Special Section: COVID-19 Management in Clinical Dental Care

# COVID-19 Management in Clinical Dental Care Part II: Personal Protective Equipment for the Dental Care Professional

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ABSTRACT

*Background:* Facing the coronavirus disease 2019 (COVID-19) challenge on a global level, dental care professionals are encouraged to optimize universal precautions and adopt measures that ensure protection against infection by contaminated aerosols and droplets. Although aerosol transmission is possible, direct contact through large droplets is probably responsible for the vast majority of transmissions. *Methods:* This paper is the second of a series of 3 on the management of COVID-19 in clinical dental care settings and aims to describe the selection and use of personal protection equipment (PPE) by dental care professionals (DCP), with consideration of the level of risk associated with the planned procedures. PPE selection depends directly on the local epidemiological setting, the patient's characteristics, and the level of risk of the planned procedures. The procedures performed in the office environment are classified as low-, moderate-, or high-risk. Moderate risk includes 2 further sublevels associated with the cleaning, disinfection, and sterilization of materials for clinical procedures that do not generate aerosols. The training of DCP on how to properly don (put on) and doff (remove) PPE is as important as choosing the appropriate PPE because it can be associated with a risk of infection. *Discussion:* When there is limited availability of PPE, measures should be adjusted to the risk associated with the intervention. Assuming that an effective COVID-19 vaccine will be developed, once it becomes widely available for DCP, PPE requirements will likely be different. *Conclusion:* The proper use of PPE, together with the adoption of other operational procedures, can provide effective protection against microorganisms being transmitted via body fluids or in the air.

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## Introduction

Current measures for preventing and minimising the risk of infection in dental practice, developed in the context of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic, are heterogeneous because health policies, the current epidemiological status, and economic, technical, and human resources differ among countries. At the global level, dental care professionals are encouraged to optimise universal precautions and adopt measures that ensure protection for them and their patients against viral infection.[1] Assuming that SARS-CoV-2 infection occurs mainly through mucous membranes, the proper use of personal protective equipment (PPE), patient use of a preprocedural rinse with a disinfectant mouthwash, together with the adoption of other operational procedures, may provide effective protection against

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microorganisms transmitted via body fluids or through the air.[2,3] Although aerosol transmission is possible, direct contact through large droplets is probably responsible for the vast majority of transmissions.[2,3]

Published reports and updates regarding coronavirus disease 2019 (COVID-19) prevention and control highlight the uncertainty regarding the role of droplets, aerosols, and fomites in SARS-CoV-2 transmission, as well as the virus transmissibility at different stages of the disease. Additionally COVID-19 presymptomatic transmission is an increasing concern.[3]

The PPE should suit the procedure to be performed, considering factors such as the infectiousness of the pathogen(s), the type of interventions planned, provider comfort, ergonomics, reusability, and cost.[2,4,5] However, in the early stage of the pandemic because the global shortages, PPE was judiciously and rationally selected and used. After the first stage of the pandemic, PPE use must be determined by the level of perceived risk in each situation based on the available knowledge.

PPE should include protection for the head, eyes, hands, body, and feet, with particular concern for respiratory protection.[4] Head protection may be achieved with a cap. Eyes may be protected with specific protective glasses or a face shield. Respiratory protection is obtained with a mask appropriate for the level of risk of the procedure. Hands are protected with 1 pair of gloves. The body, besides the long-sleeved tunic and pants (which are part of the protective equipment commonly worn in the dental office during the workday), should also be protected with a fluid-resistant gown or waterproof apron. Feet should be protected with clinical footwear or shoe covers.[4]

As explained in Part I of this series, PPE selection depends directly on the local epidemiological setting, the patient's characteristics, and the level of risk of the planned procedures. The procedures performed in the clinical dental care environment are classified as low, moderate, or high risk. Moderate risk includes 2 further sublevels associated with the cleaning, disinfection, and sterilization of materials for clinical procedures and the clinical procedures that do not generate aerosols or droplets. High risk includes all aerosol-generating procedures (AGP). It must be emphasized that, depending on each country's epidemiologic situation, PPE selection should consider the level of risk of the planned procedure, regardless of the oral health care professional who provides that care (Table 1).

Choosing and testing the appropriate PPE, in terms of comfort and fit, is essential because it will have implications for movements and visibility during clinical or other procedures.

