Brunei International Medical Journal

OFFICIAL PUBLICATION OF
THE MINISTRY OF HEALTH
AND
UNIVERSITI BRUNEI DARUSSALAM

Volume 17

16 August 2021 (7 Muharram 1443H)

COVID-19 PANDEMIC: IMPROVISATIONS OF AEROSOL BOX FOR SAFE PERIOPERATIVE INTUBATIONS COVID-19 PATIENTS.

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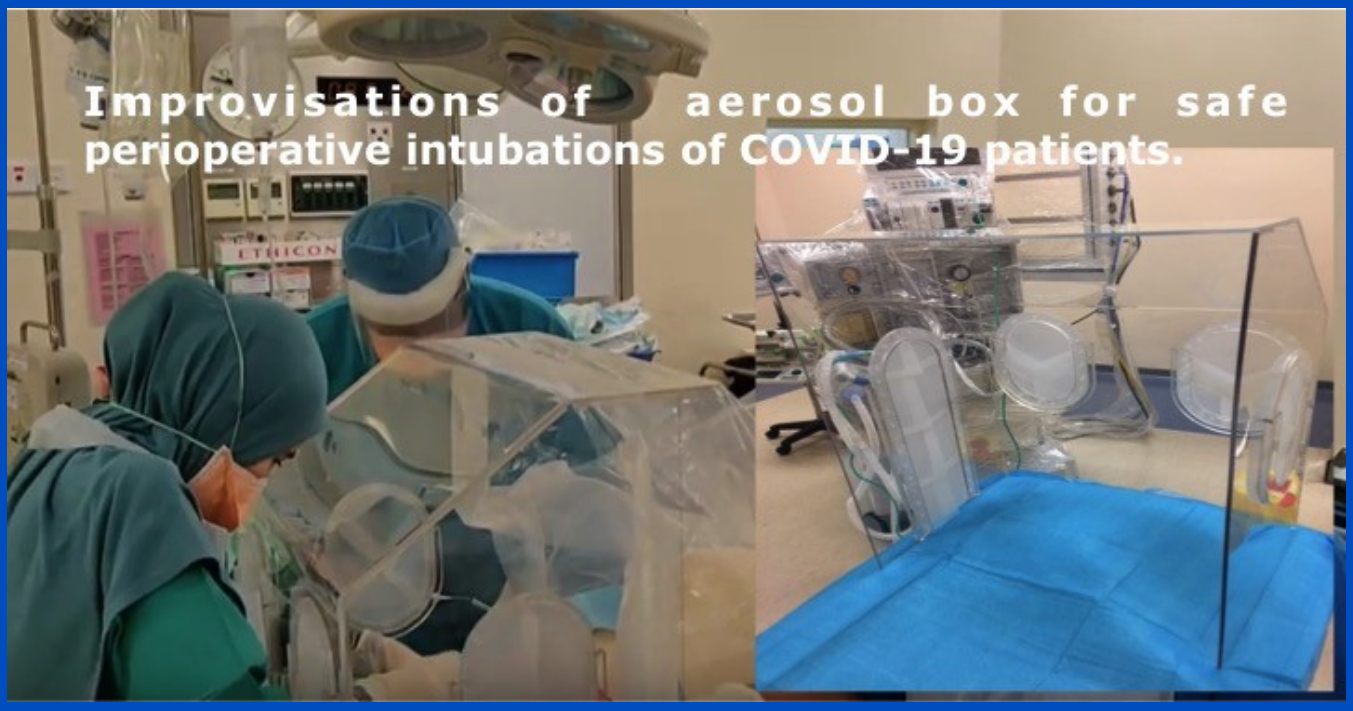

Brunei Int Med J. 2021;17:98-101

ISSN 1560 5876 Print
ISSN 2079 3146 Online

Online version of the journal is available at www.bimjonline.com

Brunei International Medical Journal (BIMJ)
Official Publication of
The Ministry of Health
and
Universiti Brunei Darussalam

ISSN 1560-5876 Print
ISSN 2079-3146 Online

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Acknowledgements
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INTRODUCTION

The aerosol box which was originally developed by Lai Hsien-Yung, a Taiwanese anaesthetist, is currently used across the globe as an adjunct to the standard personal protective equipment (PPE) for healthcare workers.[1] It acts as a barrier against aerosol particles that are potentially released during intubation and extubation, which is well known as an aerosolized procedure.

