

# COVID-19: Special Precautions in Ophthalmic Practice and FAQs on Personal Protection and Mask Selection

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**Abstract:** The Coronavirus Disease 2019 (COVID-19), caused by severe acute respiratory coronavirus-2, was first reported in December 2019. The World Health Organization declared COVID-19 a pandemic on March 11, 2020 and as of April 17, 2020, 210 countries are affected with >2,000,000 infected and 140,000 deaths. The estimated case fatality rate is around 6.7%. We need to step up our infection control measures immediately or else it may be too late to contain or control the spread of COVID-19. In case of local outbreaks, the risk of infection to healthcare workers and patients is high. Ophthalmic practice carries some unique risks and therefore high vigilance and special precautions are needed. We share our protocols and experiences in the prevention of infection in the current COVID-19 outbreak and the previous severe acute respiratory syndrome epidemic in Hong Kong. We also endeavor to answer the key frequently asked questions in areas of the coronaviruses, COVID-19, disease transmission, personal protection, mask selection, and special measures in ophthalmic practices. COVID-19 is highly infectious and could be life-threatening. Using our protocol and measures, we have achieved zero infection in our ophthalmic practices in Hong Kong and China. Preventing spread of COVID-19 is possible and achievable.

**Key Words:** COVID-19, frequently asked questions, mask selection, ophthalmic practice, preventive measures, SARS-CoV-2

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## INTRODUCTION

The World Health Organization (WHO) officially named the atypical pneumonia the Coronavirus Disease 2019 (COVID-19), which is caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). On March 11, 2020, WHO declared COVID-19 outbreak a pandemic. As of April 17, 2020, >2,000,000 people from 210 countries and territories had been infected. The death toll is >140,000. The case fatality rate (CFR) is 6.7%.

Despite sharing similar properties with other lethal coronaviruses, COVID-19 is much more infectious, and has become the biggest challenge to healthcare systems in many countries including the developed ones who have the most advanced healthcare facilities. Before vaccines and/or specific treatments are available, infection control is the key to minimize damage made by COVID-19. This can be achieved by case identification, contact tracing, isolation, and supportive treatment. Personal hygiene and social distancing are extremely important as well, since these are the means to prevent community spread.

Ophthalmologists are at risk of COVID-19 infection, since routine ophthalmic examinations are usually performed in a setting with close doctor–patient contact. Moreover, the COVID-19 present in tears could become a source of cross-infection. Therefore, eye care professionals shall remain highly vigilant all the time during the pandemic.

In the following sessions, we will discuss the properties and characteristics of SARS-CoV-2 and COVID-19. We have also prepared answers to frequently asked questions (FAQ) regarding the virus, personal hygiene, and the differences between various face masks. We have also shared the precautions and strategies that we have implemented in our ophthalmic practice, based on our previous and current successful experiences in preventing severe acute respiratory syndrome (SARS) in 2003 and the current COVID-19 outbreaks in Hong Kong.

## Modes of Transmission

Coronaviruses spread mainly through inhalation of droplets, direct or indirect contacts, and to a limited scale, aerosol-related transmission. Direct contact means the virus is transmitted from the infected to the healthy through direct physical contacts, whereas indirect contacts are usually transmitted through fomites. Droplets as well can transmit the infection both by direct and indirect means. It can be inhaled directly by others when the infected cough or sneeze; in contrast, droplets may settle on table

surface, and later on when another person touches the table before touching his own mucosal surfaces (including nose, mouth, and eyes), the transmission of disease might then happen.<sup>1-3</sup>

Aerosols are a collection of very tiny droplets in air, produced in specific circumstances, which are capable of traveling a longer distance and longer time in air, compared with typical droplets, before settling down owing to the small size and light weight. Aerosols can be generated during aerosol-generating procedures in hospital settings, such as resuscitation, endotracheal intubation, positive pressure ventilation, tracheostomy insertion, bronchoscopy, airway suction, and so on.<sup>4,5</sup> When medical personnel is performing aerosol-generating procedures, full personal-protective equipment should be put on, including goggles, N95 respirators, face shield, protective gowns, and shoe-cover, among others. Coughing, sneezing, toilet flushing, cigarette smoke, and hot pot steam, among others, might also have a possibility to generate infective aerosols but need further studies to confirm it (Fig. 1).

### Infectivity and CFR

Epidemiologists use Basic Reproductive Number ( $R_0$ ) to represent the infectivity of certain infectious disease. It is defined as the number of individuals being infected when a confirmed case enters the population composed of only susceptible individuals.<sup>6</sup> For example,  $R_0 = 1.0$  means on average an infected patient would infect one other healthy individual in the community and  $R_0 = 2.0$  refers to 2 healthy individuals acquired the infection from a single confirmed case.  $R_0$  of COVID-19 was initially estimated to be 2.2 to 2.7; however, as more data are available with time, some epidemiologists suggested that the true  $R_0$  of this virus could be much higher and lies between 3.3 and 5.47, or even higher between 4.7 and 6.6.<sup>7,8</sup> In contrast,  $R_0$  of SARS-CoV were 1.88 in Beijing, 1.70 in Hong Kong, and 0.95 worldwide,<sup>9,10</sup> whereas  $R_0$  of MERS-CoV were 0.47 in Middle East, 0.45 in

Saudi Arabia, and 0.91 overall for Middle East and South Korea.<sup>10,11</sup> The infectivity of COVID-19 is, therefore, highest among the 3 lethal coronavirus infections. The CFR, however, has a reverse order for the 3 viruses when comparing with infectivity. They are 6.7%, 9.6%, and 34.4% for COVID-19, SARS, and MERS, respectively.<sup>12</sup>

### Possible Reasons for the COVID-19 to Be More Infectious Than MERS or SARS Coronavirus

SARS-CoV-2 utilizes the same cellular receptors as SARS-CoV, the human angiotensin-converting enzyme 2. Therefore, it is expected that this new virus would behave very similar to SARS-CoV in terms of transmission properties, such as causing lower instead of upper respiratory tract symptoms.<sup>13</sup> However, unlike SARS-CoV or MERS-CoV, epithelial cells in human airway are more suitable than standard tissue culture medium for the growth of SARS-CoV-2.<sup>13</sup> Moreover, the incubation period of this virus is up to 24 days and the virus is capable of transmitting the disease even when patients only have mild or even no symptoms.<sup>14</sup> Unlike SARS in which most patients developed fever, studies from China and Europe showed only 43% to 48% of them had fever at the time of admission.<sup>15,16</sup> This renders comprehensive early identification of cases extremely difficult. Lastly, the low CFR of the disease relative to SARS and MERS may make people more complacent and less compliant with preventive measures. With global spread, the role of quarantine is to slow or stop the transmission of infection so that serious cases are at least spread over a longer period of time. An uncontrolled outbreak of infection could easily overwhelm the ability to care for patients and lead to exponential spread. All of the aforementioned characteristics of COVID-19 facilitate the transmission of virus in the community thus increasing the difficulty of its containment. Further studies to investigate the mechanisms for COVID-19's high infectivity are warranted.

