Concise Review

Dentistry and the COVID-19 Outbreak

Luís Filipe Lima Sobral Amante [a,*], *João Torres Monteiro Afonso* [b], *Greta Skrupskelyte* [c]

[a] *MyDentist, 540 Barking Road, London E13 8QE, UK*
[b] *King's College London, London, UK*
[c] *Wellcome - MRC Cambridge Stem Cell Institute, University of Cambridge, Cambridge, UK*

Editor's Note: This review describes a U.K./global perspective of how COVID-19 affects the dental profession and provision of dental care. It is written from the perspective of the situation in mid-2020, and therefore should be read in the context of the evolving pandemic. Our understanding and prevention of the pandemic, and guidance regarding clinical dental care, have changed dramatically in 6 months.

ARTICLE INFO

Article history:
Available online 19 December 2020

Key words:
Dentistry
Coronavirus
COVID-19
severe acute respiratory coronavirus 2 (SARS-CoV-2)
Infection

ABSTRACT

Introduction: Infection prevention in dental practice is a principle of utmost importance aiming to protect patients, the dental team, and ultimately, public health. The recent pandemic of coronavirus disease 2019 (COVID-19), caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has instigated worldwide public concern. This highly contagious disease has called for profound changes in patient care around the world. The goal of this article is to review the current literature and introduce essential knowledge about COVID-19, recommend management protocols and adequate protection for dental professionals during the outbreak.

Material and methods: The literature search was conducted from April to June 2020. After full-text screening a total of 85 studies were included.

Results: Given the novelty of SARS-CoV-2, some characteristics of the virus remain yet unknown. The virus is aerosol-transmissible and, because of the nature of dental procedures, this puts dental professionals and patients at a high risk of contamination by this pathogen. Adequate management protocols and specific protective approaches are essential to minimise the spread of COVID-19 in dental settings during the outbreak.

Discussion: The overall impact of COVID-19 in health care worldwide is yet to be determined. This constitutes a significant limitation to this review because the information obtained risks being outdated as the pandemic progresses. The prudent practitioner will use this review as a starting point and continue to proactively update themselves as the outbreak continues. Further studies are required to investigate the potential impact of infections with SARS-CoV-2 within dental settings.

Introduction

Dentistry is a field of health care that involves close proximity of dental professionals and the patient's oral cavity, which is a biological niche that can harbour opportunistic and pathogenic microorganisms that can pose a risk for cross contamination, infection, and may eventually result in systemic infections.[1] Moreover, the risk of exposure during procedures performed by dentists is amplified because of the open and invasive nature of dental services. Despite this, until recently, the transmission of infectious pathogens among patients and dental professionals has been reported as rare and was often caused by break downs in simple procedures to prevent infection, including failures in the sterilisation cycle of dental hand pieces or instruments between patients, failure to adequately monitor autoclaves (ie, conduct spore testing), and unsafe injection practices.[2] The main purpose of infection control in dental practice

* *Corresponding author*. 7 Elm Road, Cambridge, CB2 9PP, UK.
E-mail address: luis.filipe.amante@gmail.com (L.F.L.S. Amante).

https://doi.org/10.1016/j.identj.2020.12.010

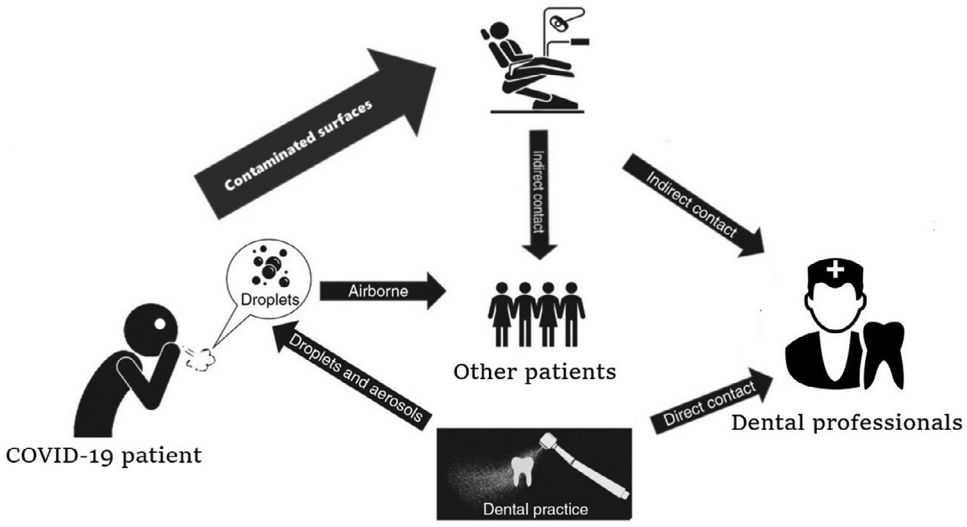

Fig. 1 – Illustration of potential transmission routes of coronavirus disease 2019 (COVID-19) in dental settings.

should be the prevention of transmitting disease-causing agents such as bacteria, viruses, and fungi between patients and from patients to the dental team and vice versa.[3]

