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Review Article

Role of Respirators in Controlling Novel Covid-19 - A Review Article

Subramanian Ajithkumar, MDS1 | Chakravarthy Dhanavel MDS[2,*] | Kavimalar Sitharthan[3] | Srinivasan Madhumita[4] | S. Vijayaraja[5]

[1]Post graduate, Department of Conservative Dentistry and Endodontics, Sri Balaji Vidyapeeth, Puducherry, India
[2] Professor and HOD, Department of Conservative Dentistry and Endodontics, Sri Balaji Vidyapeeth, Puducherry, India
[3]Post graduate, Department of Conservative Dentistry and Endodontics, Sri Balaji Vidyapeeth, Puducherry, India
[4]Post graduate, Department of Conservative Dentistry and Endodontics, Sri Balaji Vidyapeeth, Puducherry, India
[5]Senior lecturer, Department of Conservative Dentistry and Endodontics, Sri Balaji Vidyapeeth, Puducherry, India
[*]Corresponding Author:
Dr. Dhanavel Chakravarthy
E-mail address:
ajithfury7@gmail.com

Abstract:

During this pandemic situation of COVID-19 outbreak throughout the world, the respirator has become a basic need for people in day-to-day life. Spread of virus can be minimized by social distancing. As health care professionals are front line servers in this pandemic situation, the social distancing is not possible. To prevent spread among health professionals PPE, Universal precautions are essential. Since COVID-19 has positive affinity towards respiratory system, respirators have become front-line barrier against the disease. Different respirators are available in the market, few only prevents spread of virus. One among them is surgical mask, Filtering facepiece respirators (FFRs), Powered Air-purifying respirators (PAPRs). Protection factor of N95 (FFRs) is thirty times greater than normal surgical masks. N95 prefix N is a description of the filter material (N oil nonresistant) Suffix 95 describes its filtering efficiency (95 would filter 95% particles). This article enlightens availability different respirators and its shapes, types of respirators, Fit test of respirators and donning and doffing of PPE, reuse and decontamination of respirators.

Keywords: COVID-19**,** Pandemic, Respirators.

Introduction:

With the emerging outbreak of COVID-19 pandemic, healthcare professionals are in facade situation and also helping in managing the highly infectious corona virus. [1] Virus outbreak was first reported in Wuhan, China in December 2019 [2]. COVID-19 spreads through three direct and one indirect way. The three possible ways of transmission are:(i) By infectious droplets expulsed by coughing or sneezing into environment that contacts mouth, nose, eyes of recipient individual, (ii) By aerosols, (iii) By direct contact (e.g., by

kissing, touching hands or other parts of a body). The fourth, indirect transmission way is by contact with fomites contaminated surfaces. However, fomites are likely rare sources of transmission [1]

So, it is critical for healthcare workers to wear the personal protective equipment (PPE) including gowns, masks and goggles [2]. Occupational Safety and Health Administration (OSHA) within the Department of Labor, USA, has proposed occupational risk pyramid which defines the risk of healthcare providers based on exposure, Health care workers belong to the group of very high risk [2]. So, this paper review on advantages of the respirators, different types and shape of respirator, with fit test and donning and doffing techniques.

WHY RESPIRATOR REQUIRED DENTAL HEALTH CARE PROVIDERS?

The SARS (Severe Acute Respiratory Syndrome) CoV- 2 virus has an fondness for the angiotensin-converting enzyme 2 (ACE-2) receptor, which is abundantly present in the respiratory tract and salivary gland duct epithelium and therefore saliva has more affinity to have more viral load [2]. With the available data, the most common way of transmission of virus for dental health care providers is through droplets during face to face contact during dental procedure. Aerosols in dentistry has a particle of size less than 50 μm was first introduced by Micik and colleagues, and there were able to last in environment for longer period of time before eventually settling in the environment. The particle size of 0.5–10 μm is of distinct importance as they are most likely to transmit infection [2]. Numerous ACE2-positive cells were detected along the respiratory tract and in the lamina propria, as well as the cells of salivary gland duct epithelium [3]. So, there are numerous validated studies and evidence are available to prove that SARS spreads through aerosol transmission. Since COVID-19 is also similar to SARS there are more likewise chances of aerosol transmission.

WHY RESPIRATORS?? WHY NOT SURGICAL MASK??

