A Comparative Study of SARS, MERS with COVID-19

Chandra Mohan1 and Vinod Kumar2,*

1Department of Chemistry, SBAS, K.R. Mangalam University, Gurugram 122103, Haryana, India; 2Department of Pharmacy, SMAS, K.R. Mangalam University, Gurugram 122103, Haryana, India

Abstract: Background: B814, now’s called Coronavirus first identified by Tyrrell and Bynoe in 1965 from the respiratory tract (embryonic tracheal) of an adult and later on during working on National Institutes of Health Robert Chanock used the term “OC” for same virus strain. After several years researchers reported that coronaviruses were cause disease in rats, mice, chickens, turkeys, calves, dogs, cats, rabbits etc. after effecting the enormous variety of animal, in year 2002-2003 it caused new respiratory disease named severe acute respiratory syndrome, (SARS) in southern China.

Objective: The main objective of this article is to compare the status of various previous pandemics (i.e., SARS, MERS) with the current COVID-19 pandemic in terms of the life cycle, diagnosis process and prevention

Results: On 31st December 2019, the World Health Organization (WHO) office in China received information regarding pneumonia cases of unknown etiology from the Wuhan district in central China. Subsequently, this new disease spread to China, and from there, to the rest of the world. By the end of March 2020, more than 2 million cases were confirmed of this new disease, with over 70000 deaths worldwide. After some time, researchers have identified that this new disease is caused by a novel beta-Coronavirus (virus SARS-CoV-2) and the new disease was named COVID-19. Since then, the Ministry of Health of various countries and WHO have been fighting this health emergency, which has not only affected public health, but also affected various economic sectors.

Conclusion: The current outbreak SARS-CoV-2 phylogenetically resembled to Bat SARS, which was previously identified in year 2002 and 2012 having low mortality rate than MERS and SARS. However, SARS-CoV-2 and MERS having high virological similarity but both use different receptors to take entry in to the host cell via ACE-2 and DPP-4 respectively. Unfortunately, currently there is no approved treatment available worldwide. Currently, we can hope that together we will recover from this public health emergency very soon

Keywords: Severe Acute Respiratory Syndrome (SARS), Middle East respiratory syndrome coronavirus (MERS-CoV), COVID-19 (SARS CoV-2), life cycle, diagnosis, comparative analysis.

1. INTRODUCTION

Currently, almost all countries of the world are faced with an epidemic situation due to COVID-19. Globally, about 1,214,466 people have been infected with COVID-19 in about 211 countries or regions, and approximately 67,767 people have died. On 31st December 2019, the WHO Country Office of China received information about the first case of this disease in Wuhan, China, as pneumonia of unknown cause with breathing difficulties. Within a very short period of time, this disease spread throughout the region, and investigations revealed that this disease was caused by a novel virus called SARS-CoV-2, and the disease was then named COVID-19. However, this is not the first time that we have encountered such a pandemic situation, before also we have seen such emergences such as the late 19th century plague, the Asian flu in 1957 and the Hong Kong flu in 1968 [1].

This novel coronavirus disease, known as COVID-19, mainly affects the respiratory system related to the severe acute respiratory syndrome (SARS) and the Middle East respiratory syndrome (MERS). Gene sequence analysis of SARS-CoV-2 showed more than 80% genetic similarities with previously encountered viruses, SARS-CoV and MERS-CoV in 2002 and 2012, respectively. As it possesses a similar genetic structure consisting of open reading frames (ORF1 and 2), spike protein (S), envelope protein (E), membrane protein (M), and nucleocapsid (N) at 3′-terminal regions like other beta coronaviruses, hence a comparative study is required for the exploration of the underlying pathology of COVID-19 [2].

1.1. Severe Acute Respiratory Syndrome (SARS)

On November 2002, 17 years ago, a new type of plague emerged from Guangdong Province, China, caused by Beta-coronavirus subgroup and was named as SARS-CoV, causing Severe Acute Respiratory Syndrome (SARS), and in the year 2003, the first outbreak of this disease was found in
Hong Kong after a physician from Guangdong spent a day in hotel ‘M’. Till July 5, 2003, around 774 deaths and more than 8,000 infected people were reported worldwide. Literature reports state that the droplet infection, aerosolization, tears and fomites are the major routes of transmission of SARS [3], and pneumonia, fever, decreased platelet counts, elevated serum hepatic enzymes, malaise and lymphopenia are the major clinical symptoms observed in SARS-CoV patients. Apart from this, subpleural consolidation (ground glass) like changes have also been observed by chest radiography.