Traditionally, based on the routes of transmission, diseases can be classified as bloodborne, airborne, or spread through fomites (objects that may be contaminated with infectious organisms and serve in their transmission). As health care providers, dentists have a responsibility to understand these diseases and to implement strict protocols and protective measures during the provision of dental care to reduce potential spread within the clinical arena.[3] Patient's bodily fluids such as blood and saliva can become major vectors of cross transmission in dental practice. The contact of infectious materials through lesions on skin and mucosa can potentially cause bloodborne contamination. The emanation of pathogens caused through the spray of dental hand pieces can also be considered an airborne means of transmission, potentially affecting both patients and dental professionals. Generally, the risk of any such transmission depends on a number of factors: the dose of the pathogens transmitted, the virulence of the pathogen, the frequency or probability of exposure to the infectious material, and finally, the state of the host immune system.[1]

Nosocomial infections occur in patients in a health care setting. This may include infections acquired in the hospital or dental practice but appearing after discharge and also include occupational infections transmitted among facility staff. Several viruses can be transmitted as nosocomial infections including hepatitis B and C viruses, enteroviruses, respiratory syncytial virus (RSV), rotavirus, cytomegalovirus, Ebola virus, HIV, herpes simplex virus, influenza viruses, and varicella-zoster virus.[4] Health care professionals have a serious responsibility to prevent nosocomial infections and, therefore, should abide by strict rules and protocols.

In December 2019, an outbreak of viral pneumonia caused by a previously unknown coronavirus originated in Wuhan, China. This disease was caused by a novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and has since spread throughout the planet, becoming a major challenge for public health.[5,6] The progression of the outbreak by January 30 led the World Health Organization (WHO) to declare it a public health emergency of international concern, and on February 11, they officially named it coronavirus disease 2019 (COVID-19).[7] Because of the characteristics of dental treatment, there is a considerable risk of cross infection with this virus in dental settings.[8] Researchers have identified SARS-CoV2 in saliva of infected patients, and transmission routes of the disease suggest that dental professionals and patients are potentially at a considerable risk of infection with this highly contagious pathogen[9] (Figure 1). Therefore, dental professionals have to be well-informed about the disease, be strict with their protocols and policies for infection control, and be diligent in protecting the population against the rampant dissemination of this public health threat.[10] The goal of this article is to review the current literature and introduce essential knowledge about COVID-19 and provide recommended management protocols, including adequate protection for dental professionals during this viral outbreak.

Materials and methods

PubMed, Elsevier, ScienceDirect, and WHO databases were used to search for the material published until June 30, 2020, using the following: "infections in dentistry" [MeSH] OR "infection prevention" [MeSH] AND "dental" [MeSH]; "SARS to MERS" [MeSH] OR "coronavirus in Wuhan" [Mesh] AND "epidemiology" [MeSH] OR "pandemic" [MeSH]; "coronavirus disease 2019" [MeSH] OR "corona viruses" [MeSH] OR "COVID-19" [MeSH] OR "novel coronavirus" [MeSH] OR "2019-nCoV" [MeSH] OR "SARS-CoV-2" [MeSH] AND "dentistry" [MeSH] OR "oral medicine" [MeSH] OR "saliva" [MeSH] OR "diagnosis and treatment" [MeSH] OR "aerosols" [MeSH] AND "dental" [MeSH] OR "transmission" [MeSH] OR "control" [MeSH] OR "vaccine" [MeSH]. Titles and abstracts were separately reviewed by the 3 authors, and they chose the most relevant and up-to-date material according to their field of expertise. The studies described included information about the novel coronaviruses and infection control in a dental setting.

