

Clinical features, Diagnosis, and Treatment of COVID-19: A systematic review of case reports and case series

Azin Tahvildari^{1†}, Mahta Arbabi^{1†}, Yeganeh Farsi^{1†}, Parnian Jamshidi^{1†}, Saba Hasanzadeh^{1†}, Tess Moore Calcagno^{2†}, Mohammad Javad Nasiri^{1*}, and Mehdi Mirsaeidi^{2*}

1Shahid Beheshti University of Medical Sciences, Tehran, Iran
2University of Miami Miller School of Medicine, Miami Florida

*Corresponding authors:
Mehdi Mirsaeidi, MD, MPH
Email: msm249@med.miami.edu

Mohammad Javad Nasiri, PhD
Email: mj.nasiri@hotmail.com

†Equally first authors

1 **Abstract**

2

3 **Objectives:** The 2019 novel coronavirus (COVID-19) has been declared a public health
4 emergency worldwide. The objective of this systematic review was to characterize the clinical,
5 diagnostic, and treatment characteristics of patients presenting with COVID-19.

6 **Methods:** We conducted a structured search using PubMed/Medline, Embase, Web of Science
7 and the Cochrane Library to collect both case reports and case series on COVID-19 published up
8 to February 30, 2020.

9 **Results:** Thirty-four articles were included analyzing a total of 99 patients with a mean age of
10 46.2 years. The most common presenting symptom in patients who tested positive for COVID-
11 19 was fever, reported in up to 83% of patients from 76.4% of the analyzed studies. Other
12 symptoms including rhinorrhea, dizziness, and chills were less frequently reported. Additionally,
13 in studies which reported C-reactive protein (CRP) measurements (44%), a large majority of
14 patients displayed an elevated CRP (73%). Progression to acute respiratory distress syndrome
15 (ARDS) was the most common complication of patients testing positive for COVID-19 (33%).
16 CT images displayed ground-glass opacification (GGO) patterns (80%) as well as bilateral lung
17 involvement (71.0%). The most commonly used antiviral treatment modalities included,
18 lopinavir (HIV protease inhibitor), arbidol hydrochloride (influenza fusion inhibitor), and
19 oseltamivir (neuraminidase inhibitor).

20 **Conclusions:** Development of ARDS may play a role in estimating disease progression and
21 mortality risk. Early detection of elevations in serum CRP, combined with a clinical COVID-19
22 symptom presentation may be used as a surrogate marker for presence and severity of disease.
23 There is a paucity of data surrounding the efficacy of treatments. There is currently not a well-
24 established gold standard therapy for the treatment of diagnosed COVID-19. Further prospective
25 investigations are necessary.

26

27 **Keywords:** COVID-19, Clinical characteristics, Systematic review

28

29 **Introduction**

30 Late in December 2019 and early in January 2020, reports of a very progressive pneumonia-like
31 respiratory syndrome, starting in Wuhan, China, induced global health concerns [1]. Soon after
32 the onset of disease, it was found that the pathogen was a new member of the coronaviridae
33 family, named SARS-COV-2 which is now called 2019-n-CoV [2]. The respiratory syndrome
34 caused by 2019-n-CoV is called COVID-19. COVID-19 is characterized by low-grade fever,
35 cough, dyspnea, lymphopenia, and ground-glass opacities on chest CT scan [3, 4]. COVID-19 is
36 a highly contagious disease, probably an aerosol born one, with human to human transmission
37 capacity which has implicated many countries all around the world [5]. In this review article, we
38 systematically surveyed case reports and case series from many countries in the world to give a
39 picture of the epidemiology, clinical presentations, laboratory changes, imaging findings,
40 diagnostic criteria, treatments, outcomes, prognostic factors, and risk factors of COVID-19.

41 **Methods**

42 This review conforms to the “Preferred Reporting Items for Systematic Reviews and Meta-
43 Analyses” (PRISMA) statement [6].

44 *Search strategy*

45 We carried out systematic searches of the literature in the following bibliographical databases:
46 PubMed/Medline, Embase, Web of Science and the Cochrane Library. Search criteria included
47 articles published in the period from January 1, 2019, to February 30, 2020, and only included
48 articles published in English. The search terms for our review were: COVID-19, severe acute
49 respiratory syndrome coronavirus 2, novel coronavirus, SARS-CoV-2, nCoV disease, SARS2,
50 COVID-19, 2019-nCoV, coronavirus disease-19, coronavirus disease 2019, and 2019 novel
51 coronavirus.

