**Review Article**

**Historical Evolution and Filtering Characteristics of Masks and Respirators in Dentistry in the Context of COVID-19: A Literature Review**

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**Objectives:** At present, it is very important to identify the available literature regarding the use of masks and respirators by analyzing their historical evolution in the medical field. In addition, consideration should be given to the major filtering characteristics of those most used due to the current SARS-CoV-2 pandemic. Therefore, the purpose of this literature review is to describe the qualitative evolution that facemasks and respirators have undergone along with their different characteristics.

**Materials and Methods:** This literature review was conducted between September and December 2020. Articles were identified from PubMed Central, Scopus, and Web of Science. The following keywords were used: “COVID-19,” “dentistry,” and “masks.” These MeSH terms were combined with the Boolean operators “AND” and “OR.”

**Results:** We found 36 articles in PubMed Central, 21 in Scopus, and 17 in Web of Science, which included reviews, clinical, descriptive, and experimental trials.

**Conclusion:** The emergence of new pathogens leads to continuous improvement in masks and respirators. It was determined that for the dental field, respirators with filtration characteristics greater than 95%, such as FFP3, N100, N95, and KN95, are indicated in addition to their decontamination and reuse processes.

**Keywords:** Covid-19, dentistry, masks, N95 respirators, personal protective equipment (PPE)

**INTRODUCTION**

Infection with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), discovered in the city of Wuhan, China, has resulted in high mortality rates worldwide. This pathogen is directly transmitted by small droplet particles found in the air and aerosols.[1]

The first cases of coronavirus disease 2019 (COVID-19), caused by SARS-CoV-2, were reported in December 2019. SARS-CoV-2 is transmitted by direct contact or exposure to symptomatic and asymptomatic patients. Transmission by means of aerosols has also been reported, since this virus remains in an infectious and transmissible state for several days.[2-4]

In the current context of the pandemic, the use of masks and respirators by the population, especially healthcare workers, is essential to reduce the risk of the contagion, since there is currently no vaccine or other specific treatment with worldwide coverage.[4-15] There are significant differences among masks and respirators that will determine their level of protection against microorganisms, as well as their mode of use and possible methods of reuse, which will be important to analyze, especially in the dental field.[2,3]

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For instance, respiratory droplets emitted by people infected with respiratory viruses are an immediate source of infection, and they also descend very quickly, creating barriers less than a meter away from the infected people. On the other hand, the nuclei of the droplets can remain in the air for a prolonged period with the risk of exposure; hence, they may constitute a source of infection at distances >1 m.[9]

Therefore, the purpose of this literature review was to describe the qualitative evolution that masks and respirators have presented together with their different characteristics, as well as to establish a discussion regarding the distribution of these in underdeveloped countries.

**Materials and Methods**

This literature review was conducted between September 2020 and January 2021. The articles were identified from PubMed Central, Scopus, and Web of Science. The following keywords were used: “COVID-19,” “dentistry,” and “masks.” These MeSH terms were combined with the Boolean operators “AND” and “OR.”

Search strategy involved the following formula (“COVID-19” [All Fields] AND “dentistry” [All Fields]) AND “masks” [All Fields]. In addition, for each keyword, the following variations were used:

For COVID-19: “severe acute respiratory syndrome coronavirus 2” [Supplementary Concept] OR “severe acute respiratory syndrome coronavirus 2” [All Fields] OR “ncov” [All Fields] OR “2019-nCoV” [All Fields] OR “COVID-19” [All Fields] OR “SARS-CoV-2” [All Fields] OR (coronavirus [All Fields] OR “cov” [All Fields])

For dentistry: “dentistry” [MeSH Terms] OR “dentistry” [All Fields] OR “dentistry’s” [All Fields]

For masks: “mask’s” [All Fields] OR “masked” [All Fields] OR “masking” [All Fields] OR “masks” [MeSH Terms] OR “masks” [All Fields].

**Results**

We found 36 articles in PubMed Central, 21 in Scopus, and 17 in Web of Science, which included reviews, clinical, descriptive, and experimental trials.

