Post-Pandemic Dental Practice: COVID-19, Oral Health & Infection Control

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Conflict of Interest Disclosure Statement

- Dr. Geisinger reports no conflicts of interest associated with this course. She has no relevant financial relationships to disclose.

Short Description

This course seeks to discuss the evolution of infection control in the dental office and our understanding of the interactions between oral disease and COVID-19 infection.

Course Contents

Overview

The COVID-19 pandemic represented a paradigm shift in dental care delivery and risk mitigation within the dental practice. As we move forward as a profession, reflecting on the impact that the COVID-19 pandemic has had on our practices and what we have learned regarding the importance of oral health for outcomes with high consequence infectious diseases (HCIDs) allows us to better serve our patients and to communicate how essential dental care is to overall wellness. This course will review the impact of the COVID-19 pandemic on the field of dentistry in the US and globally. We will review the expansion of our knowledge base regarding in-office dental infectious control, including emerging data on aerosol transmission of disease within dental practices. We will also assess the emerging data regarding the long- and short-term oral manifestations of COVID-19 infection and the impact of periodontal health and inflammation of COVID-19 symptom severity.

Learning Objectives

Upon completion of this course, the dental professional should be able to:

- Assess enhanced infection control practices based upon expanded scientific knowledge after the COVID-19 pandemic.
- Review data regarding short and long-term oral manifestations of COVID-19 and the potential impact of COVID-19 related stress on patients' oral health.
- Assess the emerging science regarding periodontal disease and oral inflammation and COVID-19 disease severity.
- Identify gaps in our knowledge and further research questions regarding the impact of COVID-19 for the dental field.

Introduction

In 2019, a novel β-coronavirus [severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2)] causing severe and potentially fatal pneumonia was identified in Wuhan city, Hubei province, China.[1-3] This virus and the subsequent illness, coronavirus disease 2019 (COVID-19) initiated a pandemic.[4] Clinical symptoms of acute SARS-CoV-2 infection in a patient without immunity include fever, dry cough, myalgia, fatigue, and pneumonia with abnormal chest CT. Less commonly observed symptoms include sputum production, headache, hemoptysis, and diarrhea.[5-7] Further, heterogeneity in symptom frequency have been demonstrated with shifts in symptoms based upon different variants.[8] The person-to-person transmission of SARS-CoV-2 includes direct transmission, such as cough, sneeze, saliva and other droplet inhalation transmission, distant airborne transmission of droplet nuclei, and contact transmission, such as the contact with oral, nasal, and eye mucous membranes.[9-11] Fomite transmission has also been proposed, although it is likely a very minor transmission pathway.[11]

Prior to the COVID-19 pandemic, infection control in the dental office focused on bloodborne pathogens and Standard and Transmission based precautions limiting exposure to bodily fluids and other potentially infectious materials.[12-17] There are three categories of Transmission-based Precautions: contact precaution, droplet precautions, and airborne precautions associated with droplet nuclei.[15-17] During the initial days of the pandemic, the airborne transmission of SARS-CoV-2 was believed to pose particular issues for delivery of safe dental care. Dental health care personnel (DHCP) and their patients were presumed to be at increased occupational risk associated with aerosols in the dental office due to the frequency of close, personal face-to-face communication and exposure to saliva,

blood, and other body fluids, and—indirectly—by the handling of sharp instruments and touching contaminated dental surfaces.[18-21] It has been well-established that delivery of many dental procedures results in the generation of aerosols, which could result in the airborne spread of infectious material and the perception of routes of transmission in dentistry have been altered by COVID-19 and the subsequent practices of enhanced infectious control during and following the pandemic.[22,23] Recent evidence has also shown that there may be a link between oral health and COVID-19 infection. Given these considerations, this course seeks to review the evidence on infectious diseases and oral and overall health that was gleaned during and after the COVID-19 pandemic and the implications on the provision of dental care.