Wen et al conducted a study in 2013 to check the variation in viral aerosol contamination load between surgical mask and different respirator and there confined that protection factor of N95 respirator is thirty times greater than normal surgical mask [4]. (Fig 1)

A recent systematic review and Metanalysis failed to provide data on the superiority of N95 respirator over surgical mask, the author claims that there were conflicting results and high risk of bias in the randomized control trail, also low compliance of wearing N95 respirator and frequent doffing as respirator was uncomfortable to wear for a long period of time [5]

To abridge, the use of respirator would be logical for dental health care provider during the virulent COVID-19 situation rather than normal surgical mask since respirator offer more resistance to fluid penetration and forms a seal around the mouth and nose in contrast to surgical mask only protects the penetration against droplets including large respiratory particles. As well the American Dental Association recommends 14 days of isolation for both Patients and Dental Health care provider if there were exposed to any aerosol generating procedure performed with surgical mask. (fig: 1)

DIFFERENT TYPES OF RESPIRATOR?

There are two major range of respirator which includes full and half mask. In this most commonly used respirator by the healthcare providers are half mask with (i) Filtering facepiece respirators (FFRs) (ii) Powered Air purifying respirators (PAPRs) [2].

(i) Filtering facepiece respirators (FFRs) (Fig 2)

FFRs are the N95 respirator, the most widely used respirator which as disposable filtering facepiece respirator that provide tight fit and optimum face seal with 95% and more filtering capacity.

The prefix N is a description of the filter material

i) N = Oil Non Resistant
ii) R = Some Resistance to Oil
iii) P = Oil Proof

Suffix 95 describes its filtering efficiancy (95 would filter 95% particles whilst 99 filters 99% particles) [2].

Other equivalent N95 FFRs are:

i) FFP2 (Europe EN 149-2001) (fig: 3)

ii) KN95 (China GB2626-2006) (fig: 4)

iii) P2 Particulate respirator (1716:2012; 3M TM Australia/ New Zealand) (fig: 5)

iv) Korea 1st class (Korea KMOEL-2017-64)

v) DS (Japan JMHLW-Notification 214, 2018)(2)

(ii)Powered Air Purifying Respirators (PAPRs) (fig 6)

PAPRs are positive pressure devices are generally considered more protective and vigilant compared to FFR, as the efficiency of their filters is >99.97% for particles both larger and smaller than 0.3 μm. PAPRs use motor to draw air through a filter into the facepiece to maintain positive pressure inside and thereby minimizing inward leakage. PAPRs

are easier to wear for longer duration of time due to the positive airflow which decreases CO2 content, warmth and moisture inside the facepiece. Despite these significant features, there has been limited adoption of PAPRs [2,6].

DIFFERENT SHAPES OF RESPIRATORS:

i) Cupshaped 1860 (3MTM, St. Paul, MN, United States) (fig: 7)

ii) Flatfold 1870 (3MTM) (fig: 8)

iii) Duckbill PFR95-270 (Kimberly Clark Corp., Dallas, TX, United States).(2) (fig: 9)

These variations allow for better fit and comfort for different face types. Some masks have exhalation valves that tend to keep the face cooler and prevent moisture build-up. The masks with an exhalation valve should not be used when working under sterile conditions

HOW TO EVALUATE FIT TEST FOR RESPIRATORS:

Fit testing is recommended for each type of respirators for healthcare providers, the selection of the most suitable model should be tested by experienced fit tester who would evaluate the best fit based on following criteria facial dimensions, ethnicity and appearance of fit [2]. The advantage of N95 mask will be neglected if the mouth and nose is not appropriate. So, the process of fit testing is most important and it as to done periodically. There are two types of fit test available,

(i)Qualitative test

(ii) Quantitative tests.

