WHO has declared the epidemic of COVID-19 as a priority disease. Some patients with COVID-19 pneumonia had symptoms of failure of multiple organs, and death. The published articles on COVID-19 infection were reviewed. The origin of COVID-19 is still incompletely established. Person-to-person transmission via droplets, probable aerosols or close contacts is considered as the main mode of transmission. With the increase of COVID-19 infected patients and associated mortality, valuable clinical indicators or treatments are further identified and summarized. CT scan plays an important role in the diagnosis and evaluation of 2019-nCoV pneumonia in suspected patients with initial negative RT-PCR or asymptomatic results. No specific antiviral therapy is still recommended except the main supportive treatments, and effective measures should be taken into consideration to protect important organs and prevent the development of ARDS in patients with severe infection.
A current emerging respiratory infection: epidemiological and clinical characteristics, diagnosis and treatments of COVID-19

Hai Yuan*, Xiaoguang Cao, Xiaoji Ji, Fangbing Du, Xuan Zhou, Jiawei He, Yanghu Xie, Yu Zhu*

*Joint corresponding authors

Department of Rehabilitation Medicine (H Yuan, X Cao), Intensive Care Unit (X Ji), Respiratory Medicine (F Du, X Zhou), Radiology (J He), Laboratory Medicine (Y Xie), The Second People’s Hospital of Hefei City, Hefei, China; School of Public Health (Y Zhu), Wannan Medical College, Wuhu, China

*Correspondence to: Dr. Hai Yuan, The Second People’s Hospital of Hefei City, Hefei, Anhui Province 230011, China. haiyuan103@163.com or Yu Zhu, School of Public Health, Wannan Medical College, Wuhu, Anhui Province 241002, China. kutuomonk@wnmc.edu.cn.

Abstract WHO has declared the epidemic of COVID-19 as a priority disease. Some patients with COVID-19 pneumonia had symptoms of failure of multiple organs, and death. The published articles on COVID-19 infection were reviewed. The origin of CIVID-19 is still incompletely established. Person-to-person transmission via droplets, probable aerosols or close contacts is considered as the main mode of transmission. With the increase of COVID-19 infected patients and associated mortality, valuable clinical indicators or treatments are further identified and summarized. CT scan plays an important role in the diagnosis and evaluation of 2019-nCoV pneumonia in suspected patients with initial negative RT-PCR or asymptomatic results. No specific antiviral therapy is still recommended except the main supportive treatments, and effective measures should be taken into consideration to protect important organs and prevent the development of ARDS in patients with severe infection.

Keywords: COVID-19; Respiratory infection; Epidemiology; Clinical characteristics; Treatment strategies

Introduction

A cluster of unknown etiology of pneumonia has been detected in Wuhan, China since Dec, 2019[1]. The Chinese Center for Disease Control and Prevention[2-4] and the World Health Organization (WHO)[5-7] reported the confirmation of a novel coronavirus (2019-nCoV) on 07 Jan 2020. This virus has been isolated and verified from the infected patients[8], and named it as the Corona Virus Disease 2019 (COVID-19)[9-10] or Severe Acute Respiratory Syndrome-Coronavirus-2 (SARS-CoV-2)[11] by the WHO, the International Committee on Taxonomy of Viruses, respectively. At 12:00 pm (Beijing time) on 04 March, there were 520 suspected cases, 80422 confirmed cases, 2984 deaths and 49923 recoveries reported in China. The cases with COVID-19 infection have also been detected and reported in Thailand (Jan 13), Japan (Jan 15), South Korea (Jan 20), the United States (Jan 23), Vietnam (Jan 24), Republic of Singapore (Jan 24), France (Jan 25), Nepal (Jan 25), Australia (Jan 25), Malaysia (Jan 26) on or after[12]. On 30 Jan 2020, following the advice of the Emergency Committee, the WHO Director-General has announced the outbreak of COVID-19 as a Public Health Emergency of International Concern[13,14]. The epidemic transmission in China has been effectively controlled currently. The COVID-19 has gradually spread outside China and its situation still remains to be intolerable in Japan, South Korea, Italy, Iran and so on[12]. There is a possible epidemiological link of this disease with seafood and wild animal markets for the initiation of the outbreak of viral pneumonia in Wuhan. Most of the cases who lived or worked at in this market had initiated this infection, and showed association with the exposure to virus reservoir, indicating a possible condition of zoonoses. However, the origins and hosts of COVID-19 are still not clarified. The patients with COVID-19 pneumonia have been discharged from hospitals, and its pathogenesis is gradually identified. Of course, the diagnosis and treatments of viral pneumonia should be further summarized. In this review, the epidemic situation of COVID-19 is presented to discuss the current state to combat the emerging coronavirus infections. The clinical features, diagnosis and treatments to viral pneumonia were discussed to assist the physicians in timely and accurate diagnoses and treatment of infected patients.

Epidemiology
**Origin**

The initial cases showed direct or indirect contact history with the original seafood market, and is considered as an original place of the outbreak of COVID-19. It is unknown as to whether this novel coronavirus is originated from the sold wild animals of Huanan seafood market?, and its origin also still remains unclear.

COVID-19 is an enveloped single-stranded plus stranded RNA virus with a diameter of 60-140 nm. This virus was isolated from a patient on 7 Jan 2020 and the viral genomic sequence of COVID-19 was released by the Chinese researchers on 10 Jan 2020 on the Global Initiative on Sharing All Influenza Data (GISAID). The COVID-19 is a new beta coronavirus belonging to group 2B based on genome sequence analysis and its S-protein sequence differed from that of SARS-CoV. Nevertheless, a common ancestor with that of Severe Acute Respiratory Syndrome (SARS) to the bat HKU9-1 coronavirus was found.

