Strategic Preparation for Dental Care Delivery during COVID-19 Transition-An Update

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Abstract

As we all look forward to phasing towards the new normal, COVID-19 has certainly changed the way we would be practicing dentistry. As the global health organizations are working relentlessly laying down guidelines to control the transmission, the dental team should effectively integrate these guidelines to establish safe practices considering the scarcity of available armamentarium. As we cautiously move from treating emergencies to regular care, it would be important to modify and reorganize our existing offices to best contain and prevent cross contaminations of the novel corona virus. Incorporating teledentistry wherever possible, careful management of personal protective equipment, employing strategies for extended use, re use and decontamination of respirators, improvising disinfection protocols will enable us to effectively surmount the existing scarcities and provide quality care. Also it is important that each and every one of the dental team have clear guidelines on how to manage patients with different COVID experiences. These experiences may range from COVID screening to dealing with patients who have active infection or patients who have resolved COVID infection when presented for dental care, and if situations arise, the team should be prepared for self quarantine. It is crucial to be in collaboration with local and state health departments to better understand local disease transmission rates and follow guidelines until we receive evidence based data.

Key Words: COVID-19, Teledentistry, Respirators, Dental operatory, Risk assessment

Introduction

Never have been the global health organizations in such a state of quandary in recent times absorbing the enormity of the Corona virus pandemic. This worldwide crisis started as unexplained pneumonia attacks in December 2019 in Wuhan, China with evidence suggesting it to be a zoonotic spillover where a pathogen is transferred from a vertebrate animal to a human being [1,2]. Corona virus belongs to a group of viruses that have characteristic club shaped spikes projecting from their surface in electron micrographs creating an image similar to the solar corona [3]. This new strain of virus is found to be structurally similar to severe acute respiratory syndrome coronavirus (SARS-CoV) and middle east respiratory syndrome coronavirus (MERS-CoV) and is named as SARS-CoV2 with a higher rate of infectivity [4]. Since it is a novel strain, it has been named by the World Health Organization (WHO) as Corona Virus Disease-19 (COVID-19), as it is first observed in humans in 2019 [5]. On January 12, 2020 china publicly shared the genetic sequence of this virus [6]. Based on phylogenetic information from protein sequence, bats are considered a natural host and pangolins, turtles and snakes appear to be potential intermediate hosts in this zoonotic chain [7,8]. On January 30, 2020, WHO declared a global health emergency and designated COVID-19 as a "public health emergency of international concern" and on 11 March 2020 due to the alarming levels of spread and severity, it has been characterized as a pandemic [6]. As of 7 June 2020, WHO announced about seven million confirmed cases globally with 400,135 cases of death [9].

SARS-CoV-2 has high affinity to Acetyl Choline Esterase 2 (ACE2) as a cellular entry receptor and thus infects the host cells. Therefore all cells expressing ACE2 like lungs, esophagus, bronchoalveolar-lavage fluid are susceptible to SARS-CoV2, similar to SARS-CoV [10,11]. Studies have shown that ACE2 receptors are expressed in salivary glands and tongue implicating that SARS-CoV2 can invade through oral cavity [12,13]. SARS-CoV2 has been detected in saliva and its dissemination by aerosol transmission is the issue of concern [14]. This has significant implications for the dental team, and hence they are categorized as the very high risk exposure group.

The global health organizations are working relentlessly bringing out strategies and guidelines to best protect both patients and Health Care Professionals (HCP). The goal is to minimize transmission of the coronavirus and to bring out practical solutions to combat scarcities. It is therefore important to strategize our response plan for a smooth transition to provide oral health care in a safe environment for our patients. Hence the purpose of the article is on methods of integrating evolving guidelines of global health organizations into our dental health facilities, so that we can best prepare and respond to community spread of the novel corona virus disease and decrease the burden on health care system. These guidelines can be discussed under following steps.