**Evolution of Masks Over Time**

The appearance of the first masks dates back to the middle of the Middle Ages with the emergence of the bubonic plague in the years 1347 to 1353. It was mentioned that the physicians of the time wore black capes and hats, as well as beak masks, to care for patients who contracted the disease.[16] These protective devices were likely filled with cloves, cinnamon, or other substances and thus were better protected from the “miasma,” contaminated air from the East, which was considered to be the cause of the pandemic.[16,17] However, it is also noted that there is no strong evidence of the actual existence of physicians wearing spike masks in this context. Although two of such masks are recorded in German museums, they are suspected to be forgeries of a younger era, which could suggest that “beak doctors” served another function.[16,18]

The best-known introduction of nose and mouth protectors was made in surgical rooms during the 20th century. This is because in the late 1800s, research into the transmission of germs increased. Carl Flügge (1847–1923), a bacterial hygienist from Kochian, found that “droplet infection” from the mouth and nose of surgeons was a major source of germs. He even mentioned that speech alone spread a large number of oral bacteria into the environment.[19–21] On this basis, Johann von Mikulicz (1850–1905) made a publication that pointed out the use of mouth dressings during a surgical operation, describing a mask made of a layer of gauze.[21,22] His assistants, Hübner et al., extended their research by mentioning that such mouthguards should be made of two layers of gauze.[21–24]

During the First World War, more research related to masks of variable thickness emerged. Their use gradually became more accepted within the medical and nursing community, who began to use cloth or gauze masks more continuously. It was not until 1920 that surgical masks began to be used more frequently in operating rooms in the United States and Germany for small surgeries. Sixteen years later, Martin Kirschner, director of surgery in Heidelberg, wrote a book in which the chapter “measures to combat infection” mentioned the need to wear a face mask during surgery.[16,25] However, many surgeons and health workers of the time were still reluctant to wear masks during their clinical activities, expressing discomfort in their use.[16]

It was in the year 1940 that washable and sterilizable masks were introduced, which gained special popularity in surgical rooms in the country of Germany.[16,26] Then, in the middle of the year 1960, the United States began to manufacture disposable masks, implementing its trade worldwide. However, 30 years later, it was again put on trial if infections in the surgical field could be reduced with the use of masks and face shields. This issue was resolved by the German Institute for Hygiene “Robert Koch” who presented truthful data indicating that surgical face masks reduce indoor air pollution.[16,27]
Over time, European standards have considered surgical mask as a medical device. Thus, they designated it the official nomenclature of EN 14683 and established its classification as Type I, Type II, and IIR, differentiating between them by their filtration capacity. Later, the same European Committee for Standardization (EN) 149:2001 established three categories for respirators. This classification was also based on their filtering capacity. These respirators are called filtering facepiece parts (FFP) and are divided into FFP1, FFP2, and FFP3. 

In addition, the U.S. federal agency, the National Institute for Occupational Safety and Health (NIOSH), established nine classifications for respirators by their filtering capacity and effectiveness level. The classification is based on groups N, R, and P. As an example of the first group, we can talk about N95 respirators, which are considered the U.S. standard according to the NIOSH. On the other hand, there is a group of respirators of Chinese origin, the KN95. Some authors refer to this group of respirators as having the same characteristics as the N group of the NIOSH.

**Types and Characteristics**

The diameter of the particles of the COVID-19 virus ranges from 250 to 500 nm, and these values are extremely important in determining which respirators or masks are the most appropriate and effective for use in the hospital environment, dental practice, and for the general population. For this purpose, the characteristics and filtering capacities of some of these are presented in Table 1.

Among the masks presented in the market, the filtration efficiency of the F, N, and KN types is achieved by the combination of a polypropylene network and electrostatic charge produced by the aerosols generated.

