JO JOURNAL OF OSSEOINTEGRATION periodontics and prosthodontics

Prevention and safety in the dental office after Novel Human Coronavirus outbreak: unresolved questions and future directions

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TO CITE THIS ARTICLE
Spicciarelli V, Marruganti C, Viviano M, Baldini N, Franciosi G, Tortoriello M, Grandini S. Prevention and safety in the dental office after Novel Human Coronavirus outbreak: unresolved questions and future directions. J Osseointegr 2020;12(2):145-153.

DOI 10.23805 /JO.2020.12.01.11

KEYWORDS SARS-CoV-2, Dental public health, Infection control, Transmission.

ABSTRACT

Aim Since the outbreak of the Novel Human Coronavirus epidemic, researchers around the world focused their efforts on tackling this global emergency. Research labs are joining forces to find a therapy and a preventive vaccine. Preventive and extraordinary safety measures are crucial to reduce the spread of SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus-2) among Health-Care Professionals (HCP). HCP performing or assisting aerosol-generating procedures are classified as "very high exposure risk" workers. New findings suggest that saliva delivered through cough, droplets released through normal breathing and oral mucosa represents a vector of SARS-CoV-2 transmission. Consequently, viruses can be easily vehiculated by most of dental procedures and it is essential for dental offices to change the operating modes. The present narrative review aimed to gather evidence in order to propose operative guidelines to reduce the risk of SARS-CoV-2 transmission in the dental offices. Emphasis was also given to unresolved questions about COVID-19 (Coronavirus Disease 2019) diagnostics and future directions to improve the preventive and safety measures in daily dental practice.
Results Operative guidelines aimed to reduce the risk of transmission in the dental office are drawn and described.
Conclusion A rapid and reliable diagnostic test detecting COVID-19 positive patients upon arrival at the dental office could allow dental HCP to work in "semi-ordinary" conditions; infected or suspected patients would be postponed or treated only in case of a real emergency employing high-level PPE and extraordinary preventive strategies.

INTRODUCTION

The World Health Organization (WHO) recently defined COVID-19 as an health emergency of global concern, and estimated the risk to be "very high" (1). Since the epidemic outbreak, medical research had unprecedented momentum due to the lethality of SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus-2) and its global spread in just a few months. Research labs and doctors around the world are joining forces to provide answers to many unresolved questions and, of course, to develop a new preventive vaccine.
As expected, many health-care professionals (HCP) worried about the spread of SARS-CoV-2 in clinical structures, where a huge number of HCP have been infected. HCP performing or assisting in aerosol-generating procedures/therapies are classified as "very high exposure risk" workers for pandemic Influenza (2).
In addition to the presence of Novel Human Coronavirus in saliva (3), the ACE2 (angiotensin-converting enzyme 2) receptor has been reported to be the main receptor for 2019-nCoV (2019 Novel Human Coronavirus) host cells (4). Xu et al. demonstrated that the ACE2 receptor is mainly expressed in the oral cavity through epithelial cells; its expression seems to be higher in the tongue rather than in buccal and gingival tissues. These findings indicate that the oral mucosa could represent an important vehicle for the 2019-nCov transmission (5).
Even though saliva can be delivered through cough, "droplets" can be emitted also through normal breathing (6). Therefore, viruses can be easily vehiculated by the aerosol generated by most of dental procedures. On

	Before SARS-CoV-2	During SARS-CoV-2
Before appointment	-	Phone-Triage
First appointment	Medical history: systemic diseases, allergies, drugs, smoke, alcohol	Screening: temperature < 37.5°C Medical history: systemic diseases, allergies, drugs, smoke, alcohol Fast blood test IgM/IgG COVID-19/swabs
For dental staff and patients in administration office/waiting room	Social hygiene	Social hygiene Frequent hand washing Hand disinfection with alcoholic gel before entering the operative area Respect the social distancing Communicate through protective partition Wear surgical mask
For dental professionals and dental staff in operative area	Hand washing Work uniform and washable work shoes, surgical mask, surgical cap, eye protection, gloves	Hand washing twice before and 3 times after intervention Hand disinfection with alcoholic gel FFP2 or FFP3 mask, surgical mask, surgical cap, overshoes or washable work clogs, disposable waterproof gown, protective goggles or full-face shield, double gloves
Hygiene oral cavity (for patients)	Brush your teeth Mouthrinse with chlorhexidine before starting the visit with the specialist for one minute	Brush your teeth Mouthrinse with 1% hydrogen peroxide or 0.2% povidone for one minute Mouthrinse with chlorhexidine before starting the visit with the specialist for one minute
Dental procedures	-	Extraoral x-rays Early isolation with rubber dam Reduce aerosol making procedures Use disposable instruments as much as possible High volume aspirating system CAD/CAM dental records or traditional dental records made of disinfectable synthetic material
Hygiene dental office	Air exchange after dental operation Normal cleansing and disinfection of the dental unit	Air exchange after dental operation Air exchange equipment with air purification and air sanitization Extraordinary cleansing and disinfection with ethanol/sodium hypoclorite of all surfaces of the operating areas for every patient

