Special Section: COVID-19 Management in Clinical Dental Care

COVID-19 Management in Clinical Dental Care. Part I: Epidemiology, Public Health Implications, and Risk Assessment

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ABSTRACT

Coronavirus disease 2019 (COVID-19), a viral disease declared a pandemic by the World Health Organization (WHO) in March 2020, has posed great changes to many sectors of society across the globe. Its virulence and rapid dissemination have forced the adoption of strict public health measures in most countries, which, collaterally, resulted in economic hardship.

This article is the first in a series of 3 that aims to contextualise the clinical impact of COVID-19 for the dental profession. It presents the epidemiological conditions of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), namely, its modes of transmission, incubation, and transmissibility period, signs and symptoms, immunity, immunological tests, and risk management in dental care.

Individuals in dental care settings are exposed to 3 potential sources of contamination with COVID-19: close interpersonal contacts (<1 m), contact with saliva, and aerosol-generating dental procedures. Thus, a risk management model is propsoed for the provision of dental care depending on the epidemiological setting, the patient's characteristics, and the type of procedures performed in the office environment.

Although herd immunity seems difficult to achieve, a significant number of people has been infected throughout the first 9 months of the pandemic and vaccination has been implemented, which means that there will be a growing number of presumable "immune" individuals that might not require many precautions that differ from those before COVID-19.

In conclusion, dental care professionals may manage their risk by following the proposed model, which considers the recommendations by local and international health authorities, thus providing a safe environment for both professionals and patients.

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Introduction

Since the beginning of this century, 3 novel coronaviruses (CoV) capable of infecting human beings have caused a significant number of infections, which led to the declaration of a public health emergency.

In November 2002, from the Guangdong province in China, came the first reports of patients with symptoms of a new disease that would come to be known as severe acute

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respiratory syndrome (SARS). A novel coronavirus responsible for this disease (SARS-CoV) was isolated in February 2003.[1] The SARS epidemic affected 26 countries on 5 continents (Asia, Oceania, North America, Europe, and Africa), resulting in 8096 reported infections and 774 deaths, until the outbreak was declared contained in July 2003 by the World Health Organization (WHO).[2,3] The case fatality rate associated with SARS was 9.6%.[3] Since 2004, no new cases of SARS have been reported worldwide.[4]

Ten years later, in June 2012, Saudi Arabia reported the first cases of a new disease, later named Middle East respiratory syndrome (MERS). The pathogen responsible for this disease, a novel coronavirus (MERS-CoV), was isolated in September 2012.[5,6] Since then, several outbreaks have been reported, with cases diagnosed in 27 countries. However, approximately 80% of cases were reported in Saudi Arabia, and the cases identified outside the Middle East have usually been associated with travellers infected in that region before returning to their original country.[7,8] As of January 2020, 2519 cases of MERS had been confirmed, resulting in 866 deaths, which corresponds to a case fatality rate of 37.1%.[9]

In December 2019, the city of Wuhan, in the province of Hubei in China, became the epicentre of an outbreak of pneumonia of unknown aetiology.[10-12] On January 7, 2020, a novel virus was isolated from patients with that disease, and the International Committee on Taxonomy of Viruses named it "severe acute respiratory syndrome coronavirus 2" (SARS-CoV-2) in February. In March, WHO named the disease the coronavirus disease 2019 (COVID-19).[13,14] Initially, the SARS-CoV-2 epidemic remained limited to China, with most cases being reported in the province of Hubei, and only isolated cases being detected in neighbouring countries, such as Thailand, Japan, and the Republic of Korea.[15] However, in the following months, the disease spread worldwide. On January 23, the United States reported its first case.[16] On January 25, the first cases were reported in Australia and France—presumably, the first European country to be affected by this disease.[17] On February 15, WHO reported the first case on the African continent (in Egypt).[18] On February 27, the first case of this novel coronavirus appeared in South America (in Brazil).[19] During March 2020, with the reported number of new cases decreasing in China, the epicentre of the epidemic shifted to Europe, with the largest outbreaks of cases first in Italy and then in Spain. On March 12, with the disease reported in more than 100 countries, COVID-19 was officially declared a pandemic by WHO.[20] During April, May, and June, the epicentre of the epidemic shifted once again, this time to the Americas, mainly the United States, Brazil, and Chile. The following months, some countries that had the epidemic under control faced new foci or the second wave with a significant increase in the number of deaths This trend resulted in making COVID-19 the leading cause of death in some countries.[21]