Extensive sequence analysis and comparison among different animal species showed snake as a possible reservoir of COVID-19, and homologous recombination within the S glycoprotein might contribute to the snake-human transmission of COVID-19. But this result has been disputed by other researchers. The high nucleotide identity of S protein of COVID-19, a protein with the highest genetic variations for different coronaviruses, along with the two bat SARS-like coronavirus (bat-SL-CoVZXL4 and bat-SL-CoVZXL21) demonstrated high homology with that of bat SARS-like coronaviruses. This indicated that COVID-19 might be originated from bat, Rhinolophus sinicus. Several studies reported similar results. A more than 85% consistency of the nucleotide sequence of COVID-19 with the SARS-like coronavirus in bats (bat-SL-CoVZXL45) has been reported. The nucleotide sequence of S protein is also highly similar to that of bat-SL-CoVZXL45. The results of a study also showed that RaTG13, a short RdRp region from a bat coronavirus, is the closest relative of the COVID-19, which came into light through phylogenetic analysis, and the receptor binding protein S gene was 93.1% nt identical to that of RaTG13, providing a evidence of a bat origin of COVID-19. Furthermore, a recent study also revealed that pangolin might be a potential animal host of the virus. The consistency of genomic sequence between the beta coronavirus isolated from pangolin and that of the currently infected human virus strains is as high as 99%. Metagenomic sequencing of novel coronavirus genomes of pangolin demonstrated approximately 85.5% to 92.4% consistency with that of COVID-19, representing pangolin (Manis javanica) as a probable host. However, the natural or intermediate host is still under debate and needs further determination.

**Transmission routes**

The initially infected patients had an exposure history with Wuhan wild animal market. The animal-to-human transmission is considered during the initial phase of the epidemic. According to the recent epidemic data and regions, human-to-human transmission has evolved as an important route of transmission. More and more evidences have confirmed this view. One family member after several days of contact with infected members were identified to be infected. One person with positive throat swab in Vietnam was reported to have close contact with his infected father. A familial cluster demonstrated a close contact history with an asymptomatic carrier and is ascertained as COVID-19 pneumonia. An infected case was also observed outside Asia, in which the person met a Chinese business partner with no symptoms of COVID-19 infection, and suggested that the transmission might have occurred during the incubation period. In addition, the positive real-time reverse transcriptase polymerase chain reaction (RT-PCR) results of patients who were discharged were tested again, and were shown to be virus carriers. Asymptomatic carriers or positive patients should be further focused and their transmissibility should be reevaluated. Also whether or not the patients are infectious should be enquired, and requires isolation.

The patient’s nasopharyngeal and oropharyngeal swabs were tested to be positive and one positive sputum sample was also found for COVID-19 by RT-PCR assay. This implied that COVID-19 virus particles could spread through airway. Person-to-person transmission occurs via droplets from coughing or sneezing, close contacts or probable aerosols. Stools obtained on day 7 of illness also showed positive from an infected patient in the United States by RT-PCR. Also positive RT-PCR results were confirmed from the feces of infected patients.
by Guan W et al. 36. Hu Y et al. found that several cases showed negative results in the respiratory tract, but still continued to show positive results in the stool specimens 37. It is possible that fecal-oral transmission is another route of transmission, and fecal management is also necessary. Additionally, the positive results were also obtained in conjunctival secretions and tears of an infected patient with conjunctivitis 38. The isolation of patients and quarantining of contacts are essential, and hygiene protection should also be taken into account. After 30 hours of birth, a baby, whose mother with confirmed 2019-nCoV pneumonia, was tested to be positive for COVID-19 in Wuhan Children’s Hospital 39. However, in another study, it was shown that the amniotic fluid, breast milk, and cord blood samples from six late pregnant patients with pneumonia were shown to be negative 40. At present, there was no evidence on the identification of intrauterine infection or mother-to-child transmission.

**Susceptible population** Based on the investigation and analysis of 44627 confirmed cases before Feb 11 2020 in China, people of all ages are generally susceptible. Patients are concentrated in 30-79 years old group, accounting for 86.6%. The cases in the over 60 years old group was 31.2%. The ratio of men to women was 1.06: 1 and men may be more susceptible 41. It is more susceptible for patients with older years onset, underlying diseases, such as diabetes, asthma, cardiovascular diseases and so on. The high-risk population are those who have close contact of patients with COVID-19 infection 45. Most pediatric patients had milder symptoms than adults, and good prognosis was also presented 42,43. Compared to men, women not only have less symptoms, but also have a longer incubation period. So, the differential controls should be adopted as early as possible 44.

The information regarding the transmissibility has been published by several analytical models 45. The World Health Organization estimated the R0 (reproduction number) as 1.4 to 2.5, which demonstrated that every infected person could infect between 1.4 to 2.5 individuals. A series of R0, epidemic doubling time, incubation period, cumulative number and case fatality rate were also calculated and analyzed 41,46-48. These epidemiological characteristics were estimated based on the infection initiated patients, or even incomplete cases. These results warrant interpretation. Furthermore, stringent prevention and control measures to stop further spread or reduce transmission have been implemented in China, and the ability to predict these data is limited and even weakened.