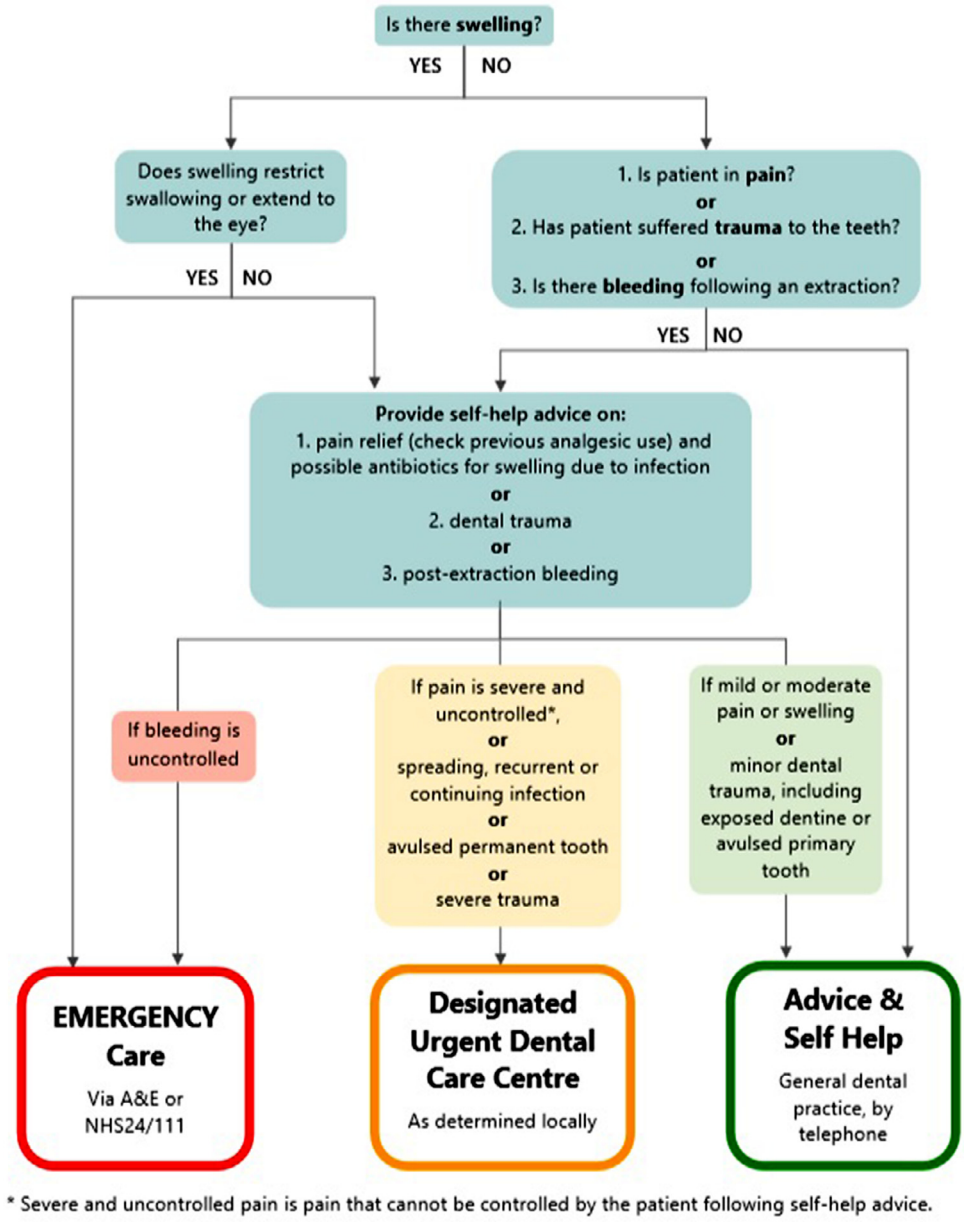

Fig. 2 – Flowchart for triage of commonly presenting dental problems during the coronavirus disease 2019 (COVID-19) outbreak in the United Kingdom.

Excluded studies were those not in English and not relevant to humans. After the screening, a total of 85 studies were included.

Results

What is COVID-19?

COVID-19 is the name given to the infectious disease caused by the most recently discovered coronavirus, previously dubbed 2019-nCoV, and now officially called SARS-CoV-2.[5] This new virus and its associated disease were completely unknown before the outbreak began in Wuhan, China, in December 2019.[5] Coronaviruses are part of a large family of single-stranded RNA pathogens known as Coronaviridae of the order *Nidovirales*.[11] The virus is comprised of a large, positive-sense single-stranded RNA encapsulated in a lipid bilayer envelope.[12,13] The coronavirus infection usually produces mild respiratory symptoms in humans. Having said that, severe acute respiratory syndrome coronavirus (SARS-CoV) in 2002 and Middle East respiratory syndrome coronavirus (MERS-CoV) in 2012 were responsible for worldwide outbreaks and severe fatal respiratory diseases.[14-18] This family of viruses is zoonotic, meaning it can be transmitted from animals to humans. The interspecies transmission can be far

more dangerous because the host immune system is not adapted to respond to the pathogen, and this constitutes a key aspect to explain the recent pandemic. Given the novelty of COVID-19, some of the characteristics of the virus remain yet unknown.

Clinical manifestations

The common symptoms of COVID-19 at illness onset are fever, fatigue, dry cough, myalgia, and dyspnoea. These symptoms are frequently mild and start gradually. Some patients can experience headache, dizziness, abdominal pain, diarrhoea, nausea, and vomiting.[19] According to the latest available published data by WHO approximately 1 out of every 6 people infected with SARS-CoV-2 becomes seriously ill and develops breathing difficulties.[4] Furthermore, one-fourth to one-third of hospitalised patients in Wuhan were reported to have developed severe complications, such as acute respiratory distress syndrome, arrhythmia, and shock, and had to be admitted to intensive care units.[20–22] The literature states that approximately 80% of patients with COVID-19 only experienced minor symptoms, often similar to those expected with the seasonal flu or seasonal allergies.[23] This feature of the disease has caused an increased number of undiagnosed cases and has played a quintessential role in the progression of the pandemic.[23]

The onset of COVID-19 may result in progressive respiratory failure, caused by alveolar damage and, eventually, death.[24] Presently, there is still a lack of robust estimates for case fatality rates, and the numbers available are potentially biased by incomplete outcome data and inconsistencies in testing policies. The mean crude case-fatality (proportion of deaths amongst total cases reported) from the EU/EEA and the UK by 23 March 2020, was reported to be 5.4%.[25] According to Malik et al the reported fatality rate (cumulative deaths divided by cumulative cases) of COVID-19 in China varied between 0.39% and 4.05%, depending on the region in the country. These numbers are reported to be lower when compared to SARS (≈10%) and MERS (≈34%) and higher than seasonal influenza (0.01%-0.17%) according to the data published by the US Centers for Disease Control and Prevention.[26] The literature suggests that factors such as older age and the existence of predisposing comorbidities (ie, cardiovascular disease, diabetes, and hypertension) were associated with worse prognosis.[21,27] Nevertheless, current observations have established that people of all ages and without prior comorbidities can be susceptible to COVID-19. The current numbers published daily by WHO report an excess of 10 million people infected with SARS-CoV-2 worldwide and hundreds of thousands of deaths recorded. Additionally, the progression of the pandemic outbreak is still an uncertainty.[4,28]