Judicious planning at the front desk area

- Triaging for dental treatment
- Incorporating tele dentistry and its applications

Preparation of dental team

Management of personal protective equipment

- WHO recommendations on using PPE during shortages
- NIOSH approved alternatives to N95 respirators
- Strategies for extended use and reuse of N95 respirators Recommendations for decontamination and reuse of respirators

Preparation of operatory

- Integration of HEPA filtration system and high energy ionizing UV radiation
- Negative pressure rooms

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- Expanded list of EPA-registered disinfectants against SARS-CoV-2

Screening for COVID-19 status

- Patients who are COVID positive
- Patients who have recovered from COVID infection
- Normal patients who have no symptoms or asymptomatic carriers

Risk assessment and postoperative protocol for patients and the dental team Guidelines for treating patients with fever

- Guidelines for dental team upon exposure to self-quarantine (explained below in detail)

Judicious Planning at the Front Desk Area

As we look forward to relaxing restrictions, we would realize that this pandemic would be changing the future of health care delivery. Social distancing would be the new norm and as health care providers, we would make every effort to flatten the curve. Effective telecommunication with patients, prioritizing their visits, screening everyone for signs and symptoms of COVID, minimizing contact between patients will be our new reality [15] and this requires careful planning by the front desk area for seamless execution. Triaging our patients for dental treatment and integrating teledentistry would help us provide effective care in these critical times as per CDC (Center of Disease Control) guidelines.

Incorporating teledentistry into our practices allows us to connect to our patients virtually and manage dental emergencies thus reducing influx of patients to health care facilities. The Office for Civil Rights is exercising its enforcement discretion as not to impose penalties for noncompliance with the HIPAA (Health Insurance Portability and Accountability Act) rules in provision of telehealth during this pandemic. They have approved usage of non-public facing applications such as Apple FaceTime, Skype, Facebook Messenger video chat, Google Hangouts video or Zoom to offer assistance to these patients. However, public facing applications like Facebook Live, Twitch, TikTok, and similar video communications should not be used by health care providers. After evaluation, the services have to be documented and reported in the patient's record and to a third party payer if applicable. Having both an audio as well as a visual (video or photographs) component appears necessary to appropriately conduct a problem-focused dental evaluation.

This service of teledentistry can be provided as a synchronous (live video) encounter or asynchronous (recorded) encounter. Synchronous or real time encounter is a live video interaction between patient and dentist through approved technology as discussed above. Asynchronous interaction refers to situations where information like photographs, radiographs are stored and forwarded through a secure electronic communications system to dentist for subsequent review to evaluate a patient's condition or provide a service outside a real-time or live interaction. Most importantly, all patient encounters using telecommunication technology should be appropriately documented in the patient's record including date/time/duration of service, reasons for such service and the required clinical notes [16].

Preparation of Dental Team

- The dental team should educate themselves to implement engineering, administrative, and work practice controls as per OSHA Guidance on Preparing Workplaces for COVID-19
- Ensure that the dental health care personnel are healthy and have received their seasonal flu vaccine [17]
- The entire staff need to be trained to wear appropriate personal protective equipment (PPE) with proper donning and doffing protocol

The controversy of Hydroxy Chloroquine (HCQ) as prophylaxis

- On March 28 2020, U.S Food and Drug Administration (FDA) had allowed chloroquine and chloroquine related formulations to be provided to certain hospitalized patients under an Emergency Use Authorization (EUA) to limit the burden of COVID-19 [18]. Some scientific literature reported possible use of chloroquine or hydroxychloroquine as prophylaxis [19]
- The scientific rationale was that HCQ and chloroquine showed an in vitro antiviral activity against severe acute respiratory syndrome-coronavirus 2 (SARS-CoV-2) [20,21]. Gautret et al. reported a higher frequency of SARS-CoV-2 clearance from the nasopharynx with HCQ plus Azithromycin (AZM) if necessary, versus an untreated control group [22]. However, there are several limitations of this study including small sample size, lack of randomization and methodological flaws affecting the validity of the findings [23]

Despite substantial limitations of the study, the overpromised results propagated by the press and social media resulted in acute shortage of these drugs resulting in severe inconvenience to patients who depended on them [24]. Moreover the American Heart Association recommended to exercise caution on COVID-19 treatment with hydroxychloroquine and azithromycin for patients with cardiovascular disease [25]. FDA Drug Safety Communication stated that they are reviewing case reports where inadvertent usage of these drugs resulted in adverse effects like QT interval prolongation, ventricular tachycardia and in some cases death [26]. On April 14 2020 Center of Evidence Based Medicine stated that current data do not support the use of hydroxychloroquine for prophylaxis or treatment of COVID-19 [27].