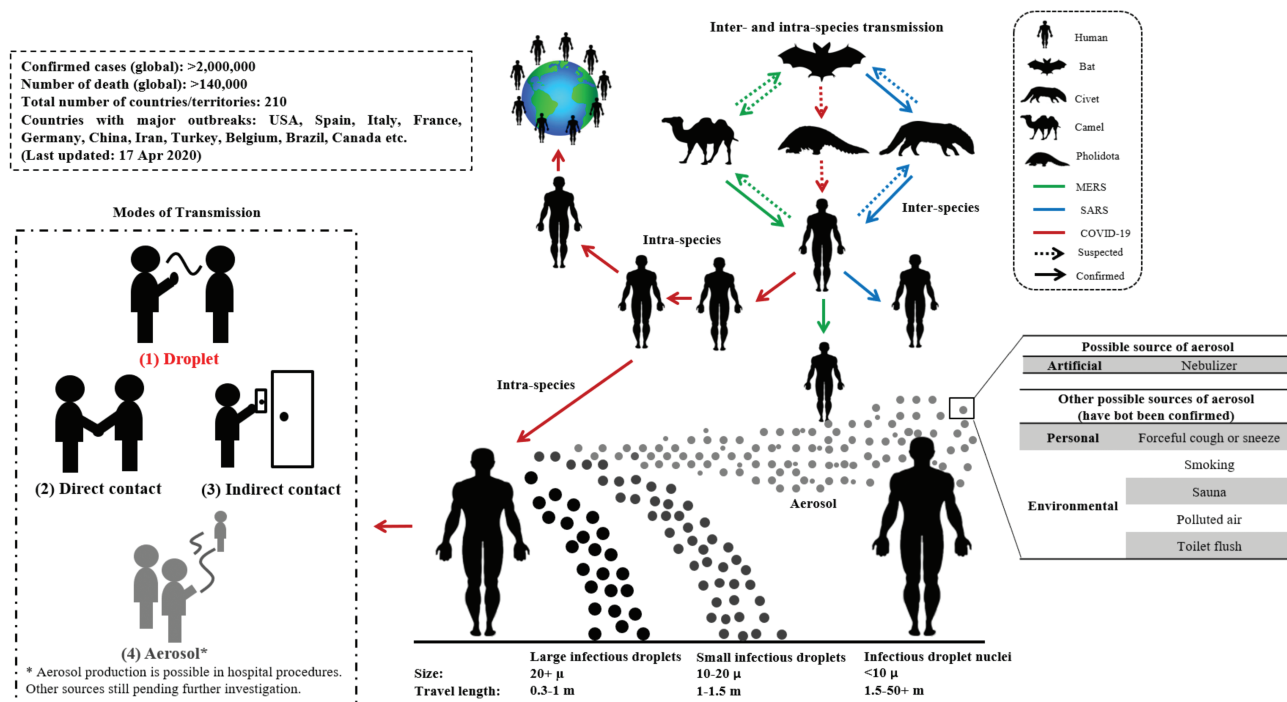


Figure 1. The inter- and intra-species transmission of COVID-19, SARS, and MERS, and the travel distances of the infectious droplets.

## FREQUENTLY ASKED QUESTIONS

### Part 1: SARS-CoV-2 and COVID-19

#### FAQ 1. What Are Coronaviruses?

Coronaviruses (CoVs) are the largest group of viruses belonging to the *Nidovirales* order. The name “coronavirus” comes from the Latin “corona,” which means crown, due to its characteristic appearance resembling a crown or solar corona. CoV can induce respiratory, gastrointestinal, and neurological dysfunction in their hosts and predominately respiratory infections in human (Fig. 2).<sup>17</sup>

A total of 7 species of CoVs have been found to be pathogenic to humans, including HKU1, OC43, NL63, and 229E,

which can lead to mild upper respiratory tract infections and are still circulating among human,<sup>18,19</sup> whereas the more aggressive SARS-CoV, MERS-CoV, and SARS-CoV-2 are zoonotic and these viruses crossed species from animals and infected human.

SARS was first known to human in 2002 to 2003, starting in Guangdong Province of China, infecting 8098 people worldwide and with a CFR of 9.6%.<sup>20,21</sup> MERS-CoV, however, first appeared in 2012 in Saudi Arabia, infected almost 2500 people, mainly in the Middle East and Korea and with a high CFR of 34.4%.<sup>22</sup> Recently, a new member to the coronavirus family, SARS-CoV-2, has led to a large-scale pandemic with an estimated CFR of 6.7%.<sup>23</sup>

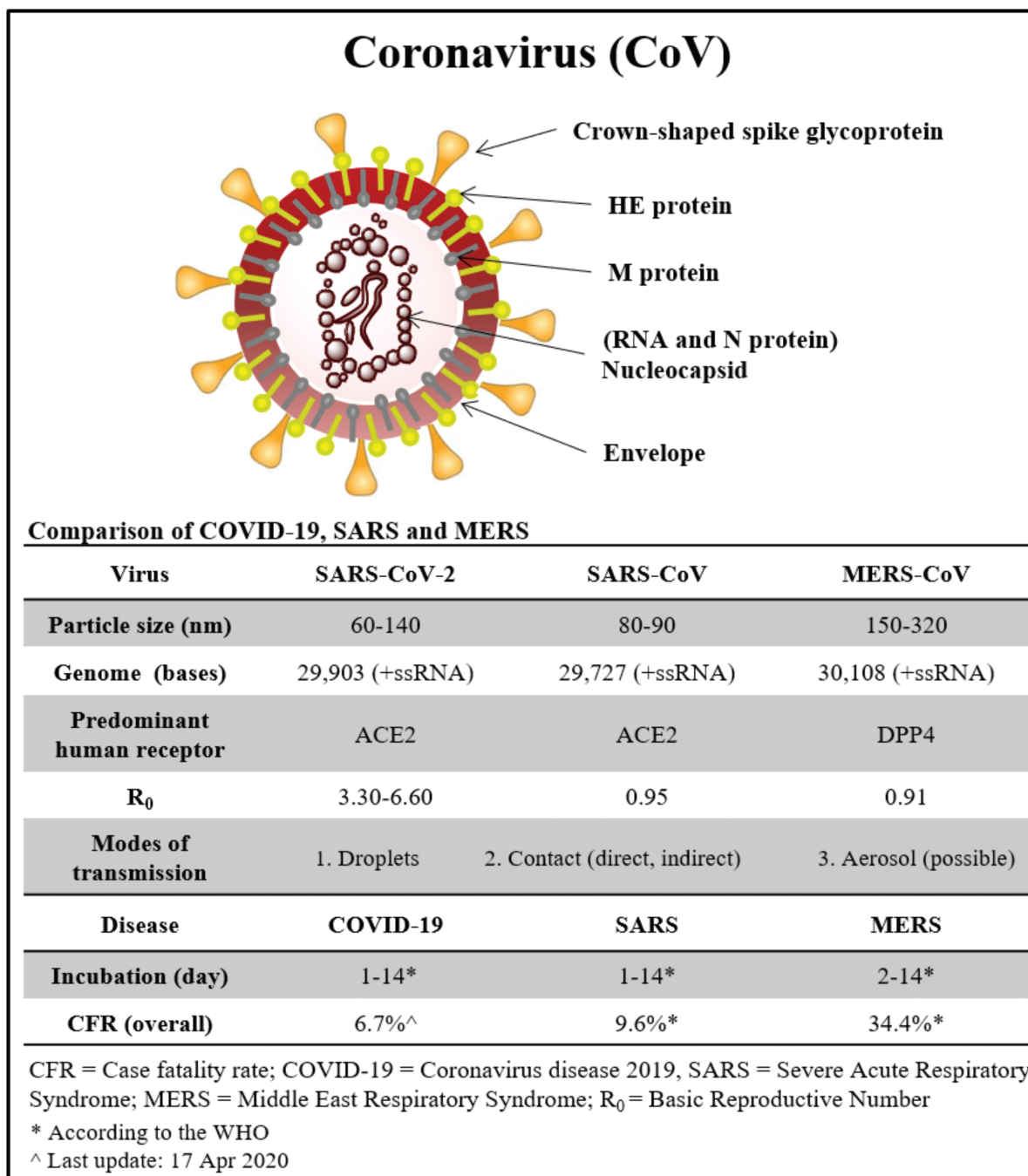


Figure 2. Comparison of the coronaviruses causing COVID-19, SARS, and MERS.