Regardless of the planned intervention, 1 additional step of protection should be performed by the patient before dental treatment begins. Although there is still no clinical evidence that the use of mouthwashes could prevent SARS-CoV-2 transmission, considering the potential infectivity of saliva, the patient should perform a preprocedural rinse with a disinfectant mouthwash to help reduce the contamination risk for the dental care professional.[6-10] To reduce viral load in the oropharyngeal region, a major site of viral replication, oral antiseptic rinses have been suggested, namely those that target the lipid envelope of SARS- CoV-2.[11]

A hydrogen peroxide solution at a concentration as low as 0.5% efficiently inactivates coronaviruses (eg, severe acute respiratory syndrome [SARS], Middle East respiratory syndrome [MERS]) on inanimate surfaces within 1 minute.[12,13]

Because SARS-CoV-2 is vulnerable is vulnerable to oxidation, preprocedural mouth rinses containing oxidative agents such as 1% hydrogen peroxide have been suggested to reduce the salivary viral load.[8,9,14]

The patient should rinse with a 1% hydrogen peroxide solution for 30 seconds or 0.2% iodopovidone (except if the patient is allergic to iodine). Although both mouthwashes show good virucidal properties because SARS-CoV-2 is sensitive to oxidation, there are some controversial results on the virucidal activity of hydrogen peroxide solution.[11]

The present article does not mention other dental care professionals besides the dentist. Other types of dental care professionals vary across the globe, and their safety is of equal importance.

Currently, several companies and partnerships are working on the development of different types of vaccines for SARS-CoV-2.[1,4]Despite the great effort that has been made for a rapid development of vaccines, these preventive inoculations require thorough assessment of safety and effectiveness.[1,4] When these vaccines become available, dental care professionals should be part of the group of high-risk health professionals that are among the first to be vaccinated. However, until the

**Table 1 – Personal protective equipment selection according to the level of risk of the planned procedures.**

| Low risk | Moderate risk | | High risk |
|---|---|---|---|
| Reception | Cleaning, disinfection, and sterilization | Clinical procedures without AGP* | Clinical procedures with AGP |
| • Surgical mask<br>• Protective glasses or face shield†<br>• Uniform<br>• Clinical footwear | • Cap/bonnet‡<br>• Protective glasses or face shield<br>• Surgical mask or type IIR surgical mask<br>• Uniform<br>• Waterproof apron<br>• Thick gloves<br>• Clinical footwear | • Cap/bonnet†<br>• Protective glasses or face shield<br>• FFP2 mask or type IIR surgical mask<br>• Uniform<br>• Fluid-resistant gown<br>• Gloves<br>• Clinical footwear<br>• Shoe covers‡ | • Cap/bonnet<br>• Protective glasses or face shield<br>• FFP2 or FFP3 mask<br>• Uniform<br>• Fluid-resistant gown<br>• Gloves§<br>• Clinical footwear<br>• Shoe covers |

AGP, aerosol-generating procedures; FFP, filtering face piece.

* Including cleaning and disinfection of the office after each visit.
† Or protective barrier.
‡ Optional.
§ High-risk or epidemiological situation might use 2 pairs of long-sleeved gloves.

effectiveness and duration of the vaccine-induced immunity are established, other preventive measures such as PPE should continue to be used. If SARS-CoV-2 becomes endemic and recurring, vaccines will help reduce the morbidity and mortality associated with this viral infection.[1] Access to the vaccine by dental care professionals will likely mean significant changes in PPE recommendations.

There is some evidence that the infection rate among professionals seems to be low, probably due to the strict measures instituted and the use of the recommended PPE. According to American Dental Association (ADA) studies, the infection rate among professionals is less than 1%.[15]

In some countries, besides the general principles defined in their own infection control and prevention policies, when there is a lack of or limited access to PPE, measures that mitigate risk associated with the procedure should be adopted. In that context, priority should be given to controlling the risk of viral transmission via AGP and using a minimum set of barriers to prevent COVID-19 transmission.[4] Therefore, first and foremost, dentists should prioritize planned treatments. Moreover, whenever possible, treatments should be provided with a minimally invasive approach, using manual instruments or instruments that do not generate aerosols. However, using respiratory protection, gloves, a fluid-resistant gown and eye protection is essential, though these could be adapted to the existing limitations. For example, when filtering face piece (FFP2) masks are not available, 2 surgical masks can be used instead, and when these are limited, the internal mask might be replaced less frequently. Also, when appropriate, using waterproof aprons (eg, composed of plastic) on top of the usual clinical apparel can be an alternative, along with reinforcing disinfection measures.[16]

