Review Article

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Comparison of SARS-CoV-2 (Coronavirus) with other Similar Viruses Based on Current Evidence

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Abstract

The rapid spread and high mortality rate of Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) have recently received worldwide attention. Understanding the pathologic features and behavior of this new virus can help control its spread. The present study aimed to compare SARS-CoV-2 with other similar viruses.

This study is a systematic review of current evidence conducted in September 2020. A search was carried out utilizing the keywords in the online databases, including Google Scholar, PubMed, Scopus, Science Direct, and Web of Science. The original peer-reviewed papers written in English that met the eligibility criteria were included in the final report.

In this study, we compared SARS-CoV-2 with similar viruses such as influenza, Zika, Ebola, HIV, SARS-COV, and Middle East Respiratory Syndrome Coronaviruses (MERS-COV) in the features such as envelope structure, risk factors, duration of the disease, common symptoms, and treatments. Moreover, Coronavirus Disease 2019 (COVID-19) has many similarities with the other viruses explained in the present study. However, there are still controversies about the virus's behavior.

Although there are similarities between the abovementioned viruses, the scientific community should also pay special attention to distinct features of SARS-CoV-2, particularly the high probability of transmission in the human population, which causes substantial morbidity and mortality worldwide. Future studies are needed further to explore the biological and epidemiological behavior of this virus.

Keywords: Behavior, COVID-19, Gene expression, SARS-CoV-2, Sequence, Similarity

Introduction

Coronavirus Disease 2019 (COVID-19) started from the Huanan seafood wholesale market in December 2019, located in Wuhan, and soon became a global pandemic. Over 45.5 million people have been infected, and nearly 1.2 million people died because of the virus by October 2020, indicating the serious threat imposed by the quick spread of the virus (1, 2). Pandemic is defined as a worldwide epidemic, which could cause excessive numbers of sickness and deaths and disrupt the socioeconomic situation of afflicted countries. For instance, in 1918, the Spanish flu caused massive disruption worldwide, and currently, we are experiencing another circle of a global pandemic of COVID-19, which has caused substantial human loss so far. Therefore, reviewing the previous pandemics and comparing the Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) with similar viral species could help us to understand the virus behavior better and control the current epidemic (3).

Alsamman *et al* found that the molecular pathways for heparin-binding such as Receptor for Advanced Glycation Endproducts (RAGE), microRNA (miRNA), and Phospholipase A2 (PLA2) inhibitors might be related to COVID-19. The Neuronal Cell Adhesion Molecule *(NRCAM),* Serum Amyloid A2 (*SAA2),* Fibroblast Growth Factor (*FGF1)*, and Forkhead Box O1 (*FOXO1)* genes are associated with immune regulation in inflammatory responses. These genes are associated with a cellular gene response to COVID-19 (4). Moreover, several cytokines such as the *IL-8*, *IL-6*, demonstrated key associations with COVID-19. They also found that the gene modulation of host antiviral responses, virogenomic transcriptome of infection, and GO terms of both COVID-19 and Ebola are more similar to each other, compared to SARS, H1N1, and MERS. These data could be used in predicting virus behavior (5).

Comparing the behavior and other characteristics of the viruses may help us better identify and react to them. The study by Anderson *et al* showed that the antiviral therapy for influenza and COVID-19 would reduce the initial innate immune-associated "cytokine storm" and increase the efficacy of the adaptive immune response (6). However, such weakening of the innate immune response is not so clinically relevant for the Ebola virus. Such comparisons would help us learn from the lessons towards better treatment options for COVID-19 (7). Understanding the pathologic features and behavior of this new virus can help control its spread. Thus, the objectives of this study are to find the resemblances between the SARS-CoV-2 and some of the well-known viruses that caused similar scenarios of global pandemics in the past to learn from and act on to control the current pandemic.

Evidence acquisition

This study aimed to explore and compare the biological features and behavior of SARS-CoV-2 with other similar viruses in an attempt to comprehend the nature and behavior of this virus for the implementation of possible preventive and therapeutic measures. This is a literature review of current evidence carried out in September 2020. Our study is in adherence to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist.

Sources of data

By a comprehensive search of the keywords in the online databases, including Google Scholar, PubMed, Scopus, Science Direct, and Web of Science, we identified all the relevant papers from 2015 to 2021. We applied various combinations of keywords to enhance the comprehensiveness and integrity of our search strategy. These combinations consist of the following patterns:

A. "COVID-19" OR "SARS-CoV-2" OR "Novel Coronavirus" OR "2019-nCoV" [Title/Abstract]

B. "ZIKA" OR "HIV" OR "Ebola" OR "Influenza" [Title/Abstract]

C. "Behavior" OR "Activity" OR "Presentation" OR "Similarity" [Title/Abstract]

D. "RNA" OR "Gene expression" [Title/Abstract]

E. [A] AND [B] AND [C] AND [D]

Selection of the study

Two independent investigators retrieved the most related studies by titles and abstracts. Subsequently, we assessed the papers' full text and selected the most relevant papers based on the eligibility criteria. After extracting the relevant data, we organized them in some tables. The original peer-reviewed articles

written in English that met the eligibility criteria were included in the final report.

We considered the following exclusion criteria for this study as well:

- Papers addressing non-human studies, such as *in vitro* observations or animal experiments.
- Papers discussing COVID-19, Zika, HIV, Ebola, and Influenza as an overview and not in detail, also without reference to the keywords of this study.
- Papers which their full texts were out of access.
- Papers with their outcomes suspicious of any duplication.

Extraction of data

The information related to the authors, study type, publication date, country of origin, sample size, *etc.*, were summarized in a data sheet. Two independent researchers reviewed and checked the extracted data. To avoid duplications or to overlap in the content, we asked other co-authors to cross-check all the selected papers.

Quality assessment

Our study is in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist to ensure the suitability and validity of the selected papers and results. Two independent researchers examined the quality of the articles and possible bias risk. Whenever they encountered any differences, a third independent researcher resolved the issue. In conclusion, we read the full text of selected articles and provided the prominent findings (Figure 1).

