

BMJ Open Quality Building the barricade – DIY slit lamp breath shield

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ABSTRACT

Ophthalmologists were concerned about the risk of SARS-CoV-2 transmission via droplets given the close proximity to the patient during slit lamp examination. There is a need to design a simple, low-cost, waterproof breath shield to minimise risk of infection.

Dimensions of the Haag-Streit slit lamp (model BM 900) were recorded to guide accurate design of the breath shield. A questionnaire was circulated among slit lamp users on their perceived risk and concern about SARS-CoV-2 transmission and their perception of how effective different designs of breath shields would be at protecting them from an infection. A number of breath shield prototypes were designed and trialled. Plan, Do, Study, Act (PDSA) cycles were used to improve the design. Materials used to create the breath shields included transparent A3 laminating pouches and laminator, two sheets of A4 paper, scissors, hole punch and a ruler. The breath shield was designed to fit over the objective lens on the slit lamp after temporarily removing the standard, manufacturer-provided breath shield, before replacing it. The breath shields were cleaned after every patient with alcohol wipes and removed for deep cleaning with hand soap and water after each session. We used a proof of concept experiment using fluorescein instilled spray to test the effectiveness of each breath shield at preventing droplet transmission to the slit lamp user.

Following four PDSA cycles, a breath shield that is user-friendly, easy to clean was produced. The percentage of confidence that the final design would be effective at preventing droplet transmission increased from 5.6% to 80%.

Implementation of a low cost, simple to make, transparent, waterproof breath shield together with other forms of person protective equipment (PPE) creates a safe working environment for clinicians and patients. This intervention can be readily replicated and modified for other slit lamp models.

PROBLEM

COVID-19 has rapidly become a global health threat. It is caused by a novel virus SARS-CoV-2. Although fatality rate is likely to be lower than severe acute respiratory syndrome coronavirus (SARS-CoV) and Middle East respiratory syndrome coronavirus (MERS-CoV), it is highly transmissible. Its transmission is via respiratory droplets produced when an infected person coughs or sneezes. Several reports suggest that the virus can possibly be transmitted by aerosol contact

with the conjunctiva. A number of health-care workers have sadly passed away from COVID-19, including the first doctor to raise the alarm about the novel virus, an ophthalmologist working in Wuhan, China; and a Consultant Ophthalmologist at Croydon University Hospital, Moorfields Eye Hospital NHS Foundation Trust.^{1 2} Due to prolonged close contact with patients during slit lamp examinations and potential contamination of instruments, ophthalmic practitioners are at a higher risk of contracting the disease than other specialties.³

Since the disease was rapidly spreading in the community, authors at Epsom and St Helier University Hospitals NHS Trust Eye Units felt the urgent need to develop a quick and inexpensive way to provide protection to slit lamp users. Due to the rapid, unprecedented nature of the disease, no sufficient guidance for identifying patients with or at risk of COVID-19 in the clinic was available at the time. Understandably, colleagues expressed significant concerns about their exposure risk in an ophthalmic setting due to the close proximity to patients' faces and theirs during slit lamp examination; and a lack of confidence in Public Health England's (PHE) guidance on ophthalmic practitioners not having to routinely wear PPE.⁴ We felt that we must start to introduce our own protective equipment ahead of PHE and the Royal College of Ophthalmologists (RCOphth) guidance. Breath shields can be sourced from slit lamp companies such as Zeiss, Haag Streit, Daybreak Medical and Star Optical. However, utilising existing resources in the department means quick production of large quantities in a short period of time. We tried models and templates from other units designed to fit around the slit lamp eye pieces. The main flaw was residual openings around the eyepiece through which droplet transmission was possible should the patient cough or sneeze during the examination.

We aimed to design and implement a simple and inexpensive barrier on the slit lamp between the patient and the clinician, thereby reducing mortality and infection rate



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among healthcare professional and retaining the workforce that can be redeployed to fight in the frontline of the disease.

BACKGROUND

SARS-CoV-2 is a single-stranded RNA virus. It is highly transmissible and has a significant fatality rate especially among the elderly and patients with comorbidities such as immunosuppression, cardiac and respiratory conditions, diabetes mellitus. However, the young are not completely immune to this either. The impact has been felt worldwide, the WHO declared the outbreak a pandemic on 12 March 2020.⁵

It is thought that the primary route of transmission of the virus is through respiratory droplets via sneezing, coughing or fomites. There have been reports that suggest an oral-faecal route as the virus have been found in stools of infected patients. COVID-19 can manifest in many ways—ranging from no symptoms, mild flu-like symptoms (cough, fever, fatigue) to severe viral pneumonia requiring respiratory support. It was reported that the virus can affect the eyes in the form of viral conjunctivitis with symptoms of watery eyes, redness, swelling or discharge. Very rarely, conjunctivitis may manifest as the first sign of the disease.⁶

We wanted to alleviate some degree of anxiety among colleagues when working closely on slit lamps with patients by installing breath shields. We also wanted to simulate the process of generating droplets and how these would affect the examiner if a breath shield was not in place. Breath shields are now recommended by the RCOphth for all slit lamp examinations.