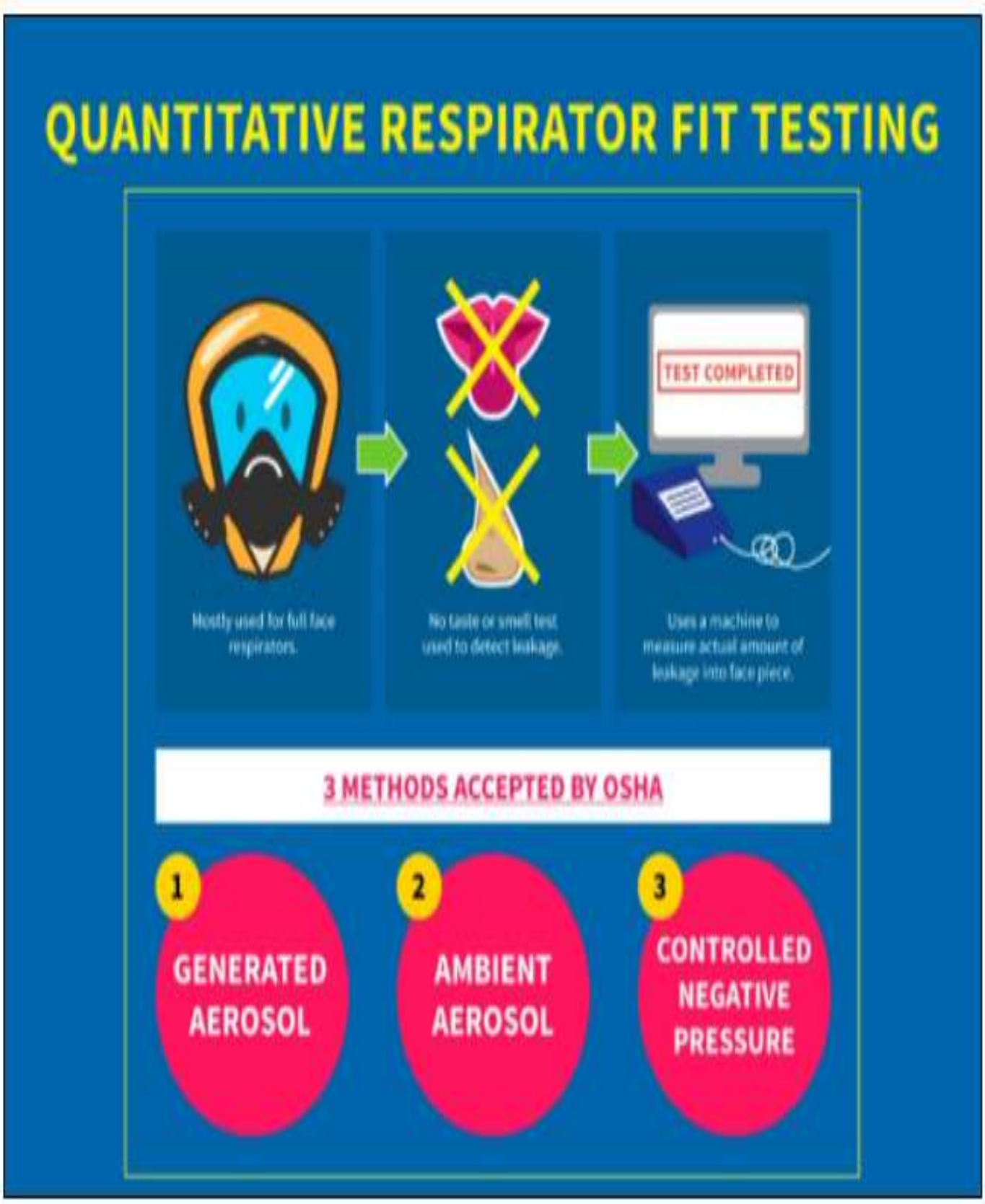
In qualitative test, if test subject does not detect the sweet or bitter taste of saccharin or Bitrex (a solution containing 95% water, 5% sodium chloride and < 0.1% denatonium benzoate) [2]. (fig: 10)

In quantitative fit test is done by using ambient aerosols to numerically estimate (fig: 11)

$$\text{Quantitative test} = \frac{\text{Aerosol particle ratio outside (Co}}{\text{Aerosol particle ratio inside (Ci)}}$$

FFR more likely to pass the QNFT (Quantitative Fit Test) is flat fold type respirator (ie, 3M 1870+), which is due to its flexible design [7].