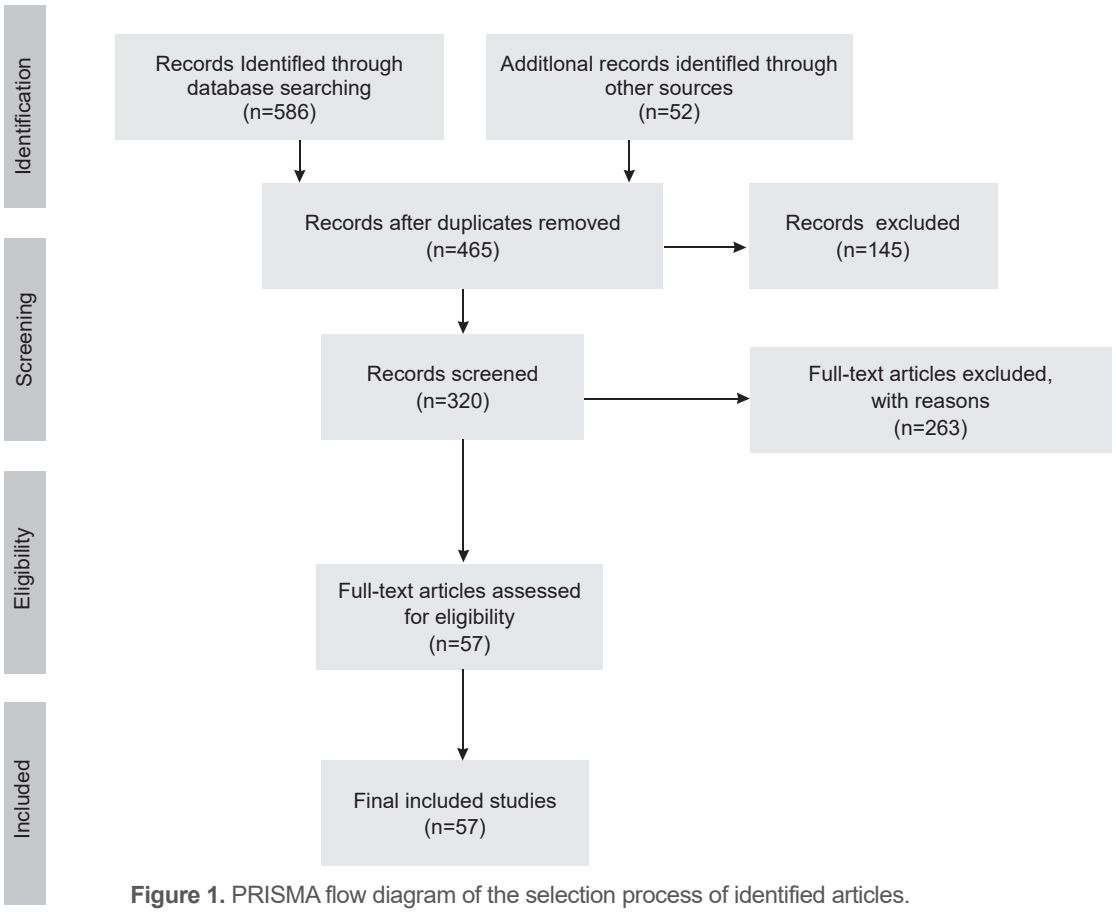

Figure 1. PRISMA flow diagram of the selection process of identified articles.

Results

The worldwide spread of the COVID-19 pandemic is very similar to Hong Kong, Spanish, Asian, and swine influenza pandemics. In this study, we compared SARS-CoV-2 with similar viruses such as influenza, Zika, Ebola, HIV, SARS-COV, and Middle East Respiratory Syndrome Coronaviruses (MERS-COV) in features of envelope structure, risk factors, duration of the disease, common symptoms, and treatments. We showed that SARS-CoV-2 has a lot of similarities with the other viruses in the present study. However, there are still controversies about the virus's behavior.

In two separate tables, we summarized the information related to the reviewed articles. The first table focuses on the information about the SARS-CoV-2 (epidemiology, diagnosis, clinical features, therapeutic options, management of the disease, biological features, genetics and mutations, transmission routes, vaccines, radiologic findings, and its reservoirs and hosts) (Table 1). Moreover, findings and comparisons of other similar viral epidemics are mentioned there (Table 2).

The second table demonstrates the seven viruses' characteristic features (SARS-CoV-2, compared to Influenza virus family, Zika virus, Ebola virus, Human Immunodeficiency Virus (HIV), SARS-CoV, and MERS-CoV).

There are numerous similarities between SARS-CoV-2 and the above-mentioned viruses, but the scientific community should also pay special attention to distinct features of SARS-CoV-2, particularly the high probability of transmission in the human population, which caused substantial morbidity and mortality worldwide.

Influenza virus

Many implications can be derived from the data gathered about the influenza virus in this paper. Both viruses have a similar envelope structure (8). Therefore, the medications affecting influenza could also possibly affect SARS-CoV-2. This has been described in previous studies in which antiviral drugs were used in influenza; for example, Peramivir appeared to inhibit the cell's SARS-CoV-2 release. Sodium Butyrate has also been used in the treatment of both infections (9,10). Although both viruses can cause Acute Respiratory Distress Syndrome (ARDS), patients with COVID-19 experience more non-productive coughs during the acute phase (6). The influenza incubation period is shorter than SARS-CoV-2. Similarly, the disease lasts shorter than COVID-19. Afflicted humans from the virus may suffer from fever, cough, and fatigue, but most influenza patients do not suffer from dyspnea; on the other hand, most COVID-19 patients usually do not have a sore throat or runny nose (6,11). This knowledge could help in early and accurate diagnosis and guide the empirical treatments, even though both have similar diagnostic methods. One of the diagnostic modalities is a chest Computed Tomography Scan (CT scan). Previous literature is not consistent with the CT scan findings and provides overlapping patterns of lung involvement for these two viruses. More evaluation is required to distinguish the exact CT scan findings for these two viruses (12-15).

The worldwide spread of COVID-19 is similar to different influenza pandemics, such as the 1918-19 influenza outbreak (16). SARS-CoV-2 has a characteristic host gene expression response, which can be similar to that of the influenza virus. The percentage of binding proteins is similar in both viruses; for example, S-proteins of COVID-19 have similarities with the fusion proteins of both HIV and influenza viruses. Binding affinity proteins, however, are similar to that of influenza and not HIV (17).

The percentage of hospitalized male patients affected by COVID-19 is higher than patients affected by influenza viruses (18). The virus has a preference for the male gender, and the symptoms are reported to be more severe in male patients. COVID-19 has more morbidity and mortality rates in older adults compared to influenza (19,20). Moreover, there is a discrepancy between different studies on which characteristics of patients could increase the likelihood of infection with SARS-CoV-2. Some studies indicate that healthier and younger patients are more likely to be afflicted by SARS-CoV-2 compared to influenza; while, others reported older patients to be affected more by the virus. Therefore, further epidemiological studies are recommended to elaborate on these gaps (20,21). The current knowledge, including similarities and differences between these two viruses, could inform the early

diagnosis and treatment of COVID-19 patients.

Zika virus

Blood transfusions, sexual intercourse, perinatal transmission, and transplantations (bone marrow and solid organs) are regarded as the means of Zika virus transmission (22,23). Therefore, the transmission pathways completely differ from those of SARS-CoV-2, including close contact, droplet, and airborne transmissions (24). Although there are controversies on whether SARS-CoV-2 is present in the semen, some reports show that SARS-CoV-2 could be extracted from the semen of infected patients (25). Regarding the importance of SARS-CoV-2 transmission, the possibility and clinical implication of sexual COVID-19 transmission should be evaluated.

Although the precise impact of Zika virus on the male reproductive system is still unclear (22), some studies reported the possible impact of COVID-19 on male reproductive hormones and raised the possibility of orchitis (25,26). Nevertheless, more robust research is needed to investigate the impact of both viruses on reproductive organs. These viruses might share some risk factors as well; for instance, pregnancy may precipitate worse outcomes in COVID-19 patients (27). Pregnant women have higher rates of hospitalization, mechanical ventilation, and Intensive Care Unit (ICU) admission due to COVID-19 compared to the general population (28). Patients infected with Zika virus often have no or mild symptoms similar to patients with COVID-19 (29). Pregnant women can transmit the Zika virus to their fetuses, which might even cause congenital disabilities (30). Therefore, pregnant women contracting these viruses are a specific group requiring special attention and management.

Ebola virus

To this date, the bats are considered as the presumable reservoir for the Ebola virus (31). Likewise, the bats are assumed to be the primary source of SARS-CoV-2 spreading (32). Direct contact with blood and body fluids (33), breast milk, placental and fetal tissue, and amniotic fluid have been mentioned as the source of the Ebola virus (34-36). Therefore, human-to-human transmission *via* direct contact and touching contaminated surfaces is the shared transmission route in both viruses (33).

