The COVID-19 pandemic and dentistry: the clinical, legal and economic consequences – part 1: clinical

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Key points

- Emergency and urgent care descriptions are presented.
- The need for the UK to pause routine dental care due to COVID-19 is discussed and compared with Hong Kong.
- Planning for a safe return to routine dental care and associated dental education is discussed.

Abstract

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus which causes COVID-19, is highly contagious. Dentistry is a high-risk profession for occupational virus transmission because of the close proximity of the operator to the patient during treatment and the procedural generation of aerosols.

The impact on the provision of dental care has been profound, with routine care restricted or paused for a period around the world. There have been adverse consequences for dental education and clinical research. Emergency and urgent care provisions have generally proceeded. However, even when a patient's condition is deemed urgent, access to the appropriate care may not have been possible due to lack of the recommended personal protective equipment. The common dental diseases of caries and periodontitis usually present with signs and symptoms after some advancement, hence the recommended regular dental examination so that these may be diagnosed early by a professional with suitable lighting, instruments and radiography. Conditions such as oral cancer similarly present in their early stages without symptoms. Many countries introduced telephone and video consultations for patients with symptoms but much disease has gone undiagnosed and without management.

It is difficult to ascertain the full effect of the disruption to dental services, education and research but it is likely to be substantial. The immediate future will focus on return to routine care provision with likely longer-term permanent changes.

Introduction

Four genera of coronavirus, including beta coronavirus (β-CoV), infect the respiratory, gastrointestinal and central nervous systems of humans and mammals. At the end of 2019, a novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) with a genome length of 29,903 nucleotides was isolated by a Chinese researcher from a patient with pneumonia in Wuhan, China.[1] This virus was noted to be highly contagious, causing a range of different clinical presentations of coronavirus disease 2019 (COVID-19) from mild respiratory symptoms to severe pneumonia. A case fatality rate reached more than 16% in some countries, especially in elderly men.[2]

A public health emergency of international concern was declared by the World Health Organisation (WHO) on 30 January 2020. The impact on the provision of dental care has been profound, with routine care restricted or paused for a period around the world.[3] Emergency and urgent care provision has generally proceeded but globally has been defined differently. Patients could be expected to experience harm if denied the dental care needed and delayed for a significant period of time. This could be expected to impact on not only quality of life but also general health and life itself. The period of 'pause' in care provision has been seen to vary considerably around the world according to the COVID-19 strategy of each country for transmission management.

In these two articles, we present the consequences for patients and dental professionals. Much medical care has also been put on hold while focusing on the COVID-19 pandemic, with many health services stretched or overwhelmed. The cost to overall health has therefore been above and beyond the reported COVID-19 infections and deaths themselves. These 'indirect costs' are substantial but harder to quantify. Patients have also been reluctant to seek oral and general healthcare when it has been available for fear of becoming infected. Attendance at accident and emergency (A&E) departments dropped by 25% and 57% in the United States of America and England, respectively.[4,5] Dental professionals have wanted to provide care for their patients but have been anxious about the risks of virus transmission. They have also been concerned about the medico-legal consequences of withholding care that patients clearly require and who may come to clinical harm. The

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natural progression of dental/oral disease along with the potential medico-legal consequences of stopping the provision of routine dental care during the COVID-19 pandemic along with the economic repercussions are presented in part two of this article.

At the Prince Philip Dental Hospital (PPDH), the academic base for the University of Hong Kong's (HKU's) Faculty of Dentistry and the only specialist multi-clinic dental centre in the city, a historical precedent existed. During a three-month period in early 2003, Hong Kong experienced a devastating outbreak of the then new and potentially fatal coronavirus pneumonia subsequently called severe acute respiratory syndrome (SARS). Effective quarantine measures in the general population, a combination of standard and transmission-based precautions (particularly frequent handwashing and wearing face masks), identification of symptomatic patients and postponement of non-urgent dental appointments formed the basis of a rapidly successful infection control policy within PPDH. Of significance, no SARS transmissions were ever identified to have occurred as a result of oral healthcare procedures.[6,7]

