

Research Article

Evidence-Based Precautionary Measures in Dentistry in the COVID-19 Pandemic: COVID-19 Compliance Scale in Dentistry

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Abstract

Background: The purpose of this paper is to provide the dentists and dental healthcare workers as a whole with an evidence-based set of precautionary methods to be implemented in dentistry during this unfortunate COVID-19 pandemic. It is the intention of this publication to codify and grade each preventative measure within a hierarchy. Such hierarchy will be awarded a score and a practice with less than a 9 out of 15 value, will be regarded as unfit to see patients.

Materials and Methods: Available references or reports in English on COVID19 were consulted from published scientific journals, books, reports from national, regional and international organizations, theses, conference papers and other grey materials. Literature was searched on international online databases such as Pubmed, MEDLINE, Science Direct, Scopus and Google using the MeSH words “Precautionary Measures in Dentistry”, “oral health”, “dental”, “primary oral health care” “SARS”, and “ COVID 19”.

Results and Discussion: The novel β -Coronavirus which has been causing severe and even fatal pneumonia globally, continues to fuel concern as to whether dental practice should continue to operate during the acute phase of this pandemic. Of significant concern to dentistry, is the possible viral content of the saliva which will inevitably through various routes directly or indirectly cross-infect dentist, dental healthcare workers, patients and the general public. Aside from the pathomechanism of such infection and the virology of COVID-19, we focus on the transmission route and how to curtail this in the daily practice of dentistry.

Conclusion: At the end of this review we were able to grade infection prevention and control precautionary methods in dental practices against the background of COVID-19 virus for suitability to engage in patient care.

Keywords: COVID-19, Dentistry, Precautionary methods, Coding, Compliance scale

Introduction

As at today March 18, 2020, (at the time of writing this paper), the United States of America has experienced a total of 100 deaths as a result of the COVID-19 virus. An additional 5,300 cases of patients with the COVID-19 virus has been diagnosed in the United States of America. A set of confusion, blasted into the Caribbean community when in the wake of March 10, 2020, the Minister of Health Dr. Christopher Tufton, and the Ministry of Health and Wellness of Jamaica confirmed the first case of COVID-19 virus in a tourist from the United Kingdom. Subsequently, 7 other cases have been confirmed and isolated with no fatality so far in Jamaica. The government of Trinidad and Tobago has already confirmed a less number of cases in Trinidad and Tobago leading to immigration limitations for entry of non-nationals into the country.

The pneumonia infection caused by the outbreak of this virus which originated in Wuhan City, China, in the late December 2019 has been the cause of this pandemic [1-3]. It is because of this, that the World Health Organization (WHO) has declared an emergency globally as a result of this emergent pneumonia on the 30th of January 2020 [4]. The typical clinical symptom of the patients who suffered from the novel viral pneumonia includes: fever, cough, myalgia, fatigue. Its pathologic findings on chest CT with sputum production, headache, hemoptysis, and diarrhea are all possible symptoms [5-7]. The majority of the clinical symptoms differ significantly from the Severe Acute Respiratory Syndrome (SARS), which in 2002 – 2003 was discovered to be caused by the SARS Coronavirus (SARS-CoV). There was indication at this time that a new person-to-person transmission of the SARS-CoV had caused this emergent viral pneumonia outbreak [8,9]. Since then, Chinese researchers at that time quickly isolated the new virus from the patients and sequenced its genome (29,903 nucleotides) [10]. On the 11th of February 2020 (just last month) WHO named COVID-19 (also designated as 2019-nCoV), as the novel virus causing this serious pneumonia despite the suggestion by the International Committee on Taxonomy of Virus (ICTV) to designate this novel corona virus as SARS-CoV2 based on the phylogenetic and taxonomic analysis of this novel virus [4,11]. Today, no standard protocol has been established in the management of patients with COVIC-19 world-wide. Therefore the pur-

pose of this paper is to provide the dentists and dental healthcare workers as a whole with an evidence-based set of precautionary methods to be implemented in dentistry during this unfortunate COVID-19 pandemic.

