Project Title: **INTUBATION ISOLATION BOX**

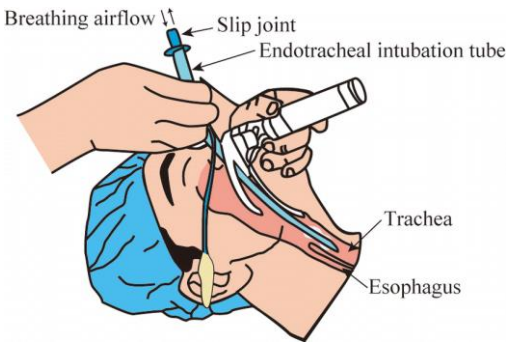
Objective:

To develop an ergonomically suitable Intubation Isolation box to protect the Healthcare providers during procedures for airborne aerosol testing.

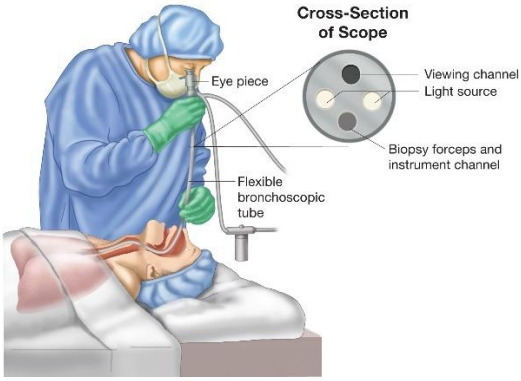
Motivation:

During procedures like Endotracheal intubation, Laryngoscopy, Bronchoscopy, patients often cough during the procedure, which can result in the spread of contaminated droplets and aerosols.

Laryngoscopy



Endotracheal intubation



Bronchoscopy

Even if the professional is wearing protective equipment, still there is a risk of being infected if droplets are not contained. Even when the patient merely breathes, there is a risk that contaminated aerosolized particles will remain suspended in the air. A common practice is to place enclosures over the patient to contain the hazards and protect caregivers. But this can

greatly complicate the procedure, especially in emergency room settings where intubation must be done quickly and efficiently.

Another inspiration for going forward with this project is Impact of COVID-19 on healthcare workers. The World Health Organization reported that one in ten health workers have been infected with coronavirus in some countries. In May 2020, the International Council of Nurses reported that at least 90,000 healthcare workers have been infected and more than 260 nurses had died in the COVID-19 pandemic. Thus, this prototype will assist health care professionals in restricting transmission of the virus and other airborne diseases during aerosol generating procedures.

Literature Review:

Lim et. al. [1] compared intubation with aerosol box and without aerosol box using mean difference. In conclusion, time to Tracheal intubation (TTI) when an aerosol box was used was significantly longer compared to intubation without an aerosol box. TTI was relatively shorter when intubation was performed by more experienced professionals using video - laryngoscopy.

Clariot et. al. [2] developed a DROPP-BOX and observed that using an easy-to-build and low-cost box slightly influences the duration of tracheal intubation in a mannequin scenario. It was also demonstrated that tracheal intubation was feasible with this device, with high levels of intubation quality and ease. Most of the participants were comfortable with the use of the box and only minor difficulties limiting the physicians' range of motion were reported.

In a study conducted at Institute of Liver and Biliary Sciences (ILBS), New Delhi by Kartik et. al. [3], cumulative success rate of endotracheal intubation using the box was 66.6% (Fig. 1). The challenges faced with the intubation box were poor vision and inadequate space for certain manoeuvres such as tilting the patient's head. For the question whether the intubation box restricted the movements and hindered the process of intubation – 76.6% responded by saying, ''yes'', and when asked to rate the ease of intubation on a scale of 1 to 10 through the intubation box, the median score given was 4.