MEASUREMENT

We used a fluorescein infused spray to simulate droplets produced by a patient when sneezing or coughing on the slit lamp to show the need for a barrier between the examiner and the examinee. Without a breath shield, fluorescein droplets are clearly seen on the examiner's side of the slit lamp. It was clear from this proof of concept experiment that clinicians can easily come into contact with viral droplets during a prolonged close contact with patients during slit lamp examinations.

Qualitative data were collected from doctors to identify their concerns about the risk of COVID-19 transmission as ophthalmologists, experience in guidance provided by PHE and slit lamp protection provided in the department.

DESIGN

Haag-Streit slit lamps (model BM 900) are used within Epsom and St Helier University Hospitals NHS Trust. The following design works in conjunction with the original breath shield and is suitable to use with BM 900 slit lamps. Materials needed are listed below:

- ▶ One A3 transparent laminator pouch (160 microns, 2×80 microns)

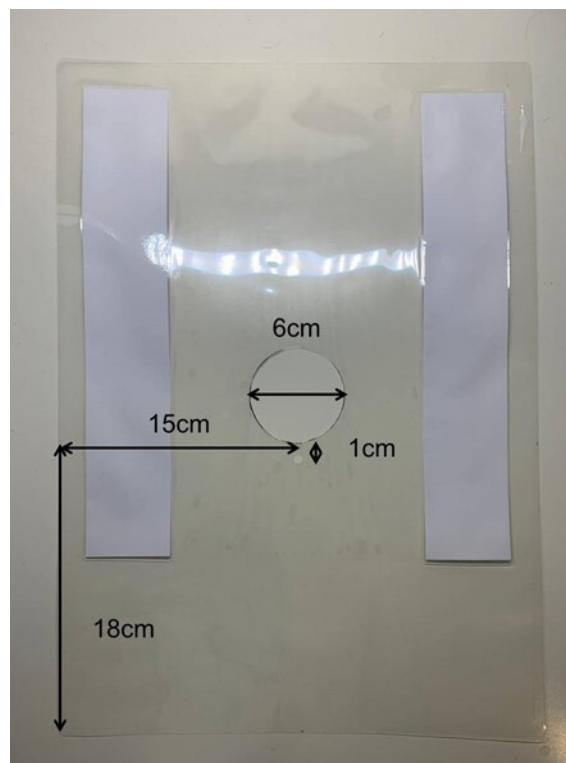


Figure 1 Breath shield measurements for Haag-Streit slit lamps (model BM 900).

- ▶ One A3 Laminator
- ▶ Two A4 pieces of paper
- ▶ A pair of scissors
- ▶ A hole punch
- ▶ A jar with a 6 cm diameter
- ▶ A ruler

Instructions are as follows:

1. Fold the A4 paper along its long edge into a quarter. Repeat this for both pieces of A4 paper.
2. Place the folded A4 papers on either side inside of the A3 laminator pouch and laminate the pouch.
3. Measure the location and size of the central circular opening (figure 1). Cut this area out.
4. Make another small opening underneath with the hole puncher for the screw of the original breath shield that came with the slit lamp to go through
5. Remove the original breath shield and mount the do it yourself (DIY) breath shield through the objective lens (figure 2A).
6. Replace the original breath shield and the screw to secure it (figure 2B).

Haag-Streit has since provided free downloadable A3 size breath shield templates for their slit lamps.⁷ The diameter they recommended for BM 900 is 6.5 cm. The circumference of the objective lens measured at 20.15 cm, making its diameter 6.41 cm. Our template of 6 cm diameter gives a tight seal around the objective lens minimising droplets from coming through the gaps however small this might be. This provides a tight seal because the laminating pouch is a semiflexible material which can stretch and mould

