

N95 Respirators vs. Surgical Masks, which One is More Effective to Prevent Novel Corona Virus 2019?: A Mini-Review

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Abstract

Medical masks which include N95 respirators and surgical masks are used to prevent and limit the spread of widespread pathogens particles that may contaminate the face of patients or health worker. They also prevent these particles to spread through the near environment of the wearer.

The performance of N95, filtering face piece respirators and surgical masks were determined.

Disposable N95 respirators and surgical masks are both worn by health care providers for self-protection; however, these masks have different intended uses.

Keywords: N95 Respirators; Surgical Masks; Novel Corona Virus

Abbreviation

CDC: Centers for Disease Control and Prevention; NIOSH: The National Institute for Occupational Safety and Health; HCW: Health Care Workers; COVID 19: Corona-Virus-Disease 2019; WHO: World Health Organization; MERS: Middle East Respiratory Syndrome

Introduction

Only Little is known about the transmission of viral respiratory pathogens and how we can best protect ourselves and others. This gap in knowledge is a major concern in light of endemic pathogens such as seasonal Influenza and emerging viruses such as avian influenza strains, the Middle East Respiratory Syndrome Coronavirus (MERS-CoV) and the novel corona virus [1].

Surgical masks have been used for a long time to protect people and medical workers from multiple pathogens [2].

Although surgical masks are known as a prevention equipment, the use of them is still controversial.

The National Institute for Occupational Safety and Health (NIOSH) is concerned to detect and show the effects of air and particles properties such as temperature and relative humidity. In NIOSH study, two types of particles were used. We found that naturalized particles are more penetrating through the mask than the charged ones [2].

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Liquid repellency is important property in surgical masks to prevent bacteria or viruses penetration that carried in liquids. Human immunodeficiency virus and hepatitis B virus are examples, which may be transported through the mask [3].

Oil aerosols are also important to be tested as pathogens can penetrate through them. The resistance of oil penetration through masks is designated as not resistance, somewhat resistance, and strongly resistance.

In other study the number of RNA copies of influenza were determined. We found that viral copies which penetrated the masks were smaller than ones which did not. These small and fine RNA particles were in infected cases with a high number of RNA copies. Although surgical masks cannot prevent penetration of the all virus particles, especially the small ones, they can reduce the total number at all. These results suggest that wearing surgical masks can limit and decrease the spread of some viruses [4].

Surgical masks were tested using multiple sizes of monodisperse latex spheres (0.895, 2.0 and 3.1 μm) at a flow rate of 6 L/min, combined with water and the aerosol was generated using a nebulizer. Surgical masks that latex aerosol penetration less than 0.6% were then evaluated for facial fit [2].

Subjects wore a single randomly assigned surgical mask without assistance and performed qualitative and quantitative tests. Only a diagram of a person wearing a mask was shown. We found that surgical mask penetration generally decreased with increasing particle size. Sex had no effect on mask fit factor, so mean fit factors for male and female were similar [2].

As it was shown in some studies, particle penetration size range through surgical masks is wide, but the average particle size is about (320 nm).

Face seal leakage is an important way for pathogens to go through and infect mask wearer, so 10% - 40% of particles can get this way, especially for organisms with a low infectious dose (e.g. tuberculosis and Novel Corona virus) [2].

Another study found that nurses who not consistently wearing either a N95 respirator nor a surgical mask had 4 times the risk factor of SARS as those consistently wearing one of them. Surgical masks need to have sufficient fit as well as high filtration efficiency [4].



Figure 1: Surgical mask (CDC website).

The N95 has been recommended by public health organizations as a tool to reduce the transmission of airborne infectious diseases (e.g. tuberculosis, measles and chickenpox) and to provide protection from other aerosol-generating procedures with infectious patients. The numerical designation '95' indicates the ability to filter at least 95% of particles with the most penetrating particle size range of (300 nm) under test conditions [5].

To fulfill the stringent requirements, manufacturers should ensure that the thickness of a respirator must be increased and fiber diameter must be decreased. Hence, the traditional N95 are thicker than surgical masks, thereby compromising breathability [5].

Disposable N95 respirators and surgical masks are both worn by Health care providers for self- protection; however, these masks have different intended uses [6].

N95 respirators are designed to prevent the wearer from inhaling small airborne particles, must meet filtration requirements, and fit tightly to the wearer's face, limiting facial seal leakage [6].

Surgical masks, frequently called surgical masks, are intended to prevent microorganism transmission from the wearer to the patient.

Medical masks fit the face loosely and do not reliably prevent inhalation of small airborne particles. However, medical masks prevent hand-to-face contact and facial contact with large droplets and sprays [6].

