Intubation Box for Covid-19 Patients

INTRODUCTION

Coronavirus disease 2019 (COVID-19) emerged in Wuhan, China, in December 2019. It spread worldwide and World Health Organization announced a public health emergency and pandemic of COVID-19 on March 11, 2020. The virus transmission was through respiratory droplets, direct contact with infected persons, or by contact with contaminated objects and surfaces. Most people with COVID-19 develop only mild (40%) or moderate (40%) disease, 15% develop severe disease that requires oxygen support, and 5% have critical disease with complications.[1] In managing infected COVID-19 patients, strict adherence to basic infection control was utmost important. Personal protective equipment (PPE) was on high demand and with limited supply, this lead to multiple innovations in battling the disease.

Intubation box is an innovation device used by medical personnel, as a protection from patient's droplets or aerosols spillage during medical procedures such as intubation. The original idea was from Dr. Lai Hsien-yung, an anesthesiologist in Taiwan and known as "Aerosol Box" (figure 1).[2] The device was designed as a solution when the personal protective equipment (PPE) for physicians were running out during COVID-19 outbreak. The cube box has a dimension of 50 cm length, 50 cm height and 40 cm depth, with two arm holes. It was made from acrylic or transparent polycarbonate sheet. The aerosol box is placed over the patient's head and it will cover from head till the chest area and medical personnel maneuver procedures through the hand holes (figure 2). The box can be reused by cleaning thoroughly with 70% alcohol or bleach.[3] This invention was licensed under the Creative Commons Attribution-Non Commercial 4.0 International License which is available openly online.[3] Similar box, known as Plexiglas box, was adapted in few hospitals in United States of America (USA) for intubation and other aerosols producing procedures.[4-7]

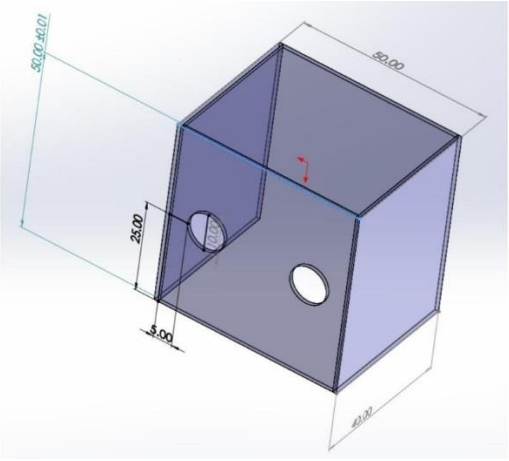

Figure 1: The "Aerosol Box" prototype[2,3]

Figure 2: Demonstration of procedure using the device[2,3]

We received a proposal from a company on an intubation box which was designed and manufactured in Malaysia (figure 3). It was built with an angled viewing window for attending physician to have a larger view during procedure. Both hand holes were inserted with soft silicon grommet to ensure good sealant and protected the physician arm sleeves. The box material was not specified in the proposal. One advantage feature of this box is stackable for space saving. The intubation box was proposed for usage in protecting the medical personnel during COVID-19 pandemic.[8] A rapid review was conducted to assess the effectiveness, safety and cost effectiveness of intubation box.