In January 2020, following the outbreak of the COVID-19 pandemic in mainland China, the Hong Kong government activated the Emergency Response Level of its longstanding 'Preparedness and response plan for novel infectious disease of public health significance'. This mandated school closures, working from home arrangements, social distancing measures, social isolation and, where applicable, formal quarantine to control community spread of the SARS-CoV-2 virus. Based firmly upon the SARS experience, rapid introduction of these measures proved highly effective in achieving local control of this new coronavirus outbreak. Through its Control of Infectious Disease Task Force, HKU suspended face-to-face undergraduate and postgraduate teaching, with online teaching arrangements and assessment protocols utilised wherever possible. The Faculty of Dentistry similarly suspended all face-to-face teaching, simulation laboratory instruction and clinical teaching for the ensuing four-month period. In addition to the impact of the COVID-19 pandemic on dental education, there has also been a suspension of clinical research around the world.

Similar strategy was adopted in the UK with all routine dental services postponed during the period between 25 March and 8 June 2020. Urgent and emergency dental care was provided by urgent dental care centres with the appropriate level of infection prevention and control (IPC), after thorough telephone triaging.[3] Multiple national guidelines were issued to guide this process and standardise the IPC protocol in these centres. All undergraduate and postgraduate theoretical teaching was provided remotely through online teaching classrooms. Clinical elements of the course were provided as remote case-based discussions when appropriate. However, patient interaction and practical experience had to be deferred. All assessments were conducted remotely using online assessment tools.[8]

Routes and risk of coronavirus transmission

Genomic sequence analysis of SARS-CoV-2 showed 88% identity with two bat-derived SARS-like coronavirus, indicating that mammals were most likely the initial reservoir.[9] Person-to-person transmission occurs through direct contact or through droplets spread by coughing or sneezing from an infected person. Individuals in the incubation period are capable of transmitting the infection from day one. Binding of the receptor-binding domain of virus spikes and the cellular receptor angiotensin-converting enzyme 2 (ACE2) receptor leads to viral entry into the host cells and establishment of infection.

SARS-CoV-2 can remain viable in an aerosol for at least three hours, with reducing infectious titre from $10^{3.5}$ to $10^{2.7}$ tissue culture infectious dose (TCID50) per litre of air. Interestingly, the virus is more stable on plastic and stainless steel in comparison to copper and cardboard. It remains viable for up to 72 hours, with reducing infectious titre from $10^{3.7}$ to $10^{0.6}$ TCID50 per millilitre of medium after 72 hours on plastic, and from $10^{3.7}$ to $10^{0.6}$ after 48 hours on stainless steel.[10]

Dentistry is a high-risk profession for transmitting this disease because of two equally important factors: 1) the generation of aerosols through different dental procedures using high-speed motors (reviewed by Harrel and Moliari, [2004][11]); and 2) the close proximity of the operator to the patient during the course of treatment, making them exposed to the aerosols generated through talking, breathing, coughing or sneezing.[12,13] While there is evidence that SARS-CoV-2-specific humoral and cellular immunity successfully develops after natural infection in recovered individuals, the duration of this immunity is currently unclear and the vaccine is currently at the trial stage. Until a validated vaccine is available for healthcare workers and/or proven long-term protection by natural immunity, the profession must be careful when providing dental care by implementing transmission-based precautions (contact, droplet and airborne) in addition to the usual standard infection control precautions. While there is little disagreement that routine dental care be suspended, the consequences are difficult to comprehend.

Principles of infection prevention

Long ago, for the purposes of preventing infection transmission in dentistry, the dental profession adopted a concept: 'standard infection control precautions'. This is a standardised multifaceted approach of providing dental care with optimum IPC precautions for all patients, regardless of their infectious disease status. Standard precautions include health clearance, vaccination for healthcare workers, hand hygiene, personal protective equipment (PPE), environmental cleaning and disinfection, instrument decontamination, clinical waste management, safe sharps handling and sharps injury management. In exceptional cases, when there is evidence that standard precautions are not enough to protect healthcare workers, patients and the public, 'transmission-based precautions' should be implemented as additional measures (reviewed by Harte [2010][14]).