Diagnosis

The Chinese Center for Disease Control and Prevention was the first to isolate the virus on 9 January 2020, and published the viral genome sequence data in international database banks, GenBank and the Global Initiative, on Sharing All Influenza Data (GISAID).[20,28] As soon as this important data became available, it enabled laboratories and researchers worldwide to begin developing unique tests to diagnose COVID-19.[21,29] There is a current consensus that the diagnosis of infection with SARS-CoV-2 should be based on a combination of epidemiologic information, clinical symptoms, computed tomography [CT]/chest X-ray imaging findings (most patients positive for COVID-19 had bilateral pneumonia with a ground-glass opacity and bilateral patchy shadows), and laboratory tests (ie, reverse transcription polymerase chain reaction [RT-PCR] in respiratory tract specimens).[20,28,30,31]

At the time of writing, swabs of upper respiratory tract samples (usually obtained from throat and nose) were being widely used for the purpose of diagnosing COVID-19. The literature also suggests that salivary diagnosis platforms can be helpful in diagnosing it.[32,33] The virus can be detected in saliva for several days after infection.[10] Moreover, the collection of saliva is a comfortable, easy, inexpensive, and noninvasive approach that requires minimal equipment and can also minimise the risk of nosocomial transmission of COVID-19 to health care workers.[34]

Treatment

At the time of writing this article, there were no vaccines or specific antiviral medications that had been approved or scientifically proven to prevent or treat the infection with SARS-Cov-2 in humans.[28] Currently, the approach to patients with COVID-19 is to control the source of infection and use measures to prevent and control infection, reducing the risk of transmission.[21] Providing early diagnosis, isolation, and supportive care have been proven essential to controlling the progression of the pandemic and should be considered priorities for affected patients.[21] Most patients recover with supportive care, but people with serious illness should be hospitalised.[28] Multiple research teams worldwide are working to produce a solution for this global pandemic.[35] A team of international researchers from the Universities of Melbourne, Athens, Radboud, and Exeter are organising randomised control studies to investigate the effects of a genetically modified vaccine for tuberculosis called VPM1002 on COVID-19. This has stemmed from research by Netea et al[36] published in 2016, in which the authors discussed the concept of “trained immunity” and tested the hypothesis of the vaccine stimulating the human immune system in a broad way, allowing it to better fight SARS-CoV-2 and, perhaps, prevent infection altogether. In April 2020, Kim et al[37] suggested a microneedle array (MNA) delivery system of recombinant coronavirus vaccines as a possible immunisation solution for COVID-19. By targeting the spike (S) protein, a component of a viral envelope in coronaviruses, the research team has produced a clinically translatable vaccine for human testing. The MNA delivery system is designed to be applied on the skin without the need for an applicator or any specialised equipment, supporting the potential for self-administration, which can become a tremendous advantage in a pandemic scenario.[37] WHO is coordinating efforts to develop vaccines and medicines to prevent and treat COVID-19 in a race against the progression of the pandemic.[4] Safe vaccines that rapidly induce potent and long-lasting virus-

specific immune responses against COVID-19 are urgently needed. At the time of writing of this article, there were **several** confirmed active projects in exploratory or preclinical stages, and the first COVID-19 vaccine had entered human clinical testing with unprecedented rapidity.[38]

Transmission routes of COVID-19

Currently, the transmission routes of COVID-19 are still to be completely determined.[29,39] The incubation period for individuals infected with this virus has been reported to be between 2 and 14 days. It has been shown that people are most infectious in the first week after becoming infected with SARS-CoV-2, in which they show no or few symptoms.[20,30,40,41] This epidemiologic feature of COVID-19 has made its control particularly challenging.[42] It is also unclear if the virus can be transmitted from mothers to their babies while they are still pregnant (vertical transmission), during labour and birth, or following birth.[43–45] Furthermore, it remains yet unknown whether patients in the recovering phase can also be potential sources of infection.[42]

The virus is mainly transmitted by direct transmission (ie, cough, sneeze, and droplet inhalation), contact transmission (ie, contact with oral, nasal, and eye mucous membranes), and fomites (ie, inanimate objects that, when contaminated with or exposed to infectious pathogens, can transfer disease to a new host).[9,46] Contact with aerosols generated during clinical procedures has also been established as a transmission route for COVID-19.[46] Aerosol is defined as a particle that is smaller than 50 μm in diameter, small enough to stay in the air before settling down on a surface or entering the respiratory tract.[47] Diseases such as the pneumonic plague, influenza, Legionnaires' disease, and SARS are also transmitted via aerosol.[48–51] Contaminated blood samples, often used to perform laboratory diagnostic tests, should also be considered possible transmission routes for SARS-CoV-2.[46]

Patients with COVID-19, even if asymptomatic, can render the virus airborne by spreading droplets when speaking, coughing, or sneezing, potentially infecting individuals in close contact (≈ 6 ft [1.80 m]), which poses a major everyday personal contact risk.[52,53] This characteristic is believed to be the main route for contamination for COVID-19 and it is the basis for the recommendation of social distancing.[52] The source of droplets can be nasopharyngeal or oropharyngeal, generally associated with saliva. Smaller droplets are responsible for the long-distance contamination because airborne pathogens can remain suspended in the air for longer periods.[54,55] Larger droplets are too heavy to remain in suspension in the air and tend to fall on floors or other surfaces, potentially contaminating instruments or environmental surfaces.[56] The literature reports that human coronaviruses are able to persevere on surfaces such as metal, glass, or plastic for several days.[54,57] This characteristic also enables a possible viral transmission between patients and health care providers by contact with fomites. Stethoscopes and neckties are common fomites associated with nosocomial infections.[58] In addition, at room temperature the viral particles of SARS-CoV-2 without the host remain infectious from 2 hours up to 9 days and persist better at higher (50%) compared to lower (30%) humidity.[58]