Methods

Available references or reports in English on COVID19 were consulted from published scientific journals, books, reports from national, regional and international organizations, theses, conference papers and other grey materials. Literature was searched on international online databases such as Pubmed, MEDLINE, Science Direct, Scopus and Google using the MeSH words “Precautionary Measures in Dentistry”, “oral health”, “dental”, “primary oral health care” “SARS”, and “COVID 19”. Extracts from the literature was used to describe the virology of COVID-19, the progression of COVID-19, COVID infection in humans and the transmission of COVID-19 in the dental practice. Evidence gathered from the literature were also used to grade infection prevention and control precautionary methods in dental practices against the background of COVID-19 virus for suitability to engage in patient care.

Results and Discussion

Virology of COVID-19

Since the presentation of the disease, the causative agent, and the pathogenesis was still obscured. It is obvious that at this time the full virology of COVID-19 is yet to be elucidated. However, knowing full well that the Coronavirus belongs to the family of *Coronaviridae* of the order *Nidovirales*, it will comprise therefore large, single plus-stranded RNA as their genome [4,12,13]. Currently there are four genera of Coronavirus the alpha (α -CoV), beta (β -CoV), gamma (γ -CoV) and the delta (δ -CoV) [14,15]. And most of them, if not all will cause infectious diseases in humans and vertebrates. It is of note that the α -CoV and the β -CoV will mainly infect the respiratory system, the gastrointestinal system and central nervous system of humans and mammals. It is for this reason that the novel β -Corona virus 2019 may not be of respiratory concern only but of gastrointestinal and central nervous system concern. For some completion in the acquisition of knowledge, the γ -CoV and the δ -CoV mainly infect birds [16,17]. Of course, most members of the Coronavirus in general will cause mild respiratory disease in humans. It is of note and of great significance, against the background of the current pandemic that

the SARS-CoV and the middle-east respiratory syndrome Coronavirus (MERS-CoV) which emerged in 2002 -2003 and in 2012, respectively also presented with fatal severe respiratory disease [18-20].

The 2019-nCoV possessed the typical Coronavirus structure with the “spike protein” in the membrane envelope [4], and also expressed other polyproteins, nucleoproteins, and membrane proteins, such as RNA polymerase, 3-chymotrypsin-like protease, papain-like protease, helicase, glycoprotein, and accessory proteins [4]. The S protein from coronavirus can bind to the receptors of the host to facilitate viral entry into target cells [4]. Although there are four amino acid variations of S protein between 2019-nCoV and SARSCoV, 2019-nCoV can also bind to the human angiotensin converting enzyme 2 (ACE2), the same host receptor for SARSCoV, as 2019-nCoV can bind to the ACE2 receptor from the cells from human, bat, civet cat, and pig, but it cannot bind to the cells without ACE2 [4]. A recombinant ACE2-Ig antibody, a SARSCoV- specific human monoclonal antibody, and the serum from a convalescent SARS-CoV- infected patient, which can neutralize 2019-nCoV, confirmed ACE2 as the host receptor for 2019-nCoV [4]. The high affinity between ACE2 and 2019-nCoV S protein also suggested that the population with higher expression of ACE2 might be more susceptible to 2019-nCoV [4]. The cellular serine protease TMPRSS2 also contributed to the S-protein priming of 2019-nCoV, indicating that the TMPRSS2 inhibitor might constitute a treatment option [4].

Progression of COVID-19 infection in humans

It has been confirmed that the incubation period for COVID-19 is within 14 days after the exposure to the virus. With most cases becoming clinically apparent within 4-5 days after exposure [21-23]. In a study of 1099 patients with COVID-19 confirmation, the median incubation period was 4 days [22] with a range of 2-7 days was reported [22]. A spectrum of symptomatic infection would range from mild to critical but fortunately, most infections are not severe [23-28]. Specifically, in a report from China targeted for disease control and prevention, which related to 44,500 confirmed infections, the estimation of disease severity is as follows [29]:

- Mild (no or mild pneumonia) was reported in 81 percent.