COVID-19 Impact on Dental Practice Infection Control

The COVID-19 pandemic has thrust infection control practices into the forefront and has highlighted the need for review of safety protocols and practices to ensure optimal working environments for patients and healthcare workers alike. In dentistry, the exposure of dental healthcare professionals and patients to both airborne and bloodborne pathogens was identified as a potential risk from early periods in the pandemic and enhanced infection control practices were sought to mitigate risks of exposure and infection during the provision of dental care.[23-26] After the initial emergence of SARS-CoV-2 in China in 2019, many governmental bodies mandated service limitations and/or shut-downs for healthcare workers, including those providing dental care.[16,17,27] Further, both pharmaceutical and nonpharmaceutical measures were put into place to limit disease transmission and severity, including quarantine, physical distancing, hygiene measures and vaccination protocols.[28] Within the dental setting, national recommendations for dental healthcare professionals included enhancements to infection control practices like enhanced personal protective equipment (PPE), surface decontamination, post-appointment surveillance, and patient assessment and triage.[29]

Due to the droplet and airborne transmission risk of SARS-CoV-2, enhanced infection control practices were recommended as interim protocols, many of which have now become standard practice in many dental offices. [9,30,31] Studies have shown that COVID-19 did result in statistically significant differences in the use of protective barriers such as hair covers and eye protection/face shields and disinfection practices.[32] Furthermore, despite concerns early in the pandemic, data indicate that with the use of such enhanced infection control practices, delivery of dentistry resulted in very low transmission rates.[33-34]These findings further highlight the expertise of dental healthcare professionals in infection control practices and the willingness of dental healthcare professionals to adapt to improve safety for their patients and colleagues.

Enhanced Infection Control Practices

In 2016, the United States Centers for Disease Control and Prevention (CDC) established "basic expectations for safe care" in dental practice settings.[35] These expectations included a set of standard precautions, including hand hygiene, PPE, respiratory etiquette, safe injection practices, appropriate storage and handling of instruments, instrument sterilization, and disinfection of practice environments/surfaces.[35] Further, the CDC recommended additional transmission-based precautions, such as identification of infectious patients, contact precautions, droplet and aerosol precautions.[35] The COVID-19 based precautions for dental settings from the CDC and the American Dental Association built upon these protocols and incorporate engineering and administrative controls (Figure 1).[36,37] In response to the COVID-19 pandemic, awareness of aerosols within the dental office came into sharp focus and practices to reduce infectious aerosols were employed. Such practices include ventilation and practice layout, extraoral suction, advanced respirators and/or mask filtration, and pre-operative patient screening.[37] A survey deployed during the pandemic demonstrated high levels of adherence to enhanced infection control practices by dentists in their practice over a six-

month period.[33] Longer studies conducted in the same manner also demonstrated low infection risks and high rates of adherence to enhanced infection control practices.[34] It is also likely that many of these practices have been incorporated into standard infection control practices post-pandemic.

Figure 1. Considerations for infection control in dentistry.

Current recommendations from the CDC and regional/state dental boards include risk-based assessment of community infection rates and individual patient and practitioner risk assessments to reduce COVID-19 transmission in the dental office. The CDC recommends routine infection prevention and control (IPC) practices, including remaining up-to-date with all recommended COVID-19 vaccine doses. The following current best-practices to address continued risk for COVID-19 infection for healthcare professionals:[29]

- ***Establish a Process to Identify and Manage Individuals with Suspected or Confirmed SARS-CoV-2 infection***: Visual alerts in strategic places throughout healthcare facilities can alert patients and healthcare professionals to the infection control practices at the facility. Individuals should be informed of the policies if they have had a positive test for SARS-CoV-2, symptoms of COVID-19, or close contact with an individual with SARS-CoV-2 infection.
- ***Implement Source Control Measures:*** This includes the use of well-fitting facemasks or respirators to reduce the spread of respiratory secretions
- ***Implement Universal Use of Personal Protective Equipment for HCP:*** This includes barrier protection for Standard and/or Transmission Based Protocols based upon suspected diagnosis. The CDC also notes that as SARS-CoV-2 transmission rates in the community increase, healthcare professionals should consider implementing broader use of respirators and eye protection.
- ***Optimize the Use of Engineering Controls and Indoor Air Quality:*** These include proper ventilation, physical barriers at reception/triage locations, appropriate disinfection,[38] intraprocedural evacuation as well as avoidance of crowded communal areas.
- ***Protocols to Address COVID-19 Infection in Practitioners:*** Ongoing self-monitoring and appropriate quarantine/infection prevention and control practices should be established a priori for all staff within the dental healthcare facility.