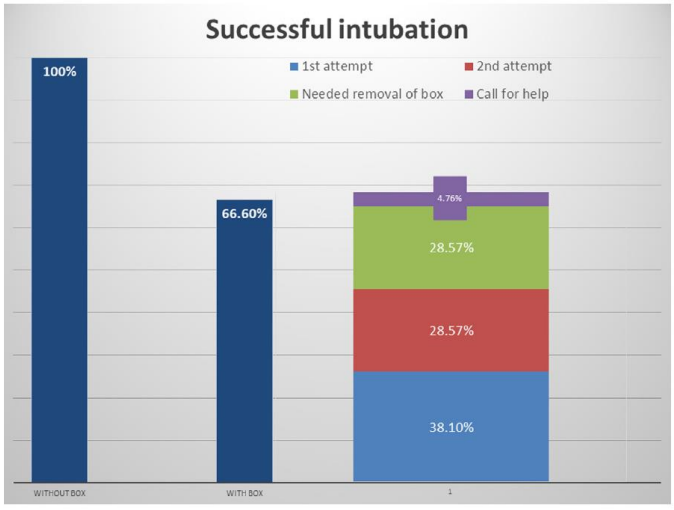


Fig. 1. Percentage of successful intubation with and without intubation/aerosol box.

In a study performed by Begley et al. [4] he showed that intubation time without an aerosol box was significantly shorter than with the early-generation box (median 42.9 seconds vs. 82.1 seconds, P = 0.002) and the latest generation box (median 52.4 seconds, P = 0.008). Aerosol boxes may increase intubation times and therefore expose patients to the risk of hypoxia. They may cause damage to conventional personal protective equipment and therefore place clinicians at risk of infection.

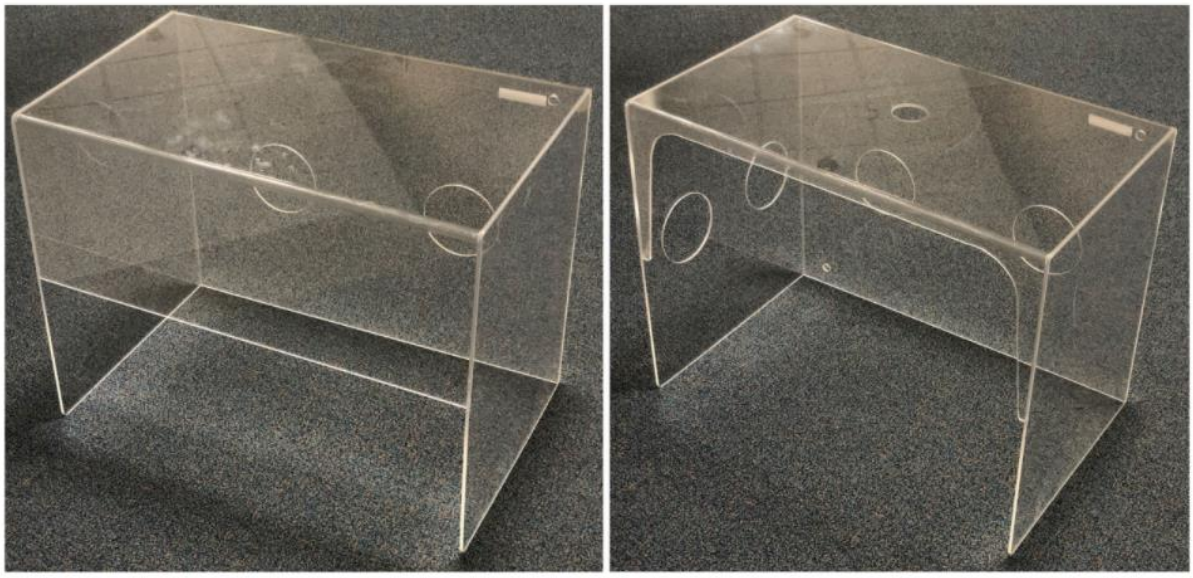


Fig. 2: The early-generation aerosol box (left) and the latest-generation aerosol box (right) which were studied. Dimensions of both boxes were the same: 65-cm wide, 50-cm tall, and 40-cm deep. The primary arm holes are 12.5 cm in diameter and positioned identically in both boxes.

