

Intubation Ergonomics and Effectiveness using Aerosol Box

Shaik Farid Abdull Wahab¹, Rohayu Othman², Ahmad Rasdan Ismail^{3,4}

¹Department of Emergency Medicine, School of Medical Sciences, Universiti Sains Malaysia (USM)

²Kolej Kemahiran Tinggi MARA Pasir Mas, Lubok Jong, Pasir Mas, Kelantan

³Faculty of Creative Technology and Heritage, Universiti Malaysia Kelantan (UMK)

⁴Centre of Management Environment, Occupational Safety and Health (CMeOSH), Universiti Malaysia Kelantan (UMK)

Shaik Farid Abdull Wahab

Corresponding Author

Department of Emergency Medicine, School of Medical Sciences, Universiti Sains Malaysia,
Trauma Centre, Hospital Universiti Sains Malaysia, Kelantan, Malaysia

E-mail: drsfarid@usm.my

Abstract

The pandemic COVID-19 has caused a rupture and disturbance in many ecosystems, especially in healthcare. Although previously patients were treated and given first-hand treatment especially during life threatening event, currently, the safety of healthcare workers have also become the utmost priority. Due to the nature of COVID-19 virus that is able to spread easily via respiratory droplets and aerosols, using mouth and eyes as the route of entry, healthcare workers need to protect themselves while saving the patients at the same time. Therefore, the most common lifesaving procedure at accident and emergency department was chosen, i.e. the intubation procedure. The aerosol box is introduced and used widely during the intubation procedure, especially in accident and emergency department. The study has three objectives. First, to determine whether the aerosol

Manuscript Received Date: 31/12/20

Manuscript Acceptance Date: 31/06/21

Manuscript Published Date: 15/08/21

©The Author(s) (2021). Published by USIM Press on behalf of the Universiti Sains Islam Malaysia. This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited. For commercial re-use, please contact usimpress@usim.edu.my

doi: 10.33102/uij.vol33no3.356



Universiti Sains Islam Malaysia
<https://uijournal.usim.edu.my>

box can provide protection to its users, secondly to suggest an improvement based on the current design of the aerosol box and thirdly to determine the risk of musculoskeletal injuries among healthcare workers using Rapid Entire Body Assessment (REBA). In this study, direct observation was made during the assessment before suggesting the required recommendation on how to improve the existing aerosol box. The first objective was achieved by conducting a direct observation when participants were conducting the intubation procedure. Any possibility of participants getting exposed to the risk of COVID-19 due to the failure of the box in guarding, was noted by the observer. Recommendation for improvement was made based on these findings, and served the second objective of the study. To achieve the third objective, ergonomics assessment using Rapid Entire Body Assessment (REBA) was conducted. REBA scores represent the severity of musculoskeletal risk imposed to healthcare workers during intubation procedure. Two participants took part in the study voluntarily. Results showed that the aerosol box used in this study does not protect healthcare workers from COVID-19. The current design of aerosol box used must be improvised in order to increase its effectiveness. As for body postures, REBA scores were between medium and high, thus it required immediate corrective actions. With modification, the aerosol box may better protect healthcare workers from being exposed to the COVID-19 virus.

Keywords: *aerosol box, intubation, COVID-19*

1. Introduction

SARS-CoV-2 that has brought about this COVID-19 pandemic, is a highly contagious virus that spreads through respiratory droplets and aerosols. The issue arises when COVID-19 patients arrive at the accident and emergency department, requiring lifesaving procedures such as intubation. The nature of working in accidents and emergency department is unique and different from other departments in hospitals (Dorevitch & Forst, 2000). In this department, the major challenge is to save the patients first. More often than not, healthcare workers need to treat the patients first, without knowing their medical history or health status.

Pre COVID-19, patients that required airway assistance were intubated directly where healthcare workers only wore personal protective equipment such as surgical gloves and apron. However, due to the characteristic of the virus that can spread easily through droplets and aerosols via route of entry such as the mouth, different ways of protecting healthcare workers need to be considered. Some studies were conducted in regards to the uses of personal protective equipment (PPE) among healthcare workers in hospitals which concluded similar findings that the healthcare workers were not fully protected (Beam, Gibbs, Boulter, & Beckerdite, 2011; Mitchell et al., 2013). These studies were conducted before the existence of COVID-19.

During this challenging time, patients who arrived at the accidents and emergency department and presented with sore throat, coughing and difficulty in breathing are considered COVID-19 positive until proven otherwise. This is due to the nature of work in the emergency department where patients arrived twenty-four hours a day and no prior appointment is needed. This differentiates emergency department from other departments in the hospital such as paediatric, orthopaedic and obstetrics and gynaecology departments. During lifesaving events, patients need to be intubated in order to assist them in breathing and giving medication. The intubation procedure was chosen as it is a lifesaving procedure and the risk of infection is high due to the release of vapour during the procedure (Tseng & Lai, 2020). This is where the patient might infect the healthcare workers and their safety might be compromised. A guideline on performing emergency tracheal intubation has been developed by

a group of researchers (Society, 2020). As for this hospital, a simply-assembled see-through box, named aerosol box has been introduced.