**Etiology and Pathogenesis**

A previous study used the cells that expressed angiotensin-converting enzyme 2 (ACE2) to investigate the pathogenesis of COVID-19, and revealed that it might enter the host cells by an entry receptor, ACE2 65,66. The other structural analysis suggested that COVID-19 might directly contact the ACE2 in humans 67. Viruses enter the host cells based on the S protein attachment to the host ACE2 and the S protein on the surface of the viruses is initiated by a cellular protease 6,16,30,68,69. Structural analysis also showed mutation of spike glycoprotein and nucleocapsid protein of COVID-19, which included replacement of four out of five important interface amino acid residues, but did not alter the structural confirmation, and S-protein was found to have a significant attaching affinity to human ACE2 19,22,66. So, COVID-19 interacts with human ACE2 molecules and COVID-19-S is provoked via S-protein of it during human-to-human transmission. ACE2 is widely expressed in lung AT2 cells, myocardial cells, esophagus epithelial cells, enterocytes of ileum and colon, cholangiocytes, proximal tubular cells of the kidney, bladder urothelial cells and spermatids or spermatids or Sertoli cells 70,74. These results indicated that the respiratory, cardiovascular, digestive, reproductive and urinary systems might be vulnerable to COVID-19 infection 71,72. Furthermore, COVID-19 might directly bind to the cholangiocytes with ACE2 expression or ACE2 positive cells of the urinary systems to induce cholangiocyte dysfunction and liver or kidney injury, respectively 72,75. A COVID-19 infected patient with acute respiratory distress syndrome (ARDS) demonstrated moderate lobular and portal activity and microvascular steatosis by liver histological examination 76, and also high cardiac troponin I (cTnI) was confirmed in patients with very severe infection 77. However, no substantial histological changes in the heart tissues were seen 76, and a large number of pathological studies are necessary to confirm this conclusion.
Clinic characteristics and Diagnosis

The detailed clinical characteristics and diagnosis were described by several articles, which were as follows (Table):

Article 1. Two younger adults (36,37 years) had diarrhea and upper respiratory tract symptoms such as sore throat, nasal mucus or congestion. One patient (36 years) had a productive cough. The younger patient (10 years) with asymptomatic infection was later confirmed virologically. Three older patients (aged >60 years) with comorbidities had more severe respiratory systemic symptoms, such as dry cough and fatigue, and the decreased platelet counts, lymphocytes and increased C-reactive protein were tested in the laboratory. Although the negative bacteria existed, a secondary bacterial infection should be considered in one patient with comorbidity of chronic sinusitis based on the productive cough and high leukocyte count. The high viral loads of the lower respiratory were taken into consideration, and this is because the cycle threshold values of the sputum samples were 8–13 cycles earlier than those of throat swabs. Furthermore, the repeated testing of respiratory tract samples is warranted in suspected cases.

Article 2. Most of the infected patients had normal serum levels of procalcitonin. Three patients with secondary infections from Intensive Care Unit (ICU) had high levels of procalcitonin. There was a very short time of 2 days between hospital admission and ARDS, and so the mortality rate remained high. Most of the patients had some similar symptoms to that of Severe Acute Respiratory Syndrome-coronavirus (SARS-CoV) and Middle East Respiratory Syndrome-coronavirus (MERS-CoV), such as dry cough, fever, dyspnea, and bilateral ground-glass opacities on chest Computerized Tomography (CT) scans. Few individuals had symptoms of upper respiratory tract, such as rhinorrhea, sore throat, or sneezing, which indicated that the invasion of 2019-nCoV of lower airway cells were of main concern. Also, an association of cytokine storm with disease severity was found. In this article, 11 patients with productive cough and 12 patients with high white blood cell count have been reported; however, there were only 4 patients with secondary infection. The high white blood cell count requires no further elucidation.

Article 3. Of the 11 deaths, 8 had lymphopenia, 7 had bilateral pneumonia, 7 were >60 years, 3 had hypertension, and 3 had a long history of smoking. One study reported that smokers had higher ACE2 gene expression in the lung tissues, meaning that the smokers might be more susceptible to COVID-19. Another study reported that older patients who were admitted to ICU had more comorbidities and symptoms of pharyngeal pain, dyspnea, dizziness, abdominal pain, and anorexia than non-ICU patients. According to the authors’ speculation, the risk of infection in men is higher, and this should be taken into consideration for further research. In addition, 51 patients who had high interleukin-6 levels and lymphocyte count were decreased in most of the patients, suggesting that 2019-nCoV might mainly act on lymphocytes, especially the T lymphocytes give rise to cascade immune responses.

Article 4. The onset of illnesses such as fever, fatigue, dry cough, myalgia, and dyspnea, were reported as the most common symptoms, but 14 patients presented initial and atypical symptoms, such as diarrhea and nausea. The most common laboratory abnormalities included prolonged prothrombin time, decreased total lymphocyte count and elevated lactate dehydrogenase, and these abnormal results might be associated with the activation of immune response and coagulation, the injury of myocardium, liver and kidney. The dynamic laboratory results were also tracked in 33 patients, and the nonsurvivors had continuous increase in the levels of D-dimer, the neutrophil count, blood urea, creatinine and decrease in lymphocyte counts until the occurrence of death.

Article 5. Of the 1099 infected patients, 79.1% developed pneumonia. The radiologic CT or X-ray scans appeared to be normal or fever was observed in only 7.55% or 43.8% of cases on initial symptoms, respectively, while diarrhea was uncommon. The signs of throat congestion were observed in 19, tonsil swelling in 23, enlargement of lymph nodes in 2 and rash in 2 were found. The elevated hepatic enzymes might be due to the severity of
infection. The positive stool, gastrointestinal tract, saliva or urine specimens of 2019-nCoV were detected initially. In one case of severe peptic ulcer, COVID-19 was directly detected at the bleeding site of esophageal erosion.

