

**The COVID-19 pandemic and ENT modified face shields**

*Editor*

The COVID-19 pandemic has resulted in a global shortage of PPE for HCW, resulting in many HCW crowdsourcing them out of desperation. Face shields (FS) is part of the package of PPE used in droplet precaution in this pandemic<sup>1</sup>.

We describe our design modified to fit the headlight (Vorotek, Australia) used by most Australian Otolaryngologists, the manufacturing process, as well as the testing and comparison processes. The manufacturing process is simple, and a local supply chain has been established. Therapeutic Goods Administration has granted approval to the Department of Medical Engineering and Physics, Royal Perth Hospital as a Class I medical device. This will ensure adequacy of supply beyond the current pandemic.

For our design, the visor is laser cut from a 500 micron polyethylene terephthalate glycol (PETG) sheeting (Adarsh Australia). PTEG is selected for its clarity and light transmission, impact resistance, economical,

readily cut with a laser thus achieving highly reproducible geometry with good tolerances. The frame is made of a forehead custom-shaped flexible polyurethane foam (Dunlop Foams C.A.S. Number: 9009-54-5), which is fixed to the visor using a food-grade cyanoacrylate glue (Loctite 435, Henkel). The glue is applied using a custom-made jig ensuring a reproducible amount is applied each application. The suspension system is circumferential with an elastic strap secured to the visor with a button through laser-cut holes. In order to fit the headlight, the binocular optic was flipped up and the distance anterior to the forehead measured (40 mm) for an extended foam projection (*Figs. 1a and b*).

Testing was in accordance to Australian/New Zealand Standard™ AS/NZS1337.1:2010 (The eye and face protectors for occupational applications) and specifically appendices K, P and V: low impact, penetration and splash resistance.

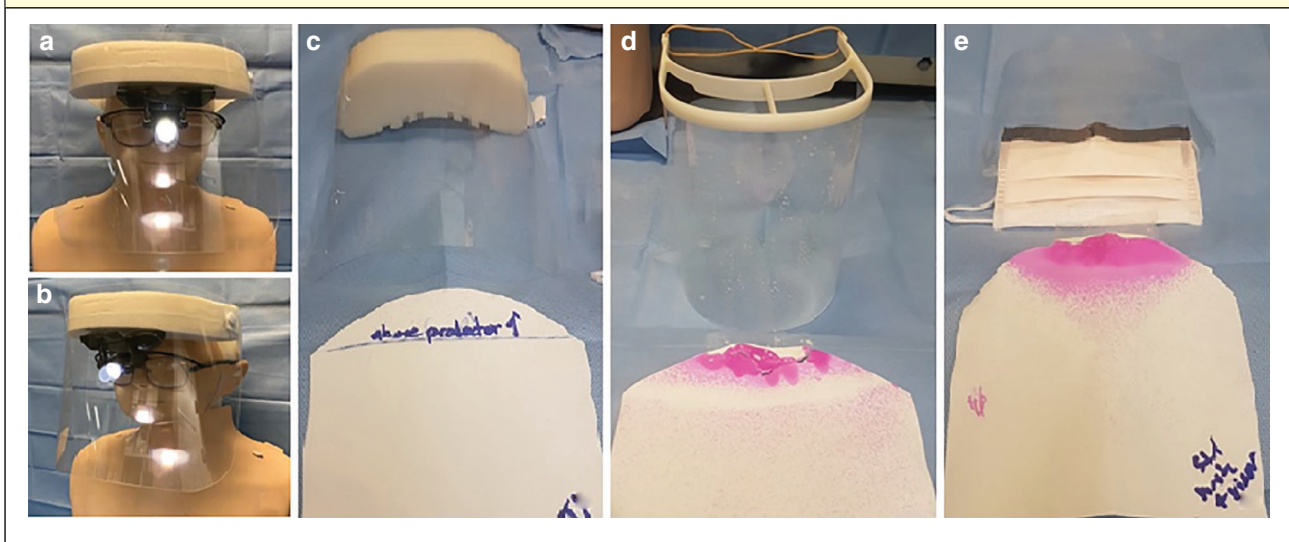
Using a resuscitation mannequin for the headform, the ocular area was covered with a white blotting

paper (180 mm × 100 mm) dipped in 0.1 mol/L of sodium carbonate and dried. A phenolphthalein solution was prepared as per the standard. A hand atomiser was sprayed at a rate of 28-30 mL/minute 600 mm from the headform in all directions within the frontal hemisphere but not extending beyond the ears over 10 seconds. If the reagent penetrated the FS, a crimson coloration will develop on the treated blotting paper.

Our FS was compared with a 3D printed FS downloadable from the internet (the recommended visor is an A4 overhead projector sheet), as well as a standard mask visor readily available in the hospital.

The most protective result is seen in *Fig. 1c*, where the ENT modified FS showed no penetration of droplets in all directions, especially superiorly, due to the protective effect of the foam and the design having the PTEG extend 10 mm above the superior edge of the foam. *Figure 1d* shows the significant diffuse contamination, due to the large gap extended to fit the headlight. In addition, the design resulted in the shield displaced anterosuperiorly


**Figure 1** ENT modified face shield (frontal view), b ENT modified face shield (oblique view), c ENT modified face shield with no droplet penetration, d 3D printed face shield with diffuse penetration, e Generic mask and visor with medial penetration superiorly



when the binocular optic is flipped up, which may contribute to contamination of the lower face and mask. Finally, *Fig. 1e* shows some contamination superiorly and medially of the mask visor, due to the angulation of the visor, with the apex directed centrally due to the position of the nose.

To our knowledge, this comparison has not been reported in the literature. We demonstrated the superior barrier to be a vital component of the FS, in addition to the adequate length and width. This design is disposable, and reusable as it is readily disinfected. It is inexpensive (AUD\$8.80/shield) to manufacture and is scalable. There is

minimal issue with retained dermal facial heat, less fogging compared to goggles, less claustrophobic, and can be worn concurrently with other eye PPE, prescription glasses or a respirator.

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