

Review

Covid-19 and Its Impact in Dental Health and Profession: A Review

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Abstract

The COVID-19 pandemic, driven by SARS-CoV-2, has profoundly affected global healthcare, challenging both medical and dental practices. Emerging in Wuhan, China, in December 2019, COVID-19 quickly escalated into a pandemic, leading the World Health Organization to declare a global health emergency. This review explores the pathogenesis, transmission, systemic health effects, and oral health implications of COVID-19. SARS-CoV-2, a beta coronavirus, spreads mainly through respiratory droplets, with aerosols and fomites also playing roles in its transmission. The virus binds strongly to the ACE2 receptor, present in respiratory, myocardial, and oral and nasal mucosa cells, facilitating infection and replication. The ensuing immune response, critical for viral clearance, can lead to a hyperinflammatory ‘cytokine storm’, causing severe complications like ARDS and multi-organ failure. Clinically, COVID-19 ranges from asymptomatic cases to severe systemic involvement, affecting cardiovascular, neurological, renal, and hematological systems. Oral health issues such as dysgeusia and xerostomia are increasingly noted, indicating the virus’s broader impact. This review emphasizes the need for stringent infection control in dental practices, including enhanced protective measures and procedural adaptations. A multidisciplinary approach integrating oral health into broader COVID-19 strategies is crucial. Continued research is essential to understand the long-term implications of COVID-19 and to refine preventive and therapeutic strategies, shaping future healthcare policies.

Keywords: COVID-19, prevention, oral cavity, oral mucosa, ACE2, oral hygiene

Резюме

Пандемията COVID-19, предизвикана от SARS-CoV-2, оказва значително въздействие върху глобалното здравеопазване, поставяйки предизвикателства пред медицинските и стоматологичните практики. Появявайки се в Ухан, Китай, през декември 2019 г., COVID-19 бързо се разпространи, което доведе до обявяване на глобална здравна извънредна ситуация от Световната здравна организация. Този преглед разглежда патогенезата, предаването, системните здравни ефекти и оралните прояви на COVID-19. SARS-CoV-2, бета коронавирус, се предава основно чрез респираторни капчици, като аерозолите и фомитите също играят роля в разпространението му. Вирусът се свързва силно с ACE2 рецептора, присъстващ в клетките на дихателния епител, миокарда и оралната и назалната лигавица, което улеснява инфекцията и репликацията. Полученият имунен отговор, важен за изчистването на вируса, може да доведе до хипервъзпалителна „циткинова буря“, причиняваща тежки усложнения като ARDS и мултиорганна недостатъчност. Клинично, COVID-19 варира от асимптоматични случаи до тежко системно засягане, включително сърдечно-съдови, неврологични, бъбречни и хематологични системи. Все повече се признават и орални здравни проблеми като дисгеузия и ксеростомия, показващи по-широкото въздействие на вируса. Този преглед подчертава необходимостта от строг контрол на инфекциите в стоматологичните практики, включително засилени защитни мерки и адаптации в процедурите. Важен е мултидисциплинарен подход, интегриращ оралното здраве в по-широките стратегии за борба с COVID-19. Продължаващите изследвания са от съществено значение за разбиране на дългосрочните последици от COVID-19 и за усъвършенстване на превантивните и терапевтичните стратегии, оформящи бъдещите здравни политики.

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Introduction

In December 2019, the medical community was alerted to the emergence of a novel coronavirus in Wuhan, China, later designated as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (Zhu *et al.*, 2019). This pathogen, responsible for the clinical syndrome termed COVID-19, rapidly transcended geographical boundaries, escalating from an epidemic to a global pandemic. The World Health Organization (WHO) officially declared it a Public Health Emergency of International Concern on January 30, 2020, and subsequently characterized it as a pandemic on March 11, 2020 (Biadsee *et al.*, 2020; World Health Organisation, 2020).

Genomic analysis of SARS-CoV-2 identified it as a member of the betacoronavirus genus, sharing substantial homology with both the severe acute respiratory syndrome coronavirus (SARS-CoV) and various bat coronaviruses, suggesting a zoonotic origin (Chen *et al.*, 2020). This discovery underscored the potential interspecies transmission mechanisms that may have facilitated its emergence in humans (Van Doremalen *et al.*, 2020). The primary transmission pathway of SARS-CoV-2 is through respiratory droplets, although aerosol, fomite, and potential fecal-oral routes have been documented, contributing to its rapid and pervasive spread (Khan *et al.*, 2020; Rodriguez-Morales *et al.*, 2020).

