## Utility of patient face masks to limit droplet spread from simulated coughs at the slit lamp

With the accelerated spread of the severe acute respiratory syndrome coronavirus 2 leading to coronavirus disease 2019 pandemic, there are unprecedented challenges on the medical community. Of major concern are the high titres of virus in the oropharynx early in the disease course, and long incubation period (5−7 days) of asymptomatic shedding of severe acute respiratory syndrome coronavirus 2.[1] Effective use of personal protective equipment (PPE) such as gloves, face masks, goggles, face shields, and gowns is critical to prevent the spread of infection to and from health care workers and patients. This is particularly important to clinicians who work in close proximity with the patient's face such as when performing slit-lamp examinations. Accordingly, the American Academy of Ophthalmology has recommended that patients not speak during slit-lamp examinations as well as the use of commercially available slit-lamp barriers or breath shields as an added measure of protection. However, breath shields may not fully eliminate the spread of droplets.[2] The use of masks by patients has been shown to mitigate the emission of various viruses into the environment and is recommended by the Centers for Disease Control and Prevention.[3] Herein, we aimed to investigate how various scenarios of masks worn by patients can reduce the spread of respiratory droplets onto the examiner during a slit-lamp examination using a simulated patient cough.

An ophthalmologist was positioned at a slit lamp donned in standard PPE with the most readily available breath shield hung on oculars (9.75 inches width by 10.5 inches in height, Carl Zeiss Meditec AG) and a manikin at the chin rest in place of a patient under examination. Under ultraviolet light conditions, a patient cough was simulated with ejected fluorescent dye droplets from a latex balloon that burst at 5 pound-force per square inch (PSI) inside the oral cavity of the manikin.[4] These methods for visualization of cough droplets were chosen based on previously validated techniques.[5,6] The detailed methodology for the conduction of the simulation has been reported elsewhere.[7]

In addition to the use of a breath shield, we aimed to identify means of further reducing the droplet spread by focusing on the use of masks for the patient under examination. Repeat simulations were conducted with (*i*) one of the most readily available cloth masks (black cotton face mouth mask); (*ii*) an ear loop surgical mask (American Society for Testing Materials Level 2, 3M) positioned incorrectly (loose and covering the mouth only to mimic a commonly encountered circumstance); (*iii*) an ear loop surgical mask with proper positioning (American Society for Testing Materials Level 2, 3M); and (*iv*) an N95 mask (Model 8210, 3M, not fitted to the manikin). The spread of droplets onto the field of the examiner and the slit lamp was identified under ultraviolet light conditions in each simulation as described above.

In the simulation with a cloth mask, droplets were identified on gloves of the examiner, and on the slit lamp (Video 1). An inspection of the inside of the mask demonstrated the spread of droplets beyond the outer borders of the mask on the superior, inferior, and lateral edges (Fig. 1). In the simulation involving the improperly positioned surgical mask, droplets were identified on the shoulders, arms, and gloves of the examiner as well as the slit lamp, floor, and walls. With the surgical mask properly positioned, the examiner was clear of droplets; however, some droplets were noted on the side bars close to the chin rest of the slit lamp. No droplets were identified on the examiner or the slit lamp in the repeat simulation with the use of the N95 mask. A view of the inside of the mask also revealed that droplets were contained within the mask.

Our findings suggest that the use of a properly fitted mask on the patient as an adjunct to the current standard PPE used by the examiner, and the breath shield is essential for limiting droplet dissemination during slit-lamp examinations. Cloth masks decrease the spread of respiratory droplets onto the examiner and can be even more effective than a surgical mask that is worn incorrectly. However, spread of some droplets was noted on the hands of the examiner during the slit-lamp examination with cloth masks. This may be owing to the poor design and poor flexibility of the material used to make cloth masks, which can lead to gaps through which respiratory droplets can disseminate easily. If worn correctly, surgical masks greatly reduce the spread of droplets onto the examiner. Although shown to be effective in this simulation, the current limited resources of N95 masks were have not been professionally fitted, for routine clinical encounters is not supported. These findings are consistent with other studies that have demonstrated reduced droplet transmission when wearing a face mask.[8] In addition to decreasing the spread of droplets, surgical masks worn by patients have been found to decrease the emission of different viruses into the environment, including influenza virus and coronavirus.[3]