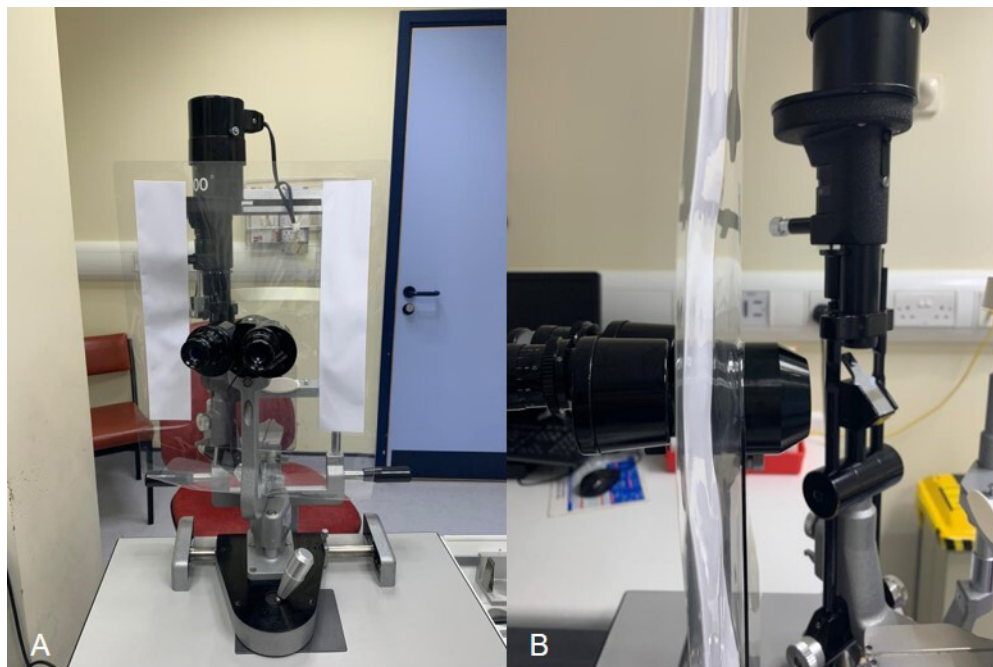


Figure 2 (A) Mount the DIY breath shield through the objective lens. (B) Side view after the placement of breath shield and the tight seal it forms around the objective lens.

around the objective lens. The breath shield is a cheap, easy to implement intervention that provides a large enough barrier between the examiner and the examinee during prolonged, close proximity slit lamp examination. It is also easy to clean after every consultation.

STRATEGY

PDSA cycle 1: we tried different materials and methods of mounting the breath shield. First, we used a clear A4 folder that was cut open into A3 size. This was placed through the objective lens piece working in conjunction with the original breath shield. Unfortunately, it was too soft and bent easily at the top making examination difficult for the clinician.

PDSA cycle 2: we then used an A4 laminated pouch with a sheet of A4 paper in it to provide strength. However, the size does not provide adequate cover and having paper inside means it is not transparent.

Verbal and written feedback from our questionnaire showed that all trainees, fellows and consultants in the department felt that they were at a high risk of COVID-19 transmission due to the close distance between them and the patient during slit lamp examinations. 72.2% felt that guidance provided by PHE was either insufficient or unclear on identifying patients with or at risk of COVID-19. The initial models of breath shield were not of a sufficient size, users had difficulties in accessing controls and in performing basic procedures such as intraocular pressure measurements, corneal scrapes and foreign body removal.

PDSA cycle 3: finally, we tried using an A3 laminated pouch alone and cut openings for the eyepiece and slit length control. This is a strong and transparent shield

but gaps around the opening means droplets can still go through and reach the examiner. From these experiences, we have learnt that we would like to produce an A3 sized, transparent, strong, waterproof breath shield that is in keeping with where the original slit lamp breath shield is located.

PDSA cycle 4: in order to ensure that the next version of the breath shield includes all the lessons learnt from the first few attempts, we decided to use A3 laminating pouches to provide transparency, folded A4 paper to provide visibility and strength. Measurements were taken more accurately for the height between the microscope rotating arm, the original breath shield screw and objective lens; as well as the circumference of the objective lens. We produced the final product as shown in [figure 1](#). This was trialled on slit lamps at St Helier Hospital. We gained verbal and written feedback from medical and nursing colleagues who felt that the breath shield was easy to instal and use. 80% felt more confident that the breath shield can provide protection against droplet transmission compared with the initial 5.6% ([table 1](#)). We then mass produced for the rest of the department in both sites (Epsom General Hospital and St Helier Hospital) including ophthalmic theatres.

