International Journal of Infectious Diseases 94 (2020) 44–48

Contents lists available at ScienceDirect

International Journal of Infectious Diseases

journal homepage: www.elsevier.com/locate/ijid

Review

The SARS-CoV-2 outbreak: What we know

Di Wu[1], Tiantian Wu[2], Qun Liu[1], Zhicong Yang[1,*]

[1] Guangzhou Center for Disease Control and Prevention, Guangzhou, China
[2] Zhongshan School of Medicine, Sun Yat-sen University, Guangzhou, China

ARTICLE INFO

Article history:
Received 28 February 2020
Received in revised form 3 March 2020
Accepted 5 March 2020

Keywords:
Coronavirus
SARS-CoV-2
CoVID-19
Epidemiology
Clinical features
Diagnosis
Treatments
Managements strategies

ABSTRACT

There is a current worldwide outbreak of the novel coronavirus Covid-19 (coronavirus disease 2019; the pathogen called SARS-CoV-2; previously 2019-nCoV), which originated from Wuhan in China and has now spread to 6 continents including 66 countries, as of 24:00 on March 2, 2020. Governments are under increased pressure to stop the outbreak from spiraling into a global health emergency. At this stage, preparedness, transparency, and sharing of information are crucial to risk assessments and beginning outbreak control activities. This information should include reports from outbreak site and from laboratories supporting the investigation. This paper aggregates and consolidates the epidemiology, clinical manifestations, diagnosis, treatments and preventions of this new type of coronavirus.

Introduction

Coronaviruses (CoVs), a large family of single-stranded RNA viruses, can infect animals and also humans, causing respiratory, gastrointestinal, hepatic, and neurologic diseases (Weiss and Leibowitz, 2013). As the largest known RNA viruses, CoVs are further divided into four genera: alpha-coronavirus, beta- coronavirus, gamma-coronavirus and delta-coronavirus (Yang and Leibowitz, 2015). To date, there have been six human coronaviruses (HCoVs) identified, including the alpha-CoVs HCoVs-NL63 and HCoVs-229E and the beta-CoVs HCoVs-OC43, HCoVs-HKU1, severe acute respiratory syndrome-CoV (SARS-CoV) (Drosten et al., 2020), and Middle East respiratory syndrome-CoV (MERS-CoV) (Zaki et al., 2012). New coronaviruses appear to emerge periodically in humans, mainly due to the high prevalence and wide distribution of coronaviruses, the large genetic diversity and frequent recombination of their genomes, and the increase of human-animal interface activities (Cui et al., 2019; Zhu et al., 2019).

In late December 2019, a number of local health authorities reported clusters of patients with pneumonia of unknown cause, which were epidemiologically linked to a seafood market in Wuhan, Hubei Province, China (Zhu et al., 2019) The pathogen, a novel coronavirus (SARS-CoV-2), was identified by local hospitals using a surveillance mechanism for “pneumonia of unknown etiology” that was established in the wake of the 2003 SARS outbreak with the aim of allowing timely identification of novel pathogens (Li et al., 2020a; Zhu et al., 2019). On 30 January 2020, the World Health Organization (WHO) declared that CoVID-19 is a “public-health emergency of international concern” (Li et al., 2020b). The pandemic is escalating rapidly. We searched the associated literature on CoVID-19 to summarize the epidemiology, clinical characteristics, diagnosis and treatments, and preventions of the infection of SARS-CoV-

Epidemiology

Scope of the CoVID-19 infection outbreak

Since December 2019, multiple cases with unexplainable pneumonia were successively reported in some hospitals in Wuhan city. The cases had a history of exposure to a large seafood market in Wuhan city, Hubei province, China. It has been confirmed to be an acute respiratory infection caused by a novel coronavirus. So far, this disease has rapidly spread from Wuhan to China’s other areas, and 66 countries. And then, clustered cases and confirmed cases without a history of travel to Wuhan emerged as the advancement of this disease (Jin et al., 2020). In addition, confirmed cases without clear exposure to the seafood market of Wuhan have been spread in many foreign countries (Stoecklin et al., 2020).