It should also be noted that the implementation and utilization of such protocols is currently being revised by OSHA and the CDC and dental healthcare workers are encouraged to regularly review all of the following:[39]

- The *level of ongoing community transmission* of COVID-19 in their community. The CDC continues to monitor community levels of COVID transmission and track those in their COVID Risk assessment tool.
- The *phase of reopening* (if applicable) the community in which the dental practice is located has entered.
- The *risk to dental practitioners and support staff* of being exposed to sources of SARS-CoV-2, including suspected and confirmed COVID-19 cases and people who are infected with SARS-CoV-2 but do not have signs and/or symptoms of COVID-19 (but who may be able to spread the virus to others without knowing it).

- The availability and ability of the employer to implement controls to protect workers from exposure to sources of SARS-CoV-2.

Screening Mechanisms

Every practice needs to have a daily production The implementation of teledentistry practices during the pandemic allowed for pre-procedural assessments of patient symptoms without an in-person interaction between patient and dental healthcare professional. Such pre-procedural assessments allow dental healthcare professionals to assess patients for exposure and infectious symptoms prior to delivery of dental care and may identify high-risk patients and reduce exposure for dental healthcare professionals. The objective of such screening allows dental healthcare professionals to limit or select the patients who have access to the dental clinical environment. Further, evidence suggests that utilization of teledentistry increased significantly during and after the COVID-19 pandemic.[39,40] It is notable that social influences positively impacted dentists' willingness to engage in teledentistry and the increase in the utilization during COVID-19 may result in long-term shifts in dental consultation delivery via teledentistry services.[41] This could result in triage or delivery of palliative care for patients with urgent/emergent leads who may be at higher risk of infectious spread and postponement of elective procedures in high-risk individuals.[23] It should be noted that the application of teledentistry varies by localities and dental healthcare providers should confirm with their regulatory bodies, including federal, state, and/or other regulatory boards to determine allowable application in their area.

Adjunctive Infection Control Methods

In addition to enhanced methods to reduce aerosols, dental healthcare professionals should implement additional infection control measures, including vaccination protocols and administrative and engineering controls within the dental office. Recommendations from the CDC include administrative measures and education for individuals in dentistry. The occupational safety and health administration (OSHA) has created a hierarchy of controls to address workplace health and safety, including in healthcare settings: Risk elimination, Engineering controls, Administrative practices, and PPE (Figure 2).[42]

Figure 2. OSHA's Hierarchy of Infection Controls in Healthcare Environments

Recommendations for infection control in a dental office include:

1. Develop and maintain infection prevention and occupational health programs.
2. Provide supplies necessary for adherence to Standard Precautions (e.g., hand hygiene products, safer devices to reduce percutaneous injuries, personal protective equipment).
3. Assign at least one individual trained in infection prevention responsibility for coordinating an infection control program.
4. Develop and maintain written infection prevention policies and procedures appropriate for the services provided by the facility and based on evidence-based guidelines, regulations, or standards.
5. Facility has system for early detection and management of potentially infectious persons at initial points of patient encounter.
6. Provide job or task-specific infection prevention education and training to all DHCP. This includes those employed by outside agencies and available by contract or on a volunteer basis to the facility.
7. Provide training on principles of both DHCP safety and patient safety.
8. Provide training during orientation and at regular intervals (e.g., annually).
9. Maintain training records according to state and federal requirements.