It is a transparent four-sided plexiglass box, without a panel at the bottom and chest end, made of acrylic or polycarbonate and designed to cover a patient's head. It has two circular ports at the head end panel through which the operator can perform airway procedures. A recent simulation by Canelli et al has demonstrated the added protection accorded by this enclosure.[2] However, this simulation was not validated for projectile direction and particle-size distribution.

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Our concern with the original aerosol box stems from the possibility of aerosols dispersing in all directions during an aerosolized procedure. This is especially so at the circular ports which are not tight-fitting as well as at the chest end of the patient, where the box has no barrier placed. The passage of airway devices, application of cricoid pressure as well as the connection and disconnection of the endotracheal tube performed through the chest end of the box, are all potential sites for spread of infected aerosols. As there are no valid studies measuring the distance and direction of aerosols that are dispersed, it is imperative for the medical personnel to be equipped with as much safety measures as possible.

As it is near-impossible to create an air-tight barrier enclosure, we would like to recommend improvisations that can be instituted to the original aerosol box, which we feel will confer additional protection as well as better ergonomics.

This innovation was a collaboration between Hospital Universiti Teknologi Mara (UiTM), Malaysia and Universiti Teknologi Malaysia Kuala Lumpur (UTMKL), Malaysia. The development prototype underwent numerous

real-time clinical tests before the end-product was finalized and delivered to hospitals nationwide.

TECHNICAL IMPROVISATIONS

Although the materials of the box were similar, improvisations on the design and dimensions were made to address the aforementioned concerns. Oblong-shaped ports were added on the right and left of the original aerosol box. This enables a safer and easier access for the healthcare workers assisting during the intubation and extubation process without having to access via the exposed chest end of the box repeatedly (Figure 1a).

The oblong-shaped port on the right side also extends down to the base of the box which remains open terminally (Figure 1b). This enables a seamless connection between the breathing circuit and the endotracheal tube and allows the box to be lifted easily at the end of the intubation procedure without having to disconnect the circuit and potentially disseminating the droplets into the surrounding environment.

The originally placed two circular ports at the head end of the box were similarly changed to oblong-shaped ports, enabling more degree of freedom for the operator's hands and forearms during airway manipulation (Figure 1c).

All these port accesses are covered by a one-way valve made of silicone sheet (Figure 1d). Silicon rubber's "organosiloxanes polymer" characteristic makes it superior to ordinary organic rubber. With its helical and low intermolecular force resulting in a high elasticity and compressibility, high tear and tensile strengths with significant flex fatigue resistance[3], these properties will enable a tight fit around the forearms despite repeated manipulations, hence should limit the dispersion of droplets externally. These one-way valves can be removed from the box and be disinfected separately upon completion of the intubation process (Figure 1e).

The height of the box's top panel is also increased for easier manipulation of a video laryngoscope, endotracheal tube with stylet or even an airway bougie. Additionally, it was made angulated and slanted, to confer a more ideal visual field to facilitate a seamless intubation process (Figure 1f).