SARS-CoV-2, Severe Acute Respiratory Syndrome Coronavirus-2; IgG/IgM, Immunoglobulin G/Immunoglobulin M; COVID-19, Coronavirus disease 2019; FFP, Filtering Facepiece Particles; CAD/CAM, Computer-Aided Device/Computer-Aided Manufacturing

TABLE 1 Prevention and safety measures in dental office before and after SARS-CoV-2 outbreak.

these grounds, the aim of the present review was to draw operative guidelines in order to reduce the risk of transmission in dental offices. Currently, in the absence of a rapid diagnostic device with high sensitivity/specificity and without an effective therapy or vaccine against SARS-CoV2, it is strongly recommended to treat each patient as a COVID-19 positive.

SAFETY MEASURES

Dental team preparation

Prevention and safety measures before and after Novel Human Coronavirus Outbreak are summarized in Table 1. Dental Health-Care Providers (DHCP) with flu-like symptoms (fever with cough/sore throat, muscle pains) should not go to work (7,8).

Older DHCP and/or with pre-existing systemic diseases, pregnancy etc., are considered at higher risk of contracting COVID-19 from confirmed or suspected cases (9). Dental offices "should consider and address the risk levels associated with the different job sites and tasks that workers perform at those sites". It is suggested that workers excluded from the afore-mentioned categories (old age, presence of chronic systemic diseases or immune-deficits, pregnancy) should be prioritized to provide assistance (10).

All DHCP should monitor their own health, looking out especially for respiratory symptoms (e.g. cough, shortness of breath, sore throat); moreover, body temperature should be checked twice a day, irrespective of the presence of other symptoms consistent with a COVID-19 infection. Dental offices should create a pathway to follow every time symptoms appear in their employees, so it can be decided whether a medical evaluation is needed or not (11).

In order to prevent the spread of the pandemic among dental professionals and in order to preserve personal protective equipment (PPE), the CDC (Centers for Disease Control and Prevention) recommended to prioritize urgent procedures over elective treatments, surgeries and visits until the contagion starts to fall off.

This aligns with the American Dental Association (ADA) guidelines, the American Dental Hygienists' Association (ADHA) and the Centers for Medicare and Medicaid Services (CMS); CMS recommended that all non-essential examinations and procedures be postponed until new notice (12). Whether or not each procedure is undeferrable relies on clinical judgement and should be investigated case by case.

Phone triage

Before each appointment, it is mandatory to carry out a phone triage to every patient, asking the following questions.

1. Do you have today or have you had any of these symptoms in the last 14 days (13): Body temperature >37.5°, dyspnea, cough, running nose, watery eyes, nausea, vomit, diarrhea, anosmia and ageusia, muscle pain. In case of at least one positive answer, postpone the appointment for at least 14 days (treat only if the emergency is undeferrable).
2. Have you participated to a meeting in the last 14 days?
3. Have you moved outside your city/country for work or personal needs in the last 14 days?
4. Have you been to the hospital for work or personal needs in the last 14 days?
5. Are in quarantine now or have you had any contact with quarantined subjects in the last 14 days?

It is essential to recommend patients to come to the dental office alone; in case of minors or subjects that are not self-sufficient, the presence of just one companion is advised. In any case, the companion will wait in the waiting room and will not enter the operating area for any reason (14).