According to National Health Commission of the People`s Republic of China, as of 24:00 on March 2, 2020, a total of 80, 302

* Corresponding author.
E-mail addresses: wudi0729@gzcdc.org.cn (D. Wu), ttw19941101@163.com (T. Wu), liuqunss@163.com (Q. Liu), yangzc@gzcdc.org.cn (Z. Yang).

https://doi.org/10.1016/j.ijid.2020.03.004

CoVID-19 cases in China have been confirmed in 31 provinces (autonomous regions and municipalities), and Xinjiang Production and Construction Crops, including Hong Kong, Macao, and Taiwan, including 2947 (3.66%) deaths. At present, there are 30,095 confirmed cases (6806 severe cases), 47,260 (58.85%) discharged cases, and 587 suspected cases recorded. It is worth mentioning that up to now, Tibet and Qinghai provinces have no new coronavirus infected patients (National-Health-Commission-of-the-People's-Republic-of-China, 2020). As of 11 February, a total of 1715 medical workers had been infected, of which 5 had died, with a crude case fatality rate of 0.3%. The number of confirmed cases has surpassed those of SARS in 2003.

Internationally, confirmed cases have been reported in 66 countries and 6 continents and aboard the Diamond Princess. Outside of China, a total of 10,415 cases of CoVID-19 have been reported from 66 countries, with 168 deaths. The epidemics in the Republic of Korea, Italy, Iran and Japan have been became the greatest concern of WHO (WHO and WHO, 2020). According to the European Centre for Disease Prevention and Control (ECDC) (European-Centre-for-Disease-Prevention-and-Control, 2020), regarding the latest daily risk assessment on COVID-19, March 2, the ECDC has now considered the risk moderate to high level. The case fatality rate of the currently reported cases in China is less than 4%, which implies that so far, this novel coronavirus does not seem to cause the high fatality rates previously observed for SARS-CoV and MERS-CoV, 10% and 37%, respectively (Chaolin et al., 2020). According to the latest data, a total of 36167 cases were reported in Hubei, China, which gives a cumulative attack rate (CAA) of 0.11% (the permanent resident population of Hubei is about 59, 170,000). However, when compared to the influenza virus of pH1N1, which shared the same transmission route but had a 50 times higher CAA, these data showed the importance of the intense quarantine and social distancing measures the Hubei government has taken.

Host and reservoir

Wild animals and bats are considered as the natural reservoir hosts and play a crucial role in transmitting various viruses, including Ebola, Nipah, Coronavirus and others (Cui et al., 2019; Malik et al., 2020). SARS-CoV-2 is the seventh member of the family coronaviruses, which is the beta-CoV with over 70% similarity in genetic sequence to SARS-nCoV (Cheng and Shan, 2019). Like SARS-CoV, MERS-CoV, and many other coronaviruses, SARS-CoV-2 likely originated in bats, but it requires further confirmation of whether pneumonia infection by the SARS-CoV-2 is transmitted directly from bats or through an intermediate host (Another Decade, 2020; Jin et al., 2020; Zhou et al., 2020). Recent research has found that the virus is 96% identical at the whole-genome level to a bat coronavirus, which means bats are the most possible host of the SARS-CoV-2 (Another Decade, 2020; Zhou et al., 2020). Also, Ji and colleagues (Ji et al., 2020) demonstrated that snakes are a possible virus reservoir for human infection. Zhu et al. (Cheng and Shan, 2019) indicated that bats and minks maybe two potential hosts of the novel coronavirus, while minks may be the intermediate hosts of this virus. Subsequently, studies have shown that pangolins are potential intermediate hosts, but in general, there may be multiple intermediate hosts (Lam et al., 2020). For many viruses, one of the key steps in the emergence process is the jump from animals to humans. Thus, identifying the source of the virus will help control its spread (Another Decade, 2020).