52 *Study Selection*

53 Studies included in the review met the following criteria: prospective or retrospective descriptive
54 case reports and case series of COVID-19 in the hospital setting which included diagnostic
55 methods, clinical manifestations, laboratory features, treatment, and outcomes. Articles
56 describing experimental approaches as well as reviews and publications without peer-review
57 processes were excluded.

58 All potentially relevant articles were screened in two stages for eligibility. In the first stage, the
59 titles and abstracts of potentially relevant articles were screened independently by two reviewers
60 (YF, PJ). In the second stage of assessment, the full text of those abstracts which met the
61 inclusion criteria was retrieved and independently reviewed by the same authors. Disagreements
62 and technical uncertainties were discussed and resolved between review authors (AT, SH, MA,
63 MJN).

64 *Data extraction*

65 The extracted data included bibliographic data, patient demographics (e.g., age and gender),
66 radiological and laboratory findings, treatment protocols, and medical consequences. Two
67 authors (AT, SH) independently extracted the data from the selected studies. The data was jointly
68 reconciled, and disagreements were discussed and resolved between review authors (YF, PJ,
69 MA, MJN).

70 **Results:**

71 As illustrated in Figure 1, our systematic search resulted in an initial number of 1102 of
72 potentially relevant articles, of which 346 were excluded by title and abstract evaluation.
73 Applying the inclusion/exclusion criteria to the full-text documents, 34 articles were eligible for
74 inclusion in the systematic review. 23 case reports and 11 case series from 9 countries were
75 identified with a total of 99 unique cases of COVID-19. RT-PCR COVID-19 was present in 32
76 (94%) articles as inclusion criteria. In addition to RT-PCR, CT scan served as a diagnostic tool in
77 14 (41.0%) of papers. Reported comorbidities included hypertension, diabetes, cardiovascular
78 disease, and pulmonary disease. Hypertension was investigated the most, studied in 7/34 (20%)
79 of papers. Of the 16 COVID-19 positive patients found in the studies investigating hypertension,
80 8 patients were hypertensive (50%). (Table 2). Lymphopenia was reported in 10 studies which
81 identified 12/21 (57%) of COVID-19 positive patients with lymphopenia. Additionally, in
82 studies which reported C-reactive protein (CRP) measurements (44%), a large majority of
83 patients displayed an elevated CRP (73%). CT imaging was used as a diagnostic and prognostic
84 tool in 8 studies. CT images commonly displayed ground-glass opacification (GGO) patterns
85 (80%) as well as bilateral lung involvement (71.0%). Progression to acute respiratory distress
86 syndrome (ARDS) was the most common complication of patients testing positive for COVID-
87 19. We found 2/34 (5.8%) reports on Acute Respiratory Distress Syndrome (ARDS), 2 of 6
88 (33%) investigated cases had ARDS. Morality outcomes were difficult to assess; only two
89 studies showed mortality data in which 2/2 COVID-19 patients died. A wide range of therapeutic
90 modalities were tried across studies, with antiviral treatments being the most used. Common
91 antiviral treatment modalities included lopinavir (HIV protease inhibitor), arbidol hydrochloride
92 (influenza fusion inhibitor), and oseltamivir (neuraminidase inhibitor). In Table 3 we summarize
93 all of the drugs used.

94

95 **Discussion:**

96 The 2019 novel coronavirus has been declared a public health emergency worldwide. The World
97 Health Organization (WHO) declared COVID-19 a pandemic affecting 110 countries around the
98 world with continued global spread. The 2019-nCoV is likely to be transmitted by asymptomatic
99 individuals [7]. Asymptomatic transfer leads to lower prevalence estimates and higher
100 transmission rates in the community. Until universal screening and vaccination become

101 available, it is necessary to trace close contacts of those testing positive for COVID-19 and
102 quarantining contacts to prevent asymptomatic transmission.

103 According to the articles we included, 2019-nCoV can only be transferred from person to
104 person[8]. Chen et al suggested that they had no evidence of vertical transmission from mother to
105 child [9]. Any person infected with 2019-nCoV can develop a clinical course of Covid-19.
106 However, it is reported to cause the most severe symptoms such as respiratory failure in older
107 men with comorbidities[10]. Children, teenagers, and younger people mostly showed a mild
108 presentation of the disease [11].

109 Based on our reviewed articles, hypertension, diabetes, cardiovascular disease, and pulmonary
110 disease were the most common morbidities among COVID-19 patients. This point was also
111 mentioned in Alraddadi et al. study about MERS-CoV patients [12]. They showed that
112 individuals with comorbidities like diabetes, smoking, and cardiovascular disease were
113 associated with a more severe clinical course [12]. According to Yang et al., chronic diseases can
114 debilitate the immune system and make proinflammatory conditions, leading to more severe
115 infection and subsequently higher mortality rates [13].