1.2. Middle East Respiratory Syndrome Coronavirus (MERS-CoV)

In September 2012, after the SARS outbreak in the 2003, we were again faced with the new epidemic situation named Middle East respiratory syndrome coronavirus (MERS-CoV) from the Kingdom of Saudi Arabia and the Republic of Korea, which very soon spread across continents and raised pandemic concerns with around 804 deaths in 27 countries. Data received from various scientific sources reported that the dromedary camel was the source of human zoonotic infection [4]; first case of MERS-CoV was reported in Philippines in February 2015, and MERS-CoV and SARS (severe acute respiratory syndrome) were observed to have genetic similarities in their structure.

1.3. COVID-19

According to the available data, COVID-19 first outbreak was observed in a local animal food market of Wuhan, China, in November 2019. Initially, the cases of this disease were recognized in the various medical centers of China and very soon, similar cases appeared in some foreign countries. However, many issues still exist in diagnosing those patients who are highly suspected but having a lack of etiological evidence. Clinical features include fever (≥38.5 °C), pharyngeal discomfort and difficulties in breathing [1] in almost all cases and none of the patients show nasal congestion, runny nose, vomiting and diarrhea.

2. DIAGNOSIS OF COVID-19

All clinical testing for COVID-19 should be conducted as per the provided guidelines by a healthcare provider. Initial diagnostic testing is done by collecting the Nasopharyngeal specimen, an Oropharyngeal (OP) specimen, a nasal mid-turbinate (NMT) swab and by an anterior nares specimen; out of these, Nasopharyngeal specimen is the preferred choice for swab-based SARS-CoV-2 testing. Currently, there are two main ways to test the infection with SARS-CoV 2; A) a very sensitive test named polymerase chain reaction (PCR) test; it detects the presence of antigen and not antibodies [5]. It provides effective information about the patients, like who is infected, who needs isolation and needs to be quarantined; by making use of this test, we can break the transmission chain. B) By measuring the antibody responses to virus in blood serum.

Apart from these, one new test is also used for the detection of COVID-19; however, it possesses less accuracy than lab methods. It is named Rapid Test. It works like a pregnancy test, such that the blood sample reacts with antiviral antibody and if one line is shown, it means the result is negative while two lines indicate the test to be positive, as shown in Fig. (1).

3. LIFE CYCLE OF CORONAVIRUS

3.1. Attachment and Entry

The attachment between the virus and host cell is initiated by interactions between the S protein and its receptor-binding domain (RBD), i.e. Angiotensin-converting enzyme 2 (ACE2) at the C-terminus of S1 region, which utilizes ACE2 as a cellular receptor except in case of MERS-CoV which binds to Dipeptidyl-peptidase 4 (DPP4) and gains access to the host cytosol via acid-dependent proteolytic cleavage of S protein. The cleavage of protein S generally occurs at two sites: site-A) separating the RBD and fusion domains, and site-B) exposing the fusion peptide (cleavage at S2’) that inserts into the biological membrane and forms a six-helix bundle (antiparallel), which ultimately releases the viral genome into the host cytoplasm [6].

3.2. Protein Expression

The next step of the coronavirus lifecycle is the translation of the replicase gene (encodes two large ORFs, rep1a and rep1b and expresses two co-terminal polyproteins (pp1a and pp1ab) from the virion genomic RNA). Virus utilizes the sequence (5’-UUUAAAAC-3’) and an RNA pseudoknot to form polyproteins, which subsequently [7] cleave into the individual nsps, providing the suitable environment for RNA synthesis by assembling on the replicase-transcriptase complex (RTC). Coronavirus cleave the replicase polyproteins by encoding either two or three proteases, as shown in Fig. (2).

3.3. Replication and Transcription

Coronavirus RNA synthesis produces genomic and subgenomic RNAs (which act as mRNAs for structural and accessory genes). Only Cis-acting sequences involved in the replication of viral RNAs form 5’ UTR seven stem-loop structures, while 3’ UTR only contains a bulged stem-loop, a pseudoknot, and a hypervariable region which regulates the alternate stages of RNA synthesis, identified by the use of Oxford Nanopore Technologies (ONT), which enables RNA for sequencing without fragmentation [7].