Dental office triage

Brochures, magazines, newspapers and other unnecessary objects should be removed from the waiting room (15).

Signs should be printed and posted in the dental office in order to instruct patients about standard respiratory hygiene recommendations and social distancing (16-18).

First screening of patients is performed through body temperature detection with a contactless thermometer.

All patients must wear a surgical mask, as it protects others from saliva/breathing droplets of who is wearing it (19); therefore, they are indicated in low risk environments such as waiting rooms, provided that social distance is maintained among subjects.

All patients must disinfect their hands with alcoholic gel taken from a dispenser placed in the waiting room.

Operators standing at the front office should communicate with patients maintaining at least 1 meter of distance, preferably through a protective screen.

An area/room in the dental office should be dedicated to triage. Triage operators should communicate with patients from a 1-meter distance, preferably through a partition panel. In the triage area, a rapid test should be performed (IgG/IgM anti-SARS-CoV-2 detection, rapid PCR kit SARS-CoV). If the test results positive, the appointment will be postponed for at least 14 days and should be reported to competent institutions. If the test results negative, patient can have access to the operating area.

Define the maximum number of people that could fit in the waiting room maintaining the security distance (at least 1 meter) (20). If the waiting room does not allow for proper "social distance", patients can wait in their personal car or outside the office, until they are contacted on their phone when their turn arrives.

According to the procedures followed by each dental office, this information can be provided during appointment planning on the phone (21).

Dental Office workflow after Novel Human Coronavirus outbreak is summarized in Figure 1.

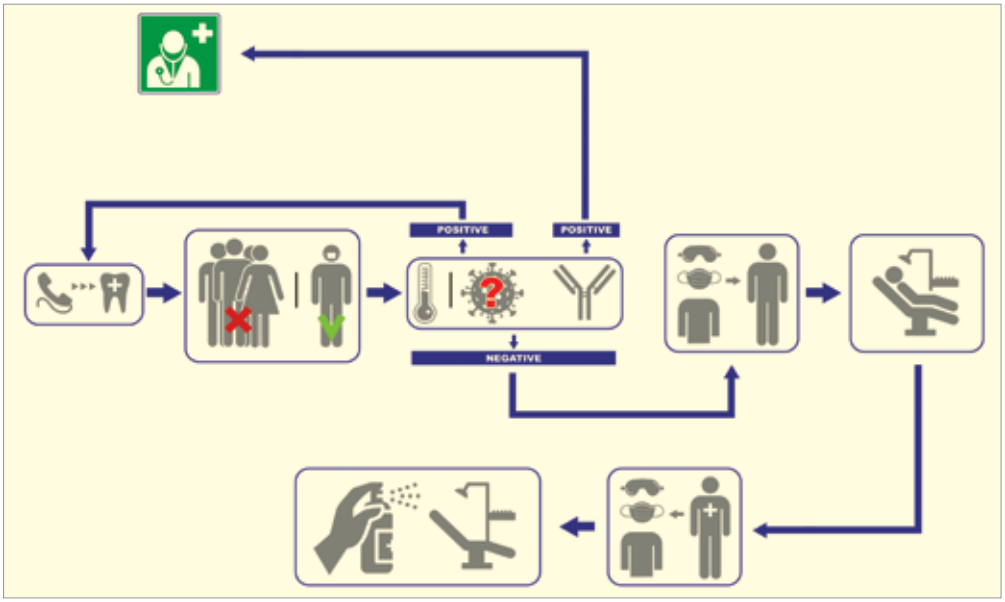

FIG. 1 Phone and dental office workflow after novel human coronavirus outbreak.

Sequence for putting on personal protective equipment (PPE)

The operator should be prepared outside of the operating room and according to a specific sequence (22,23) as follows.