Route of transmission

Chan and colleagues (Fuk-Woo et al., 2020) reported a case of five patients in a family cluster, which confirmed person-to-person transmission of CoVID-19. Health officials have identified evidence of transmission along a chain of 4 "generations" (a person who originally contracted the virus from a nonhuman source infected someone else, who infected another individual, who then infected another individual), suggesting sustained human-to-human transmission (Phelan and RebeccaKatz, 2020; WHO, 2020). Up to the present, the main infection source was the patients with pneumonia infected by SARS-CoV-2. Respiratory droplet transmission is the main route of transmission, and it can also be transmitted through aerial droplets and contact (Jin et al., 2020). However, we also should attach importance to asymptomatic cases, which may play a critical role in the transmission process (Shen et al., 2020). Recently, new coronavirus was detected in the feces of confirmed patients in Wuhan, Shenzhen and even the first case in the United States, indicating that the virus can exist and replicate in the digestive tract, suggesting the possibility of fecal-oral transmission (Holshue et al., 2020), but it is not certain that eating virus-contaminated food causes infection and transmission. There were also views that viruses in feces may be re-transmitted by aerosol formation of virus-containing droplets, requiring further investigation. At present, there is no evidence for aerosol transmission of CoVID-19. WHO also believes that further evidence is needed to assess the possibility of aerosol transmission (WHO, 2020). In addition, it has been reported that a mother was diagnosed with the new type of coronavirus pneumonia, and her newborn was positive for viral nucleic acid in pharynx swabs after 30 hours of birth (CCTV.COM, 2020), suggesting that the new type of coronavirus may cause neonatal infection through mother-to-child transmission, which of course needs to be confirmed by more scientific studies (Zhu et al., 2020).

WHO has published their estimation of $R0$ to be 2.0–2.5 using early information (WHO and WHO, 2019). Li et al. (2020a) analyzed data on the first 425 confirmed cases in Wuhan and found the $R0$ to be 2.2, without specifying their modelling method. Jonathan Read and his colleagues (Cheng and Shan, 2019) from Lancaster University used a deterministic Susceptible-Exposed-Infected-Recovered (SEIR) metapopulation transmission model to determine the $R0$ to be around 3.1. Majumder and colleagues (Maimuna, 2020) used the Incidence Decay and Exponential Adjustment (IDEA) model to estimate the $R0$ to be 2.0–3.3 (the study did not publish yet, available at SSRN). Recently, a large group of researchers from multiple institutes led by Jianhong Wu from York University (Tang et al., 2020) proposed a more general deterministic SEIR compartmental model using more parameters, and arrived at a much higher $R0$ number of 6.47. Recent research (Zhang et al., 2020) on the Diamond Princess cruise ship outbreak, at a looser intervention and quarantine condition, showed the $R0$ was 2.28, and if the R_0 were reduced by 25% and 50%, the estimated cumulative cases would be reduced from 1514 to 1081 and 758, also proving that intense quarantine and social distancing measures should be taken to control the outbreak.

Estimates from the SARS-CoV outbreak in 2003 reported an $R0$ of 3 (Bauch et al., 2005), which means SARS-CoV-2 has a similar ability to spread as SARS-CoV or a higher spreading ability than SARS-CoV, so that the SARS-CoV-2 outbreak caused more than 90,000 cases in 66 countries all over the world in less than 2 months, that's times of the SARS-COV outbreak (Peeri et al., 2020; Wu and McGoogan, 2019).

Clinical manifestations

A wide range of clinical manifestations is seen in patients with SARS-CoV-2 from mild, moderate, to severe and rapidly progressive and fulminant disease. Most of the patients with SARS-CoV-2 were normal and mild, and their mortality was lower than in SARS-CoV and MERS-CoV.

