Journal of Hospital Infection 123 (2022) 12–14

Available online at www.sciencedirect.com

Journal of Hospital Infection

journal homepage: www.elsevier.com/locate/jhin

Practice Points

Oropharyngeal suctioning and nasogastric tube insertion with a new mask for reduction of droplet dispersion: a proposal for a new preventive strategy during the coronavirus disease pandemic

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A R T I C L E I N F O

Article history:
Received 27 January 2022
Accepted 28 January 2022
Available online 8 February 2022

Coronavirus disease (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), is spread via respiratory droplets in close contact [1]. Healthcare workers (HCWs) are at increased risk of COVID-19 as compared with the general community. The risk is highest among those working in the inpatient setting and nursing homes because their work requires close personal exposure to patients with SARS-CoV-2 [2]. Use of personal protective equipment (PPE), including gloves, masks, goggles or face shields, and gowns, can reduce nosocomial transmission, whereas inadequate PPE is considered to be a risk factor for acquiring COVID-19 [2,3].

Airway suctioning is an important healthcare intervention to maintain airway patency that may generate aerosols directly, or indirectly by inducing coughing [4]. Jackson *et al*. classified airway suctioning as an active or passive aerosol-generating procedure in their systematic review [5]. Nasogastric tube (NGT) placement is another common procedure that may increase the risk of exposure of HCWs to SARS-CoV-2, because it requires close proximity to the patient for some time and can induce coughing [6]. At least one guideline on nutrition for COVID-19 patients considers NGT placement to be an aerosol-generating procedure and recommends covering the patient's mouth during insertion of the tube in the nasal cavity [7].

We have developed a new mask for patients undergoing these medical procedures with a 10-mm slit in the centre and a 6-mm slit on both sides (Figure 1a). The slits are closed with an electrified filter and remain closed unless the tube is pierced. The mask was originally developed for bronchoscopy and allows scope insertion through the slit into the oral or nasal cavity. However, the mask could potentially be used for oropharyngeal suctioning or NGT insertion through the slits to reduce the infectious risk of HCWs. Using a high-sensitivity camera capable of visualizing airborne particles >80 nm and a high-power light source (ViEST System), we evaluated the protective effect of the mask during catheter insertion. When a simulated patient coughed with or without the mask during insertion of one catheter, almost no droplets were observed (Figure 1b). When we quantified the pixels of airborne particles visualized by the visualization system, we found a significant reduction in the number of airborne particles when the mask was worn as compared with when it was not worn (P=0.011, Student's t-test). We

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https://doi.org/10.1016/j.jhin.2022.01.022