- Severe disease (eg, with dyspnea, hypoxia, or >50 percent lung involvement on imaging within 24 to 48 hours) was reported in 14 percent.
- Critical disease (eg, with respiratory failure, shock, or multiorgan dysfunction) was reported in 5 percent.
- The overall case fatality rate was 2.3 percent; no deaths were reported among noncritical cases.

According to WHO, the case fatality rate ranges from 5.8% in Wuhan to 0.7% in the rest of China. With the majority of fatalities occurring in patients with advanced age with underlying medical comorbidities to include cardiovascular disease, diabetes, chronic lung disease, hypertension and cancer [30,31]. The proportion of severe and fatal infection will of course vary from one location to the other. Individuals of any age can be affected by COVID-19 infection, although adults of middle age and older are most commonly affected. Despite the dearth of frequency, asymptomatic infection has also been described [32-34]. Within an infected group or in an infected community approximately 17% of the population may become positive after testing for the virus [35]. However, it must be noted that some patients with asymptomatic infection may present with some objective clinical abnormalities. Routine chest x-ray may not detect the rapidly progressing lung pathology and as such, chest computerized tomography (CT) is mandatory and will show the typical ground glass opacities or patchy shadows in 50% of cases with another 20% of cases having atypical abnormality [36]. In the initial clinical manifestation, pneumonia is the most frequent and serious presentation of the infection which is characterized primarily by: fever, cough, dyspnea and bilateral infiltrate on chest imaging [37-39].

Unfortunately there are no specific clinical features currently that will reliably distinguish COVID-19 from other viral respiratory infection. It is for these reasons that the International Committee on Taxonomy of Viruses (ICTV) which suggested that this new novel β -Coronavirus be named SARS-CoV2 can be credited without much rejoice.

Without much deliberation, it is important to note that in the study of 138 patients with COVID-19 pneumonia in Wuhan, China, the most common clinical features in the onset of the illness were: [39]

- Fever in 99%

- Fatigue in 70%
- Dry cough in 59%
- Anorexia in 40%
- Myalgias in 35%
- Dyspnea in 31%
- Sputum production in 27%

The fever may be low grade <100.4°F/38°C. However, this may be in approximately 20% of the cases. Hospitalization may be required for patients with a temperature of over 99.5°F/37.5°C (this is the axillary temperature). Headache, sore throat and rhinorrhea together with nausea and diarrhea (gastrointestinal symptoms) may present in addition to the severe respiratory symptom [37,39]. All the above mentioned symptoms can range from mild to critical to dictate the spectrum of illness severity [4].

Laboratory findings and imaging findings are very important and critical in the confirmation of the COVID-19 infection. In addition to the imaging findings described above, laboratory findings of leukopenia, leukocytosis and lymphopenia have been reported with lymphopenia being the most common situation [37-39]. The lactate dehydrogenase, and the ferritin level and the aminotransferase level have also been shown to be elevated in patients with COVID-19 infection. Additionally, on admission to the Hospital, many patients with pneumonia as a result of COVID-19 infection will show normal serum procalcitonin level. It is of importance to note that when the serum procalcitonin level is high, intensive care unit admission is mandatory.

It is obvious that in all current clinical studies of patients with COVID-19 infection, no mention has been made of the oral cavity examination and as such, it is uncertain if there is an oral manifestation for patients with COVID-19 infection. It is for this reason that the Faculty of Dentistry of the International Postgraduate Medical College (IPMC) is recommending oral examination by a dentist (at least for all the confirmed clinical cases of COVID-19 infection).

Transmission of COVID-19 in the dental practice

Generally, studies have shown that respiratory viruses can be transmitted from person-person through direct or indirect contact or through coarse or small droplets. It is important that COVID-19 can be transmitted directly or indirectly through the saliva and as such drawing the attention of practicing dentists and

dental healthcare workers.