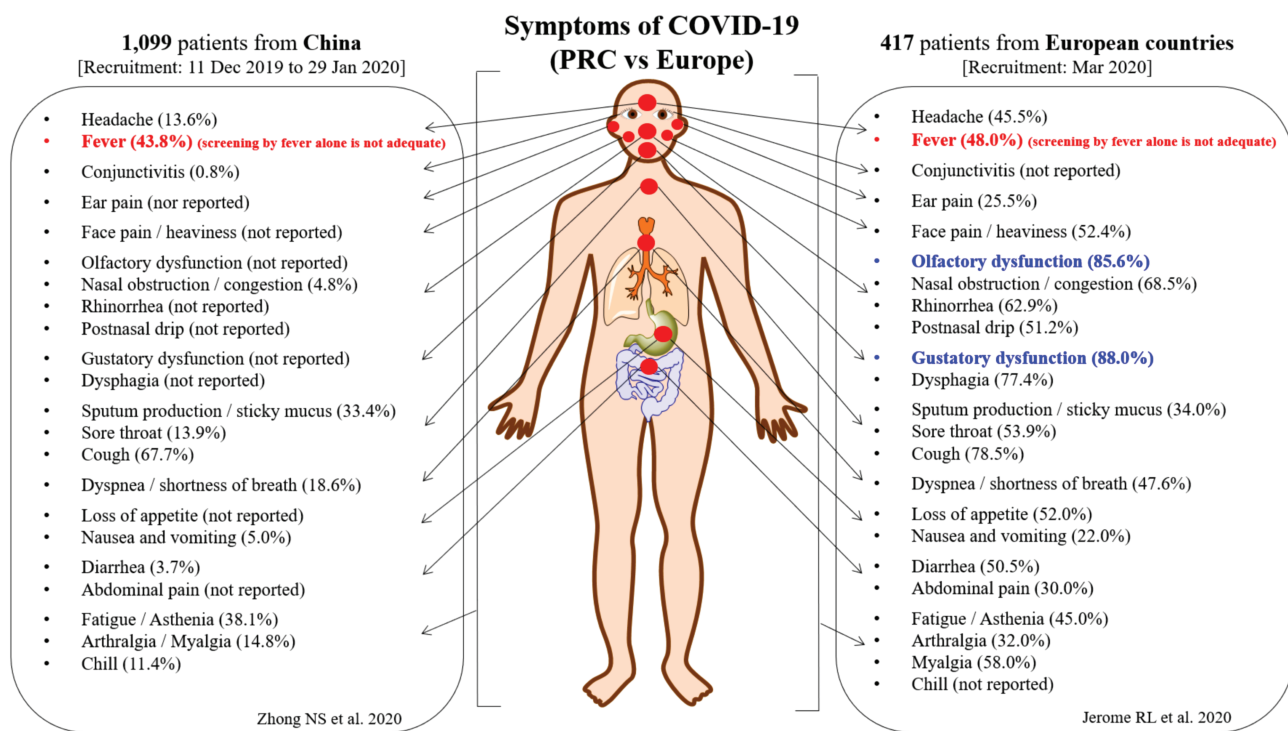


Figure 3. Common symptoms of COVID-19 reported in the studies from China and Europe.

**FAQ 2. What Are the Common Symptoms of COVID-19?**

The earliest cluster of COVID-19 identified as “pneumonia of unknown etiology” or “atypical pneumonia” was defined as evidence of pneumonia on x-Ray or computer tomography scans, fever of  $\geq 38^{\circ}\text{C}$ , normal or low white blood cell count, and no clinical improvement despite standard antibiotics treatment for 3 to 5 days. According to the studies from China and Europe, symptoms of COVID-19 include fever, olfactory dysfunction, gustatory dysfunction, cough, fatigue, sputum, shortness of breath, conjunctival injection, and so on (Fig. 3).<sup>13,15,16</sup>

**FAQ 3. What Is the Survival Time of SARS-CoV-2 on Different Surfaces?**

Viable SARS-CoV-2 could be detected in aerosol up to 3 hours after aerosolization, thus raising concerns on the possibility of viral transmission through aerosolization. The survival time of SARS-CoV-2 varies among different materials. For example, viable SARS-CoV-2 could only be detected on copper up to 4 hours, but its survival time could be as long as 2 to 3 days on plastic and stainless steel (Table 1).<sup>24</sup> Therefore, indirect transmission of SARS-CoV-2 through fomite is highly likely! To lower the risk of infection, we must always remain vigilant and be aware of personal hygiene.

**FAQ 4. What Are Droplets, Aerosols, and Droplet Nuclei?**

Droplets, in term of respiratory infections, refer to small liquid drops that are generated by expiratory events such as coughing, sneezing, laughing, talking, or even breathing.<sup>25</sup> Aerosols are suspensions of small liquid droplets or solid particles in air. Droplets are subdivided by size into large and small droplets, and the smallest form as droplet nuclei. The size definitions vary among studies, but most naturally and artificially produced aerosols contain a range of droplet sizes. After being expelled, droplets are usually brought down to ground under gravity and are

transmitted over a limited distance only. However, the water content of small droplets may evaporate during the stay in air, producing even smaller droplet nuclei that could then remain suspended in air and could be transmitted over a long distance (Fig. 1).<sup>26</sup>

**Part 2: Prevention and Personal Protection**

The traditional model of infectious disease, known as the epidemiologic triad, consists of a pathogen, a susceptible host, and an environment that brings the host and agent together. The overall risk of infection further depends on the infectivity, pathogenicity, and virulence of the invading pathogen. Effective preventive measures for infectious disease require assessment of all the above components and their interactions. In general, it is advisable to avoid going to places that are crowded with people, or with higher risk of infection such as clinics or hospitals. Good hand hygiene and proper wear of suitable face mask are other key preventive measures.

**FAQ 5. Which Is the Best Way of Hand Hygiene, Alcohol Hand Rubbing, or Washing?**

Standard recommendation on hand hygiene is to use alcohol-based handrubs or washing hands with soap and water for at least

Table 1. Survival Time and Half-Life of SARS-CoV-2 on Different Materials

Material	Survival Time	Half-Life* (median)
Aerosol	3 h	1.1 h
Copper	<4 h	0.8 h
Cardboard	<24 h	3.5 h
Plastic	72 h	6.8 h
Steel	72 h	5.6 h

\*Half-life indicates the time required for SARS-CoV-2 to decay to half of its initial viable virus titer per liter.

20 seconds. When hands are visibly dirty, there is no doubt that washing hands with soap and water is necessary.<sup>27</sup> However, when hands are not visibly dirty, there had been controversies regarding the effectiveness of different methods. The current recommendation by Centers for Disease Control and Prevention and WHO put alcohol-based handrubs as preferred method, as it demonstrated better antiseptic efficacy. It is also easier to be used at the point of care and is minimally time-consuming, resulting in better compliance.<sup>28</sup> On a further note, use of gloves does not constitute part of hand hygiene. Proper hand hygiene should still be performed before and after wearing gloves. It is not recommended to use alcohol-based handrubs while gloves are on hands.

**FAQ 6. Which Is Better, Ethanol or Isopropyl Alcohol? What Is the Best Concentration?**

Alcohols such as ethanol or isopropyl alcohol could be used as hand rubbing agents, or disinfectant for general surfaces and ophthalmic instruments. Both alcohols exert their antimicrobial activity by protein denaturation and are equally effective at 60% to 80% concentrations.<sup>29</sup> Ethanol is the ingredient present in most alcoholic drink. However, commercially available high concentration ethanol may contain toxic additives to prevent people from drinking as required by certain countries, making it less popular as disinfectant. Isopropyl alcohol, however, is produced in high quantities with high purity, and is widely used in households and industries as disinfectants or detergents.

