long-term observations of this disease. Third, part of data was obtained after conversion, which might induce result bias. Fourth, because no quantitative statistical analysis was carried out, findings of this study should be interpreted with caution. Fifth, because the number of MERS-COV patients treated by drugs is minimal, careful understanding is needed for drug cure rate of this disease. Finally, as COVID-19 is still developing globally, and there are still many unknowns, the results of this study are staged and need to be carefully understood. A more large-sample, multicenter, high-quality research should be performed to update this study.

Conclusions

Our systematic review reveals that main clinical manifestations of both COVID-19 and MERS-COV populations are fever, cough, and generalized weakness or myalgia. ARDS is the main complication of both populations. COVID-19 population has a shorter incubation period and lower rate of ICU admissions, discharges and fatalities compared with MRES-COV population.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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Authors' Contribution

PX and ZZL conceived the study. PX and GDS wrote the systematic review protocol, did the literature review and extracted data. PX did the analyses and wrote the first draft of the manuscript, supported by GDS and ZZL. All authors contributed to the interpretation. All authors have seen and agreed on the final submitted version of the manuscript.

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