Incubation period

In recent publications, the mean incubation period of CoVID-19 was a little bit different. Wang et al., with 138 cases, reported that the median durations from first symptoms to dyspnea, hospital admission, and acute severe respiratory syndrome (ARDS) were 5 days (range, 1–10), 7 days (range, 4–8), and 8 days (range, 6–12), respectively (Wang et al., 2019). Li et al., with 425 confirmed cases, instructed that the mean incubation period was 5.2 days (95% confidence interval [CI], 4.1–7.0), with the 95th percentile of the distribution at 12.5 days. In its early stages, the epidemic doubled in size every 7.4 days. With a mean serial interval of 7.5 days (95% CI, 5.3–19), the basic reproductive number was estimated to be 2.2 (95% CI, 1.4–3.9) (Li et al., 2020a). While Guan et al. (2019), with 1099 patients, reported that the estimated mean incubation period of SARS-CoV-2 infection was 3.0 days (range, 0–24.0), which was shorter than in the two research reports above (3.0 days vs 5 days and 5.2 days). The median incubation period of CoVID-19 ARD was 3.0 days and it had a relatively lower fatality rate than SARS and MERS (Wang et al., 2019), while the estimated mean incubation period of SARS-CoV infection was 4.6 days (95% CI, 3.8–5.8 days) (Chiu et al., 2003) and 95% of illness onset occurred within 10 days (DC et al., 2003). The mean time from symptom onset to hospitalization was between 2 and 8 days, but was shorter toward the later phase of the epidemic. The mean time from symptom onset to need for invasive mechanical ventilation (IMV) and to death was 11 and 23.7 days, respectively (Leung et al., 2020).

Symptoms

Symptom of CoVID-19 are non-specific and the disease presentation can range from no symptoms (asymptomatic) to severe pneumonia and death. A study of 41 patients (Chaolin et al., 2020) who were initially diagnosed with the outbreak (the diagnosis date was up to 2 January) found that the most common symptoms were fever (98%), cough (76%), myalgia or fatigue (44%); and atypical symptoms included sputum (28%), headache (8%), hemoptysis (5%) and diarrhea (3%). About half of the patients had dyspnea (the median from onset to dyspnea was 8 days). Lymphocytopenia was observed in 63% of patients. All patients had pneumonia. Complications included acute respiratory distress syndrome (29%), acute heart injury (12%), and secondary infections (10%); 32% of patients required treatment in the ICU. An analysis of 1099 confirmed cases (up to 29 January) conducted by NanShan Zhong's team (Weijie et al., 2020) found that the most common symptoms were fever (87.9%), cough (67.7%), diarrhea (3.7%) and vomiting (5.0%). 25.2% of the patients had at least one underlying disease (such as hypertension, chronic obstructive pulmonary disease). Lymphocytopenia was observed in 82.1% of patients. On admission, 50% of the patients presented ground-glass shadow on chest CT. A retrospective study (Wang et al., 2019) of 138 hospitalized patients from January 1 to 28 found that patients receiving treatment in the ICU were older, more likely to have underlying diseases, and more likely to have dyspnea, and the median length of stay was 10 days (Wang et al., 2019). Recent studies indicate that patients≥60 years of age are at higher risk than children who might be less likely to become infected or, if so, may show milder symptoms or even asymptomatic infection (Li et al., 2020a). Epidemiology Working Group for NCIP Epidemic Response of the Chinese Center for Disease Control and Prevention (Working, 2020), with a total of 72,314 patients, reported that there were 44,672 (61.8%) confirmed cases, and 889 asymptomatic cases (1.2%) among the total number of patients. Among confirmed cases, most were age 30-79 years (86.6%), and considered mild/mild pneumonia (80.9%).

Diagnosis

Clinical diagnosis

The SARS-CoV-2 infected cases have symptoms like fever, fatigue, dry cough, dyspnea etc., with or without nasal congestion, runny nose or other upper respiratory symptoms (Holshue et al., 2020; Lam et al., 2020). Despite the atypical symptoms reported, Guan et al. (Weijie et al., 2020) pointed out that fever is still the typical symptom of SARS-CoV-2 infection.

a) **Physical examination**

Patients with mild symptoms may not present positive signs. Patients in severe condition may have shortness of breath, moist rales in lungs, weakened breath sounds, dullness in percussion, and increased or decreased tactile speech tremor, etc.

a) **CT imaging examination**

The imaging findings vary with the patient`s age, immunity status, disease stage at the time of scanning, underlying diseases, and drug interventions.

