



Types of Face Mask and Control of Respiratory Pathogen COVID19 – A Brief Review

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Abstract

Since the outbreak of Coronavirus Disease 2019 (COVID-19), the use of face masks has become common everywhere. All over the world, health authorities have enforced compulsory use of face mask policies in public places; however, World Health Organization (WHO) guidelines has adopted a risk-based approach in offering recommendations for using face masks among health-care workers and the public. Since the outbreak of COVID19, there is not enough evidence to prove that wearing a surgical mask significantly reduces a healthy individual's risk of becoming infected while wearing the mask. In this review, we compared different types of face mask which is recommended by different health authorities and its effectiveness. Despite the consistency in the recommendation that clinically symptomatic individual and those in health-care settings should use face masks, discrepancies were observed in the public and in the community settings. An important reason to discourage widespread use of face masks has been to preserve limited supplies for health care professional use in health-care settings. Universal face mask use in the community has also been limited with the argument that face masks provide no effective protection against the pandemic viral infection like COVID19.

Received: May 04, 2020

Accepted: Jul 24, 2020

Published Online: Jul 30, 2020

Journal: Annals of Epidemiology and Public health

Publisher: MedDocs Publishers LLC

Online edition: <http://meddocsonline.org/>

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Keywords: COVID19; Mask; Effectiveness.

Introduction

A pneumonia of unknown origin identified detected Wuhan, China was first reported to the World Health Organization(WHO) Country Office in China on 31 December 2019. A novel virus, previously called the 2019-novel coronavirus (2019-nCoV), is currently named as the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2). COVID19 was announced as a global pandemic by World Health organization on March 11th 2020. The COVID-19 pandemic continues to take a serious toll on families, communities and nations the world over. According to WHO's March 23 update, globally, over 14,000 people have died, and more than 3, 34,000 have been infected by COVID19.

Recent information suggests that the two main routes of transmission of the COVID-19 virus are respiratory droplets and contact with the infected individuals. Usually, respiratory droplets are generated when an infected person coughs or sneezes. Any person who is in close contact (within 1 m) with someone who has respiratory symptoms (coughing, sneezing) is at risk of being exposed to potentially infective respiratory droplets. Droplets may also land on surfaces where the virus could stay viable; thus, the immediate environment of an infected individual can serve as a source of transmission [1]. It is possible that people infected with COVID-19 could transmit the virus in asymptomatic or before symptoms de-



velop also. It is important to recognize that pre-symptomatic transmission requires the virus to be spread via contaminated droplets or through touching contaminated surfaces. Hence, wearing a medical mask is one of the prevention measures that can limit the spread of certain respiratory viral infections, including COVID-19. Studies of influenza, influenza-like illness, and human coronaviruses provide a strong evidence that the use of a medical mask can prevent the spread of infection which spread through droplets from an infected person to someone else or through environment by these droplets [2]. A face mask that is worn without the extra recommended protection will be less effective. Therefore effective training is an essential step of any Personal Protective Equipment program since the correct wearing that is donning and removal or offing are key to worker protection. In particular, care should be taken not to contaminate masks on inanimate surfaces.

Objective: To evaluate the effectiveness of different types of mask in preventing Covid-19 infection – A brief review

Search strategy

The information presented in this review was collected after an extensive search of the Medline database using the key words effectiveness and face mask and Covid 19. Similar search was carried out on Google scholar and official website of CDC.

WHO initiative for prevention

The beginning of the COVID 19 outbreak, the Operations Support and Logistics (OSL) unit at WHO has shipped more than 900,000 surgical masks, 62,000 N95 masks, 1 million gloves, 1,15,000 gowns, 17,000 goggles and 34,000 face shields supplied to 133 countries. But, some countries have recommended the use of both medical and non-medical masks in the general population to prevent the spread of COVID-19 infection.

Among the health care facilities, WHO continues to recommend the use of medical masks, respirators and other personal protective equipment for health care workers? In the community, WHO recommended the use of medical masks by people who are infected and those who are caring for an infected person at home? WHO has given guidance to all health care professionals and general public on how to put on, take off and dispose of masks. In this regard, there is no proper research done and what is clear is that there is only limited research in this area. WHO released updated guidance on masks, including a new decision on advice to decision-makers on mask use by healthy people in communities.

First and foremost, medical masks must be prioritized for health workers on the front lines of the response to prevent them from infection. If masks are worn, they must be used safely and properly work with the infected individuals. WHO has given guidelines to those who have symptoms as follows:

- Health care professional should wear a medical mask, self-isolate, and get medical advice as soon as they start to feel ill. They may have symptoms like fever, fatigue, cough, sore throat, and difficulty breathing. It is important to note that early symptoms for some people infected with COVID-19 may be mild or asymptomatic

- They have given guidance on how to put on, take off, and dispose of medical masks;

- Should follow all necessary preventive measures, in particular, proper hand hygiene and maintaining physical distance from infected or non-infected individuals.