Information and training of all health care professionals should be promoted and reinforced, including basic protocols for hand hygiene, respiratory etiquette (cover your mouth and nose with the inner elbow or a tissue when coughing or sneezing, and dispose of the used tissue in the nearest waste receptacle immediately after use), social distancing, correct use of PPE, cleaning and disinfection, and knowledge of COVID-19 symptoms, as well as a strategic plan designed to answer a possible future COVID-19 infection situation happening in the health care center.[2,4] The training of dental care professionals on how to properly don (put on) and doff (remove) PPE is as important as choosing the appropriate PPE because proper donning is protective and doffing can be associated with a risk of infection.

## Body protection

The preferred attire should consist of a long-sleeved fluid-resistant gown with elastic cuffs that should cover the legs to below the knees and be tied in the back.[17] The gown should be worn over clinical apparel consisting of a long-sleeved tunic and pants. Alternatively, and in some situations, a waterproof apron may be used. A cap or a bonnet is recommended to protect the head in high-risk situations. The use of protective hoods provides coverage of the head and neck but may be associated with greater discomfort and complicate the correct removal of PPE; therefore, their potential benefits are unclear.[4,14] Since the use of complete suits as an alternative to wearing a fluid-resistant gown, a cap, and a protective hood may also be uncomfortable, their use in environments that may expose providers to SARS-CoV-2 should be carefully considered.

Certificate type 3B protective clothing (protection against pressurized liquid chemical products) provides an effective barrier for several types of exposure, including droplets and small particles such as viruses and spores. The use of breathable materials does not imply greater risk of contamination and is more comfortable for the wearer.[16]

## Protection for the eyes

The proper use of protective glasses or a face shield guards against contamination from spatters. In AGP, protective glasses and a face shield should be used together.[17]

The selected face shield should be sturdy, cover the whole face from the forehead to the chin, and not interfere with the mask.[4,18] The protective glasses should be compatible with the mask and adapt to the provider's facial features. Professionals who wear graduated glasses must wear a face shield.[4]

## Masks

The type of mask to be used depends on the required level of protection and should be adjusted to the level of risk.[4,19,20] The facial or surgical masks commonly used by health care professionals provide a barrier that minimises the direct transmission of infectious agents through exhalation and inhalation of particles between the professional and the patient but do not provide a complete seal and, thus, are not indicated for AGP.[20] Surgical masks should be replaced every time they become moist or after 4-6 hours of use due to a reduction of effectiveness.[4,20,21]

On the other hand, respirators, also known as FFP masks, ensure complete sealing of the nose and mouth area and prevent the inhalation of droplets and aerosols. Some models have a valve that eases air passage during expiration and reduces carbon dioxide accumulation; however, because air is exhaled near the patient, their use is discouraged and may only be considered for exceptional circumstances. In those cases, the respirator should be covered by a surgical mask to reduce the risk of infection. Their use is recommended when there is a shortage of respirators, and then only on a case-by-case basis.[4]

There are European, US, and Chinese standards that classify respirators. The European standards classify respirators into 3 types according to their particle filtering capacity: FFP1, FFP2, and FFP3 (Table 2). In the context of prevention of SARS-CoV-2 infection in a clinical environment with droplet generation (particles <5 $\mu$m), type FFP2 masks without an exhalation valve or equivalent should be used.[17] A European type FFP2 mask is generally equivalent to the US N95 or the Chinese KN95 (Table 3).

To ensure that the respirator is correctly adjusted to the face and that no air leakage is possible, the following sequence is advised: (i) adapt the respirator below the chin, with the metallic part (nasal clip) upwards; (ii) adjust the straps or elastics on the head or behind the ears and confirm that they are not twisted; (iii) use both hands to adjust the

**Table 2 – Performance of the different types of respirators.***

| EU type of respirator (EU-OSHA) | Equivalent in USA (NIOSH) | Filter penetration limit (at 95 L/min airflow) | Total inner leakage | Penetration in the filtering material (maximum %) |
|---|---|---|---|---|
| FFP1 | — | Filters **at least 80%** of airborne particles | <22% | 20% |
| FFP2 | N95 (Filters 95% of airborne particles) | Filters **at least 94%** of airborne particles | <8% | 6% |
| FFP3 | N99 | Filters **at least 99%** of airborne particles | <2% | 1% |

EU, European Union; FFP, filtering face piece; NIOSH, National Institute for Occupational Safety and Health; OSHA, Occupational Safety and Health Administration.