Despite initial scarce national and international guidance on precautions required in dentistry, detailed guidance was published on 24 April 2020 by Public Health England in collaboration with Public Health Scotland, Public Health Agency, Public Health Wales and the NHS.[15] During sustained human-to-human transmission of the highly infectious SARS-CoV-2 virus in the UK, transmission-based precautions were implemented in dentistry for the provision of emergency and urgent treatment. All routine dental care was postponed and a thorough triaging protocol, directed by the emergency and urgent dental care centres distributed throughout England, was initiated. The aforementioned guidance specified the level of PPE required during aerosol generating procedures (AGPs) versus non-AGPs, and highlighted the importance of hand hygiene and environmental

Fig. 1 Personal protective equipment (PPE). a) PPE for non-aerosol generating procedures (non-AGPs) including visor, fluid-resistant surgical mask, apron and gloves. b) PPE for AGPs including hat, visor, fit-tested respirator, long-sleeved gown, apron (optional) and gloves. c) Visor and fit-tested filtered face piece (FFP3)

decontamination (Fig. 1). Using fit-tested filtered face piece (FFP3) respirators and disposable gowns, in addition to the usual gloves and eye protection, was recommended for AGPs. In case of the unavailability of FFP3 respirators (99.95% filtration of 0.3 micron particles), N95 (95% filtration of 0.3 micron particles) or FFP2 (94% filtration of 0.3 micron particles) respirators were considered to provide enough protection, provided that a face fit test was carried out for the specific user.[16,17,18] However, N95 respirators are not CE-marked; therefore, their use is not recommended in UK health and social care settings.

Testing frontline healthcare workers in clinical settings (whether in general medicine or dentistry) is important, but carries with it some challenges. Generally, there are two main tests for infectious diseases:

1. A test to determine the infectious status, which is usually done by isolating the infectious agent by standard culturing techniques or identifying it by molecular investigation. This is usually very useful for symptomatic individuals to help in their diagnosis and management. It is also useful to determine the infectivity of asymptomatic persons when the infection can cause carriage status
2. A test to determine the immunity level by looking at whether specific immunoglobulin is IgG (past infection) or IgM (recent or acute infection).

It is crucial to know that frontline healthcare workers are not infectious and therefore testing the infectious status by detecting SARS-CoV-2 RNA by reverse transcription polymerase chain reaction (RT-PCR) is useful.[19] Having said this, SARS-CoV-2 can be transmitted during the incubation period when the individual is asymptomatic. Furthermore, the disease can present subclinical symptoms or cause very mild symptoms. It was found that the peak shedding of the virus is at the end of the first week of infection, just before developing the symptoms. This in turn poses a challenge when determining the criteria and frequency of testing. Validated rapid near-patient testing with reasonable cost and sensitivity could offer the solution and allow periodic testing for frontline healthcare workers. At the same time, testing the immune status of healthcare workers for SARS-CoV-2 is also important, especially if exposure provides long-term immunity. This may allow future downgrading of the level of infection control precautions to the usual standard precautions if all healthcare workers are immune to the virus either through natural immunity or vaccination.[20]

What oral care is urgent when there is risk of coronavirus transmission?

Clearly, there were risks to continuing the practice of dentistry following the WHO announcement on 30 January 2020 of a world health emergency due to a novel virus for the reasons described above. There was no vaccine, uncertain immunity level and, while 'standard infection control precautions' were escalated to 'transmission-based precautions', this was no guarantee of preventing transmission. There has been universal agreement that it was wise to suspend routine care, but little international consistency about what care would need to continue. There is a moral obligation to maintain some care. Emergency care may describe those conditions that require immediate attention as life-threatening emergencies, such as spreading infection and swelling compromising the airway. Pre-COVID-19, these patients have typically presented directly to A&E departments or have been immediately referred from dental practice for which this service continued. Emergency care may also include trauma to the face and mouth with soft tissue and hard tissue injury.