3.4. Release of Virion

The viral genome contains proteins named S, E (small quantity), and M (relatively abundant), which are translated and inserted into the endoplasmic reticulum (ER); however M protein with E protein forms VLPs, which are further enhanced by N protein. The above proteins move via a secretory pathway into the ER-Golgi intermediate compartment (ERGC), forming mature virions which transport to the cell surface in vesicles and are released by exocytosis. This causes the formation of giant, multinucleated cells, which allow the virus to spread within an infected organism.

4. PREVENTION OF COVID-19

However, there is currently no vaccine or clinical treatment available to protect people from COVID 19 infection
but scientists have suggested the following prevention measures to be taken in order to reduce the risk of infection:

- Wash your hands often with soap and water for at least 20 seconds, and use an alcohol-based hand sanitizer (if soap and water are not available).
- Cover your nose and mouth with a mask, a cloth or tissue when you cough or sneeze, then throw the used mask or cloth or tissue in the untouched bin.
- Avoid touching your eyes, nose, and mouth with unwashed hands.
- Avoid personal contact (kissing, sharing cups or eating utensils) with sick people.
- Clean and disinfect frequently touched surfaces and objects, such as doorknobs, etc. at the earliest.
- Avoid social gatherings and maintain social distance.
- Stay at home.

5. COMPARATIVE ANALYSIS OF COVID-19 WITH SARS AND MERS

Worldwide, researchers are working to obtain medicine for the treatment of current pandemic situation. But it is not the first time that we are faced with such health emergency condition; earlier encountered conditions were H1N1 influenza (20 years ago) as well as severe acute respiratory syndrome coronavirus (SARS-CoV) in China (2002) and Middle East respiratory syndrome coronavirus (MERS-CoV) in Saudi Arabia in 2012. However, all MERS, SARS and COVID-19 possess almost the same clinical symptoms and also originate from the same virus species. Apart from this, there are several similarities and differences regarding their source, genetic makeup, symptoms, severity, treatment, etc. as provided in Table 1 [9-14].

CONCLUSION

The current outbreak SARS-CoV-2 phylogenetically resembles Bat SARS, which was previously identified in the year 2002 and 2012 having low mortality rate than MERS and SARS [2]. However, others viruses replicate in the upper respiratory tract and cause pneumonia with lower spreading potential like H1N1, but on the other hand, SARS-CoV-2, SARS-CoV and MERS-CoV all use receptors that are found in both the upper and the lower respiratory tract, showing inoculum dose-dependent severity; heavy inoculums lead to deeper penetration, causing severe pneumonia, whereas lower inoculum exposures cause milder infection because virus presents only in the upper airway. These findings suggest that SARS-CoV-2 loads are higher at onset in the nose than in the throat and may spread more easily with mild symptoms or no symptoms. However, SARS-CoV-2 and MERS have high virological similarity but both use different receptors to take entry into the host cell via ACE-2 and DPP-4, respectively. Interestingly, despite all this, the gastrointestinal symptoms and diarrhoea occur in all the three infections, which may contribute to the hypothesis that COVID-19 could also be transmitted via the same route as SARs and
MERS (faecal–oral transmission) [15]. Unfortunately, currently, there is no approved treatment available worldwide for the new pandemic situation named COVID-19, which not only has caused harm to the health of human population but has also affected various life activities like trade, travel, day-to-day supply chains and personal and social lives of people living globally. However, researchers are making efforts to accelerate the inception of new therapeutics (by using biosensors that utilize bio-receptor and signal transduction mechanism [16]), especially of Hydroxy-chloroquine, Remdesivir and Kaletra [17].

Apart from this, diagnostic care, the utility of facemasks, identification of the animal reservoir, social distancing etc., should be top priorities of health ministries globally as well as individuals locally because with all this, we can minimize the COVID-19 infection on a global level. We hope that together we will recover from this public health emergency very soon.

**CONSENT FOR PUBLICATION**

Not applicable.

**FUNDING**

None.

**CONFLICT OF INTEREST**

The authors declare no conflict of interest, financial or otherwise.

**ACKNOWLEDGEMENTS**

The authors extend their sincere thanks to World health organization (WHO), Information Network for Epidemics (EPI-WIN) dashboard and The Johns Hopkins Center for Systems Science and Engineering site for providing correct and authentic data on COVID-19.

**REFERENCES**


http://dx.doi.org/10.1128/JVI.00127-20 PMID: 31996437