As of December 27, 2020, a total 79,231,893 cases of COVID-19 had been reported worldwide, of which 1,754,574 resulted in death, corresponding to a case fatality rate (CFR in percentage; number of reported deaths/number of reported cases) of 2.2%.[22] However, slight variations in the reported CFR in different parts of the world have been observed: Africa 2.2%; Americas 2.4%; Eastern Mediterranean 2.5%; Europe 2.2%; Southeast Asia 1.5%; and Western Pacific 1.8%.[22] Such differences seem to be related to geographic and social differences of the countries in those regions, including the methods used for counting cases, the mean age of the population, the intensity of the outbreak, the type of containment measures adopted, and how soon those measures were adopted.[23] It has been found that patients older than 65 years of age have a higher risk of death if they become infected.[24] The COVID-19 CFR has also been higher in individuals with a previous chronic disease, which corresponds to more than half of the countries reaching 90% of the cases of infection.[25-27] Most COVID-19 confirmed cases have been in patients older than 30 years age, with more than 90% being older than 45 years of age.[28,29] Determining the severity of COVID-19 is critical for implementing mitigation strategies and planning for health care needs as the pandemic evolves. However, the CFR is a poor measure of the mortality risk because a large number of people are asymptomatic or present with mild symptoms, and testing has not been performed on the entire population.[30] A better way to estimate the mortality risk is the infection fatality rate (IFR in percentage; number of deaths from COVID-19/total number of infected individuals). Published research data on COVID-19 showed overall IFR converging around 0.2%-1.6% in the first months of the pandemic.[31] Moreover, the estimated age-specific IFR is low for children and younger adults (eg, 0.002% at age 10 and 0.01% at age 25) and increases progressively to 0.4% at age 55, 1.4% at age 65, 4.6% at age 75, and 15% at age 85.[32-34]

Due to its infection rate and lethality, the COVID-19 pandemic has become one of the greatest public health challenges of this century because no treatment or vaccine were initially available. The main problem has been the rate of COVID-19 patients that require admission in intensive care units (ICUs) and, particularly, the use of mechanical ventilation because some health care services might not be able to meet the demand, which may ultimately increase the percentage of infected individuals who die, raising the IFR. Thus, infection control measures are essential to prevent viral propagation and help control the epidemic.[35] With the COVID-19 pandemic's geographic expression progressively widening across the globe, several countries have implemented strict measures to reduce interpersonal COVID-19 transmission. In the health sector, particularly in the provision of dental care, the implementation of additional measures to contain the possible transmission of the disease was considered essential.[36]

Currently, people suspected of having COVID-19 present with certain symptoms including acute respiratory infection (sudden onset of fever, dry cough, or respiratory distress) without other aetiology that explains the clinical signs and symptoms and with history of travelling or living in areas with active community transmission in the 14 days before symptoms onset; acute respiratory infection and contact with a person with a confirmed or probable case of COVID-19 in the 14 days prior to the onset of symptoms; or severe acute respiratory infection, requiring hospitalisation, without other aetiology that could explain the clinical presentation.[37]

This article is the first of a series of 3. With these 3, we aim to contextualise the virus SARS-CoV-2 and the disease COVID-19 for the dental profession, focusing on risk management in dental care, COVID-19's repercussion in dental settings, personal protective equipment (PPE) selection and proper use, and measures to be applied in the dental office.

This first article aims to contextualise the clinical impact of the disease for the dental profession. It presents the epidemiological conditions of COVID-19, namely, its modes of transmission, incubation and transmissibility period, signs and symptoms, immunity, immunological tests, and risk management when dental care is provided.

