Cross-Holes on a Plastic Bag Can Prevent Droplet Spread During Extubation

To the Editor

We read with great interest the article on endotracheal intubation for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) patients by Orser[1] and would like to add some comments related to their excellent study. Physicians must pay attention to droplet spread during not only intubation but also extubation, because extubation can produce more aerosol than intubation.[2] Intubation can be performed for a paralyzed patient, and generation of droplets and aerosols is then difficult. Inversely, extubation can cause cough and rough breathing, and the patient, who has already recovered from paralysis, can produce droplets and aerosols. As anesthesiologists, we consider that every extubation must be performed with precautions against droplet and aerosol spread, because patients who recover from SARS-CoV-2 may have positive test results again,[3] and, moreover, SARS-CoV-2 can be transmitted from asymptomatic patients to others.[3]

Unfortunately, whether perioperative patients have serious infections such as SARS-CoV-2 cannot be determined with absolute certainty. Even in a severe pandemic, semiurgent and urgent surgeries must continue, and extubation must be performed after surgeries if possible. However, diagnostic tools such as reverse transcription-polymerase chain reaction testing cannot be performed for all surgical patients because of the inconvenience and limited medical resources. If this pandemic were to continue for a long time, physicians will have to manage more extubations because elective surgeries must restart, and convenient, inexpensive devices to prevent droplet infection during extubation are needed. In this letter, a barrier with cross-holes on a plastic bag covering the patient's whole head, which can prevent droplet spread during extubation in a cough simulation model, is introduced.

Droplet spread was investigated using 2 different models, a normal extubation model (A) and an improved extubation model (B) with a 45-L clear plastic bag (80 cm long, 65 cm wide), usually used as a garbage bag for noninfective trash in our operating theater, with 2 elliptical holes forming a cross-hole (Figure). The 5-cm distance between 2 holes can avoid direct connection of the 2 holes and creates a free air layer inside the plastic bag, forming a double barrier structure to prevent droplet spread (Figure). We developed an experimental cough model and generated forceful spread of droplets and aerosols with a small latex balloon containing 10 mL of blue ink. The balloon was placed in the hypopharynx of the mannequin. The balloon was inflated with compressed oxygen run through tubing inside the mannequin until balloon explosion. A needle was attached on the tongue of the mannequin to explode the balloon in the mouth. The explosion of the balloon represented a crude simulation of a cough.[4] In model B, the endotracheal tube was removed in the caudal direction via the 2 holes just after bursting the balloon. Droplet spread was assessed as the spread of blue stains on 5 white papers placed at the front, top, head, right, and left inside the intubation box. The blue stains on the papers were changed to black and white by photo manipulation for easy identification of droplet spread and contrast. The experimental procedure and droplet spread were recorded with slow-mode videography.

Supplemental Digital Content 1, Figure 1, http://links.lww.com/AA/D161, shows the spread of blue stain on the white papers in both models, with no spread of droplets in model B. The slow-mode videography in model B indicated that our barrier would prevent droplet spread effectively. (Supplemental Digital Content 2, Video 1, http://links.lww.com/AA/D162). VIDEO+

These results show that the barrier with 2 holes in a plastic bag was critical in preventing droplet spread during extubation. Physicians must protect themselves, other doctors, and medical staff from droplet infection during every extubation, because SARS-CoV-2 can be transmitted from asymptomatic patients to others.[5] There are several safe techniques with a surgical mask, a drape, and an intubation box during extubation.[2,6] In this letter, a normal plastic bag was used, and no other assistants were required during extubation with this barrier. Besides these benefits, 2 cross-holes on a plastic bag can be easily prepared and provide a double barrier structure to block droplets. Cross-holes can decrease free space around the endotracheal tube compared with linear holes. In addition, the 5-cm distance between the 2 holes can create a free air layer as a double barrier structure, and the 2 holes close immediately and automatically because of the shape memory of a plastic bag. An endotracheal tube must be removed in the caudal direction, which makes the double barrier structure most effective, because the outer hole is created caudally to the inner hole. This barrier can also be useful for intubated patients in intensive care units, because oral suction or mouth care can be performed through cross-holes. After extubation, we can protect ourselves from droplets of coughs secondary