- Keep you garments in a locker.
- Take off rings, bracelets, necklaces, earrings from exposed areas.
- Wear your scrubs, preferably in non-woven fabric.
- Take everything off from your pockets, personal belongings included.
- Wash your hands before the procedure according to WHO guidelines (24). The department for infections control of the Stomatology Hospital in West China (Sichuan University) proposed a "two-before-andthree- after" protocol for hands hygiene. Dentists should wash their hands before the procedure, after the contact with the patient (buccal mucosa, skin, damaged tissues, blood, bodily fluids) or the surrounding surfaces. It is essential for clinicians to avoid touching their eyes, mouth and nose during the procedures.
- Wear overshoes or easily cleansable shoes; overshoes will not be changed in-between appointments and will be discarded at the end of the working day.
- Wear the first pair of gloves (the first pair will substitute hands skin).
- Wear the water-repellent disposable gown from the front paying attention to fasten at the back neck and waist; fasten the upper part firstly trying not to leave exposed areas of the scrubs underneath; then fasten the gown at the waist overlapping the two sides of the gown. Fasten the gown from the front or from a side in order to make the undressing procedure smoother.
- Wear the cap in such a way as not to leave skin exposed. Tie your hair and do not leave any locks off the cap.
- Wear a FFP3 respirator or equivalent (at least FFP2 or equivalent) and a surgical mask; if no respirator is available, use a combination of a surgical mask and a full-face shield (minimally acceptable level of protection) (25).
- Wear highly-adherent protective goggles (26).
- Wear a second pair of gloves placing it above the disposable gown.

Once the operator is fully equipped, it is crucial not to touch respirator, surgical cap and goggles, in order to keep the field sterile.

According to the legislation Standard European UNI EN 149:2001+A1:2009 (EN 149+A1), the use of FFP3 masks is strongly advised when exposed to potentially contaminated aerosol. FFP3 masks (or equivalents) offer the highest achievable protection in high-risk environments.

CDC recommends at least the use of N95 respirators, in order to protect against the inhalation of SARS-CoV infectious particles (27). N95 respirators are regarded as functionally equivalent to other respirators approved by non-US legislations, e.g. FFP2 in the EU or KN95 in China. Despite that, different criteria are applied to certify their performance, such as filtration efficiency, test agent and the pressure drop allowed (28,29). Comparing the different respirators, it can be concluded that China KN95, AS/NZ P2, Korea 1st Class, and Japan DS FFRs are equivalent to respirators such as US NIOSH N95 and European FFP2, in order to have an effective filtration against bio-aerosols (non-oil based particles). Therefore, the use of N95 respirators offers an acceptable level of protection against aerosol transmission of SARS-CoV, despite their protection level seems variable (30).

Respirators should be worn following manufacturers' instructions; in order not to lose their protective filtering ability, they should be closely adherent. Qian et al. demonstrated that N95 respirators were highly effective in filtering microbial particles when they were tightly sealed/adapted to the shape of the face (31).

Operating room

The dental unit should be covered in all its components (handles, headrest, chair) with disposable protections.

Patients can take off the surgical mask once they are seated in the chair.

Before starting any procedure, give the patient a mouthwash containing 0,2% povidone-iodine or 1% hydrogen peroxide for 1 minute, then a mouthwash with 2% chlorhexidine for 1 minute; the latter further reduces bacterial load due to its bacteriostatic and bactericidal activity. During mouth rinsing, patients must not gargle and should expel all mouthwash in the sink.

Whenever possible, perform early isolation with rubber dam.

If isolation cannot be performed, use disposable instruments as much as possible and minimize aerosol generating procedures by substituting them with manual instruments (32).

The use of handpieces without anti-retraction function should be prohibited during the COVID-19 epidemic.

Sedation should be taken into account when treating patients with excessive gag reflex (33).

Extraoral x-rays should be preferred to intra-oral radiographs, as the latter could generate saliva secretion or cough (34).

It is preferable to use resorbable sutures to avoid follow up appointment.

Whenever possible, prioritize digital dental impressions over traditional ones (they could be contaminated with SARS-CoV2). Traditional impressions should be immediately disinfected with the use alcohol-based disinfectants (35); afterwards, impressions should be sealed in an envelope and sent to the laboratory. Pay attention not to contaminate the envelope or other papers (e.g. prescriptions). Since cast models are usually contaminated with many microbial species and are difficult to sanitize, prefer models made of synthetic