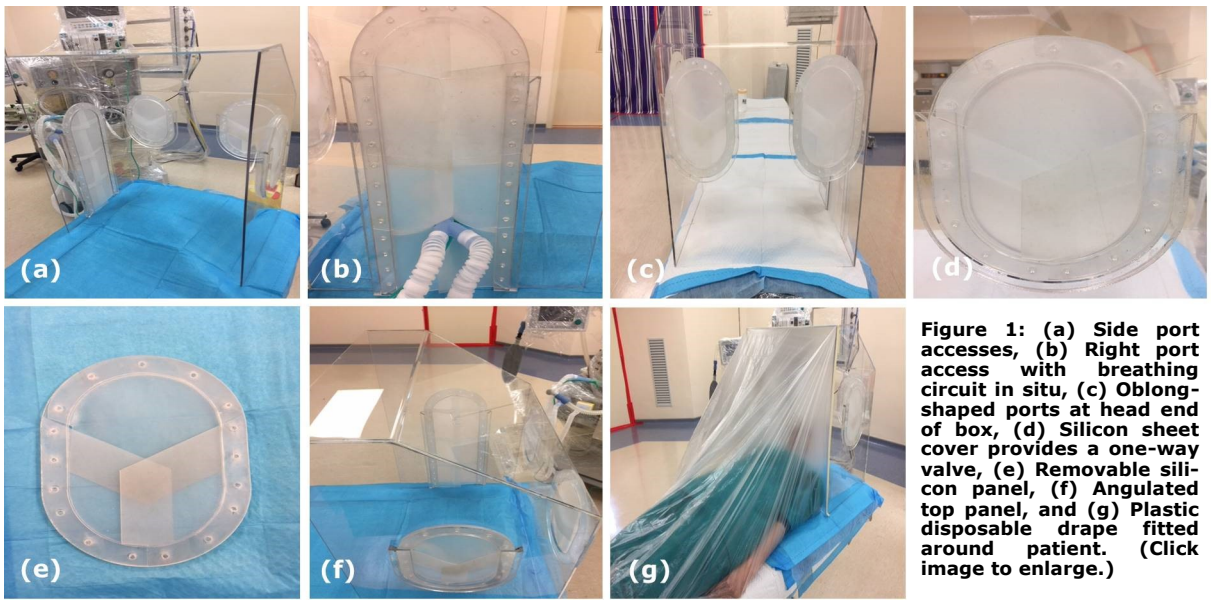

Figure 1: (a) Side port accesses, (b) Right port access with breathing circuit in situ, (c) Oblong-shaped ports at head end of box, (d) Silicon sheet cover provides a one-way valve, (e) Removable silicon panel, (f) Angulated top panel, and (g) Plastic disposable drape fitted around patient. (Click image to enlarge.)

Finally, we recommended a transparent and waterproof plastic drape to be attached via adhesive, to the perimeter of the chest end of the box and pulled down to be tightly snugged around the patient's waist and peripherally under both upper limbs (Figure 1g). This will help to limit aerosolization and droplet spray during extubation.[4,5] This drape can be detached and is disposed upon the completion of the procedure. As much as possible, it is pertinent to exclude the patient from the external environment during this high risk aerosolization procedure in view of minimizing cross-contamination with the health-care workers.

At the present moment, 29 of these improvised barriers have been distributed and is currently in use in 10 government and private tertiary hospitals across Malaysia. These include Hospital Universiti Teknologi Mara, Hospital Sungai Buloh, Hospital Putrajaya, Hospital Kuala Lumpur, Hospital Selayang, Hospital Serdang, Hospital Tuanku Mizan, Hospital Canselor Tuanku Mukhriz, KPJ Ampang Puteri Hospital, and Columbia Asia Setapak Hospital respectively. This additional armamentarium to the existing personal protective equipment will be of added benefit to further protect healthcare workers against this virulent infection. The Youtube video link below shows the device being used in an operating theatre settings in a government hospital in Malaysia.
(https://youtu.be/Wb--bes9a2k).

CONCLUSION

Our focus is on limiting the amount of cross-contamination between patients and healthcare workers while improving the ergonomics and optimizing the conditions in achieving a smooth airway intubation and extubation. With the highly infective nature of the novel coronavirus, it is crucial that all steps are taken to ensure the safety of healthcare workers, especially at a time when the supply of PPE globally is in dire shortage. This pandemic has brought upon a massive change in the current medical practice. The need for medical innovations and improvisations have never been more paramount as it has now.

ACKNOWLEDGEMENT

We would like to acknowledge the following individuals who have contributed and made

this project a success: Mr Hairul Lail Ismail, Dr Isqandar Adnan, Dr Mohd Firdaus Shukery, Dr Adiin Dasima Abdul Kadir and Dr Marhiah@Sarah Harnani Mansor.

CONFLICT OF INTEREST

The authors reported no conflict of interest or financial liability.

INFORMED CONSENT

Consent has been obtained from the appropriate institutions and patient in regards to the use of the pictures and video included in this report.

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