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CHAPTER 1

Respiratory virus and COVID-19

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1. Overview of respiratory viruses

Viral infectious diseases remain a major challenge for human health. Following the emergence of a new coronavirus pneumonia, more than 10,000 species of wild viruses have been mentioned by mass media, but only a few are well recognized. In recent decades, human beings have constantly faced the challenge of bacterial and viral infections. The most common pathogens of new infectious diseases are viruses, the latest being COVID-19. Therefore, we should pay close attention to the severity of respiratory virus infection. There are many common viruses that can cause respiratory infections, including influenza-related viruses, human metapneumovirus, measles virus, rhinovirus, enterovirus, coronavirus, respiratory tract syncytial virus, adenovirus, cytomegalovirus, herpes simplex virus, etc. In particular, there are more than 100 species of coronaviruses. We usually ignore "coronavirus" due to its weak relationship with human beings. However, we became aware of it after the spread of severe acute respiratory syndrome (SARS) and COVID-19. Bats seem to be one of the most capable hosts of coronavirus. To date, there are seven known kinds of contagious coronaviruses, including SARS-CoV-2. Human coronavirus 229E, human coronavirus nCoV, and human coronavirus OC43 are common viruses causing human colds, without more serious pathogenicity. Since they are usually self-limiting with no specific treatment, we do not pay much attention to them. Now we have realized that SARS and COVID-19 have a serious influence on human society. There is thus an urgent need to pay more attention to respiratory tract-related virus infection.
From the “A” of avian influenza to the “Z” of Zika, new viruses have sprouted in recent years and show the uncertainty of outbreaks: the occurrence of new viruses will not end with the alphabet, and mankind will have to face new challenges in the future. Continuous screening and preclinical research are always required for infectious disease control. It is necessary to launch a global virus genome plan and to distribute an “active attack” and “all-out attack” strategy on new emerging infectious diseases.

When infected by a virus, patients may present with various clinical symptoms, including colds, pharyngitis, tracheitis, bronchiolitis, pneumonia, etc. Although the spectrum of diseases caused by different kinds of virus is diverse, different viruses may result in the same diseases. For example, influenza viruses can cause adult pneumonia; adenovirus can also cause severe pneumonia. Rhinovirus mainly causes colds as well as pneumonia. Infection of cytomegalovirus in an immunocompromised population is a great challenge for modern interventions (high dose chemotherapy, immunosuppressive therapy, organ transplantation, etc.).

Viruses are common pathogens of community acquired pneumonia (CAP), and their importance has been increasingly emphasized. Viruses also play a role in HAP, AECOPD, bronchiecstasy, and other diseases.

2. Etiology of COVID-19

The new coronavirus belongs to the beta genus of coronavirus. It has envelopes, round or oval, but is usually polymorphic. Its diameter is 60–140 nm. The World Health Organization (WHO) named it SARS-CoV-2. SARS coronavirus appeared in 2003, originating in Guangdong, Middle East respiratory syndrome (MERS) coronavirus appeared in 2012, originating in the Middle East, and COVID-19 emerged in 2019, originally found in Wuhan. All three of these coronaviruses are contagious and virulent. Four other coronaviruses are also known to cause human diseases. However, they mainly cause colds—accounting for 10%–15% of cold viruses—and the infection is not severe.

Fig. 1.1 shows that the four genera of coronaviruses, alpha, beta, gamma, and delta, have different genetic structures. Even in the same genus, e.g., beta, coronaviruses of different species are quite different. The new coronavirus is quite different from the coronavirus shown in Fig. 1.1.

Fig. 1.2 presents the different genera of coronavirus: the alpha genus is shown in purple, the beta genus in pink, the gamma genus in green, and the delta genus in blue. Gamma is the smallest genus. As shown in Fig. 1.2,
camels are associated with the Middle East respiratory syndrome virus. Above the camel, the civet cat is shown, which is associated with SARS coronavirus. The bat is the original source of the coronavirus that causes SARS and Middle East respiratory syndrome. The new coronavirus has also been demonstrated to come from bats; specifically, existing evidence suggests that it originates from the chrysanthemum bat. Its intermediate host has not yet been determined, but studies have shown that it may be related to wild animals such as pangolins or snakes.

3. Transmission of COVID-19

First, the source of infection is currently mainly from COVID-19 patients; those with mild and asymptomatic infections can also become a source of infection. The capacity of SARA-CoV-2 infection remains unclear. Based on the pathogenesis of COVID-19, the infectious capacity of SARS-CoV-2 is stronger, especially in severe cases, and the risk of infection is highest during the tracheal intubation intervention process.

Second, there are two main routes of transmission routes for COVID-19: respiratory droplet transmission and close contact transmission.
Fig. 1.2 Coronavirus and intermediate host.

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The emergence of respiratory droplets is mainly caused by coughing, sneezing, or talking. The propagation distance for droplets more than 5 μm in diameter is limited and generally less than 1 m. In the case of close contact transmission, droplets can contaminate the surface of objects. The excrement of the patient, such as feces and urine, can pollute the environment as well as the surfaces of objects. If the patient’s hands touch the environment or an object’s surface of the object, the hands will also be contaminated. The contaminated hands can subsequently make contact with the nasal cavity, oral cavity, or face, which may lead to transmission via close contact. Family clustering transmission is one of the specific transmission characteristics of COVID-19, where there are more than two family members—even up to five members—infected, which confirms the importance of droplet transmission, but does not exclude the possibility of close contact factors.

In a relatively confined space, the virus may be transmitted by aerosol, with a high level of aerosol exposure for a long time. However, there have been very few cases of aerosol transmission until now. New evidence is still needed. Although nucleic acids have occasionally been detected in the air recently, their significance remains to be determined. Generally speaking, the possibility of aerosol propagation is relatively small, and aerosol propagation is not the main route of transmission. It is secondary, but necessary to observe this form of transmission in research. In some patients, the virus can be detected in the feces. It is thus not yet clear whether it can spread through the alimentary canal. At least in some patients we have found that the virus can exist longer in feces than in the respiratory tract, which may bring some challenges for disease prevention and control. More research is needed to determine how long the transmission period is.

The third point to consider regarding transmission is vulnerable people. People are generally susceptible, especially among the immunocompromised population. It is certain that risks are related to exposure mode, quantity, and duration. The elderly and people with underlying diseases are presenting more serious symptoms, while children and infants experience milder effects. No one is innately immune to SARS-CoV-2, even those who have experienced infection. It remains unclear how high the antibody titer level is in the late stage and whether one has the ability to guard against a recurrent infection. In general, the risk of recurrent infection is very low, at least within 6 months to 1 year, with the sustainability of neutralizing antibodies.

The link between the three steps of infectious diseases—source of infection, transmission route, and vulnerable people—is very important.
Infectious diseases can spread only when all three steps exist. The infectious disease will be controlled if any one of these three steps is stopped. How to cut off the transmission channels to prevent the spread of the infection is the most important challenge at this moment. Each infectious disease has its own characteristics. No matter how many doctors, nurses, and beds are available, these are useless if the source of infection or route of transmission is out of control. In the case that no adequate ICU resources are available for the treatment of critically ill patients, people have to face the dilemma of treating or giving up on those patients. COVID-19 is not only a respiratory disease, but also a contagious disease. We hope that we can provide some public education using our knowledge of infectious diseases, so that we can take effective steps to prevent the spread of this disease. That is the only way to control the pandemic. It will definitely be very harsh if we focus only on the patients admitted to hospital.