Critical to the pathogenesis of SARS-CoV-2 is its affinity for the angiotensin-converting enzyme 2 (ACE2) receptor, extensively expressed in human tissues, including the respiratory epithelium, myocardial cells, and notably within the oral and nasal mucosa (Yan *et al.*, 2020; Walls *et al.*, 2020). This receptor serves as the primary entry point for the virus, mediating cellular infection and facilitating viral replication. The ensuing host immune response, while essential for viral clearance, can in severe cases, become dysregulated, leading to widespread tissue damage and clinical complications (Chen *et al.*, 2020).

This review aims to elucidate the comprehensive landscape of COVID-19, with an emphasis on its oral manifestations and implications for dental health and practice (Wang *et al.*, 2020). Given the ubiquitous nature of the virus and its significant impact on healthcare systems globally, a thorough understanding of its pathophysiology, transmission dynamics, and clinical implications is imperative for the medical and dental communities.

Pathogenesis and transmission of COVID-19

The pathogenesis of COVID-19, instigated

by SARS-CoV-2, initiates with the viral entry into the host organism, primarily through inhalation of infectious respiratory droplets (Pereira *et al.*, 2020). SARS-CoV-2, an enveloped, single-stranded RNA virus from the Coronaviridae family, is characterized by its surface spike glycoproteins, pivotal in mediating host cell entry (VanDoremalen *et al.*, 2020). These surface glycoproteins exhibit a high affinity for the angiotensin-converting enzyme 2 (ACE2) receptors, extensively expressed in various human tissues including pulmonary alveolar epithelial cells, myocardial tissue, renal epithelium, and notably within the epithelial cells of the oral and nasal mucosa (Wang *et al.*, 2020). The binding of the viral spike protein to the ACE2 receptor, followed by its priming by the host cell's transmembrane protease, serine 2 (TMPRSS2), facilitates viral entry and subsequent endocytosis (Wang *et al.*, 2020).

Once successfully internalized, the virus exploits the host cellular machinery to replicate its RNA and synthesize essential viral proteins (Zhou *et al.*, 2020). This intracellular replication leads to the assembly of progeny virions, which are subsequently released to infect additional host cells, thereby propagating the viral infection. Concurrently, the host's innate immune system responds to the viral invasion. However, in severe cases of COVID-19, this immune response can become dysregulated, resulting in a pathological hyperinflammatory state known as the 'cytokine storm' (Hererra *et al.*, 2020). Characterized by elevated levels of pro-inflammatory cytokines and chemokines, this immune dysregulation can lead to acute respiratory distress syndrome (ARDS), systemic inflammatory response syndrome (SIRS), and multi-organ failure (Xu *et al.*, 2020).

Clinical manifestations of COVID-19

COVID-19, precipitated by the novel SARS-CoV-2 virus, manifests with a spectrum of clinical presentations, ranging from asymptomatic carriage to severe respiratory distress and multi-organ dysfunction. The symptomatic profile of COVID-19 is predominantly respiratory, characterized initially by fever, cough, and dyspnea (Alterio *et al.*, 2020). However, the clinical tableau can rapidly evolve, particularly in individuals with underlying comorbidities, to more severe forms including pneumonia, acute respiratory distress syndrome (ARDS), and critical systemic complications (Alterio *et al.*, 2020).

The pathophysiology of COVID-19-induced respiratory pathology is intricately linked to the

virus's affinity for pulmonary epithelial cells, facilitated by the ubiquitous expression of the ACE2 receptor. Once internalized, the virus triggers a cascade of immune responses, leading in some instances to a disproportionate inflammatory reaction, the so-called "cytokine storm". This hyperinflammatory state is characterized by elevated levels of proinflammatory cytokines such as interleukin-6 (IL-6), tumour necrosis factor-alpha (TNF- α), and interleukin-1beta (IL-1 β). The resultant pulmonary inflammation and capillary leak can culminate in ARDS, a major cause of morbidity and mortality in severe COVID-19 cases (Zhu *et al.*, 2019).

Moreover, emerging evidence indicates a broader systemic involvement, with COVID-19 affecting multiple organ systems. Reports have documented cardiovascular complications, including myocarditis, arrhythmias, and acute coronary syndromes, likely resultant from direct viral invasion and systemic inflammation (Chen *et al.*, 2020). Neurological manifestations, ranging from anosmia and ageusia to more severe encephalopathies and strokes, have been observed, suggesting neurotropic potential of the virus (Walls *et al.*, 2020, Chen *et al.*, 2020; Calabrese *et al.*, 2020). Renal impairment, coagulopathies manifesting as thromboembolic events, and gastrointestinal symptoms further delineate the systemic impact of COVID-19 (Tay *et al.*, 2020; VanDoremalen *et al.*, 2020).

Notably, the virus's implications in the oral cavity are increasingly recognized. Manifestations such as xerostomia, dysgeusia, and potential oral mucosal lesions are being reported, underscoring the virus's impact beyond the respiratory system. These oral symptoms not only contribute to the disease's symptomatic diversity but also pose specific challenges and considerations in dental practice (Wong *et al.*, 2004).