materials whenever possible (35,36).
Since SARS-CoV 2019 seems to be sensitive to oxidation, a preprocedural mouthrinse with oxidant agents such as 1% hydrogen peroxide or 0.2% povidone-iodine is recommended to reduce microbial load, SARS-CoV included. Mouthrinsing before starting the procedure is even more important when isolation with rubber dam cannot be performed (37).
Rubber dam helps minimizing the contact with infected aerosols, blood drops or saliva. Samaranayake et al. reported a 70% reduction of infected particles in the air at a 3 feet distance from the operating field when rubber dam was placed (38). Split-dam techniques could be used when gingival tissues are involved, for example during class V restorations or crown preparations.
Aerosol-generating procedures should be avoided whenever possible, especially if rubber dam isolation is not achievable. Some of these procedures involve non-surgical periodontal therapy and the use of high-speed handpieces under water cooling. When the rubber dam is used, an additional high-volume aspiration system should be used; a peculiar kind of mouth opener could be connected to the aspiration system to help avoid leaking of infected saliva.

Sequence for taking off personal protective equipment (PPE)

Taking off PPE must follow an exact sequence (22,23), as follows.
- Take off the gown touching it only in the external surface; during this phase the second pair of gloves worn will be taken off together with the gown;
- Remove the goggles and place them in the dedicated container;
- Remove face mask, touching the posterior part only (the anterior part could potentially be contaminated);
- Remove cap and overshoes;
- Remove the first pair of gloves;
- Wash your hands and sanitize with hydroalcoholic gel (24).

If magnification systems or other devices have been used, they should be touched with new gloves and sanitized thoroughly with ethanol and according to the manufacturers' instructions.

DENTAL UNIT CLEANING AND DI SINFECTION

Cleaning and disinfection of the operating areas represents a complex action requiring time and accuracy.
Many instruments are used during procedures and they could all be potentially contaminated. The presence of an adequate number of trained assistants could make the procedure run smoothly.

When discharging a patient:
- Remove the drape from the patient without letting anything drop;
- Remove every obstacle before raising the patient;
- Raise the patient slowly and tell him/her not to touch their mouth;
- If necessary, let the patient wash hands or wear a pair of gloves;
- It is advisable to make the patient wear a surgical mask again, until leaving the dental office;
- Open the windows and air the room.

Removal of all sharp and cutting objects

Separate the needle from the suture to make it more easily disposable.
Remove burrs and endodontic instruments from handpieces then perform flushing for at least 1 minute. As a precaution, it is useful to expel some water from fluid conductors (handpieces not attached). This procedure is recommended also with anti-retraction handpieces.
Remove the blade from the scalpel using pincers; use disposable scalpels if possible.
Handle only one tool at a time.
Place cutting and sharp objects in the appropriate dispenser, and always use a tray to move them from one place to another.

First phase of decontamination

During decontamination and cleaning phases, avoid overlapping objects and let them be visible.
Remove any inorganic residue from instruments (e.g. endodontic cement, resin etc.); use mechanical tools or solvents.
Turn off all mobile devices used during the intervention and remove all protective films.
Discard all disposable materials/instruments and dispose them according to the type of waste.
Let the water flow on the sink from the patient's side, suction water from the suction system for at least one minute and then proceed with disinfection.

Detersion

Place all instruments in a perforated basket and rinse them under tap water for at least one minute while mechanically brushing away residues, then rinse them with hot water.
Cleaning of instruments should be performed according to the manufacturer's instructions; an excessively diluted solution could be ineffective, whereas a highly concentrated solution could be aggressive to instruments surfaces.
Cleaning operations should take place from top to bottom, finishing with the floor.
Avoid using high-pressure water jets (pulivapor, pressure washer); contaminated droplets resist in air suspension (for a maximum of 8 hours) and could

contaminate sanitized surfaces.
It is essential to perform a final rinsing with tap water, because it washes away any detergent residue that could inactive the disinfectant.

Disinfection
Start by disinfecting all dental unit components and surfaces. Contamination of dental unit is due to contaminated hands contact and aerosol produced by dental procedures.
Proceed with the disinfection of the suction tube.
Encourage all disinfection procedures of the dental unit water supply through continuous or discontinuous systems.

DISINFECTION SUBSTANCES

Ethanol
Ethanol (70%) is often used to disinfect small surfaces. Since it is inflammable, its use should be limited to well-aired spaces and in the absence of functioning electrical systems. Repeated use of ethanol could cause discolorations and cracking of rubber and plastic materials. Ethanol is considered to be effective against SARS-CoV-2.