When droplets can contaminate a wide range of surfaces and survive everywhere from 1 to 3 days, we need to properly wash our hands and also we should not to touch our face as much as possible. A face covering is meant to trace droplets when we sneeze or cough so that we can protect others from ourselves by keeping those droplets off of other individuals, surfaces, and our own hands. Habitually, a surgical mask accomplishes this because it has a waterproof outer layer. But unlike an N95 mask, that forms an air-tight seal around the face and that also filters out airborne microbes, a surgical mask allows air to flow freely along to its edges. Hence, a surgical mask is a barrier, not a filter. Many studies have been done to compare standard face masks with respirator masks in the context of influenza or other relatively benign respiratory conditions.

Types of masks

Homemade cloth face masks

If we prevent the spread of the virus from people without symptoms, the Centers for Disease Control and Prevention(3) (CDC) is now advising everyone to wear cloth face masks, such as homemade face masks [4], while in public area where it's difficult to maintain a 6-foot distance from other persons. This recommendation is in addition to social distancing and proper hygiene practices.

A recommendation for the use of cloth mask includes:

- Should wear cloth face masks in public settings, especially in areas of significant community-based transmission, such as departmental stores.
- Don't put cloth face masks on children under the age of 2 yrs, people who have trouble in breathing, people who are unconscious, or people who are not able to remove the mask on their own.
- Should use cloth face masks rather than surgical masks or N95 respirators, as these critical supplies must be reserved for healthcare workers.
- All health care professionals should exercise caution when using homemade face masks. These masks should preferably be used in combination with a face shield that covers the entire front and sides of the face.

How to wear cloth face mask

Cloth face mask should cover

- Fit snugly but comfortably opposite to the side of the face
- Be secured with ties and or ear loops
- Include multiple layers of fabrics
- Allow for breathing without restrictions
- Be able to be laundered and machine dried without damage or change to different shape

The below figure shows how to wear cloth mask

How to use surgical mask?

The standard surgical mask is designed to provide a barrier to droplets impacting on the wearer's nose, mouth and respiratory tract. It fits fairly loosely to the user's face. These single-use masks are used for a variety of procedures in community as well as hospi-

tal settings. It should be worn with your eye protection.

The surgical mask's layers work as follows:

- The outer layer repels blood, water and other body fluids.
- The middle layer filters pathogens.
- The inner layer absorbs moisture and sweat from the exhaled air.

However, the edges of surgical masks don't form a tight seal around your nose or mouth. Therefore, they can't filter out small airborne particles such as those transmitted by coughing or sneezing.

Use of Respirator mask/N95 mask

The N95 mask is used to prevent from inhaling small airborne particles in Aerosol-Generating Procedures (AGPs). It must fit tightly to the user's face. This mask must be worn with eye protection. This mask and other highly effective PPE are needed to protect against small airborne particles in Aerosol-Generating Procedures (AGPs) such as intubation. For non-AGPs, there is no evidence that N95 masks add value over standard masks when both are used with recommended wider PPE measures to prevent pathogenic particle transmission.