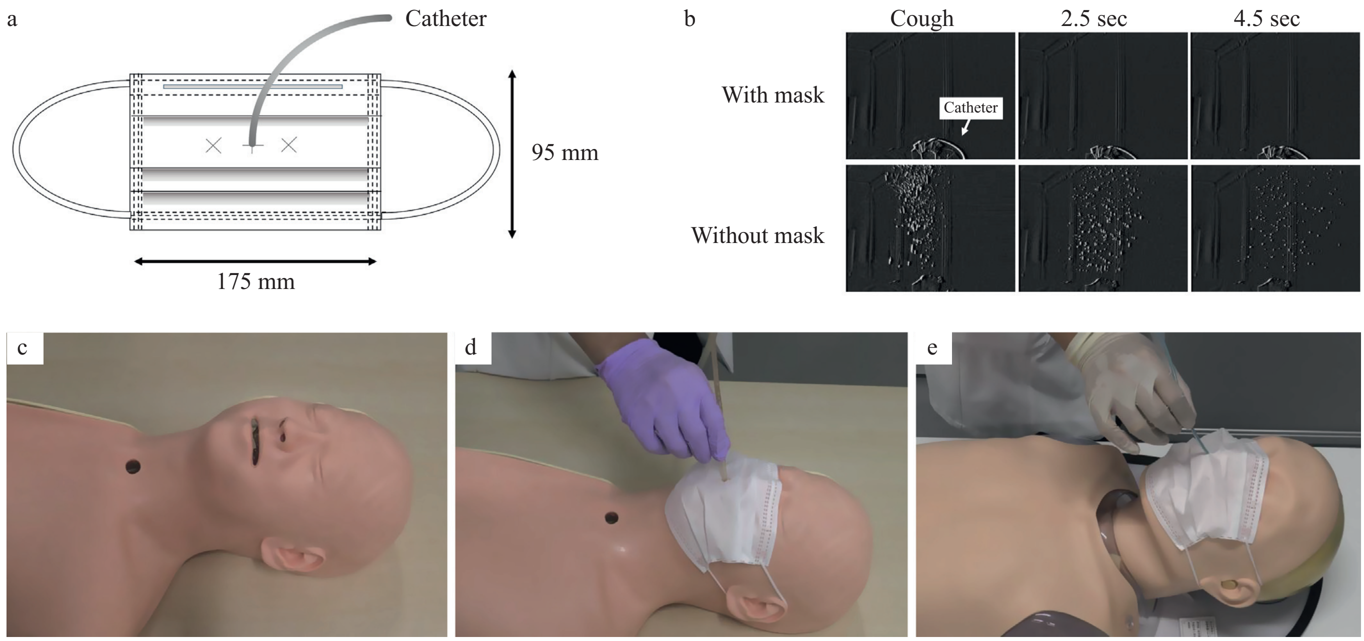

Figure 1. (a) Schema of the mask, which has a 10-mm slit in the centre and a 6-mm slit on both sides for catheter insertion. (b) Visualization of cough droplets using a high-speed sensitive camera (ViEST System) during catheter insertion with and without the mask. The mask reduced the droplet dispersion to almost nil. (c) The appearance of the mannequin without the mask for the catheter insertion test. (d) With the mask, a suction catheter is smoothly inserted orally and nasally, and the simulated phlegm is suctioned. (e) A nasogastric tube is smoothly inserted through the nose with the mask.

tested the effectiveness of the mask by performing NGT insertion and oropharyngeal suctioning using a mannequin (Figure 1c) wearing the mask. In the oropharyngeal suctioning test, we successfully inserted a suction catheter (14 Fr) smoothly and suctioned the simulated phlegm orally and nasally (Figure 1d). Then, we also successfully inserted an NGT (10 Fr) smoothly through the slits of the mask into the nose (Figure 1e).

We demonstrated the feasibility of oropharyngeal suctioning and NGT insertion, and visualized the reduction effect on droplet dispersion with our new mask. The structure of our mask is similar to that of the common surgical mask made of non-woven fabric; therefore, patients are less likely to feel discomfort. In addition, it is disposable, easy to use, and inexpensive. However, a few concerns about the mask remain. First, the nose and mouth are not directly visible during catheter insertion when the mask is worn by the patient. However, this can be solved by training or temporarily shifting the mask and visualizing the nose and mouth. Second, the use of the mask during the procedure may temporarily restrict ventilation, especially in patients with pulmonary diseases such as advanced chronic obstructive pulmonary disease. Care should be taken to avoid elevated CO_2 and decreased SpO_2 concentrations.

In conclusion, our newly developed mask might be a simple and valuable protective tool for HCWs. We propose a new preventive strategy against the spread of SARS-CoV-2 infection during airway suctioning and NGT insertion that uses our mask concomitantly with PPE during the medical procedures, which have the potential to produce aerosols.

Acknowledgements

The authors would like to thank all of the members of our laboratory and section for their comments and suggests on this research. We thank Akinori Terazawa and Takanao Yokoi in Shirohao Co., Ltd, for industrial mask production. We also thank Ryuta Okamoto and Kozo Takahashi for the ViEST System.

Author contributions

All authors equally contributed to this work. S.O., T.I., H.Y., and K.S. mainly conducted the experiment and wrote the manuscript. N.F. performed the image analysis. S.O. and K.S. supervised, designed, conceived, and conducted all aspects of the research project.

Conflict of interest statement

S.O., H.Y., and K.S. have a patent pending. There are no conflicts of interest to declare for the remaining authors.

Funding sources

This research was supported by the Nagoya University Dean fund for B3, Yahoo Japan kikin against COVID-19, KAKEN (grant numbers 18K15923 and 21K07217) (JSPS), CREST (JPMJCR19H2, JST) and FOREST-Souhatsu (JST) to K.S, and KAKEN (grant numbers 19K20319 and 21K11960) (JSPS) to S.O. Funders only provided funding, and had no role in the study design, data collection, data analysis, interpretation, and writing of the report.

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