* Adapted from ECDC 2014 and ACT 2016. Safe use of personal protective equipment in the treatment of infectious diseases of high consequence. https://www.ecdc.europa.eu/sites/default/files/media/en/publications/Publications/safe-use-of-ppe.pdf.

**Table 3 – International standards regarding respirators.**

| Type of respirator | Country | Standard |
|---|---|---|
| FFP2 | EU | EN 149-2001* |
| N95 | USA | NIOSH-42CFR84† |
| KN95 | China | GB2626-2006‡ |
| P2 | Australia/ New Zealand | AS/NZA 1716:2012§ |
| Korea 1st Class | Korea | KMOEL - 2017-64‖ |
| DS | Japan | JMHLW-Notification 214, 2018¶ |

* EN = European Norms.
† NIOSH = National Institute for Occupational Safety and Health standards.
‡ GB = Guobiao standards.
§ AS/NZA = Joint Australia and New Zealand standards.
‖ KOSHA = Korea Occupational Safety and Health Agency standards.
¶ JMHLW = Japan Ministry of Health, Labour and Welfare standards.

nasal clip around the nose and adapted to the cheeks; (iv) conduct a seal check test before sharing the room with the patient.[1,4,18,20,22] The test to verify the correct adjustment of the respirator consists of covering it with both hands (which have been disinfected) and then forcing an inspiration and expiration. During a successful positive-pressure seal check, the respirator is slightly pressurized before increased pressure causes outward leakage. During a negative-pressure seal check, a well-adapted respirator collapses slightly under the negative pressure.

Respirators are disposable, but their reuse and reprocessing have been necessary because of the global shortage in the context of the SARS-CoV-2 pandemic. Respirators may be worn for a total of 8 hours in a single use or up to 5 periods of use until they have to be replaced; however, if they are moist or visibly soiled, they should be replaced.[14] In AGP, respirators should be replaced at the end of each visit.[16] In the current pandemic, and due to the current shortage of material in the market, respirators may be protected by placing a surgical mask or a waterproof surgical mask (type IIR) on top of them.[4,19] If respirators are used for several periods, they should be kept in properly identified paper bags and never in plastic bags. Extended use is favoured over reuse because it involves less touching of the respirator and, therefore, less risk of contact transmission.[19]

It should be highlighted that some disinfection methods may change the respirator's filtering capacity and thereby promote the inhalation of toxic substances and twist or damage parts of the respirator.[16] The exposure to UV radiation, hydrogen peroxide vapor, or humid heat have been regarded as the most ideal methods of disinfection. On the other hand, disinfecting respirators with alcohol or bleach is not advisable because this changes their filtering capacity.[16] Because the impact of decontamination on the respirator's performance is unknown, this procedure should not be undertaken without precisely following instructions provided by the manufacturer.

Respirators should only be decontaminated and subsequently reused where there is shortage of respirators. The decision to implement policies that permit extended use, limited reuse, or reprocessing of respirators should be made on a case-by-case basis taking into account local conditions and regulations.[1,23]

## Gloves

In most of the epidemic situations, single latex gloving may be appropriate. Nitrile gloves are indicated for situations where there is a latex allergy. When damage to a glove is detected or suspected, it should be replaced, following the correct doffing and donning sequence.[4] Gloves should be correctly doffed to prevent self-contamination, following this sequence: hold the external part of one of the gloves with the opposite hand wearing a glove; doff the glove; hold the removed glove with the hand wearing a glove; slide the fingers of the hand without a glove under the glove worn at the wrist level, without touching its external surface; doff the second glove; dispose of both gloves in a proper waste container.[22] The use of gloves does not exempt a person from performing hand hygiene before and after use.[22]

In some countries, high-risk or epidemiological situations might use 2 pairs of long-sleeved gloves, which should cover the cuffs of the gown, and is advised for AGP.[18,23] The inner gloves work as a "second skin" and should have an intermediate thickness and, if possible, a sleeve longer than the outer gloves. The outer gloves should be suited to the type of procedure to be conducted. When sterile conditions are required, the inner gloves should be disinfected before donning the sterile external pair.