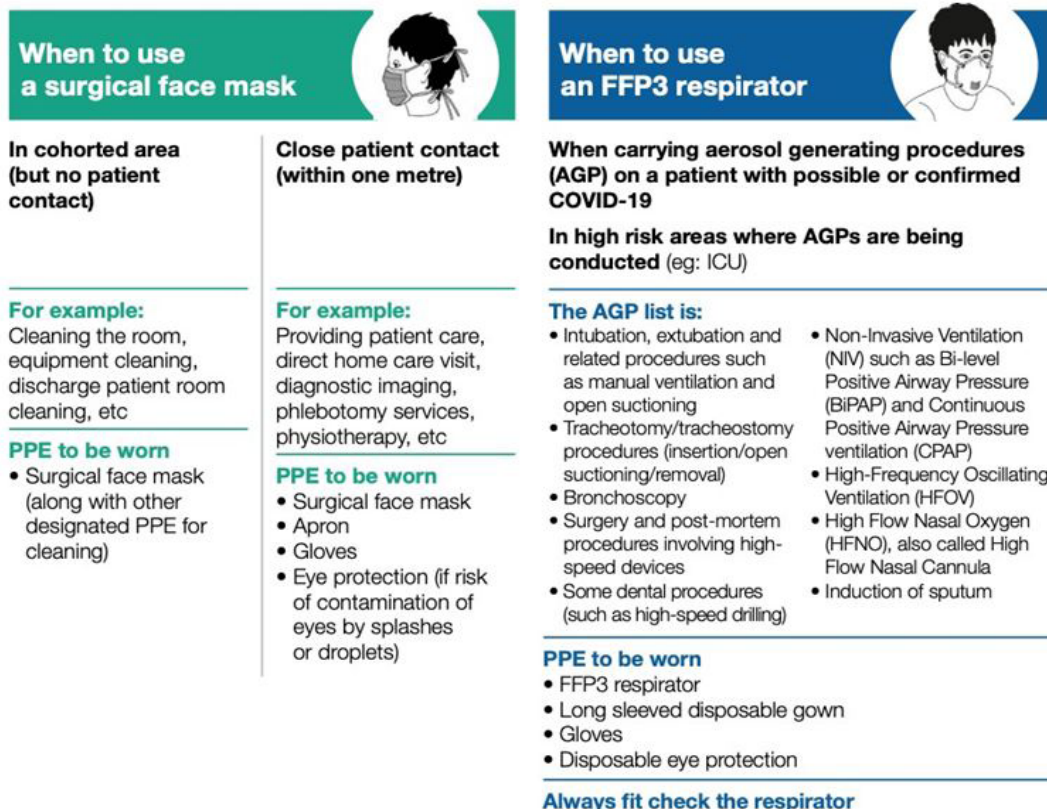


Figure 1: Different PPE for different stages or level of risk.

WHO Guidance for three different level of risk

- Triage (implicitly, non-clinical staff without prolonged contact: requires hand hygiene with mask)
- Suspected or confirmed case of COVID-19 requiring healthcare facility admission and no AGPs
- Suspected or confirmed case of COVID-19 requiring healthcare facility admission and AGP OR collection of specimens for laboratory diagnosis with a proper hand hygiene practices, respirator, gown, goggles, gloves [5].

In a recent study, they observed that the N95 respirators, disinfection and hand washing appeared to help reduce the infectious risk of 2019-nCoV in Health care professionals. Interestingly, they also showed, departments with a high proportion of male doctors seemed to have a higher risk of infection. Their findings emphasize the need for strict occupational protection measures in fighting COVID-19. [6]

Filter efficiency of different mask

A research showed that masks and respirators work by collecting particles through several physical mechanisms, including diffusion (small particles) and interception and impaction (large particles) [7]. Every filter has a particle size range that it collects inefficiently. Above and below this range, particles should be collected with greater efficiency. For fibrous non-electret filters, this size is about 0.3 micrometers (µm); for electret filters, it ranges from 0.06 to 0.1 µm. When used for testing, we care most about the point of inefficiency. As flow increases, particles in this range will be collected less efficiently. Respiratory or N95 filtering facepiece respirators (FFRs) are constructed from electret filter material, with electrostatic attraction for additional collection of all the particle sizes [8]. The N95 means the filter exhibits at least 95% efficiency in the least efficient particle size range.

Filtering performance of N95 Mask compared with other Mask

A study conducted to measure the filter efficiency of N95 mask across a wide range of small particle sizes (0.02 to 1 μm) at 33 and 99 L/min. N95 respirators had efficiencies greater than 95%. Of particles tested, t-shirts had 10% efficiency, scarves 10% to 20%, sweatshirts 20% to 40%, cloth masks 10% to 30%, and towels 40%. All of the other type of cloth masks and materials had near zero efficiency at 0.3 μm , a particle size that can easily penetrate into the lungs.[9] Another study evaluated on N95 FFR filter efficiency showed greater than 95%. Medical masks exhibited 55% efficiency, general masks 38% and handkerchiefs showed 2% (one layer) to 13% (four layers).[10] Many studies showed that cloth or homemade masks will have very low filter efficiency (2% to 38%). Medical masks are made from a wide range of materials, and studies have found that a wide range of filter efficiency (2% to 98%), with most exhibiting 30% to 50% efficiency [11,13].

A study conducted on surgical masks, showed relatively high efficiencies of 70% to 95% using NIOSH test methods measured total mask efficiencies of 67% to 90%. These results illustrate that surgical masks, even with relatively efficient filters, do not fit well against the face [14]. And the cloth masks exhibit very low filter efficiency. Thus, even masks that fit well against the face will not prevent inhalation of small particles by the wearer or emission of small particles from the wearer. Another study that evaluated the use of cloth masks in a health care facility found that health workers using cotton cloth masks were at increased risk of infection compared with those who wore medical masks [15]. Hence, cotton cloth masks are not considered appropriate for health care workers. As for other PPE items, if manufacturing of cloth masks for use in health care settings is proposed locally in situations of shortage, a local authority should assess the proposed PPE according to specific standards and technical specifications.

Surgical mask as a source of infection control

Several researches done on household survey showed that very limited effectiveness of surgical masks at reducing respiratory illness in other household members [16,18].