Managing Personal Protective Equipment

The OSHA's (Occupational Safety and Health Administration) Guidance on Preparing Workplaces for COVID-19, places dental health care professionals in the very high exposure risk category due to potential exposure to the virus [28]. Most dental settings do not have airborne infection isolation rooms, nor have a respiratory protection program and do not routinely stock N95 respirators. In view of the global PPE shortage, the following interventions can minimize the use and need for PPE while ensuring that the protection of

dental team and patients is not compromised. The World Health Organization (WHO) interim protocol stated that coveralls, double gloves, or head covers (hood) that cover the head and neck used in the context of filovirus disease outbreaks (e.g. Ebola virus) are not required when managing COVID-19 patients (*Table 1*).

Table 1. Rationale use of PPE for COVID-19 and considerations during severe shortages: Interim guidance by WHO.

Setting	Personnel	Activity	Type of PPE
Front desk area	Health care workers	Preliminary screening of Pts not involving direct contact	Maintain physical distance of 1 m
			Ideally build glass/ plastic barrier between Pts and HCW
			No PPE required
			When physical distancing is not feasible, yet no patient contact; use mask and eye protection
			Perform Hand Hygiene
Dental operatory	Dentist and Chair side assistant	Non Aerosol generating procedures	Medical mask
			PPE (Gown, gloves, eye protection)
			Perform Hand Hygiene
Dental operatory	Dentist and Chair side assistant	Aerosol generating procedures	Respirator N95 or equivalent
			Facemask
			PPE
			Perform Hand Hygiene
Dental operatory	Cleaners	Entering the room of COVID-19 patient	Medical mask
			Heavy duty gloves
			PPE (Gown, eye protection)
			Closed work shoes
			Perform Hand Hygiene

On March 28, 2020, National Institute for Occupational Safety and Health (NIOSH) has approved N99, N100, P95, P99, P100, R95, R99 and R100 as alternatives to N95 respirators [29].

These along with other classes of filtering facepiece respirators like elastomeric half-mask and full facepiece air purifying respirators and powered air purifying respirators (PAPRs) provide equivalent or superior protection than N95 respirators [30] (*Table 2*).

In United States, respirators should meet NIOSH standards, which indicate oil resistance and percentage of filtration of suspended particles [31].

- Class N: No Oil Resistance; N95, N99, N100
- Class R: Oil Resistant for 8 hours; R95, R99, R100
- Class P: Completely Oil Resistant; P95, P99, P100

A) 95: Removes 95% of all particles that are at least 0.3 microns in diameter

B) 99: Removes 99% of all particles that are at least 0.3 microns in diameter

C) 100: Removes 99.97% of all particles that are at least 0.3 microns in diameter or larger

- European standard EN 149: 2001 has three classes of disposable particulate respirators [32]
  - FFP1: Least Filtering Face Piece (FFP) with aerosol filtration of at least 80% and leakage of 22%
  - FFP2: 94% filtration of air borne particles and 8% leakage; comparable to N95; showed protection against Corona and influenza viruses
  - FFP3: maximum filtration of 99% of airborne particles with 2% leakage

Due to acute shortage of availability of filtering face piece respirators, NIOSH has recommended strategies of extended use and reuse without decontamination [33]. Consideration can be made to use N95 respirators beyond the manufacturer-designated shelf life.

Extended use refers to use of the same N95 respirator for repeated close contact with several patients, without removing the respirator between patient encounters. Extended use can be implemented when multiple patients are infected with the same respiratory pathogen or if the infected patient is seen at the end of the day [33].

Reuse refers to use of the same N95 respirator for multiple encounters with patients but removing it (‘doffing’) after each encounter. The respirator is stored in between encounters to be put on again (‘donned’) prior to the next encounter with a patient. One such strategy is to issue five respirators to each of the health care workers so that they can wear one respirator each day and store it in a breathable paper bag and would reuse with a gap of five days between each FFR (filtering

facepiece respirator) use. These masks would still be considered as contaminated and still use reuse protocol as laid down by CDC [33].