## Clinical footwear

Clinical footwear should be closed and made of a resistant material to avoid splatter from penetrating the surface and

the possibility of injuries from dropped or fallen instruments. Medical shoes may be color-coded according to the area of the practice where they will be used. Other clinical footwear, such as everyday shoes or sneakers, may also be used, as long as they are protected with shoe covers because they cannot be disinfected. Although boots provide a higher level of protection compared to medical shoes, their use may be uncomfortable in the clinical setting.[4]

Clinical footwear should be cleaned with water and detergent and then disinfected with 70% alcohol.[4]

## Shoe covers

Shoe covers should be resistant, waterproof, and anti-slip. When wearing medical shoes in combination with gowns, medical shoes may be covered with shoe covers to prevent accumulation of liquid in the shoes.[22]

## Donning and doffing PPE

Preparation, practice, and focus are essential to don and doff PPE properly. The dental care professional has a risk of accidental exposure during both procedures, and that should be minimised. It is recommended to don and doff PPE in front of another person, who may identify potential errors, or in front of a mirror.[22,23] There are several methods to don and doff PPE, but none can be considered the gold standard.

Before donning the PPE, the professional should ensure that they have removed all jewellery, consider the need to drink water to prevent dehydration, and check equipment conformity.[22] During treatment, the user should not make any adjustments to the protective equipment.[22,23]

The first step is hand hygiene, followed by donning the fluid-resistant gown, adjusting the respirator and conducting the test, and donning the cap/bonnet, the protective glasses/face shield, and the gloves, covering the gown cuffs. The sequence to don PPE for procedures in a clinical environment of moderate to high risk is provided in Tables 4 and 5.

Additional sealing of the junctions between the different pieces of equipment with adhesive tape poses some risks and does not help overcome issues associated with using ill-fitting PPE. Also fixing the junction between the mask and the glasses may cause both to lose their sealing capacity or limit the entry of air through the mask.[4]

PPE should be doffed according to the standard sequence and without rapid movements. To avoid the risk of infection, contaminated hands should never touch clean areas or the skin. Doffing PPE should be accomplished carefully.

The sequence to doff PPE for procedures in a dental clinical environment where there is moderate to high risk can be found in Tables 6 and 7. The gloves are the most contaminated piece of equipment and should be removed first. In AGP, if using 2 pairs of gloves, before removing the inner pair of gloves, these should be disinfected. The protective glasses or face shield should be doffed by holding the posterior portion. If reusable, they should be carefully disinfected with alcohol after use. The fluid-resistant gown should be undone and doffed by touching only its internal face and folding it inside out, so that its potentially contaminated external surface faces the inside, before throwing it in the trash or storing

**Table 4 – Suggested sequence for donning PPE for procedures in a clinical environment of moderate risk.**

| Steps | Action |
|---|---|
| 1 | Perform hand hygiene |
| 2 | Put on the shoe covers (optional) |
| 3 | Put on the fluid-resistant gown |
| 4 | Put on and adapt the respirator* or surgical mask |
| 5 | Put on the cap/bonnet† |
| 6 | Put on the protective glasses or face shield |
| 7 | Put on the gloves, covering the gown cuffs |

PPE, personal protective equipment.

* Should always be tested.
† Optional.
Adapted from the Centers for Disease Control and Prevention. Using Personal Protective Equipment (PPE) https://www.cdc.gov/coronavirus/2019-ncov/hcp/using-ppe.html

**Table 5 – Suggested sequence for donning PPE for procedures in a clinical environment of high risk.**

| Steps | Action |
|---|---|
| 1 | Perform hand hygiene |
| 2 | Put on the shoe covers |
| 3 | Perform hand hygiene |
| 4 | Put on the first pair of gloves |
| 5 | Put on the disposable fluid-resistant long-sleeved gown that covers the legs up to below the knees |
| 6 | Put on and test the respirator |
| 7 | Put on the protective glasses |
| 8 | Put on the cap/bonnet |
| 9 | Put on the face shield |
| 10 | Disinfect the first pair of gloves and put on the second pair of gloves* |
| 11 | Check the entire set of PPE |

PPE, personal protective equipment.

