# Safe Slit-lamp Shield: Maintaining a balance between ergonomics and safety

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Since the emergence of COVID pandemic, health workers have been facing major challenges every day. Ophthalmology practice has encountered countless modifications in the practice pattern not to jeopardize patient care and at the same time maintain all safety measures to reduce transmission. One such modification we made was the Safe Slit-Lamp Shield (SSS) which has been found to be extremely protective in differentiation to other available shield. Although SSS has a larger surface area when compared to already available shields, it won't compromise the comfort of the clinician at the same time gives satisfactory protection.

**Keywords:** Slit-lamp, COVID -19, Aerosol, Shield

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COVID-19 has imparted within us the need to observe social distancing and wear personal protective equipment (PPE) to protect us from the aerosol spread. By far and wide we practice all the recommended safety measures, but when it comes to the slit-lamp examination, it becomes an unfeasible situation. Slit-lamp examination is inevitable and now compelled to adapt to the new normal, we are placing ourselves at high risk of exposure while using slit lamp because of the close proximity between the doctor and patient. Hence, the use of a slit-lamp shield is highly recommended to protect ourselves from exposure to aerosol droplets during the examination.[1] Several shields of varying sizes and different materials like glass, acrylic, and X-ray sheets have been devised for slit lamp, but there is no standard or reliable size that has been proposed to be fully protective.

## Methods

An acrylic sheet was used to design a safe slit-lamp shield (SSS) of 67.3 cm length and 44.45 cm width. A central circular gap was created 15.25 cm below the upper edge for mounting the shield over the slit-lamp. Inverted "U" shaped cut measuring 21.59 × 7.62 cm was constructed on either side on the lower and outer aspect of the shield to allow for easy manipulation by the examiner while performing various investigations and interventions [Fig. 1].

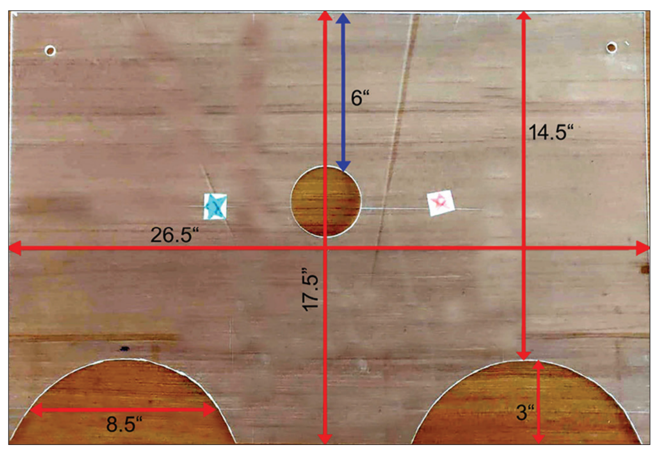


**Figure 1:** Shows the dimensions of Safe Slit lamp Shield

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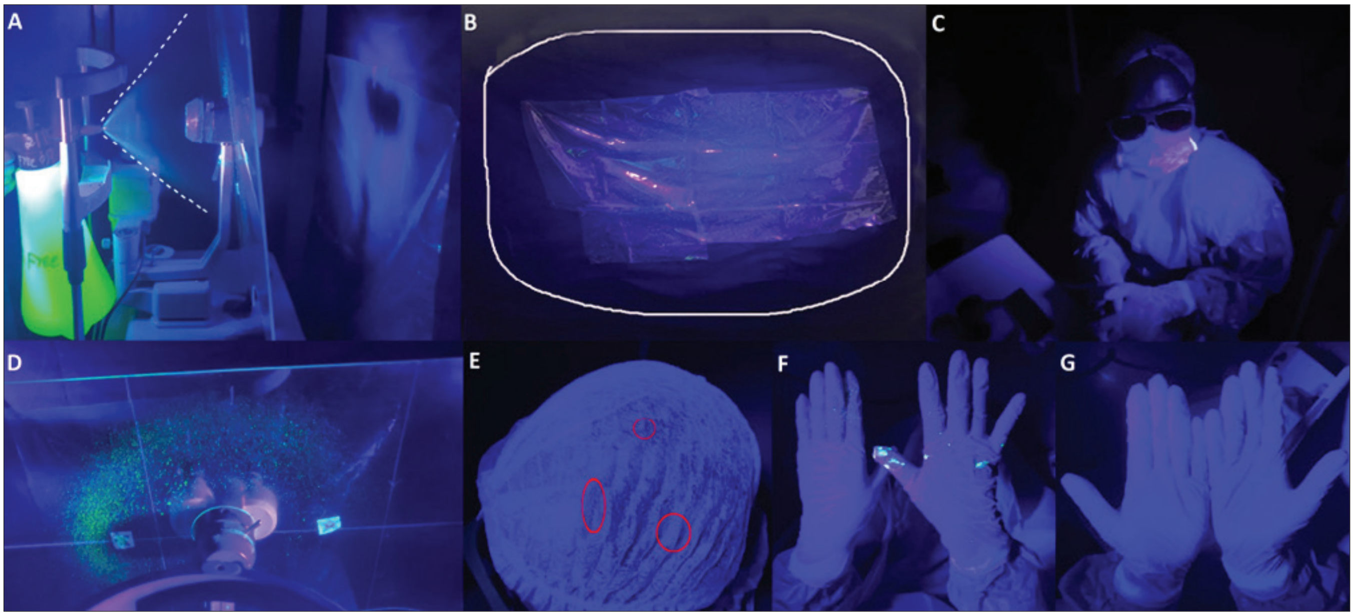