Ebola can cause high fatality rates and neonatal loss in pregnant women, similar to COVID-19 (30). Ebola, resemblance to COVID-19, can provoke a cytokine storm, and this is described as the main responsible mechanism for developing a high mortality percentage among patients (37). This can raise the possibility that the proposed Ebola treatment strategies and mechanisms of action (*e.g.*, REGN-EB3 and mAb114) (38) might also provide clues for fighting COVID-19, and researchers could conduct experiments on similar drugs to examine their effectiveness.

Ebola was named the fastest vaccine to be prequalified by the World Health Organization, confirming its quality, efficacy, and safety (39). It was only five years from the Ebola vaccine's phase 1 trial commencement until achieving Food and Drug Administration (FDA) approval, much more rapid than the usual 10-15 year process (29, 40,41). Speeding up the research for the potential SARS-CoV-2 vaccine is of critical importance these days. Therefore, many similar experiences and findings during Ebola vaccine development could be successfully replicated during the research for the SARS-CoV-2 vaccine. Clinical, manufacturing, regulatory, and general lessons ought to be learned and implemented (41). Moreover, following vaccine development, countries should learn from the Ebola vaccine's experiences to convince the general population of the vaccine effectiveness while global inoculation programs are set up (41, 42). Governments should also implement active measures to ensure that ethical guidelines are in place and respected, and that the high-risk groups are prioritized (42).

HIV

Similar to the influenza virus, HIV and SARS-CoV-2 are structurally alike, and thus, the medications that affect the structure of the HIV (*e.g.*, the envelope) may also affect SARS-CoV-2 (43). However, the envelope of SARS-CoV-2 is more robust and can resist longer on hard surfaces. Unlike influenza, HIV has a more extended incubation period (12 weeks)

than COVID-19, and the 10-year survival rate for HIV patients is 57% (44-46).

Studies show that people living with HIV affected by COVID-19 have more extended disease periods (more than the usual two weeks) and a slower antibodies production than HIV-negative patients with COVID-19. Therefore, poorly managed HIV patients may experience higher morbidity and mortality rates due to COVID-19 (47-50). HIV medications seemed to affect SARS-CoV-2, and antiretroviral drugs such as Raltegravir appeared to closely interact with the active sites of COVID-19 viruses as well (50,51).

SARS-CoV & MERS-CoV

Clinical manifestations and pathophysiology of COVID-19 substantially resemble those of SARS and MERS (52). Elaborating around the common features of these viruses could extend our limited knowledge about the SARS-CoV-2 virus. The 80% similarity in genome sequence between COVID-19 and SARS-CoV affirms this claim (8). On the other hand, MERS-CoV shows only 50% similarity (53). Structurally, SARS-CoV-2 and SARS-CoV also have a similar host cell receptor, namely Angiotensin-Converting Enzyme 2 (ACE2), and similar S-protein structures. In contrast, MERS-CoV invades the target cell by Dipeptidyl Peptidase 4 (DPP4) as a binding receptor (54).

These tree virus species are members of the beta-Coronavirus family and share similar spreading routes mainly through nosocomial infection. Besides, all of them survive in the human body by replicating in the lower respiratory airway especially COVID-19 accompanied by the overreaction of the host immune system (19). Cytokine and chemokine overproduction within SARS-CoV infection and COVID-19 (known as cytokine storm) cause host innate immune system dysfunction (55). Cytokine quantity is correlated with the severity of disease symptoms. Concentrations of some interleukins such as IL2, IL7 and IL10 in the serum are much higher in severe cases of disease hospitalized in ICU (56). In contrast with SARS-CoV, COVID-19 induces the production of IL-10, which leads to a different immuno-pathological pathway involved in lung injury (57,58).

Coronaviruses (CoV) are highly contagious enveloped viruses. The high resistance of these viruses on hard surfaces might be a reason for this contagiousness. SARS-CoV particles are contagious on hard surfaces for at least 1-4 days. MERS-CoV survives on hard surfaces at most 2-3 days. Infectivity of SARS-CoV-2 and SARS-CoV did not significantly differ in aerosol (median half-live is about 1.1-1.2 hours) or on hard surfaces (59). This suggests that we should find other factors to rationalize the epidemiologic feature of COVID-19.

Another key reason for the strong transmissibility of COVID-19 is the high receptor-binding ability, which is more than 10-20 folds greater than SARS-CoV (60). COVID-19 has a higher reproductive number compared to the two [SARS-CoV-2 = 3.28, SARS-CoV = 3, and MERS = less than 1 (61)], longer incubation period (SARS-CoV-2: ranges 4.75-6.4 days with the longest incubation time of 14 days, versus SARS = 4 days, and MERS = 4.5-5.2 days), and shorter serial interval (SARS-CoV-2: about 2.6-7.5 days in two different studies, SARS = 8.4 days, and MERS = 12.6 days). Despite all these alarming characteristics, COVID-19 has a lower fatality rate (estimated about 3% versus SARS = 9.6%, MERS = 35.5%) (52). However, the total death cases worldwide are innumerable. Furin cleavage site, a new variation in the S-protein of COVID-19, does not exist in other coronaviruses. It amplifies the spreading of the virus among humans. If this site were not developed in the virus, like SARS-CoV, the S-protein function would be disturbed (62).

The presence of a mutation in the endosome-associated-protein-like domain of non-structural protein 2 (nsp2) and phosphate domain of nsp3 is probably responsible for the high ability of contagion of the COVID-19 and different behavior from SARS-CoV (63). Investigating the most Differentially Expressed Genes (DEGs) with COVID-19 presented the crucial role of serum amyloid A2 (*SAA2*) gene, which is responsible for *SAA2*, an inflammatory factor predicting illness prognosis. The expression of *SAA2* is specific for COVID-19 and is not observed in SARS-CoV, MERS-CoV, and other viruses (8, 64). The *SAA2* is a member of acute-phase Serum amyloid A (A-SAA), which encodes *SAA2* that shows a remarkable increase during the Acute-Phase Response (APR) similar to C-Reactive Protein (CRP) (65). About 8-24 hours after APR onset, the

SAA2 expressed as high as 1000 folds higher than the baseline amount. By comparing the SAA2 and CRP, we found that SAA2 increases more quickly to a more significant extent, returns to normal faster, and is more conclusive for viral infectious disease (65). The SAA2 is associated with severe inflammation and an aggressive cellular immune response to COVID-19 infection (8,65-67).

Other principal host defense systems, including the *CCL20* gene (which adjusts cell proliferation) and interleukins gene *(IL6, CXCL1, CXCL3* and *CXCL5, IL-17*, and the *IL8*), are also involved in host response versus COVID-19 (8).

Based on the evidence, the COVID-19 genome is more stable than SARS-CoV or MERS-CoV (68). Genomic deletion in Open Reading Frame 8 (ORF8) of SARS-CoV attenuates the virus and diminishes its replication capacity since ORF8 of SARS-CoV has an essential role in the replication capacity of the virus. Despite that, ORF8 of COVID-19 is structurally and characteristically different. Deletion in ORF8 of COVID-19 does not decrease the replication capacity of the virus. The appearance of ORF8 deletion is a consequence of immune-driven selection due to the host antibody response to ORF8 in COVID-19 (68).