* High-risk or epidemiological situation might use 2 pairs of long-sleeved gloves; otherwise a single pair of gloves must be put on here.
Adapted from the Centers for Disease Control and Prevention. Using Personal Protective Equipment (PPE) https://www.cdc.gov/coronavirus/2019-ncov/hcp/using-ppe.html

**Table 6 – Sequence proposed for doffing PPE for procedures in a clinical environment of moderate risk.**

| Steps | Action |
|---|---|
| 1 | Take off the gloves |
| 2 | Hand hygiene |
| 3 | Take off the protective glasses or face shield by the posterior aspect |
| 4 | Take off the cap/bonnet* |
| 5 | Take off the gown without touching its exterior surface |
| 6 | Take off the surgical mask or the respirator using the elastics |
| 7 | Hand hygiene |

PPE, personal protective equipment.

* If wearing it.
Adapted from the Centers for Disease Control and Prevention. Using Personal Protective Equipment (PPE) https://www.cdc.gov/coronavirus/2019-ncov/hcp/using-ppe.html

**Table 7 – Sequence proposed for doffing PPE in procedures of high risk.**

| Steps | Action |
|---|---|
| 1 | Take off the outer pair of gloves* |
| 2 | Disinfect the inner gloves |
| 3 | Take off the face shield and the protective glasses by the posterior aspect |
| 4 | Take off the cap/bonnet |
| 5 | Take off the gown without touching its exterior surface |
| 6 | Take off the shoe covers |
| 7 | Take off the inner pair of gloves |
| 8 | Disinfect hands with ABAS† |
| 9 | Take off the respirator by its posterior aspect, when outside the room |
| 10 | Hand hygiene |

ABAS, alcohol-based antiseptic solution; PPE, personal protective equipment.

* High-risk or epidemiological situation might use 2 pairs of long-sleeved gloves; otherwise a single pair of gloves must be taken off here followed by hand disinfection with ABAS.

† During the procedure, if hands are contaminated, they should be disinfected with ABAS.

Adapted from the Centers for Disease Control and Prevention. Using Personal Protective Equipment (PPE) https://www.cdc.gov/coronavirus/2019-ncov/hcp/using-ppe.html

it to be washed. The work uniform should be doffed without shaking, to avoid releasing contaminated particles. Disposable materials should be discarded in the usual way established for highly infectious waste.[4]

When passing from the contaminated area to the clean area (transition area), dental care professionals should remove the boot covers (when used). Then, they should perform thorough hand hygiene with an alcohol-based antiseptic solution (ABAS) from a clean dispenser, and they should also rub the disinfectant on their neck.[4]

The quality of the scientific evidence regarding the recommended equipment is, in general, poor. Different combinations of equipment are proposed based on recommendations published in manuals developed by international authorities for the control of infectious diseases and based on recommendations by experts.[4] This information will be revised as understanding of viral transmission and treatment options, as well as the availability of a vaccine, evolves. Different combinations of equipment for different risk situations are listed in Table 8. The purpose is to show the different PPE options that must be adequate to the perceived risk at each moment that might vary between low, moderate, or high.

Personal protective measures are essential but might create obstacles to the provider during treatment (less freedom of movement, heat, dehydration, and difficult communication), require new work routines, and imply shorter working periods, primarily when a PPE set designed for maximum protection is used.[4] Some of the PPE used at the first phase of the pandemic, besides being uncomfortable are now questionable, due to the assumption that the infection rate among professionals seems to be low.[15] Nevertheless, in very high-risk situations they might be considered an option.

In places or countries where the epidemiological risk is different from that determined by the World Health Organization or where judicious management of PPE is required, PPE replacement between patients should depend on the level of risk, and alternative solutions should be found. Namely, the decision to replace PPE should consider work periods and the level of risk of the procedures, without ever neglecting hand hygiene. The mandatory actions are the replacement of gloves between patients and the disinfection of the protective glasses or face shield and neck. The fluid-resistant gown or waterproof apron if reusable, may be worn for the entire clinical session, depending on AGP, and must be disinfected between each patient. This disinfection should be performed only inside the office and when the surfaces and floor are being cleaned and disinfected. The cap and the shoe covers may be worn during the entire clinical session if the professional does not touch them (as advised) while they are with patients. If in 1 day there are 2 periods of clinical care, the cap and the shoe covers should be changed between those periods. The gown or waterproof apron, if reusable, may be worn in the next clinical period, depending on AGP, if they are