DONNING AND DOFFING OF FFR: (fig: 12,13)



Donning and Doffing-According to the Fair Labor Standards Act (FLSA), which was established in 1938 to establish workers' rights, the term "**donning** and **doffing**" is used to refer to the practice of putting on (**donning**) and taking off (**doffing**) protective gear, clothing and uniforms [8]. Proper donning and doffing of procedure is key to use PPE and in the same way all the precaution as to be taken while wearing and removal of respirator. fig: 12

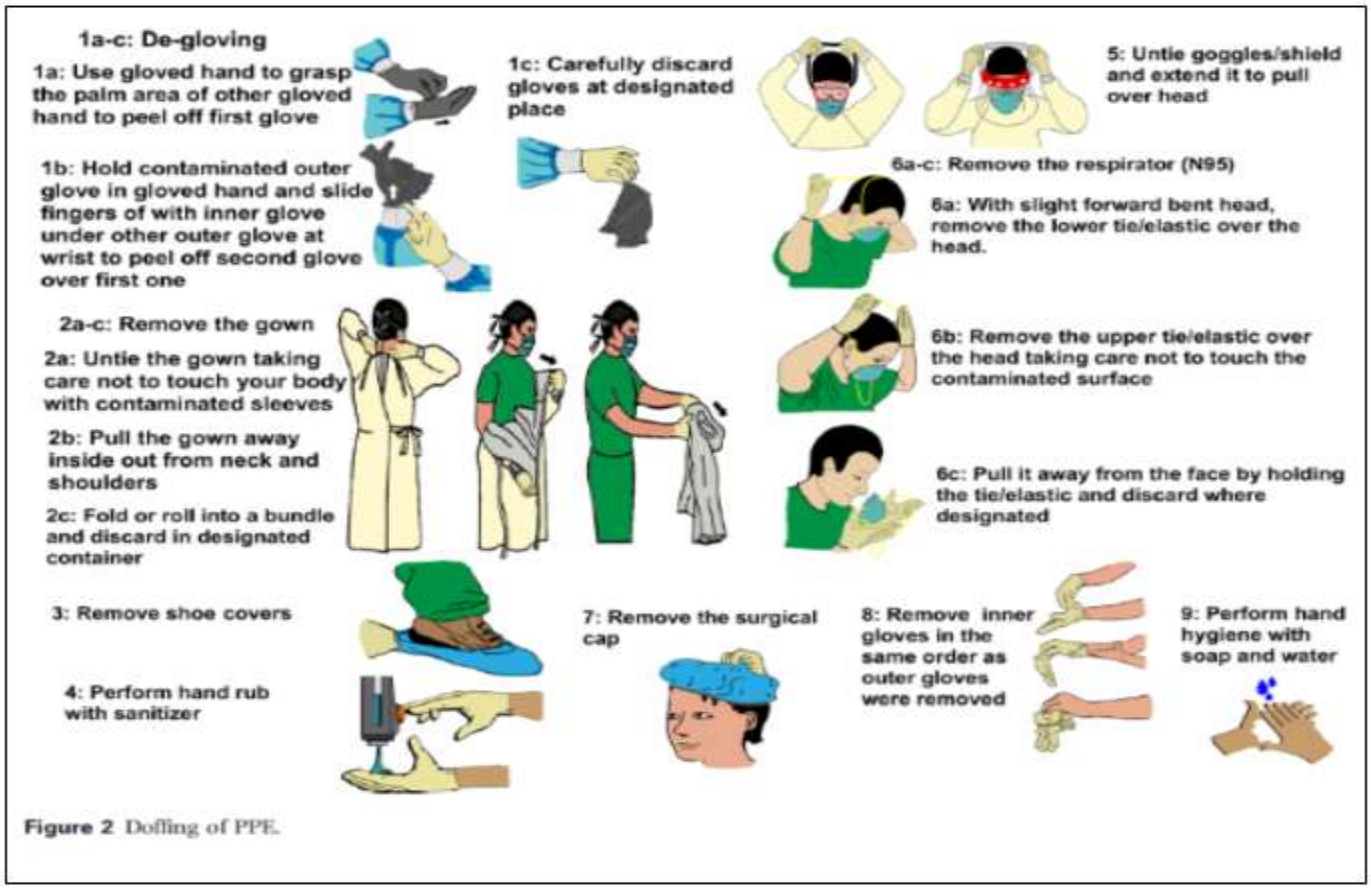


Figure 2 Doffing of PPE.