116 According to the included studies, the most common clinical manifestations were fever, cough,
117 dyspnea, and myalgia or fatigue. Less common clinical manifestations included nausea or
118 vomiting, dizziness, rhinorrhea, and chills. Liu et al reported that infants had mild clinical
119 manifestations and a better prognosis. Furthermore, some asymptomatic cases were seen among
120 children.

121 The most common abnormal laboratory changes were lymphopenia, high concentrations of C-
122 reactive protein, and elevated levels of aspartate aminotransferase; however, we do not know the
123 exact pathogenesis and the reason for these alterations. Laboratory abnormalities may indicate
124 the severity of disease and developing complications. According to Huang et al., most patients
125 with secondary infection had a procalcitonin level greater than 0.5 ng/ml and ICU patients had
126 higher levels of prothrombin time and D-dimer [14]. Also, Liu et al. mentioned using
127 hypoalbuminemia, lymphopenia, high concentrations of CRP, and elevated LDH to predict
128 severity of acute lung injury[3]. Higher levels of angiotensin II are also proposed to be related to
129 acute lung injury [3]. Meanwhile, non-survivors are suggested to have higher D-dimer and FDP
130 levels, longer PT and aPTT, and lower fibrinogen and antithrombin levels [15].

131 CT scan as a diagnostic tool can be used to evaluate severity of pulmonary involvement and
132 monitor clinical progression. CT scan has good sensitivity and can be used to establish COVID-
133 19 diagnosis in patients who are highly suspicious based on epidemiologic history and clinical
134 manifestations, but have negative PCR-based test results [16, 17]. It is important to highlight that
135 the CT scan can be normal during initial days, and a normal CT scan in a suspected case would
136 never definitely rule out the diagnosis of COVID-19 [18]. Moreover, the CT scan is dynamic in
137 patients with COVID-19 and changes rapidly [19-21]. The earliest abnormal finding in the CT
138 scan is the appearance of ground-glass opacities in peripheral and sub-pleural areas [22]. As the
139 disease progresses, the GGO's will expand and distribute more, most commonly to the right
140 lower lung lobes. Later findings include consolidations, paving patterns, thickening of lobar
141 fissures and adjacent pleura. Pleural effusion, hilar lymphadenopathies, and mediastinal
142 lymphadenopathies are not common findings and have only been reported scarcely [23]. Lung
143 pathology can progress to a "white lung" with low functional capacity or heal with some fibrotic
144 remnants [24]. Dynamic changes in the lungs seen on CT imaging will continue even after the
145 patient's discharge [22]. In fact, CT scan findings have prognostic value in some patients, as Shi
146 et al. have reported, deterioration on follow-up CT scan, old age, male sex, and underlying
147 comorbidities are associated with poor prognosis.

148 ARDS was the most common complication among the confirmed COVID-19 patients;
149 development of ARDS increased risk of patient mortality[25]. Huang et al reported that the
150 median time from onset of symptoms to the development of ARDS was 9 days [14]. Other
151 complications were acute cardiac injury, acute kidney injury, secondary infection, and shock that
152 lead to multiple organ failure [26, 27]. ICU patients in comparison to non-ICU patients were also
153 more likely to have complications [28]. The mortality rate was higher in critically ill patients as
154 well as in older patients with comorbidities and ARDS. Yang et al reported that the median
155 duration from ICU admission to death was 7 days [25]. The window between the presentation to
156 the time of ICU admission and/or development of ARDS is an optimal time for medical
157 intervention.

158 There are many challenges in COVID-19 therapeutic strategies. There is currently no cure for
159 COVID-19. However, pharmacologic and non-pharmacologic symptom management and
160 supportive care measures should be given to all patients with symptomatic COVID-19. Other
161 various therapeutic strategies have been trialed in patients with COVID-19 with the goal of

162 slowing disease progression. There is a paucity of data surrounding the efficacy of treatments. Of
163 the case controls and case series we included, antiviral agents including HIV protease inhibitors
164 (lopinavir and ritonavir) as well as anti-influenza compounds (oseltamivir and arbidol) were used
165 as treatment regimens. Unfortunately, we didn't have enough information about the efficacy of
166 each regimen; however, according to some studies, anti-HIV based medications could have
167 benefits in more rapid improvement of clinical manifestations and decrease in viral load [19, 20,
168 29].