The common transmission route of this novel Coronavirus includes direct contamination (cough, sneeze, droplet inhalation transmission) and contact transmission (contact with oral, nasal and eye mucous membrane) [40]. It is for this reason that the Faculty of Dentistry of the International Postgraduate Medical College is suggesting a mandatory masking manoeuvre for the eyes and nasal cavity in patients undergoing dental treatment as shown in Figure 1 with or without the use of rubber dam. This may be the most important dental-clinical manoeuvre to prevent transmission and spread of 2019-nCoV. Because studies have suggested that 2019-nCoV is airborne through aerosol formed during dental procedures (Figure 2), it is important that if our preventive methods in dentistry would be evidence-based that such preventive methods encompass the limitation of the aerosol transmission route by the reduction in the use of high speed handpieces and ultrasonic scalers.

The fecal-oral transmission is also a concern in dentistry as well as to the general public, however it is impossible to ascertain pa-



Figure 1: Showing the chairside use of face mask for patients to avoid the transmission of droplets and aerosol to the conjunctiva and nasal mucosa.

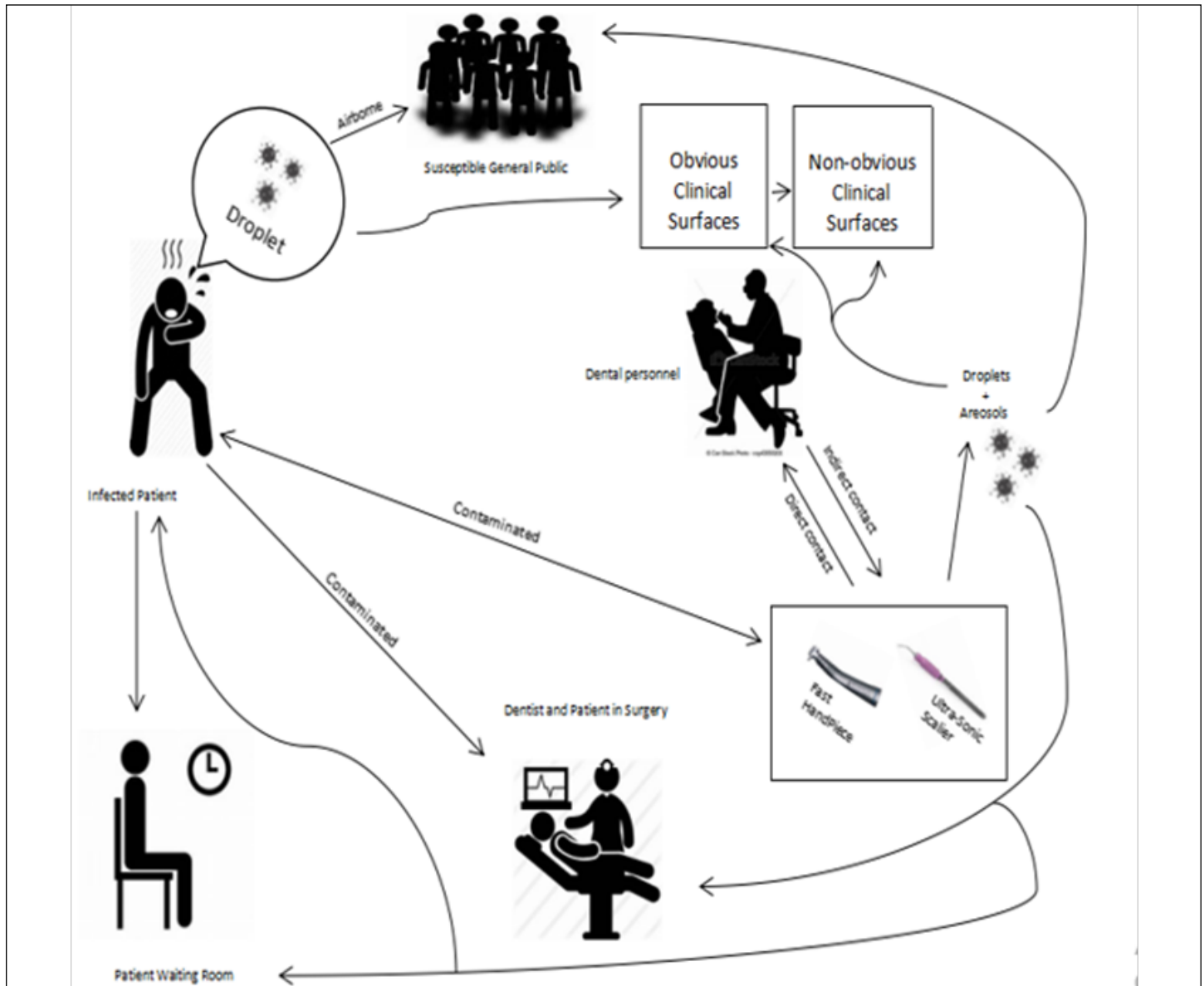


Figure 2: Showing the possible directions spread of COVID-19 in the dental practice.

tients who practice oral and/or anal sex and who may be high risk for transmission of COVID-19 during dental treatment. To, et al. [41] have reported that live viruses were present in the saliva of infected individuals by way of viral culture record. Furthermore, the 2019-nCoV enters the cell in the same path as SARS Coronavirus that is to say through the ACE2 cell receptor [42]. The 2019-nCoV can as such effectively utilize ACE 2 as a receptor to invade cells and it is this that propagates human-to-human transmission [11]. In hypertensive and diabetic patients, circulating amounts of angiotensin converting enzyme-2 (ACE2) are increased. Moreover, some drugs including some types of antihypertensive drugs

act as ACE inhibitors which further increase ACE2, and as SARS-CoV-2 binds to the host cell's membrane via ACE2, an increased risk to infection is noticed [43].

A study was carried out between January 26 through February 10, 2020 during an outbreak of 2019 novel coronavirus disease (COVID-19) where 10 persons affected from 3 families who had eaten at the same air-conditioned restaurant in Guangzhou, China. One of the families had just travelled from Wuhan, Hubei Province, China which was an epicentre for COVID-19. They concluded that droplet transmission was prompted by air-conditioned ventilation. The key factor for infection was the direction of

