Comparison of SARS-CoV (2003) and SARS-CoV-2 (2019)

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Abstract. This article compares the most well-known outbreaks of coronaviruses in the past twenty years, SARS-CoV and SARS-CoV-2, to illustrate the correlation between them and impact on human society. Pre-existing scholarship has been consulted to compare and analyze the viruses' known range of symptoms, incubation period, risk factors, fatality rate, and sequelae. The main difference in SARS and SARS-CoV-2's symptoms is that more than half of SARS-CoV-2's transmissions are asymptomatic, which is rare for SARS-CoV. Most clinical features for both diseases appeared similar to the symptoms of basic respiratory diseases. SARS-CoV-2 shows a longer incubation period in general. Risk factors for both diseases include age, with elders being more susceptible. SARS has a higher case fatality rate than SARS-CoV-2. The long-term sequelae of both diseases are still uncertain, however, after recovery, overall lung functions are damaged. As technology have progressed, there are more varieties of vaccine being developed for SARS-CoV-2 than SARS.

Keywords: SARS · SARS-CoV-2 · coronavirus · pandemic

1 Introduction

This study compares and contrasts the most well-known outbreaks of coronaviruses in the past twenty years. Although the origin of this virus is still not concluded, analyzing the past diseases caused by similar pathogens are important as they can help with developing prevention measures and treatment in the future.

SARS (Severe Acute Respiratory Syndrome) is caused by a SARS-associated coronavirus [1]. It is both airborne and zoonotic. It can be spread via air as a medium by respiratory droplets produced when coughing and sneezing. The main way of transmission is by person-to-person close contact. It can also be transferred from animals to humans and also between humans.

SARS first emerged in mainland China in 2002 and subsequently in Hong Kong. Afterwards, it began to spread worldwide as Hong Kong is a very busy city with many international ports. Within a few months, it was spread to the continents of Asia, Europe, North America, and South America. Although it was spread internationally, it quickly became under control without interfering with much of basic functions of the society.

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SARS-CoV-2 is a strain of coronavirus that is related to SARS, it emerged in December of 2019. Thus, it shares many similarities with the outbreak of SARS in 2003. After spreading rapidly in the major cities of China, such as Wuhan, the World Health Organization declared it to be a pandemic on March of 2020. To this day, after various vaccines targeted toward this virus have developed, it is still adapting and affecting populations and societies.

Fully considering the aforementioned issues in the history of this pathogen, this article makes a comparative study. It is completed by investing and comparing past articles published during the period of the outbreak. The symptoms, incubation duration, risk factors, fatality rate, sequelae, and vaccines of SARS and SARS-CoV-2 are examined.

2 Main body

2.1 Symptoms

SARS and SARS-CoV-2 share most symptoms. The most common symptoms of SARS are persistent fever, cough, chills, and headache. Less common symptoms include sputum production, sore throat, coryza, dizziness, nausea, vomiting, and diarrhea. Older patients are likely to have more severe symptoms and thus their clinical features and general well-being are also impacted [2]. In addition, lymphocytic depletion of CD4 and CD8 cells, thrombocytopenia, extended activated partial thromboplastin time, raised D-Dimer, high alanine transaminases, lactate dehydrogenase, and creatinine kinase are all typical laboratory findings [2]. As for SARS-CoV-2, the general symptoms are very similar, patients most commonly suffered from fever (around 90%), cough (68.6%), aching muscles or fatigue (35.8%), expectoration (28.1%), and dyspnea (21.9%). Minor symptoms include headaches or dizziness (12.1%), diarrhea (4.8%), nausea, and vomiting (3.9%) [3]. Laboratory features show that lymphocytopenia, an increase in C-reactive protein, an increase in lactic dehydrogenase, and leukocytopenia were all more prevalent [3]. However, asymptomatic cases became more and more common as the pandemic developed. During the SARS outbreak, asymptomatic and clinically mild infections were uncommon. No cases of transmission from people before the beginning of symptoms were observed. SARS-CoV-2 has spread quicker than SARS-CoV, and accumulated evidence indicating SARS-CoV-2, unlike SARS-CoV, is transmitted by people who did not have any symptoms [4]. Asymptomatic transmission accounted for roughly 59 percent of total transmission, according to baseline assumptions: Pre-symptomatic people make up 35% of the sample, whereas never-symptomatic people make up 24% [4].

In comparison, most of the cases of SARS and SARS-CoV-2 share almost all the common symptoms. However, in SARS-CoV-2, cases appeared to be asymptomatic. Without symptoms, it is less likely for people to notice their changing health condition and get tested. Therefore silent carriers of SARS-CoV-2 can spread the disease without knowing it. This factor has contributed to the higher dissemination of SARS-CoV-2.