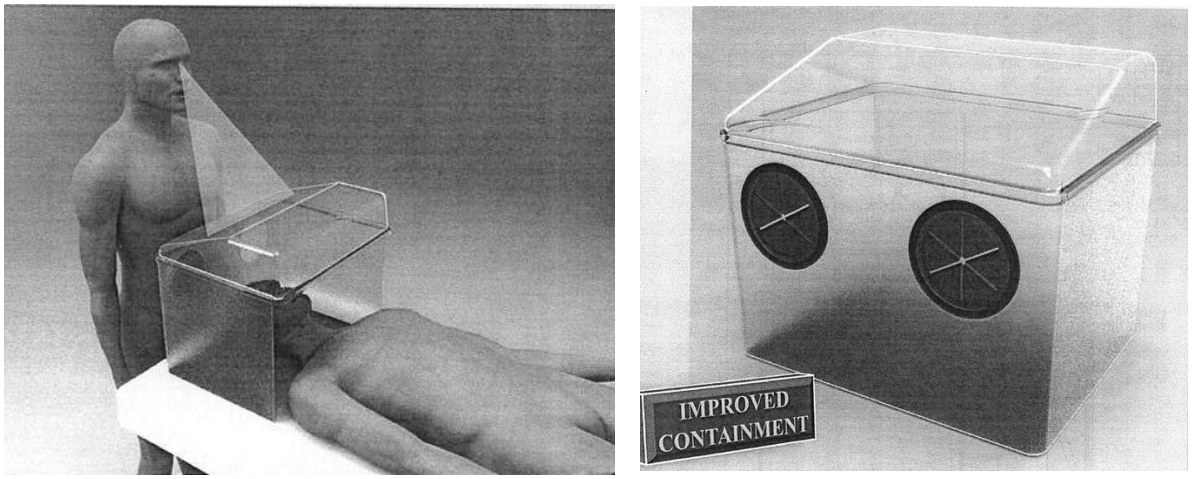

Figure 3: Medishield Intubation Box[8] (source: document received from the company)

EVIDENCE on EFFECTIVENESS and SAFETY

The systematic search for new evidence from the scientific databases such as Medline, EBM Reviews, EMBASE via OVID, Pubmed and from the general search engines [Google Scholar and US Environmental Protection Agency (US EPA)], did not retrieved any articles to demonstrate the efficacy, safety or cost-effectiveness of intubation box for COVID-19. However, there were two in-situ simulation studies, one case series and one ongoing clinical trial. There were many letters to editors and short reports in peer review journals commenting on this innovative device.

Begley et al (2020) conducted an in-situ simulation crossover study to evaluate the impact of two types of aerosol boxes on tracheal intubations of a simulated patients with severe COVID-19. The early-generation box resembled the original box designed by Dr. Lai Hsien-yung with modifications suitable for larger body build. Second box, latest-generation box, was an adaptation and locally designed with addition features of two holes for assistant's hands on one of the lateral wall, a hole on top wall for insertion of a bougie to aid intubation, and ports for applying suction to generate negative pressure (not used in this study). The second model cover the holes with occlusive dressings to create a tighter seal and has a plastic drape to cover the patient's chest replacing the plastic wall. Both boxes have similar dimensions of 65 cm wide, 50 cm tall, and 40 cm deep with arm holes of 12.5 cm in diameter (figure 4). Twelve specialist (consultant) anesthetists participated and each participant performed three intubations at three different scenarios (one with no aerosol box, one with early-generation box and one with latest-generation box). The order of intubations for each participant was block randomised. Procedure was performed in a negative-pressure room in the intensive care unit (ICU) at Cabrini Hospital, Melbourne, Australia, that has experience in the care of severe COVID-19 patients. The anesthetists wore PPE consisting of a face-shield, googles

or glasses, mask, gown and gloves. All intubations was assisted by a single experienced intensive care nurse. An Airsim Advance Crico manikin (figure 5) was used and assembled to realistic presentation of intubating a normal adult. A videolaryngoscope with a disposable blade was used for all intubations. Results in Table 1 showed **intubation time** without aerosol box was significantly shorter compared with the early-generation box (p=0.002) and the latest-generation box (p=0.008). All intubations without aerosol box were less than one minute compared to with aerosol box, 58% intubations took over one minute and 17% were above two minutes (including one failed intubation). Post-hoc analysis found no difference in intubation times between the two boxes (p=0.209). All anesthetists obtained **first-pass success** in intubation without the usage of aerosol box. The drawback reported were breaches of PPE with tear in a gown sleeve and gowns were pull back from the glove thus exposing the skin. This is due to the gown being stuck at the arm hole. One breach occurred with the early-generation box and seven mishaps arise with the latest-generation box particularly over the arm hole with occlusive dressings. The participants also commented factors that encountered using the aerosol boxes such as discomfort of the arms, back or knees, increased cognitive load, use of airway device restricted by the box, issue with laryngoscope contacting box and migration of box off bed. The authors stated the limitation of small sample size and unable to blind both the participants and researchers. They concluded that further research is required before these devices can be considered safe for clinical use.[9]