Table 2. Overview on respirators.

Respirator	Requirement of fit testing	Frequency of Use	Method of Use
N95 (Standard N95 or Surgical N95)[19] tight-fitting respirators	requires fit testing	Disposable	Standard N95 effectively filters airborne droplet containing viruses and bacteria can be worn in non surgical settings where maintaining a sterile field is not required
		For non aerosol generating procedures, they can be decontaminated up to 10 times for single-user reuse (Interim emergency management)	
		For aerosol generating procedures, N95 should be a single time use	Surgical N95 can be used in surgical settings that may expose them to high pressure streams of bodily fluid or working in a sterile field
Elastomeric respirators: half-facepiece, tight-fitting respirators	requires annual fit testing	They can be repeatedly disinfected, cleaned, and reused as they are made of synthetic or rubber material	Should not be used in surgical settings due to concerns that air coming out of the exhalation valve may contaminate the sterile field.
		Equipped with replaceable filter cartridges.	
Powered Air Purifying respirator (PAPR): typically loose-fitting hoods or helmets	do not require fit-testing and can be worn by people with facial hair.	Reusable, Battery -powered with blower that pulls air through attached filters or cartridges.	Should not be used in surgical settings due to concerns that the blower exhaust and exhaled air may contaminate the sterile field.
		The filter is typically a high-efficiency particulate air (HEPA) filter	

Recommendations for Decontamination of FFR in this Crisis

As a part of addressing the current shortages, on April 10, 2020 The U.S. Food and Drug Administration issued the second emergency use authorization (EUA) to decontaminate compatible N95 or N95-equivalent respirators for reuse by health care workers in hospital settings [34]. Each respirator can be processed up to 10 times for single-user reuse.

- Vaporous hydrogen peroxide [35], ultraviolet germicidal irradiation [36], and moist heat are the most promising decontamination methods
- Decontamination of FFR models by bleach (0.525% sodium hypochlorite and 5.25% sodium hypochlorite) was studied by Viscusi et al. [37] and he observed some degradation in filtration performance though not below acceptable levels
- Autoclave, 160°C dry heat, 70% isopropyl alcohol, microwave irradiation and soap and water caused significant filter degradation to both FFRs and particle penetration levels and did not meet the standards of decontamination of NIOSH
- However, these decontamination methods are expensive and cannot be implemented in small health care settings like dental clinics. Hence the Federal Emergency Management Agency (FEMA) issued an EUA and has awarded contracts to organizations to provide N95 decontamination at no charge to all health care personnel (HCP) [38]. These organizations have satellite locations where HCP's have to label their respirators with appropriate location identifier codes and send them for decontamination

How do we Prepare our Operatory

When viral particles are aerosolized by various dental procedures, these travel across the operatory far more than 6 feet settling down as droplet nuclei with active virus particles [39]. This would set up the entire dental team along with subsequent patients in grave risk of secondary infections. Studies show that corona virus particles remain active from hours to days depending on the surface [40]. Therefore, it is more sensible than ever to reevaluate disinfection protocol of our dental operatories.

Medical grade HEPA (High-efficiency particulate air) filtration systems have an efficiency rating of 99.995% and are incorporated with high-energy ultraviolet light units or panels, with anti-microbial coating. These units kill off the live bacteria and aerosolized viruses trapped by the filter media assuring high level of protection against airborne disease transmissions [41]. The short-wavelength UV (UVC) considered "germicidal UV" with wavelengths between about 200 nm.

and 300 nm are strongly absorbed by nucleic acids resulting in defective pyrimidine dimers. These defective dimers prevent replication of necessary proteins, resulting in the death or inactivation of the organisms [42]. UVC disinfection is often used to augment existing processes in a multi-barrier approach to ensure that whatever pathogen is not "killed" by one method (say filtering or cleaning) would be inactivated by another (UVC).