Bats are considered the stem of the beta-Coronavirus family and serve as their reservoir hosts (69,70). Reporting COVID-19 in animals is rare, and it shows that it is not necessary to focus on animal population health. COVID-19 fails to develop in dogs, pigs, chickens, and ducks (13). Besides, humans, cats, and ferrets are susceptible to the COVID-19 virus (69). Based on the evidence, the potential intermediate host of COVID-19 is pangolin (71). Animals including the ferret-badger, red fox, lesser rice-field rats *etc*. are all prone to SARS-CoV. MERS-CoV also has alpacas and camels as a reservoir of the virus. Animals that are vulnerable to MERS-CoV are rhesus macaque, llamas, pigs, cattle, sheep, goats, donkeys, and horses. At present, the mortality of COVID-19 in China is 4.1%, 3 lower than 9.6% of Past experiences of the SARS-CoV epidemic should be more regarded in the current situation due to the similarities in the behavior of this virus with SARS-CoV-2, consisting of the epidemiology, propagation pattern, and the mechanism of action. Both viruses are disseminated by respiratory droplets, contact, and fomites with similar symptoms, including fever, cough, and flu-like symptoms. Nevertheless, COVID-19 patients fail to exhibit the upper respiratory tract and gastrointestinal symptoms as much as SARS-CoV (22,52). This fact guides us to detect lower respiratory cells as the principal victim of the SARS-CoV-2 (60). It is suggested that SARS-CoV and SARS-CoV-2 both cause sperm pathologies (oligospermia, asthenospermia, and teratospermia) without presenting virus particles in the semen (22). Nevertheless, there are controversies about whether SARS-CoV-2 may or may not be present in seminal fluid (25).

Pegylated Interferon alpha (IFN-alpha) as an antiviral agent is effective for SAR-CoV infection and causes less pulmonary harm by reducing the viral replication and propagation (72). However, there is no proved vaccine for it. For MERS-CoV, Modified Vaccinia Ankara (MVA)-based vaccine proved to be effective in camels (73). Moreover, chloroquine is a potent medication to treat MERS-CoV. Trials for an effective medication against COVID-19 are going on. There are various experimental treatments for patients with COVID-19; however, none of them are definite. Corticosteroids showed a promising effect in patients under ventilation. FDA approved Remdesivir and convalescent plasma in hospitalized patients. Various medications are under clinical trial studies (74).

There are some pitfalls in the present review. First is our limited knowledge of COVID-19 and its biological behavior. Although human knowledge of this virus evolves rapidly, there are several aspects that are still unknown and might be discovered soon. For example, researchers are conducting numerous clinical trials to find effective treatments and post-exposure prophylaxis for COVID-19, trying to study the effects of emerging variants on morbidity, mortality, and escape from immunity, researching on possible long-term adverse outcomes of COVID-19, the effects of lockdowns and social distancing on health issues, and numerous other unknown aspects (75,76). Moreover, various similar types of viruses exist that were not included in the present review; however, we compared six viruses with the most similarities in structure and behavior with SARS-CoV-2.

Conclusion

This review provided a summary of resemblances

and differences between six similar viruses in structure and behavior with SARS-CoV-2. This study took a step forward and enhanced the current knowledge about SARS-CoV-2 and combined the past experiences of similar viruses to strengthen the ability to fight the COVID-19 pandemic. There are several similarities in the structure and behavior of the above-mentioned viruses with SARS-CoV-2. Several treatments were utilized with various successes in SARS-CoV-2 and other viruses. Origin, structure, signs and symptoms, and organ involvements of several viruses resembled that of SARS-CoV-2; and these similarities can be the focus of future research that integrates past knowledge to provide future advances in COVID-19 containment. However, the scientific community should also pay careful attention to SARS-CoV-2's distinct features and utilize unique approaches and solutions for it. For instance, the high transmissibility of SARS-CoV-2 imposed unmatched burdens worldwide that were not similar to previous viruses observed in recent years. Future studies are recommended to explore and characterize the precise biological behavior of SARS-CoV-2 to inform the preventive and therapeutic guidelines.

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Table 1. A summary of the findings of the reviewed articles

ID	Date of publication (reference number)	Title of the study	Type of study	Country	Important findings
1	2020 (77)	Understanding the dynamics of pandemics	Comparative Analysis	Turkey	This study focused on baseline characteristics of different pandemics and the similarity of COVID-19 to Spanish, Hong Kong, Asian, and swine flu pandemics in terms of spreading to the world. The authors highlighted that the case definition, early case detection, early quarantine and treatment, sufficient stockpiles of medicine, and population co-operation with the containment strategy should be considered for pandemic burden reduction.
2	2020 (78)	The Human Coronavirus Disease COVID-19: Its Origin, Characteristics, and Insights into Potential Drugs and Its Mechanisms	Review	Jordan	This study focuses on the summary of the recently investigated drugs for COVID-19 treatment. Amongst them, Hydroxychloroquine has gained much attention and is currently authorized in most treatment protocols of COVID-19, particularly when prescribed with other antiretroviral and antibiotics.
3	2020 (4)	The transcriptomic profiling of COVID-19 compared to SARS, MERS, Ebola, and H1N1	Comparative Analysis	Egypt	This research determined the relation in cellular host response of Ebola and COVID-19. In both of them GO words and many genes are enriched. Also, particular relation of IL-8 and IL-6 with COVID-19 was shown. Some routes, like PLA2 inhibitors, may be important for potential drugs to cure COVID-19. They stated that simultaneous treatment of various types of experimental methods and parameters have been useful in assessing the etiology of COVID-19 immunopathology in contrast to other viral infections.
4	2020 (6)	Melatonin: Roles in influenza, Covid-19, and other viral infections	Review	UK	Melatonin plays a key role in the adjustment of viral infections. Also, Melatonin is efficient in the management of preexisting medical conditions that lead to influenza and COVID-19 fatality. Sodium Butyrate with suppressing immune system, mitochondrial optimization effects, induction of the Melatonergic pathway, and ability to decrease gut permeability has potential benefits in controling COVID-19 and influenza infections.
5	2020 (5)	Molecular biology of coronaviruses: current knowledge	Review	Indonesia	This study focuses on the molecular characteristics and life cycle of coronaviruses and sheds light on the molecular characteristics of SARS CoV-2. They indicated that it is critical to understand the molecular mechanism which drives cross-species transmission of SARS-CoV-2.
6	2020 (7)	Binding affinities of 438 HLA proteins to complete proteomes of seven pandemic viruses and distribution of strongest and weakest HLA peptide binders in populations worldwide	Research	Germany	The results of this study showed significant discrepancy in Class II HLA and Class I molecules in their valence to present SARS-CoV-2 peptides, among HLA-A proteins a stronger proportion of binders being found. The binding affinity profiles predicted for SARS-CoV-2 are very resembling to all other viruses, except HIV-1.