**Masks or respirators in the COVID-19 context?**

In the current context of the COVID-19 pandemic, healthcare workers are even more exposed to cross-infection. Hence, the importance of responsible use of personal protective equipment (PPE), which includes both facemasks and respirators, is paramount, and it is important to differentiate between the two. The design of respirators is bidirectional; that is, it is based on preventing the user from inhaling the small particles dissipated in the air and at the same time from emitting contaminating fluids; in addition, they must comply with filtration provisions and must also firmly seal the user’s face. Medical masks, also called surgical masks, are unidirectional and are intended to prevent transmission from the user to the patient. They do not present a correct seal and do not reliably prevent inhalation of particles; however, they prevent contact with droplets and hands with the face. It should be noted that whether they are respirators or surgical masks, both are disposable protective equipment.

**Biosafety protocols described in dentistry**

Aerosol-generating medical procedures pose a challenge in dentistry because of the large number of aerosols they generate in clinical practice. In addition, the dentist’s work area involves direct contact with saliva, blood, and the tongue, in which are...
clinical care is essential even during a pandemic, been implemented. Therefore, the use of face shields, protective eyewear, and PPE, which are crucial for the development of dental clinical practice. Despite the health emergency in China, the demand for emergency dental treatment was reduced by only 38%, This provides evidence that emergency dental care is essential even during a pandemic, and dentists should ensure compliance with strict biosafety protocols in each work environment. These protocols include the use of disinfectants, sterilizers, and PPE, which are crucial for the development of dental clinical practice.

Previously, the PPE used during clinical care were gloves, masks, and aprons. However, with the emergence of SARS-CoV-2 and the knowledge of its spread through the air, the World Health Organization recommended implementing more PPE to reduce cross-infection between patients and health care workers Therefore, the use of face shields, protective eyewear, aprons or hooded overalls, and disposable boots have been implemented.

It should be noted that Umer et al. established a special emphasis on the placement of each PPE. They pointed out that carrying out a determined sequence of placing the protective equipment guarantees the maintenance and control of biosafety. These are focused on ensuring adequate protection of the nose and mouth by covering the entrance of the airways of medical personnel. There is a debate over which one would be the most recommended for use. Therefore, it is important to conduct a review that compares the protective effectiveness of surgical masks, N and FFR respirators, among others.

**DISCUSSION**

For this virus (SARS-CoV-2), several methods of transmission have been studied, including aerosols, surface contamination, and fecal routes. Aerosol transmission has a spread of more than 1 m. This finding suggests that SARS-CoV-2 is an opportunistic infection that is transmitted through the air. Something similar occurs with the infectious virions of this virus that have not been isolated, but it has been possible to discover viral RNA in the air from areas in hospitals to which COVID-19 patients have been admitted. In addition, the deposition of aerosols with viral loads could contaminate objects through fomites, and thus lead to human transmission. Finally, there is also fecal–oral transmission, which is a human transmission route still under study despite the existence of RNA-loaded aerosols found near toilets, in addition to the SARS-CoV-2 RNA detected in rectal swabs during the COVID-19 pandemic in China.

In summary, Harrison et al. pointed out that droplet dispersal above 5 µm is the most relevant mode of transmission. Transmission by direct contact takes <1 s from person to person, especially in households where members are in constant interaction. On the other hand, cases of airborne and fecal–oral transmission from person to person have not yet been reported. The symbol of the virus in the patient indicates the places where the presence of RNA/infectious virus has been confirmed.

How to use them, placement and removal, adjustment and adherence as for the mode of use, it must be done with responsibility and care, since the prevention and reduction of the risk of infection will depend on it. For placement, first take the bands with both hands and place them just halfway behind the head and at the neck level, then adjust the band to the bridge of the nose and seal the chin and face contour. Finally, ensure that there is an adequate seal to the face to prevent any microorganism from leaking from the outside and/or escaping from the body. After the application, hand washing with soap should be performed for at least 20 s.

