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Editorial: SARS-CoV-2: virology, epidemiology, diagnosis, pathogenesis, and control

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Editorial on the Research Topic

SARS-CoV-2: virology, epidemiology, diagnosis, pathogenesis, and control

Introduction

The rapid spread of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has resulted in the most severe public health challenge since the 1918 Spanish influenza pandemic (1). Consequently, the crisis caused by the coronavirus disease 2019 (COVID-19) has massively impacted global public health, which has rapidly called for public health authorities and scientists to improve our knowledge about this condition (2). In this Research Topic, we serve as editors, and our primary goal was to gather knowledge about the virology of SARS-CoV-2 and different aspects of COVID-19, including epidemiology, pathogenesis, diagnosis, and control. Below, we provide a brief context of the published studies, including 19 original articles, three narrative reviews, and one systematic review.

Virology: SARS-CoV-2 genomics and variants of concern

During the course of the COVID-19 pandemic, the emergence of SARS-CoV-2 variants has been associated with evasion of immunity from natural infection and vaccinations, reduced susceptibility to therapies, increased transmissibility, risk of reinfection, and disease severity (1, 3–7), resulting in a tremendous challenge to controlling the pandemic phase (8). Within this perspective, the rapid spread of SARS-CoV-2 variants worldwide has been associated with a series of waves, as reported in many countries worldwide. To understand this impact in Santiago (Chile), [Acuña-Castillo et al.](#) showed that the highest rate of reinfections described during the fourth and fifth COVID-19 waves

in Santiago was primarily driven by the omicron variant, where the interval between initial infection and reinfection was found to be 372 days.

In Brazil, [Pinho et al.](#) provided relevant insights into the transmission dynamics of SARS-CoV-2 variants in the Brazilian state of Pará by deep sequencing 1,003 SARS-CoV-2 genomes (from May 2020 to October 2022). They found the gamma variant as a predominant variant associated with 290 (28.91%) cases, followed by delta with 53 (5.28%) cases, omicron with 7 (0.69%) cases, and non-variants of concern (VOCs) with 651 (64.9%) cases. Similarly, [Freitas et al.](#) investigated the spatiotemporal dispersion of emerging SARS-CoV-2 variants in the first three years of the COVID-19 pandemic in Sergipe state, Northeast Brazil. The results revealed the presence of five predominant SARS-CoV-2 lineages (B.1, B.1.1, B.1.1.33, B.1.1.28, and B.1.212).

Epidemiology and pathogenesis of COVID-19

In the context of the epidemiology of COVID-19 cases, [Zhang et al.](#) described the epidemiological characteristics of overseas imported COVID-19 cases into China. The findings showed that most overseas imported COVID-19 cases occurred in young and middle-aged Chinese students and businessmen returning from Europe, the United States, and some neighboring countries.

Clinical and experimental advances have shown that individuals infected by SARS-CoV-2 demonstrate a wide range of disease severity ranging from asymptomatic cases to individuals who develop a severe respiratory disease that requires hospital admission or that leads to death (2, 9). In this Research Topic, [Zhu et al.](#) provided a solid and interesting review article highlighting the distinct phases of SARS-CoV-2 pathogenesis and critical points associated with the clinical management of patients with COVID-19. Moving forward, several original studies published on this topic also investigated parameters and mechanisms related to the SARS-CoV-2 pathophysiology, discussing potential mechanisms behind SARS-CoV-2-associated outcomes.

While SARS-CoV-2 infection is known to cause mainly respiratory disease in infected patients, extrapulmonary manifestations are also common, especially in severe cases (10). To address this question, [Wu et al.](#) conducted a cross-sectional descriptive study to evaluate the otologic symptoms in 2,247 patients with COVID-19. The most common otologic symptoms following SARS-CoV-2 infection were vertigo, tinnitus, otalgia, aural fullness, hearing loss, otorrhea, and facial paralysis.

To evaluate the epidemiological, clinical, and laboratory characteristics of patients with COVID-19 admitted to the intensive care unit (ICU), [Sodré et al.](#) conducted a cross-sectional study in a reference hospital for COVID-19 treatment in the Southern Region of Bahia State, Brazil. Briefly, they showed that the use of bladder catheters and central venous catheters were the main factors associated with death in patients with COVID-19 in the ICU. In another study, [Canuti et al.](#) evaluated the role of immune suppression in 1,727 hospitalized patients with COVID-19 in Milan (Lombardy, Northern Italy). The results demonstrated

that immune suppression significantly predicted severe outcomes, while vaccination was a protective factor. In another context, [Kaufman et al.](#) investigated the association between SARS-CoV-2 spike-protein targeted antibody levels and clinically relevant outcomes. In summary, they showed that individuals with detectable SARS-CoV-2 spike-protein targeted antibody levels had less serious outcomes.