Chloride
Chloride can be used both liquid (sodium hypochlorite) and solid (calcium hypochlorite). Sodium hypochlorite is effective but it is easily inactivated by organic material. Common bleach is widely available and it is advisable for surfaces disinfection, but it can irritate skin, mucosa and respiratory airways and could react with other chemical products. Therefore, bleach can be used in aired spaces only. Sodium hypochlorite is considered to be effective against SARS-CoV-2.

Active oxygen
Hydrogen peroxide: it has an elevated germicidal, virucidal, sporicidal, fungicidal activity in different concentrations. The 3% solution is the most commonly used; it is not toxic as it is quickly degraded into oxygen and water.
Because of its oxidant capability, hydrogen peroxide can be considered effective against SARS-CoV-2.
Ozone: Ozone can be used as a gas to sanitize the surroundings or as ozonated water for surface and materials disinfection. In vitro studies are needed to demonstrate its efficacy but yet, given its strong oxidant action, it can be considered active against SARS-Cov-2.
Peracetic acid: it is usually produced in 5-15% concentrations. It retains an excellent and rapid activity against all micro-organisms even in the presence of organic material. Peracetic acid oxidizing potential exceeds chloride and chloride dioxide, but it has corroding activity on metals and it is unstable over time; that is the reason why its use in extensive surfaces disinfection should be chosen carefully. No data are available regarding its efficacy, but yet, given its strong oxidizing action, it can be considered active against SARS-CoV-2.

Quaternary ammonium compounds
Quaternary ammonium compounds are not supposed to be active against COVID-19.

Aldehydes
No specific data have been demonstrated regarding their capability to inactivate SARS-Cov-2. Aldehydes are considered chemical sterilizing agents so it is plausible to assume their efficacy. Their use is not advised: given the low resistance of the virus, their use is not consistent with their effectiveness.

Iodophors
Iodophors are used for skin and mucosa disinfection. They are considered germicidal, virucidal and tubercolicidal but they require elevated contact time. Iodophors are not used for surfaces disinfection as they cause permanent stains.

Effectiveness against SARS-Cov-2
A recent work by Kampf et al. (39) reported data of studies regarding the efficacy of several disinfectants against different human and animal coronaviruses. The study stated how 78-95% ethanol, 70-100% 2-propanol, a combination of 45% 2-propanol and 30% 1-propanol, 0.5-2.5% glutaraldehyde, 0.7-1% formaldehyde and 0.23-7.5% povidone-iodine effectively inactivated many types of human and animal coronaviruses.
Moreover, a minimum concentration of 0.21% sodium hypochlorite was proven to be effective, and 0.5% hydrogen peroxide was shown to be effective within 1 minute.
Benzalkonium chloride was tested for different contact times: a 0.2% solution within 10 minutes resulted to be ineffective against coronavirus. Results gathered by Kampf et al. are related to studies carried out on various human and animal coronaviruses; therefore, the efficacy of the afore-mentioned combination of disinfectants against SARS-CoV-2 has yet to be proven.
Many guidelines (i.e. Italian Society of Periodontology) advise the use of a preprocedural mouthwash with 0,2% chlorhexidine in order to decrease aerosol bacterial load.
In order to reduce the risk of COVID-19 cross-infection, it is deemed necessary to disinfect critical and semicritical articles with products effective against coronavirus. Moreover, all critical, semicritical, and non critical tools and surfaces have a potentially high infective risk and should be subjected to high-level chemical and/or physical disinfection and sterilization (Table 2).
On the grounds of the gathered evidence, the proposed disinfection sequence is as follows.
It is suggested to carry out cleaning operations with a neutral detergent, followed by rinsing. First,

