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COVID-19 Flexible and Transparent Aerosol Box

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Clinicians with poor access to basic personal protective equipment (PPE) is the primary reason for the high proportion of healthcare workers being infected with the COVID-19 virus worldwide.[1]

Intubating a COVID-19 patient is considered an extremely high-risk procedure for the healthcare workers in an emergency room or ICU. Current guidelines recommend a negative pressure room for the aerosol generating procedures. However, the number of such rooms is limited in low- and middle-income countries. Clinicians rely on personal protective equipment (PPE) to protect themselves from airborne transmission especially during the aerosol generating procedures. To help the healthcare professionals with an extra line of protection and free range of motion during resuscitation of COVID-19 patients, we have started to use a modified aerosol box in the pediatric emergency department. Our design is based on an open source original plan presented by Dr. Hsien Yung Lai from Taiwan.[2] The fluorescent dye experiment conducted by Robert Canelli and colleagues have suggested that the transparent aerosol box provides additional protection during the endotracheal intubation; however, the restricted hand movement during the procedure was its main limitation.[3] We have found that a design based on a light frame and a flexible transparent plastic cover enclosing it could facilitate greater hand movement and enhance the efficacy of the procedure (see Figures 1a-d).

The modified version consists of a flexible transparent nylon sheet and PPR plastic fitting pipes presented in Figures 2a and 2b with detailed measurements. The entire system is relatively economical and the materials, such as PPR plastic fitting pipes, three-way and two-way valves, transparent 3 mm nylon sheets and zippers are readily available in low-and middle-income countries. It takes 2-3 hours for a plumber to assemble the modified aerosol box. The rectangular frame is made up of PPR plastic fitting pipes (2.5 mm) with a length of 50 cm, a width of 50 cm and a height of 60 cm. Linear PPR fitting pipes are held together with six pieces of three-way valves from points a, b, c, d, e, and f, as shown in Fig. 2a. A pair of 2-way valves g and h connect P1 to P2 and P3 to P4 respectively, as shown in Fig. 2a. Five rectangular transparent semi-flexible 3 mm nylon sheets, in proportion to the rectangular frame are sewed together to cover the intubation frame. The edges are covered with stiff fabrics along the entire length of the nylon sheet to prevent leakage. The rectangular nylon sheet which covers the frame can be taken off when needed. Two denoted circles at the front contain plus-shaped flexible openings to minimize the contamination (Fig. 1c). Two vertical zippered openings on the right side allow cardiac massage in extreme scenarios; however, the site will remain closed during the aerosol procedures. Unlike the rigid aerosol box, the rostral side of the flexible aerosol box is also covered by a nylon sheet with a 40 cm zipper and allows opening and manipulation when necessary (Fig. 1d). Thus, the aerosol released during the procedure remains in the box and healthcare workers who intervene are less likely to become infected.

The second model (Fig. 2b), which is based on the first model, is designed to be used in the emergency room, intensive care unit, and COVID-19 service for post-intubation follow-up and treatment. The extended model consists of a rectangular prism cut at an angle (point g and h) and transparent nylon sheets sewed together to cover the entire area. Two 25 cm oblique zippers covered with nylon flaps (openings i and j on the body) allow intravenous applications. One circular-shaped opening (k) on the lateral side, covered with extended nylon flaps, are designed for aspiration and ventilator connections. The vertical openings (m and n) with 25 cm zippers in the front is designed for urgent intervention when necessary (Fig. 2b). Thus, the patient is isolated in a room without an isolated bed or negative pressure. Hence, an isolated environment is formed at a low cost, and the spread of an infection such as COVID-19 is prevented to some extent.

However, we strongly agree with Kearsley[4] that the aerosol box should be used cautiously without compromising the patient or staff safety while intervening in already complex processes. For example, we recommend that a flexible aerosol box should be used by experienced medical staff for all aerosol generating procedures to minimize the risk of contamination and failure of the procedure. After each intervention, the box can be cleaned thoroughly with 70% alcohol or bleach as recommended by the CDC[5] and becomes reusable for the next patient. We have found that the illustrated design based upon a transparent flexible plastic cover and a light frame may facilitate greater hand movement and enhance the efficacy of the procedure. There is little evidence and a lack of data regarding the efficacy of the aerosol box, therefore caution should be applied during the intervention. We recommend that the aerosol box may be used as an extra line of protection for aerosol generating procedures.

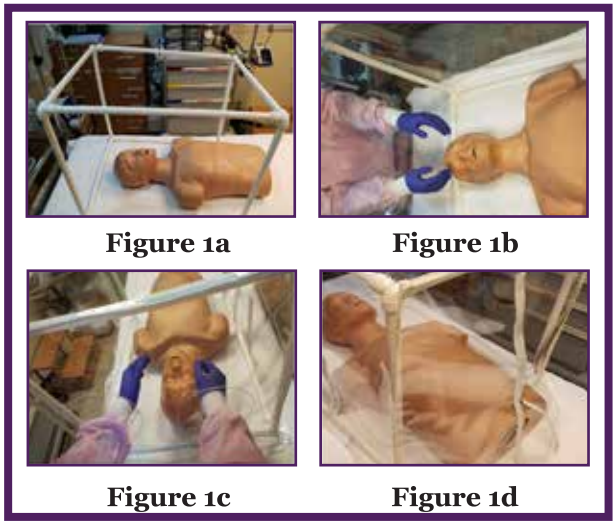

Figure 1a **Figure 1b**

Figure 1c **Figure 1d**

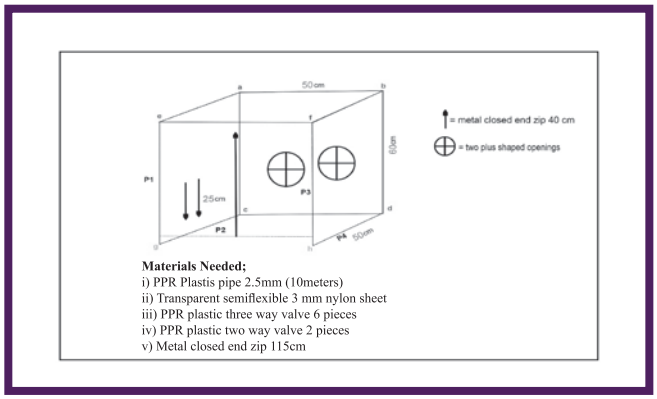

Figure 2a

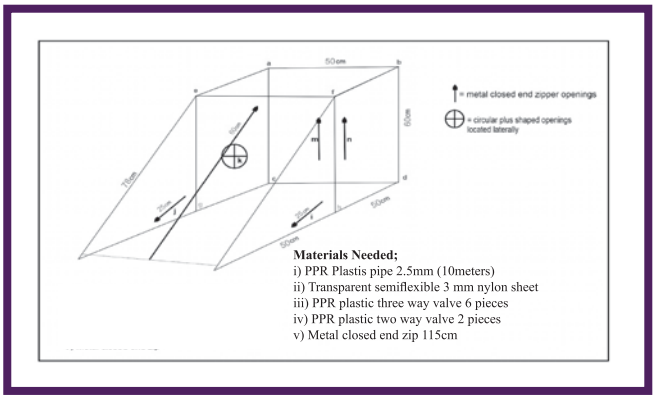

Figure 2b

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