In general, young people and children with SARS-CoV-2 infection experience asymptomatic or mild disease, while patients with comorbidities are more likely to be susceptible to developing a severe respiratory disease that requires hospital admission (11). To address this question in Bangladesh, [Sharif et al.](#) investigated the prevalence and impact of long COVID-19 among patients with diabetes and cardiovascular diseases. They found that acute long COVID-19 was detected among 28.4% of patients and chronic long COVID-19 was detected among 71.6% of patients. In addition, they showed that the co-prevalence of cardiovascular diseases, diabetes, and COVID-19 was involved in most cases (95%). Within the same context, [Malaeb et al.](#) investigated the clinical features and the mortality outcomes of patients with COVID-19 admitted to the ICU during the first wave and two subsequent surges in Iraq, while [Hu et al.](#) evaluated the impact of the first wave of COVID-19 on Crohn's disease after the end of the zero-COVID policy in China.

Diagnosis of COVID-19

Accurate COVID-19 diagnosis and testing have shown to be key for disease control, especially before vaccines were widely available (2, 12). However, diagnostics also plays an important role in other contexts. Thus, [Acuña-Castillo et al.](#) did an ecological study on COVID-19 reinfection in Chile using RT-PCR data information from over 300,000 individuals tested between 2020 and 2022. They found that the highest rate of reinfections took place during the fourth and fifth COVID-19 waves and was primarily driven by the omicron variant. The reinfection rate was 1.52 per 100,000 inhabitants, and the interval between initial infection and reinfection was found to be close to one year.

Serological tests were of limited value for clinical decision-making and implementation of patient isolation and quarantine (12). However, SARS-CoV-2-specific antibodies are major players in the immune defense against COVID-19. To address this, [Kaufman et al.](#) conducted a retrospective study to estimate the association between SARS-CoV-2 spike-protein targeted antibody levels and clinical outcomes in a cohort of almost 200,000 patients. Individuals with detectable SARS-CoV-2 antibody levels were less prone to be infected by SARS-CoV-2 and had lower risks of developing serious diseases upon infection.

Vaccination against SARS-CoV-2 in different perspectives

In a rapidly moving field of study, several articles have evaluated the effectiveness of available vaccines against SARS-CoV-2 variants, especially within the emergence of omicron VOC. To address this

question, Song et al. conducted a systematic review to evaluate the effectiveness of SARS-CoV-2 vaccines against omicron infection. Using 42 articles for analysis, they concluded that one or two SARS-CoV-2 booster doses provide considerable protection against omicron infection and substantial protection against severe COVID-19-related events. Similarly, three other studies (Reyes et al., Paduano et al., and Liviero et al.) provided relevant insights into the protective effect of the COVID-19 vaccine in the general population, highlighting the importance of vaccination as an effective strategy to reduce the number of cases, hospitalizations, and deaths.

On the other hand, Asefa et al. investigated the adverse reactions to COVID-19 vaccines among Ethiopian healthcare professionals. Among the 277 study participants, the most reported short-term adverse reactions were injection site pain, headache, fever, fatigue, chills, and muscle pain, and there was no detectable association between adverse reactions and the types of COVID-19 vaccine (Oxford AstraZeneca, Johnson & Johnson, Sinopharm, and Pfizer) subjects received. Subsequently, Xie et al. described relevant insights into the COVID-19 vaccination among groups of cancer patients, while Giudice et al. reported the factors involved in parents' hesitancy to vaccinate their children against COVID-19 in Italy. In the same direction, Kotronia et al. investigated willingness to vaccinate and the associated factors in samples of unvaccinated and vaccinated adults in Poland. These findings suggest that although COVID-19 vaccines have shown to be safe and effective, some individuals were reluctant to take the vaccine during the pandemic course, negatively impacting the establishment of effective vaccination programs and therapeutic interventions. Branch-Elliman et al. explained how we can improve our response to infectious diseases using COVID-19 as a study model.

Final considerations

Despite the passage of 4 years since the beginning of the pandemic, there are still many gaps that we need to address about this devastating disease that will certainly be recorded as one of the greatest public health problems in the history of humanity. The COVID-19 pandemic has highlighted both our ability to respond and our resilience to face biothreats of this magnitude. Most importantly, the lessons acquired during the COVID-19 pandemic will be essential for dealing with future public health

threats, particularly for the response against new pathogens. Through this Research Topic, we contributed to the advancement of knowledge related to COVID-19 in several aspects, including epidemiology, genomic surveillance, diagnosis, pathogenesis, and control.

Author contributions

SS: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. SK: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Visualization, Writing – original draft. LP: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Visualization, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The authors SS, SK, and LP declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

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