**Figure 2:** (a) Phase 1 of the experiment showing the nozzle spray bottle, angle of dispersion (dotted lines) of simulated aerosols which were captured using UV flashlight. (b) showing the area of safe zone around a plastic sheet (white circle) within which no aerosol could be detected. (c) Set-up of the clinician wearing protective gear in black for the qualitative assessment of the shields. (d) Phase 2 experiment with Safe Slit lamp Shield (SSS), droplets did not cross beyond the shield. Clear areas can be seen around the aerosols showing the extent of spread. (e-f) Phase 3 experiment with smaller shields proved that aerosols transferred to head cap and palm of the clinician. (g) Use of SSS for the same experiment showed clear hands of the clinician

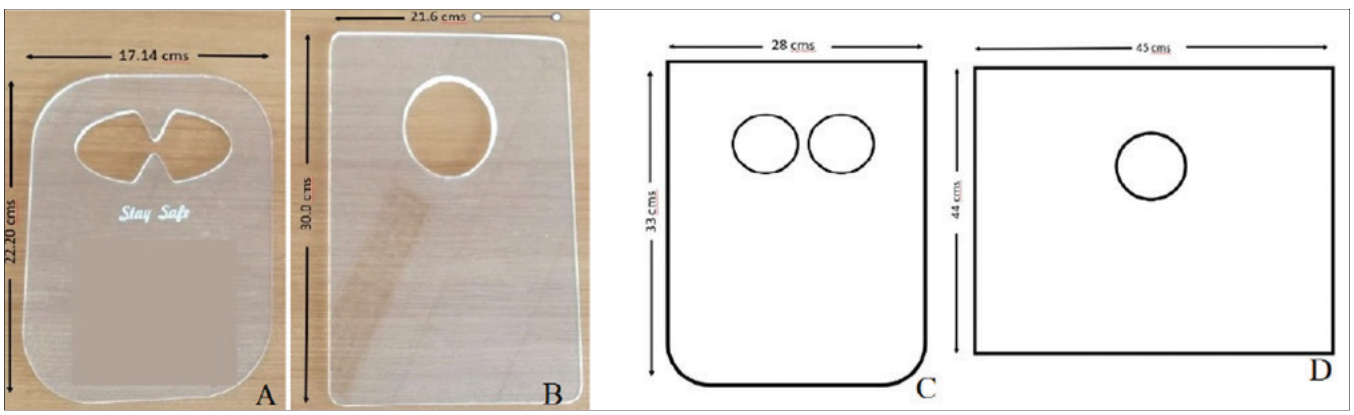



**Figure 3:** (A-D) Various commercially available Slit-Lamp Shields models' replica used in the Phased-experiments as mentioned in Table 1

Double-sided foam tape was applied below the eyepiece to ensure stability. Fixation targets were pasted on either side of the shield for easy focussing and quicker examination, especially for children. To evaluate the efficacy of this shield when compared to other commonly available commercial shields, we performed experiments in three phases [Video 1].

### Phase 1 – setup of the experiment

A Topcon SL-2G slit-lamp was placed in a black cubicle to avoid surrounding artifacts. We used a spray gun filled with fluorescein dye mixed with saline at specified parameters to simulate cough and sneezing as mentioned in previous studies.[2] The aerosol droplets were traced with the help of ultraviolet (UV) torchlight (THINK3 ™ 100 LED Professional UV Flashlight) [Fig. 2a] The droplets were captured using slow-motion video support for 1080p at 240 frames per second in iPhone 11.

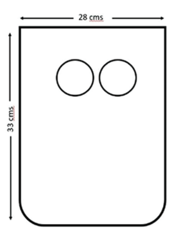
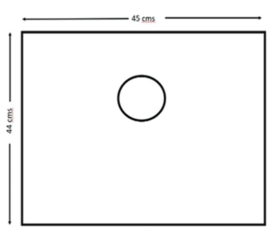
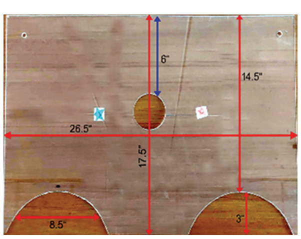
### Phase 2 – quantitative analysis

We tried to determine the potential area of aerosol spillage with various shield models described in the literature. We quantified the efficacy of each slit-lamp shield model along with this newly designed SSS by calculating the mean area of safe-zone over plastic screen kept at the examiner's distance. The area of safe zone was defined as the best fit circle around the plastic sheet beyond which droplets were identified [Fig. 2b]. The mean area was measured after three repetitions with each model and the 95% confidence interval (CI) value was taken [Table 1 and Fig. 3a-d].