It is important to note that this simulation does not identify the spread of very small particles and droplets. Although the bursting pressure for the balloon was adjusted to simulate a voluntary cough, the volume of the cough was overproduced beyond what would be expected in a natural cough in order to account for the potential extent and multidirectional spread of a true cough in various scenarios under one simulated setting. No means of accounting for turbulence of mucosalivary filaments in a simulated cough have been previously reported and thus were not accounted for in this simulation. Given that the goal of this simulation was to provide effective means of protecting the examiner, we did not assess the spread of droplets beyond the slit lamp

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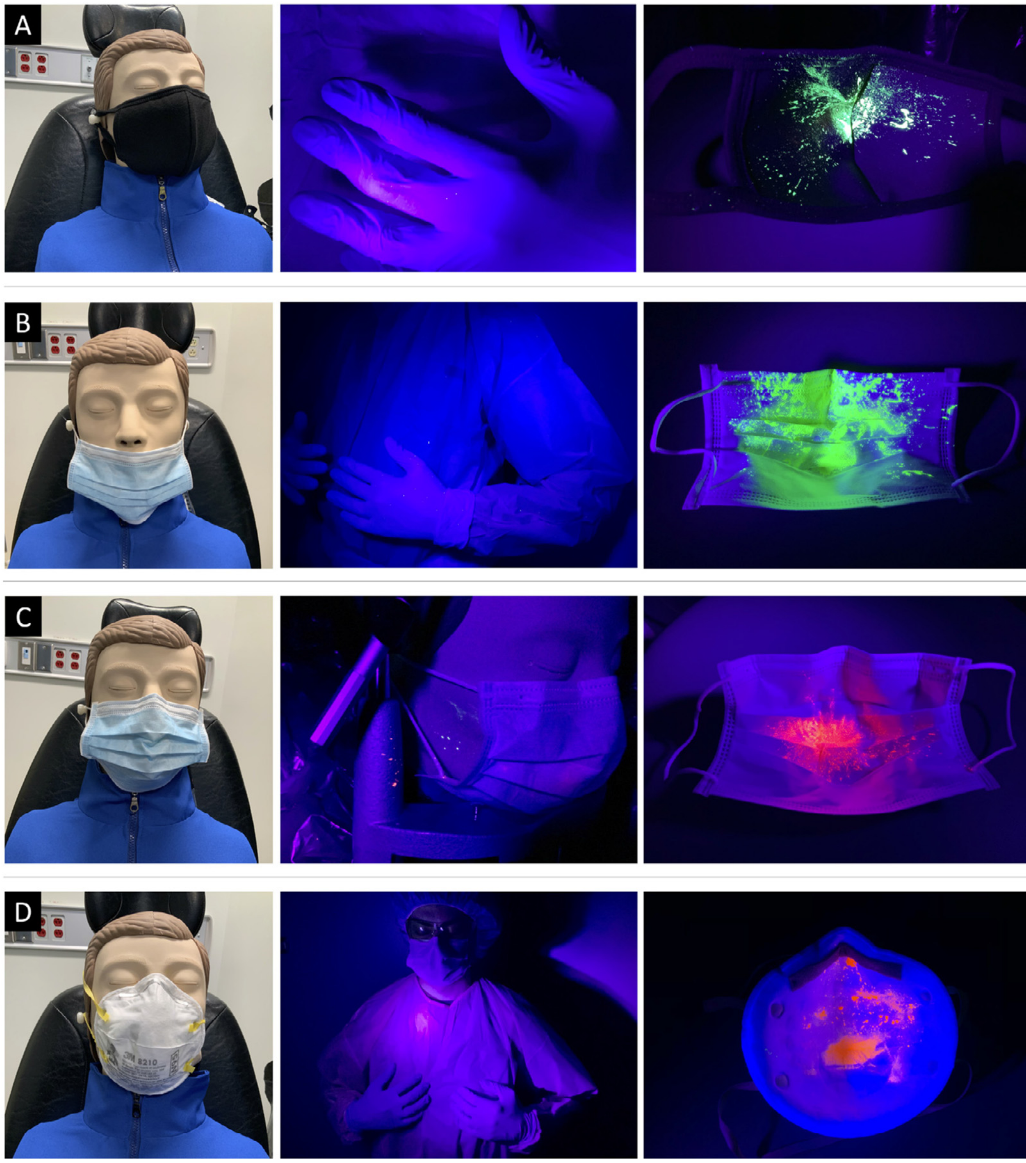