The objective of this study was to determine whether the aerosol box can provide adequate guarding and protection to its users and secondly, to improve the design of the aerosol box. Thirdly, to determine the risk of musculoskeletal disorder by assessing body posture of healthcare workers using Rapid Entire Body Assessment (REBA). This is due to the findings that healthcare workers are at risk of musculoskeletal disorder due to poor body posture and excessive load they have to lift while working (Smith, Wei, Zhang, & Wang, 2006)(Ribeiro, Serranheira, & Loureiro, 2017). No real patients were involved in the study. Airway mannequin was used as a substitution of a real patient.

2. Materials and Methods

To achieve the first objective, a direct observation was made during the assessment on how the participants conducted the procedure. At this point of time, the observer would note if there were any instances the box failed to provide adequate guarding. These can be seen whether the box was properly fitted to the bed, or the equipment used during the procedure caused the box to be lifted. Then, suggestions and recommendation were made on how to improve existing aerosol box to fulfil the second objective of the study. During the assessment, mannequin was used, similar with the study done in Hong Kong (Kong, 2020). Figure 1 shows the aerosol box used in some hospitals when intubating patients with positive COVID-19 or severe acute respiratory infection (SARI) patient. Two participants were involved in the study, who were medical officers who conducted intubation procedures during their work shifts.

Participants were required to perform the intubation procedure on the standard training airway mannequin. The aerosol box was placed over the patient's head and participants conducted the intubation procedure. All steps required during real intubation procedure were performed on the mannequin.

As for the third objective, ergonomics assessment using Rapid Entire Body Assessment (REBA) was conducted to assess the healthcare workers' body postures. The severity of the postures were measured using Rapid Entire Body Assessment (REBA) score sheet (Hignett & McAtamney, 2000). REBA has been widely used in studies involving sensitive industries such as healthcare (Janowitz et al., 2006; Bartnicka, 2015). It evaluates whole body postures involving all 4 limbs. However, only the worst body posture was evaluated. It was a paper and pencil method that was suitable to use in a sensitive industry such as healthcare, where no recording is allowed due to the patient's modesty and ethical reasons. REBA score sheet has two sections which is neck, trunk and leg and another section is arm and wrist analysis. REBA score was obtained by adding each value measured for each section.

At the same time, the body posture of the participants was charted on REBA sheet. Later, the score was concluded to determine the risk level of musculoskeletal disorder (MSD) due to this procedure. REBA score 1, is negligible, 2- 3, is considered low risk, 4-7 is medium risk and 8-10 is high risk. Score 11 and above falls under very high risk (Hignett & McAtamney, 2000). The REBA score indicates the risk of healthcare workers to get MSD due to the activity, in this case performing the intubation with the presence of the aerosol box.

3. Results and Discussion

In Figure 1, arrows show that when the box is put at the end of the bed, there will be exposed space at both ends of the box corners due to the patient trolley design, thus this will defeat the objective of using the box. In order to avoid this, healthcare workers need to place the box at a suitable distance on the bed. As a result, the box had to be placed approximately 30 cm from the edge.



Figure 1: Aerosol Box

During the observation, the intubation stylet was used to assist the intubation process; that kept hitting the upper part of the box, resulting the box to move slightly upward. As a result, the box is accidentally lifted, thus exposing the healthcare worker to the risk of infection of COVID-19 because vapour could be released to the breathing zone of the healthcare worker.



Figure 2: Expose area during intubation

Another interesting finding was the holes where the healthcare workers inserted their hands. It is clearly seen in Figure 2 that the holes are bigger than the arms of the healthcare worker. This again will expose the worker to contagious aerosols and droplets when this procedure is conducted. The findings were aligned with findings from previous researchers that measured the releases of vapour using dye during intubation procedure (Connor, 2020). A modification is needed such as to attach rubber gloves that can be changed after each use. This will seal the hole and lessen the risk of vapour escaping from the box and inhaled by the healthcare worker. Although during the procedure the healthcare worker might wear full PPE, one must remember that PPE is the last defend. It is the last resort. Thus, any innovation to control the spread of COVID-19 is justifiable to be considered. The findings of this study were quite parallel with the finding from Azhar et al. (2020) that stated the risk of infections is reduced significantly but increases procedure time and limits movement during the intubation procedure. Furthermore, the aerosol box used in that study is different from the one used in the present study as few parts such as rubber gloves which have been attached at the hole.

The lower part of the box must be redesigned according to the shape of the bed so that it can be placed at the near end of the bed. This will ensure enclosure when placing the box on the bed. Immediate action is to close the exposed bottom with thick paper or plastic. However, these thick paper or plastic must be changed when the box is used for a new patient to minimize risk of infection

As for body posture of the healthcare worker, he needs to bend his body with neck and head slightly held up, as shown in Figure 3. The shoulder was raised and legs were wide opened to support the body. Analysis using REBA indicated the scores were medium to high. However, during the intubation procedure, the tools used were light weight. The REBA score ranges from medium to high, which indicated further investigation and improvement needs to be done.