Chest X-ray examination: In the early stage of pneumonia cases, chest images show multiple small patchy shadows and interstitial changes (Chaolin et al., 2020), remarkable in the lung periphery (Fuk-Woo et al., 2020). Severe cases can further develop to bilateral multiple ground-glass opacity, infiltrating shadows, and pulmonary consolidation, with infrequent pleural effusion. *Chest CT scan:* Pulmonary lesions are shown more clearly by CT than *X-ray examination*, including ground-glass opacity and segmental consolidation in bilateral lungs, especially in the lung periphery. In children with severe infection, multiple lobar lesions may be present in both lungs. A study of CT scans of 21 patients with SARS-CoV-2 infection showed three (21%) with normal CT scans, 12 (57%) with ground-glass opacity only, and six (29%) with ground-glass opacity and consolidation at presentation (Chung et al., 2020). Another study of 41 patients with confirmed SARS-CoV-2 infection was reported to have bilateral lung involvement on chest radiographs (Chaolin et al., 2020). Overall, the imaging findings reported for CoVID-19 are similar to those reported with SARS (Nicolaouet al., 2003; Ooi et al., 2004) and MERS (Das et al., 2015; DK et al., 2015), not surprising as the responsible viruses are also coronaviruses.

Laboratory diagnosis

It mainly should be distinguished from other known viruses of pneumonia, such as influenza viruses, parainfluenza virus, adenovirus, respiratory syncytial virus, rhinovirus, SARS-CoV, etc.; and also, from mycoplasma pneumonia, chlamydia pneumonia, and bacterial pneumonia. In addition, it should be distinguished from non-infectious diseases, such as vasculitis, dermatomyositis, and organizing pneumonia (Jin et al., 2020). Therefore, laboratory diagnosis is necessary. Identification of CoVID-19 mainly includes virus isolation and viral nucleic acid detection. According to the traditional Koch`s postulates, virus isolation is the "gold standard" for virus diagnosis in the laboratory (Yu et al., 2020) A variety of specimens (such as swabs, nasal swabs, nasopharynx or trachea extracts, sputum or lung tissue, blood and feces) should be retained for testing in a timely manner, which gives a higher rate of positive detection of lower respiratory tract specimens (Yu et al., 2020).

Viral nucleic acids can also be used for early diagnosis, which is the most important thing. So, we should detect SARS-CoV-2 nucleic acid: accurate RNA detection of SARS-CoV-2 is of diagnostic

value (Yu et al., 2020). The full gene sequence of SARS-CoV-2 has now been obtained, and samples can be collected from the upper respiratory tract (oropharyngeal and nasopharyngeal) and lower respiratory tract (endotracheal aspirate, expectorated sputum, or bronchoalveolar lavage) of patients suspected of SARS-CoV-2 infection for diagnosis by real time RT-PCR (Corman et al., 2020) Also, in the early stage of the disease, the total number of leukocytes decreases or remains normal, with decreased lymphocyte count or increased or normal monocytes also indicating the diagnosis of CoVID-19 (Jin et al., 2020).

Treatments and preventions

At present, there is no vaccine or antiviral treatment for human and animal coronavirus, so that identifying the drug treatment options as soon as possible is critical for the response to the CoVID-19 outbreak. WHO has announced that a vaccine for SARS-CoV-2 should be available in 18 months, but achieving this will require funding and public interest to be maintained even if the threat level falls (Diseases, 2019). The mainstay of clinical management is largely symptomatic treatment, with organ support in intensive care for seriously ill patients (Zumla et al., 2020).

The general strategies include bed rest and supportive treatment, including antiviral therapy (Arabi et al., 2018), antibioic application, immunomodulating therapy (Arabi et al., 2020), organ function support, respiratory support, bronchoalveolar lavage (BAL), blood purification and extracorporeal membrane oxygenation (ECMO) (Wang et al., 2020).