Once the respirator is in place, it should not be handled at any time, because when in contact with people we should sense that it has already been contaminated. To remove the respirator, avoid handling the front of the respirator because it is contaminated; to do this,
hold the elastic bands and remove them in an upward direction to avoid touching the front. Then, the mask should be discarded in the trash can; finally, hands should be washed with soap for at least 20 s.[3,43]

How effective are tissue masks in absorbing particles that cause respiratory infections? As a result of the pandemic, the use of respirators or face masks by health care workers and the general public has been mandated to prevent airborne transmission of SARS-CoV-2 by inhaling contaminated aerosols or droplets of the virus.[44] Previous studies on fiber spacing demonstrated that fabric masks had large holes; hence, it would be possible to transpose more than 680 million droplets (5.75 µm),[30] and that if fabric masks were multilayered, they could offer greater protection against nanometric-sized aerosols.[45] To date, the FFP2 respirator and surgical mask continue to provide greater blockage to SARS-CoV-2 particles due to the interposition of the different layers they present.[30] Silk, like an FFP2 respirator, has properties that may provide a protective barrier against respiratory infection particles such as SARS-CoV-2, but its effectiveness for the respective function remains to be evaluated.[46] Dentists are the health professionals most at risk for exposure to respiratory infections, and a fabric mask would not provide the necessary protection in a clinical setting.[45,47]

The high demand for face masks to prevent SARS-CoV-2 infection has led to a shortage of this product.[48] For this reason, studies have been conducted using ultraviolet germicidal irradiation (UVGI) in N95 and SN95 surgical masks. The application of a UVGI cycle did not affect the performance of the masks with respect to aerosol penetration and airflow filtration, but it was able to decontaminate the surfaces of the masks that had been exposed to the virus in a laboratory. However, the assessments were conducted in a laboratory setting and do not represent real-world conditions, as multiple mask removal and placement reduces the ability to fit the mask.[49] Another promising method is hydrogen peroxide (H₂O₂) vapor decontamination, which has been shown to maintain aerosol filtration efficiency and airflow in N95 masks.[50]

On the contrary, the filtration efficiency of aerosols from gauze masks decreased with wet heat decontamination (autoclave), in dry heat at 160°, and isopropyl alcohol at 70–75%, being more significant the filtration efficiency decreased when using the chemical agent sodium hypochlorite (bleach).[3,38,48] Previous studies have shown that face mask exposure to radiation doses (10–30 kGy) degrades the performance of standard N95 respirator.[50,51] It should be noted that surgical masks should not be worn for more than 8 h according to provider recommendations.[3,32,53]

Several authors have reported that the pressure and force exerted by mask elastics is likely to be a cause of headaches and stress in the current pandemic situation manifested by healthcare workers.[41]

There is rapid adaptation of new biosafety protocols and implementation in dental clinical practice due to the continuity of work and closeness to the patient. It is noted that the percentage of emergency dental treatment has been maintained.[8] Despite this, Uguru et al. pointed out that the public sector does not have the necessary economic resources or sufficient political guidelines for the acquisition of PPE.[54] This information probably coincides with the reality that is emerging in Peru; however, there are few studies on this, and research on the subject is suggested.

The use of appropriate respirators that guarantee the highest percentage of protection is indispensable; therefore, the use of FFP3, N100, and KN95 is suggested in different parts of the world. On the other hand, a review by Arellano et al. recommends that N95, FFP2, FFP3, and KN95 respirators should be used in the dental office because of their filtration capacity and protection against aerosols.[3,36,38] It should be noted that these types of respirators are more widely available in the South American and Peruvian markets. In addition, surgical masks and those made from fabrics have low filtration and protection efficiency due to the lack of an airtight seal around the face.[41]

The cost of respirators during this COVID-19 pandemic has risen considerably, with their acquisition and scarcity being a disadvantage. Consequently, methods have been developed that have proven effective in maintaining necessary protection through the reuse of respirators. This is based on their sterilization by minimizing their deterioration, ensuring the prolongation of their useful life, and preventing the transmission of the virus. Therefore, the use of exposure to UVGI, ethylene oxide, and vaporized hydrogen peroxide is proposed, which requires further studies to assess their effectiveness in a clinical environment.[3,38,40,48,49]

Recent studies indicate that the copper surface has an effective capacity for inactivation of SARS-Cov-2 virus in a short period of time. Warnes et al. also established the same conclusions because in their study in the year 2015, they indicated that a higher percentage of copper increased the inhibition of CoV-229E. It should be noted that the inactivation of the coronavirus is due to the release of copper ions and generation of reactive oxygen species.[55] Therefore, it is suggested to evaluate...
the possibility of using nanoparticles based on copper or copper salt for the preparation of EPP. This would help prevent and limit the spread of the virus.