**Table 8 – Overview of personal protection measures.**

| Procedures | In common areas | | In the clinical environment | |
|---|---|---|---|---|
| | Low risk (reception) | Moderate risk (cleaning, disinfection, and sterilization) | Moderate risk (visits without AGP) | High risk (visits with AGP) |
| Hand hygiene | ✓ | ✓ | ✓ | ✓ |
| Uniform | ✓ | ✓ | ✓ | ✓ |
| Cap/bonnet | **X** | **O** | **O** | ✓ |
| Surgical mask | ✓ | ✓ | **O** | **X** |
| FFP2 mask | **X** | **X** | **O** | ✓ |
| Protective glasses | **O** | **O** | **O** | ✓ |
| Face shield | ✓ | ✓ | ✓ | ✓ |
| Gloves | **X** | ✓* | ✓ | ✓✓ |
| Fluid-resistant gown | **X** | ✓† | ✓† | ✓ |
| Clinical footwear | ✓ | ✓ | ✓ | ✓ |
| Shoe covers | **X** | **X** | **O** | ✓ |

AGP, aerosol-generating procedures; FFP, filtering face piece.

✓ = Recommended; **O** = Optional; **X** = Not recommended; ✓✓ = high-risk or epidemiological situation might use 2 pairs of long-sleeved gloves.

* Thick.

† Or waterproof apron.

disinfected and placed in an area with good sun (UV) exposure during the interval between the 2 periods. The replacement of the surgical mask or respirator should follow the recommendations of each location, with consideration of the information presented here.

## Cleaning and disinfection of reusable equipment

The reuse of PPE requires thorough cleaning and disinfection. The protective glasses and the face shield should be placed on a tray and sprayed with 70% alcohol or submerged in a chloride solution. The gown or waterproof apron, if reusable, may be disinfected between each patient by spraying with 70% alcohol or using a surface or domestic detergent/disinfectant, such as 0.1%-0.5% sodium hypochlorite for 1 minute.[21]

Washable gowns should be doffed without shaking and be rolled up inside out and stored in a waterproof bag. This equipment should be washed at the highest temperature tolerable – minimum 60 °C for 30 minutes or 80-90 °C with the clothing in contact with the heat for 10 minutes. If the clothing cannot be washed at high temperatures, it should be washed in the washing machine at 30-40 °C with a disinfectant appropriate for the type of clothing and compatible with the machine.[24] If no washing machine is available, the clothing should be safely stored in a waterproof bag that should be kept adequately closed until arriving at the location where it will be washed, and then the clothing should be placed directly into the washing machine, following the preceding instructions.[24]

## Conclusion

To provide effective protection against transmission of viral microorganisms (and other pathogens) via body fluids or air, the level of risk of the planned dental procedures (low, moderate, or high) will directly influence the selection of PPE. The PPE used is determined by the level of perceived risk and should take into account each country's infection control and prevention policies and the availability of PPE. Given the lack of solid evidence regarding the risk of AGP, providers should rely on the precautionary principle. To avoid a high risk of infection, the training of dental care professionals on how to properly don and doff PPE is essential.

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## Conflict of interest

None disclosed.