Oral Manifestations of COVID-19

It was noted early in the pandemic that early signs of COVID-19 infection included dysosmia and dysgeusia.[43,44,] It is also known that SARS-CoV-2, as well as SARS-CoV-1 and MERS, enter cells through binding to angiotensin-converting enzyme 2 receptor (ACE2), which is highly expressed in many cell types and, of particular interest to dental healthcare professionals, in oral mucosa and salivary glands. In particular ACE2 is expressed with higher density on the tongue dorsum and major and minor salivary glands in the buccal mucosa and palate.[43-48] Further, case reports published early in the pandemic described a myriad of oral manifestations of COVID-19 infection including: oral ulcerations, mucosal erosion, bullae, vesicle formation, pustules, fissured or depapillated tongue, macules, papules, increased and/or decreased pigmentation, halitosis, leukoplakia, hemorrhagic crust, oral tissue necrosis, petechiae, edema, erythema, and spontaneous bleeding.[45-49] It should also be noted that post-infection xerostomia has also been noted in a significant number of cases, even after resolution of other acute COVID-19 symptoms.[48]

While reports in the current literature have a high level of heterogeneity, findings indicate that the prevalence of oral lesions was approximately 33% and aphthous lesions were found in approximately 10% of cases.[48] Multiple suggested diagnoses have been proposed for oral lesions associated with COVID-19 to include aphthous stomatitis, herpetiform lesions, candidiasis, vasculitis, Kawasaki-like, erythema multiforme-like, mucositis, necrotizing periodontal disease, angina bullosa-like, angular cheilitis, atypical Sweet syndrome, and Melkerson-Rosenthal syndrome.[45] Reported oral lesions were symptomatic in approximately 68% of cases and older individuals and those who presented with more severe systemic COVID-19 symptoms demonstrated more severe and widespread oral lesions.[45] Oral health measures, including poor oral hygiene and pre-existing oral disease, were also associated with higher rates and increased severity of COVID-19 associated oral lesions.[43,47,48,] Current case reports do not allow for evaluation of all underlying etiologies for these oral lesions, including direct and/or indirect causation by the SARS-CoV-2 virus, secondary opportunistic infections, or coincidental outcomes.[50]

Dental healthcare professionals should be aware that oral lesions may present as prodromal and/or early signs of COVID infection (Figure 3). In the case pictured below, an afebrile patient presenting with cough also noted oral lesions, dysgeusia and discomfort associated with the affected oral areas. Antigen COVID-19 tests on the day of presentation with oral lesions resulted in a negative test result, but PCR test performed the same day resulted in a positive test result that was available 24 hours after nasal swab testing. Identification of such lesions in combination with monitoring for other COVID-19 symptoms could result in earlier testing and/or referral to reduce asymptomatic/early SARS-CoV-2 spread. Additionally, a focus on establishing and promoting oral health as a mechanism to impact overall health is a critical learning point from the findings related to COVID-19 and oral health.

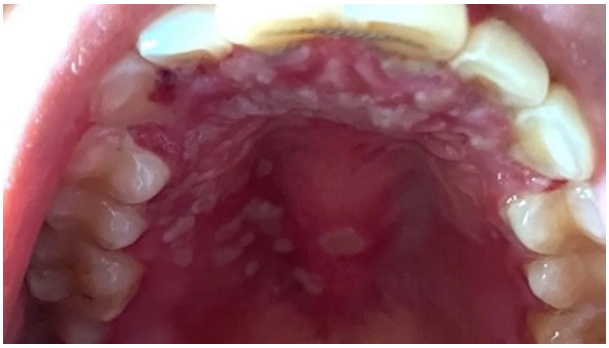

Figure 3. Oral Lesion Presenting Prior to frank COVID-19 Infection (*Photo Courtesy of Dr. Mengyi (Lisa) Shi-Franks)*