Epidemiology

Modes of transmission

The origin of the virus responsible for COVID-19, SARS-CoV-2, is still being debated and investigated. Despite some controversy and although not yet fully clarified, the comparative analysis of genomic data suggests that the outbreak may have begun with a zoonotic animal-to-human transmission, with a pangolin that was infected by a bat in a market in Wuhan and later infecting a human being.[38] It was then followed by human-to-human transmission, which led to its spread, starting in the city of Wuhan in China.[39]

SARS-CoV-2 is highly contagious and is transmitted via respiratory droplets, by direct contact with infected people, or by contact with contaminated surfaces and objects.[40] The respiratory droplets expelled from the nose or mouth when an infected individual coughs, sneezes, or speaks may come in contact with the oral, nasal, or conjunctival mucosae of an individual standing nearby, thus resulting in transmission of the disease.[40,41] Contamination may also occur indirectly by hand contact with contaminated surfaces followed by hands in contact with the face.[40,42] Research has shown that in an external environment, such as inert dry surfaces, SARS-CoV-2 might survive up to 72 hours on plastic and stainless steel, 24 hours on paper or cardboard, and less than 4 hours on copper surfaces, depending on the temperature and humidity. In watery environments, the virus might survive several days.[43]

Clinical and virologic studies suggest that the viral load is particularly high in the superior respiratory tract, nose, and throat in the first 3 days after the onset of symptoms.[44,45] However, the virus has also been found in several body fluids, including faeces, and, thus, the risk of faecal-oral transmission cannot be dismissed.[42,46-48]

The viral load needed for SARS-CoV-2 transmission is approximately 1000 viral particles per minute (vp/min). As a reference, when breathing, approximately 20 vp/min are expelled; when talking, 200 vp/min; and when coughing or sneezing, 200 million vp /min. The transmission risk is low in outside spaces and surfaces.[49]

It is known that the SARS-CoV-2 viral load peaks approximately at symptom onset, with a viral load similar to that of influenza.[50] Conversely, SARS-CoV and MERS-CoV peak at around 10 days or during the second week after symptom onset. This viral load profile behaviour of SARS-CoV-2 suggests that it can be easily transmissible at an early stage of infection.[51] Older people may have higher viral loads.[50]

It has been suggested that, although there is no clear evidence that SARS-CoV-2 can be transmitted to humans through pet cats and dogs, these animals can be contaminated with COVID-19 by their owners.[52,53] A different SARS-CoV-2 strain has also been reported in mink on farms in multiple countries.[54] Usually asymptomatic or with slight respiratory and digestive symptoms, pets may act as asymptomatic dispersers of SARS-CoV-2.[52,53]

SARS-CoV-2 presents as a sphere of 0.06 to 0.14 μm in diameter and may be found in saliva droplets, which can remain in the air for long periods.[55,56] Therefore, airborne transmission is a possibility, mainly in closed areas, in some aerosol-generating procedures (AGP), such as those occurring in tracheal intubation, bronchoscopy, noninvasive ventilation, tracheotomy, manual ventilation prior to intubation, and cardiopulmonary resuscitation, among others.[57,58] There is no evidence of SARS-CoV-2 transmission through AGP in dental care environments, but it remains a possibility.[59]

Since SARS-CoV-2 is an RNA virus, this type of virus tends to mutate more easily. Three different strains were initially detected in different continents: A in Australia and the United States; B in China and Europe; and C in Europe via Singapore. Another mutation (D614G) emerged in Europe in February and became the dominant form of the virus throughout the world.[60] Since then, different strains have developed without changing its virulence. In November, new strains were found in the United Kingdom and in South Africa. The UK strain seems to spread 70% faster, which may lead to faster virus spread in a population.[61] This strain presents 17 potentially important mutations, including changes in the spike protein.[61]