Negative pressure rooms or airborne infection isolation rooms are designed to create a crucial barrier so that airborne infections stay contained in one patient's room, rather than infecting others nearby [43]. If a patient is exhaling a virus or other contagion into the air, the objective is to suck out 30% to 40% more air than they are taking in at any moment thus ensuring one-way flow of contaminated air out of the room. Converting dental units to negative pressure operatories may sound very promising and exciting at this moment, but it needs to be thoroughly researched to bring out practical solutions. Presently CDC has not laid down any guidelines on creating negative pressure operatories in dental settings.

However HEPA filtration system and short wave length ultraviolet light units which can be incorporated into central HVAC systems or as stand-alone units appear to be valuable additions to augment safety in the operatory.

On March 13, 2020 the U.S. Environmental Protection Agency (EPA) released an expanded list of EPA-registered

disinfectant products that have qualified for use against SARS-CoV-2, the novel coronavirus that causes COVID-19 [44]. Some of the disinfectants are tabulated and EPA has stressed the importance of adhering to manufacturer's instructions, specially the contact time of the disinfectant, to achieve desirable disinfection (*Table 3*).

Table 3. *Expanded list of some of EPA-registered disinfectant products effective against SARS-CoV-2.*

EPA regn number	Product name	Active Ingredient	Preparation of the following virus	Contact time in minutes	Use Site
11346-4	Clorox QS	n- alkyl dimethyl benzyl ammonium chloride	Human coronavirus	2	Healthcare; Residential
46781-6	Cavicide	Diisobutylphenoxyethoxyethy l dimethyl benzyl ammonium chloride	Human coronavirus	2	Healthcare; Institutional; Residential
5813-50	Ultra Clorox brand Regular Bleach	Sodium Hypochlotite 6%	Human coronavirus	5	Healthcare; Institutional; Residential
67619-13	CPCC Storm	Sodium Hypochlotite 2.4%	Human coronavirus	1	Healthcare; Institutional; Residential
72977-5	SDC3A	Silver Citric Acid	Human coronavirus	1	Healthcare; Institutional; Residential
74559-6	Oxy -res	Hydrogen Peroxide 4.25%	Human coronavirus	5	Healthcare; Institutional; Residential
777-66	Lysol Brand All Purpose Cleaner	Alkyl dimethyl benzyl ammonium chlorides	Human coronavirus	0.5	Healthcare; Institutional; Residential
8383-12	Peridox	Hydrogen Peroxide 24% Peroxyacetic acid 1.2%	Human coronavirus	2	Healthcare; Institutional; Residential

Screening for COVID-19 status

Patients who walk into the dental health setting can be grouped as three categories 1:

a. Patients who are COVID positive

b. Patients who have recovered from COVID infection

c. Normal patients who have no symptoms or asymptomatic carriers

Figure 1 explains the management of each group of these patients (*Figure 1*).

- It would be very convenient if the dental team has "At the point COVID testing kits" available in their practices. The preferred technique for COVID-19 testing as per NHS guidance is molecular diagnosis using real-time RT-PCR (RdRp gene) assay [45]. Abbott laboratories have recently developed "ID NOW COVID-19" [46] (*Figure 2*), an at the point molecular testing kit which can and deliver results in less than 5 minutes
- For initial diagnostic testing for SARS-CoV-2, CDC recommends collecting and testing an upper respiratory specimen preferably a nasopharyngeal specimen. When collection of a nasopharyngeal swab is not possible, the oropharyngeal (OP) specimen can be an effective acceptable alternative [47]. An oropharyngeal specimen is collected by inserting a swab into the posterior oropharynx and tonsillar areas without touching the tongue, teeth, and gums to prevent contamination (*Figure 3*). When the procured sample is loaded, reagents break open the viral envelope releasing viral RNA. The fluorescent DNA probe (ATCCGA) specifically identifies the replicated target pathogen and produces fluorescent light
- ID NOW COVID-19 detects the fluorescence in the test and if fluorescence reaches specific level, sample is positive for that pathogen and shows an onscreen visual display
- The device typically takes as less as 5 minutes to detect a positive result and would process the specimen for 13 minutes before confirming the negative result
- On May 8 2020, FDA issued an EUA to authorize the first diagnostic saliva test to use home collected saliva samples for testing COVID-19 [48]. The patient spits the saliva directly into a funnel, where it gets mixed with a stabilizing buffer in the LLC SDNA-1000 Saliva Collection Device. The buffer stabilizes the viral RNA and provides ambient conditions till the sample is transported to the laboratory
- Currently these kits are supplied only to the front line health care professionals due to their limited availability. In very near future, their usage in dental operatories may be a reality