There is strong evidence from laboratory studies with coughing infectious subjects that surgical masks are effective at preventing emission of large particles [19,22] and reducing lateral dispersion of cough particles, but with alternate displacement of aerosol emission upward and downward from the surgical mask. [23] Wearing surgical masks in households appears to have very little impact on transmission of respiratory disease. One possible reason may be that masks are not likely worn continuously in households. These data suggest that surgical masks worn by the public will have no or very low impact on disease transmission during a pandemic. There is a evidence suggest that surgical masks worn by patients in healthcare settings can lower the emission of large particles generated during coughing and limited evidence that small particle emission may also be reduced.

There is few evidence suggest that surgical masks can be more effective at reducing overall particle emission from patients who have influenza than other types [24]. There is no proper evidence that surgical masks worn by healthcare workers are effective at limiting the emission of small particles or in preventing contamination of wounds during surgery.

Effect of different masks as PPE among HCW

A randomized trial conducted to compare the effect of medical and cloth masks on healthcare worker (HCW) illness showed that those wearing cloth masks were 13 times more likely to experience influenza-like illness than those wearing medical masks [25]. Many randomized trials have not found any statistical difference in the efficacy of surgical masks versus N95 FFRs at lowering infectious respiratory disease outcomes for healthcare workers to reduce the infection [26,29].

A major meta-analyses study found that N95 FFRs providing higher protection against clinical respiratory illness and lab-confirmed only bacterial infections, but not viral infections or influenza-like illness [30]. The data supporting the use of surgical masks as PPE in real-world settings are limited, the two meta-analyses and the most recent randomized controlled study was combined with evidence of moderate filter efficiency and complete lack of face piece fit lead us to confirmed that surgical masks offer very low levels of protection for the wearer from aerosol inhalation. There may be some protection from droplets transmission and liquids propelled directly onto the mask, but a faceshield would be a better choice if it is a major concern. [31].

Recently, a retrospective cohort study among nurses' showed the risk of SARS-2 caused by a coronavirus was lower with consistent use of N95 FFRs than with consistent use of a surgical mask [32]. Loeb et al study showed high filter efficiency and they concluded that N95 FFRs offer superior protection from inhalable infectious aerosols likely to be encountered when caring for suspected or confirmed COVID-19 cases.

Very recently, a study (32) done among health care settings, cluster analysis was done to compare usage of N95 respirators and their findings showed that wearing particulate respirator (N95) masks provided no benefit to HCWs compared with standard medical ("surgical") masks for preventing acquisition of respiratory viral illnesses during peak influenza seasons. Recent research works showed, the possible reason why didn't N95 masks work better was probably respiratory viruses are often transmitted by large amount droplets which could be adequately stopped by medical masks [33,34].

Over all, Health care facilities should encourage influenza vaccination and masking unvaccinated employees during the influenza season. So that, the mask can be a medical mask and not the more uncomfortable and expensive N95 respirator. The messages to health care workers are to stay home if you have a viral respiratory infection. If you are an HCW seeing patients with respiratory infections, practice the best infection prevention practices, including proper hand hygiene and use of personal protective equipment and along with a conventional medical mask to decrease exposure as indicated [35].

Another study comparing the effectiveness N95 respirators with surgical masks in the prevention of respiratory infections among clinicians, published in 2016, which, identify that N95 respirators are likely superior in controlled laboratory settings [36]. A review conducted on "physical interventions to interrupt or reduce the spread of respiratory viruses" also concluded that both surgical masks and N95 respirators may be useful [37].

Mask management

For any type of mask, proper use and disposal are essential to ensure that they are effective and to avoid any increase in

transmission. Who has given the guidelines on the correct use of masks is derived from practices in health care settings as follows.

- Should Place the mask carefully, ensure it covers the mouth and nose, and tie it securely to minimize any gaps between the face and the mask and avoid touching the mask while wearing it.
- Should remove the mask using the appropriate technique: do not touch the front of the mask but untie it from behind.
- Once removed or whenever a used mask is inadvertently touched, clean hands with alcohol-based hand rub or soap and water if hands are visibly dirty.
- Should replace masks as soon as possible with a new clean, dry mask.
- Should not re-use single-use masks.
- Always discard single-use masks after each use and dispose of them immediately upon removal.

Conclusion

All types of mask seem to have almost same effectiveness in preventing the dissemination of SARS-CoV-2 from the droplets at environment and external mask surface. Always, face masks can be unexpectedly complicated, especially for those who are new to wearing them. The benefit of wearing masks in public isn't to protect the individual from getting infection. It's to protect other people from exposure if you are sick or if you're an asymptomatic carrier. But if we all wear masks, we could help each other. It's also essential to remember that the CDC recommends cloth face coverings for the public. Only, N95 respirators, which can filter out particles as small as 0.3 microns, and surgical masks, made of non-woven fabric to block droplets, are in short supply and are best reserved for health care professionals. Even if you wear a mask, maintaining 6-foot social distancing is still important to slowing the spread of the Covid19 virus.

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