Periodontal Disease Impact and COVID-19 Severity

It is well-established that periodontal diseases are infectious and inflammatory and that the inflammatory burden of periodontal diseases can impact systemic health and create a hyperinflammatory state.[51-53] During the COVID-19 pandemic, a puzzling aspect of disease presentation was the heterogeneity of symptoms experienced by infected patients with presentations ranging from asymptomatic infections to severe disease resulting in

hospitalization or death.[54,55] Underlying systemic disease and hyperinflammatory conditions, including obesity, cardiovascular disease, diabetes mellitus and tobacco use, were associated with increased morbidity and mortality from COVID-19 infections.[56-59] Much of the link between such diseases as COVID-19 severity has been attributed to the impact of a "cytokine storm" mounted by host defenses during the course of the infection.[57] Because of the inflammatory nature of both periodontitis and severe COVID-19, multiple investigations have focused on the impact of periodontitis on COVID-19 disease severity.[60-70]

Common risk factors have been associated with both periodontitis and severe COVID-19, including smoking, increased age, obesity, diabetes mellitus, and cardiovascular disease.[56,61] It was initially unclear if these common comorbidities were responsible for any association between periodontitis and COVID-19 severity or if specific pathophysiology linked periodontitis and COVID-19 severity.[65,66] Studies conducted early in the pandemic demonstrated that moderate to severe periodontitis (stage 2-4) was significantly associated with an increased risk of COVID-19 complications and mortality and that radiographic alveolar bone loss was associated with increased COVID-19 seropositivity and disease severity.[67,68]

Mechanisms for this association have been proposed to include: 1) the periodontal pocket as a reservoir for infectious material and/or micro-RNAs associated with upregulating ACE2 expression, 2) periodontitis as a contributor to systemic inflammation and thus the "cytokine storm", and 3) periodontitis resulting increased bacterial aspiration into the lungs as a contributor to secondary pneumonias.[65]

Periodontal Pockets as Reservoirs of Disease

Cadaveric biopsies in COVID-19 patients have demonstrated SARS-CoV-2 present within periodontal tissues.[69] As periodontal disease is associated with ulcerated pocket epithelium,[52] the presence of periodontitis could represent a pathway for entry of SARS-CoV-2 into the systemic circulation, either directly through ulcerated epithelium or via uptake into cells through ACE2 receptors, which may be upregulated in the presence of periodontal pathogens (e.g. *F. nucleatum*) and micro-RNAs 146a and 155, which are increased in the periodontal pocket at sites with periodontitis.[70-72]

Periodontitis and Systemic Inflammation

Systemic inflammation in periodontitis is characterized by high levels of pro-inflammatory cytokines and C-reactive protein.[73,74] Periodontitis has also been shown to prime the immune response to react to an infectious challenge with an exaggerated innate response through activation of polymorphonuclear leukocytes (PMNs) that results in their chemotaxis and activation in response to local and systemic triggers.[75] The contribution of pro-inflammatory cytokines, including those cytokines associated with periodontitis, to the "cytokine storm" which is associated with significant morbidity and mortality after COVID-19 infection could indicate that the systemic inflammation associated with periodontitis could help induce and/or potentiate this cytokine activity.[76-79] PMNs with an activated phenotype have also been noted in COVID-19 patients, resulting in increased oxidative bursts and phagocytosis which contribute to the acute respiratory distress syndrome. These activated PMNs may be upregulated or primed by pre-existing periodontitis.[79]

Periodontal Bacterial Aspiration

The oral microbiome has been connected to pneumonias and other respiratory diseases.[80-81] This connection is especially pronounced in individuals with suboptimal oral hygiene, periodontitis, immune dysfunction and in nosocomial settings.[60] In such cases the oral cavity can serve as a reservoir for respiratory pathogens.[82-84] Because the oral cavity has been demonstrated to be a niche for SARS-CoV-2, viral seeding through aspiration along with other oral pathogens may also serve to enhance severity of COVID-19 or potentiate secondary pneumonias.[61] Further, the combination of periodontopathogenic bacteria which may upregulate ACE2 receptors could also enhance patients' susceptibility to SARS-CoV-2 infections.[70-72] It has also been observed that opportunistic oral pathogens,

Capnocytophaga and Veillonella can be present in pulmonary tissues and fluids of individuals with COVID-19 acute respiratory distress syndrome.[60] These pathways for secondary infection and/or potentiation of SAR-CoV-2 infection highlight the importance of oral disease prevention and the maintenance of oral health.