Urgent care is more difficult to define and is a qualitative judgement based on severity of the pathology and symptoms, likely benefit of care and risk of virus transmission. The range of conditions considered likely to be urgent in the UK NHS are listed in Box 1. It was recommended that AGPs should be avoided unless absolutely necessary. As there were stringent social distancing measures in place, many consultations took place remotely via video link. Patients with mild symptoms or conditions not deemed to be urgent were offered advice, analgesia and antimicrobials where appropriate. It was recognised that there would be variations of threshold for onward referral for face-to-face assessment and treatment, and that this could be a problem if a patient's condition deteriorated substantially. There were also worries about the overuse of antimicrobial agents in an era of antimicrobial resistance, which could contribute to a future global health problem.

Even when a patient's condition is deemed urgent, access to the appropriate care may not have always been possible because of the lack of recommended PPE. The common dental diseases of caries and periodontitis usually present with signs and symptoms after some advancement (discussed in part two), hence the recommended regular dental examination intervals. These conditions may be diagnosed early by a professional with suitable lighting, instruments and radiography.[22] Serious conditions such as oral cancer similarly present in the early stages without symptoms. Many countries introduced telephone and video consultations for patients with symptoms, but clearly much disease has gone undiagnosed and without management. Patients are anxious about this and so is the dental profession.

The vast majority of dental disease requires physical treatments. Pain may be managed to some degree with systemic analgesics but this

can only be a temporary short-term holding position. Pulpitis is typically associated with severe continuous pain and this is difficult to control with paracetamol and non-steroidal anti-inflammatory drugs. There are risks of analgesic overdoses with unmanaged dental pain.[23] The addition of mild opioids can help but their prescription is restricted in many countries now, including the UK. Furthermore, opioids do not have an anti-inflammatory effect and therefore the added benefit of using them in managing dental pain is controversial. The appropriate treatment is removal of the pulp or removal of the tooth. Without appropriate treatment, the disease will progress as described in part two of this article. The loss of a restoration may not be considered 'urgent' during a pandemic but is likely to be associated with sensitivity and has the potential to lead to further caries or pulpitis, or inability to re-restore and consequent loss of the tooth.

Antibiotics for the management of infection in dentistry may be appropriate when justified by evidence of spreading infection, but will only be useful if combined with the appropriate physical dental intervention. If access to such treatments is not possible for weeks or months, then the infection will progress and likely cause pain and local and systemic spread of infection, which could ultimately be life-threatening.

Box 1 The range of conditions considered urgent in the UK NHS are likely to include, but are not limited to, the stated conditions

- Life-threatening emergencies; for example, airway obstruction or difficulty breathing/swallowing due to facial swelling
- Trauma including facial/oral lacerations and/or dentoalveolar injuries
- Orofacial swelling that is significant and worsening
- Bleeding that the patient cannot control with local measures
- Dental conditions that have resulted in acute and severe systemic illness
- Severe dental and facial pain; that is, pain that cannot be controlled by the patient following self-help advice
- Fractured teeth or tooth with pulpal exposure
- Dental and soft tissue infections without systemic effect
- Suspected oral cancer
- Oro-dental conditions likely to exacerbate systemic medical conditions.

Information derived from:[21]

Planning the return to routine care

As evidenced by the perplexing difficulties faced by governments worldwide, reactivation following a period of such 'lockdown' is a particularly perilous and uncharted journey. Although emergency and urgent clinical care continued to some degree throughout 'lockdown', the Faculty of Dentistry in Hong Kong (like dental clinics and teaching services elsewhere) were faced with increasingly difficult decision-making regarding how, where and when to reactivate clinical and teaching activities. Clearly, mainland China, the origin of the pandemic, as well as Hong Kong, Singapore, South Korea and other Asian countries experienced the spread of the virus ahead of Europe and the rest of the world, and also developed experience in the suspension of/planning to resume routine dental care. Like most dental teaching institutes, PPDH relies heavily upon the use of open multiple-surgery clinic layouts designed for simultaneous teaching of comprehensive dental care to large groups of undergraduate students. On any given day, approximately 1,500 people may be in the hospital building. In the post-COVID-19 era, such environments pose potential risks not only for patient-to-clinician cross infection but also patient-to-patient viral transmission, especially when multiple treatments (including widespread AGPs) all take place at once.