Although the respirators are designed for a determined number of times of use and with a duration of 8 continuous hours at most, this varies according to the direct contact and direct exposure to aerosols in consultation with COVID-19 patients. In such cases, their reuse can be allowed, thus saving economic resources. This has an impact on the recommendation for use of a face shield and a second mask, which will be discarded immediately after the consultation. This reduces the risk of contamination and preserves the main respiratory mask.

As a result of the pandemic, dental care, like hospital care, requires prolonged use of respirators, involving more than 4h of work without rest. This has led to the presentation of adverse manifestations such as headaches, overheating, lack of concentration, pressure areas, extreme exhaustion, and even fainting. Therefore, it is suggested that the necessary management should have more human resources in health facilities, and thus reduce the time of use of the respirator. On the other hand, to manage cross-contamination, it is important to have knowledge of the sanitary strategies to counteract the SARS-CoV-2 infection. It is essential that the dental staff be up to date to protect the oral health of these patients.

Research is suggested on the management of biosafety protocols in rural areas of Peru. Due to the country's socioeconomic condition and the precarious health system in the regions, we can extrapolate that access to materials in these areas is very scarce. On the other hand, we state that there is little information about the appearance of respirators in a given historical context.

**Conclusions**

With the passage of time and the emergence of new pathogens, humans have implemented continuous improvement of respirators to avoid cross-infection during clinical care. In the current context of the SARS-CoV-2 pandemic, respirators with filtration characteristics greater than 95%, such as FFP3, N100, N95, and KN95, are indicated for use in the dental setting. This has generated a greater demand for their use; therefore, their cost has risen. From this, several authors recommend the decontamination process and that it be evaluated in in vivo studies to confirm its use for the benefit of society.

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The authors declare that this review was carried out with our own resources.

**Conflicts of Interest**

The authors declare that they have no conflicts of interest.

**Author Contributions**

AR, DO, GL, BT, RW, DAT, and FMT: conception. FMT and RW: design of the manuscript, review for relevant intellectual content, writing-review and editing, and final approval of the version to be published. AR, DO, BR, and FMT: writing original draft.

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**References**

1. Long Y, Hu T, Liu L, Chen R, Guo Q, Yang L, et al. Effectiveness of N95 respirators versus surgical masks against influenza: A systematic review and meta-analysis. J Evid Based Med 2020;13:93-101.

2. Zhang M, Emery AR, Tannyhill RJ 3rd, Zheng H, Wang J. Masks or N95 respirators during COVID-19 Pandemic—Which one should I wear? J Oral Maxillofac Surg 2020;78:2114-27.

3. Arellano-Cotrina JJ, Marengo-Corcel N, Atoche-Socola KJ, Peña-Soto C, Arriola-Guillen LE. Effectiveness and recommendations for the use of dental masks in the prevention of COVID-19: A literature review. Disaster Med Public Health Prep 2020;14:1-6.

4. Barbosa F, Bastos R, Weber C, Neves G. Graphic simulation of SARS-CoV-2 droplets: Why respirators should be used in dental healthcare settings? J Clin Diag Res 2020;14:31-5.

5. Barbato L, Bernardelli F, Braga G, Clementini M, Di Gioia C, Littarru C, et al. Surface disinfection and protective masks for SARS-CoV-2 and other respiratory viruses: A review by SIdP COVID-19 task force. Oral Dis 2020. doi: 10.1111/odi.13646.