Figure 3: Body posture during Intubation

When the box is placed nearer to the end of the bed, healthcare workers would not have to bend their body too much, thus it will improve the standing posture, resulting in a lower REBA score. The height of the box must be increased to accommodate the tools used in intubation, such as the intubation stylet. This will ensure the box will not be lifted during the intubation procedure. The aerosol box itself must be cleaned and sanitized after each single use to avoid contamination and spreading the virus to other patients or users. Thus, even though the use of aerosol box during intubation is possible to reduce the risk of infection of SARS-CoV-2, healthcare workers should still wear PPE as stated by Incollingo & Gallo (2020) in a study conducted at accident and emergency department in Italy.

4. Conclusion

The use of aerosol box can increase the level of safety and protect healthcare workers from being exposed to the pathogens. However, modification is still necessary. With modification, aerosol box can be useful not just during the present COVID-19 pandemic, but in assisting any procedures that involve patients with a high risk of being affected with other potential respiratory viruses such as influenza and other coronaviruses.

5. Acknowledgement

We would like to thank Dr Kewaldeep Sandhu and Dr Ahmad Ghaus B Mohd Ghouse for their support in conducting this study.

References

- Azhar, M. N., Bustam, A., Poh, K., Zulkarnain, A., Zahedi, A., Zahir, M., Iskandar, A. (2020). COVID-19 aerosol box as protection from droplet and aerosol contaminations in healthcare workers performing airway intubation: a randomised cross-over simulation study, 1–7. <https://doi.org/10.1136/emermed-2020-210514>
- Bartnicka, J. (2015). Knowledge-based ergonomic assessment of working conditions in surgical ward - A case study. *Safety Science*. <https://doi.org/10.1016/j.ssci.2014.08.010>
- Beam, E. L., Gibbs, S. G., Boulter, K. C., & Beckerdite, M. E. (2011). A method for evaluating health care workers' personal protective equipment technique. *American Journal of Infection Control*, 39(5), 415–420. <https://doi.org/10.1016/j.ajic.2010.07.009>
- Connor, C. W. (2020). Correspondence Barrier Enclosure during Endotracheal Intubation, 1–2. <https://doi.org/10.1056/NEJMc2007589>
- Dorevitch, S., & Forst, L. (n.d.). The Occupational Hazards of Emergency Physicians.
- Hignett, S., & McAtamney, L. (2000). Rapid Entire Body Assessment (REBA). *Applied Ergonomics*. [https://doi.org/10.1016/S0003-6870\(99\)00039-3](https://doi.org/10.1016/S0003-6870(99)00039-3)

- Incollingo, F. B. P., & Gallo, U. G. G. (2020). Preventing transmission among operating room staff during COVID - 19 pandemic : the role of the Aerosol Box and other personal protective equipment. *Updates in Surgery*, 72(3), 907–910. <https://doi.org/10.1007/s13304-020-00818-2>
- Janowitz, I. L., Gillen, M., Ryan, G., Rempel, D., Trupin, L., Swig, L., ... Blanc, P. D. (2006). Measuring the physical demands of work in hospital settings: Design and implementation of an ergonomics assessment. *Applied Ergonomics*. <https://doi.org/10.1016/j.apergo.2005.08.004>
- Kong, C.-H. (2020). Correspondence Staff safety during emergency airway management for. *The Lancet Respiratory*, 2600(20), 30084. [https://doi.org/10.1016/S2213-2600\(20\)30084-9](https://doi.org/10.1016/S2213-2600(20)30084-9)
- Mitchell, R., Roth, V., Gravel, D., Astrakianakis, G., Bryce, E., Forgie, S., ... Program, S. (2013). American Journal of Infection Control Are health care workers protected? An observational study of selection and removal of personal protective equipment in Canadian acute care hospitals. *American Journal of Infection Control*, 41(3), 240–244. <https://doi.org/10.1016/j.ajic.2012.04.332>
- Ribeiro, T., Serranheira, F., & Loureiro, H. (2017). Work related musculoskeletal disorders in primary health care nurses. *Applied Nursing Research*, 33, 72–77. <https://doi.org/10.1016/j.apnr.2016.09.003>
- Smith, D. R., Wei, N., Zhang, Y., & Wang, R. (2006). Musculoskeletal complaints and psychosocial risk factors among physicians in mainland China, 36, 599–603. <https://doi.org/10.1016/j.ergon.2006.01.014>
- Society, I. C. (2020). Consensus guidelines for managing the airway in patients with COVID-19 Guidelines from the Dif fi cult Airway Society , the Association of Anaesthetists the Intensive Care Society , the Faculty of Intensive Care Medicine and the Royal College of Anaesthetists, 1–15. <https://doi.org/10.1111/anae.15054>
- Tseng, J., & Lai, H. (2020). Protecting against COVID-19 aerosol infection during intubation, 2020. <https://doi.org/10.1097/JCMA.0000000000000324>.