2.2 Incubation Period

The incubation period plays an important role in the spread of the disease. A longer incubation period allows a longer period for the pathogen to be spread without the

subject being aware of it. Although the incubation period may vary from case to case, the most common period can still be compared. As for SARS, it has an incubation period of four to seven days and seldomly as long as 14 days, which is typically very long for respiratory diseases [5]. The SARS-CoV-2 is quite different. When the median age of the patients was 60 years old, the virus's average incubation period was 12.5 days, which increases by one day every ten years of the patient's age [6].

Many factors influence the incubation duration; nonetheless, SARS-CoV-2 had a longer overall incubation period than SARS. Cases are more likely to go unnoticed and untreated. This might have a detrimental impact on the mortality rate and range of population impacted.

2.3 Risk Factor

Risk factors for SARS include visiting potentially high-risk locations and meeting at-risk persons [7]. This may include visiting mainland China during the time, meeting a close contact case, or a probable case. Another risk factor is age, data has shown that children appear to have a milder form of the illness than adults, with a lower viral load and degree of infectivity. The viral load in adults starts off low, rises during the second week of sickness, and tends to be greater in individuals with more severe diseases [8].

In SARS-CoV-2, it is also similar, most infected youngsters, in comparison to infected adults, tend to have a milder clinical course [9]. The reason for this is still unknown. However, for SARS-CoV-2, previous medical history is a risk factor that can even affect the fatality rate. It is stated by the World Health Organization that serious sickness is more likely to strike the elderly and those with underlying medical disorders such as cardiovascular disease, diabetes, chronic respiratory disease, or cancer. COVID-19 can make anyone sick and cause them to get very ill or die at any age [10]. Knowing the risk factor helps with creating prevention measures and implying them to certain populations.

2.4 Case Fatality Rate

The case fatality rate of SARS is significantly higher than the case fatality rate of SARS-CoV-2. For SARS, in the most affected regions, the case fatality rate ranges from 7 to 27%, with the average being 11% [11]. In comparison, presented by the Chinese CDC, the overall case-fatality rate of SARS-CoV-2 appeared to be 2.3%, increasing with age [12].

However, these numbers did not accurately reflect the number of deaths caused by each virus. Case fatality rates can be dependent on many factors and may be biased. The subject's health status, previous medical history, and age all have an effect on the case fatality rate. Improper and not timely treatment all contribute to the bias of case fatality rate. In the commence of the two outbreaks, some cases were treated just as a common cold, this could also result in a higher case fatality rate. It can not be certain if a case's main cause of death is SARS or SARS-CoV-2, or their previous medical condition or improper treatment.

2.5 Sequelae

The data on the long-term sequelae of both diseases are very limited at this point, no data can directly prove that a certain type of sequelae will be developed as a result of contracting the disease. However, it is sure that lung function and overall health status are greatly negatively impacted after the recovery of SARS and SARS-CoV-2. Data shows that serious sickness is more likely to strike the elderly and those with underlying medical disorders such as cardiovascular disease, diabetes, chronic respiratory disease, or cancer. COVID-19 may make anyone sick and cause them to get very ill or die at any age [11].

A systematic review concluded that the sequelae of post-SARS-CoV-2 are rather common, 5 out of 10 survivors develop some type of sequelae [13]. These conditions include nervous system and neurocognitive illnesses, mental disorders, cardiovascular disorders, gastrointestinal disorders, skin disorders, and signs and symptoms of poor general health such as malaise, weariness, musculoskeletal discomfort, and decreased quality of life [13]. The persistent viremia due to immune fatigue and paresis, relapse or reinfection, hyperinflammatory immune response, cytokine and hypoxia-induced injury, and autoimmunity, as well as neurotropism via a transsynaptic spread mechanism, resulting in hypoxic- or hemorrhagic-driven neuronal apoptosis, are all hypotheses that can explain the direct viral effects. Widespread acute injury to cortical/subcortical and white matter fiber bundles has been shown to alter brain function and inhibit distal brain connectivity, resulting in symptoms like those described in this article. Headaches (encephalopathy), cognitive difficulties (widespread neuropathological processes), and smell and taste disturbances are examples of these symptoms (ie, acute injury to the olfactory bulb) [13].

Other than the direct destruction done to the health system by the virus, there are also indirect harms. Such as depression, anxiety, pressure caused by social isolation, and economic pressure. These indirect impacts can not be measured on a standard scale.

2.6 Vaccine

To prevent infection and spread of the virus, vaccines are needed to generate antibodies in the immune system. For a SARS vaccine, ideally it should elicit antibody responses against a vide spectrum of viral strains, provide protection against infection and transmission, and safe to generalize by not inducing side-effects [14].