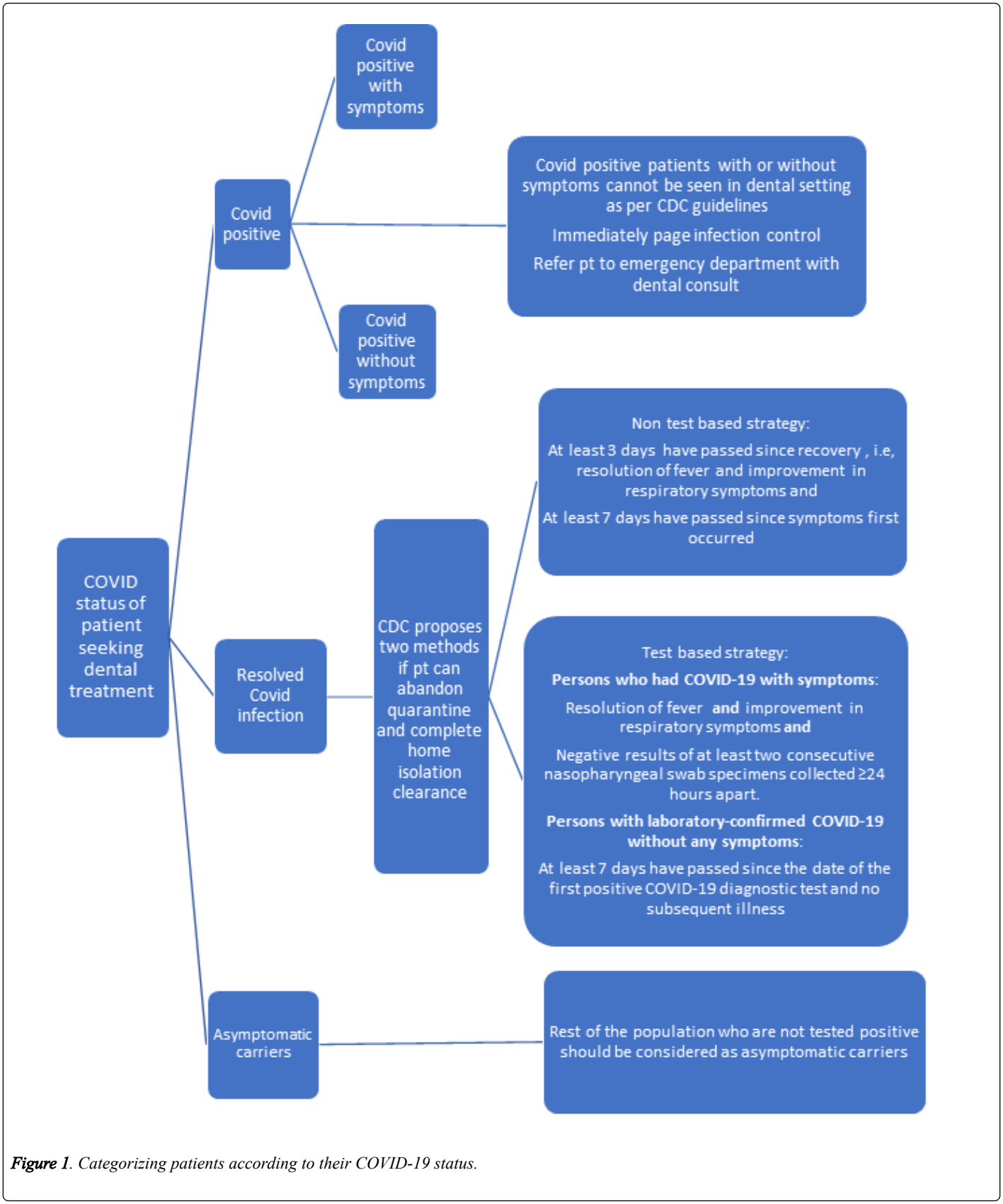

Figure 1. *Categorizing patients according to their COVID-19 status.*

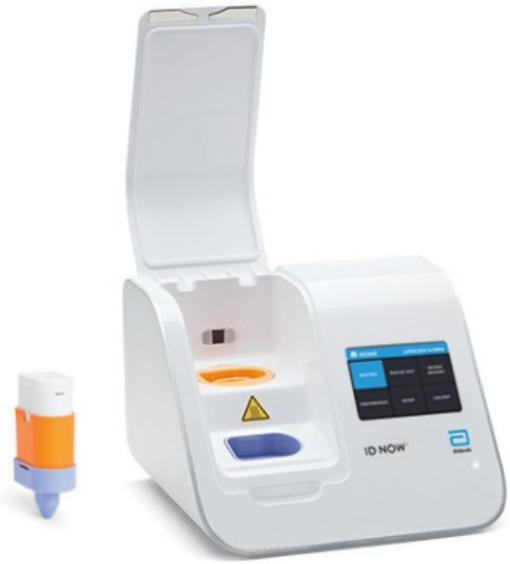

Figure 2. *ID NOW™ COVID–19, an at the point molecular testing kit.*

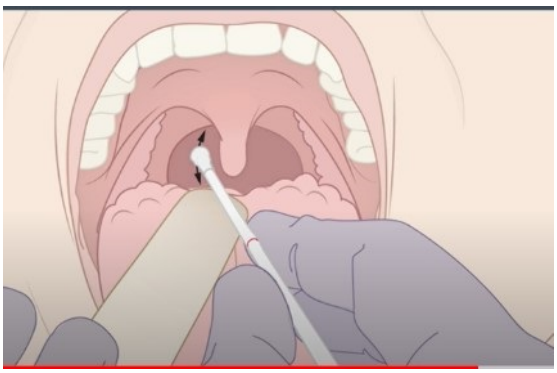

Figure 3. *Collecting oropharyngeal specimen.*

- Risk assessment and postoperative protocol for patients and the dental team
- When a patient presents in the dental facility for emergency or urgent care, a systematic risk assessment is done involving their possible contact with COVID patients, history of travel and signs and symptoms of a respiratory infection
- If the patient is febrile (temperature>100.4˚F), and has no respiratory symptoms, the fever should be associated with dental infection than as a COVID symptom and treated accordingly in the dental setting. However, if the patient is febrile and has associated respiratory symptoms, COVID should be suspected and the patient should immediately be referred to infection control emergency department with dental facility
- To provide emergency care in asymptomatic patients or patients with resolved COVID infection, who have cleared the home isolation clearance, an ideal scenario would be to treat them with N95 respirators, face shield and PPE as guided by OSHA. However taking into account the scarcity of N95 masks, CDC outlined guidelines to categorize aerosol generating and non aerosol generating procedures into low, medium risk and medium-high risk procedures [49] (*Figure 4*)
- Non aerosol generating procedures done with surgical mask and basic PPE (without N95 and faceshield) are graded as low risk. Even aerosol generating procedures in presence of proper PPE, N95 and face shield is still graded as low risk category due to appropriate protection
- For aerosol generating procedures, N95 or equivalent respirator, face shield and PPE are mandatory and lack of any of them should be categorized as medium or medium-high risk. In absence of the above PPE, the patient needs to be referred to facilities where proper armamentarium is available
- If situations arise, where the patient has to be treated with surgical mask (no respirator), but has face shield and PPE, it is categorized as medium risk procedure, and patient is suggested to get their COVID status checked. If the patient tests positive, the dental team in the operatory should quarantine for 14 days

If an aerosol generating procedure needs to be performed only with surgical mask and PPE, without a respirator and faceshield, then it is mandatory to send the patient for COVID testing as there can be asymptomatic carriers, and if they test positive, the dental team in the operatory should quarantine for 14 days.