6. Harrison AG, Lin T, Wang P. Mechanisms of SARS-CoV-2 transmission and pathogenesis. Trend Immunol 2020;41:1100-15.

7. Radonovich LJ Jr, Simberkoff MS, Bessesen MT, Brown AC, Cummings DAT, Gaydos CA, et al.; ResPECT investigators. N95 respirators vs medical masks for preventing influenza among health care personnel: A randomized clinical trial. Jama 2019;322:824-33.

8. To KK, Tsang OT, Yip CC, Chan KH, Wu TC, Chan JM, et al. Consistent detection of 2019 novel coronavirus in saliva. Clin Infect Dis 2020;71:841-3.

9. Persoon IF, Stankiewicz N, Smith A, de Soet JJ, Volgenant CMC. A review of respiratory protection measures recommended in europe for dental procedures during the COVID-19 pandemic. J Hosp Infect 2020;106:330-1.
10. Guo H, Zhou Y, Liu X, Tan J. The impact of the COVID-19 epidemic on the utilization of emergency dental services. J Dent Sci 2020;15:564-7.

11. Alharbi A, Alharbi S, Alqaidi S. Guidelines for dental care provision during the COVID-19 pandemic. Saudi Dent J 2020;32:181-6.

12. Villani FA, Aiuto R, Paglia L, Re D. COVID-19 and dentistry: Prevention in dental practice, a literature review. Int J Environ Res Public Health 2020;17:2-12.

13. World Health Organization. Rational use of personal protective equipment for coronavirus disease (COVID-19) and considerations during severe shortages. Interim guidance. Geneva: WHO; 2002 [Internet] [Accessed [on 27 Nov 2020].

14. Odeh N, Babkair H, Abu-Hammad S, Borzangy S, Abu-Hammad A, Abu-Hammad O. COVID-19: Present and future challenges for dental practice. Int J Environ Res Public Health 2020;17:1-10.

15. Umer F, Haji Z, Zafar K. Role of respirators in controlling the spread of novel coronavirus (COVID-19) amongst dental healthcare providers: A review. Int Endod J 2020;53:1062-7.

16. Matuschek C, Moll F, Fangerau H, Fischer JC, Zänker K, van Griensven m, et al. The history and value of face masks. Eur J Med Res 2020;25:23.

17. Byrne J. Daily Life during the Black Death. Westport: Greenwood Press; 2006 [Internet] [Accessed on 22 Nov 2020].

18. Ruisinger M. Die Pestarztmaske im Deutschen Krankenhaushygiene und Infektionsprävention (KRINKO) beim Robert Koch-Institut. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz. 2018;61:448-73.

19. Schlich T. Asepsis and bacteriology: A realignment of surgery and laboratory science. Med Hist 2012;56:308-34.

20. Flügge C. Über Luft infektion. ZtschrHyg Infektkrkh 1897;25:179-224.

21. Nakayama K. Surgical masks during the influenza pandemic of 1918–1920. Am Surg 2020;86:557-9.

22. Mikulicz J. Das Operieren in steriliserten Zwirnhandschuren und mit Mundbinde. Zentralbl Chir 1897;25:179-7.

23. Hübnner W. Über die Möglichkeit der Wundinfektion vom Munde aus und ihre Verhütung durch Operationsmasken. Ztschr f Hyg 1898;28:348.

24. Piccinelli V. Contributo alla studio della fora bacteria nell’ambiente e nel campo operatorio. Riv Osped 1910;3:297-304.

25. Kirschner M, Schuster M. Die Bekämpfung der Infektion. Allgemeine und Spezielle Chirurgische. 1st ed. Berlin: Springer; 1927.

26. Sonntag E. Grundriß der gesamten Chirurgie Allgemeine Chirurgie I. Abschnitt Aseptik. Berlin: Springer; 1937.

27. Prävention postoperativer Wundinfektionen : Empfehlung der Kommission für Krankenhaushygiene und Infektionsprävention (KRINKO) beim Robert Koch-Institut. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz. 2018;61:448-73.