COVID-19 and Dental Practice

The COVID-19 pandemic has highlighted the essential role that dental healthcare professionals play in the larger healthcare system and the promotion of patient wellness and disease prevention. Based upon the emerging evidence of the association between periodontitis and COVID-19 infection rates and severity, it has been proposed that periodontal care as a mechanism to establish oral and overall health could play a role in the prevention and management of severe COVID-19 complications.[85] Enhanced identification of patients with periodontal disease, through regular comprehensive periodontal examinations and health promotion in patients without periodontitis is critical to reduce periodontitis incidence.[86] Periodontitis prevention through meticulous oral hygiene measures (e.g., professional dental prophylaxis) to remove and/or prevent the formation of a dysbiotic biofilm is appropriate for patients without periodontal attachment loss who are at low risk of disease development.[86,87] Such care can reduce the incidence of gingivitis and the associated gingival sulcular ulceration which would subsequently prevent viruses and bacteria from the oral cavity from entering the systemic circulation.[88,89]

In addition to the primary prevention of periodontal diseases, treatment of ongoing periodontal infection and inflammation could decrease systemic inflammation and ameliorate comorbid diseases, such diabetes mellitus.[90-92] The elimination of pathologic periodontal pockets and the niches for bacteria that are formed within them could also reduce those sites as potential reservoirs for oral pathogens and SARS-CoV-2 that could worsen coronavirus-associated pneumonias.

Gaps in our Knowledge Regarding COVID-19 and Oral Health

While current evidence highlights an association between periodontal disease, oral hygiene, and COVID-19 severity as well as a biologic plausibility of the possible nature of this relationship,[64,93,94] the true mechanisms of action of the interaction between these diseases is not fully elucidated. Currently, there is scarce data from clinical trials and cohort studies to allow for assessment of the interaction between periodontitis and COVID-19. It is imperative that future studies incorporate measures of dental health and oral assessments as a part of risk factor quantification.

It is also currently unknown what the potential long-term effects of COVID-19 infection may be, including the potential for oral diseases. For instance, evidence that has emerged in the last several decades has identified chronic human papilloma virus infection as a causative agent for oropharyngeal cancer.[95] As more data becomes available about post-acute COVID-19 infection symptomatology and the potential oral manifestations of such so-called “long haul” COVID-19 infections, we may identify other potential oral impacts of COVID-19 infection. Emerging data focused on post-acute COVID-19 syndrome is reported to affect up to 2.5% of infected individuals at 3 months.[96] Post-acute COVID-19 syndrome demonstrates approximately a 4:1 preponderance for females.[97] In such individuals more severe symptom presentation has been associated with alterations in taste and smell and it has been established that changes in taste and smell have been associated with a negative impact on mental health and cognitive impairment.[98,99] As more time post-pandemic unfolds, the scientific community and dental healthcare professionals will learn more about the potential oral implications of COVID-19 infection.[100] Data gathering, including COVID-19 infection and symptoms, is critical to allow dental healthcare professionals to continue to assess oral symptoms and implications of COVID-19 in their patients.

Summary

COVID-19 caused worldwide disruption of delivery of dental care and altered many ways in which dental healthcare professionals approach infection control. Similar to the paradigm shift that occurred after the HIV epidemic and the subsequent focus on prevention of bloodborne pathogen transmission in the dental office, COVID-19 will likely result in substantive changes in infection control methods, particularly as it pertains aerosol disease transmission in dental practice. The COVID-19 pandemic also served to highlight the oral cavity as a source for uptake of SARS-CoV-2 viral pathogens into the body and the impact of periodontitis and periodontal inflammation on COVID-19 severity. As the impacts of the pandemic continue to be better understood, dental healthcare providers play an integral role in the promotion of overall health through oral health and will help identify and manage the oral impacts of COVID-19 infection.

