

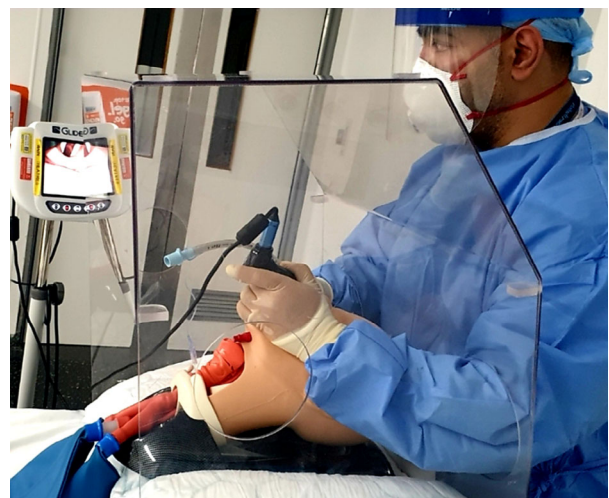
## Maximising application of the aerosol box in protecting healthcare workers during the COVID-19 pandemic

We report the rapid evolution of the aerosol box, originally designed by Dr Hsien Yung Lai, Mennonite Christian Hospital, Taiwan [1]. The aerosol box was intended to protect healthcare workers performing aerosol generating procedures, specifically tracheal intubation, by providing a physical barrier to droplet and/or aerosol exposure [2]. An increased infection rate has been reported in healthcare workers internationally, particularly when the level of personal protective equipment (PPE) has been inadequate or when the supply of PPE has been depleted [3]. The aerosol box can be made of transparent acrylic or polycarbonate sheeting, and is re-usable after careful decontamination with an appropriate cleansing agent. The original model was based on a simple cuboid design, with two access ports for arms.

We have made significant modifications to the design (Fig. 1) in order to improve patient safety, maximise viral protection for staff, optimise operator ergonomics and increase its utility for different tasks and in different clinical settings. The modified box is wider and taller than the original, to enable use with larger patients, permit ramped positioning of patients (rather than only supine), and provide additional space for manoeuvring unwieldy airway equipment such as a gum elastic bougie, if required. The newly added sloping angled surfaces reduce refractive error and improve operator ergonomics, particularly for those staff that are shorter in stature, who were previously placed in a disadvantageous position by the vertical sides of the original design. We too shared the concerns expressed by Kearsley [4], regarding the 'one size fitting all' for patients and staff, as well as the inability to manipulate a gum elastic bougie in the original design, which we feel have now been adequately addressed. We have also added a front lip and base support to stabilise the aerosol box, particularly when the bed is in a reverse Trendelenburg position, and side handles to facilitate swift removal of the aerosol box if required. There are now side ports to permit access of an assistant's hand, suction tubing or a videolaryngoscope lead. The newly tapered panels facilitate safe stacking and space-saving storage of multiple units, and the plastic stoppers attached to the roof prevent damage during storage. A transparent plastic drape can be attached to the anterior surface (not shown in Fig. 1), that provides additional protection to staff positioned in front of the

patient, and enabling a rudimentary negative pressure chamber to be created with application of suction or scavenging.

From the trials we have undertaken in our respective anaesthetic and critical care units, it is evident that these new design features have significantly increased the versatility and applicability of the aerosol box. We agree with Kearsley [4] that the aerosol box (or any similar enclosed barrier device) should not compromise patient or staff safety, or excessively complicate already complex processes. Therefore, we recommend the aerosol box be used as an additional measure to supplement existing airborne PPE precautions when undertaking carefully selected aerosol generating procedures, and not as an alternative to appropriate PPE, or for all aerosol generating procedures. For example, we do not recommend the modified aerosol box to be used during emergency tracheal intubations, where any reduction in manoeuvrability may be significant in such a time-critical task. We have, however, discovered multiple alternative uses where it may confer additional staff protection without compromising patient safety. These might include controlled postoperative tracheal extubation in theatres (but not critical care patients) and nasogastric tube insertion, where droplet exposure (and potentially airborne transmission [5]) is expected to be high due to forceful patient coughing. The modified aerosol box may also be



**Figure 1** Modified aerosol box, showing the laryngoscopist intubating the trachea of a manikin, with his arms inserted through the posterior access ports.

used for tracheal tube exchange, and for tracheostomy tube changes, where tube clamps cannot be applied. Similarly, the box may be advantageous for tracheostomy inner cannula changes and tracheostomy suctioning, especially because these are highly repetitive procedures (performed every 2–4 h in some units), where cumulative viral exposure may be significant. The box may also have a role in the intra-hospital transfer of COVID-19 ventilated and non-ventilated patients, and in the cleaning of highly contaminated equipment.

As Cook states in his narrative review of PPE [6], there is very little quality evidence in this area, and a scarcity of data supporting any aspect of PPE. Innovation should be embraced, but caution should be applied. We must emphasise that the modified aerosol box is an adjunct to the PPE advocated by Public Health England, and that a high degree of vigilance is necessary when utilising it, combined with meticulous cleaning of the unit between uses, in order to avoid inadvertent operator breaches in PPE and cross-contamination.

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