Recommended management protocols and adequate protection to the dental team

There is a great deal of advice about how dentists should treat patients during the current pandemic. This can make it difficult to decide what is the best way to manage patients, especially those who are in pain.[59] Since January 2020, routine dental procedures in most cities of China have been deferred until further notification, and only emergency treatments have been performed but require the use of strict infection prevention and control measures.[8] On 16 March 2020, the American Dental Association (ADA)[53] recommended that dentists suspend elective procedures for the following three weeks and focus on providing treatment for dental emergencies only. In a statement issued in March 2020, the British General Dental Council (GDC)[59] also emphasised that "in many cases, the right approach will be to stop providing treatment altogether" for the duration of the outbreak. More recently, as the pandemic continues to evolve, dental authorities around the world have recognised that dentists may gradually need to start delivering nonemergency dental care, whilst strictly complying with protocols aimed at minimising the risks to patients and to dental professionals.[60,61]

Because of the unique characteristics of dental procedures, the standard protective measures in daily clinical work are likely to be ineffective in preventing the progression of this highly contagious virus. This is particularly relevant because patients may seek treatment and possibly unknowingly transmit COVID-19, or they may be unaware of their infection. It is essential that dental professionals are familiar

Table 1 – Summary of management protocols and protection for the dental team during the COVID-19 outbreak.

Management protocols and protection for the dental team during COVID-19 outbreak
"No routine treatment should be provided by dental practices to the patients at this time"—BDA
Evaluation and triage
• Ideally performed by dentists with access to patient's records
• If possible/feasible advice and remote prescription only
Minimizing risks
• Treat patients in UDC hubs or similar (ideally AIIRs with improved ventilation)
• Hand hygiene
• Adequate PPE
• Surface disinfection
• Adequate disposal of medical waste
• Aerosol procedures to minimum
Examination
• Preprocedural mouth rinses with 1% hydrogen peroxide or 0.2% povidone
• Avoid intraoral x-rays (consider panoramic/CBCT . . .)
• Avoid using a 3-1 syringe
Treatment
• Use rubber dams (with high-volume suction)
• Use high speed with antiretraction function
• If indicated, perform pulp extirpation (only coronally)
• If indicated, perform extractions and treat soft tissue contusions (use absorbable sutures)
• Consider treating tooth fracture, luxations, or avulsions if feasible
• Life-threatening cases w/oral and max-fac compound injuries to be referred to hospital

AIIRs = airborne infection isolation rooms; CBCT = cone beam computed topography; COVID-19 = coronavirus disease 2019; PPE = personal protective equipment; UDC = urgent dental care.

with the transmission routes of SARS-CoV-2, how to potentially identify patients with the infection, and to strictly abide by effective protective measures and infection control protocols. After a careful literature analysis, we suggest the infection control measures and protocols outlined in Table 1 be followed by dental professionals.

Evaluation and Triaging of Patients (Figure 2)

During the COVID-19 pandemic, dental surgeries should not be operating on an "open-door" basis and patients should not visit a dental health care facility without undergoing a triage process prior to the visit. The British Dental Association (BDA)[59] recommended that in the vast majority of cases telephone triaging of patients is appropriate. The triage should ideally be done by a dentist that has full access to the patient's records, which allows the dentist full access to medical history; existing comorbidities; ongoing, recently completed, or planned treatment; history of current problem; and social history. After a consultation and a careful risk assessment, it is perfectly acceptable to provide telephone advice and even issue prescriptions for antibiotics or other medications as needed.[59] The British Faculty of General Dental Practitioners (FGDP) [62] stresses that, during the pandemic, antimicrobials should be prescribed in a responsible manner and only when clinically indicated, and dentists should consult their "Antimicrobial Prescribing for General Dental Practitioners" for guidance. This document states that "the prescribing of antibiotics for toothache, including acute pulpitis, is inappropriate as they are of no clinical benefit in managing dental pain. Analgesics can provide pain relief prior to provision of definitive treatment." Furthermore, this guidance notes that "antimicrobials may be appropriate where patients present with an acute dental infection for which definitive treatment has to be delayed because of a need to refer for specialist services due to an inability to establish drainage. It may therefore be appropriate to prescribe antimicrobials based on a provisional diagnosis, conducted remotely, of a swelling associated with an acute dental infection."[62] This approach may offer symptomatic relief to patients and provide dental professionals with some time to strategize the delivery of required dental care with all the appropriate measures in place to prevent the spread of infection.[53] "Any patient prescribed antimicrobials should be rapidly referred for definitive treatment in an urgent care setting to avoid repeat prescribing of antimicrobials."[62] The most updated COVID-19 guidance issued by the British Dental Association has suggested a list of nonclinical risk assessment factors for considering whether to treat a patient face-to-face. A nonexhaustive list of these factors can be found in Table 2.

Approaches to minimising the risk of COVID-19 in a dental setting

If the triage or assessment process concludes that the patient needs to be seen, it is essential to ascertain the potential risk of SARS-CoV-2 infection and how to better deal with the patient's treatment needs accordingly. Patients that have suspected or confirmed COVID-19 ideally should not be treated in a routine dental practice setting and should be referred to an urgent dental care (UDC) hub or similar emergency dental service that is purposely set up for this. It is recommended that dental practices routinely perform precheck triage to measure and record the temperature of every staff and patient.[4] Patients that are shielding or that are considered high risk should be seen as early in the clinical session as possible. Appointment slots should be scheduled so that appropriate time for infection control protocols are done between patients to minimise the chances of cross infection.