Incubation period and transmission

The mean incubation period for COVID-19, from exposure to the virus to the onset of symptoms, is 5 to 6 days on average, although it may be as short as 2 days and as long as 14 days.[62-64] The high viral load found mainly in the first 3 days after the onset of symptoms seems to explain why COVID-19 is transmitted mostly by patients who are symptomatic.[44,45] Nevertheless, considering that some individuals may test positive for COVID-19 a few days before developing symptoms, and based on some clinical reports, transmission in a presymptomatic stage (the incubation period) is also a possibility.[39,65-71] Lastly, although there are reports of truly asymptomatic cases confirmed by laboratory tests, there is no evidence of asymptomatic transmission (when the infected person has no symptoms throughout the course of the disease)[72] because that is difficult to quantify. However, this does not exclude the risk of COVID-19 transmission by asymptomatic carriers that may be 3-25 times lower than for those with symptoms.[63,69,73,74]

As in most infections, clinical signs and symptoms may be mild or absent (asymptomatic carrier), and patients who have been exposed are advised to remain under medical observation and quarantine or isolation for at least 14 days.[37]

Clinical signs and symptoms

The clinical signs and symptoms of COVID-19 vary widely, from asymptomatic or subsymptomatic presentations to a flu-like syndrome[43] to severe respiratory insufficiency requiring mechanical ventilation in ICUs, which may ultimately lead to death.[75] The most common signs and symptoms are fever, dry cough, and tiredness. Less common symptoms, such as aches and pains (headache and muscular pain), sore throat, expectoration, rhinorrhoea, haemoptysis, anosmia (loss of the sense of smell), ageusia (loss of taste), diarrhoea, and vomiting, may also be present.[76]

Of those, anosmia and ageusia might cause dental patients to visit to the dentist and provide to the dentist a reason to suspect COVID-19.

In more complex situations, the clinical presentation may be moderate to severe disease with pneumonia, dyspnoea, increased respiratory rate, and decreased blood oxygen saturation; or critical disease with respiratory insufficiency, acute cardiac injury, septic shock, and multiple organ failure, which more frequently results in death.[26] These more severe cases seem to be associated with massive inflammatory reactions in the endothelium of several organs, including the lungs and the heart.[77-79] On the other hand, the high incidence of thromboembolic events suggests that COVID-19-induced coagulopathy plays an important role in the disease outcome.[79-81] Patients infected with coronaviruses associated with severe respiratory disease, such as COVID-19, have shown inappropriate activation of the coagulation cascade and subsequent formation of systemic or intra-alveolar fibrin clots, which may result from an attempt of the prothrombotic response to prevent diffuse alveolar haemorrhage that instead causes clot formation, negatively affecting recovery and survival.[82,83]

Platelet and fibrin thrombi found in small pulmonary vessels of patients who died from this disease may explain the severe hypoxemia that is characteristic of the acute respiratory distress syndrome associated with the more severe forms of COVID-19.[78,80] Most patients seem to develop SARS-CoV-2-induced pulmonary changes, with diffuse alveolar damage, leading to acute respiratory insufficiency.[84] Pneumonia, which can be combined with pulmonary embolism/emboli, have been identified as the main cause of death.[81,85]

Additionally, it is clear that bacterial superinfections are common in patients suffering from a severe case of COVID-19.[86] Poor oral hygiene should be considered a risk to COVID-19 complications in patients with diabetes, hypertension, or cardiovascular disease because they are more prone to have biofilms with a higher percentage of pathogens.[86] In these particular cases, oral hygiene should be improved during a COVID-19 infection to reduce the bacterial load in the mouth and the risk of a bacterial superinfection.[86]

Although the combination of the previously described signs and symptoms with lung imaging may suggest COVID-19 infection, the final diagnosis depends on the confirmation by a laboratory test.[87] Samples obtained via an oral or nasal swab, as well as from the trachea and nasopharynx, pulmonary tissue, saliva, expectoration, faeces, and blood can be isolated and used for detection of COVID-19 using molecular diagnostic techniques.[88]

Immunity

The nature and duration of potential immunity after contact with the virus remains unknown. Advancing scientific knowledge on this particular aspect of infection may lead to significant changes in the management of the disease within a community. Herd immunity to SARS-CoV-2, requiring more than 60% of the population to have been infected, is believed to be achievable but depends directly on whether a robust immune response is generated after contact with the virus. At present, it is estimated that only 12% of the world population has come in contact with the virus, but it can be predicted that this is 6.2 times larger than the estimated rate,[89] which is far below the 60% target.