169 In conclusion, we discussed the clinical symptoms, laboratory abnormalities, common
170 comorbidities, imaging modalities, and potential therapeutic options in COVID-19. We indicated
171 that the most common symptoms were fever, cough, and dyspnea, but some young infected cases
172 had no signs or symptoms. ARDS was the most common reported complication and was
173 associated with poor prognosis. In the wake of the COVID-19 pandemic, countries are
174 scrambling to produce enough RT-PCR diagnostic tests. Diagnostic information from other
175 surrogate markers would be valuable if markers proved to be sensitive and specific. Namely, we
176 learned that laboratory data like CRP may not only be related to the severity of disease, but it
177 may be predictive of disease outcomes. Further studies are needed to relate quantified elevations
178 in CRP to disease severity. Due to the high sensitivity of CT scan, it is considered as a good
179 diagnostic tool. However, it should be kept in mind that a normal CT scan will never rule out the
180 diagnosis of COVID-19 in a highly suspicious case based on history and clinical findings. Lastly,
181 there are different therapeutic strategies for COVID-19 patients, but we don't have enough data
182 for their efficacy. Additional investigations including randomized controlled trials will be
183 necessary to further our understanding in the treatment of COVID-19.

184

185 **Acknowledgment**

186 This study was supported by Shahid Beheshti University of Medical Sciences, Tehran, Iran.

187

188 **Conflict of interest**

189 None.

190

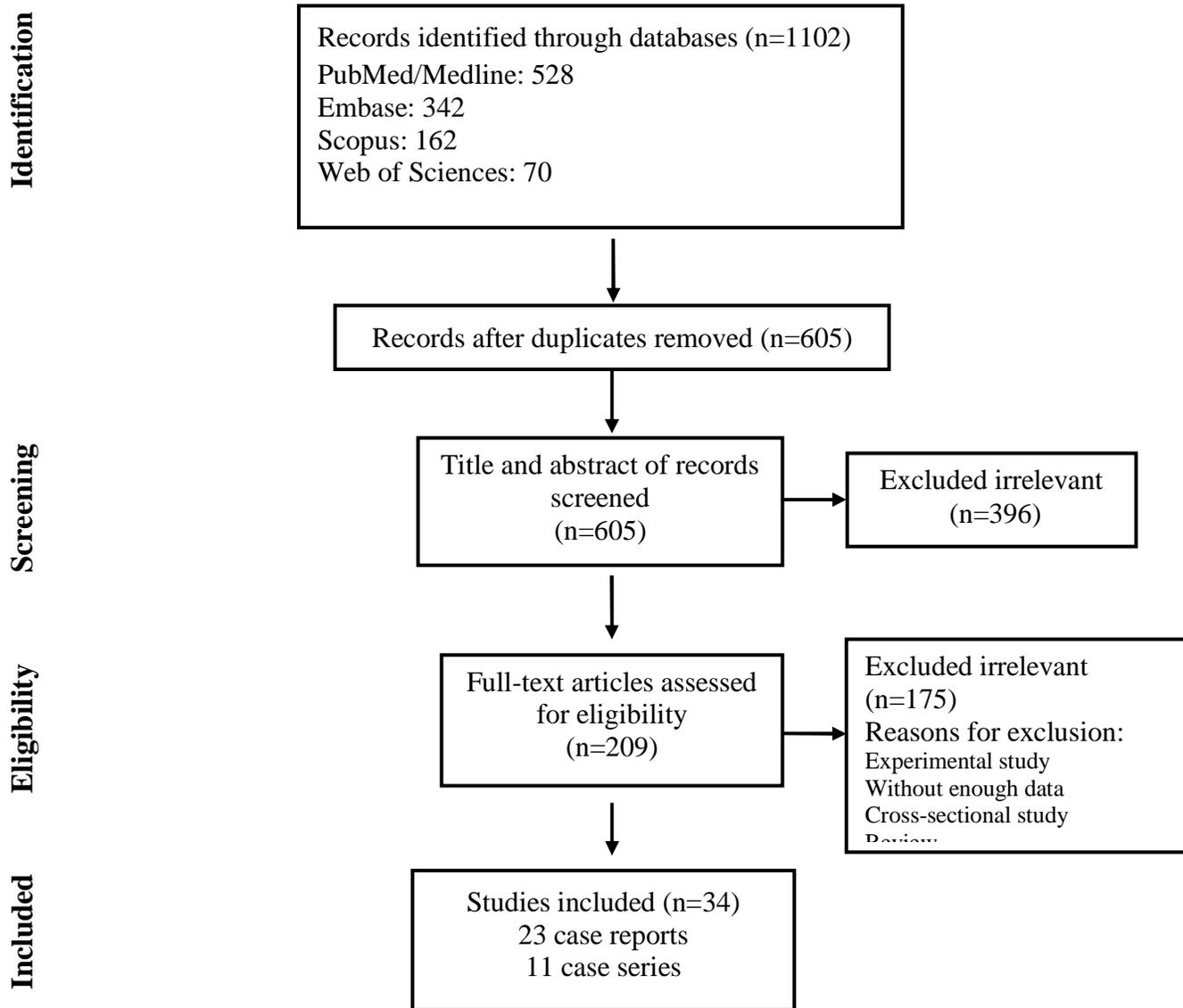


Figure1. Flow chart of study selection for inclusion in the systematic review

Table1. Characteristics of the included studies

First Author	Country	Published time	Type of study	Mean age	Male/Female	No. of patient (s)	Diagnostic methods
Kim [30]	South Korea	19, Feb, 2020	Case report	45	1M,1F	2	RT-PCR/CT-scan
Ping Yu [31]	China	18, Feb, 2020	Case report	74.2	2M, 2F	4	RT-PCR
Bastola [32]	Nepal	10, Feb, 2020	Case report	32	M	1	RT-PCR
