Coronaviruses: SARS, MERS, and 2019-nCoV

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Background

Coronaviruses (CoVs) are a family of RNA viruses that typically cause mild respiratory disease in humans.[1] However, the 2003 emergence of the severe acute respiratory syndrome coronavirus (SARS-CoV) demonstrated that CoVs are also capable of causing outbreaks of severe infections in humans.[2] A second severe CoV, Middle East respiratory syndrome coronavirus (MERS- CoV), emerged in 2012 in Saudi Arabia.[3] The third severe CoV, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), was identified in Wuhan, China, in December 2019 and has driven this current pandemic.[4]

The emergence of human coronaviruses, including MERS-CoV and SARS-CoV, is thought to be driven by the spillover of bat-adapted CoVs into an intermediate host. For SARS-CoV, this intermediate host is believed to have been palm civets, while camels play that role for MERS-CoV. Genetic analyses of SARS-CoV-2 suggest that the virus likely originated from a bat reservoir.[5] There are a number of theories regarding the presence of an intermediary animal host for the origins of SARS-CoV-2, but the evidence is inconclusive.

Epidemiology and Clinical Characteristics

SARS-CoV-2 is one of 7 coronaviruses known to infect humans.[6] At the beginning of the outbreak only MERS-CoV and SARS-CoV were known to be routinely capable of causing severe disease. It is now known that COVID-19, the disease stemming from most SARS-CoV-2 infections, is sometimes quite severe. The remaining 4 coronaviruses are responsible for mild respiratory illnesses like the common cold but can cause severe infections in immunocompromised individuals.

SARS-CoV

The only recognized SARS-CoV outbreak began in China in 2002 and spread internationally, most notably to Toronto, Canada. From November 2002 to July 2003, the World Health Organization (WHO) reported 8,437 SARS cases and 813 deaths.[7] There have been no known cases of SARS. since the end of 2003. Like other coronaviruses, SARS-CoV is transmitted from person to person through respiratory droplets and close contact.

The incubation period was 4 days (range 1 to 13 days). The main symptoms of SARS were fever, cough, and shortness of breath. The case fatality risk was approximately 10%.

MERS-CoV

MERS-CoV was first identified in Saudi Arabia in 2012. To date, there have been more than 2,400 cases, mostly in the Middle East.[8] Individual cases and small clusters continue to be reported in that region. Travel-related MERS cases have also been reported in South Korea, where it caused a significant hospital-based outbreak in 2015, and in the United States, where 2 very mild cases were diagnosed. MERS-CoV is transmitted from person to person via respiratory droplets and close contact.

The incubation period is 5 days (range 2 to 15 days). The main symptoms of MERS are fever, chills, generalized myalgia, cough, shortness of breath, nausea, vomiting, and diarrhea. The case fatality risk is approximately 35%.

SARS-CoV-2

The scientific community is still working to define the precise clinical and epidemiological characteristics of SARS-CoV-2. As of April 8, there have been 1,353,361 confirmed COVID-19 cases and 79,235 deaths linked to the disease.[9] These case numbers do not represent the full number of SARS-CoV-2 infections, which often manifests as mild symptoms in infected individuals. Initial evidence suggests that SARS-CoV-2 passes from one host to another via droplets produced while coughing, breathing, talking, or singing.[10] Other methods of transmission have been explored, including the ability for the virus to persist on surfaces and fecal-oral transmission.

The most common symptoms of COVID-19 are fever and cough.[11] Studies suggest that these symptoms usually present roughly 5 days after exposure, but can show up as early as 2 days and as long as 14 days after exposure.[12] Preliminary data suggest a majority of COVID-19 cases will not require advanced medical attention. Severe COVID-19 cases typically progress to viral pneumonia and often require mechanical ventilation to aid in breathing.10 While the scientific community is still collecting data as the outbreak grows, initial estimates of case fatality ratio with treatment range from 1.4% to 4.7%.[13]

Diagnosis and Treatment

Laboratory diagnosis of coronavirus infections relies on nucleic acid–based testing early in the clinical course and serology later on. It is possible to isolate SARS-CoV, MERS-CoV, and other coronaviruses from respiratory secretions, blood, urine, and fecal samples for diagnostic testing. Clinically, coronavirus infections (except SARS-CoV-2) can be diagnosed with respiratory viral panels that are commercially available.[14]

The development of SARS-CoV-2 diagnostics has advanced rapidly in the months since the virus's emergence. Most countries are relying on nucleic acid–based testing, although there are several variations of these tests currently in circulation.[15] There is an ongoing effort to develop serological testing.[16]

Care for most coronavirus patients is home-based and supportive with fever reduction and oral hydration. This is also true for most COVID-19 patients. For a minority of patients, especially

the elderly and infirm and those infected with SARS-CoV, MERs-CoV, and SARS-CoV-2, hospitalization may be needed for supplemental oxygen and fluid administration. Some of these patients will become critically ill and require intensive care, including invasive or noninvasive mechanical ventilation.

There are a number of ongoing trials to determine if any preexisting therapeutics have sufficient effectiveness for treating COVID-19 patients.[17] As of April 9, none of these treatments has yet demonstrated effectiveness. In addition to these trials, there are a number of studies gauging the effectiveness of convalescent serum as a potential therapeutic in severe COVID-19 patients.[18]

Infection Control Measures

Hospitals have amplified both SARS-CoV and MERS-CoV outbreaks, and superspreading events have been noted.[19] Consequently, stringent infection control is critical to preventing transmission to healthcare workers and other patients. Droplet precautions (eg, surgical or procedure mask, gown, and gloves) are indicated during the treatment of all coronavirus patients, and such protocols for droplet-spread respiratory viruses are part of hospital infection control practices. Additional respiratory precautions may also be appropriate during aerosol-generating procedures.

SARS-CoV-2 has shown high transmissibility both inside and outside of healthcare settings. WHO has developed infection control technical guidance for various groups, including health workers. This guidance also provides insights on best practices for personal protective equipment.[20]

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