## REFERENCES

1. World Health Organization. Infection prevention and control during health care when COVID-19 is suspected: interim guidance. Available from: https://www.ecdc.europa.eu/en/publications-data/guidance-wearing-and-removing-personal-protective-equipment-healthcare-settings. Accessed June 2020.
2. European Centre for Disease Prevention and Control. Guidance for wearing and removing personal protective equipment in healthcare settings for the care of patients with suspected or confirmed COVID-19. Available from: https://www.ecdc.europa.eu/sites/default/files/documents/COVID-19-guidance-wearing-and-removing-personal-protective-equipment-healthcare-settings-updated.pdf. Accessed June 2020.
3. World Health Organization. Transmission of SARS-CoV-2: implications for infection prevention precautions. Available from: https://www.who.int/publications/i/item/modes-of-transmission-of-virus-causing-covid-19-implications-for-ipc-precaution-recommendations. Accessed August 2020.
4. European Centre for Disease Prevention and Control. Safe use of personal protective equipment in the treatment of infectious diseases of high consequence. Available from: https://www.ecdc.europa.eu/sites/default/files/media/en/publications/Publications/safe-use-of-ppe.pdf. Accessed June 2020.
5. European Union. Minimum health and safety requirements for the use by workers of personal protective equipment at the workplace (third individual directive within the meaning of article 16 (1) of Directive 89/391/EEC) in 89/656/EEC1989. 1989, Council Directive. Available from: https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX:31989L0656. Accessed June 2020.
6. Xu J, Li Y, Gan F, Du Y, Yao Y. Salivary glands: potential reservoirs for COVID-19 asymptomatic infection. J Dent Res 2020;99(8):989.
7. Xu H, Zhong L, Deng J, et al. High expression of ACE2 receptor of 2019-nCoV on the epithelial cells of oral mucosa. Int J Oral Sci 2020;12(1):8.
8. Vergara-Buenaventura A, Castro-Ruiz C. Use of mouthwashes against COVID-19 in dentistry. Br J Oral Maxillofac Surg 2020;58:924–7.
9. American Dental Association. ADA interim guidance for minimizing risk of COVID-19 transmission. Available from: https://www.ada.org/en/publications/ada-news/2020-archive/april/ada-releases-interim-guidance-on-minimizing-covid-19-transmission-risk-when-treating-emergencies. Accessed June 2020.
10. Centers for Disease Control and Prevention. Interim infection prevention and control guidance for dental settings during the COVID-19 response. Available from: https://www.cdc.gov/coronavirus/2019-ncov/hcp/dental-settings.html. Accessed June 2020.
11. Bidra AS, Pelletier JS, Westover JB, Frank S, Brown SM, Tessema B. Comparison of in vitro inactivation of SARS CoV-2 with hydrogen peroxide and povidone-iodine oral antiseptic rinses. J Prosthodontics 2020;29(7):599–603.
12. Caruso AA, Del Prete A, Lazzarino A. Hydrogen peroxide and viral infections: a literature review with research hypothesis definition in relation to the current COVID-19 pandemic. Med Hypotheses 2020;144:109910.
13. Kampf G, Todt D, Pfaender S, Steinmann E. Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents. J Hosp Infect 2020;104:246–51.
14. Peng X, Xu X, Li Y, et al. Transmission routes of 2019-nCoV and controls in dental practice. Int J Oral Sci 2020;12(1):9.
15. Estrich CG, Mikkelsen M, Morrissey R, et al. Estimating COVID-19 prevalence and infection control practices among US dentists. J Am Dent Assoc 2020;151(11):815–24.
16. Centers for Disease Control and Prevention. Recommended guidance for extended use and limited reuse of N95 filtering facepiece respirators in healthcare settings. Available from:

http://www.cdc.gov/niosh/topics/hcwcontrols/recommendedguidanceextuse.html. Accessed June 2020.
17. COVID-19 Dental Services Evidence Review Working Group. Recommendations for the re-opening of dental services: a rapid review of international sources. Available from: https://oralhealth.cochrane.org/sites/oralhealth.cochrane.org/files/public/uploads/covid19_dental_reopening_rapid_review_13052020.pdf. Accessed June 2020.
18. Occupational Safety and Health Administration. Guidance on preparing workplaces for COVID-19. Available from: http://www.osha.gov/Publications/OSHA3990.pdf. Accessed June 2020.
19. Société Française de Stomatologie, Chirurgie Maxillo-Faciale et Chirurgie Orale (SFSCMFCO). Practitioners specialized in oral health and coronavirus disease 2019: professional guidelines from the French Society of Stomatology, Maxillofacial Surgery and Oral Surgery, to form a common front against the infectious risk. J Stomatol Oral Maxillofac Surg 2020;121(2):155–8.
20. Bollinger N. NIOSH respirator selection logic, 2004. Available from: https://www.cdc.gov/niosh/docs/2005-100/pdfs/2005-100.pdf?id=10.26616/NIOSHPUB2005100. Accessed June 2020.
21. Izzetti R, Nisi M, Gabriele M, Graziani F. COVID-19 transmission in dental practice: brief review of preventive measures in Italy. J Dent Res 2020;99(9):1030–8.
22. World Health Organization. Occupational safety and health in public health emergencies: a manual for protecting health workers and responders. Available from: https://www.who.int/occupational_health/Web_OSH_manual.pdf. Accessed June 2020.
23. Verbeek JH, Rajamaki B, Ijaz S, et al. Personal protective equipment for preventing highly infectious diseases due to exposure to contaminated body fluids in healthcare staff. Cochrane Database Syst Rev 2020;4(4):CD011621.
24. Food and Drug Administration. Enforcement policy for sterilizers, disinfectant devices, and air purifiers during the coronavirus disease 2019 (COVID-19). Available from: https://www.fda.gov/media/136533/download. Accessed June 2020.