POST MEASUREMENT

With the breath shield installed, it gives a good barrier when it is sprayed with a fluorescein infused spray ([figure 3A,B](#)). The examiner's side of the slit lamp is spared from fluorescein. The breath shield allowed fluorescein to slide and drip down its surface. Following this, we tested whether the breath shield is waterproof. We removed it from the slit lamp and washed it under

Table 1 Users feel more confident that the final product of the breath shield is easy to instal and use, they are able to perform basic procedures at the slit lamp and more reassured that this forms a barrier that protects them from droplet transmission

	PDSA cycles 1–2	PDSA cycles 3–4
Size	A4	A3
Transparency	No	Yes
The breath shield is of sufficient size	11.1%	72.2%
The breath shield is easy to instal	72.2%	77.8%
I am able to reach all the controls with ease	16.7%	61.1%
I am able to perform basic procedures such as intraocular pressure measurement, corneal scrape/ suture removal/ foreign body removal with this breath shield on	16.7%	55.6%
I am confident that this provides protection to droplet transmission	5.6%	80%

PDSA, Plan, Do, Study, Act.

water until it was fluorescein free. Similar to handwashing advice, we washed the breath shield with water and hand soap for at least 20s. The A4 papers inside the breath shield remained dry confirming the shield is waterproof. In addition, we were able to demonstrate that this product is easily cleaned.

LESSONS AND LIMITATIONS

Although breath shields are already widely used in other countries, there were challenges and resistance in implementing this in our department initially because there was no existing trust guidance on this. However, it soon became clear that breath shields form part of the PPE and frontline staff should be adequately protected. Ahead of published guidance, the lesson highlighted here is the

need for leadership, initiative and persistence in such unprecedented times. Since trialling them at St Helier Hospital, breath shields were made for all slit lamps for both sites of Epsom and St Helier University Hospitals NHS Trust including ophthalmic theatres within 24 hours.

A limitation highlighted by users was the access to the slit length and filter controls. This can be overcome by moving the microscope rotation arm to either side for easier access, adding additional openings or trimming the upper border of the breath shield to access controls. However, we do not recommend the latter two options due to the increased risk of droplet transmission. Another potential limitation is the size of the breath shield. Some particles of fluorescein can be seen beyond the barrier. A solution to this could be having a wider shield or a different shape, however, a balance between adequate protection and ease of access to key slit lamp controls must be struck. Finally, there are many models and manufacturers of slit lamps. This particular breath shield we made is specific for models in our hospital. However, it is easily replicable and modified for other models using similar design process.

CONCLUSION

Utilising existing and readily available resources minimises the financial burden in underfunded healthcare systems and developing countries. This is a sustainable product as it is easily replicable should future replacements are required. Patient and clinician safety is paramount; clinicians should be working and patients should be treated in a safe environment, protected from avoidable harm. Due to the exceptional circumstances of the ongoing outbreak, staff can be asked to act outside of their normal role in a different department. It is in patients' best interest to preserve our workforce as much as possible in order to deploy clinical staff to frontline practice to assist with the national COVID-19 response. Finally, addition of the breath shield does not replace the need for hand hygiene and the use of face masks for both the patient and clinician. Handwashing with soap and water as well as wearing face masks remain important

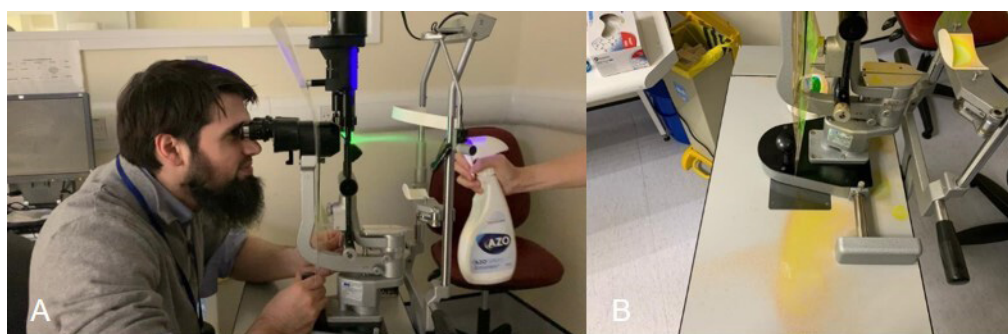


Figure 3 (A) Fluorescein instilled spray sprayed towards the clinician to simulate when a patient cough or sneeze with the breath shield in place. (B) After four consecutive sprays, there is a clear demarcation where the breath shield is protective against droplets produced in close proximity.

methods to prevent infection. In summary, we present a simple, tested, cost-effective, easily reproducible design of slit lamp breath shield amenable to mass production to protect slit lamp users and patients alike during the current coronavirus pandemic.

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