A potential solution for the pandemic is the development and deployment of vaccines. Until now the average time to develop a vaccine was 10 years, and the fastest was the Ebola vaccine that was produced in 5 years. Several companies started the development of scientific tests to produce a vaccine within an acceptable time frame.[90] Due to great investments and compromise between companies, governments and regulatory agencies, 5 vaccines became available in less than a year.

The first vaccines to be administered in the United States and Europe were the Pfizer/BioNTech and Moderna vaccines. Both are lipid nanoparticle-formulated, nucleoside-modified RNA vaccines that encode the prefusion stabilised SARS-CoV-2 full-length spike protein with similar vaccine efficacy (around 95%) and low incidence of serious adverse events.[91,92] Spike proteins are thus produced by host cells, which mount an immune response to those proteins.

Vaccines using a viral vector are also available, such as AstraZeneca/Oxford, the Chinese Sinovac, and the Russian Sputnik V vaccines, in which modified viruses deliver the genetic code for antigens to stimulate the body to develop immunity. Overall efficacy of the Oxford vaccine was reported at 70.4% (62.1% in participants who received 2 standard doses and 90.0% in participants who received a low dose followed by a standard dose) with an acceptable safety profile.[93]

Vaccination has started in several countries, with priority to the high-risk groups and is expected to continue throughout the year.

Advances in hospital-based COVID-19 care and therapeutic agents authorised by national agencies such as monoclonal antibodies Remdesivir and dexamethasone treatments seem to show effectivity for SARS-CoV-2, although some variants appear to be more resistant to monoclonal antibody treatment.[94,95] However, at this moment, prevention is still the main approach to controlling the pandemic.

Tests

Two types of tests are available to detect viral infections: reverse transcription-quantitative polymerase chain reaction (RT-qPCR) assays and serological immunoassays that detect viral-specific antibodies (immunoglobulin M [IgM] and immunoglobulin G [IgG]) or viral antigens, typically part of the surface protein.

Presently, RT-qPCR and antigen tests are used for ongoing infection detection for SARS-CoV-2. These tests has been essential to screen and identify people infected with COVID-19. RT-qPCR diagnostic tests can be quick, providing results after 1-8 hours and WHO's interim guidelines indicates its use to confirm suspected cases of COVID-19.[96,97]

Nevertheless, due to the incubation period, the technique used to obtain samples, their transportation, and the analysis method, these tests have relatively low sensitivity, from 60% to 80% and may result in many false-negative results.[98]

In situations where RT-qPCR diagnostic tests are unavailable or time constrains are a problem, antigen-detecting rapid diagnostic tests (Ag-RDT) can be used in the diagnosis of SARS CoV-2. Antigen-detecting rapid diagnostic tests compared to a RT-qPCR appears to be highly variable, ranging from 0%-94% but specificity is consistently reported to be high (>97%).[99,100]

Immunological methods, such as serologic tests (to identify IgG and IgM), may be used to detect whether an individual has been exposed to SARS-CoV-2.[87] These tests required more time to be developed because they require knowledge of the structure of the proteins that form the viral coat. Highly specific serological tests sensitive for SARS-CoV-2 antibodies, with a precision higher than 95%, are currently available using several SARS-CoV-2 proteins.[101] The clinical sensitivity of the serological tests for anti-SARS-CoV-2 IgM and IgG antibodies, when used in combination, is 98.5%, with a clinical specificity of 98.7%. A positive result for IgM may reflect recent exposure to the virus, 3 to 10 days after the onset of symptoms, whereas a positive result for IgG may represent an exposure 10 to 20 days after onset of symptoms. During the convalescence stage, the IgG antibody may increase approximately 4-fold compared with the acute stage.[64,98,102] The SARS-CoV-2 spike protein (S protein), which makes the serological tests more unique and lowers the odds of cross-reactivity, is used for differentiation from other coronaviruses. However, assessment of acquired immunity is further complicated by lack of clarity related to cross-reactivity to IgG directed towards other coronaviruses.[97,103-106]