Novel coronavirus infection is a new communicable disease with an emergent outbreak that affects all populations (Burki, 2019). SARS-CoV-2 infection has been classified as a category B infectious disease legally but managed as a category A infectious disease by the Chinese government. It is paramount to implement infection control practices by controlling infection source, blocking transmission route, and protecting susceptible populations. The unprecedented flurry of activity by WHO and other global public health bodies has mainly focused on preventing transmission, infection control measures, and screening of travelers (Zumla et al., 2020).

Conclusions

How easily is the virus transmitted between persons, and how does it affect individual persons and potentially vulnerable population subgroups, such as the elderly or those with chronic health conditions? What is the source of the virus? And how can it spread around the world in such a short time? At the moment, we know relatively little about CoVID-19, except that it is a highly pathogenic human pathogen, possibly a zoonotic agent. Now that a pandemic has occurred, it is critical that countries around the world take steps to stop transmission and save lives. In addition, we should actively study its origin, tropism, and pathogenesis with the aim of providing some guidance in dealing with this rapidly spreading epidemic. Challenges remain in several key areas, including the recent cases of people who have tested positive for the virus. Can these cured patients still transmit to others? All of these suggest that we should develop more detailed criteria for the prevention and control of the virus, and more stringent criteria for discharge of patients after treatment.

Contributors

All authors contributed to the conception of the review. Di Wu, Tiantian Wu and Qun Liu contributed the literature search, data traction and data synthesis, created the tables, and wrote the manuscript. All authors contributed to the interpretation of the data and revision of the manuscript.

Conflicts of interests

We declare no conflicts of interest.

Funding source

This work was supported by the National Natural Science Foundation of China Grants (81803325), Medical Science and Technology Project of Guangzhou (20191A011064, 20201A011067), Guangdong Medical Science and Technology Research Project (A2019379).

Ethical approval

None.