Challenges Forseen:

- Real time testing with patients suffering from COVID-19, Tuberculosis, other airborne diseases.
- Time limitation for prototype development using CFD analysis.
- Lack of fabrication experience

Components Required

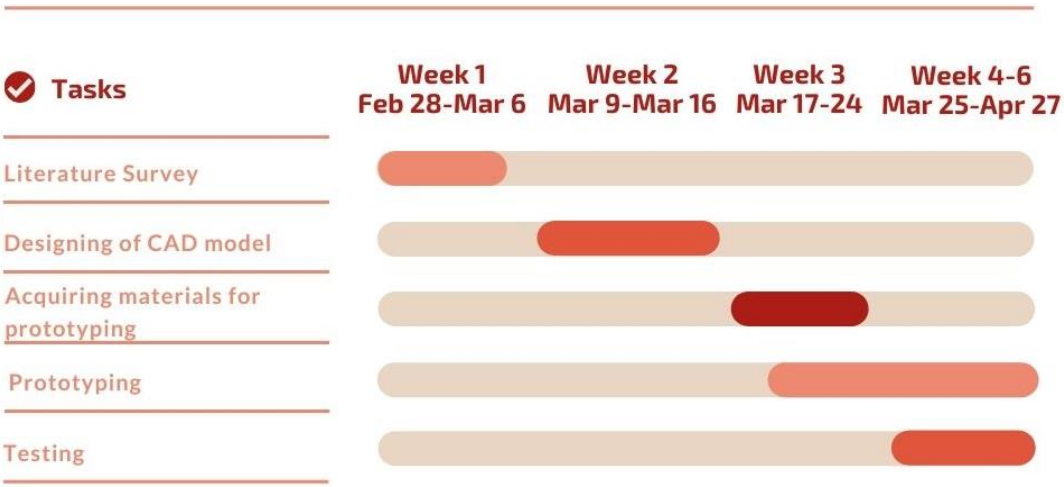
IR Camera	For smoke test
Acrylic sheets	For construction of box fabric
PVC pipes and fittings	For construction of PVC pipe network for suction operation
Suction cup	For sucking air from patient's mouth.
Glue	To join glass pieces together by means mortise and tenon joint.
Cyanoacrylate glue	To join glass and wooden parts.
HEPA Filters	To filter the sucked air.
Vacuum pump	For sucking out the air

Skills to be used

- CAD Modelling
- Fabrication
- Concept Validation

The prototype will be modelled in **Fusion 360**(by AutoDesk). The fabrication of protype will be carried out in Makerspace. The fabrication process will use **CNC, Press fit and Laser Cutting**. Finally, the prototype will be tested at AIIMS Delhi using a **neutrally buoyant smoke**. The smoke will be recorded through **Infrared camera** to arrive at the results of the testing.

Timeline



References

[1] Z. J. Lim, . M. P. Reddy, D. Karalapillai, K. Shekar and A. Subramaniam, "Impact of an aerosol box on time to tracheal intubation: systematic review and meta analysis," *British Journal of Anaesthesia,* pp. e122-e125, 2020.

[2] S. Clariot, G. Dumain, E. Gauci, O. Langeron and E. r. Levesquea, "Minimising COVID-19 exposure during tracheal intubation by using a transparent plastic box: A randomised prospective simulation study," *Anaesthesia and Reanimation,* vol. 39, no. Letter to the Editor, pp. 461-463, 2020.

[3] K. T. Ponnappan, A. F. Sam, D. K. Tempe and M. K. Arora, "Intubation box in the current," *Anaesth Crit Care Pain Med,* vol. 39, no. Letter to the Editor, pp. 587-588, 2020.

[4] J. L. Begley, K. E. Lavery, C. P. Nickson and D. J. Brewster, "The aerosol box for intubation in coronavirus disease 2019 patients: an in-situ simulation crossover study," *Anaesthesia,* vol. 75, p. 1014–1021, 2020.