**FAQ 7. What Are Face Masks and Respirators and How Do They Work?**

Face mask is defined as a physical barrier loosely worn between the mouth and nose of the wearer and the surrounding. It is not tightly fit and offers no air-sealing. Surgical masks are face masks that are qualified to prevent contamination of sterile surgical field. Respirators (eg, N95 respirators) are air filtration

devices designed to remove particulates from inhaled air. It should be tightly fitted onto the mouth and nose to ensure air sealing. One major common property is that they utilize filters to prevent unwanted substances from passing through the barrier, while allowing air to pass through.<sup>30</sup> Filters can capture particles of different size through various mechanisms. Larger particles are captured by filter fibers directly when they impact or intercept the fibers. Smaller particles are constantly bombarded by air molecules, causing them to deviate from the air stream and come into contact with a fiber. Furthermore, oppositely charged particles are attracted to charged fiber. All particles that come into contact with a fiber will stay attached to the fiber firmly. In that way, filters can capture particles smaller than the pore size. Structures and mechanisms of various filter materials are illustrated in Figure 4.

**FAQ 8. What Are the American Society for Testing and Materials Standards and N95 Classification of Masks and Respirators?**

Surgical masks are regulated by the Food and Drug Administration, and should fulfill requirements set by the American Society for Testing and Materials (ASTM). There are 3 levels (1, 2, and 3) of surgical masks and the function and performance details are shown in Table 2. N95 respirators are primarily developed for industrial safety to reduce particulates inhaled by wearers.<sup>30,31</sup> They are certified by National Institute for Occupational Safety and Health (NIOSH) under the guidance of “NIOSH 42 CFR Part 84,” with the mark “NIOSH” printed on the surface of the respirators. The notation “95” implies that they can filter at least 95% of particles sized 0.3 microns, and “N” represents non-oil particles. They are tested under stringent protocols which aim to simulate the “worst case” condition.<sup>32</sup> Noncharged sodium chloride particles of 0.3 μm was selected, which represent the most penetrating particle size, where the particles are most likely to bypass various mechanisms to capture

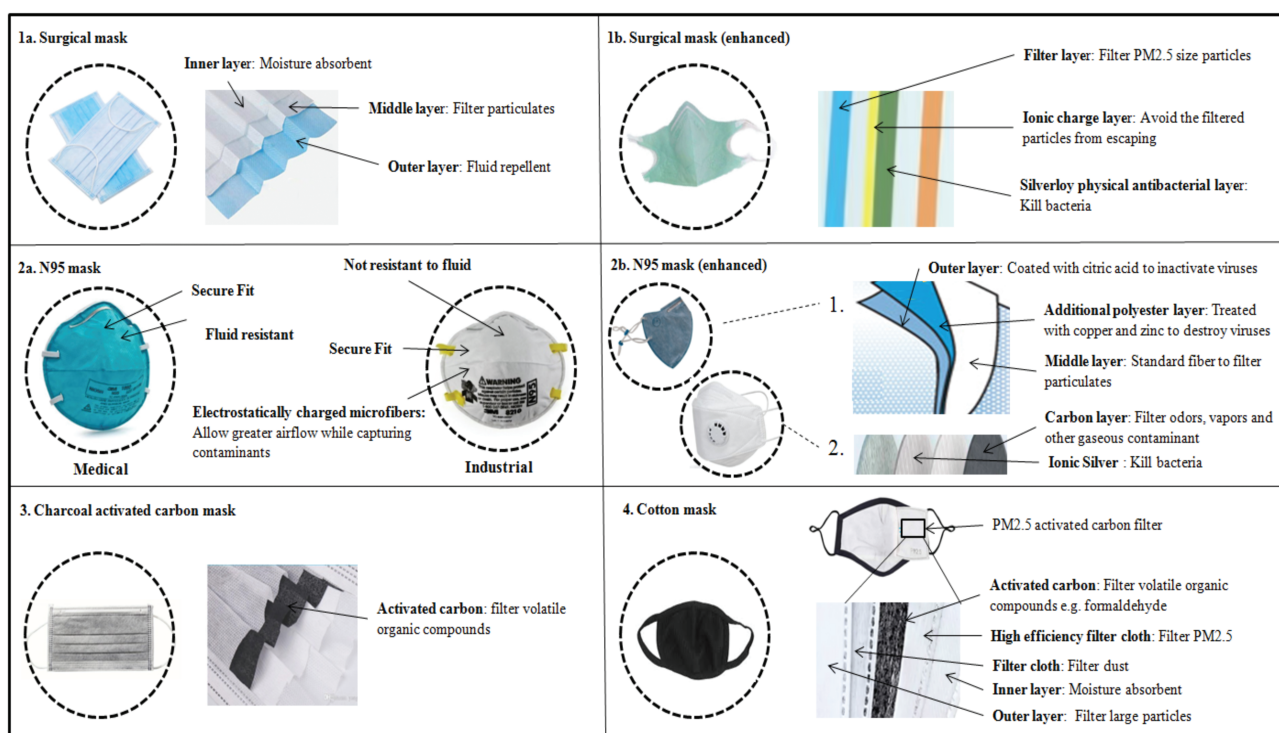


Figure 4. Compositions and functions of different layers in various types of masks.

**Table 2.** Protection and Performance of Different Levels of Surgical Masks According to ASTM

	Function	ASTM Standard	Performance
Level 1	FR	80 mm Hg	⊙
	BFE	≥95%	⊙⊙
	PFE	>95%	⊙⊙
	Breathability	<4	⊙⊙⊙
Level 2	FR	120 mm Hg	⊙⊙
	BFE	≥98%	⊙⊙⊙
	PFE	>98%	⊙⊙⊙
	Breathability	<5	⊙⊙
Level 3	FR	160 mm Hg	⊙⊙⊙
	BFE	≥98%	⊙⊙⊙
	PFE	>98%	⊙⊙⊙
	Breathability	<5	⊙⊙

ASTM indicates American Society for Testing and Materials; BFE, bacterial filtration efficiency; FR, fluid resistance; PFE, particle filtration efficiency.

them. N95 respirators have also been tested under conditions similar to that of ASTM standards, showing filtration efficiency of >99% for uncharged particles sized around 0.1 μm.<sup>33</sup> The overall filtration efficiency of N95 respirators is superior to surgical masks of all ASTM levels. (see Fig. 5 for performance of various respirators and masks).<sup>34</sup>





**FAQ 9. Which One Is Better, Surgical Masks or N95 Respirators, in Terms of Protection Against Respiratory Infections?**

N95 respirators offer better protection than surgical masks, which are loosely fit and not air-tight. Both of them offer protection against splash of fluid and droplets, but only N95

respirators protect the wearer against small viral particles or aerosol inhalation. Fitting procedure is required for N95 to ensure tight air-seal, and should not be worn by children, men with beard or individuals with breathing difficulty. N95 respirators offer better protection against air-borne infection. For surgical masks, fitting procedure is not required. Although the theoretical particle filtration efficiency of the filter material in surgical mask may reach 98% (for ASTM level 2 and 3 masks), the actual total inward leakage (TIL) may reach 30% to 35% due to inadequate sealing.<sup>34,35</sup> Therefore, 30% to 35% of air that is breathed into the wearer’s respiratory system might not have passed through the filtering materials of surgical marks. This is the reason why surgical masks can prevent droplets but not airborne particles or aerosols. Despite that, surgical masks should be worn by individuals with suspected respiratory infections, effectively lowering the environmental contamination due to droplets expelled by individuals with respiratory infection.