Course Test Preview

To receive Continuing Education credit for this course, you must complete the online test. Please go to: *www.dentalcare.com/en-us/ce-courses/ce665/test*

1. Which of the following is the causative infectious agent for COVID-19?

A. Yersinia pestis
B. SARS-CoV-1
C. SARS-CoV-2
D. BatCoV RaTG13

2. Which of the following is NOT a known method of person-to-person transmission for COVID-19?

A. Direct transmission through cough, sneeze, or saliva
B. Contact with mucous membranes
C. Fomite transmission
D. Ingestion

3. Consider the following two statements:

Recommendations and requirements for enhanced infection control practices resulted in statistically significant differences in infectious control practices in the dental office.

Such enhancements included increased use of protective barriers like hair covers, but decreased use of eye protection and face shields.

A. Both statements are true
B. The first statement is true, the second statement is false
C. The first statement is false, the second statement is true
D. Both statements are false

4. In the current post-pandemic environment, which of the following NOT a recommended best practice for infection control and prevention?

A. Delivery of only emergent dental care
B. Identification and management of individuals with confirmed or suspected SARS-CoV-2 infection
C. Implementation of source control measures
D. Universal use of personal protective equipment for healthcare providers

5. Teledentistry increased significantly during and after the COVID-19 pandemic and engagement in teledentistry was positively impacted by _____.

A. Technology upgrades in the dental office
B. Age of dental healthcare professional
C. Social influences
D. Community COVID-19 infection rates

6. OSHA has established a hierarchy of infection control practices with the LEAST effective being:

A. Risk elimination/Risk substitution
B. Engineering Controls
C. Administrative and Workplace Practice
D. Personal Protective Equipment

7. SARS-CoV-2 enters human cells through the which cell-surface receptor?

A. RANK-ligand
B. Protein-tyrosine phosphatase
C. Angiotensin converting enzyme 2 (ACE2)
D. Interleukin-1

8. Aphthous lesions were present as COVID-19 manifestation in approximately _____% of COVID-19 cases.

A. 10%
B. 25%
C. 33%
D. 50%

9. Poor oral hygiene and pre-existing oral disease has been associated with _____ COVID-associated oral lesions.

A. higher rates and increased severity
B. lower rates but increased severity
C. higher rates but decreased severity
D. lower rates and decreased severity

10. Which of the following systemic disease/hyperinflammatory conditions is NOT associated with increased morbidity and mortality from COVID-19 infections?

A. Obesity
B. Chronic liver disease
C. Diabetes Mellitus
D. Tobacco use

11. Consider the following two statements:

Periodontitis has been associated with COVID-19 severity in large cohort studies.

One mechanism for this association have been proposed to be the contribution of periodontitis to systemic inflammation and the "cytokine storm."

A. Both statements are true
B. The first statement is true, the second statement is false
C. The first statement is false, the second statement is true
D. Both statements are false

12. Which of the following is NOT associated with the upregulation of ACE2 receptors and increased viral entry into cells?

A. micro-RNA 146a
B. micro-RNA 155
C. F. nucleatum
D. S. mitis

13. PMNs with an activated phenotype that demonstrate _____ oxidative bursts and phagocytosis have been noted in COVID-19 positive patients.

A. Increased
B. Decreased
C. Altered
D. Unchanged

14. Post-acute COVID-19 syndrome is reported to affect up to _____% of infected individuals at 3 months.

A. 1%
B. 2.5%
C. 5%
D. 10%

15. Individuals experiencing post-acute COVID-19 syndrome demonstrate a _____ female:male ratio.

A. 1:1
B. 2:1
C. 3:1
D. 4:1

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Additional Resources

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