fig 13

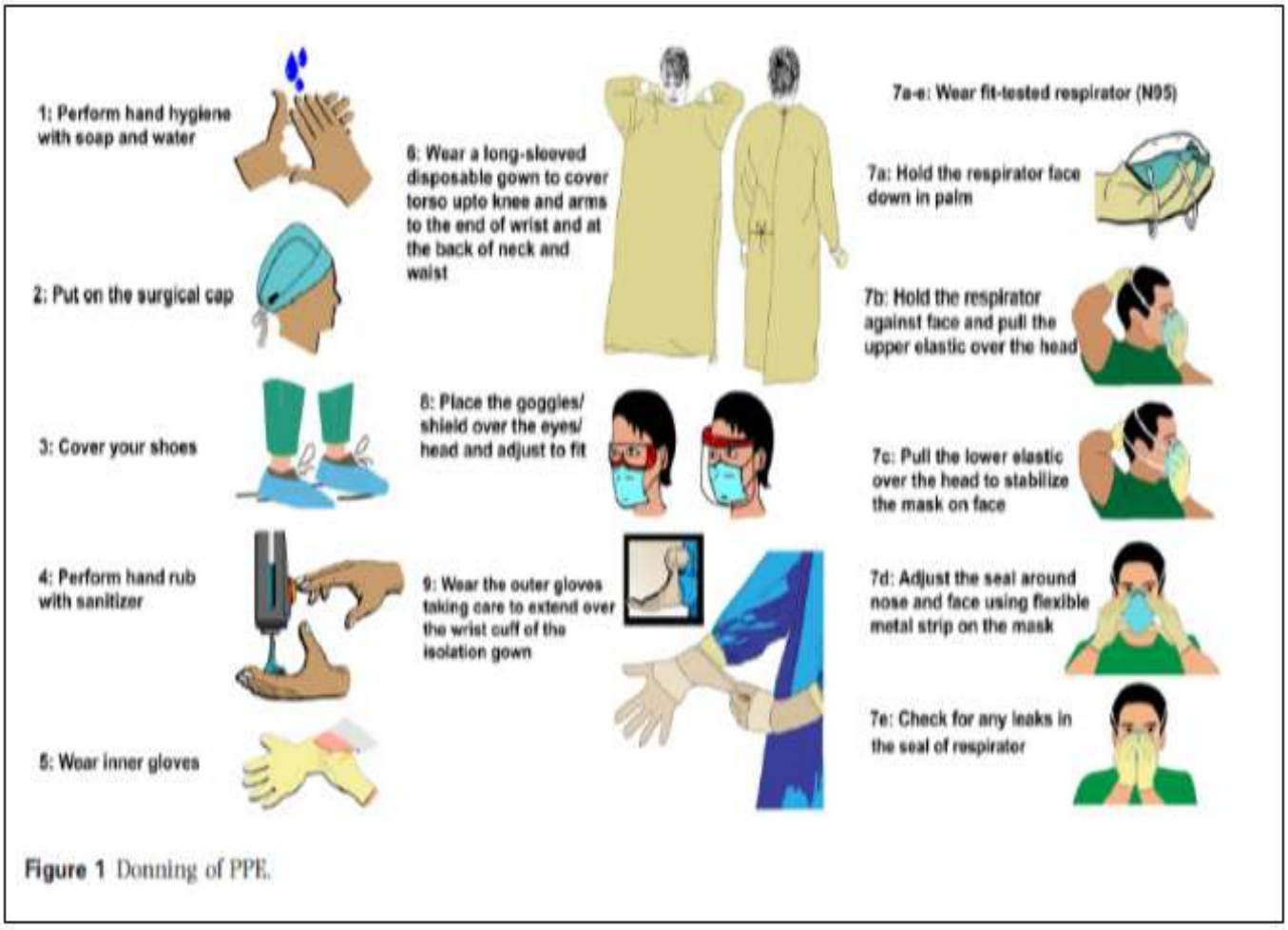


Figure 1 Donning of PPE.

Reuse and Decontamination of FFR:
Usually respirators are not reused again, but during pandemic situation the availability of respirators is decreased. The reuse of respirators is done by Ultraviolet germicidal irradiation (UVGI), vaporous hydrogen peroxide (VHP) and moist heat are ideal decontamination procedures. However, the COVID-19 endure up to 72 hours over surfaces, the chance for contamination during donning and doffing of respirators is high. And also, there is no literature support about reuse of respirators against COVID-19 [2, 9].

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