Cont Table 1

ID	Date of publication (reference number)	Title of the study	Type of study	Country	Important findings
7	2020 (79)	Anti-HIV and Anti-HCV drugs are the putative inhibitors of RNA-dependent-RNA polymerase activity of NSP12 of the SARS CoV-2 (COVID-19)	Research	India	It has been shown that the HIV-drugs could play the putative inhibitor role against SARS-Cov-2 RdRpis, drugs such as Nelfinavir (NFV), Raltegravir (RAL), and Delavirdine (DLV) could be effective against COVID-19. Furthermore, HCV-drugs such as Paritaprevir (PTV), Beclabuvir (BCV), and Ledipasvir (LDV) have tightly linked to substrate-binding domains and active sites.
8	2020 (80)	Developing Vaccines for SARS-CoV-2 and Future Epidemics and Pandemics: Applying Lessons from Past Outbreaks	Commentary	Netherlands	COVID-19 is an emerging infectious disease that can cause many complications and problems with epidemic and pandemic potential like other infectious diseases. Making a vaccine production requires spending a long time, high budget and perform high-risk experiments and there is no guarantee of production success.
9	2020 (81)	COVID-19 in patients with HIV: clinical case series	Research	Spain	This study showed that people living with HIV accounted for almost 1% of patients with COVID-19 who needed hospitalization. Five people who were HIV-positive, MSM, younger than 50 years old, and were identified as COVID-19 patients were studied. None of them died. Two of them were admitted to ICU. Two of them were sex workers and one of them reported participating in chemsex party 6 days before hospitalization. Providing health education programs to inform these people about the ways of transmission and the high risk of SARS-CoV-2 infection whether they have sexual activity seems important. All patients were on ART and a regimen of protease inhibitors, three patients received Lopinavir-boosted ritonavir and twogiven darunavir-boosted cobicistat.
10	2020 (82)	Deep phenotyping of 34,128 patients hospitalized with COVID-19 and a comparison with 81,596 influenza patients in America, Europe and Asia: an international network study	Comparative	Spain	Between 2014 and 2019, a large population of hospitalized patients with COVID-19 was male and younger compared to those admitted to hospital with influenza.
11	2020 (83)	Comparison of Citations Trends between the COVID-19 Pandemic and SARS-CoV, MERS-CoV, Ebola, Zika, Avian and Swine Influenza Epidemics	Comparative	Greece	This study demonstrates that significant correlations were found between COVID-19 and MERS, Ebola and SARS.
12	2020 (84)	Potential for elimination of SAR-CoV-2 through vaccination as inspired by elimination of multiple influenza viruses through natural pandemics or mass vaccination	Review	China	Future vaccination against COVID-19 may take long and be costly. The coming two years is an important time to develop proper vaccines with coordinated cooperation at national and international levels. This study also indicates precedence of vaccines' efficacy for COVID-19 and clarifies the significance of the development of more live vaccines for COVID-19.
13	2020 (85)	Coronavirus disease 2019 (COVID-19) outcomes in HIV/AIDS patients	Review	UK	The findings indicate that currently, people living with HIV (PLHIV) who have an undetectable viral load and sufficient Cluster of Differentiation (CD) count, are not at greater risk than the general population. In other words, HIV infection that managed well is not a risk factor for more vigorous COVID-19. However, the risk of being infected with severe COVID-19 in people living with HIV who are in poor control of HIV or are in Acquired Immunodeficiency Syndrome (AIDS) level is unknown.
14	2020 (86)	Efficacy and safety of convalescent plasma for severe COVID-19 based on evidence in other severe respiratory viral infections: a systematic review and meta-analysis	systematic review and meta-analysis	India	In previous studies of viral infections which leads to severe respiratory, except COVID-19, present indirect and very low-quality evidence show that convalescent plasma has minimal effect on the treatment of COVID-19 or even has no effect and low-quality evidence in a way that causes no serious adverse events.
15	2020 (87)	Coronavirus Disease 2019-COVID-19	Review	India	This study focuses on the epidemiological, remedial, diagnostic, and clinical perspectives, such as prospects of vaccines and preventive actions that globally have been recommended to collate this pandemic virus. Currently, there is a lack of licensed antiretroviral drugs and vaccines against SARS-CoV, MERS-CoV, and SARS-CoV-2. However, for developing a proper therapeutic agent against COVID-19, it is essential to design antiretroviral drugs and develop vaccines.

Cont Table 1

ID	Date of publication (reference number)	Title of the study	Type of study	Country	Important findings
16	2020(88)	Genetic variants of the human host influencing the coronavirus-associated phenotypes (SARS, MERS and COVID-19): rapid systematic review and field synopsis	Review	Italy	Out of 22 eligible articles that investigated candidate genes (2 as associated with COVID-19), the top-ranked genes in the number of studies were ACE2, CLEC4M (L-SIGN), MBL, MxA (n = 3), ACE, CD209, FCER2, OAS-1, TLR4, TNF-α (n = 2). Only variants in MBL and MxA were found as possibly implicated in CoV-associated phenotypes in at least two studies.
17	2020 (89)	Coronavirus in Continuous Flux: From SARS-CoV to SARS-CoV-2	Review	China	The majority of recent studies have mainly focused on the SARS-CoV-2 S protein that is the target of many vaccine development strategies and has been instrumental in aiding our understanding of the mechanism of viral invasion into host cells. Wrap et al revealed the S protein's structural rearrangements following the entry of the virus into the host cells and observed that SARS-CoV-2 showed 10–20-fold increased affinity for ACE2 compared to SARS-CoV. Also, a 382-nt deletion in the majority of the SARS-CoV-2 *ORF8* gene was found in some genome sequences obtained from eight hospitalized patients in Singapore, which may be associated with reduced viral replicative fitness.
18	2018 (90)	Influenza A Virus Cell Entry, Replication, Virion Assembly and Movement	Review	Sweden	The best-characterized protein in IAVs is HA, which has two primary functions (i) to initiate binding to the host cell and (ii) to deliver the vRNPs to the host cell cytosol by fusing the viral and endosomal membranes. Based on this knowledge, several exciting new strategies are being developed to elicit the production of antibodies that target the more conserved region of H.
19	2020 (91)	Why COVID-19 transmission is more efficient and aggressive than viral transmission in previous coronavirus epidemics?	Review	Egypt	SARS-CoV-2 uses multiple ways for efficient transmission. It has a virion structure optimized for various environmental conditions, allowing this virus to use both respiratory and fecal-oral transmission modes. SARS-CoV-2 can interact with ACE2, ANPEP, and DPP4. It can also utilize non-peptidase receptors, such as DC-SIGN1, CLEC4G, and CLEC4M. It efficiently undergoes genomic re-arrangements, thereby developing important means for immunological escape. This broad spectrum of means for the efficient SARS-CoV-2 transmission indicates that it is very unlikely that COVID-19 can be cured by targeting just one segment of this complex mosaic.
20	2015 (92)	Ebola virus outbreak, updates on current therapeutic strategies	Review	USA	Several studies have reported the development of passive immunotherapies in antibodies and small-molecule antivirals with inhibitory activities against Ebola virus infection *in vitro* and in animal models of infection.
21	2021 (93)	SARS-CoV, MERS-CoV, and SARS-CoV-2: A Diagnostic Challenge	Review	India	This study highlights the importance of early and accurate diagnosis and mentions that CT scans and PCRs are the most promising tools for the diagnosis of COVID 19. Most of the diagnostics tools used for the diagnosis of SARS consume time for analysis and require a sophisticated laboratory with trained personnel. The next step is developing 3-D printed microfluidic diagnostic devices to analyze multiple samples obtained from SARS infected patients with high throughput.
22	2020 (94)	Susceptibility to SARS, MERS, and COVID-19 from an animal health perspective	Review	Nepal	Non-human primates and carnivores are susceptible to SARS-coronavirus and SARS-CoV-2, respectively, whereas the dromedary camel is susceptible to MERS-coronavirus. These viruses are reported to originate from bats and can undergo mutation and genomic recombination to infect humans. In addition to humans, several animals like cats, dogs, and tigers also tested positive, but no animal or animal to human transmission is reported. The susceptibility of various animal species to MERS-CoV, SARS CoV, and SARS CoV2 and their clinical presentation is also reported.
23	2020 (95)	Encephalopathy and seizure activity in a COVID-19 well-controlled HIV patient	Case report	USA	A 41-year-old male with a history of well-controlled HIV presented with confusion and was found to have COVID-19. LP was negative. He had worsening encephalopathy with tonic-clonic seizure requiring intubation. He was treated with hydroxychloroquine and azithromycin with improvement in mental status back to baseline after 6 days.