Patient management

It may be beneficial for patients to wait in a personal vehicle or outside the dental facility where they can communicate their arrival via mobile phone and be contacted when it is their turn for dental care.[60] If feasible, should patients need to wait in the building, they should be seated in a separate, well-ventilated area, at a safe social distance not facing another person.[53,63,64] Objects or products that may harbour the virus (ie, magazines, coffee cups, flower pots, toys) should be removed from the area. The use of pens and Clinipads to collect medical information should be limited and should be regularly disinfected with an appropriate stringent surface disinfectant. Patients should attend their appointments alone and not bring others unless strictly necessary.[63] Using a surgical mask, maintaining social distance, and following strict respiratory hygiene (ie, covering mouth and nose with a tissue before coughing or sneezing followed by adequate

Table 2 – Nonexhaustive risk assessment factors for consideration during the COVID-19 outbreak.

Risk assessment factors
- Have previous measures not managed the situation? (For example, advice/analgesics/antibiotics if indicated)
- Is the patient COVID-19 positive/COVID-19 negative/asymptomatic/in known recovery from COVID-19/in self-isolation/in a high-risk group?
- The health of the dentist and dental staff
- The availability of appropriate PPE
- What procedure would be planned
- Whether the planned procedure requires an aerosol-generating procedure
- Whether there is a local urgent dental care hub set up in your area that you can refer to
- The patient's views/wishes having discussed the risk factors
- The patient's best interests
- The patient's consent (following the Mental Capacity Act for those people who lack capacity)
- The welfare of practice staff

These are all professional judgements that will be nuanced, and there are no binary questions or definitive answers that will guide you to a decision to see and treat or refer.

COVID-19 = coronavirus disease 2019; PPE = personal protective equipment.

discarding) should be strongly recommended and stressed to patients prior to their appointment.[65] Installing physical barriers such as glass or plastic screens at reception areas can also help prevent cross infection.[60]

Hand hygiene

During training, health care professionals are taught the importance of hand hygiene and how it plays an integral part in preventing infection in clinical practice. Hand hygiene is considered the most critical measure in minimising the risk of transmitting pathogens in dental settings and reducing nosocomial infections.[66] Because of the possible transmission routes of SARS-CoV-2, this routine prerequisite is crucial in avoiding the transmitting the disease in dental settings.[58] Using hand sanitisers or antiseptics, preferably delivered through a sensor-detected, nontouch system, before and after dental procedures is strongly advised for all dental professionals and patients.[52,63,67,68] Using alcohol-based hand rubs with 60%-95% alcohol or washing hands with soap and water for at least 20 seconds is recommended particularly before using personal protective equipment (PPE).[60]

Surface disinfection

This highly infectious pathogen can persist on surfaces for hours up to several days.[58,69] This underpins the need for good hand hygiene and the importance of thorough disinfection using hospital-grade disinfectants (ie, ethanol 70%) of all relevant surfaces within the dental practice after each patient is seen. If there is a shortage of hospital-grade disinfectants, surface decontamination may be performed with 0.1% sodium hypochlorite after cleaning with a neutral detergent, although its effectiveness against SARS-CoV-2 is not absolutely certain.[64] Communal areas and public facilities must be cleaned and disinfected on a regular basis, which will include total disinfection of all door handles, chairs, desks, touchscreens, and monitors.

PPE

As a part of source control efforts, dental professionals should wear a cloth face covering or face mask at all times whilst they are in the dental setting.[60] SARS-CoV-2 is "aerosol-transmissible," and this has significant implications for how the dental team should manage possibly infected patients and what sort of PPE they are required to wear. Dental clinical professionals typically use face masks or visors; however, it is unknown whether the protection provided by this type of PPE acts as an efficient protective barrier for aerosols.[50] Furthermore, often this equipment does not fit perfectly or are placed and removed inadequately in clinical practice.[50] Using disposable PPE and devices such as mouth mirrors, syringes, masks, gloves, long-sleeved gowns, and goggles or face shields/visors is recommended to protect skin and mucosa from potentially infected blood or saliva and to prevent cross contamination.[8,53] Because respiratory droplets are the main route of transmission of SARS-CoV-2, adequately fitting particulate respirators (ie, N-95 masks, as authenticated by Chinese health authorities or FFP2/FFP3-standard masks, as set by the European Union) are recommended for dental professionals treating patients during the COVID-19 pandemic. A diagram of suggested PPE for dental clinical staff in direct contact with patients with COVID-19 is displayed in Figure 3. It is essential that all clinical and nonclinical dental professionals are appropriately trained on the proper use of PPE, and particularly which PPE is needed for each circumstance and how to proceed with safe wearing and disposing practices.

