Modified Barrier Enclosure for Noninvasive Respiratory Support in COVID-19 Outbreak

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Abstract

Aim: To develop a device that can reduce the exposure of aerosols to healthcare workers (HCWs) who are working in coronavirus disease-2019 (COVID-19) critical units.

Background: Barrier enclosure has recently been proposed for use during intubations where the risk of aerosolization is high. In COVID-19 outbreak, use of noninvasive respiratory support is increasing. But at the same time, it is associated with high risk of aerosol generation, leading to infections among HCWs. We have made a modification in the intubation box and hence expanded its use with an aim to reduce COVID-19 exposure.

Technique: Vacuum suction tubing was attached to wall mount, and the other end of tubing was fixed, using adhesive surgical tapes, to the inside of the roof of barrier enclosure. Keeping the vacuum suction switched-on inside the box created a negative pressure while overall air flow is into the box from outside. This led us to believe that aerosols if generated are not contaminating patient's vicinity. Currently, we are using barrier enclosure boxes on all patients who are on noninvasive support (noninvasive ventilation or high-flow oxygen therapy).

Conclusion and clinical significance: We believe that adding barrier enclosure with the above-mentioned negative-pressure modification will provide an opportunity to use noninvasive support widely, while at the same time, HCW's exposure to aerosols will be reduced.

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Background

Pandemic of coronavirus disease-2019 (COVID-19) has spread over more than 200 countries and has infected over more than 3.5 million people. Till the writing of this manuscript, more than 250,000 deaths have been reported due to COVID-19.[1] COVID-19 outbreak has increased intensive care requirements all over the world. Most of the patients who develop acute respiratory distress syndrome in COVID-19 require oxygen therapy and a few of them will require mechanical ventilation. Invasive mechanical ventilation is associated with high mortality rates. Eventually, high-flow oxygen therapy (HFOT) and noninvasive ventilation (NIV) are increasingly being used in COVID-19-related acute respiratory distress syndrome.[2–4] These types of support inadvertently lead to high degree of aerosol generation.[5]

In spite of the optimal use of respirators and personal protective equipment's, healthcare workers (HCWs) are at increased risk of infection in such settings.[5] Recently, barrier enclosure intubation has been suggested as a modification to reduce exposure to aerosols while intubating. We hereby have modified this "barrier-enclosure" and its use in subjects with noninvasive respiratory support.[6,7] We anticipate that it will expand the indications of use of barrier enclosure/intubation box and at the same time will provide much safer opportunities to use noninvasive respiratory support.

Technique

Barrier enclosure or intubation box is a transparent cubicle box which is able to cover the head and upper part of thorax of the patient while intubating. It has four-full wall and one-half wall. Except for the roof, all full walls have holes for manipulation during intubations. We modified its use by closing all the holes with adhesive surgical tape [easily available in intensive care units (ICUs)] and creating a negative pressure inside the box. Adhesive surgical tapes were used in our design for their easy availability, but due to their high propensity to retain infections, it is recommended that the hole can be covered by rubber sealing, which can be cleaned easily. For negative pressure, a vacuum suction tubing was attached to wall mount, and the other end of tubing was fixed, using adhesive surgical tapes, to the inside of the roof of box (Fig. 1A). This enclosure can accommodate shoulders, neck, and head of the patient while having NIV mask on (Fig. 1B). Keeping the vacuum suction switched on inside the box created a negative pressure while overall air flow is into the box from outside. The negative pressure used inside the barrier enclosure was –200 mm Hg. This led us to believe that aerosols if generated are not contaminating patient's vicinity. Currently, we are using barrier enclosure boxes on all patients who are on noninvasive support (NIV or HFOT).

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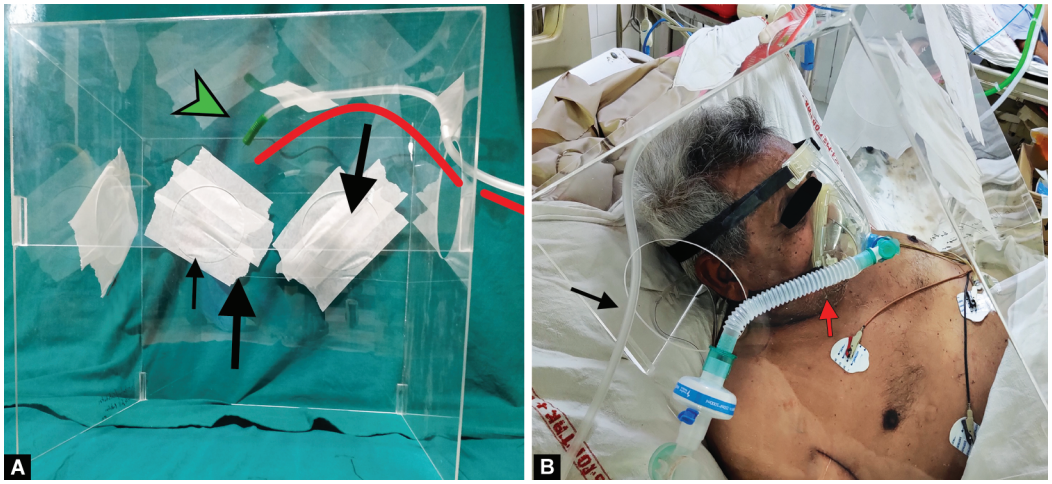

Figs 1A and B: (A) Barrier enclosure/intubation box (three-full transparent walls with manipulation holes and one-half wall). Black arrows representing adhesive tapes used to cover the holes. The red schematic line to show the path of suction tubing entering into the box and its fixation on the inner aspect of roof. Green arrowhead indicating the hanging tip of the suction tube; (B) Barrier enclosure placed on the patient who is on noninvasive ventilation. The box can cover up to the upper parts of shoulders. Black arrow denotes the suction tubing going inside the box, and red arrow showings the ventilation circuit

For its repeated use, we are following the WHO guidelines of disinfection using hypochlorite 0.1%.[8] Surface is cleaned with hypochlorite after use on one patient and is later washed with detergent and water.