28. Hirschmann M, Hart A, Henkel J, Sadoghi P, Seil R, Mouton C. COVID-19 coronavirus: Recommended personal protective equipment for the orthopaedic and trauma surgeon. Knee Surg Sport Traumatol Arthroscopy 2020;28:1690-8.

29. Liao M, Liu H, Wang X, Hu X, Huang Y, Liu X, et al. A technical review of face mask wearing in preventing respiratory COVID-19 transmission. Curr Opin Colloid Interface Sci 2021;52:101417.

30. Zangmeister CD, Radney JG, Vicenzi EP, Weaver JL. Filtration efficiencies of nanoscale aerosol by cloth mask materials used to slow the spread of SARS-cov-2. ACS Nano 2020;14:9188-200.

31. He X, Reponen T, McKay RT, Grinshpun SA. Effect of particle size on the performance of an N95 filtering facepiece respirator and a surgical mask at various breathing conditions. Aerosol Sci Technol 2013;47:1180-7.

32. ADA. Extending the use of N95 masks. Available from: https://www.massdental.org/Member-Resources/Practice-Management/Coronavirus/Extending-the-Use-of-N95-Respirators. [Accessed 2 Mar 2021].

33. Liao L, Xiao W, Zhao M, Yu X, Wang H, Wang Q, et al. Can N95 respirators be reused after disinfection? How many times? ACS Nano 2020;14:6348-56.

34. Sigua-Rodriguez EA, Bernal-Pérez JL, Lanata-Flores AG, Sánchez-Romero C, Rodrigoz-Chessa J, Haidar ZS, et al. COVID-19 and dentistry: A review of recommendations and perspectives for Latin America. Int J Odontostomatol 2020;14:299-309.

35. Lepelletier D, Grandbastien B, Romano-Bertrand S, Aho S, Chidicai C, Geghano JF, et al.; French Society for Hospital Hygiene and the High Council for Public Health. What face mask for what use in the context of COVID-19 pandemic? The French guidelines J Hosp Infect 2020;105:414-8.

36. Azap A, Erdinç FS. Medical mask or N95 respirator: When and how to use? Turk J Med Sci 2020;50:633-7.

37. 3M Respirator selection guide. Available from: https://multimedia.3m.com/mws/media/6391100/3m-respirator-selection-guide.pdf [Accessed 2 Mar 2021].

38. Boškoski I, Gallo C, Wallace MB, Costamagna G. COVID-19 pandemic and personal protective equipment shortage: Protective efficacy comparing masks and scientific methods for respirator reuse. Gastrointest Endosc 2020;92:519-23.

39. Howard BE. High-risk aerosol-generating procedures in COVID-19: Respiratory protective equipment consideration. Otolaryngol Head Neck Surg 2020;163:98-103.

40. Bradford Smith P, Agostini G, Mitchell JC. A scoping review of surgical masks and N95 filtering facepiece respirators: Learning from the past to guide the future of dentistry. Saf Sci 2020;131:104920.

41. Farronato M, Boccalari E, Rosso E, Lanteri V, Mulder R, Maspero C. A scoping review of respirator literature and a survey among dental professionals. Int J Environ Res Public Health 2020;17:5968.

42. Ministerio de Salud. Especificación técnica para la confección de RPE. Available from: https://cdn.www.gob.pe/uploads/document/file/572315/RM_135-2020-MINSA.PDF. [Accessed on 10 Nov 2020].

43. Ather A, Patel B, Ruparel NB, Diogenes A, Hargreaves KM. Can respirators be reused after disinfection? How many times? 3M Respirator. [Accessed 2 Mar 2021].

44. Bradford Smith P, Agostini G, Mitchell JC. A scoping review of surgical masks and N95 filtering facepiece respirators: Learning from the past to guide the future of dentistry. Saf Sci 2020;131:104920.

45. Farronato M, Boccalari E, Rosso E, Lanteri V, Mulder R, Maspero C. A scoping review of respirator literature and a survey among dental professionals. Int J Environ Res Public Health 2020;17:5968.