References

Weiss SR, Leibowitz JL. Coronavirus pathogenesis. Adv Virus Res 2011;81:85–164.
CCTV.COM. A 30-hour old infant in Wuhan diagnosed and mother-to-child infection suspected. Available at:. http://m.news.cctv.com/2020/02/05/ARTIywVxQI-CUUURSIWzSzvkf200205.shtml.
Arabi YM, Alothman A, Balkhy HH, et al. Treatment of Middle East Respiratory Syndrome with a combination of lopinavir-ritonavir and interferon-beta1b (MIRACLE trial): study protocol for a randomized controlled trial. Trials 2018;19:81.
Arabi YM, Mandourah Y, Al-Hameed F, Sindi AA, Mekhlafi GAA. Corticosteroid therapy for critically Ill patients with Middle East respiratory syndrome. Am J Respir Crit Care Med 2020;197:757–67.
Bauch CT, Lloyd-Smith JO, Coffee MP, Galvani AP. Dynamically modeling SARS and other newly emerging respiratory illnesses past, present, and future. Epidemiology 2005;16:791–801.
Burki T. Outbreak of coronavirus disease 2019. Lancet Infect Dis 2019;S1473-3099:30076–81.
Chaolin H, Yeming W, Xingwang L, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet 2020;(395):497–506.
Cheng ZJ, Shan J. 2019 Novel coronavirus: where we are and what we know. Infection 2019; Epub ahead of print.
Chiu WK, Cheung PC, Ng KL, et al. Severe acute respiratory syndrome in children: experience in a regional hospital in Hong Kong. Pediatr Crit Care Med 2003;4:279–83.
Chung M, Bernheim A, Mei X, Zhang N. CT imaging features of 2019 novel coronavirus (2019-nCoV). Radiology 2020;4: Epub ahead of print.
Corman VM, Olfert LandtKaiser M, Kaiser M, et al. Detection of 2019 novel coronavirus (2019-nCoV) by real-time RT-PCR. Euro Surveill 2020;(25):1–8.
Cui J, Li F, Shi Z. Origin and evolution of pathogenic coronaviruses. Nat Rev Microbiol 2019;17:181–92.
Das KM, Lee EY, Jawder SEA, Enani MA. Acute Middle East respiratory syndrome coronavirus: temporal lung changes observed on the chest radiographs of 55 patients. AJR Am J Roentgenol 2015;205:W267–74.
DC A, GA C, LG M, et al. Epidemiological determinants of spread of causal agent of severe acute respiratory syndrome in Hong Kong. Lancet 2003;361:1761–6.
Diseases TLI. Challenges of coronavirus disease 2019. Lancet Infect Dis 2019;S1473-3099:30072–4.
DK M, LE Y, EM A, et al. CT correlation with outcomes in 15 patients with acute Middle East respiratory syndrome coronavirus. Am J Roentgenol 2015;204:736–42.
Drosten C, Günther S, Preiser W. Identification of a novel coronavirus in patients with severe acute respiratory syndrome. N Engl J Med 2020;348:1967–76.
European-Centre-for-Disease-Prevention-and-Control. Daily risk assessment on COVID-19, 2 March. Available at:. 2020. https://www.ecdc.europa.eu/en/current-risk-assessment-novel-coronavirus-situation.
Fuk-Woo CJ, Shuofeng Y, Kin-Hang K, et al. A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster. Lancet 2020;395:514–23.
Guan WJ, Ni ZY, Hu Y, et al. Clinical characteristics of coronavirus disease 2019 in China. N Engl J Med 2019;.
Holshue ML, DeBolt C, Lindquist S, et al. First case of 2019 novel coronavirus in the United States. N Engl J Med 2020; Epub ahead of print.
Ji W, Wang W, Zhao X, Zai J, Li X. Homologous recombination within the spike glycoprotein of the newly identified coronavirus may boost cross-species transmission from snake to human. J Med Virol 2020;92:433–40.
Jin Y-H, Cai L, Cheng Z-S, et al. A rapid advice guideline for the diagnosis and treatment of 2019 novel coronavirus (2019-nCoV) infected pneumonia (standard version). Mil Med Res 2020;7:4.