Article 6. Dynamic observation of laboratory tests and clinical characteristics of 61 patients with COVID-19 pneumonia was done. The neutrophil-to-lymphocyte ratio (NLR) was identified as an independent factor in the prediction of the severity of illness. Further research revealed that individuals aged ≥50 and NLR≥3.13 contributed to the deterioration of illness.

Article 7. Forty-five family clusters of infected individuals were demonstrated in 89 hospitalized patients. The symptoms in some patients with severe infection showed gradual improvement and the abnormality of lung injury according to the chest CTs was gradually lessened after methylprednisolone and other treatments.

Article 8. A high mortality rate was observed in most of the ARDS patients with comorbidities, such as diabetes, cerebrovascular diseases, chronic kidney diseases, and so on. The significant effect of relevant treatment plans, such as antiviral, glucocorticoid, or immunoglobulin treatments, assisted in the nonoccurrence of ARDS in patients.

In addition, Liu W et al. have reported that patients with positive COVID-19, 80% had myalgia, and 75% had dyspnea. In contrast, fever and cough are the most common symptoms observed in negative patients. The combination of fever with bilateral abnormal changes of lung in CT scans contributed to 79.8% accuracy of the initial diagnosis, and bilateral ground glass-like abnormality in CT-scans along with the below eosinophils can reach up to 77.0%.

During the incubation period, an epidemic exposure history is considered to be extremely important to screen the 2019-nCoV infectious disease. During the disease onset, the infected person presented with fever, dry cough and ground glass opacification, consolidation and ill-defined margins. The multifocal, unilateral imaging abnormality is done for asymptomatic patients, and the ground-glass opacities have rapidly evolved into consolidation after the onset of symptoms. For 1014 suspected patients, 88% showed positive rates with CT scans, which were higher than 59% of RT-PCR assay in diagnosing the infected patients. Also 42% (24/57) patients showed improvement through abnormal CT scans before the negative RT-PCR results were confirmed. Five patients with initial negative RT-PCR results presented the ground-glass opacity and/or consolidation on CT scans was eventually diagnosed by repeated swab laboratory tests. Also, the positive CT findings showed association with time of illness onset. The sensitivity of CT scan was 98% during the initially infected days (i.e., 3 days) in 51 patients, and RT-PCR was 71% in 91. Finally, the virus mainly acts on the lower respiratory tract to cause pneumonia. The CT scans play an important role in diagnosing and evaluating the situation of 2019-nCoV pneumonia, and sometimes it is considered good. Also the early CT changes are considered to be a sensitive modality to screen the suspected patients with asymptomatic or false-negative RT-PCR results.

Leukocyte, lymphocyte or platelet count were usually reduced, and progressive lymphocytopenia represents the severity in cases. Lymphopenia and thrombocytopenia are taken as reference indexes to diagnose COVID-19 infection. The lower levels of CD4+T, CD8+T and higher levels of cytokines,
IL-6, IL-10 and so on, should be considered. Eosinopenia is also considered as a potentially reliable laboratory indicator that should not be neglected during diagnosis. Additionally, the levels of CD4+T, CD8+T and IL-6, IL-10 and NLR are possible in predicting the development of COVID-19 pneumonia and the severity of illness. Abnormal coagulation function and elevated lactate dehydrogenase are considered important laboratory methods to diagnose the disease. Abnormal levels of procalcitonin might indicate secondary bacterial infection. The elevation of liver enzymes, creatine kinase and urine protein warns the target organ dysfunction. Serum specific IgM and IgG antibodies of COVID-19 have been recommended for diagnosing the disease. The old age onset, comorbidities and ARDS should be taken into consideration as a possible predictive risk of death. The failure of multiple organs, such as acute cardiac, renal, pulmonary and hepatic injuries still remain the main cause of death. Due to small sample size, the interpretation of relevant indicators showed individual differences.

**Treatments**

Until now, there is no specific antiviral therapy recommended except for the main supportive treatments. The fever is treated by using acetaminophen, and ibuprofen. The continued cough should be intervened, and the oxygen supplementation should be given. The articles included respiratory distress patients who require non-invasive or invasive ventilator mechanical ventilation (Table).

Most of the patients were given antiviral therapy (with oseltamivir, lopinavir, ritonavir, and remdesivir, nelfinavir) based on the previous reports of MERS-CoV, SARS or HIV. Although some possible effective antiviral drugs were predicted, such as inhibitors of protease Mpro or an immunoglobulin Fc domain (ACE2-Fc), the effective proof has not been found with the use of antiviral treatment. Remdesivir and chloroquine have been revealed to effectively control the 2019-nCoV infection in vitro, and chloroquine has been recommended as a possible effective antiviral drug for COVID-19 infections in China. Fortunately, the clinical trials on remdesivir has been approved and carried out.

Antibiotics (such as cephalosporins, quinolones, carbapenem, vancomycin cefepime) were given along with a single or combined therapy to cover the common or atypical pathogens. Of course, for patients with secondary infection, antibiotics or antifungal drugs are essential according to the results of bacterial or fungal culture and drug sensitivity.