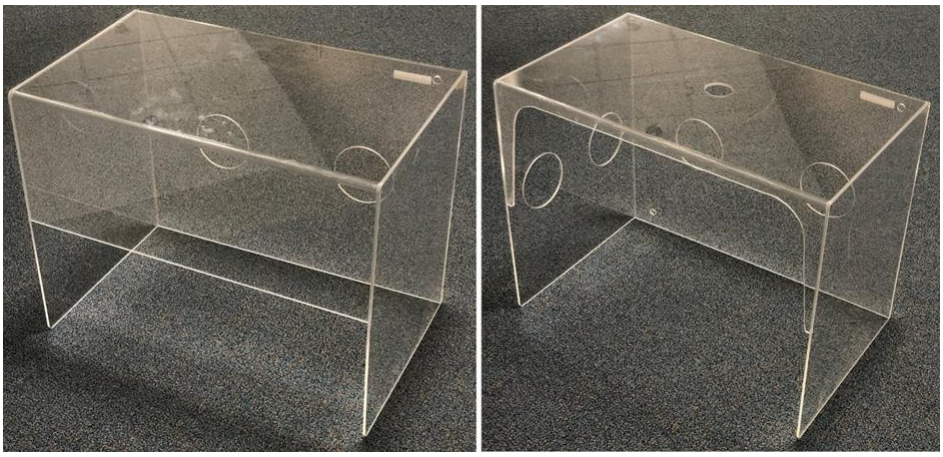

Figure 4: The early-generation aerosol box (left) and the latest-generation aerosol box (right) which were studied.[9]

Figure 5: AirSim Advance Crico Simulator[10]

Table 1: Primary and secondary outcomes for simulated patients intubated with no aerosol box, early-generation box or latest-generation box. Values are median (IQR [range]) or number (proportion).[9]

	No aerosol box n=12	Early-generation aerosol box n=12	Latest-generation aerosol box n=12
Time to intubation (seconds)	42.9 (32.9–46.9 [30.9–57.6])	82.1 (45.1–98.3 [30.8–180.0])	52.4 (43.1–70.3 [35.7–169.2])
First-pass success	12 (100%)	9 (75%)	10 (83%)
Breaks in pre-oxygenation	0	1 (8%)	1 (8%)
Laryngoscopy grade[a]	2A: 9 (75%) 2B: 3 (25%)	2A: 8 (67%) 2B: 4 (33%)	2A: 10 (83%) 2B: 2 (17%)
PPE breaches	0	1 (8%)	1 (8%)

PPE, personal protective equipment.
[a]All laryngoscopy grades were either 2A or 2B.

Simpson et al (2020) conducted an in-situ simulation study to evaluate laryngoscopist exposure to airborne particles using the aerosol containment device with no aerosol box. Seven volunteers participated in the study with a role as a patient and laryngoscopist in random order. Five aerosol containment devices were tested: aerosol box, a clear plastic placed as vertical sheet between laryngoscopist and patients' head, a clear plastic drape forming a horizontal tent above the patients' upper torso, sealed aerosol box with heat and moist exchange viral filter, with and without wall suction, compared with no aerosol box. Aerosols were generated by nebulized saline held beneath patients' mouth and patient coughed every 30 seconds during the five minutes trial. Exposure of airborne particles sized 0.3, 0.5, 1.0, 2.5 and 5.0 microns were analysed at 30, 60, 120, 300 and 360 seconds. The sealed intubation box with suction resulted in a decrease in 0.3, 0.5, 1.0 and 2.5 micron, but not 5.0 micron, particle exposure over all time periods (p=0.003) compared with no device used. The horizontal and vertical drapes aerosol containment showed no difference in any particle size exposure at any time, compared with no device use. The aerosol box showed an increase in 1.0, 2.5 and 5.0 micron airborne particle exposure at 300 seconds (p=0.002, 0.008 and 0.002 respectively) as compared without device. This study also demonstrated marked increase in airborne particle exposure when the patient coughed in the aerosol box compared with other devices or no device use.[11]