Discussion

Barrier enclosure was initially intended for intubations during the management of COVID-19 cases/suspects but eventually its use was extended to other specialties like surgery.[9] But, once intubation is over with its use has not been further studies.

It has been observed that HFOT and NIV are becoming more favored approaches of oxygenation in critically ill hypoxic cases, their use is bound to increase.[2,10] High aerosol generation, despite use of all personal protective equipment can lead to healthcare-associated infections.[11] At the same time, negative-pressure isolation rooms, which are recommended for aerosol-borne infections, are not commonly available.[12]

In such scenarios, creating a negative pressure at the source of generation (patients face) can decrease the viral load in ambient air. We believe that adding barrier enclosure with the above-mentioned negative-pressure modification will provide an opportunity to use noninvasive support widely, while at the same time, HCW's exposure to aerosols will be reduced. Though yet to be experienced but one of the flaws with the design is its potential to cause claustrophobia, as it is being used in awake patients. This might be because of its transparent design and presence of continuous ventilation inside it.

Though our proposed role for barrier enclosure is use in relatively stable subjects of COVID-19 who require noninvasive respiratory support, but there are some limitations related to the design of the box like difficulty in airway management[6] or putting central lines in jugular or subclavian route. It is therefore recommended that operator should be ready to abandon the barrier enclosure while facing or anticipating any such difficulty. Also, despite its plausible mechanism and clinical utility, the practical validity in a prospective study is mandatory for its widespread use.

Conclusion

Modified negative-pressure intubation box can be used in patients of COVID-19 who are on noninvasive respiratory support. Frequent use of the same can help in adding one more layer of protection against healthcare-associated infections of COVID-19.

Clinical Significance

Its use is likely to reduce infections of COVID-19 to the HCWs, doing duties in critical units.

References

1. WHO, Situation Report- 108 2020 [Available from: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200507covid-19-sitrep-108.pdf?sfvrsn=44cc8ed8_2.
2. Winck JC, Ambrosino N. COVID-19 pandemic and non invasive respiratory management: every Goliath needs a David. An evidence based evaluation of problems. Pulmonology 2020;26(4):213–220. DOI: 10.1016/j.pulmoe.2020.04.013.
3. Cinesi Gómez C, Peñuelas Rodríguez Ó, Luján Torné M, Egea Santaolalla C, Masa Jiménez JF, García Fernández J, et al. Clinical consensus recommendations regarding non-invasive respiratory support in the adult patient with acute respiratory failure secondary to SARS-CoV-2 infection. Arch Bronconeumol 2020;56(Suppl 2):11–18. DOI: 10.1016/j.arbres.2020.03.005.
4. Geng S, Mei Q, Zhu C, Yang T, Yang Y, Fang X, et al. High flow nasal cannula is a good treatment option for COVID-19. Heart Lung 2020;49(5):444–445. DOI: 10.1016/j.hrtlng.2020.03.018.
5. Arulkumaran N, Brealey D, Howell D, Singer M. Use of non-invasive ventilation for patients with COVID-19: a cause for concern? Lancet Respirat Med 2020;8(6):e45. DOI: 10.1016/S2213-2600(20)30181-8.
6. Canelli R, Connor CW, Gonzalez M, Nozari A, Ortega R. Barrier enclosure during endotracheal intubation. N Eng J Medicine 2020;382(20):1957–1958. DOI: 10.1056/NEJMc2007589.
7. Leyva Moraga FA, Leyva Moraga E, Leyva Moraga F, Juanz González A, Ibarra Celaya JM, Ocejo Gallegos JA, et al. Aerosol box, an operating room security measure in COVID-19 pandemic. World J Surg 2020(7):1–2. DOI: 10.1007/s00268-020-05542-x.
8. Organization WH, Cleaning and disinfection of environmental surfaces in the context of COVID-19 Global: WHO; 2020 [Available

from: https://www.who.int/publications/i/item/cleaning-and-disinfection-of-environmental-surfaces-inthe-context-of-covid-19.
9. Babazade R, Khan ES, Ibrahim M, Simon M, Vadhera RB. Additional barrier to protect healthcare workers during intubation. Anesthesia Analgesia 2020; 131(1):e47–e48.
10. Lyons C, Callaghan M. The use of high-flow nasal oxygen in COVID-19. Anaesthesia 2020;75(7):843–847. DOI: 10.1111/anae.15073.
11. Remy KE, Lin JC, Verhoef PA. High-flow nasal cannula may be no safer than non-invasive positive pressure ventilation for COVID-19 patients. Crit Care 2020;24(1):169. DOI: 10.1186/s13054-020-02892-9.
12. Rebmann T. Management of patients infected with airborne-spread diseases: an algorithm for infection control professionals. Am J Infect Cont 2005;33(10):571–579. DOI: 10.1016/j.ajic.2005.05.015.