There were controversial results between studies: Among outpatient health care personnel, N95 respirators vs. medical masks as worn by participants in this trial resulted in no significant difference in the incidence of laboratory-confirmed influenza [6].

Virions, which are very small viruses, are difficult to be prevented by N95 respirators. Surgical masks may let a large number of virions particles to penetrate as well, so surgical masks and N95 respirators are providing a low protective efficacy against these virions that have size range (10 - 80 nm) and other small particles in addition [7].

Even though surgical masks have a low efficiency to protect the wearer against some particles, they can protect the environment from the wearer more than expected. On the other hand, N95 respirators have high protective effect for the wearer [7].

Although surgical masks have been recommended as part of universal precautions in the clinical setting, they cannot provide adequate protection for users under specific contagious conditions [5].

Discomfort experienced by health care workers (HCWs) who wear N95 respirators is often associated with the tight-fit models. A variety of sensations and experiences, such as facial pressure, facial heat, facial movement or skin itchiness, may lead to discomfort, thereby affecting compliance during usage [5].

Perceived exertion, perceived shortness of air, complaints of headache or lightheadedness, difficulty in communication and respirator adjustments by users may increase over time. Discomfort associated with the device may also interfere with the occupational duties of workers [5].

Therefore, the perceived usability of N95 is as important as mask fit. Evidently, the improvement and modification of N95 warrants further investigation to increase the acceptance of this tool and improve the compliance rates of users [5].

This mask must be worn with caution in patients with COPD [8].

Some of COPD subjects who had high dyspnea scale scores and low FEV1 percent could not wear the N95 respirators for entire test time. In stark contrast, subjects who successfully did the test and wore the N95 respirators for entire time had high FEV1 percent and

low dyspnea scale scores, so subjects with scale scores ≥ 3 or FEV1 $< 30\%$ predicted must wear N95s only with doctor instructions and recommendations [8].

We should emphasize on a new technique which uses a powered air purifying respirator. This technique is a highly protection way from aerosols particles. In comparing N95 respirators to that new technique, we found that about 10% subjects who were wearing N95 respirators encountered when they were exposure to influenza viruses [9].

In vitro studies we found that both types of masks may not give the full protection against small particles such as influenza [10].

SARS corona virus and influenza virus are classified as small viruses depending on their very small microscopical size, so this make them highly penetrable particles through both surgical mask and N95 respirator.

It is important to know that novel corona virus diameter is about (50 - 200 nm) [11].



Figure 2: N95 Respirator mask (CDC Website).

CDC Recommendations (March 2020)

Upon the Centers for Disease Control and Prevention (CDC) recommendations, general public do not have to wear surgical masks to protect themselves from mouth and nose transported disease such as COVID-19 and other viruses. Otherwise, CDC show that the best protection way is to wash your hands continuously when it needed. Based on that, avoiding any way which may transport COVID- 19 to you is very highly recommended.

Wearing N95 respirator or any such protective equipment did not show any benefits for general public in American Society. For some public societies, risk factor of COVID-19 is still low, so wearing N95 should not be generalized in them.

When the N95 respirator is carefully fitted on the face, it limits and prevents 95 percent of the small particles which can go through. Based on that, the N95 respirator protection efficiency exceeds face mask. However, there is still infection risk with wearing N95 respirators.

Asking health care provider before using the N95 respirator is important, especially for those who have severe respiratory or cardiac problems, because of N95 respirators make it difficult to breathe for who wear it. One model of N95 respirators comes with exhalation valves that opens during exhalation and closes during inhalation, so this may interfere with sterile condition. The valved N95 respirator should not be used when we need high sterile conditions.

FDA recommendations showed that N95 respirators should be used only once as disposable devices. The used N95 respirator must be put in a plastic bag and disposed in the trash. If you difficulty breathes when you wear your N95 respirator or yours become damaged, you should replace it with a new one. Remember to wash your hands after every use of N95 respirator.

WHO Recommendations

Do not recommend wearing surgical masks by the public, but only health care providers who are in a close contact with suspected or infected patient.

WHO suggest only wearing N95 for a little period of time when doing a procedure or dealing with patients [12].

Conclusion

1. Upon their properties, the N95 respirators are basically used to prevent the pathogen particles to contaminate the wearer, whereas, the surgical masks have proved efficiency to protect the near environment from the wearer.
2. It is recommended that NIOSH-certified respirators, not surgical masks, be used to reduce employee exposure to airborne infectious organisms, otherwise surgical masks are still beneficiary in certain cases.
3. Corona viruses are small in size (50 - 200 nm), So they can penetrate the surgical masks especially with the poor fitting properties of this masks.
4. N95 respirators can prevent small particles (less to 80 nm), so HCP can wear it when they are in close contact with patient confirmed or suspected to have COVID-19.

Even though, there is no need to wear this mask too in public places.

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