the airflow. The source patient was afebrile and 1% of the patients in this outbreak were asymptomatic, providing a potential source of outbreaks among the public [44]. The investigation further reported that On January 24, a total of 91 persons (83 customers, 8 staff members) were in the restaurant. Of these, a total of 83 had eaten lunch at 15 tables on the third floor. Among the 83 customers, 10 became ill with COVID-19 [44]. They recommended that, to prevent spread of COVID-19 in restaurants, strengthening temperature-monitoring surveillance, increasing the distance between tables, and improving ventilation should be implemented [44].

Prevention in the dental practice

The dental professionals can be exposed together with their patients and the general public to pathogenic microorganisms which include virus and bacteria and even candida that may infect the oral cavity and respiratory tract. It is now highly suspected that 2019-nCoV can be exposed to the dental healthcare workers and their patients during this pandemic, as most dental treatment/procedures involve face-to-face communication with patients and frequent exposure to saliva, blood and bloody saliva, and other body fluid together with the handling of sharp instruments.

This is because dental procedures in general are categorized into two groups according to aerosol generation. Most dental procedures generate aerosol; preparing cavities for fillings, use of rotary instruments for root canal treatment, scaling and polishing of teeth, dental implantation, and surgical removal of teeth are only some examples. Asymptomatic COVID-19 patients may present for emergency dental treatment. These patients are expected to have saliva contaminated with the virus and they are a confirmed source of infection. Moreover, the conjunctiva mucosa and upper respiratory tract are connected by the nasolacrimal duct, and they share ACE2 on the cell membrane. This exposes dental healthcare personnel to the risk of infection via direct exposure of conjunctiva (eyes) to droplets from patients during dental treatment [43]. Therefore the most probable transmission route for COVID-19 in dental settings is the inhalation of airborne microorganisms that has been suspended in the air for a long period [43].