The clinical course of COVID-19 is thus multifaceted, with implications extending beyond the respiratory system to a pan-systemic involvement. This necessitates a multidisciplinary approach to management, encompassing not only respiratory support but also comprehensive care addressing cardiovascular, neurological, renal, and haematological dimensions of the disease (Chen *et al.*, 2020).

COVID-19 and oral health

The intersection of COVID-19 with oral health represents a critical aspect of the disease's systemic impact. SARS-CoV-2's interaction with the oral cavity is multifaceted, reflecting both direct viral effects and secondary manifestations due to systemic involvement and immune responses.

The oral manifestations associated with COVID-19 are increasingly being recognized and reported, with implications for dental practice and oral health management (Yao *et al.*, 2020).

The oral cavity, rich in ACE2 receptors, particularly in the epithelial cells of the tongue, buccal, and gingival tissues, serves as a potential site for SARS-CoV-2 entry and replication. This predilection may explain some of the oral symptoms observed in COVID-19 patients, including dysgeusia (altered taste sensation) and xerostomia (dry mouth). These symptoms, while not life-threatening, can significantly impact quality of life and nutritional status, and may serve as early indicators of the disease (Yao *et al.*, 2020).

Beyond these direct effects, COVID-19's systemic inflammatory response can also manifest within the oral cavity. Inflammatory responses and subsequent immune dysregulation associated with severe COVID-19 can potentially exacerbate pre-existing oral conditions, such as gingivitis and periodontitis. The cytokine storm, characterized by elevated levels of pro-inflammatory mediators, may have implications for oral mucosal health, potentially leading to an increased incidence of oral ulcerations and other mucosal lesions (Xu *et al.*, 2020).

The implications for dental practice are profound (Takahashi *et al.*, 2020). Dental professionals are at heightened risk due to proximity to patients' oral cavities and the potential for aerosol generation during procedures. This necessitates stringent infection control measures and modifications in dental practice to mitigate the risk of virus transmission. Additionally, the management of oral manifestations in COVID-19 patients, particularly in those with severe disease, requires a multidisciplinary approach, integrating dental care with broader medical management (Pitones *et al.*, 2020; Burton *et al.*, 2020).

Understanding the relationship between COVID-19 and oral health is pivotal, not only for the management of oral symptoms but also for broader public health strategies. As the pandemic evolves, continued research and clinical observation are essential to deepen our understanding of these interactions and to guide evidence-based practice in dentistry (Gherlone *et al.*, 2020).

Systemic health implications and oral hygiene

The interplay between COVID-19 and systemic health, particularly in the context of oral hygiene, is a critical area of focus (Eggers, 2019). Emerging evidence suggests that the state of oral health may not only be affected by COVID-19 but

could also influence the severity and progression of the disease (Eggers *et al.*, 2018). This bidirectional relationship underscores the importance of maintaining optimal oral hygiene, especially in the context of a pandemic (Katagiri *et al.*, 2009).

Poor oral hygiene can lead to periodontal disease, characterized by chronic inflammation and bacterial dysbiosis (Zhou *et al.*, 2009). This inflammatory state may exacerbate systemic inflammatory responses, particularly relevant in the context of COVID-19. Patients with periodontitis, for instance, exhibit heightened levels of proinflammatory cytokines, similar to those observed in the cytokine storm associated with severe COVID-19. This systemic inflammatory burden can potentially worsen the course of COVID-19, leading to more severe complications. Conversely, the systemic inflammatory milieu of severe COVID-19 may aggravate periodontal conditions, creating a vicious cycle of inflammation (Abe *et al.*, 2006).

Moreover, the oral cavity acts as a reservoir for various microorganisms, including potential pathogens (Yoneyama *et al.*, 1999). Good oral hygiene practices can reduce the bacterial load in the oral cavity, thereby possibly decreasing the risk of secondary bacterial infections in COVID-19 patients (Carrouel *et al.*, 2021). This is particularly important in hospitalized patients, where the risk of nosocomial infections, including respiratory infections, is elevated (Chaudhary *et al.*, 2021).

The implications of these findings are significant for healthcare providers. They highlight the need for integrated care approaches, where oral health is considered as part of the overall health management strategy for COVID-19 patients. Regular dental check-ups and oral hygiene practices should be emphasized, not only for general health but also as a potential factor in mitigating the severity of COVID-19 (Suzuki and Delisle, 1984).

In summary, the relationship between oral health and systemic health in the context of COVID-19 is complex and interdependent. Further research is needed to fully understand the mechanisms behind this relationship and to develop comprehensive care strategies that incorporate oral health as a key component of overall health, particularly in the management of COVID-19 patients (Rodriguez-Morales *et al.*, 2020).