**FAQ 10. When Should I Wear a Surgical Mask or N95 Respirator?**

For healthcare workers, surgical masks should be worn when performing sterile procedures, or as general protection against droplets infections. For public use, such as individuals with respiratory symptoms, people exposed in crowded and poorly ventilated places, such as taking public transports, students in school and individuals visiting clinics or hospitals, surgical masks are also recommended.<sup>36</sup> N95 respirators are recommended to be worn by healthcare workers when working in high-risk areas such as fever wards, inpatient or isolation rooms for patients with confirmed or suspected COVID-19.<sup>36</sup> They should be removed and discarded when leaving the patient room or care area, followed by immediate hand hygiene.

Performance of Various Masks						
Type of Masks		Bacterial Filtration Efficiency (BFE) Filter particles (3 microns) E.g. pollens and droplets	Particulate Filtration Efficiency (PFE) Filter particles (~0.1 micron) E.g. viral particles	Fluid Resistance	Breathability	FDA-cleared for maintaining sterile surgical field
<b>Surgical Mask (ASTM)</b>						
	Level 1	≥ 95%	≥ 95%	Poor	Good	Yes
	Level 2	≥ 98%	≥ 98%	Fair		
	Level 3	≥ 98%	≥ 98%	Good		
<b>N95 Mask</b>						
	Surgical	>99%	>99%	Good	Fair	Yes
	Industrial	Not Tested	>99%	Not Tested		No
<b>Carbon Charcoal Mask (Nuisance odor relief)</b>						
		Offer limited protection	Offer little protection	Not Tested	Good	No
<b>Comfort Mask (For warmth and comfort)</b>						
		Offer limited protection	Offer little protection	Not Tested	Good	No

**FIGURE 5.** Performance of various respirators and masks.

**FAQ 11. How to Wear and Take-Off Surgical Masks Properly?**

The outer layer of masks is considered dirty, whereas the inner layer is relatively clean. Hand hygiene should be performed before and after taking off the mask to avoid contamination of our hands. Mask should be fitted snugly over the face. Other points worth noting are: the colored side of the mask should face outwards; the metallic strip at the uppermost side molds to the bridge of the nose; the mask covers the nose, mouth, and chin; the strings or elastic bands are positioned properly to keep the mask firmly in place; and avoid touching or manipulating the mask once secured on face as frequent handling may reduce its protection. If you must do so, wash your hands before and after touching would help.

Change masks timely. Replace the mask immediately if it is damaged, wetted, or soiled. After taking off the mask, discard it into a lidded waste bin and perform hand hygiene immediately.

**FAQ 12. What Is the Key Difference Between Standard N95 Respirators and Surgical N95 Masks?**

Surgical N95 mask is a subgroup of N95 respirator that also fulfils ASTM requirements and Food and Drug Administration-cleared as surgical mask. They are fluid-resistant, whereas other standard N95 respirators may not be fluid-resistant. Both types exhibit similar filtration efficiencies for small particles like viruses. For general protection of the wearer, standard or surgical N95 respirators will all suffice.<sup>32</sup> The key difference is that the surgical N95 masks prevent the wearers from contaminating the surgical field or environment and are used when performing sterile procedures under the threat of air-borne transmission.

**FAQ 13. Do N99 and P100 Industrial Respirators Offer Better Protection Against Infection?**

There are industrial respirators with higher filtration efficiency available, eg, N99, P100, etc. However, their uses in healthcare settings are often limited due to relatively lower breathability. Respiratory distress may occur after prolonged wearing. N95 respirators already provide good protection against viral droplets or aerosol protection and their breathability are similar to surgical masks. Therefore, they are satisfactory in most healthcare settings, especially when prolonged wearing is needed.<sup>31</sup>

**FAQ 14. Would Other Comfort Face Masks Such As Cotton or Charcoal Activated Carbon Masks Be Able to Offer Protection Against COVID-19 Infection?**

No, the protection is very limited! Although reusable cotton masks can be sterilized for reuse, they generally suffer from limitations including low filtration efficiency, time-consuming production, and higher risk of contamination. Charcoal-activated carbon masks are intended to absorb chemicals from inhaled air. Those masks are not formally tested for the particle and bacterial filtration efficiency, and do not claim for protection from air-borne or droplet transmission. At the height of COVID-19 epidemic, it would be better than none to be worn by patients with respiratory symptoms to reduce environmental contamination, if surgical masks are not available.

**Part 3: Precautions in Ophthalmic Practices**

The close proximity of patients and doctors during eye examination, the presence of tears and liquids for anesthesia

and dilation, or the potential aerosol or droplets from “air puff” tonometry, all pose a high risk for infective transmission.<sup>37</sup> Conjunctivitis was reported to be present in 0.8% to 5.2% of COVID-19 patients.<sup>15,38,39</sup> Conjunctivitis can be the presenting symptom/sign of COVID-19, high vigilance is essential as conjunctivitis is a common condition in ophthalmic practice. Furthermore, because eye centers could harbor asymptomatic patients with COVID-19 that have subtle or even no symptoms, proper precautions should be taken to protect for both patients and staff from the infection.

**FAQ 15. Is COVID-19 Important in Ophthalmic Practices?**

Yes. Conjunctivitis could be present in COVID-19 patients, and virus may even be present in their tears and conjunctival secretion. Direct contact with the ocular surface and mucosal membrane during routine ophthalmic examination may have risk of infection. The doctor–patient distance during examination is usually <1 m, where the possibility of droplet transmission is high if there is no proper protection. Air jet produced in non-contact tonometry might also generate aerosol of fluids from the eye, which might be infectious. Last but not least, ophthalmic centers may be crowded with patients with potential risk of infection. Extra precautions should be taken in ophthalmic practices.

**FAQ 16. What Are the General Precautions to Be Taken in Ophthalmic Practices?**

Preventing patients with potential respiratory infection from entering the facilities might minimize the chance of exposure. For patients with potential risk, nonurgent ophthalmic consultations will be deferred after appropriate period of quarantine and observation. Special precautions will be taken in handling such patients with sight-threatening conditions (Fig. 6 and Table 3).

Patients are screened before entering the facilities by phone screening and triage at the entrance. Face masks should be worn by all personnel and visitors inside the facilities. Visitors wait at an adequately ventilated area, keeping at least 1-m distance from others, and were provided with adequate alcohol-based handrubs, rubbish bins, and educational material in the waiting area. In consultation rooms, transparent shields are installed on slit-lamps to prevent droplet transmission. All instruments and surfaces are disinfected properly after each use.

**FAQ 17. What Precautions Should Be Taken When Seeing Ophthalmic Patients With High Risk of COVID-19 Infection?**

If patients are screened as high risk of COVID-19 infection and having ophthalmic emergencies, doctor-in-charge should be informed. Ideally patient should be isolated in a single room, with a dedicated team of healthcare workers entering with full personal protective equipment including N95 respirators for examination. Patients are not allowed to enter the public waiting areas. Potentially aerosol-generating procedures are to be avoided. All equipments are disinfected immediately after patient contact.

