Personal Protective Equipment for Dentists

Subjects: Pathology

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Severe Acute Respiratory-Syndrome-CoronaVirus-2 (SARS-CoV-2) and all infectious agents can determine serious risk for systemic diseases. In literature there are some models of safety protocols in dentistry. All the personal protective equipment (PPE) actually on the market and their indications are reported and compared before and after COVID-19 onset, focusing on the correct safety procedures for each dental practice.

Keywords: COVID-19 ; PPE ; dentistry ; infectious disease

1. Introduction

The dental team must adapt several precautions to avoid these infections; an adequate training and information of the personnel is mandatory in order to control infections in the dental office. The individual protection methods include a series of enforcement with the aim to reduce the risks of contamination, unfortunately without being able to eliminate them. The basic principle of infection control is to approach to each patient as if he was an infected patient (by one of the main microbes listed above) and to correctly carry out the protection methods[1].

Adequate personal protective equipment (PPE) must be selected based on a risk assessment and the procedure to be performed. The precautions for infection control require wearing gloves, aprons, as well as eye and mouth protection (goggles and mask, such as medical masks and Filtering Face Piece or FPP) for each procedure involving direct contact with the patient body fluids. Whenever possible "single use" or "disposable" equipment should be used[2](Table 1).

Table 1. The types of PPE commonly used for high-risk settings are shown with each advantages and disadvantages.

TYPE OF PPE	ADVANTAGES	DISADVANTAGES
Medical mask	Easy to wear, disposable, comfortable compared withN95, N99 respirator or PAPR	Controversial adequacy against novel influenza or highly virulent droplet pathogens, not indicated when operator is in contact with highly virulent pathogens during aerosol-generating procedure
Particulate respirators (FFP2, FFP3, N95…)	Indicated for airborne pathogens, able to protect from virulent pathogens during aerosol-generating procedure, disposable	Less comfortable, facial hair and facial deformity prevent sealing mask to face
Powered air purifying respirator (PAPR)	Desired for high-risk aerosol-generating procedures, half or full face piece provides facial protection	Unwieldy, battery-operated, not disposable
Gown	Easy to put on and take off, not causing heat, disposable, more available	Have more openings than coveralls
Coverall	Covers large part of surface area	Causes heat stress unwieldy
Apron	Additional protection when using gowns or coveralls	Disinfection is needed with apron not disposable

Goggles	Easy to wear, Protection to eyes	Affect visibility with fogging, some parts of face may not be protected
Face shield	Less fogging, Easy to wear, covers larger part of face	
Gloves (double gloving)	Reduction of the risk of transmission for high virulent pathogens through glove holes, reduction of contamination risk for hands when removing gloves	Reduction tactile sensation, unwieldy removal process
Head and neck cover	Protects head, neck skin and hair	No evidence about protection in high-risk
Boots	Easy to disinfect, considered a standard equipment in high-risk procedures	Lack of information in comparison boots vs shoes with covers
Shoes with covers	Easy to wear	Not optimal when floors is wet

(modified from Honda et al., 2106)[3]

2. Mask/Respirators

If the necessary precautions are not taken, it is inevitable that operators can become infected through contact of the mucous membranes with blood, saliva, and aerosols from a potentially infective patient[2]. In healthcare setting, masks are used in order to:

1. protect personnel from contact with patient infectious material;
2. protect patients from infectious agents carried by healthcare workers;
3. limit the potential spread of infectious respiratory aerosol between patients[4].

Masks can be worn with goggles in order to protect mouth, nose and eyes, or with a face shield to provide more complete face protection. We must distinguish masks from particle respirators that are used to prevent inhalation of small particles which may contain infectious agents transmitted through the respiratory tract. The mouth, nose, and eyes are sensitive portals to the entry of infective pathogens, such as skin cuts.

Medical masks:

- could be flat or pleated (some are like cups) and fixed to the head with straps or elastic bands;
- does not offer complete protection against small particle aerosols (droplet nuclei) and should not be used during contact with patients with diseases caused by airborne pathogens;
- they are not designed to isolate the face and therefore cannot prevent inhalation by the health personnel wearing them;
- they must be replaced if wet or dirty.

There are no standards that evaluate the efficiency of the medical mask filter. AORN (Association of peri-Operative Registered Nurses*)* recommends that medical (surgical) masks filter at least 0.3 μ particles or have a bacterial filtration efficiency of 90%–95%[5].

Surgical masks (SM) are used to prevent that large particles (such as droplets, sprays or splashes), containing pathogens, could reach nose and mouth[6]. Although their purpose is to protect patients from healthcare professionals (and healthcare team from patients) by minimizing exposure to saliva and respiratory secretions, they do not create a seal against the skin of the face and therefore are not indicated to protect people from airborne infectious diseases.