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ID	Date of publication (reference number)	Title of the study	Type of study	Country	Important findings
24	2020 (96)	Comparing COVID-19 and the 1918–19 influenza pandemics in the United Kingdom	Comparative analysis	UK	The findings showed similarities between the current COVID-19 epidemic and the major wave of 1918-19 influenza pandemic over the previous 2 months. Besides their similarities, 1918–19 influenza and COVID-19 also have differences in terms of age patterns for infection and mortality, pre-existing immunity, and vastly different conditions.
25	2020 (97)	Contribution of monocytes and macrophages to the local tissue inflammation and cytokine storm in COVID-19: Lessons from SARS and MERS, and potential therapeutic interventions	Review	Iran	Local tissue inflammation and cytokine storms play a fundamental role in the development of COVID-19-related complications, such as Acute Respiratory Distress Syndrome (ARDS), which is the main cause of death. Macrophage polarization is a reversible process. It is necessary to clarify the factors affecting macrophage plasticity during COVID-19 and how to manipulate macrophage plasticity in a favorable direction. A better understanding of subsets that drive the pathology of the disease is important for the development of proper therapeutic interventions.
26	2020 (98)	Therapeutic Strategies Against COVID-19 and Structural Characterization of SARS-CoV-2: A Review	Review	South Korea	This review focuses on describing the ongoing therapeutic strategies targeting various components of the SARS-CoV-2 life cycle and providing structural insights into the mechanism of action in well-characterized drugs targeting the interaction between hACE2 and the spike protein of SARS-CoV-2 for viral entry, as well as Mopar and RdRp for viral replication. They believe that structural characterization can aid in developing an effective therapeutic strategy not only against COVID-19 but also other viral outbreaks in the future.
27	2015 (99)	Ebola virus comparative genomics	research	USA	This study predicted regions of the Ebola virus that could contain epitope-binding sites, which might be good vaccine targets. This information, combined with glycosylation sites and experimentally determined epitopes, can identify the most promising regions for the development of therapeutic strategies.
28	2020 (100)	Comprehensive overview of COVID-19 based on current evidence	Review	China	Three points raised by the authors: 1) Although the lung is the main target organ for COVID-19, it is also accompanied by multiple organ injuries; therefore, we should pay attention to protection of the function of other related organs while providing respiratory support to patients, especially those with the respiratory crisis. 2) We need to focus on the patients' immune system and take necessary measures to restore their immune function. 3) Pathological analysis of COVID-19 indicates systemic involvement of small vessels, including severe bleeding and micro thrombosis in the lung, heart, and kidney. Therefore, preventive measures could reduce the lesions of small blood vessels and the formation of micro thrombosis and prevent the embolism of large blood vessels.
29	2020 (101)	Innate Immune Evasion by Human Respiratory RNA Viruses	Review	Netherland	Understanding immunologic features of respiratory viruses could shed light on the possibilities for the prevention and therapy in asthmatic complications associated with respiratory infections. Exploiting the innate immune evasive function of the virus could guide the development of new vaccines to remove one or more of these defensive mechanisms from the virus using reverse genetic technology. Therefore, the virus would become attenuated, and at the same time, a better innate immune response due could be evoked due to the virus's inability to activate its evasive functions.
30	2020 (102)	From SARS to SARS-CoV-2, insights on structure, pathogenicity, and immunity aspects of pandemic human coronaviruses	Review	India	This review highlighted the utmost importance of the intermediate hosts for viral transmission to humans. It also elaborated on the damage caused by the failure of the host immune system against CoV infection and the further insurgence of cytokines, which lead to severe mutilation of the host body. Future therapeutic strategies should involve deep immune profiling of the infected individuals and personalization of therapeutics when feasible to accelerate progress towards more effective treatment approaches.

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ID	Date of publication (reference number)	Title of the study	Type of study	Country	Important findings
31	2020 (103)	Immunophenotyping of COVID-19 and influenza highlights the role of type I interferons in the development of severe COVID-19	Review	Korea	The authors investigated the relative proportions of immune cells among Peripheral Blood Mononuclear Cells (PBMCs) in the disease groups compared with the healthy donor group. Unlike the limited changes in mild COVID-19, significant changes were observed in both influenza and severe COVID-19 across multiple cell types among PBMCs. In severe COVID-19, the proportion of classical monocytes significantly increased, whereas those of DCs, nonclassical monocytes, intermediate monocytes, NK cells, EM-like CD8+ T cells, and EM-like CD4+ T cells significantly decreased. In severe influenza, the proportion of classical monocytes significantly increased, whereas those of DCs, non–EM-like CD4+ T cells, EM-like CD4+ T cells, IgG+B cells, and IgG− B cells significantly decreased.
32	2020 (104)	CT Manifestations of Coronavirus Disease (COVID-19) Pneumonia and Influenza Virus Pneumonia: A Comparative Study	Comparative Study	China	CT manifestations of COVID-19 and influenza virus could overlap, “even with the characteristics evaluated using AI software,” Lin et al opined “no significant differences were detected.” Thus, the authors of this AJR article concluded that the more important role of CT during the present pandemic is to find the lesions and evaluate the effects of treatment.
33	2020 (105)	COVID-19 pneumonia: CT findings of 122 patients and differentiation from influenza pneumonia	Cross-sectional	China	The sensitivity of chest CT was reported to be greater than that of RT-PCR (98% vs. 71%). Patients with PCR-confirmed COVID-19 may have normal CT findings at admission; however, a normal CT scan cannot rule out the diagnosis. The combination of chest CT and RT-PCR is necessary for the diagnosis of COVID-19. Edema and smooth muscle hyperplasia could result in bronchiolar wall thickening, which has been reported in influenza, parainfluenza, and adenovirus. Nodule size is helpful in the differential diagnosis of infectious causes of nodules. Nodules were present in 71% of the patients with influenza, but in only 28% of patients with COVID-19, which was consistent with a previous study.
34	2020 (106)	How Is the World Responding to the Novel Coronavirus Disease (COVID-19) Compared with the 2014 West African Ebola Epidemic? The Importance of China as a Player in the Global Economy	Perspective Piece	USA	The mortality rate is estimated to be less than 3%, and basic reproduction (R0) is estimated between 2 and 3, but the fatality rate of Ebola Virus Disease (EVD) was high, including around 50-70% of infected patients and an R0 of a similar range. The negative impact of COVID-19 on the global economy has been much greater than EVD, $1.1 trillion and $25.2 billion, respectively.
35	2020 (107)	Chemokine receptor gene polymorphisms and COVID-19: Could knowledge gained from HIV/AIDS be important?	Review	USA	In COVID-19 patients c-c chemokine receptors (CCR) 1 (CCR1), CCR2, and CCR5 were expressed in hDRG, and are the probable connections of cytokines/chemokines and sensory neuron activation in the lung.
36	2020 (108)	Genotype and phenotype of COVID-19: Their roles in the pathogenesis	Review	Iran	Any adaptation in the COVID-19 sequence that improves the transmission in the human population could also boost its virulence. COVID-19 is expected to become less virulent through human to human transmissions due to genetic bottlenecks for RNA viruses which often occur during respiratory droplet transmissions.
37	2020 (109)	Chest Computed Tomography Findings in COVID-19 and Influenza: A Narrative Review	Review	Grenada	This review compared chest CT findings of COVID-19 and H1N1 influenza cases using existing publications. The findings showed that the ground-glass opacities related to COVID-19 are usually peripherally located compared to influenza, in which central and random lesions could be located as well. Vascular engorgement, pleural thickening, and subpleural lines were more frequently reported in COVID-19 patients. Lymphadenopathy was rare in both COVID-19 and influenza patients. In contrast, pneumomediastinum and pneumothorax were reported only in studies on influenza.