**FAQ 18. How to Make an Effective Slit-Lamp Shield to Prevent Infection?**

In slit-lamp examination, physical barrier between doctors and patients is advisable to prevent droplet transmission. Commercially available breath shields are available, but producing home-made shields is not difficult. The material chosen should be highly transparent to allow effective visualization, rigid enough

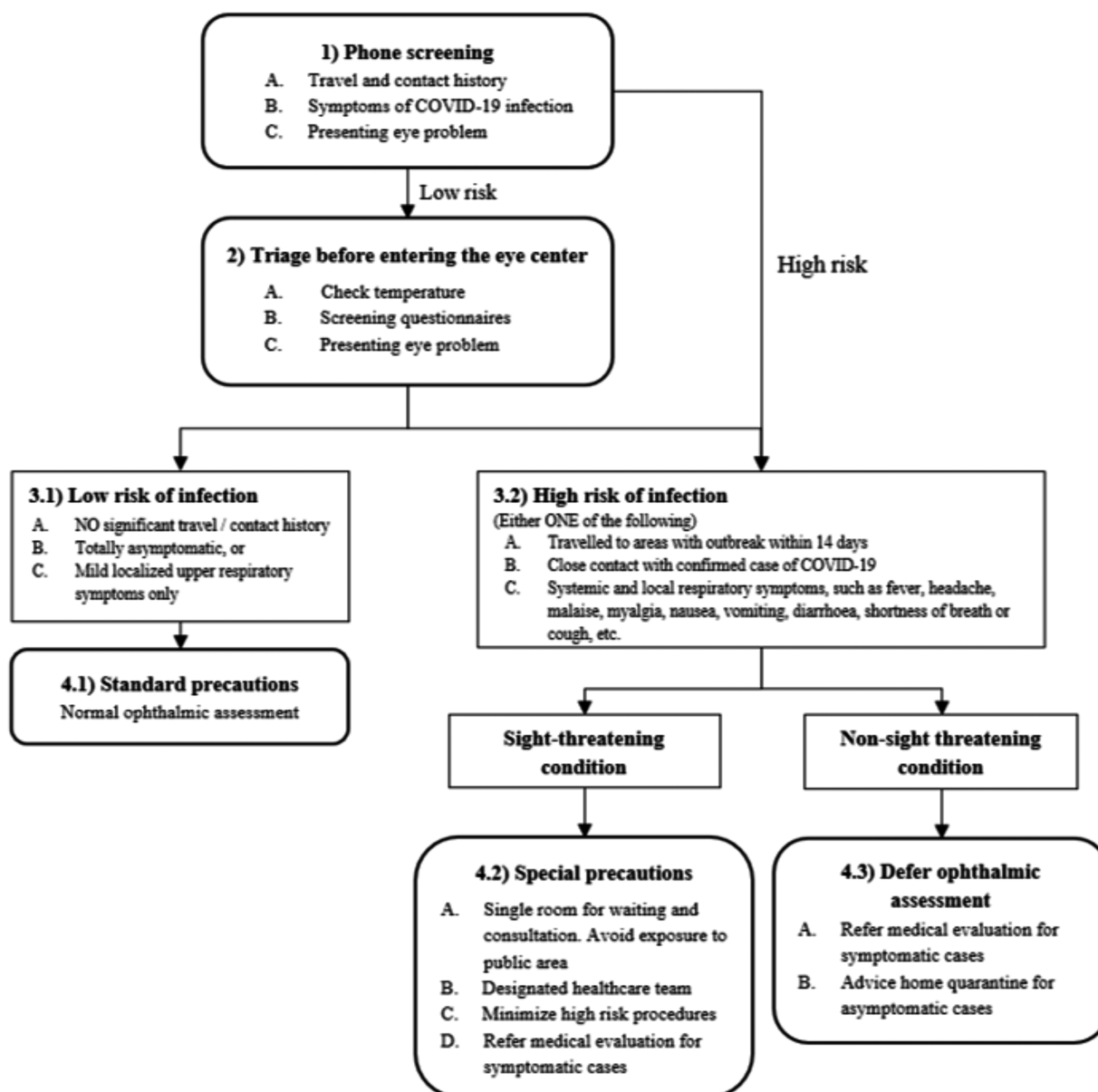


FIGURE 6. Flow-chart of phone screening and triage system for preventing COVID-19 in eye centers.

not to collapse, and thin enough to be cut into desired shape (Fig. 7). A clear polyvinyl chloride document holder is a good choice. Make a central opening and fit it in between the optical modules. The edges of the shield should be smoothed with a sand paper polisher should it be too rough or sharp. The size of the shield should not be too small in which protection effect will be compromised; or too large in which manipulation of the slit-lamp equipment will become difficult. The size of an A3 size paper or one that is slightly larger would be quite optimal and recommended. The location of the hole is also important. We want the upper portion to be larger to provide more protection while the lower portion to be smaller to allow easier access to slit-lamp manipulation. It should be cleaned and disinfected regularly.

#### FAQ 19. How Should I Disinfect Ophthalmic Instruments After Using It?

The patient contact areas of general equipment such as slit-lamp, non-contact tonometer, autorefractor, and so on should be

disinfected with 70% to 75% ethanol or isopropyl alcohol immediately after each use. Instruments that had direct contact with patient's ocular surface such as Goldmann applanation tonometer prisms and diagnostic contact lenses are disinfected by immersion in either 1:10 diluted bleach solution with sodium hypochlorite or 3% hydrogen peroxide for at least 5 minutes. Surgical instruments are sterilized according to standard protocols.

#### FAQ 20. Is There Any Risk With Noncontact Tonometry?

In non-contact tonometry, the air jet impacted on the tear film was reported to general micro-aerosols.<sup>40,41</sup> Since SARS-CoV-2 was reported to be present in tears and conjunctival secretions from COVID-19 confirmed patients with conjunctivitis, extra caution shall be exercised when performing noncontact tonometry on patients with red eyes. Alternative methods such as rebound tonometry could be considered. Operators should wear proper face mask or respirator.



**Table 3.** Standard and Special Precautions to Be Taken in Eye Clinic or Center

	Standard Precautions	Special Precautions
A. Consultation room	<ol style="list-style-type: none"> <li>1. Adequate disinfection and cleaning materials (alcohol prep wipes, tissue paper, disposable gloves, waste bins)</li> <li>2. Appropriate personal protective equipment (PPE), such as:               <ol style="list-style-type: none"> <li>a. Surgical mask / N95 respirator</li> <li>b. Eye goggle/face shield</li> <li>c. Protective gown</li> <li>d. Gloves</li> </ol> </li> <li>3. Follow one-in-one-out policy</li> <li>4. Reduce nonurgent bookings to shorten waiting time and allow time for cleaning after end of session</li> </ol>	<ol style="list-style-type: none"> <li>5. Use designated consultation room for individuals at risk</li> <li>6. Minimize the number of personnel entering the room. Keep a log of personnel entry</li> <li>7. Use dedicated or disposable noncritical patient-care equipment. Avoid direct ophthalmoscopy to avoid close contact</li> <li>8. Avoid procedures that may cause spillage of droplets, eg, syringing and probing, incision and curettage, subconjunctival injection, and so on.</li> </ol>
B. Ophthalmology ward	<ol style="list-style-type: none"> <li>1. Reduce unnecessary admission of nonurgent cases</li> <li>2. Epidemiological surveillance of all admitted patients, and do laboratory confirmation test for all suspicious cases</li> <li>3. Temperature check for all visitors. Limit visitor number and visiting duration</li> <li>4. Special cubicle/room for all patients with exposure risk and respiratory symptoms</li> </ol>	
C. Operating theaters	<ol style="list-style-type: none"> <li>1. Reduce nonurgent operations</li> <li>2. All patients must wear face mask in operating areas</li> <li>3. All patients should change their cloths and put on new surgical caps and surgical masks to prevent contamination from outside environment</li> <li>4. Exercise standard precautions for needles and sharps injury</li> </ol>	<p>In addition to standard measures,</p> <ol style="list-style-type: none"> <li>5. Schedule patient as the last case of the operation list</li> <li>6. Operation to be done in negative pressure ventilation operating theatre, or one with proper infection control measures</li> <li>7. Proper PPE for all medical personnel. Restrict unrelated persons from entering. Patient must wear face mask</li> </ol>
D. Waiting area	<ol style="list-style-type: none"> <li>1. Adequate ventilation</li> <li>2. Only one accompanying person is allowed for each patient (except patients with special needs)</li> <li>3. Educational material regarding respiratory hygiene, hand hygiene, and symptoms of COVID-19 infection are shown, eg, in the form of posters</li> <li>4. Adequate ventilation</li> <li>5. At least 1 m spacing between patients</li> <li>6. Frequent disinfection of all commonly touched surfaces</li> </ol>	<ol style="list-style-type: none"> <li>7. Cared by designated team of healthcare workers in single rooms. Patient not allowed to enter common waiting area</li> <li>8. May wait in personal vehicle or outside the healthcare facility and called back upon their turn for ophthalmic assessment</li> <li>9. Patient must wear face mask</li> </ol>