Some patients with rapid aggravation of chest CTs and emerging ARDS received systemic corticosteroids (methylprednisolone or dexamethasone) to reduce inflammatory-induced lung injury. However, several studies have exhibited invalid treatment with corticosteroids for lung protection, and patients with SARS or MEAS. So, corticosteroids are not routinely recommended. However, histological examination of biopsy samples of COVID-19 patients with ARDS showed evident desquamation of pneumocytes and hyaline membrane formation in the lung. Also the authors suggest that timely and appropriate use of corticosteroids along with ventilator support should be considered to control ARDS development for patients with severe infection. A multicentre, open-label, randomized controlled trial was adopted to investigate the effect of prolonged use of dexamethasone for ARDS patients, and exhibited that dexamethasone showed effective reduction in the duration of ventilation and mortality of patients.

Continuous blood purification is indispensable for renal failure. Extracorporeal membrane oxygenation (ECMO) therapy is suitable when cardiopulmonary failure is difficult to cure. In addition, receiving immunoglobulins strengthens the power of anti-infection during severe infectious conditions, and combined use of Chinese and Western medicine treatment is not completely excluded.

Plasma and antibodies obtained from convalescent patients have been proposed for the use of treatment. Nebulization inhalation of human interferon α2b might also be an effective therapy. Vaccines have been created, but the results might lately occur. Now, the most available approach for infected patients is to identify
it early and provide supportive treatments timely. For individuals, the stringent protective precautions, such as good personal hygiene, fitted mask and ventilation, are considered essential.

The urgent priorities for the research of COVID-19 infection have been discussed in the meeting sponsored by WHO in collaboration with GloPID-R (the Global Research Collaboration for infectious Disease Preparedness). However, significant approaches should be further identified, which were as follows. 1. Origins and intermediate transmission of vectors should be identified to stem the ongoing outbreak. The exposure history of Huanan Seafood Wholesale Market in Wuhan is still doubtful. The initially diagnosed patient has not been published in the article of 24 Jan 2020. The SARS-CoV-2 source at the HuaNan market might be imported from elsewhere based on the phyloepidemiological analyses. A recent or early expansion on 6 January 2020 or an expansion on 8 December 2019 was estimated according to the results of both DnaSP and Arlequin. 2. The nearly identical virus sequences in different patients meant its recent introduction into humans, and so future surveillance of viral ability to mutate, replicate and spread should be reminded. 3. Patients during incubation period might act as a potential source of infection, and in other words, there is a possibility of human-to-human transmission during asymptomatic period. Therefore, epidemiological investigation of patients is necessary, and especially the history of exposure. The isolated patients and quarantining of contacts remain crucial. 4. Some suspicious transmission routes should be further determined, such as fecal-oral or vertical transmission. Also personal hygiene and ventilation are crucial. 5. The autopsy findings of large samples are warranted to clarify the damage of the target organs and pathogenesis. 6. At present, the specific drug treatment through stringent clinical trials is urgently needed to support its effectiveness and safety measures against COVID-19 infected cases.

Conclusions
The published articles were reviewed and found that bat or pangolin as a probable host. Person-to-person transmission via droplets is the main mode, and the probable modes include aerosols or contacts. Older age onset, comorbidities and history of smoking assists in predicting the disease severity. Lymphopenia could be adopted as a reference index to diagnose COVID-19 infection. Lymphopenia, thrombocytopenia, abnormal coagulation function and elevated lactate dehydrogenase levels could be taken into consideration as important methods of laboratory diagnosis of COVID-19 infection. A series of cytokines and NLR demonstrated a possibility to evaluate the situation of illness. CT scan should be used as an important imaging method to diagnose and evaluate the situation of 2019-nCoV for patients with initial negative RT-PCR or asymptomatic results. Early diagnosis and timely treatment are critical for COVID-19 infection. It is necessary to protect important organs in patients infected with pneumonia and effective measures, such as corticosteroid treatment, should be regarded to prevent the development of ARDS in severe patients. Asymptomatic or positive patients again should be focused on and provide attention to face, and urine is also considered significant. Stringent isolation of patients and trace and quarantining the contacts are essential to prevent further spread of COVID-19. Personal hygiene, mask precaution and ventilation should be considered.

Contributors
HY and YZ engaged in study design, interpretation of results and final manuscript approval. XC, XJ and FD contributed to the articles search, collection and review, and any discrepancies were resolved by discussions with HY and YZ. XZ, JH and YX wrote the first manuscript of the review.

Declaration of interests
All authors declare no competing interests.

Acknowledgments
The authors declare that there are no sources of funding to be acknowledged.

References

This preprint research paper has not been peer reviewed. Electronic copy available at: https://ssrn.com/abstract=3551344


68. Zou X, Chen K, Zou JW, et al. The single-cell RNA-seq data analysis on the receptor ACE2 expression reveals the potential risk of different human organs vulnerable to Wuhan 2019-nCoV infection. Front Med 2020; Published online Feb 08. DOI: 10.1007/s11684-020-0754-0.


Cai G. Bulk and single-cell transcriptomics identify tobacco-use disparity in lung gene expression of ACE2, the receptor of 2019-nCov. *MedRxiv* 2020; Published online Feb 05. DOI: 10.1101/2020.02.05.2002107 (preprint).