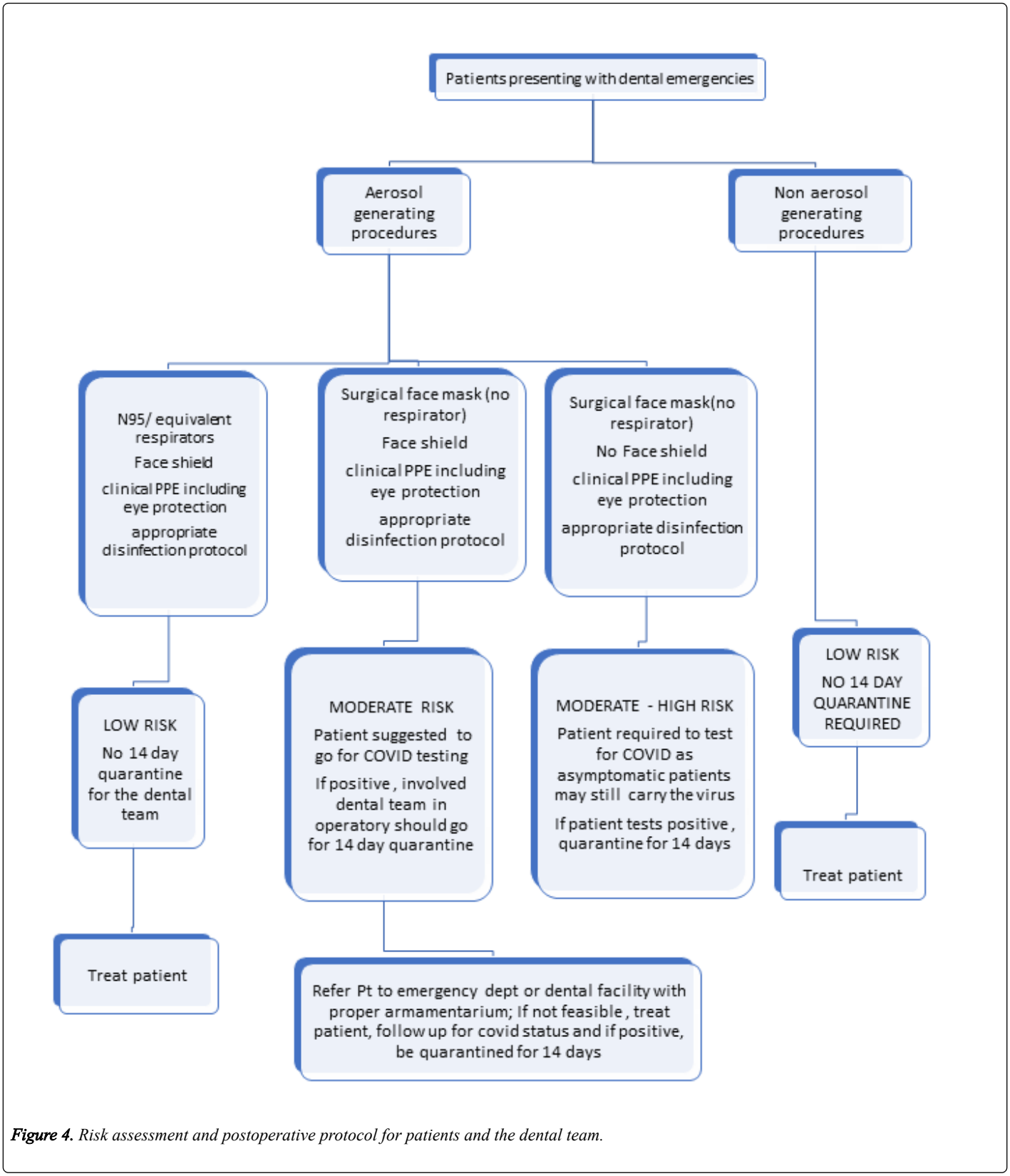

Figure 4. *Risk assessment and postoperative protocol for patients and the dental team.*

Conclusion

Projections on how this COVID pandemic would end are largely speculative, but it would definitely leave a lasting impact on how we would practice dentistry. As we all progress to phase towards normalcy, it is important not to forget how easily the virus is transmissible and the deadly impact it can have. Hence dentists should exercise keen professional judgment and establish safe practices carefully considering the availability of appropriate PPE to reduce the risk of exposure. It is important for the dental team to be in collaboration with local and state health departments and state dental societies to better understand local disease transmission rates and effectively implement state guidelines to minimize the risk of virus transmission.

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