Categories	Devices	Surfaces definition	Potential infection risk	Level of sterilization/disinfection
Critical tools	Surgical instruments, needles, probes, burs etc.	-	Before SARS-Cov-2 High During SARS-Cov-2 High	Before SARS-Cov-2 High level: physical or chemical During SARS-Cov-2 High level: physical or chemical
Semicritical tools Semicritical surfaces	Mirrors, trays, prosthetic products etc. Dental unit accessories: handpieces, scalers, handles and lamp	Dental unit surfaces in contact with contaminated operator's hands or tools	Before SARS-Cov-2 Intermediate During SARS-Cov-2 High	Before SARS-Cov-2 High level: physical or chemical Intermediate level: chemical During SARS-Cov-2 High level: physical or chemical
Non-critical tools Non-critical surfaces	X-ray cone, facial arch, bleaching lamp, extraoral cameras etc. Floors, service unit surfaces, furniture surfaces etc.	All surfaces not belonging to the dental unit in contact with contaminated operator's hands or tools	Before SARS-Cov-2 Low During SARS-Cov-2 High	Before SARS-Cov-2 Low level: physical or chemical During SARS-Cov-2 High level: physical or chemical
SARS-CoV-2: Severe Acute Respiratory Syndrome Coronavirus-2				

TABLE 2 Hygiene of dental instruments before SARS-CoV-2 and after SARS-CoV-2 outbreak.

disinfect surfaces around the dental unit (therefore, potentially contaminated by secretions) with 0.1% sodium hypochlorite. If bleach is used, choose a 5% initial concentration with 1:50 dilution. For disinfecting surfaces suitable for the aforementioned agent, contact times are as follows.

- For non-porous surfaces: 5-minute contact time.
- For immersion procedures: 30 minutes contact time.
- For tissues or delicate materials, it is advisable to use 70% ethanol or 0.5% hydrogen peroxide with a minimum contact time of 1 minute.

All instrumentations used for cleaning and disinfection should be sanitized before being used in other spaces or before being moved from higher to lower risk areas. If deemed appropriate, proceed with environmental ozonization.

Automatically decontaminate air through filtering systems and/or dry aerosol-generating devices based on hydrogen peroxide.

Regularly check the upkeep air conditioning and suction systems (40,41).

Recent WHO guidelines deemed water and detergent followed by disinfectants (bleach 1:50) effective against COVID-19 (42). In order to reduce the cross-infection risk, it is strongly recommended to follow cleaning and disinfection workflows of the operative room in-between patients. Conversely, all the other spaces (front office and waiting room included) should be sanitized at the end of the working day.

POST-OPERATIVE INSTRUCTIONS

For patients with tooth pain and edema, DHCP must decide a definitive and conservative treatment (e.g. pulpotomy, pulpectomy, non-surgical endodontic treatment or incision for abscess draining). ADA in 2019 provided recommendations regarding the use of antibiotics in adult healthy patients with symptomatic irreversible pulpitis with or without apical periodontitis, pulpal necrosis and symptomatic apical periodontitis, or pulpal necrosis and localized acute abscess; all patients with the aforementioned conditions should be referred to a specialist analyzing the case at hand.

DHCP, before heading back home, should put on their own garments. Upon coming home, DHCP should take off their shoes, garments (wash them separately) and immediately take a shower.

WHAT TO DO IN CASE OF ACCIDENTAL EXPOSURE

Aerosol-generating procedures should be programmed at the end of the working day. If performing these procedures with a surgical mask (without N95 respirators), DHCP are at a moderate risk of COVID-19 transmission. Given that asymptomatic patients could still be infectious, CDC suggests a 14 days quarantine.

Alternatively, ask the patient to be tested for COVID-19 straight after dental treatment; if positive, DHCP should be quarantined for 14 days. Patients redirected to COVID-19 testing should be supplied with detailed instructions on when/where the test will be performed, how to justify the request for the test and how communicate the results to the dental office. If the test results positive, DHCP should report the exposure to all patients treated afterwards.