103. Diagnosis of 2019-nCoV pneumonia and clinical classification according to the new coronavirus pneumonia diagnosis and treatment plan (trial version 7) developed by the National Health Committee of the People's Republic of China. Available online:

This preprint research paper has not been peer reviewed. Electronic copy available at: [https://ssrn.com/abstract=3551344](https://ssrn.com/abstract=3551344)


### Table. Clinical Characteristics, Laboratory Findings, and Treatment included eight articles

<table>
<thead>
<tr>
<th>Patients</th>
<th>Article 1&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Article 2&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Article 3&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Article 4&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Article 5&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Article 6&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Article 7&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Article 8&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>(10-66) (range)</td>
<td>49 (41-58)</td>
<td>55.5(13.1)</td>
<td>52.4(68)</td>
<td>47, Median</td>
<td>40 (1-86)</td>
<td>55(23-86)</td>
<td>55 (43-66)</td>
</tr>
<tr>
<td>Regions</td>
<td>Shenzhen City</td>
<td>Wuhan City</td>
<td>Wuhan City</td>
<td>Wuhan City</td>
<td>Beijing City</td>
<td>Shishou City</td>
<td>Wuhan City</td>
<td></td>
</tr>
<tr>
<td>Smoking history</td>
<td>NA</td>
<td>3</td>
<td>NA</td>
<td>NA</td>
<td>21</td>
<td>4 Current smoking</td>
<td>21 Current smoking</td>
<td>NA</td>
</tr>
<tr>
<td>Exposure history</td>
<td>4 Wuhan Travel</td>
<td>27 Huanan seafood market</td>
<td>Huanan seafood market</td>
<td>12 Huanan seafood market</td>
<td>27</td>
<td>14 diabetes, 43 hypertension, 20 cardiovascular disease, 7 cerebrovascular disease, 11 Digestive system disease, 13 Endocrine system disease, 1 Malignant tumour, 1 Nervous system disease, 1 Respiratory system disease</td>
<td>12 diabetes, 15 hypertension, 1 cardiovascular disease, 23 Hepatitis B infection, 15 Malignancy, 8 Chronic renal disease, 21 Immune deficiency, 12 Chronic obstructive pulmonary disease</td>
<td>10 diabetes, 15 hypertension, 3 cardiovascular disease, 5 Chronic obstructive pulmonary disease, 2 Malignancy, 1 Chronic kidney disease, 5 Chronic liver disease</td>
</tr>
<tr>
<td>Comorbidities</td>
<td>2 Hypertension, 1 Diabetes, 1 Chronic sinusitis</td>
<td>8 diabetes, 6 hypertension, 6 cardiovascular disease, 1 Chronic obstructive pulmonary disease, 1 Malignancy, 1 Chronic liver disease</td>
<td>40 Cardiovascular and cerebrovascular disease, 11 Digestive system disease, 13 Endocrine system disease, 1 Malignant tumour, 1 Nervous system disease, 1 Respiratory system disease</td>
<td>14 diabetes, 43 hypertension, 1 cardiovascular disease, 7 Cerebrovascular disease, 4 Chronic obstructive pulmonary disease, 10 Malignancy, 4 Chronic liver disease, 4 Chronic kidney disease, 2 HIV infection</td>
<td>10 diabetes, 15 hypertension, 3 cardiovascular disease, 5 Chronic obstructive pulmonary disease, 2 Malignancy, 1 Chronic kidney disease, 5 Chronic liver disease</td>
<td>12 diabetes, 37 hypertension, 7 cardiovascular disease, 4 Chronic obstructive pulmonary disease, 6 cerebrovascular disease, 10 Chronic kidney disease</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Symptoms and Signs

- **Fever**: 4 | 40 | 82 | 136 | 473 | 60 | 86 | 90
- **Cough**: 4 (Dry, productive) | 31 | 81 | 82 | 74 | 39 | 83 | 67
- **Fatigue**: 1 | 18 | NA | 96 | 419 | 35 | NA | NA
- **Nasal congestion**: 1 | NA | NA | NA | 53 | NA | NA | NA
- **Rhinorrhoea**: 1 | NA | 4 | NA | NA | NA | NA | NA
- **Sneezing**: 1 | NA | NA | NA | NA | NA | NA | NA
- **Sore throat**: 1 | NA | 5 | 24 | 153 | 10 | NA | NA
- **Sore throat**: 1 | NA | 2 | NA | NA | 1 | NA | 7
- **Headache**: NA | 3 | 8 | 9 | 150 | 21 | 15 | NA
- **Conjunctival congestion**: NA | NA | NA | NA | 9 | NA | NA | NA
- **Nausea/vomiting**: NA | NA | 1 | 14/5 | 55 | 5 | NA | NA
- **Dizziness**: NA | NA | 9 | 13 | NA | NA | 16 | NA
- **Myalgia or arthralgia**: NA | 18 | 11 | 48 | 163 | NA | NA | NA
- **Dyspnoea or shortness of breath**: NA | 22 | 31 | 43 | 204 | 3/7 | 27 | NA
- **Anorexia**: NA | NA | NA | 55 | NA | 8 | NA | NA
- **Spumon production**: 1 | 11 | NA | 37 | 367 | 27 | NA | NA
- **Haemoptysis**: NA | 2 | NA | NA | 10 | NA | NA | NA
- **Chill**: NA | NA | NA | NA | 125 | 12 | NA | NA