**Fig. 1—Images depicting each of the masks used in repeat simulations, spread of droplets, and droplets within the inside of the masks visualized with ultraviolet light. With the properly positioned cloth mask (A1), the examiner had spread of droplets onto gloves (A2). Droplets spread beyond the outer borders of the mask (A3). With the improperly positioned surgical mask (B1), the examiner had droplets on the gloves, arm, chest, and shoulders (B2). Droplets spread beyond the outer borders of the mask (B3). With a properly positioned surgical mask (C1), the examiner was clear of droplets, but droplets were detected on the side bar of the slit lamp (C2). No droplets spread beyond the outer borders of the mask (C3). With a properly positioned N95 mask (D1), no droplets were detected on examiner or the slit lamp (D2). No droplets spread beyond the outer borders of the mask (D3).**

and the examiner with the use of various masks. Furthermore, some variations may be noted in repeat simulations. Lastly, appropriate PPE for the examiner should be selected on a case-by-case basis for patients who are low risk, suspect, or confirmed positive for coronavirus disease 2019 and based on the recommendation of the local health authority.

Based on this, our recommendations for the use of masks for patients include the following: (*i*) patients should wear a mask during slit-lamp examinations (including a well-fitted cloth mask if it is the only available option); (*ii*) correct positioning of the mask is critical, and an improperly fitted mask may provide a false reassurance of protection; (*iii*) slit lamps should be disinfected between patients to prevent cross-contamination.

## Supplementary Materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.jcjo.2020.06.010.

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## Comparison of anterior segment measurements obtained by different swept-source OCT-based biometers

Precise estimation of intraocular lens (IOL) power is indispensable for achieving the desired refraction after cataract surgery. To minimize refractive prediction error, accurate preoperative biometry and optimal formula-based calculation of IOL power are crucial.

The IOLMaster 700 (Carl Zeiss Meditec AG, Oberkochen, Germany) is a new swept-source optical coherence tomography (SS-OCT)—based optical biometer that improves scanning speed, scanning sensitivity, tissue penetration, and image quality.[1,2] The IOLMaster 700 achieves a 44-mm scan depth with 22-$\mu$m tissue resolution using a laser with a wavelength centred on 1055 nm; it measures not only axial length but also anterior segment parameters, including anterior chamber depth (ACD) and lens thickness (LT), which are used for IOL power calculation. The CASIA2 (Tomey Corp, Nagoya, Japan) is another SS-OCT-based optical biometer, with a 13-mm-depth and a 16-mm-width scan range along with $\leq$10 $\mu$m of axial resolution when utilizing a wavelength light of 1310 nm. The CASIA2 is dedicated to measurement of anterior segment parameters. Huang et al demonstrated excellent agreement of axial length measurements obtained by 3 different SS-OCT biometers[3]; however, no previous study has compared measurements of anterior segment parameters obtained by different SS-OCT biometers.

The purpose of this study was to investigate the agreement of those measurements between the IOLMaster 700 and the CASIA2.

This prospective, nonrandomized, observational study was conducted with the approval of the Institutional Review Board of Hayashi Eye Hospital and adhered to the tenets of the Declaration of Helsinki.

Consecutive patients who were scheduled for cataract surgery by one experienced surgeon (T.S.) at Hayashi Eye Hospital between August 2018 and January 2019 were screened for possible inclusion in the study. In cases with bilateral cataract, the first operated eye of each patient was enrolled. The exclusion criteria were ocular pathology other than cataract that might affect visual acuity; a history of ocular surgery; and anticipated difficulty undergoing SS-OCT examination. Eligible patients were enrolled in the study after they had been given an explanation of its nature and possible consequences. Screening was continued until 100 eyes of 100 patients were recruited. Written informed consent was obtained from all study participants.

Preoperative optical biometry was performed under pupil-dilated conditions by 2 independent examiners (J.Y. and S. S.) using the IOLMaster 700 and CASIA2, both of which have excellent repeatability and reproducibility for measurement of anterior segment parameters.[2,4,5] The 2 biometers were used in a randomized order, and the measurements were consecutively performed within a short time interval to avoid the influence of circadian variation. Both SS-OCT biometers produce B-scan images to allow cross-sectional visualization of ocular structures along the visual axis. In the CASIA2 examination, any tracing error, particularly for the lens capsule, was checked on the captured image, and, if needed, corrected semi-automatically or manually.

The measurements for corneal curvature (K), central corneal thickness (CCT), ACD (distance from the corneal epithelium to the anterior surface of lens capsule), and LT were