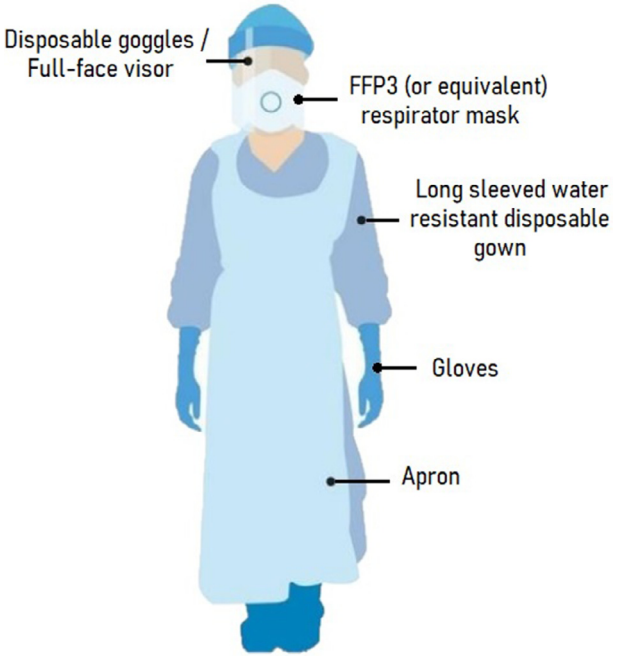

Fig. 3 – Suggested PPE for dental clinical staff in direct contact with potential patients with coronavirus 2019 (COVID-19). PPE = personal protective equipment.

Air management

Patients with suspected or confirmed infection by SARS-CoV-2 should ideally be treated in negative-pressure treatment rooms or airborne infection isolation rooms (AIIRs).[65] Using high-volume suction is indispensable in removing potential infectious droplets and aerosols at their source as soon as they are emitted, which minimises or prevents their dispersion in the air. The filters of the suction apparatus should be cleaned regularly to ensure their effectiveness, and to prevent the recirculation of potentially contaminated air, the exhaust air should be vented outside.[70]

Medical waste

The management of medical and domestic waste produced following the treatment of suspected or confirmed patients infected with SARS-CoV-2 should be treated as infectious clinical waste category B.[58,64] Therefore, double-layer yellow colour medical waste package bags and "gooseneck" ligation are advised and should be handled by staff with appropriate PPE. The surface of the package bags should be clearly marked and disposed in accordance with the health care facility policies and local regulations.[64,71]

Dental treatment during the COVID-19 outbreak

Preprocedural mouth rinses (PPMR)

There is no published evidence regarding the clinical effectiveness of PPMR to reduce SARS-CoV-2 viral load in saliva or to prevent the transmission of COVID-19.[60] Some of the literature seems to suggest that using PPMR may reduce the amount of pathogens intraorally prior to a dental examination, and therefore, this may be advantageous.[72,73] In May 2020, Yoon et al[74] reported that wearing a mask, hand washing, and chlorhexidine PPMR could be beneficial in controlling droplet transmission and SARS-CoV-2 transmission. Because coronaviruses are vulnerable to oxidation, PPMR with oxidative agents such as 0.2% povidone or 1% hydrogen peroxide can potentially decrease the viral load of this pathogen in the oral cavity and, therefore, reduce the risk of infection for patients and dental professionals.[58]

Oral examination

Some dental procedures have a higher risk of causing patients to cough and, consequently, produce potentially infectious droplets in the process. Therefore, clinicians should be mindful and try to avoid such procedures, perform them with extra caution, or try and find feasible alternatives. Periapical or bitewing intraoral X-rays are frequently used in dental examinations; however, they often cause an increase on saliva production and can potentially cause patients to cough because of the position of the radiographic holders.[75] Therefore, extraoral dental imaging alternatives like panoramic images, oblique lateral views, as well as, cone beam computed topography (CBCT) are suitable substitutes during the COVID-19 outbreak.[71] When intraoral x-rays are required, it is prudent to consider having a double-protecting barrier on the sensors to avoid perforation and prevent cross contamination.[76] Examination procedures that are likely to generate aerosols, such as the use of a 3-1 syringe, should be reduced as much as possible. [75]

Aerosol-generating procedures (AGPs)

AGPs should be avoided whenever possible and minimally invasive or atraumatic restorative techniques are preferred. If AGPs are necessary, using four-handed dentistry, adequate PPE, high-volume suction, and dental dams are advised to minimise droplet spatter and the production of aerosols.[60,61,77] Ideally, dental treatment should be provided in individual patient rooms whenever possible, and if AGPs are performed, the room should be left vacant for a period of time before cleaning is done.[78] The rate of clearance of aerosols in an enclosed space is dependent on the extent of any mechanical or natural ventilation and the size of the droplets created, that is, the greater the number of air changes per hour (ventilation rate), the sooner any aerosol will be cleared.[78]

Rubber dams

Using rubber dams is a widely employed isolation technique that has a significant effect on the control of moisture during dental treatments.[79] Rubber dams can reduce the production of potentially contaminated saliva and aerosols, therefore minimising the risk of cross contamination by SARS-CoV-2 when using high-speed dental hand pieces or ultrasonic devices.[79] The British Endodontist Society (BES) [80] has stated it may be beneficial, if feasible, to position the rubber dam so that it covers the nose of the patient to minimise the risk of inhalation of pathogens.