46. Ministry of Health. Specification of the medical mask or N95 respirator: When and how to use? Turk J Med Sci 2020;50:633-7.

47. 3M Respirator selection guide. Available from: https://multimedia.3m.com/mws/media/6391100/3m-respirator-selection-guide.pdf [Accessed 2 Mar 2021].

48. Boškoski I, Gallo C, Wallace MB, Costamagna G. COVID-19 pandemic and personal protective equipment shortage: Protective efficacy comparing masks and scientific methods for respirator reuse. Gastrointest Endosc 2020;92:518-36.

49. Howard BE. High-risk aerosol-generating procedures in COVID-19: Respiratory protective equipment consideration. Otolaryngol Head Neck Surg 2020;163:98-103.

50. Bradford Smith P, Agostini G, Mitchell JC. A scoping review of surgical masks and N95 filtering facepiece respirators: Learning from the past to guide the future of dentistry. Saf Sci 2020;131:104920.

51. Farronato M, Boccalari E, Rosso E, Lanteri V, Mulder R, Maspero C. A scoping review of respirator literature and a survey among dental professionals. Int J Environ Res Public Health 2020;17:5968.

52. Farronato M, Boccalari E, Rosso E, Lanteri V, Mulder R, Maspero C. A scoping review of respirator literature and a survey among dental professionals. Int J Environ Res Public Health 2020;17:5968.
the reuse of surgical mask personal protective equipment: A systematic review. J Hosp Infect 2020;106:283-94.
49. O’Hearn K, Gertsman S, Sampson M, Webster R, Tsampalieros A, Ng R, et al. Decontaminating N95 and SN95 masks with ultraviolet germicidal irradiation does not impair mask efficacy and safety. J Hosp Infect 2020;106:163-75.
50. Lin TH, Tseng CC, Hunag YL, Lin HC, Lai CY, Lee SA. Effectiveness of N95 facepiece respirators in filtering aerosol following storage and sterilization. Aerosol Air Qual Res 2020;20:833-43.
51. Sachin W, Manish J, Navin K, Balvinder K, Arshad K, Pradeep K, et al. Particle removal from air by face masks made from sterilization wraps: Effectiveness and reusability. Edited por Amitava Mukherjee. PLoS One 2020;15:e0240398.
52. Vidua RK, Chouksey VK, Bhargava DC, Kumar J. Problems arising from PPE when worn for long periods. Med Leg J 2020;88:47-9.
53. Tabah A, Ramanan M, Laupland KB, Buetti N, Cortegiani A, Mellinghoff J, et al.; PPE-SAFE contributors. Personal protective equipment and intensive care unit healthcare worker safety in the COVID-19 era (PPE-SAFE): An international survey. J Crit Care 2020;59:70-5.
54. Uguru N, Onwujekwe O, Ogu UU, Uguru C. Access to oral health care: A focus on dental caries treatment provision in Enugu Nigeria. BMC Oral Health 2020;20:145.
55. Warnes SL, Little ZR, Keevil CW. Human coronavirus 229E remains infectious on common touch surface materials. Mbio 2015;6:e01697-15.
56. Mayta-Tovalino F, Diaz-Soriano A, Munive-Degregori A, Perez-Vargas F, Luza S, Bocanegra R, et al. Proposal for a provisional protocol for the care and identification of dental transmission routes of COVID-19 in Latin America: A literature review. J Clin Exp Dent 2020;12:e979-90.
57. Beesoon S, Behary N, Perwuelz A. Universal masking during COVID-19 pandemic: Can textile engineering help public health? Narrative review of the evidence. Prev Med 2020;139:106236.
58. Cotrin P, Bahls AC, da Silva DO, Girão VMP, Pinzan-Vercelino CRM, de Oliveira RCG, et al. The use of facemasks during the COVID-19 pandemic by the brazilian population. J Multidiscip Healthc 2020;13:1169-78.