Duan [33]	China	4, Feb, 2020	Case report	46	F	1	RT-PCR/CT-scan
X. Fang [17]	China	19, Feb, 2020	Case report	47	M	1	RT-PCR/CT-scan
Wenzheng Han [20]	China	19, Feb, 2020	Case report	47	M	1	RT-PCR/CT-scan
Heng Wei [34]	China	25, Feb, 2020	Case report	62	M	1	RT-PCR/CT-scan
Holshue [35]	USA	5, Mar, 2020	Case report	35	M	1	RT-PCR
Lim [36]	South Korea	14, Feb, 2020	Case report	54	M	1	RT-PCR/CT-scan
Heshui Shi1 [21]	China	4, Feb, 2020	Case report	42	M	1	RT-PCR/CT-scan
Silverstein [37]	Canada	13, Feb, 2020	Case report	56	M	1	RT-PCR
Jiangping Wei [38]	China	17, Feb, 2020	Case report	40	F	1	RT-PCR
Fan Wu [39]	China	3, Feb, 2020	Case report	41	M	1	RT-PCR
Zhe Xu [40]	China	17, Feb, 2020	Case report	50	M	1	RT-PCR
Winichakoon [41]	Thailand	26, Feb, 2020	Case report	28	M	1	RT-PCR
Zhan Zhang [42]	China	28, Jan, 2020	Case report	38	1M, 1F	2	RT-PCR
Yicheng Fang1 [43]	China	7, Feb, 2020	Case report	38.5	1M,1F	2	RT-PCR/CT-scan
Xiaoqi Lin [44]	China	11, Feb, 2020	Case report	37	M	2	RT-PCR/CT-scan

Ying-Chu Liu [45]	Taiwan	12, Mar, 2020	Case report	51	1M, 1F	2	RT-PCR
Phan [46]	Vietnam	27, Feb, 2020	Case report	Father: 65, Son: 27	M	2	RT-PCR
Pongpirul [47]	Thailand	12, Mar, 2020	Case report	51	M	1	RT-PCR
W. Hao [48]	China	2, Feb, 2020	Case report	60	M	1	RT-PCR/CT-scan
Wendong Hao [49]	China	17, Feb, 2020	Case report	58	M	1	RT-PCR
Woo Chan [50]	China	24, Jan, 2020	Case series	46	3M,3F	6	RT-PCR
Huijun Chen [51]	China	12, Feb, 2020	Case series	29.8	F	9	RT-PCR/CT-scan
Min Wei [52]	China	21, Feb, 2020	Case series	6 month	2 M, 7F	9	RT-PCR
Qin [53]	China	22, Feb, 2020	Case series	55.5	2M, 2F	4	CT-scan
Wang [54]	China	9, Feb, 2020	Case series	44.2	3M, 1F	4	RT-PCR/CT-scan
Xie [23]	China	12, Feb, 2020	Case series	48.4	M4, F1	5	RT-PCR
Ho Yoon [55]	Korea	18, Feb, 2020	Case series	54	4M, 5F	9	CT-scan
Stoecklin [56]	France	13, Feb, 2020	Case series	36.3	2M, 1F	3	RT-PCR
Rothe [57]	Germany	5, Mar, 2020	Case series	33	NR	5	RT-PCR
Bai [58]	China	21, Feb, 2020	Case series	42-57	1M, 5F	6	RT-PCR
Dong Tong [59]	China	9, May, 2020	Case series	31.1	4M, 3F	7	RT-PCR