Direct contact with blood, oral fluid, contact of conjunctiva, nasal mucosa, oral mucosa or other patient material with droplets and aerosols containing microorganisms generated from an infected

individual and propelled a short distance by coughing and talking without a mask [45,46], and indirect contact with contaminated instrument and surfaces within the dental environment are important transmission routes in dentistry. The illustration depicted in figure 2 is important to dentists in understanding of the containment of this novel virus in the dental clinics and hospitals during this outbreak. It is for this reason that this manuscript is not only geared at outlining the various preventive measures, but it also has deliberately invented a codification and scoring system to ensure compliance within the dental practice. We elect to call this codification system the International Postgraduate Medical College codification and scoring system.

Precautionary Methods in dentistry

For operation in the COVID-19 pandemic, a dental practice must acquire a weekly average score of 9 out of 15 to be operational as it relates to provision of dental care. Clinical set audit should be done at the beginning of the week, mid week and at the end of the week (Table 1).

In a newspaper article recently published relating to dental professionals safeguarding measures against the COVID-19 [47]. Ogunsalu [47] emphasized that fellow dental professionals must create a safe surrounding for themselves and their patients. Ogunsalu further emphasized that universal precaution which commenced in dental practice after the emergence of HIV must continue but with additional preventative measures specifically targeted against the spread of COVID-19 in the dental practice environment. Very easy procedures or manoeuvres such as spraying of the entire waiting room, operatories and toilets overnight is relatively inexpensive and readily available for application and may be the single main deterrent to the spread of this novel β -Coronavirus. Other measures that were recommended by Ogunsalu in this newspaper article are to reduce the number of procedures done and also the number of patients seen per day during the period of this pandemic. Ogunsalu further recommended the use of disposable protective outwears and if not available, dirty clinical clothing must not be taken home but must be cleaned and washed appropriately in the clinic setting [47]. The article further stressed that at this time, procedures such as ultrasonic scaling which can be alternatively provided to patients manually should be discontinued (discontinue ultrasonic scaling and electronic polishing). Unnec-

PREVENTATIVE CODE	PREVENTATIVE MEASURES	SCORE	RATIONALE
Grade I (G 1)	<ul style="list-style-type: none"> No air conditioner use Open doors and windows Sanitization of contact fields/stations Hand sanitization of patients and every staff member with each new patient Protective outwears Single use of mask per patient Eye wear, Multiple glove usage at chairside by worker for each patient Reduction of number of patients seen for day Reduction of number of procedures done per patient 	<p>0 or 1</p> <p>Maximum score of 1 is required</p>	Very easy preventative measures that must be fully complied with or practice is unfit to operate
Grade II (G 2)	<ul style="list-style-type: none"> Face shield usage Overnight disinfection of clinic setting and maximal dental waste management Sterilization of instruments and immediate disposal of single use product 	<p>0 or 2</p> <p>Maximum score of 2 is required</p>	Reasonably inexpensive and can be easily provided as a combo
Grade III (G 3)	<ul style="list-style-type: none"> Chairside use of face mask as shown in figure 1 for patients No use of ultrasonic scaler Emergency fillings only Emergency 3rd molar surgery only No use of air syringe/3 way syringe 	<p>0 – 3</p> <p>Subjectively can score from; 0,1,2,to 3</p>	
Grade IV (G 4)	<ul style="list-style-type: none"> Use of anti-retraction handpiece or 1 hand piece per day per patient Discarding of high-speed burs after use – Figure 4 	0 or 4	This is an all or none preventive grade geared at elimination of droplets and aerosols in the clinic
Grade V (G 5)	<ul style="list-style-type: none"> Possible use of rubber dam for isolation for each treatment with high vacuum suction system- Figure 3 	0 or 5	Total elimination of saliva and its transmission into droplets or aerosol

Table 1: COVID Compliance Scale in Dentistry (CCSD).

essary dental visits must be discouraged and patients must be encouraged to do consultation, reviews and enquiries electronically via whatsapp which everybody now has [47].