The use of saliva for the diagnosis of COVID-19 has been a worldwide focus of interest. This fact is related to the sensitivity of the salivary sample being similar to that of respiratory samples. On the other hand, the ease of collecting allows the risk of viral transmission for health professionals to be reduced and can be self-collected without the need for trained people, saving medical human resources in the context of pandemics.[107,108] Although RT-qPCR represents the reference standard for molecular diagnosis in salivary samples, the time spent makes it difficult to use when a population screening program is intended to be carried out. However, rapid salivary antigen tests can be used in pandemic outbreak containment programs. These tests have a main application outside the hospital context due to their ease of use and speed in providing results (30-60 minutes), requiring no specialists.[107]

COVID-19 in dental care

Coronaviruses possess specific characteristics that explain their tropism for the host cells.[109] The SARS-CoV-2 shares the typical structure of coronaviruses, with spike proteins (S protein) in its external membrane, allowing for host cell penetration. The coronavirus S protein links to the receptor of the human angiotensin-converting enzyme 2 (ACE2), facilitating the entry of the virus in target cells.[110] ACE2 is anchored to the plasma membrane of cells on a number of tissues. In the oral cavity, cells of the salivary glands, tongue, and oral epithelium have receptors for ACE2. Salivary glands, in particular, seem to be an early target for SARS-CoV and, therefore, will likely be involved in SARS-CoV-2 infection, which may explain its transmission by patients who are asymptomatic.[36,56,110-114]

Despite scarce scientific evidence, procedures conducted in the oral health care environment that involve the use of ultrasonic or rotative instrumentation under irrigation or 3-way air or water spray capable of generating aerosols may potentiate airborne transmission of SARS-CoV-2.[115] Droplets <5 μm in diameter are referred to as droplet nuclei or aerosols and may stay in the air for long time, whereas droplets >5 μm will quickly fall to a surface.[116] Aerosols and droplets generated by their use in the presence of the patient's saliva, blood, and other secretions may contaminate the surrounding environment.[36,75,117] As such, considering the risk and the stage of community transmission of COVID-19, it is essential to adjust infection control measures to protect patients and dental care providers and, thus, help contain or mitigate the disease. Such measures should be adjusted to the particularities of each local setting, as well as the level of risk associated with each visit, considering the patient's characteristics and the procedures to be performed.

Risk management

Considering the currently known modes of transmission, the dental care environment presents 3 sources for potential contamination by SARS-CoV-2: close interpersonal contact (<1 m), contact with saliva, and AGP.[36,118-120] Thus, considering the characteristics of delivery of dental care and transmission of the virus, every in-office dental visit should be considered a risk for the involved health care personnel, regardless of the procedures to be performed. Therefore, patients must be contacted one day before the visit to confirm no COVID-19 symptoms and undergo measures to again confirm no COVID-19 symptoms on the day of the visit, including a temperature check.

The relative risk associated with each visit will depend on 3 factors: the epidemiological setting (prevalence of infection in the area at the time when care is delivered), the patient's individual characteristics, and the type of procedures to be performed.

Epidemiological setting

A pandemic is a worldwide dissemination of a disease for which most of the population does not have immunity.[121] It is an enormous public health concern and epidemiology plays a fundamental role in the development and adoption of containment strategies. The type and intensity of control measures vary at the different stages of a pandemic. Although each pandemic has specific characteristics, the WHO has described 6 phases of pandemic development for an influenza-like pandemic followed by a postpeak and a postpandemic periods (Table 1).[122]

Table 1 – WHO pandemic phases description (adapted).[122]