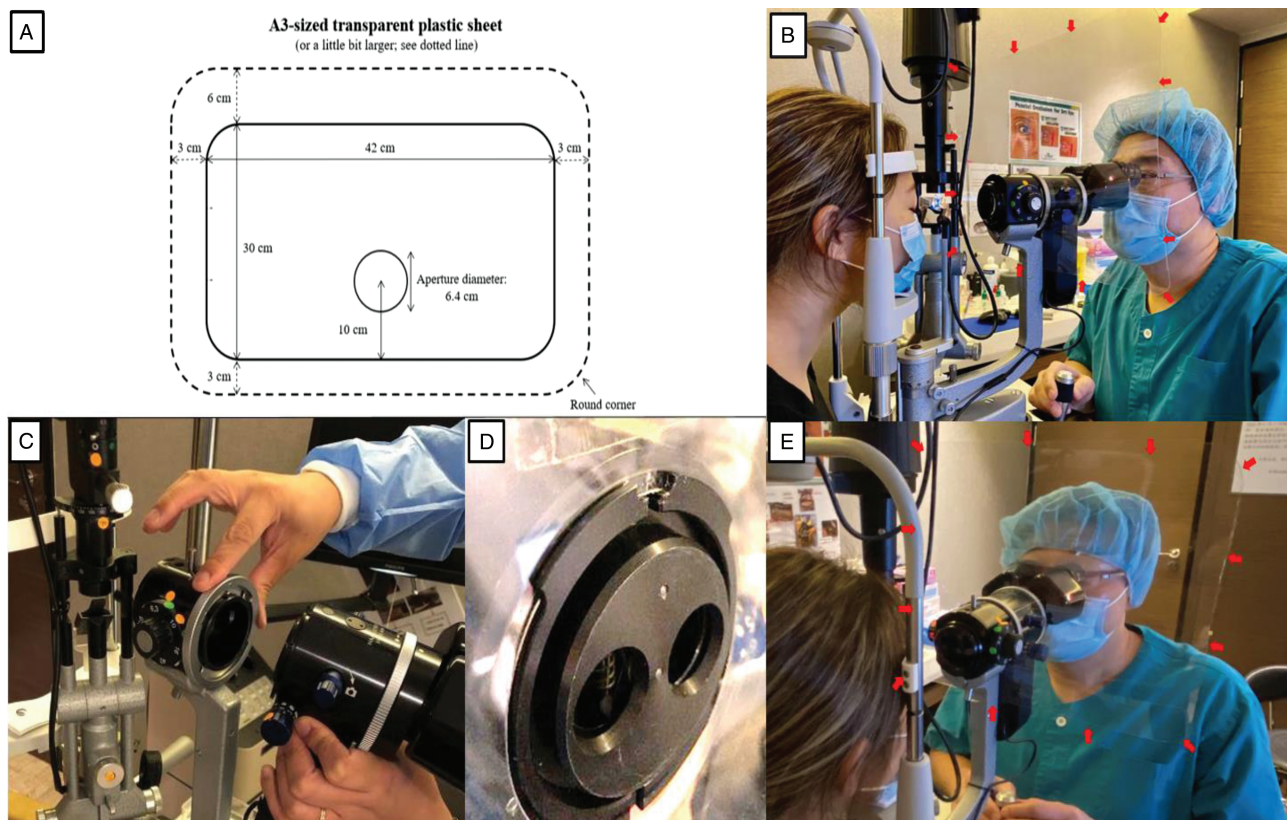
### FAQ 21. Are There Any Special Precautions for Patients Undergoing Ophthalmic Operations?

Surgical mask should be worn by all patients entering operating rooms, to prevent contamination from coughing or sneezing. Adhesive tape could be applied across the nose bridge area to ensure complete coverage of patient's nose and mouth. In our center, we also require patients changing their clothes and putting on surgical caps to further reduce the risk. For patients with suspected respiratory infection or exposure risk, only urgent operations would be considered. They would be scheduled as last case of operation to allow thorough disinfection afterwards. All personnel should be cautious and vigilant against sharp needles or blades injury. It would be a good idea to refer high-risk cases to hospitals that have adequate facilities such as negative-pressure isolation rooms to provide proper care to patients.

### CONCLUSIONS

The outbreak of COVID-19 has now spread to every part of the world. The key to successful reduction in morbidity and mortality during this pandemic relies on early identification, containment, prevention of transmission, and adequate supportive treatments. Before safe and effective vaccines and specific treatments are available, the only way to control and contain COVID-19 would be applying the basic principles and measures in the prevention of the transmission of the disease.

COVID-19 is an infectious disease following every rule in the field of infection control; therefore, as long as good infection control measures are implemented, prevention of disease spreading and zero new case in medical practices are not impossible. These are extremely important and relevant since there have been at least 3000 and 2600 medical professionals and healthcare



**FIGURE 7.** Photos showing (A) A3-sized transparent plastic sheet with round corners and a round hole of 64 mm (fit for Haag-Streit models) in diameter produced by a round cutter. The upper portion is larger to provide better protection, while the lower portion is smaller to allow easier access to slit-lamp manipulation; (B) the shield (red arrows) provides a barrier between the patient and the ophthalmologist; (C) the eye piece and the microscope modules of the slit-lamp are carefully disassembled; (D) the plastic sheet is fit into the microscope module through the circular hole; (E) the 2 modules are reassembled.

workers infected in China and Italy, respectively. In the midst of the current pandemic, everyone on this planet has to be highly vigilant and compliant to the precautions. We hope our answers to the frequently asked questions would help one be more fully equipped with the necessary knowledge and know how to protect oneself and the people around him/her.