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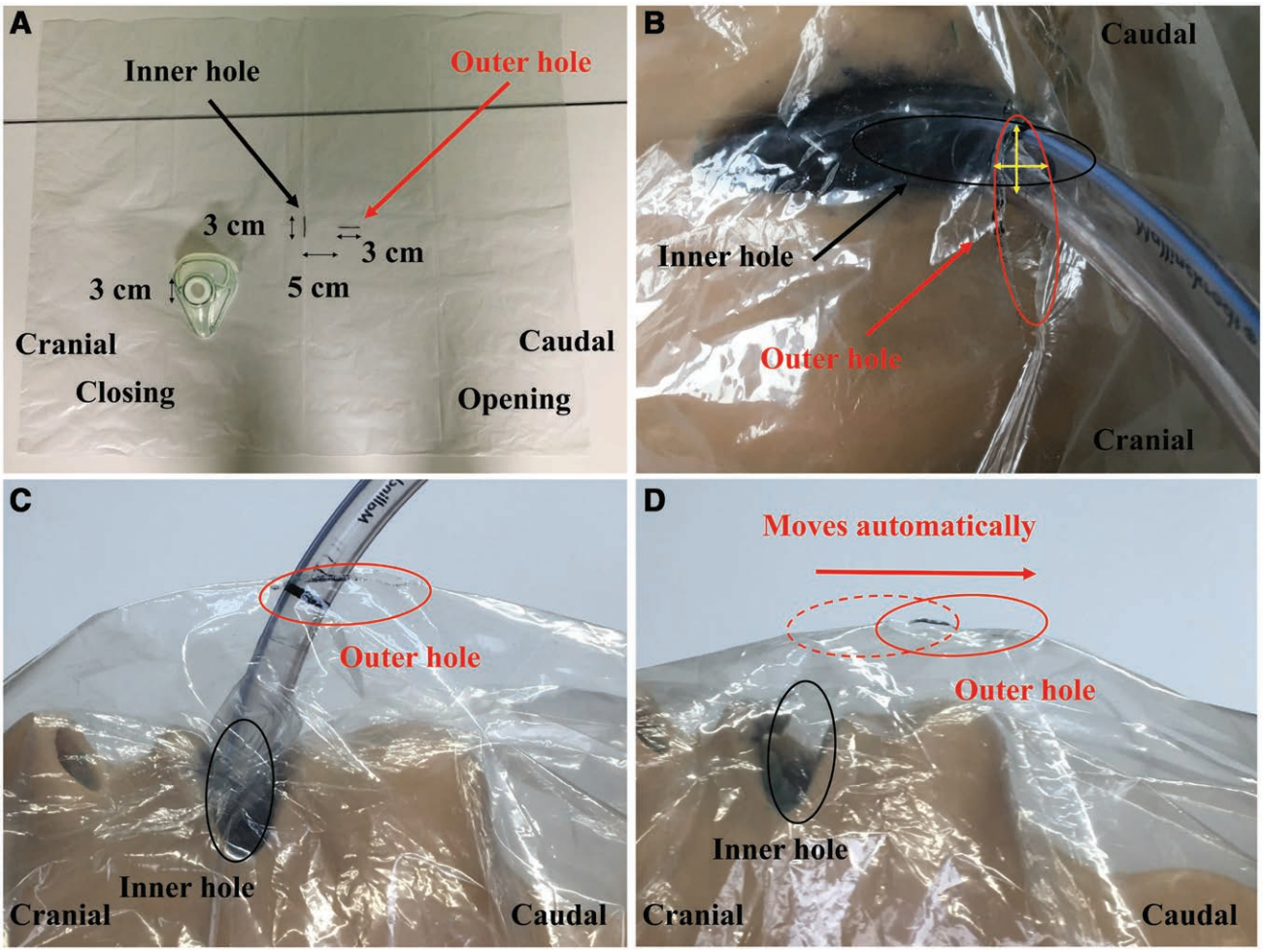

Figure. A, Method of preparation and location of the 2 cross-holes on the plastic bag. The hole sizes and their placement on the plastic bag. Each hole is 3 cm, which is the same size as the connection for the facemask. The distance between the 2 holes is 5 cm. B, The outer hole (red circle) is put on the inner hole (black circle) crosswise. An endotracheal tube can be passed through the center of the cross-hole (yellow cross). C, Just before extubation. The endotracheal tube must be removed in the caudal direction because the outer hole is created caudally to the inner hole, thus providing the greatest effectiveness of the double barrier structure. D, Just after extubation. The outer hole can automatically move in the caudal direction (from the dotted red circle into the red circle) just after extubation because of the shape memory of the plastic bag.

to extubation and ventilate the patient easily, rapidly, and safely through the 2 holes sandwiched between the ventilation mask and the circuit. Although patients sometimes become agitated and/or restless after extubation, which makes it more difficult to prevent contamination by droplets, the present technique is much better to protect medical staff from droplets because the plastic bag can cover the patient's head completely. We consider that every intubated patient in intensive care units should be managed and extubated with this barrier, because patients who recover from SARS-CoV-2 may have positive test results again.[3] To use this barrier in the intensive care unit, we recommend passing the endotracheal tube into the barrier while the patient is paralyzed. The contaminated endotracheal tube could also be disposed of inside the plastic bag immediately after extubation, causing less environmental contamination.

In our operating room, we can select our barrier method for all intubated patients to prevent droplet spread without any issues. Our medical staff can obtain a sense of security and not have to worry about droplet spread during extubation, and our extubated patients did not complain of strong discomfort after use of our barrier method.

In conclusion, physicians must use not only personal protective equipment but also a barrier covering the whole patient's head during extubation, as described above.

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REFERENCES

1. Orser BA. Recommendations for endotracheal intubation of COVID-19 patients. *Anesth Analg*. 2020;130:1109–1110.
2. D'Silva DF, McCulloch TJ, Lim JS, Smith SS, Carayannis D. Extubation of patients with COVID-19. *Br J Anaesth*. 2020;125:e192–e195.
3. Lan L, Xu D, Ye G, Xia C, Wang S, Li Y, Xu H. Positive RT-PCR test results in patients recovered from COVID-19. *JAMA*. 2020;323:1502–1503.
4. Canelli R, Connor CW, Gonzalez M, Nozari A, Ortega R. Barrier enclosure during endotracheal intubation. *N Engl J Med*. 2020;382:1957–1958.
5. Rothe C, Schunk M, Sothmann P, et al. Transmission of 2019-nCoV infection from an asymptomatic contact in Germany. *N Engl J Med*. 2020;382:970–971.
6. Patino Montoya M, Chitilian HV. Extubation barrier drape to minimise droplet spread. *Br J Anaesth*. 2020;125:e195–e196.

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