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ID	Date of publication (reference number)	Title of the study	Type of study	Country	Important findings
38	2020 (110)	Clinical, molecular, and epidemiological characterization of the SARS-CoV2 virus and the Coronavirus disease 2019 (COVID-19)	Review	Ecuador	The authors of this study reviewed the genetic, virologic, clinical, and therapeutic evidence on the SARS-CoV-2 virus and the novel coronavirus diseases 2019. They summarized some drug repurposing agents currently known to be effective against other RNA viruses, including SARS-CoV, MERS-CoV and Influenza. The use of chloroquine or hydroxychloroquine in primary health care is not recommended for the management of COVID 19. These drugs are associated with an increased risk of heart damage, especially when administered concurrently with macrolides (QT interval prolongation). Drugs like Tocilizumab have been included in severe or critical patients. Remdesivir is effective against the 2019-nCoV in vitro in Vero E6 cells through the mechanism of involving the host cells' post-entry stage. Several randomized trials are underway to evaluate the efficacy of remdesivir for moderate or severe COVID-19. Oseltamivir inhibits the viral neuraminidase, a drug approved for influenza A and B treatment. Its use was reported during the COVID-19 epidemic in China, but it has no effective outcomes. Tocilizumab, an inhibitor of IL-6 is considered in a group of critical patients, in which 75% cursed with improved respiratory function after treatment. The last treatment reported in a 5-patient case series is convalescent plasma. Following plasma transfusion normalized temperature within 3 days in 4 out of 5 patients, decreased SOFA score, increased PAO2/FIO2 within 12 days, and viral loads also decreased and became negative within 12 days after the transfusion. A promising drug, although the evidence level is low [217]. Bevacizumab is a monoclonal antibody that targets vascular endothelial growth factor (VEGF) that might suppress the edema in patients with COVID-19.
39	2020 (111)	The journey of remdesivir: from Ebola to COVID-19	Review	USA	Remdesivir had potency of vitro activity against the Ebola virus (EBOV) and was highly efficacious in animal models of Ebola virus disease (EVD). Unfortunately, early hopes for a new paradigm in EVD management were deflated with the completion of the first randomized trial. Remdesivir holds promise for COVID-19, but the first published randomized trial was underpowered and inconclusive.
40	2020 (112)	Twenty-First Century Viral Pandemics: A Literature Review of Sexual Transmission and Fertility Implications in Men	Review	USA	Zika virus has been reported in semen up to 370 days after disease onset but appears to be present for a median time of 40 days for most individuals. EBOV has also been detected in semen, with studies indicating its presence for an average of 115 days. West Nile virus has only been reported in semen or to be transmitted sexually in isolated case reports. Influenza has not been found in semen or has been shown to be sexually transmissible. The SARS virus has not been shown to be present in semen. For both SARS and SARS-CoV-2, there is a speculation that the viruses' interaction with ACE2, which is present in the Leydig cells and the testes' seminiferous ducts, could have implications for spermatogenesis. Further studies are needed to explore this possibility.
41	2020 (113)	Comparing SARS-CoV-2 with SARS-CoV and influenza pandemics	Personal View	Italy	Severe morbidity and mortality of SARS-CoV-2 in older adults have been documented in the COVID-19 epidemic even much higher than pandemic influenza. There are no current effective treatments such as antivirals or passive immunization schemes for COVID-19
42	2020 (114)	Clinical characteristics of COVID-19 and its comparison with influenza pneumonia	Original	China	The authors outlined the findings as follows: 1) Males, aged 65 or above, smokers, and those with comorbidities are susceptible to more severe COVID-19 pneumonia. 2) Reduced lymphocyte numbers in COVID-19 patients were documented. 3) Influenza groups displayed higher white blood cell counts and procalcitonin values. 4) There is no significant gender difference in the incidence of COVID-19 pneumonia. 5) COVID-19 is more infectious; however, the rate of secondary bacterial infection is lower in COVID-19 patients compared to influenza.

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ID	Date of publication (reference number)	Title of the study	Type of study	Country	Important findings
43	2020 (115)	What's Old is New! Similarities Between SARS-CoV-2 and HIV	Editorial	USA	This is an editorial written by a nurse/scientist who believes we hear much more about the disease, COVID-19, and not much about the virus, SARS-CoV-2 and although a Phase I clinical trial was launched on March 16, 2020, to test a vaccine, we are months away, at very best, from having it publicly available whether it is proved to be efficacious. She compared that previously, the word 'GRID' was used for HIV, and now the coronavirus is repeatedly used instead of SARS-CoV-2. Unfortunately, like HIV, stigma is becoming a part of the discourse associated with COVID-19's disease trajectory. We notice discrimination toward Asians and Asian Americans, people who have traveled, and health care providers.
44	2017 (116)	AIDS, Avian flu, SARS, MERS, Ebola, Zika… what next?	Review	Netherlands	The authors pointed 1) Increased technologies and approaches to improve response preparation towards the increasing and unpredictable threat posed by the emerging pathogens. 2) Descriptions of the origin, rate of mortality, and vaccine for these diseases, including AIDS, Avian flu, SARS, MERS, Ebola, and Zika.
45	2017 (117)	Pathogen genomic surveillance elucidates the origins, transmission, and evolution of emerging viral agents in China	Review	China	Genomic sequencing has become a standard research tool in the field of emerging infectious diseases, which has been proven invaluable in containing these viral infections and reducing the burden of disease in humans and animals. Genomic surveillance of pathogenic agents will serve as a key epidemiological and research tool in the modern era of precision infectious diseases and the future studies of the virosphere.
46	2020 (118)	Comparison of hospitalized patients with ARDS caused by COVID-19 and H1N1 [manuscript published online ahead of print 26 March 2020]	Original	China	The median age of COVID-19 patients was higher than that of patients with H1N1, and a higher proportion of male subjects were in the H1N1 cohort. COVID-19 patients exhibited higher proportions of non-productive coughs, fatigue, and GI symptoms. H1N1 patients had higher Sequential Organ Failure Assessment (SOFA) scores. Ground-glass opacities were more common in COVID-19 patients. We found the severity of respiratory failure was not equal between COVID-19 and H1N1 patients. The Pao2/Fio2 of 198.5 mm Hg in the COVID-19 cohort was significantly higher. There was a greater variety of antiviral therapies administered to COVID-19 patients. SOFA score-adjusted mortality of H1N1 patients was significantly higher than that of COVID-19 patients, with a rate ratio of 2.009. Both COVID-19 and H1N1 infections may be accompanied by ARDS.
47	2020 (119)	Clinical and Laboratory Findings on the Differences Between H1N1 Influenza and Coronavirus Disease-2019 (COVID-19): Focusing on the Treatment Approach	Original	Iran	Fever and cough are the most prevalent clinical manifestations of both H1N1 influenza and COVID-19 patients. Both COVID-19 and H1N1 patients showed leukopenia as the main laboratory findings. Lopinavir/ritonavir and nucleoside analogs could be drug treatment options for patients with COVID-19. Similar diagnostic methods are used for H1N1 and COVID-19 patients, and they have the same clinical and laboratory features. The prevalence of COVID-19 is larger than that of H1N1 in 2009. The median age for H1N1 patients is the early 40s and for COVID 19 patients, it is 50. Comorbidities have an important role in the increased risk of severe infection.
48	2020 (120)	Case Report: One Case of Coronavirus Disease 2019 (COVID-19) in Patient Co-infected by HIV With a Low CD4+ T Cell Count	Case report	China	Patients who are concomitantly infected with COVID-19 and HIV tend to have a longer disease period and slower generation of antibodies. For suspected cases, nucleic acid amplification, gene sequencing, and antibody detection can affirm the diagnosis.SARS-Cov-2 may damage lymphocytes, especially T-lymphocytes, and the immune system is impaired during the course of the disease.
49	2020 (121)	COVID-19: Understanding the science of antibody testing and lessons from the HIV epidemic	Commentary	USA	Studies have shown that in some people whose nasopharyngeal swab testing is negative for SARS-CoV-2 RNA by RT-PCR, the test is positive on lung secretions.
50	2020 (122)	Applying lessons from the Ebola vaccine experience for SARS-CoV-2 and other epidemic pathogens	perspective	USA	The development of new vaccines and therapeutics is important to achieve long-term prevention and control measures for the virus. This paper provides a summary of experiences related to Ebola vaccine development similar to COVID-19.