## REFERENCES

- Li Q, Guan X, Wu P, et al. Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. *N Engl J Med.* 2020;382:1199–1207.
- Bourouiba L. Turbulent gas clouds and respiratory pathogen emissions potential implications for reducing transmission of COVID-19. *JAMA.* 2020; doi:10.1001/jama.2020.4756.
- Sahin AR, Erdogan A, Agaoglu PM, et al. 2019 Novel Coronavirus (COVID-19) outbreak: a review of the current literature. *EJMO.* 2020;4:1–7.
- Tran K, Cimon K, Severn M, et al. Aerosol generating procedures and risk of transmission of acute respiratory infections to healthcare workers: a systematic review. *PLoS One.* 2012;7:e35797.
- Lindsley WG, Pearce TA, Hudnall JB, et al. Quantity and size distribution of cough-generated aerosol particles produced by influenza patients during and after illness. *J Occup Environ Hyg.* 2012;9:443–449.
- Holme P, Masuda N. The basic reproduction number as a predictor for epidemic outbreaks in temporal networks. *PLoS One.* 2015;10:e0120567.
- Zhao S, Lin Q, Ran J, et al. Preliminary estimation of the basic reproduction number of novel coronavirus (2019-nCoV) in China, from 2019 to 2020: a data-driven analysis in the early phase of the outbreak. *Int J Infect Dis.* 2020;92:214–217.
- Sanche S, Lin YT, Xu C, et al. The Novel Coronavirus, 2019-nCoV, is highly contagious and more infectious than initially estimated. *medRxiv.* 2020; doi:10.1101/2020.02.07.20021154.
- Lloyd-Smith JO, Schreiber SJ, Kopp PE, et al. Superspreading and the effect of individual variation on disease emergence. *Nature.* 2005;438:355–359.
- Chowell G, Abdirizak F, Lee S, et al. Transmission characteristics of MERS and SARS in the healthcare setting: a comparative study. *BMC Med.* 2015;13:210.
- Cauchemez S, Nouvellet P, Cori A, et al. Unraveling the drivers of MERS-CoV transmission. *Proc Natl Acad Sci U S A.* 2016;113:9081–9086.
- She J, Jiang J, Ye L, et al. 2019 novel coronavirus of pneumonia in Wuhan, China: emerging attack and management strategies. *Clin Transl Med.* 2020;9:19.
- Habibzadeh P, Stoneman EK. The Novel Coronavirus: a bird's eye view. *Int J Occup Environ Med.* 2020;11:65–71.
- Rothe C, Schunk M, Sothmann P, et al. Transmission of 2019-nCoV infection from an asymptomatic contact in Germany. *N Engl J Med.* 2020;382:970–971.
- Guan W, Ni ZY, Hu Y, et al. Clinical characteristics of Coronavirus Disease 2019 in China. *N Engl J Med.* 2020; doi:10.1056/NEJMoa2002032.
- Lechien JR, Chiesa-Estomba CM, De Siati DR, et al. Olfactory and gustatory dysfunctions as a clinical presentation of mild-to-moderate forms

- of the Coronavirus Disease (COVID-19): A Multicenter European Study. *Eur Arch Otorhinolaryngol*. 2020; doi:10.1007/s00405-020-05965-1.
17. Weiss SR, Leibowitz JL. Coronavirus pathogenesis. *Adv Virus Res*. 2011;81:85–164.
  18. Gaunt ER, Hardie A, Claas ECJ, et al. Epidemiology and clinical presentations of the four human coronaviruses 229E, HKU1, NL63, and OC43 detected over 3 years using a novel multiplex real-time PCR method. *J Clin Microbiol*. 2010;48:2940–2947.
  19. Matoba Y, Abiko C, Ikeda T, et al. Detection of the human coronavirus 229E, HKU1, NL63, and OC43 between 2010 and 2013 in Yamagata, Japan. *Jpn J Infect Dis*. 2015;68:138–141.
  20. Peiris JSM, Guan Y, Yuen KY. Severe acute respiratory syndrome. *Nat Med*. 2004;10:S88–S97.
  21. Poon LLM, Guan Y, Nicholls JM, et al. The aetiology, origins, and diagnosis of severe acute respiratory syndrome. *Lancet Infect Dis*. 2004;4:663–671.
  22. Memish ZA, Perlman S, Van Kerkhove MD, et al. Middle East respiratory syndrome. *Lancet*. 2020;395:1063–1077.
  23. Zhu N, Zhang D, Wang W, et al. A Novel Coronavirus from patients with pneumonia in China. *N Engl J Med*. 2019;382:727–733.
  24. van Doremalen N, Bushmaker T, Morris DH, et al. Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. *N Engl J Med*. 2020;382:1564–1567.
  25. Stilianakis NI, Drossinos Y. Dynamics of infectious disease transmission by inhalable respiratory droplets. *J R Soc Interface*. 2010;7:1355–1366.
  26. Ai ZT, Huang T, Melikov AK. Airborne transmission of exhaled droplet nuclei between occupants in a room with horizontal air distribution. *Build Environ*. 2019;163:106328.
  27. Interim infection prevention and control recommendations for patients with suspected or confirmed Coronavirus Disease 2019 (COVID-19) in healthcare settings. Available at: [https://www.cdc.gov/coronavirus/2019-ncov/infection-control/control-recommendations.html?CDC\\_AA\\_refVal=https%3A%2F%2Fwww.cdc.gov%2Fcoronavirus%2F2019-ncov%2Fhcp%2Finfection-control.html](https://www.cdc.gov/coronavirus/2019-ncov/infection-control/control-recommendations.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fcoronavirus%2F2019-ncov%2Fhcp%2Finfection-control.html). Accessed March 18, 2020.
  28. System change - changing hand hygiene behaviour at the point of care. Available at: [https://www.who.int/gpsc/tools/faqs/system\\_change/en/](https://www.who.int/gpsc/tools/faqs/system_change/en/). Accessed March 18, 2020.
  29. WHO guidelines on hand hygiene in health care. Available at: <https://www.who.int/infection-prevention/publications/hand-hygiene-2009/en/>. Accessed March 18, 2020.
  30. N95 respirators and surgical Masks. Available at: <https://blogs.cdc.gov/niosh-science-blog/2009/10/14/n95/>. Accessed February 17, 2020.
  31. Novel coronavirus and COVID-19 outbreak - 3M Personal Protective Equipment (PPE) Considerations. Available at: [https://www.3m.com/3M/en\\_US/worker-health-safety-us/all-stories/full-story-detail/?storyid=8855304f-01cb-4af2-8937-83096cdb4113](https://www.3m.com/3M/en_US/worker-health-safety-us/all-stories/full-story-detail/?storyid=8855304f-01cb-4af2-8937-83096cdb4113). Accessed February 17, 2020.
  32. NIOSH-approved particulate filtering facepiece respirators. Available at: [https://www.cdc.gov/niosh/nppt/topics/respirators/disp\\_part/default.html](https://www.cdc.gov/niosh/nppt/topics/respirators/disp_part/default.html). Accessed February 17, 2020.
  33. Eninger RM, Honda T, Adhikari A, et al. Filter performance of N99 and N95 facepiece respirators against viruses and ultrafine particles. *Ann Occup Hyg*. 2008;52:385–396.
  34. He X, Reponen T, McKay RT, et al. 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;47:1180–1187.
  35. He X, Reponen T, McKay R, et al. How does breathing frequency affect the performance of an N95 filtering facepiece respirator and a surgical mask against surrogates of viral particles? *J Occup Environ Hyg*. 2014;11:178–185.
  36. Information for healthcare professionals: 2019-nCoV. Available at: <https://www.cdc.gov/coronavirus/2019-nCoV/hcp/index.html>. Accessed February 17, 2020.
  37. Jones RM, Brosseau LM. Aerosol transmission of infectious disease. *J Occup Environ Med*. 2015;57:501–508.
  38. Xia J, Tong J, Liu M, et al. Evaluation of coronavirus in tears and conjunctival secretions of patients with SARS-CoV-2 infection. *J Med Virol*. 2020; doi:10.1002/jmv.25725.
  39. Li X, Wang M, Chen C, et al. Ophthalmologists' strategy for the prevention and control of coronavirus pneumonia with conjunctivitis or with conjunctivitis as the first symptom. *Chin J Exp Ophthalmol*. 2020;38:276–280.
  40. Britt JM, Clifton BC, Barnebey HS, et al. Microaerosol formation in noncontact 'air-puff' tonometry. *Arch Ophthalmol*. 1991;109:225–228.
  41. Li C, Tang Y, Chen Z, et al. Aerosol formation during non-contact "air-puff" tonometry and its significance for prevention of COVID-19. *Chin J Exp Ophthalmol*. 2020;38:212–216.