Lam TT-Y, Shum MH-H, Zhu H-C, et al. Identification of 2019-nCoV related coronaviruses in Malayan pangolins in southern China. 2020 bioRxiv preprint 2020:epub.
Leung GM, Hedley AJ, Ho L-M, Chau P. The epidemiology of severe acute respiratory syndrome in the 2003 Hong Kong epidemic: an analysis of all 1755 patients. Ann Intern Med 2020;(141):662–73.
Li Q, Guan X, Wu P, et al. Early transmission dynamics in Wuhan, China, of novel scoronavirus-infected pneumonia. N Engl J Med 2020a; Epub ahead of print.
Li X, Wang W, Zhao X, et al. Transmission dynamics and evolutionary history of 2019-nCoV. J Med Virol 2020b;Epub ahead of print:.
Maimuna M, MK D. Early transmissibility assessment of a novel coronavirus in Wuhan, China (January 26, 2020). SSRN 2020;, doi:http://dx.doi.org/10.2139/ssrn.3524675.
Malik YS, Sircar S, Bhat S, et al. Emerging novel coronavirus (2019-nCoV) - current scenario, evolutionary perspective based on genome analysis and recent developments. Vet Q 2020; Epub ahead of print.
National-Health-Commission-of-the-People's-Republic-of-China. CoVID-19 News Update, up to February 24, 2020. Available at:. http://www.nhc.gov.cn/xcs/yqtb/202002/67e6c59a84bd4f07b6ca4a4c5ffabb79.shtml.
Nicolaou S, Al-Nakshabandi NA, Müller NL. SARS: imaging of severe acute respiratory syndrome. AJR Am J Roentgenol 2003;180:1247–9.
Ooi GC, Khong PL, Khong PL, Yiu WC, Zhou LJ. Severe acute respiratory syndrome: temporal lung changes at thin-section CT in 30 patients. Radiology 2004;230:836–44.
Peeri NC, Shrestha N, Rahman MS, et al. The SARS, MERS and novel coronavirus (COVID-19) epidemics, the newest and biggest global health threats: what lessons have we learned?. Int J Epidemiol 2020;.
Perlman S. Another decade, another coronavirus. N Engl J Med 2020;382:760–2.
Phelan AL, Katz R, Gostin L. The novel coronavirus originating in Wuhan, China: challenges for global health governance. JAMA 2020; Epub ahead of print.
Shen K, Yang Y, Wang T, et al. Diagnosis, treatment, and prevention of 2019 novel coronavirus infection in children: experts' consensus statement. World J Pediatr 2020; Epub ahead of print.
Stoecklin SB, Rolland P, Silue Y, Mailles A. First cases of coronavirus disease 2019 (COVID-19) in France: surveillance, investigations and control measures 2020. Euro Surveill 2020;25:2000094.
Tang B, Wang X, Li Q, et al. Estimation of the transmission risk of the 2019-nCoV and its implication for public health interventions. J Clin Med 2020;9:1–13.
Wang D, Hu B, Hu C, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. JAMA 2019; Epub ahead of print.
Wang T, Wang W, Wang Y, et al. Diagnosis and treatment recommendations for pediatric respiratory infection caused by the 2019 novel coronavirus. World J Pediatr 2020; Epub ahead of print.
Weijie G, Zhengyi N, Yu H, et al. Clinical characteristics of 2019 novel coronavirus infection in China medRxiv preprint. 2020.
WHO. How does COVID-19 spread?. Available at:. https://www.who.int/news-room/q-a-detail/q-a-coronaviruses.
WHO. WHO Director-General's opening remarks at the media briefing on COVID-19-2 March 2020. Available at:. https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19—2-march-2020.
WHO. Report of the WHO-China joint mission on coronavirus disease 2019 (COVID-19). Available at:. https://www.who.int/docs/default-source/coronaviruse/who-china-joint-mission-on-covid-19-final-report.pdf.
Epidemiology Working Group for NCIP Epidemic Response CCfDCaP. The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19) in China. Chin J Epidemiol 2020;(41):145–51.
Wu Z, McGoogan JM. Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72 314 cases from the chinese center for disease control and prevention. JAMA 2019; Epub ahead of print.
Yang D, Leibowitz JL. The structure and functions of coronavirus genomic 3' and 5' ends. Virus Res 2015;206:120–33.
Yu F, Du L, Ojcius DM, Pan C, Jiang S. Measures for diagnosing and treating infections by a novel coronavirus responsible for a pneumonia outbreak originating in Wuhan, China. Microbes Infect 2020;S1286-4579:30025–33.
Zaki AM, Boheemen SV, Bestebroer TM, Osterhaus ADME, Fouchier RAM. Isolation of a novel coronavirus from a man with pneumonia in Saudi Arabia. N Engl J Med 2012;367:1814–20.
Zhang S, Diao M, Yu W, Pei L, Lin Z, Chen D. Estimation of the reproductive number of novel coronavirus (COVID-19) and the probable outbreak size on the Diamond Princess cruise ship: a data-driven analysis. Int J Infect Dis 2020;.
Zhou P, Yang XL, Wang XG, Hu B, Zhang L. A pneumonia outbreak associated with a new coronavirus of probable bat origin. Nature 2020; Epub ahead of print.
Zhu N, Zhang D, Wang W, et al. A novel coronavirus from patients with pneumonia in China, 2019. N Engl J Med 2019;382:727–33.
Zhu H, Wang L, Fang C, et al. Clinical analysis of 10 neonates born to mothers with 2019-nCoV pneumonia. Transl Pediatr 2020;9:51–60.
Zumla A, Hui DS, Azhar EI, Memish ZA, Maeurer M. Reducing mortality from 2019-nCoV: host-directed therapies should be an option. Lancet 2020;395:e35–6.