Bianco et al. (2020) reported a retrospective case series of six COVID-19 positive male patients (age range 56-77 years old) undergoing emergency surgical treatment for gastrointestinal complications. The aim was to look at the role of PPE and aerosol box in preventing transmission among operating room staff. All intubations were undertaken under video-laryngoscope guidance through a 60 cm x 60 cm x 40 cm polycarbonate sheet aerosol box with four circular arm holes (two over the posterior wall, and one over each right and left lateral wall). All laparoscopic

procedures were performed in a negative pressure room by minimising the use of electrocautery, reducing the trocars-size, and using the appropriate devices to filter released CO_2 for aerolised particles. The risk of transmission of COVID-19 during laparoscopy remains theoretical. The authors support the use of both PPE and aerosol box as a protective device during COVID-19 outbreak considering the high risk of disease transmission during aerosol-generating medical procedures.[12]

Canelli et al. (2020) in their letter to editor demonstrated a cough simulation study with fluorescent dye and reported that no macroscopic contamination was visualised with the ultraviolet light outside the aerosol box after intubation.[13]

An ongoing randomised cross-over trial conducted in University Malaya Medical Centre (UMMC), Malaysia studied on two intubation boxes that is the Taiwan "Aerosol Box" compared to the UMMC "Intubation Box". This study evaluates the clinical usefulness of the "Aerosol Box" and the time taken for first-pass success of intubation. Study is estimated to complete by December 2020.[14]

A local expert shared his experienced. During the pandemic COVID-19, intubation box was used as an extra protection device for intubation procedure. The main aim was to reduce the aerosols exposure towards medical personnel during procedures. Modification from the Taiwan “Aerosol Box” prototype was made with the distal part over patient’s chest area was covered with plastic material and a suction for suctioning the aerosols was placed inside the box. This device was mainly used in the Emergency and Trauma Department and Anesthesiology and Intensive Care Department either for emergency or elective intubation. In ensuring the protective measures, intubation was done with video-laryngoscope. The laryngoscopists need to be trained and used within the restricted environment as the intubation box device limit the hand movements during procedure maneuvere. The intubation box was useful during the surge of cases then. However, it is not recommeded for current practice.

To date, most of consensus guidelines for airway management of critical patients with COVID-19 did not have any recommendation on the usage of aerosol box or intubation box in their guidelines.[15-18]

COST

The aerosol box by Dr. Lai cost approximately USD67 (NT$2,035 or RM290) per unit.[3] Plexiglas box cost from USD100 to USD270 (around RM430 to RM1,170) per unit.[6,7]

CONCLUSION

There was no retrievable evidence on the effectiveness, safety and cost-effectiveness of intubation box for usage in COVID-19 patients. In-situ simulation studies showed longer intubation time, reduced first-pass intubation and may increase exposure to aerosols with the application of intubation box. Restricted hand movements for procedure maneuvers required trained personnel and may cause body discomfort. Care should be taken of false sense of security from virus transmission with the usage of intubation box. Stronger evidences are required to ensure the effectiveness of intubation box as a protective device for COVID-19 patients and medical personnel.

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Based on available evidence up to 6 July 2020

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Disclaimer: This rapid assessment was prepared to provide urgent evidence-based input during COVID-19 pandemic. The report is prepared based on information available at the time of research and a limited literature. It is not a definitive statement on the safety, effectiveness or cost effectiveness of the health technology covered. Additionally, other relevant scientific findings may have been reported since completion of this report.

Malaysian Health Technology Assessment Section (MaHTAS),
Medical Development Division,
Ministry of Health, Malaysia.