*This preprint research paper has not been peer reviewed. Electronic copy available at: https://ssrn.com/abstract=3551344*
### Blood routine

| Parameter                                      | Value
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Leucocytes (x10⁹/L)</td>
<td>1(↑) 2 (4.1–10.5), 10(↑), 12(↑)</td>
</tr>
<tr>
<td>Neutrophils (x10⁹/L)</td>
<td>1(↑) 5.0 (3.3–8.9)</td>
</tr>
<tr>
<td>Lymphocytes (x10⁹/L)</td>
<td>2(↑) 0.8 (0.6–1.1), 26(↑)</td>
</tr>
<tr>
<td>Haemoglobin (g/L)</td>
<td>NA 126.0 (118.0–140.0)</td>
</tr>
<tr>
<td>Platelets (x10⁹/L)</td>
<td>2(↑) 213.5 (79.1), 12(↑), 4(↑)</td>
</tr>
</tbody>
</table>

### Blood biochemistry

| Parameter                                      | Value
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Albumin (g/L)</td>
<td>NA 31.4 (28.9–36.0)</td>
</tr>
<tr>
<td>Aspartate aminotransferase (U/L)</td>
<td>NA 34.0 (26.0–45.0), 15(↑)</td>
</tr>
<tr>
<td>Alanine aminotransferase (U/L)</td>
<td>NA 32.0 (21.0–50.0)</td>
</tr>
<tr>
<td>Total bilirubin (mmol/L)</td>
<td>NA 11.7 (9.5–13.9)</td>
</tr>
<tr>
<td>Blood urea nitrogen (mmol/L)</td>
<td>NA 5.9 (2.6), 17(↑), 6(↑)</td>
</tr>
<tr>
<td>Glucose (mmol/L)</td>
<td>NA 7.4 (3.4), 1(↑), 5(↑)</td>
</tr>
<tr>
<td>Sodium (mmol/L)</td>
<td>1(↑) 139.0 (137.0–140.0)</td>
</tr>
<tr>
<td>Lactate dehydrogenase (U/L)</td>
<td>3(↑) 266.0 (242.0–408.0), 26(↑)</td>
</tr>
<tr>
<td>Creatinine (μmol/L)</td>
<td>2(↑) 74.2 (57.5–85.7), 6(↑)</td>
</tr>
<tr>
<td>Hypersensitive troponin I (μg/mL)</td>
<td>3(↑) 75.6 (25.0), 23(↑), 3(↑)</td>
</tr>
<tr>
<td>Myoglobin (ng/mL)</td>
<td>NA 49.5 (32.2–99.8), 15(↑)</td>
</tr>
<tr>
<td>Creatine kinase (U/L)</td>
<td>13(↑) 85.0 (51.0–184.0), 2(↑), 13(↑)</td>
</tr>
<tr>
<td>C-reactive protein (U/L)</td>
<td>3(↑) 51.4 (41.8), 63(↑)</td>
</tr>
<tr>
<td>Procalcitonin (ng/mL)</td>
<td>NA 0.1 (0.1–0.1), 3(↑)</td>
</tr>
</tbody>
</table>

### Coagulation function

| Parameter                                      | Value
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Activated partial thromboplastin time (s)</td>
<td>2(↑) 27.0 (24.2–34.1)</td>
</tr>
<tr>
<td>Prothrombin time (s)</td>
<td>NA 11.1 (10.1–12.4)</td>
</tr>
<tr>
<td>D-dimer (mg/L)</td>
<td>2(↑) 0.5 (0.3–1.3)</td>
</tr>
</tbody>
</table>

### Complications

- Abdominal pain: 2
- Diarrhoea: 1

### CT findings

- Multifocal patchy ground glass opacities: 6
  - Unilateral pneumonia: 1
  - Bilateral pneumonia: 40

### RT-PCR

- Nasopharyngeal swab: 4
- Throat swab: 2
- Serum: 1

### Blood biochemistry

| Parameter                                      | Value
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Albumin (g/L)</td>
<td>NA 31.4 (28.9–36.0)</td>
</tr>
<tr>
<td>Aspartate aminotransferase (U/L)</td>
<td>NA 34.0 (26.0–45.0), 15(↑)</td>
</tr>
<tr>
<td>Alanine aminotransferase (U/L)</td>
<td>NA 32.0 (21.0–50.0)</td>
</tr>
<tr>
<td>Total bilirubin (mmol/L)</td>
<td>NA 11.7 (9.5–13.9)</td>
</tr>
<tr>
<td>Blood urea nitrogen (mmol/L)</td>
<td>NA 5.9 (2.6), 17(↑), 6(↑)</td>
</tr>
<tr>
<td>Glucose (mmol/L)</td>
<td>NA 7.4 (3.4), 1(↑), 5(↑)</td>
</tr>
<tr>
<td>Sodium (mmol/L)</td>
<td>1(↑) 139.0 (137.0–140.0)</td>
</tr>
<tr>
<td>Lactate dehydrogenase (U/L)</td>
<td>3(↑) 266.0 (242.0–408.0), 26(↑)</td>
</tr>
<tr>
<td>Creatinine (μmol/L)</td>
<td>2(↑) 74.2 (57.5–85.7), 6(↑)</td>
</tr>
<tr>
<td>Hypersensitive troponin I (μg/mL)</td>
<td>3(↑) 75.6 (25.0), 23(↑), 3(↑)</td>
</tr>
<tr>
<td>Myoglobin (ng/mL)</td>
<td>NA 49.5 (32.2–99.8), 15(↑)</td>
</tr>
<tr>
<td>Creatine kinase (U/L)</td>
<td>13(↑) 85.0 (51.0–184.0), 2(↑), 13(↑)</td>
</tr>
<tr>
<td>C-reactive protein (U/L)</td>
<td>3(↑) 51.4 (41.8), 63(↑)</td>
</tr>
<tr>
<td>Procalcitonin (ng/mL)</td>
<td>NA 0.1 (0.1–0.1), 3(↑)</td>
</tr>
</tbody>
</table>