Masks are available in several shapes (modeled and unprinted), dimensions, filtration efficiency and attachment method (ribbons, elastic through the ear). Masks are disposable and must be changed for each patient.

Instead, during the treatment of patients with respiratory infections, particulate respiratory masks must be worn.

Particulate respirators (with filtering percentage) in use in various countries include:

- P2 (94%) and P3 (99.95%) in Australia and New Zeland
- II (95%) and I (99%) in China
- CE-certified FFP class 1 (FFP1) (80%), class 2 (FFP2) (95%), or class 3 (FFP3) (99.7%) in European Union
- 2nd class (95%) and 3rd class (99.9%) in Japan
- 1st class (94%) and special respirators (99.95%) in Republic of Korea
- National Institute for Occupational Safety and Health (NIOSH)-certified N95 (95%), N99 (99%) and N100 (99.7%) in United States [5].

FFP2 European respirators are comparable to N95, and they are indicated for prevention of

infectious airborne diseases. However, FFP3 respirators offer the highest level of protection against infectious agents and are the only FFP class accepted by the Health and Safety Executive (HSE) as regards the protection in the healthcare environment in the United Kingdom[5].

The powered air purifying respirator is also considered a standard part of PPE in certain situations, including aerosol generation procedures in high risk environments.

European legislation:

Particulate respirator masks are subject to compliance with directive 89/686/EEC about personal protective equipment (the directive on medical devices 93/42/EEC applies instead to surgical masks).

According to the British standard EN 149:2001 (modified in 2009) they are classified into three categories, FFP1/FFP2/FFP3, based on their level of protection and their effectiveness.

On each particulate respirator mask must be present:

- Name of the manufacturer
- Reference standard nuber (e.g. EN 149:2009)
- class (e.g. FFP1, FFP2 or FFP3)
- CE mark
- Possible reuse (NR or R)

In the event of a pandemic infection, any aerosol generation procedure on infected patients should only be carried out with an FFP3 respirator. Non-urgent procedures should be postponed until the infection resolves.

In the US, the National Institute for Occupational Safety and Health (NIOSH) defined the following particulate filter categories in 2011, in Title 42 Code of Federal Regulations, section 84 (Table 2).

Table 2. Characteristics of masks according to US classification.

Oil resistance	**NIOSH Class**	**Filtration percentage** **% filtration of airborne particles**
Not oil resistant (N)	N95	95%
	N99	99%
	N100	99.97%
Somewhat resistant to oil (R)	R95	95%
	R99	99%
	R100	99,97%

	P95	95%
Strongly resistant to oil (P)	P99	99%
	P100	99.97%

There are several models of FFP2 and FFP3 respirators, both with valves and without valves. However, this is not a filter but a valve that regulates the flow of air at the outlet and therefore makes it easier to exhale. Therefore, these masks are designed to be able to filter very well the air that comes in the mouth, nose, and lungs of those who wear them. Instead, these masks are not designed specifically to prevent the wearer from infecting someone else with their own breathing.

In practice, if a mask has a valve, it can let out particles, even if it manages to block almost all the inlet ones. And therefore, a healthy person can use it effectively so as not to get infected. For a sick person or one who could be contagious, however, using it could infect others by letting germs pass from their breath outwards. It is important to say that there is no specific test that has been done to verify the possibility that the virus spreads from an infected person passing through a mask equipped with a valve[7].

Surgical masks, on the other hand, are similar in both directions. They have been designed to prevent healthcare workers and surgeons in particular from infecting their own breath with patients, who may have open wounds on the operating table, but also work to protect the healthcare staff themselves against a potentially contagious person. Their effectiveness, however, is much lower also because they do not prevent the breath from spreading and allow a lot of air to pass through and to the mouth and nose[7].

3. Goggles, Face Shields

The choice of individual eye protection devices (such as goggles or face mask) varies according to the exposure circumstances, other PPE worn. and the need for personal vision[2]. In order to protect the eyes, eyeglasses and contact lenses are not considered suitable[8]. Eye protection must be effective but at the same time comfortable and allow sufficient peripheral vision.

There are different measures that improve the comfort of the glasses, for example anti-fog coating, different sizes, the possibility of wearing them on prescription glasses. Although they provide adequate eye protection, glasses do not protect from splash or spray the other parts of the face.

Disposable or sterilizable face shields can be used in alternative to glasses. Face shield protects the other areas of the face besides the eyes (glasses only protect the eyes). The face shields that extend from the chin to the forehead offer better protection of the face and eyes from spray and splashes[9].