Antiretraction

High-speed dental hand pieces are commonly used in everyday dental procedures, and their sterilisation is mandatory. These rotational tools can aspirate and expel debris and fluids during treatment and potentially cause cross infection by causing a backflow of pathogens that can affect the hand piece and the dental unit. Using hand pieces with antiretraction valves or other antireflux designs can minimise this risk of cross infection significantly. Therefore, these should be a preferred option for dental treatments during the COVID-19 pandemic.[58,81]

Endodontic emergencies

According to the latest BES COVID-19 guidelines, patients that present with symptomatic irreversible pulpitis, symptomatic apical periodontitis, or acute apical abscess, and analgesia, as appropriate, was not effective, may require emergency endodontic treatment.[80] If the tooth is predictably restorable this can be performed with chemomechanical caries removal, following rubber-dam isolation and using high-volume suction after local anaesthesia. The extirpation of the dental pulp should then be executed to alleviate pain.[8] The BES is currently advising that the instrumentation of the root canal system not be performed but rather access the pulp chamber only for risk-management purposes. The use of sodium hypochlorite as irrigation (higher concentrations are indicated because they are more effective in dissolving pulp tissue) and a steroid-containing dressing material (ie, Odontopaste or Ledermix) or calcium hydroxide as dressing, as indicated, prior to the restoration with a temporary filling is recommended.[80] The root-filling procedure could be performed at a later stage if feasible and indicated.

Trauma

The clinical decision of treating a tooth fracture, luxation, or avulsion should be assessed individually. Factors such as the age of the patient, the severity of the dental injury, the stage of apical development, and the duration of tooth avulsion should be carefully taken into consideration before proceeding with treatment.[82–84] Certain occurrences such as dentoalveolar trauma or progressive fascial space infection will most certainly demand emergency treatment.[53]

Surgical emergencies

If a tooth needs extraction and if the soft tissue closure demands suturing for an adequate haemostasis and better postoperative healing, using absorbable sutures is preferred. Similarly, for patients with facial soft tissue contusion, debridement, followed by suturing with absorbable sutures (if feasible), should be performed. Carefully rinse the wound whilst using high-volume suction to avoid spraying. Potentially life-threatening circumstances when oral and maxillofacial compound injuries are suspected should immediately be referred to a hospital.[8]

Table 3 – Suggested websites for updated COVID-19 numbers.

www.worldometers.info/coronavirus	Worldometer
www.who.int/emergencies/disease/novel-coronavirus-2019	World Health Organization
https://www.fdiworlddental.org/covid-19-outbreak-guidance-for-oral-health-professionals	World Dental Federation
https://www.coronavirus.gov	Centers for Disease Control and Prevention (US)
https://www.nih.gov/coronavirus	National Institutes of Health (US)
https://www.gdc-uk.org/information-standards-guidance/covid-19/covid-19-latest-information	General Dental Council (UK)
https://bda.org/advice/coronavirus/pages/latest-updates.aspx	British Dental Association (UK)

COVID-19 = coronavirus disease 2019.

Discussion

Even though a systematic search of the existing literature was performed, this is not a systematic review. Furthermore, it should be understood that the information presented is based on the best available evidence at the time this was written. At the time of publication, there was still a vast range of uncertainty in regards to the true magnitude and impact of COVID-19 worldwide. In light of this, it is challenging and perhaps overambitious to objectively reach any conclusive results on the implications of this viral outbreak in the present and in the future of dentistry. In a fast-moving situation like this, any information risks being outdated and represents a significant limitation to the review. It is beyond the scope of this article to provide absolute guidance for an active practice but rather to clarify the current knowledge of COVID-19, the challenges posed to dental professionals, and suggest possible management and protective protocols. The literature suggests that further precautions are necessary in dental practice, including careful prescreening of patients, adequate referral for dedicated services if applicable, and additional and strict protective infection control measures if treatment of patients with confirmed or suspected COVID-19 is necessary. There is a generalised consensus recommending dentists defer elective dental treatment during the pandemic and to focus only on emergency care. Dental professionals should be mindful that COVID-19 case presentations can be dynamic, and there is a good chance that dental practices may have to treat asymptomatic patients because the incubation period can range from 2 to 14 days, and most patients only develop mild symptoms.[30,42] Consequently, every patient should be regarded as potentially infected, and all dental care services need to rethink their infection control protocols and their systems of triaging, booking, and treating patients.[57,78]

In the current scenario of outbreaks, epidemics, endemics, and pandemics, the concept of multiprofessional, interdisciplinary, and transdisciplinary action is of utmost importance. The participation of dentistry, oral medicine, and pathology are essential for the better understanding, diagnosis, and management of patients with COVID-19 and to prevent the further dissemination of this pandemic as well as the serious consequences to health services and economies worldwide. This COVID-19 threat could eventually become a less pathogenic and more common infection world-wide. Indeed, it is predicted to persevere in our population as a less virulent infection with milder symptoms, if it follows the same evolutionary pattern of other human coronavirus infections (ie, SARS-CoV and MERS-CoV).[53] Therefore, it is imperative to make informed clinical decisions and educate the public to prevent panic, while promoting the oral health and general well-being of patients during these unprecedented times. Prudent practitioners will use this review as a starting point and continue to proactively update themselves with trusted online information as the COVID-19 pandemic continues[53] (Table 3).

Throughout the world it has been inspiring to see how dental professionals have united resources whilst complying with the strict limitations advised by governments and WHO: Dental practices have made any stock of PPE available to the frontline health care services; three-dimensional printing have been employed creatively for the production of masks, visors, and even ventilator components for dental workflows; many dental professionals have facilitated continued professional education remotely; and many have volunteered to be on the frontline treating patients with COVID-19. The authors would like, as a conclusive note, to use these inspirational examples as a hopeful tone to anticipate what lies ahead for the future of dentistry after the COVID-19 pandemic.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest

None disclosed.

Acknowledgement

The authors would like to thank the World Health Organization (WHO) for making the coronavirus disease 2019 (COVID-19) data available and also to Dr José Teles for providing insight and comments on the manuscript before submission.

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