# 550
- Ground glass opacity, 409
- Local patchy shadowing, 505
- Bilateral patchy shadowing, 143
- Interstitial abnormalities, 100

### Complications

- Pneumonia: 6
- Acute respiratory distress syndrome: NA
<table>
<thead>
<tr>
<th>Condition</th>
<th>NA</th>
<th>5</th>
<th>NA</th>
<th>10</th>
<th>NA</th>
<th>NA</th>
<th>NA</th>
<th>NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute cardiac injury</td>
<td>NA</td>
<td>3</td>
<td>NA</td>
<td>5</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Acute kidney injury</td>
<td>NA</td>
<td>3</td>
<td>NA</td>
<td>NA</td>
<td>6</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Acute renal injury</td>
<td>NA</td>
<td>3</td>
<td>NA</td>
<td>NA</td>
<td>1</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Rhabdomyolysis</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Disseminated intravascular</td>
<td>NA</td>
<td>3</td>
<td>4</td>
<td>12</td>
<td>11</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>coagulation</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>8</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Shock</td>
<td>NA</td>
<td>NA</td>
<td>1</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Ventilator-associated pneumonia</td>
<td>NA</td>
<td>NA</td>
<td>4</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Bacteria</td>
<td>NA</td>
<td>4</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Fungus</td>
<td>NA</td>
<td>6</td>
<td>11</td>
<td>6</td>
<td>15</td>
<td>NA</td>
<td>NA</td>
<td>31</td>
</tr>
</tbody>
</table>

**Onset of symptom to, median (IQR), day**

<table>
<thead>
<tr>
<th>Symptom</th>
<th>NA</th>
<th>7</th>
<th>4.0-8.0</th>
<th>NA</th>
<th>7.0</th>
<th>4.0-8.0</th>
<th>NA</th>
<th>5</th>
<th>0-23</th>
<th>2 (1-1)</th>
<th>Median (range)</th>
<th>NA</th>
<th>7.5-9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital admission</td>
<td>NA</td>
<td>8.0</td>
<td>5.0-13.0</td>
<td>NA</td>
<td>5.0</td>
<td>1.0-10.0</td>
<td>NA</td>
<td>3</td>
<td>7</td>
<td>3 (2-4)</td>
<td>Median (range)</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Dyspnea</td>
<td>NA</td>
<td>9</td>
<td>8.0-14.0</td>
<td>NA</td>
<td>8.0</td>
<td>6.0-12.0</td>
<td>NA</td>
<td>37</td>
<td>NA</td>
<td>NA</td>
<td></td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

**Median incubation period, day**

| NA                              | NA   | NA   | NA   | 3.0 | 0-24 | Median (range) | NA   | NA   | NA   |

**Treatment**

- Oxygen therapy, 41 antibiotic, 38 Oseltamivir, 9 Corticosteroid
- 75 Oxygen therapy, 4 Invasive Mechanical ventilation, 13 Non-invasive Mechanical ventilation, 9 CRRT, 3 ECMO, 70 Antibiotic (cephalosporin, quinolone, carbapenem, tigecycline, linezolid), 15 Antifungal therapy, 75 Antiviral therapy (oseltamivir, ganciclovir, lopinavir and ritonavir), 19 Glucocorticoid (methylprednisolone, dexamethasone), 28 Immunoglobulin
- 106 Oxygen therapy, 17 Invasive Mechanical ventilation, 15 Non-invasive Mechanical ventilation, 4 ECMO, 13 Vasopressors, 124 Oseltamivir, 89 Moxifloxacin, 34 Ceftriaxone, 25 Azithromycin, 62 Glucocorticoid, 652 antibiotic
- 418 Oxygen therapy, 24 Invasive Mechanical ventilation, 56 Non-invasive Mechanical ventilation, 5 ECMO, 204 Corticosteroid, 393 Antifungal, 393 oseltamivir, 632 antibiotic
- 418 Oxygen therapy, 24 Invasive Mechanical ventilation, 2 Corticosteroid (1 methylprednisolone), 1 methylprednisolone, 30 antifungal therapy, 34 Antiviral therapy (8 oseltamivir, 26 lopinavir and ritonavir), 26 antibiotic, 52 Nebulization inhalation (human interferon α2b and acetylcysteine)
- 20 Oxygen therapy, 2 Invasive Mechanical ventilation, 3 Non-invasive Mechanical ventilation, 2 Corticosteroid (1 methylprednisolone), 1 methylprednisolone, 30 antifungal therapy, 34 Antiviral therapy (8 oseltamivir, 26 lopinavir and ritonavir), 26 antibiotic, 52 Nebulization inhalation (human interferon α2b and acetylcysteine)
- 4 Invasive and 31 Non-invasive Mechanical ventilation, 85 Moxifloxacin, 89 Interferon, 35 Immunoglobulin, 35 Methylprednisolone, 84 Lopinavir/ritonavi
r, 4 Other antibiotics, 5 Other antiviral drugs
- 28 High-flow nasal ventilation, 106 Antibiotic, 105 Antiviral therapy, 72 Glucocorticoid, 61 Immunoglobulin

Data are median (IQR), mean (SD), and median (IQR). real-time reverse transcription polymerase chain reaction (RT-PCR), ARDS, acute respiratory distress syndrome. ECMO, extracorporeal membrane oxygenation. CRRT, continuous renal replacement therapy. NA, not applicable