Utilising expertise from HKU's microbiology department, internal consultation within the Faculty's Infection Control and Safety Committees and international discussion with colleagues in Australia, Singapore, the United Arab Emirates and the UK, a phased return to teaching was developed based upon the following fundamental principles:

1. Ensuring a safe clinical teaching environment for students, staff and patients was the overarching priority. Enhanced patient, student and staff screening measures for all PPDH attendees were developed; intermittent SARS-CoV-2 testing via deep-throat saliva sampling to identify asymptomatic patients or viral carriers was performed; and provision of robust social distancing measures were introduced in all hospital areas
2. Comprehensive delivery of updated educational sessions on IPC and development of detailed, pragmatic guidelines for the use of PPE and modification of dental/surgical procedures were all tailored specifically for application in the various specialist care environments within PPDH
3. Reintroduction of 'low-risk', non-patient simulation laboratory teaching was arranged first to test the efficacy of all new arrangements, before reactivation of clinical teaching
4. Formal assessment of the entire clinical teaching environment was undertaken to: review air ventilation and air flow (especially aerosol dispersion within open multiple-surgery clinics); provide barriers and screening between and within surgeries; and deliver timetabling modifications to ensure social distancing between multiple student operators and patients
5. Taught postgraduate clinical training sessions were commenced first, followed by final-year and then senior undergraduate students returning to clinics in a stepwise approach, optimising a 'safety-first' approach.

Throughout this reactivation process, active monitoring, review and audit were carried out to assess efficacy and measure outcome at each stage. Despite the emphasis on safety and the introduction of contingency measures within PPDH to deal with any adverse event, significant underlying concerns remained regarding the risks for future community outbreak of SARS-CoV-2 infection, the inherent reputational problems if hospital clinical activity had to be suspended again, and how to ensure both current and future patients would always feel 'safe' to attend PPDH for their treatment.

Similarly, in the UK, once there was evidence of a sustained reduction in COVID-19 transmission, the profession was prompted to prepare for resumption of routine dental care. The principles were based around practice considerations of patient flow/layout, communal areas, supplies and equipment, staff considerations of training, screening health and wellbeing, and patient considerations.

These considerations include communication, care plan identification and prioritisation, and patient journey.

The goal for patients and professionals was to resume the safe and effective provision of the full range of care in all practices, as rapidly as practicable. Working with the British Dental Association, wider professional representative groups and the dental industry, the Chief Dental Officer for England obtained consensus on the commencement of reopening services. The message was one of support for the full resumption of routine dental care, in a way that was safe, operationally deliverable, and allowed dental practices flexibility to do what was best for patients and their teams. Central to this was the acknowledged clinical judgement of practitioners and their ability to risk-manage the delivery of dental care, as service provision was recommenced. Eight key rules were adopted in the UK during the reopening phase of general dental practices: 1) phased approach to full resumption based on risk management; 2) continuation of providing remote consultations for all patients; 3) providing advice, analgesia and antimicrobials (where appropriate) in the first instance; 4) observing social distancing measures at all time; 5) minimising all face-to-face patient contact; 6) clear safety standards for PPE and IPC; 7) appropriate sequencing and scheduling of patients; and 8) referring all possible/confirmed patients to urgent dental care sites until phased resumption completed.[24]

Summary

SARS-CoV-2, the virus which causes COVID-19, is highly contagious, and dentistry is a high-risk profession for transmitting this disease because of the procedural generation of aerosols and close proximity of the operator to the patient during treatment.

The impact on the provision of dental care has been profound, with routine care restricted or paused for a period around the world. There have been associated adverse consequences for dental education and clinical research. Emergency and urgent care provision has generally proceeded, but even when a patient's condition is deemed urgent, access to the appropriate care may not have been possible because of lack of the recommended PPE. The common dental diseases and oral cancer usually only present with signs and symptoms after some advancement. Many countries introduced telephone and video consultations for patients with symptoms, but clearly much disease has gone undiagnosed and without management.

It is difficult to ascertain the full extent of disruption to dental services, education and research but it is likely to be substantial. The immediate future will focus on return to routine care provision, with likely longer-term permanent changes not only in IPC measures but also in working patterns, such as greater use of video consultation clinics, clinical simulation training and online teaching.

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