Endotracheal intubation with barrier protection

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ABSTRACT

Given the high risk of healthcare worker (HCW) infection with COVID-19 during aerosol-generating medical procedures, the use of a box barrier during intubation for protection of HCWs has been examined. Previous simulation work has demonstrated its efficacy in protecting HCWs from cough-expelled droplets. Our objective was to assess its ability to protect HCWs against aerosols generated during aerosol-generating medical procedures. We used a battery-powered vapouriser to assess movement of vapour with: (1) no barrier; (2) a box barrier; and (3) a box barrier and a plastic sheet covering the box and patient's body. We visualised the trajectory of vapour and saw that the vapour remained within the barrier space when the box barrier and plastic sheet were used. This is in contrast to the box barrier alone, where vapour diffused towards the feet of the patient and throughout the room, and to no barrier where the vapour immediately diffused to the laryngoscopist. This demonstrates that the box with the plastic sheet has the potential to limit the spread of aerosols towards the laryngoscopist, and thus may play a role in protecting HCWs during aerosol-generating medical procedures. This is of particular importance in the care of patients with suspected COVID-19.

Given the increased risk of viral contamination during aerosol-generating medical procedures, new methods of healthcare worker (HCW) protection have been devised during the COVID-19 pandemic.[1] One such method is the use of an aerosol box during intubation. As previously described, this is a transparent box that covers the patient's head with two ports that allow the laryngoscopist access to the airway for manipulation and endotracheal intubation.[2 3] Previous work using fluorescent dye with a simulated cough and expelled droplets demonstrated that use of the box limited droplet contamination to the interior of the box and the laryngoscopist's gloves and forearms, reducing overall exposure to HCWs.[2] Our method of simulation sought to further examine the movement of aerosols and efficacy of the box barrier to limit aerosol diffusion (box prototype designed by Tom Gaasenbeek of NexMED Technologies Inc, Hamilton, Ontario, based on the design by Dr Hsien Yung Lai).[3]

This simulation was performed with an interdisciplinary team, including physicians, nurses and respiratory therapists in an urban ED in Hamilton, Canada, that sees an average of 185 patients per day. Using a handheld battery-powered vapouriser, we were able to visualise the trajectory of aerosols in the box with a plastic sheet (covering the box and patient's body), when compared with the box alone, or no barrier protection (online supplementary video 1). A staff member used a nicotine-free vapouriser in a negative pressure room in the ED and simulated coughing and breathing within the three settings. The staff member consented to video recording and understood the risks associated with vaping. There was no involvement of patients or the public in the design, conduct or reporting of this research. With no protection, the vapour immediately diffused towards the laryngoscopist. With the use of the box, the vapour diffused away from the laryngoscopist, escaping towards the foot of the bed. With the box and the plastic sheet, visualisation of the vapour suggested that it remained only within the barrier space, thereby limiting diffusion into the room. Additionally, the vapour was scented, and the laryngoscopist, wearing a K-N95 mask and face shield, reported being unable to smell the vapour with use of the box or box with plastic sheet. The laryngoscopist could however smell the vapour when no barrier was used. Our institute requires the use of N95 masks during aerosol-generating medical procedures; however, due to personal protective equipment shortages, the use of the K-N95 was required during this experiment.

This work, although improvised and unconventional, shows that on visual inspection, the box with the plastic sheet appeared to limit the spread of aerosolised particles. This demonstrates the potential of the box with a plastic sheet to augment the protection provided by personal protective equipment to HCWs during aerosol-generating medical procedures, including intubation and extubation. We make specific note of the fact that the addition of the plastic sheet to the box may afford an added level of protection to HCWs not situated at the head of the bed during high-risk procedures by limiting the down-patient spread of aerosols when compared with using the box alone. Importantly, the addition of a barrier at the aerosol source may reduce the risk of exposure to COVID-19. Reliance on standard personal protective equipment must be considered in the context of pandemic supply chain issues and real-world HCW contamination risks associated with doffing errors.[4 5]

We recognise the limitations of this work, namely its qualitative nature. Our aim was to address the potential of the box barrier to limit contamination of HCWs during aerosol-generating medical procedures, not to quantify or reproduce the aerosolisation of substances during intubation. The size of aerosol particles derived from vapourisers varies from 10 nm to 900 nm, depending on factors such as puff volume, puff duration and vapouriser power, as well as method of particle analysis.[6] Although this is not exactly equivalent to aerosolised viral particles (estimated at <5 µm), our methodology assessed qualitative visualisation of aerosol movement.[7] We recognise the potential inconsistency as a limitation. Furthermore, simple aerosol diversion through the methods discussed does not eliminate the risk of contamination, nor control the source, especially given that this was an unventilated system; thus, further methods to address source control and the eventual escape of aerosols from a contained system must be developed. Given that use of the box limits airway operator mobility and can therefore be technically challenging, we recommend all HCWs directly involved in its use practice before considering it for widespread implementation. We also recognise the fact that protected intubation and code blue protocols vary by institution, and the risk of aerosol generation and the mechanism by which this risk occurs may also vary. Where intubation

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is more likely to be complicated by the need for rescue airway device insertion/removal or peri-intubation hypoxic arrest management, additional contamination risks must be weighed against potential ergonomic considerations.

At this time, our institution is not using the box routinely. In light of the infection risk to HCWs during this pandemic, the potential efficacy of the box barrier to enhance protection of HCWs must be supported with future work demonstrating that it does not compromise intubation success, especially in the context of protected protocols and patient factors common to clinical care in the current climate.

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