Codified and Graded Preventative Method in Dentistry

Grade V preventive measures – Not mandatory

The use of rubber dam in dental practice (Figure 3) will significantly minimize both the production of saliva and splashing of saliva and blood contained aerosol or splatter particularly in situations where high speed handpieces and dental ultrasonic devices are to be used inevitably. During the SARS virus pandemic, Samaranyake, et al. [48,49] reported that the use of rubber dam could significantly reduce airborne particle in ~3-foot diameter of the operational field by 70%. Additionally, when rubber dam is applied extra high volume suction for aerosol and splatter should be used during the procedure for regular suctioning [49]. All these manoeuvres relating to the use of rubber dam calls for the implementation of a complete fourhanded dental operation. It is however understandable that the use of rubber dam in dental practices today may not be feasible because of cost, unavailability and the enormous amount of time to be used for its application. Manual devices such as carisolv and handscalers are recommended for caries removal and periodontal scaling respectively in order to minimize the generation of aerosol as much as possible [4]. It is for this reason that the COVID-19 Compliance Scale in Dentistry (CCSD) developed by the IPMC has scored the use of rubber dam at 5. If not used, which is understandable a score of 0 will apply.

Grade IV preventive measures – Mandatory to operate

As it relates to the use of high speed dental handpieces, they must be anti-retraction (Figure 4) in this era of COVID-19. Anti-retraction dental handpieces with specially designed anti-retraction valves or other anti-reflux designs are strongly recommended as a mandatory, extra preventive measure for cross-infection [49]. The use of dental handpieces without anti-retraction function should be prohibited during the epidemic period of COVID-19 and one handpiece must be used per patient to allow prolonged sterilization time for each handpiece. High speed handpieces burs should also be discarded after each patient for the practice to be credited with the maximum score of 4 in this hierarchy of preventative method.

Grade III preventive measures – Graduated scores from 1 – 3

with subjectivity

All the preventative measures within Grade III such as: chair side use of face mask as shown in figure 1, no use of ultrasonic scaler, emergency fillings only, emergency 3rd molar surgery only and no use of air syringe/3 way syringe, *can be readily achieved* by a dental practice that sets out at this time of the pandemic to implement preventative methods geared towards prevention of the transmission of COVID-19 in droplets and aerosols and by so doing minimizes the risk of transmission of the virus to staff, patients and general public (Figure 2). It is for this reason that a safe and compliant practice at this time must strive to obtain a grade of 3. A practice with less than 3 but greater than 1 (that is a score of 2) should be allowed with caution. A practice with 0 in grade III preventative measure scale should be closed.



Figure 3: Showing rubber dam isolation.



Figure 4: Showing anti-retraction handpieces. One handpiece should be used per patient per day and burs should be discarded after each use.

Grade II preventive measures

All dental practice across the globe must be encouraged to implement fully all the recommended measures outlined in Grade II. It is for this reason that this level of preventative measure is an absolute all or none preventive practice scale and as such, full compliance is awarded 2 and less than full compliance is awarded 0. It is all or none.

Grade I preventive measures

The rationale behind the grade I preventive measure is: no usage of air conditioner, open doors and windows, sanitization of contact fields/stations, hand sanitization of patients and every staff member with each new patient, protective outwears, single use of mask per patient, eye wear, multiple glove usage by chairside worker for each patient, reduction of number of patients seen for the day, atraumatic restorative treatment for obturation of dental cavities and reduction of number of procedures done per patient. And as such, any practice that scores 0 and not 1 in this scale will be deemed to be unfit to practice even if their overall score on the scale with a maximum of 15 is 9 out 15.

Conclusion

The COVID-19 pandemic as serious as it is with a global warning for ceasing of person-to-person social contact and occupational

contact should not deter the dental profession in continuing to care for patients. After all, our medical counterparts continue to care for patients in clinics and hospitals and even are at the helm of diagnosing and managing confirmed cases with COVID-19 infection.

For the dental profession to be at the helm of prevention against this coronavirus, it is important that every practice utilize the suggested precautionary methods put forward in this manuscript and in particular utilize the COVID-19 Compliance Scale in Dentistry (CCSD) developed by the International Postgraduate Medical College not only for guideline, but for implementation with an aim to achieve a score equal to or greater than 9 out of 15. Any practice with a grade or score or less than 9 should review its practices to enable them to become operational.

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