Table 2. Summary of the case report and case series findings

	Variables	Number of studies	n/N*	%
Comorbidities	Hypertension	7	8/16	50
	Cardiovascular disease	2	2/6	33
	Diabetes	6	6/13	46
	Pulmonary disease	3	3/10	30
Clinical manifestations	Fever	26	50/60	83
	Cough	21	32/55	58
	Dyspnea	10	10/20	50
	Myalgia/fatigue	15	20/38	52
	Sputum production	5	5/11	45
	Sore throat	8	9/27	33
	Headache	2	2/2	100
	Diarrhea	5	6/20	30
	Nausea/vomiting	3	3/4	75
	Dizziness	3	3/10	30
	Rhinorrhea	5	6/12	50
	Chills	2	2/9	22
Laboratory findings	Lymphopenia	10	12/21	57
	Leukopenia	5	7/9	77
	Thrombocytopenia	3	4/8	50
	High CRP	15	25/34	73
	High LDH	6	8/12	66
	High ESR	7	7/11	63
	High AST	5	5/5	100
	High ALT	5	7/13	53
	High Creatinine Kinase	2	2/2	100
	High Creatinine	1	2/6	33
CT	Both of GGO & Consolidation	4	4/13	30
	GGO without consolidation	8	24/30	80
	Unilateral	1	2/4	50
	Bi lateral	3	5/7	71
Complications	ARDS	2	2/6	33
	Hospitalization	15	32/33	97
Outcome	Discharged	7	12/12	100

	Death	2	2/2	100
--	-------	---	-----	-----

*n, number of patients with any variables; N, the total number of patients with COVID-19.

Table 3. Treatment agents used in the included studies

	Treatment	Agents	Number of studies	n/N*	%
Pharmacologic treatment	Antiviral Drugs	Lopinavir	6	9/9	100
		Arbidol hydrochloride	2	6/6	100
		Oseltamivir	5	1/1	100
		Veletonavir	1	1/1	100
		Remdesivir	1	1/1	100
		Ribavirin	1	1/1	100
		Ritonavir	1	1/1	100
		Gancyclovir	1	1/1	100
	Antibacterial Drugs	Moxifloxacin	4	5/5	100
		Vancomycin	1	1/1	100
		Cefepime	1	1/1	100
		Meropenem	2	2/2	100
		Piperacillin tazobactam	2	2/2	100
		Sefoselis	1	1/1	100
		Linezolid	1	1/1	100
		Levofloxacin	1	1/2	50
	Others	Methylprednisolone	5	6/6	100
		Ambroxol Hydrochloride	1	1/1	100
		Acetaminophen	2	2/2	100
		Ibuprofen	2	2/2	100
		Intravenous Immunoglobulin	3	4/7	57
		Guaifenesin	1	1/1	100
		Ondansetron	1	1/1	100
Interferon alpha-2b		2	2/2	100	
Herbal patent medicine	2	3/3	100		
Non-Pharmacologic treatment	Oxygen therapy	Non-invasive	6	10/10	100

*n, number of patients under treatment; N, the total number of patients with COVID-19.

References:

1. Zhu, N., et al., *A novel coronavirus from patients with pneumonia in China, 2019*. New England Journal of Medicine, 2020.
2. Lu, R., et al., *Genomic characterisation and epidemiology of 2019 novel coronavirus: implications for virus origins and receptor binding*. The Lancet, 2020. **395**(10224): p. 565-574.
3. Liu, Y., et al., *Clinical and biochemical indexes from 2019-nCoV infected patients linked to viral loads and lung injury*. Science China Life Sciences, 2020. **63**(3): p. 364-374.
4. Sun, P., et al., *Clinical characteristics of 50466 hospitalized patients with 2019-nCoV infection*. Journal of medical virology, 2020.
5. Chen, J., *Pathogenicity and transmissibility of 2019-nCoV—a quick overview and comparison with other emerging viruses*. Microbes and infection, 2020.
6. Moher, D., et al., *Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement*. Annals of internal medicine, 2009. **151**(4): p. 264-269.
7. Zou, L., et al., *SARS-CoV-2 viral load in upper respiratory specimens of infected patients*. New England Journal of Medicine, 2020. **382**(12): p. 1177-1179.
8. Li, Q., et al., *Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia*. New England Journal of Medicine, 2020.
9. Chen, H., et al., *Clinical characteristics and intrauterine vertical transmission potential of COVID-19 infection in nine pregnant women: a retrospective review of medical records*. The Lancet, 2020. **395**(10226): p. 809-815.
10. Chen, N., et al., *Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study*. The Lancet, 2020. **395**(10223): p. 507-513.
11. Xu, Y.-H., et al., *Clinical and computed tomographic imaging features of Novel Coronavirus Pneumonia caused by SARS-CoV-2*. Journal of Infection, 2020.
12. Alraddadi, B.M., et al., *Risk factors for primary Middle East respiratory syndrome coronavirus illness in humans, Saudi Arabia, 2014*. Emerging infectious diseases, 2016. **22**(1): p. 49.
13. Yang, J., et al., *Prevalence of comorbidities in the novel Wuhan coronavirus (COVID-19) infection: a systematic review and meta-analysis*. International Journal of Infectious Diseases, 2020.
14. Huang, C., et al., *Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China*. The Lancet, 2020. **395**(10223): p. 497-506.
15. Tang, N., et al., *Abnormal Coagulation parameters are associated with poor prognosis in patients with novel coronavirus pneumonia*. Journal of Thrombosis and Haemostasis, 2020.
16. Ai, T., et al., *Correlation of chest CT and RT-PCR testing in coronavirus disease 2019 (COVID-19) in China: a report of 1014 cases*. Radiology, 2020: p. 200642.
17. Fang, X., et al., *Changes of CT Findings in a 2019 Novel Coronavirus (2019-nCoV) pneumonia patient*. QJM: An International Journal of Medicine, 2020.
18. Bernheim, A., et al., *Chest CT findings in coronavirus disease-19 (COVID-19): relationship to duration of infection*. Radiology, 2020: p. 200463.

19. Wei, J., et al., *2019 Novel Coronavirus (COVID-19) Pneumonia: Serial Computed Tomography Findings*. Korean Journal of Radiology, 2020. **21**(4): p. 501-504.
20. Han, W., et al., *The course of clinical diagnosis and treatment of a case infected with coronavirus disease 2019*. Journal of medical virology, 2020.
21. Shi, H., X. Han, and C. Zheng, *Evolution of CT manifestations in a patient recovered from 2019 novel coronavirus (2019-nCoV) pneumonia in Wuhan, China*. Radiology, 2020: p. 200269.
22. Lei, J., et al., *CT imaging of the 2019 novel coronavirus (2019-nCoV) pneumonia*. Radiology, 2020: p. 200236.
23. Xie, X., et al., *Chest CT for typical 2019-nCoV pneumonia: relationship to negative RT-PCR testing*. Radiology, 2020: p. 200343.
24. Pan, F., et al., *Time course of lung changes on chest CT during recovery from 2019 novel coronavirus (COVID-19) pneumonia*. Radiology, 2020: p. 200370.
25. Yang, X., et al., *Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: a single-centered, retrospective, observational study*. The Lancet Respiratory Medicine, 2020.
26. Rodriguez-Morales, A.J., et al., *Clinical, laboratory and imaging features of COVID-19: A systematic review and meta-analysis*. Travel Medicine and Infectious Disease, 2020: p. 101623.
27. Lai, C.-C., et al., *Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and corona virus disease-2019 (COVID-19): the epidemic and the challenges*. International journal of antimicrobial agents, 2020: p. 105924.
28. Wang, D., et al., *Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China*. Jama, 2020.
29. Lim, J., et al., *Case of the index patient who caused tertiary transmission of Coronavirus disease 2019 in Korea: the application of lopinavir/ritonavir for the treatment of COVID-19 pneumonia monitored by quantitative RT-PCR*. Journal of Korean Medical Science, 2020. **35**(6).
30. Kim, J.Y., et al., *Viral Load Kinetics of SARS-CoV-2 Infection in First Two Patients in Korea*. Journal of Korean Medical Science, 2019. **35**(7).
31. Yu, P., et al., *A familial cluster of infection associated with the 2019 novel coronavirus indicating potential person-to-person transmission during the incubation period*. The Journal of infectious diseases, 2020.
32. Bastola, A., et al., *The first 2019 novel coronavirus case in Nepal*. The Lancet Infectious Diseases, 2020.
33. Duan, Y.-n. and J. Qin, *Pre-and posttreatment chest CT findings: 2019 novel coronavirus (2019-nCoV) pneumonia*. Radiology, 2020: p. 200323.
34. Wei, H., et al., *The 2019 novel coronavirus pneumonia with onset of oculomotor nerve palsy: a case study*. Journal of Neurology, 2020: p. 1-4.
35. Holshue, M.L., et al., *First case of 2019 novel coronavirus in the United States*. New England Journal of Medicine, 2020.
36. Lim, J., et al., *Case of the Index Patient Who Caused Tertiary Transmission of COVID-19 Infection in Korea: the Application of Lopinavir/Ritonavir for the Treatment of COVID-19 Infected Pneumonia Monitored by Quantitative RT-PCR*. Journal of Korean Medical Science, 2020. **35**(6).