The removal of a facemask, goggles, and mask can be safely performed after removing dirty gloves and after performing hand hygiene.

4. Gowns or Coveralls

Gowns and coveralls are additional personal protective equipment in the health sector[9]. Operator hygiene, including wearing appropriate clothing and PPE, has a dual purpose: on the one hand, to defend the operator himself in an environment where the infectious risk is high, and on the other hand to prevent the operator from becoming responsible transmission of infections.

To increase the protective function of the uniform or to carry out those procedures in which high contamination is expected, additional disposable clothing can be worn[9]. These clothes can be PPE certified for biological risk and for this recognition must comply with the requirements of the technical standards, namely European standards are EN 14126 and ISO 16604 (DPI) and EN 24920 (DM). The material constituent is mainly TNT (texture not texture), which is suitable for "disposable" use in this specific area. To offer greater protection of the part front of the body, the most exposed to risk, it is required that such lab coats have standard features within the heterogeneity of the models, for example: back closure, covered or heat-sealed seams, long sleeves with cuffs tight and high collar. Obviously, for these devices, comfort and practicality are also required, so the operator must be able to move freely and perceive good perspiration[9].

Different types of gowns and overalls are available with varying levels of protection. The level of protection depends on various factors including the type of tissue, the shape and size of microorganisms, the characteristics of the conveyor, and various external factors[10].

In high-risk environments, it is recommended to use waterproof and fluid-resistant gowns or overalls.

During minor oral surgery, surgical gowns must be worn with tight cuffs that must be inserted under the gloves. Fabric work uniforms must be washed daily on a hot 60 ° C cycle. Fabric uniforms are not considered PPE since the material they are made of is absorbent and therefore offer little protection against infectious pathogens.

5. Gloves

During all dental procedures, it is impossible to avoid contact of the hands with blood and saliva[2]. That is why all operators must wear protective gloves before performing any type of procedure on patients[2]. Gloves must be changed with each patient and at every contact with contaminated surfaces to prevent cross-infection[2]. Not only the dentist, but also other dental team members must wear gloves during dental procedures[2][11].

Gloves used in dental clinic can be distinguished basically in two categories: those for purely use clinical and those for instrumentation reordering procedures and of the operational area. When cleaning dental appliances and instruments, more durable gloves should be worn than normal non-sterile gloves to prevent injury[2].

Regarding clinical gloves, a clear distinction must be made between them procedures that require invasive action on the patient, or however at clear biological risk, and the procedures that do not require them, or in any case present a negligible biological risk for the operator.

The two types of gloves resulting from this distinction are found in the words "inspection gloves" and "surgical gloves" one commonly used nomenclature[9].

Both disposable products, from a macroscopic point of view usually have some obvious differences:

- Surgical gloves in general always distinguish the right side from the left, they are long enough to be worn over the cuffs of the gowns and always packaged in sterile pairs,
- The inspection glove is usually an ambidextrous device, shorter and thinner than the previous one and rarely sterile[12].

In general, clinical gloves are made of latex, nitrile or vinyl. Latex and nitrile have proven to be more resistant than and therefore are generally preferred. Gloves contain powder to make them easier to wear, but which can cause skin irritation[2]. Powder-free gloves exist on the market and they should be used when such reactions occur[2]. Some people may experience allergies and contact dermatitis due to latex[2]. Latex-free gloves for allergy sufferers are also available[2].

Also, the weather of use is an absolutely relevant parameter in terms of protection. The use of the glove, especially if in latex, involves development not perceived of microperforations which become particularly significant from a numerical point of view after 60 minutes and which induce an increase in biological risk[13]. The simultaneous use of two pairs of gloves considerably reduces the passage of blood through microperforations[14]. There are no significant reductions in manual skills and the sensitivity of the operator wearing the double glove[12].

It was confirmed that the formation of microperforations can be also induced by washing gloves with soap, chlorhexidine, or alcohol. Moreover, particular attention should be paid also while waiting for the total drying of the alcoholic substances applied on the hands, which has also proven to be potentially harmful to the integrity of the device, before wearing gloves[12].

Other personal protective equipment include the disposable cap (headgear) and shoe covers.

A disposable cap device is recommended for clear hygienic reasons, such as containment operator contamination and prevention of dispersion of dandruff in the environment, and even more generic protective functions for the worker, such as: interlocking with subsequent tearing of hair and possibly scalp from a part of moving and/or rotating organs, the burning of the hair due to flames or incandescent bodies, and hair fouling due to various agents, including powders and drops of blood-salivary material[9].

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