Prevention and management strategies in COVID-19

The prevention and management of COVID-19, particularly in the realm of dental health, necessitates a multi-faceted approach that

encompasses both general health measures and specific strategies tailored to oral healthcare settings. Given the modes of transmission and the pathogenesis of the disease, these strategies are pivotal in controlling the spread of the virus and ensuring the safety of both patients and healthcare providers (Spellberg *et al.*, 2012; Ruan *et al.*, 2020; Tay *et al.*, 2020).

At the forefront of preventive measures is the implementation of robust infection control protocols in dental practices. This includes the use of personal protective equipment (PPE) like N95 respirators, face shields, gloves, and gowns, which are essential to protect dental professionals from aerosolized particles during dental procedures (Yan *et al.*, 2020). Additionally, the adoption of pre-procedural mouth rinses with antiviral agents, such as povidone-iodine or hydrogen peroxide, may reduce the viral load in oral secretions, thereby minimizing the risk of viral transmission during dental treatments (Yao *et al.*, 2020).

The management of COVID-19 in dental settings also involves the modification of clinical practices to reduce aerosol generation. Techniques such as rubber dam isolation and high-volume suction are recommended to limit the spread of aerosols. Furthermore, the scheduling of appointments should be managed to reduce patient overlap and allow for adequate disinfection of treatment areas between patients (Yoneyama *et al.*, 1999).

Beyond the dental clinic, public health measures play a crucial role in the broader management of COVID-19. These include widespread testing, contact tracing, and quarantine protocols to identify and isolate infected individuals. Vaccination against COVID-19 has become a central pillar in the fight against the pandemic, with ongoing efforts to increase vaccine uptake among the general population and healthcare workers (Zhou *et al.*, 2020).

In terms of oral health management in COVID-19 patients, a multidisciplinary approach is required. For patients experiencing oral manifestations such as dysgeusia or xerostomia, management strategies may include palliative care and symptomatic relief. Additionally, for patients with pre-existing oral health conditions, regular dental check-ups and maintenance of good oral hygiene are vital to prevent exacerbations (Yoneyama *et al.*, 1999).

In conclusion, the prevention and management of COVID-19 in dental health settings require a comprehensive and adaptive approach. This includes stringent infection control practices, modifications in dental procedures, and the integration of

dental care within the broader public health strategies against COVID-19 (Zhou *et al.*, 2017)

Conclusions

The COVID-19 pandemic, caused by the novel SARS-CoV-2 virus, has brought unprecedented challenges to the global healthcare system, significantly impacting various aspects of medical and dental practice (Chen *et al.*, 2020). This comprehensive review has elucidated the multifaceted nature of COVID-19, ranging from its pathogenesis and transmission to its systemic and oral health manifestations (Wong *et al.*, 2004). The insights gained underscore the complexity and interconnectivity of systemic health, oral health, and infectious diseases (Yao *et al.*, 2020; Xu *et al.*, 2020).

Key findings from this review highlight the critical role of the ACE2 receptor in mediating SARS-CoV-2 infection and the subsequent systemic implications (Yan *et al.*, 2020). The virus's impact extends beyond the respiratory system, affecting multiple organs and manifesting in diverse clinical presentations, including significant oral health implications. These findings reinforce the importance of considering oral health as an integral component of overall health, particularly in the context of systemic infectious diseases like COVID-19 (Zhou *et al.*, 2020).

In the realm of dental practice, the pandemic has necessitated a paradigm shift in infection control protocols, patient management, and clinical procedures (Herrera *et al.*, 2020). The adoption of enhanced personal protective equipment, stringent disinfection protocols, and modifications to clinical techniques are essential to ensure the safety of both patients and dental professionals (Yao *et al.*, 2020). Furthermore, the interplay between systemic health and oral health in the context of COVID-19 highlights the need for a multidisciplinary approach in patient care, emphasizing the importance of integrating dental health considerations into the broader management of COVID-19 patients (Van Doremelen *et al.*, 2020).

As the global community continues to navigate the challenges posed by the pandemic, ongoing research and clinical observations are imperative (Yoneyama *et al.*, 1999). Further studies are needed to deepen our understanding of the long-term implications of COVID-19, the efficacy of various preventive and management strategies, and the development of effective therapeutics and vaccines (Carrouel *et al.*, 2021). The lessons learned from this pandemic will undoubtedly shape future healthcare policies, clinical practices, and research

priorities in both medicine and dentistry (Chaudhary *et al.*, 2021).

In conclusion, the COVID-19 pandemic has provided valuable insights into the intricate relationship between systemic diseases and oral health (Katagiri *et al.*, 2009). It serves as a reminder of the importance of maintaining optimal oral hygiene, not only for oral health but as a crucial aspect of preventing and managing systemic diseases (Zhou *et al.*, 2020).

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