37. Silverstein, W.K., et al., *First imported case of 2019 novel coronavirus in Canada, presenting as mild pneumonia*. The Lancet, 2020.
38. Wei, J., et al., *2019 Novel Coronavirus (COVID-19) Pneumonia: Serial Computed Tomography Findings*. Korean Journal of Radiology, 2020. **21**.
39. Wu, F., et al., *A new coronavirus associated with human respiratory disease in China*. Nature, 2020: p. 1-5.
40. Xu, Z., et al., *Pathological findings of COVID-19 associated with acute respiratory distress syndrome*. The Lancet Respiratory Medicine, 2020.
41. Winichakoon, P., et al., *Negative Nasopharyngeal and Oropharyngeal Swab Does Not Rule Out COVID-19*. Journal of Clinical Microbiology, 2020.
42. Zhang, Z., et al., *Clinical Features and Treatment of 2019-nCov Pneumonia Patients in Wuhan: Report of A Couple Cases*. Virologica Sinica, 2020: p. 1-7.
43. Fang, Y., et al., *CT manifestations of two cases of 2019 novel coronavirus (2019-nCoV) pneumonia*. Radiology, 2020: p. 200280.
44. Lin, X., et al., *Novel coronavirus pneumonia outbreak in 2019: computed tomographic findings in two cases*. Korean Journal of Radiology, 2020. **21**(3): p. 365-368.
45. Liu, Y.-C., et al., *A Locally Transmitted Case of SARS-CoV-2 Infection in Taiwan*. New England Journal of Medicine, 2020.
46. Phan, L.T., et al., *Importation and human-to-human transmission of a novel coronavirus in Vietnam*. New England Journal of Medicine, 2020. **382**(9): p. 872-874.
47. Pongpirul, W.A., et al., *Journey of a Thai Taxi Driver and Novel Coronavirus*. New England Journal of Medicine, 2020.
48. Hao, W., M. Li, and X. Huang, *First Atypical case of 2019 novel coronavirus in Yan'an, China*. Clinical Microbiology and Infection, 2020.
49. Hao, W., *Clinical Features of Atypical 2019 Novel Coronavirus Pneumonia with an initially Negative RT-PCR Assay*. Journal of Infection, 2020.
50. Chan, J.F.-W., et al., *A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster*. The Lancet, 2020. **395**(10223): p. 514-523.
51. Chen, H., et al., *Clinical characteristics and intrauterine vertical transmission potential of COVID-19 infection in nine pregnant women: a retrospective review of medical records*. The Lancet, 2020.
52. Wei, M., et al., *Novel coronavirus infection in hospitalized infants under 1 year of age in China*. JAMA, 2020.
53. Qin, C., et al., *18 F-FDG PET/CT findings of COVID-19: a series of four highly suspected cases*. European Journal of Nuclear Medicine and Molecular Imaging, 2020: p. 1-6.
54. Wang, Z., et al., *Clinical characteristics and therapeutic procedure for four cases with 2019 novel coronavirus pneumonia receiving combined Chinese and Western medicine treatment*. BioScience Trends, 2020.
55. Yoon, S.H., et al., *Chest Radiographic and CT Findings of the 2019 Novel Coronavirus Disease (COVID-19): Analysis of Nine Patients Treated in Korea*. Korean Journal of Radiology, 2020. **21**.
56. Stoecklin, S.B., et al., *First cases of coronavirus disease 2019 (COVID-19) in France: surveillance, investigations and control measures, January 2020*. Eurosurveillance, 2020. **25**(6).

57. Rothe, C., et al., *Transmission of 2019-nCoV infection from an asymptomatic contact in Germany*. New England Journal of Medicine, 2020.
58. Bai, Y., et al., *Presumed asymptomatic carrier transmission of COVID-19*. Jama, 2020.
59. Tong, Z., et al., *Potential Presymptomatic Transmission of SARS-CoV-2, Zhejiang Province, China, 2020*. Emerging infectious diseases, 2020. **26**(5).