### Phase 3 – qualitative analysis

We determined the qualitative effectiveness of the shields by evaluating the droplets spread over the examiner (with protective equipment worn) in a clinical setting [Fig. 2c].

**Table 1: Variation of safe area provided along with percentage efficacy by various shield models in relation to exposure without breath shield**

| Model number | Model pictures | Breath Shield measurements L×B | Mean Area of Coverage (best-fit circle) without spillage of aerosol (95% CI) after '3' consecutive reading with each shield model through cough simulating experiment detected using UV filter light)# | Slit-lamp shield Efficacy in Percentage (Calculated using Safe area provided by using shields with-respect to the total area of spread without any shields placed) |
|---|---|---|---|---|
| Control (without any shield) | NA | NA | 6484±177 $cm^2$ | (No protection) |
| 1st Model: |  | 22.20 cm × 17.14 cm | 1336±74 $cm^2$ | 20.60% |
| 2nd Model: |  | 30 cm × 21.6 cm | 2355±215 $cm^2$ | 36.32% |
| 3rd Model: Simulated "Zombie"-Sized Shield AMBUZ |  | 33 cm × 28 cm | 2826±174 $cm^2$ | 43.58% |
| 4th Model: Simulated "Augmented Breath shield" |  | 45 cm × 44 cm | 6358±439 $cm^2$ | 98.05% |
| 5th Model: Experimental model- Safe Shield" |  | 67.30 cm × 44.45 cm | (No spillage noted beyond the shield in '3' consecutive experiments) | 100% |

#Shields were placed between the oculars and objective lens arm at distance of 21.5 cm. NA not applicable, L Length, B Breadth

## Results

With no shield in place, the mean area of spillage was found to be 6484 ± 177 $cm^2$ (95% CI) after three repetitions of the aerosol experiment. It was considered to provide 0% protection and was taken as a reference to find the efficacy of SSS and other shields.

The largest model that was mentioned in the experiment by Liu *et al*.[2] provided a mean safe area of 2826 ± 174 $cm^2$ allowing protection of 43.58%. When the same experiment was repeated using the replica model of "augmented shield" demonstrated by Poostchi *et al*.[3] it was found to provide a mean safe area of 6358 ± 439 $cm^2$ allowing efficacy of 98.05%. The newly designed


**Figure 4:** An examiner comfortably performing Foreign Body removal with the use of SSS thus showing the ease of work in OPD and triage clinics without compromising safety

SSS model barely showed any spillage of aerosol in the three consecutive spray experiments thereby providing almost 100% protection [Fig. 2d and Table 1].

The qualitative assessment of the phase 3 experiment showed that with the smaller sized shield, aerosol was found over the examiner's head-cap, upper trunk, forearm, and palm [Fig. 2e and f] While with the largest available shield the dispersion was seen till the forearm. With SSS, no droplets were observed over the clinician [Fig. 2g].

## Discussion

The efficacy of numerous shields has recently been compared by Liu *et al*. where they concluded that commercially available shields may not block up to 54% of oronasal spray.[2] The larger shield that was used in this study had a total surface area of 1254 sq.cm[3]. Our shield has a surface area of 2794 $cm^2$ which is more than double the size of the mentioned. The "augmented shield" described by Poostchi *et al*. has almost a similar dimension.[4] The effectiveness of this model was calculated with a replica model and was found to be comparable with SSS. However, the slit-lamp based maneuvers were observed to be relatively cumbersome to perform because of the shape. In contrast, SSS has an inverted "U" shaped cut at the lower edges to allow more easy manipulation during the outpatient department (OPD) procedures [Fig. 4].

The ease to disinfect between every patient, transparency allowing easy communication, and ergonomic suitability make it an effective prototype for safe slit-lamp examination. It is a cost-effective, easy to manufacture and "Do-It -Yourself" model. The portable and sturdy nature make it technically preferable without compromising doctors' comfort during examinations and performing OPD procedures.

However, it is recommended that the patient should wear masks properly with correct positioning. Moreover, the examiner should use appropriate PPE. A slit-lamp shield of adequate size besides will offer comprehensive protection. A slit-lamp and slit-lamp shield should be cleaned in between every person to decrease cross-contamination.

## Conclusion

Even a short examination time exposes the healthcare workers to potentially infectious aerosols. Thus, using a slit-lamp shield of appropriate measurements can provide a useful adjunct to PPE for healthcare workers during slit-lamp examination. Although it may compensate for the inadequacies of wearing a mask, it cannot be used as a substitute for the same.

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### Conflicts of interest

There are no conflicts of interest.

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