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ID	Date of publication (reference number)	Title of the study	Type of study	Country	Important findings
51	2020 (123)	Insight into 2019 novel coronavirus - An updated interim review and lessons from SARS-CoV and MERS-CoV	Review	China	The authors outlined the findings as follows: 1) There is currently no vaccine or specific effective antiviral therapy for COVID-19 2) COVID-19 has a high R0, a long incubation period, and a short serial interval. 3) COVID-19 has a general low CFR, but much higher in patients with comorbidities. 4) The spike protein binding to ACE2 may explain the high R0 of COVID-19. 5) Autopsy showed more exudative lesions and less fibrosis and consolidation. 6) Remdesivir, chloroquine, tocilizumab, and convalescent plasma may be effective. 7) Clinical presentation and pathology of COVID-19 greatly resembled SARS and MERS. 8) Origin of COVID19, MERS, and SARS were bats.
52	2020 (124)	Clinical features of COVID-19 and influenza: a comparative study on Nord Franche-Comte cluster	Original	France	1) Anosmia, dysgeusia, diarrhea, frontal headache, and bilateral cracklings sounds were statistically more frequent in COVID-19. 2) Sputum production, dyspnea, sore throat, conjunctival hyperemia, tearing, vomiting, and rhonchi sounds were more frequent with influenza infection. 3) This study documented the comorbidities, including cardiovascular disease, COPD, and diabetes mellitus in the COVID-19 group. 4) Most common symptoms in the COVID-19 group were fever, cough, fatigue, and myalgia. 5) One of the patients in the COVID-19 group presented with confusion without any respiratory symptoms. 6) Reports describe the torment of difficult triage decisions, and the pain of losing patients and colleagues, besides the risk of COVID-19. 7) Fever (or feeling of fever), fatigue, cough, myalgia, and arthralgia were the most prevalent symptoms for both diseases (COVID-19 and influenza). 8) Patients with COVID-19 frequently represented with a dry cough, anosmia and dysgeusia, diarrhea, frontal and retro-orbital headache, and bilateral crackling sound at pulmonary auscultation compared to the patients of the influenza group. 9) The means incubation period for COVID19 patients was 6 days.
53	2020 (125)	Early Virus Clearance and Delayed Antibody Response in a Case of Coronavirus Disease 2019 (COVID-19) With a History of Coinfection With Human Immunodeficiency Virus Type 1 and Hepatitis C Virus	Case report	China	He had a recurrent fever and muscle aches without another symptom, but CT showed right lower pneumonia. One potential explanation was the consumption of anti-HIV-1 agents that have been reported to have anti-SARS-CoV-2 effects. SARS-CoV-2 RNA test was persistently negative on different specimen samplings at various times, plasma anti-SARS-CoV-2 antibody was positive, which, together with the typical clinical presentation, confirmed the diagnosis of SARS-CoV-2 infection. This was the first case of COVID-19 in a patient with a history of co-infection of HIV-1 and HCV who showed delayed antibody response.
54	2020 (126)	Single-cell sequencing of peripheral blood mononuclear cells reveals distinct immune response landscapes of COVID-19 and influenza patients	Original	China	Increased plasma cells in PBMCs from COVID-19 and IAV patients COVID-19 is featured with XAF1-, TNF-, and Fas-induced T cell apoptosis. COVID-19 activates a distinct pathway (STAT1/IRF3) versus influenza (STAT3/NFkB) IFN response and lymphocyte apoptosis in COVID-19 patients.

- CKD: Chronic Kidney Disease
- CVD: Cardiovascular Disease
- HLA: Human Leukocyte Antigen
- ICU: Intensive Care Unit
- Ig: Immunoglobulin
- IL: Interleukin
- MxA: Myxovirus Resistance Gene A
- NK: Natural Killer
- PBMC: Peripheral Blood Mononuclear Cell
- OR: Odds Ratio
- RdRP: RNA-dependent RNA Polymerase
- RT-PCR: Real-Time Polymerase Chain Reaction
- RNA: Ribonucleic Acid
- TNF: Tumor Necrosis Factor

Table 2. Comparison of COVID-19 with other similar viruses

Feature / Virus	Envelope	Risk factor	Duration of the disease	Common symptoms	Treatment
Influenza	Yes	Age (<60 years)	Two days after exposure to the virus and last less than a week	High fever, runny nose, sore throat, muscle and joint pain headache, cough, tiredness.	Rest, adequate fluids, avoid alcohol and tobacco, and if necessary, take medications such as Acetaminophen (Paracetamol). The two classes of antiviral medications used against influenza are neuraminidase inhibitors (Oseltamivir, Zanamivir, Laninamivir and Peramivir) and M2 protein inhibitors (Adamantane derivatives).
Zika	Yes	Pregnant women	Symptoms typically begin one to two weeks after infection	Fever often causes no or only mild symptoms, similar to a very mild form of dengue fever	There is no specific treatment, Paracetamol (Acetaminophen) and rest
Ebola	Yes	--	Two days and three weeks after contracting the virus	Fever, sore throat, muscular pain, headaches, vomiting, diarrhea	An Ebola vaccine was approved in the United States in December 2019. REGN-EB3 and mAb114, Oral hydration therapy and intravenous fluids
HIV	Yes	Risky behavior, like having anal or vaginal unprotected sex, sharing needles or syringes	Twelve weeks after contracting the virus, the test is positive. 9 to 12 years is the estimated survival time	Fever, chills, rash, night sweats, muscle aches, sore throat, fatigue, swollen lymph nodes, mouth ulcers	antiretroviral drugs
SARS-COV	Yes	Age, Comorbidity, Diabetes, hypertension, and nephropathy	2-7 days(Incubation period)	Muscle pain, Headache, Fever	--
MERS-COV	Yes	Age, comorbidity, Diabetes, hypertension, and nephropathy	14 days (incubation period)	Fever, cough, diarrhea, shortness of breath	There is no specific vaccine or treatment. Using extracorporeal membrane oxygenation.
SARS-CoV-2	Yes	Age, Comorbidity, CVD, (CKD), Respiratory disease, obesity, diabetes	4-12 days (Incubation period)	Fever, cough, dyspnea, fatigue	Remdesivir, Chloroquine, Hydroxychloroquine, Lopinavir/Ritonavir, and Lopinavir/ Ritonavir combined with Interferon-beta.

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