For SARS, the types of vaccine being developed were inactivated SARS-CoV-based, S protein-based, and fragments containing neutralizing epitopes based [14]. The inactivated SARS-CoV based vaccines is easy to generate. However, it also has some risks. The SARS-CoV provides many proteins sources that can be inactivated to serve as antigens for generating an immune response. Such as nucleocapsid, membrane, envelope, and spike proteins [14]. However, the inactivated vaccine's safety is a major concern. Workers in the process of production are at risk of infection when handling concentrated live SARS-CoV. Uncompleted inactivation of the virus could result in SARS outbreaks in vaccinated populations. Also, some viral proteins could trigger harmful immune or inflammatory responses, potentially leading to SARS-like diseases [14].

As for SARS-CoV-2, there are a lot more varieties of vaccines being developed. According to a document updated by the World Health Organization, as of June 17,

2022, there are 166 vaccines in clinical development, and 198 vaccines in pre-clinical development [15]. The most common types are inactivated and protein subunit based, viral vector based, and mRNA based vaccines. Inactivated vaccines are developed by inactivating the virus after it is cultured [16]. Viral vector vaccines are genetically modified replication-deficiency virus that express the genetic sequence to produce antigens [17]. mRNA vaccines contains genetic information of antigens instead of antigens itself [16]. The vaccinated individual can then produce antigens using the mRNA which then generates immune response [17]. Another type that is also being developed is live attenuated vaccine, which is a weekend version of the vaccine that only multiply to a certain extent. This type will not cause the disease, it will only trigger a weak immune response [16]. They could also be challenging to produce as there are safety concerns during the virus' modification [16]. There are also other types of vaccines that are not as common. Such as DNA based, RNA based, and recombinant protein based proteins [16].

3 Conclusion

First, the symptoms of both diseases are very similar since they both attack the respiratory system. Common symptoms included coughing, fever, and hard to breath. However, SARS-CoV-2 has a distinct feature that made it so uncontrollable. Some strains of SARS-CoV-2 were transmitted without any symptoms. This allowed more cases to transmit without the patients being aware of it. Some SARS cases also had asymptomatic cases, but it was rather less common and rarely recorded.

Second, the incubation period is compared. The incubation period may vary by different methods of measurement, so the average of the both virus' incubation period was used. Different experiments' incubation periods were different depending on the sample size, method of measuring, and many other factors. Nevertheless, the overall incubation period for SARS-CoV-2 was still higher on average in most cases, with some exceptional cases that have a long incubation period reaching up to 14 days.

Third, the risk factors were compared. A similarity in both diseases show that younger patients had milder clinical responses to the disease. For patients with SARS-CoV-2, severity of response to the disease increased for older patients.

Next, the case fatality rate is compared. The case fatality rate of SARS is significantly higher than the case fatality rate of SARS-CoV-2. However, the measurement of case fatality rate for both diseases are cited from different resources done with different procedures. Meeting a close contact, or visiting a place with previous positive case detected both increase the risk factor. Procedures such as wearing masks and proper hygiene.

Then, the shorter and longterm sequelae of both diseases are compared. Records on the sequela of SARS is very limited, whether longterm or short term. For SARS-CoV-2, records show that effects to the lung and brain are both effected. Different people seem to be effected differently, thus the certain sequelae caused by both of the diseases are unsure. It is certain that overall health status and lung functions are negatively impacted.

Lastly, the vaccines being developed of both virus are compared. As for SARS, the types of vaccine being developed were inactivated SARS-CoV-based, S protein-based, and fragments containing neutralizing epitopes based. However, for SARS-CoV-2, the

most common types are inactivated and protein subunit based, viral vector based, and mRNA based vaccines. Other than this, there are many more vaccines being developed for SARS-CoV-2. Many newly developed vaccines are safer for mass production and more effective.

Some weaknesses of this article remain. First, the data used in this study are not first-handed due to lack of resource. Most data are cited from previous studies done on this topic. Each study has their own standards. Besides that, studies that were cited were done in different locations with different participants under different conditions. Therefore, the accuracy of these data could be doubted. Second, articles collected for SARS were around 2003 to 2005 since that is when the outbreak happened. As technology progresses and standards for testing may have varied, these may data may not still stand true.

Many other questions regarding the outbreak of SARS continue to remain unsolved, such as its natural history. The mechanism and cause of its long-term sequelae are also topics that demands attention as it affect majority of populations. Society must pay more attention to SARS and SARS-CoV-2 outbreak investigations as it still requires further study.

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