Phase	Description	Main actions				
		Planning and coordination	Situation monitoring and assessment	Communications	Reducing the spread of disease	Continuity of health care provision
Phase 1	No animal virus circulating among animals have been reported to cause infection in humans.	Develop, exercise, and periodically revise national pandemic disease preparedness and response plans.	Develop robust national surveillance systems in collaboration with national animal health authorities, and other relevant sectors.	Complete communications planning and initiate communications activities to communicate real and potential risks.	Promote beneficial behaviours in individuals for self-protection. Plan for use of pharmaceuticals and vaccines.	Prepare the health system to scale up.
Phase 2	An animal virus circulating in domesticated or wild animals is known to have caused infection in humans and is therefore considered a specific potential pandemic threat.					
Phase 3	An animal or human-animal reassortment virus has caused sporadic cases or small clusters of disease in people but has not resulted in human-to-human transmission sufficiently to sustain community-level outbreaks.					
Phase 4	Human-to-human transmission of an animal or human-animal reassortment virus able to sustain community-level outbreaks has been verified.	Direct and coordinate rapid pandemic containment activities in collaboration with WHO to limit or delay the spread of infection.	Increase surveillance. Monitor containment operations. Share findings with the WHO and the international community.	Promote and communicate recommended interventions to prevent and reduce population and individual risk.	Implement rapid pandemic containment operations and other activities; collaborate with WHO and the international community as necessary.	Activate contingency plans.
Phase 5	The same identified virus has caused sustained community-level outbreaks in 2 or more countries in 1 WHO region.	Provide leadership and coordination to multisectorial resources to mitigate the societal and economic impacts.	Actively monitor and assess the evolving pandemic and its impacts and mitigation measures.	Continue providing updates to general public and all stakeholders on the state of pandemic and measures to mitigate risk.	Implement individual, societal, and pharmaceutical measures.	Implement contingency plans for health systems at all levels.
Phase 6	In addition to the criteria defined in Phase 5, the same virus has caused sustained community-level outbreaks in at least 1 other country in another WHO region.					
Postpeak period	Levels of pandemic disease in most countries with adequate surveillance have dropped below peak levels.	Plan and coordinate for additional resources and capacities during possible future waves.	Continue surveillance to detect subsequent waves.	Regularly update the public and other stakeholders on any changes to the status of the pandemic.	Evaluate the effectiveness of the measures used to update guidelines, protocols, and algorithms.	Rest, restock resources, revise plans, and rebuild essential services.
Postpandemic period	Levels of disease activity have returned to the levels seen for seasonal disease in most countries with adequate surveillance.	Review lessons learned and share experiences with the international community. Replenish resources.	Evaluate the pandemic characteristics and situation monitoring and assessment tools for the next pandemic and other public health emergencies.	Publicly acknowledge contributions of all communities and sectors and communicate the lessons learned; incorporate lessons learned into communications activities and planning for the next major public health crisis.	Conduct a thorough evaluation of all interventions implemented.	Evaluate the response of the health system to the pandemic and share the lessons learned.

WHO = World Health Organization.

Table 2 – Risk groups for COVID-19.

Age[24,78]	+65 years
Chronic diseases[24,78,118,124-127]	Arterial hypertension Cardiovascular disease Cerebrovascular disease Diabetes Chronic respiratory disease Asthma Oncological disease Renal disease Severe hepatic disease
Immunodeficiency / Immunosuppression[125]	Chemotherapy Rheumatoid arthritis Lupus Multiple sclerosis Gastrointestinal inflammatory diseases HIV Transplant patients
Pregnancy[128,129]	
Obesity[130-132]	

COVID-19 = coronavirus disease 2019.

Though there are some differences between an influenza pandemic and the current coronavirus pandemic, the propagation periods and the measures to be adopted may be equivalent and considered in the context of dental practice. It is advisable to closely follow the recommendations issued by each country's health authorities, as well as by global health organisations, such as WHO, the European Centre for Disease Prevention and Control (ECDC), and the Centers for Disease Control and Prevention (CDC).

Patients' characteristics

The relative risk based on each patient should be interpreted considering the particular susceptibility of some population subgroups for COVID-19. Four main subgroups should be considered: patients who are asymptomatic, patients at high risk for contracting COVID-19, patients with COVID-19, and patients recovered from COVID-19. Patients who are asymptomatic are primarily healthy adults and children that, if infected, pose a higher risk of contaminating others because their infection is generally not detected due to the absence of symptoms.[39,65,123] Patients at high risk are those with a higher risk of developing severe forms of the disease, specifically individuals older than 65 years, with comorbidities, or pregnant women (Table 2).[24,39,62,64,65,78,118,124-132] Patients with COVID-19 are appropriately diagnosed and additional precautions may exist at the national level. Assuming that all other patients might be COVID-19 patients and all precautions are taken, one must consider additional precautions in patients previously diagnosed with COVID-19. Patients recovered from COVID-19 are those who presumably are immune at the time. This is important because if they tested negative twice, it can be assumed they are no longer infectious. Therefore, there will be an existing group of people that might not need the same level of precautions as others.