UNRESOL VED QUE STIO NS AND FUTURE DI RECTIONS

How can we discriminate COVID-19 positive from

healthy patients? Currently, it is impossible to ascertain it rapidly. It is therefore necessary to treat all patients as if they are potentially infectious.
Viral RNA Real-Time-PCR (RTPCR) currently embodies the gold standard for COVID-19 diagnosis (43); it is the only reliable diagnostic test developed so far (44-46). However, this test presents some limitations: results take 2-3 hours to be obtained, laboratories should be certified, expensive equipment and trained technicians are required. Moreover, nasopharyngeal viral load is not constant from the incubation to the convalescence period. Virus can be detected in a 10-15 days span, whereas it cannot be detected during other phases (47). It was shown that nasopharyngeal swab test for SARS-CoV-2 retains a 63% sensitivity, therefore it generates many false negatives (48).
SARS-CoV-2 infection has its onset at pulmonary level, not in the upper airways (49), therefore nasopharyngeal sampling during the initial stage of infection could not detect the virus. This could explain the high number of false negatives in the PCR test on nucleic acid. Nonetheless, it is the only available test for SARS-CoV-2 diagnosis (50).
The global pandemic caused a shortage of swabs, reagents and RNA extractors.
Serologic tests (Ab, IgG, IgM) could complement RNA tests for SARS-CoV-2 diagnosis and could provide useful epidemiological information about the proportion of immunized population.
A recent study demonstrated high sensitivity and specificity of serologic tests, but only symptomatic patients were evaluated; it is yet to be determined whether the immune response behaves differently in asymptomatic patients or not (51), since these subjects could spread the virus (52,53).
Another recent research demonstrated low sensitivity (<20%) of serologic tests based on combined antibodies IgG/IgM. In fact, many COVID-19 positive patients (confirmed with RT-PCR) resulted negative for the serologic test. Based on these results rapid serologic tests based on combined antibodies IgG/IgM are not be reliable for the diagnosis of COVID-19. A combination of the two techniques would be ideal.
Many unresolved questions persist in the dental field: does SARS-CoV-2 survive in human saliva and for how much time? Is SARS-CoV-2 detectable in human saliva during the early incubation period? Do some salivary constituents (e.g. lysozyme, lactoferrin, leucocyte protease inhibitor) have anticoronavirus activity? Apart from the actual presence of SARS-CoV-2 in saliva, are any other early biomarkers detectable?
Salivary biomarkers provide a specimen to investigate many diseases such as oral cancer, dental caries, periodontal diseases, diabetes, breast and lung cancer (55,56). Some experimentations for virus detection in saliva have been performed, involving culture identification for nucleic acid extraction and RT-PCR (3,57).
Wu et al. demonstrated that expectorate from lower respiratory tracts was produced only by 28% of COVID-19 patients, therefore saliva presents some shortcomings as a diagnostic medium (3). Moreover, this procedure requires specialized laboratories and personnel, is expensive and takes days to get the results. For these reasons, it cannot be taken into account for large-scale diagnostic testing of SARS-CoV-2. However, saliva has the advantage of non-invasive sample collection for diagnostics and viral load monitoring. Saliva samples can be provided by the patient easily without any contact with the HCP; so the use of saliva swabs could reduce the risk of nosocomial SARS-CoV-2 transmission (3), unlike the oropharyngeal and nasopharyngeal swabs which require a close contact between HCP and patients. Understanding disease etiology, genomics and clinical phenotypes requires highly-detailed information about sampling, laboratories and clinical studies (58,59): a non-invasive salivary diagnostic test could definitely improve disease detection (60).
Recently, the production of secretory IgA (sIgA) specific against SARS-CoV-1 in saliva was demonstrated in a preclinical model (61); considering the similarity between the two viruses, our hypothesis is that COVID-19 salivary diagnosis could be performed with the use of specific antibodies against this virus.
Further studies are necessary to investigate the diagnostic potential of saliva for COVID-19 detection. Its introduction could play a pivotal role in the implementation of preventive strategies for HCP performing aerosol-generating procedures. Salivary diagnostics could also provide a convenient and cheap point-of-care platform for COVID-19 infection.
A rapid and reliable diagnostic test detecting COVID-19 positive patients upon arrival at the dental office could allow dental HCP to work in "semi-ordinary" conditions; infected or suspected patients would be postponed or treated only in case of a real emergency employing high level PPE and extraordinary preventive strategies.

Disclosure

The authors deny any conflict of interest related to this study. This research did not receive any specific grants from funding agencies in the public, commercial, or not-for-profit sectors.

Authorship

All authors contributed to the study. Valentina Spicciarelli performed literature research and wrote the manuscript. Crystal Marruganti performed literature research and wrote the manuscript. Massimo Viviano participated in the manuscript design and performed literature research. Nicola Baldini participated in the manuscript design. Giovanni Franciosi performed literature research and participated in the manuscript design. Mario Tortoriello drafted tables and figures. Simone Grandini participated in the manuscript design and proofread the manuscript.

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