CORRESPONDENCE

Re-purposing a face tent as a disposable aerosol evacuation system to reduce contamination in COVID-19 patients: a simulated demonstration

Ban C. H. Tsui, MD, MSC, FRCPC

Received: 21 April 2020 / Revised: 23 April 2020 / Accepted: 23 April 2020 / Published online: 30 April 2020
© Canadian Anesthesiologists' Society 2020

To the Editor,

Prevention of severe acute respiratory syndrome coronavirus 2 infection, which causes coronavirus disease (COVID-19), has many challenges¹ as the virus has been shown to survive on surfaces for up to 72 hr² and to contaminate the surrounding environment for an extended period of time after aerosol-generating medical procedures (AGMP) such as intubation. Although effective, conventional personal protective equipment only provides a static physical barrier between the healthcare provider (HCP) and the infectious patient. Recently, a reusable “barrier enclosure” created to contain droplets from a “forceful cough” during AGMP has been widely publicized.³ As most experts recommend rapid sequence induction of anesthesia (that entails deep neuromuscular blockade) to prevent any coughing during AGMP,⁴ aerosolized particles remain the greater risk to HCPs when intubating COVID-19 patients rather than droplets produced by any forceful coughing. While the barrier’s ability to temporarily capture aerosolized particles has not been shown, the non-disposable barrier itself creates an additional contagious surface (fomite) for the HCP to manage and disinfect. Thus, a disposable technique to immediately evacuate all aerosols generated during AGMP may present a superior option for HCP safety.

To evacuate the generated aerosols during AGMP, a negative pressure tent (NPT) was created by re-purposing a commercially available single-use, disposable oxygen face tent (Salters face tent; Salter Labs, Arvin, CA, USA) (Figure; eVideos, available as Electronic Supplemental Material). By inverting and placing the face tent on the forehead, this tent can serve as both a physical barrier and an aerosol evacuation device. Without hindering the AGMP, this inverted face tent contains a transparent soft material with a behind-the-neck strap for a secure fit, which allows for quick adjustments. When more caudally positioned, it can act as an additional physical barrier to prevent “forceful droplets” reaching the HCP (should that remain a concern). Appropriate suction tubing can be easily adapted to connect to the face-tent inlet to draw the airflow from the patient’s face area to act as an efficient aerosol evacuation device.

To simulate the aerosols in a patient’s mouth and nose generated from the AGMP (Figure), aerosolized saline was produced (1.6 µm median diameter aerosols) using a nebulizer (Airlife Misty Max 10 disposable nebulizer; Carefusion, Yorba, CA, USA) with eight litre per minute oxygen connected to an airway mannequin’s distal bronchus to continuously deliver aerosolized vapor into the mannequin’s mouth and nose. Prior to activating suction to the NPT, the aerosols polluted the local environment. In contrast, when the NPT was placed on the forehead of the mannequin with active suction generated by a high flow smoke evacuation system (Neptune 3, Stryker, Kalamazoo, MI, USA) with 25 cubic feet per minute (CFM) or a standard suction canister from the wall inlet with 2.5 CFM, the aerosolized vapor was rapidly eliminated. After it is used, the NPT can be easily disposed of into a biohazard container to eliminate further infection risk. Most

Electronic supplementary material The online version of this article (<https://doi.org/10.1007/s12630-020-01687-4>) contains supplementary material, which is available to authorized users.

B. C. H. Tsui, MD, MSC, FRCPC (✉) ·
Department of Anesthesiology, Perioperative, and Pain
Medicine, Stanford University School of Medicine, Palo Alto,
CA, USA
e-mail: bantsui@stanford.edu

Negative pressure tent connected to smoke evacuation system (7/8-inch hose with 25 CFM)

Negative pressure tent connected to standard suction canister system (3/16-inch hose with 2.5 CFM)

Figure Negative pressure tent illustration using inverted face tent (Salters Face Tent, Salter Labs, Arvin, CA, USA). Simulated aerosols were generated by an aerosol nebulizer with eight litres per minute oxygen connected to a mannequin's airway to continuously deliver aerosolized normal saline into the mannequin's mouth and nose. (Top) High-flow smoke evacuation system (Neptune 3, Stryker, Kalamazoo, MI, USA) was used for optimal results. The smoke

evacuator contains a high efficiency particulate air filter that captures particulates as small as 0.1 μm with at least a 99.99% efficiency rate for removing harmful aerosols. (Bottom) the negative pressure tent connected to a standard suction canister from the wall inlet or anesthetic machine, which provides less suction power than higher-efficiency systems. CFM = cubic feet per minute

importantly, an appropriate filter such as high efficiency particulate air must be placed in the suction system to prevent virus leakage into the surrounding environment or central vacuum system. As all components of this low-cost disposable NPT are readily available, rapid implementation during intubation (and possibly extubation) procedures regardless of COVID-19 status may enhance HCP safety by actively evacuating aerosols close to their source.

Acknowledgements The author would like to thank his pediatric anesthesiologist colleagues (Dr. Fabian Okonski, Dr. Stephanie Pan, Dr. Carole Lin and Dr. Mohammad Esfahanian), Aaron Deng (clinical research coordinator) from the Department of Anesthesiology, Lucile Packard Children's Hospital at Stanford for their contribution.

Disclosures None.

Funding statement None.

Editorial responsibility This submission was handled by Dr. Hilary P. Grocott, Editor-in-Chief, *Canadian Journal of Anesthesia*.

References

1. Phua J, Weng L, Ling L, et al. Intensive care management of coronavirus disease 2019 (COVID-19): challenges and recommendations. *Lancet Respir Med* 2019; DOI: [https://doi.org/10.1016/S2213-2600\(20\)30161-2](https://doi.org/10.1016/S2213-2600(20)30161-2).
2. van Doremalen N, Bushmaker T, Morris DH, et al. Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. *N Engl J Med* 2020; DOI: <https://doi.org/10.1056/NEJMc2004973>.

3. *Canelli R, Connor CW, Gonzalez M, Nozari A, Ortega R.* Barrier enclosure during endotracheal intubation. *N Engl J Med* 2020; DOI: <https://doi.org/10.1056/NEJMc2007589>.
4. *Cheung JC, Ho LT, Cheng JV, Cham EY, Lam KN.* Staff safety during emergency airway management for COVID-19 in Hong

Kong. *Lancet Respir* 2020; DOI: [https://doi.org/10.1016/S2213-2600\(20\)30084-9](https://doi.org/10.1016/S2213-2600(20)30084-9).

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.