Therefore, the office schedule should be managed in a way that limits the contact the high-risk patients have with other patients throughout the pandemic.

Risk associated with dental care procedures

No in-office dental care procedure or visit should be considered risk-free because the patient cannot wear a facial barrier when care is provided. In the presence of a disease where herd immunity is yet unknown, a low viral load may be sufficient to transmit the infection between the patient and dental care professionals.[36,117,126,133,134] On the other hand, direct contact with saliva and respiratory secretions is a risk factor common to every in-office dental visit and might be further worsened by treatment duration and AGP.[57,58,135]

The AGPs production during each of the procedures described in Table 3 should also be taken in consideration. It is not the same situation treating the maxillary second molar or the maxillary central incisor.

The procedures conducted in the dental care environment may be classified, according to their risk, as follows (Table 3):

1. Low risk: Procedures in common areas (conducted outside the operatory room) with proper social distancing (including administrative procedures conducted in the reception area);
2. Moderate risk:
   a. Cleaning, disinfection, and sterilisation procedures;
   b. Procedures in a clinical environment (conducted inside the operatory room and associated with patients' examination and treatment, affecting both the dentist and auxiliary staff) without AGP — no ultrasonic, rotation instruments, or 3-way air or water spray used;
3. High risk: Procedures in a clinical environment with AGP — dental procedures that use spray-generating equipment such as ultrasonic, rotation instruments, or 3-way air or water spray. The most common AGP are prophylaxis with ultrasonic scaler and polishing; periodontal treatment with ultrasonic scaler; any kind of dental preparation with high- or low-speed handpieces; direct and indirect restoration and polishing; definitive cementation of crown or bridge; mechanical endodontic treatment and surgical

Table 3 – Levels of risk in the dental environment.

	Low risk	Moderate risk	High risk
Common Areas	Administrative procedures with a barrier or social distancing	Cleaning Disinfection Sterilisation	
Clinical Environment		Visits without AGP	Visits with AGP[36,120]

AGP = aerosol-generating procedure.

implant placement. Besides the risk of surface contamination within the dental treatment room, these visits also present a higher risk of airborne contamination and consequent contamination of surfaces further away from the dental chair.[36,120]

These factors should be considered during the current pandemic because they will influence the visit scheduling and preparation, the level of personal protective equipment that the dentist and auxiliary staff should wear, the treatment approach, and cleaning and disinfection procedures.

Assuming that COVID-19 will remain a pandemic disease for more than a year, with more than one wave, it is important to define strategies that attend to the specific epidemiologic situation at the moment in a way that allows dental offices to work safely.

In this article and the following 2 in this series, the aim is to develop a risk management model for different phases of the COVID-19 pandemic, which considers all patients as potentially infected. This model was developed considering the specifics of different dental care procedures, while simultaneously ensuring the protection and safety of both professionals and patients. During the first months of the pandemic, there was a level of scientific uncertainty regarding the behaviour of this new virus and consequently significant public alarm. The adoption and implementation of the first protocols for management of clinical dental care in COVID-19 may now be seen as excessive; in this sense, the current protocols are more reasonable and are expected to become even more so as soon as a significant percentage of the population is vaccinated.

Conclusions

SARS-CoV-2 and the resulting COVID-19 pandemic present a series of public health challenges that affect dental practice. Three potential sources of contamination are pertinent in this context: close interpersonal interaction (<1 m), contact with saliva, or AGP. As such, the relative risk of in-office visits depends on the epidemiological setting at a specific time and in a geographic region, patient characteristics, and the type of procedures to be performed. The dental team is responsible for managing these considerations, following the recommendations made by local health authorities. These steps will minimise the risk of viral infection in the dental environment.

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Conflict of interest

None disclosed.

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