SPECIAL ARTICLE COVID-19

“Endoscopy Salon” for Controlling Respiratory Droplet Spreading During Endoscopic Procedure

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Abstract

Introduction Preventing droplet dispersal is an important issue for decreasing the coronavirus 2019 (COVID-19) transmission rate; numerous personal protective equipment (PPE) devices have been recently developed for this.

Objective To evaluate the effectiveness of a novel PPE device to prevent droplet spread during nasal endoscopic and fiber optic laryngoscopic examination and postuse equipment cleaning technique.

Methods The “endoscopy salon” was created with a hooded salon hair dryer, plastic sheath, and silicone nipple. Comparison fluorescence dye dispersal from simulating forceful coughing with and without using the “endoscopy salon” was conducted to assess the droplet spread control. The effects of heat produced in the “endoscopy salon” and disinfection cleaning were also evaluated.

Results Fluorescent dye droplet spread from a mannequin’s mouth without using the “endoscopy salon” to care providers’ clothes and the floor surrounding mannequin, whereas no dye droplets spread out when using the “endoscopy salon”. The maximal temperature observed in the hair dryer was 56.3°C. During the cleaning process, when a plastic bag was attached to the hair dryer’s hood to create a closed system, the temperature increased to 79.8 ± 3.1 °C. These temperatures eliminated four test organism cultures during equipment disinfection.

Conclusion This novel “endoscopy salon” device prevented respiratory droplet spread and eliminated infectious organisms during postuse equipment cleaning.

Keywords
- endoscopy
- droplet
- transmission
- coronavirus

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Introduction

The outbreak of the coronavirus disease 2019 (COVID-19), the new β-coronavirus severe acute respiratory syndrome (SARS-CoV-2), has caused a cluster of acute severe respiratory failure in patients around the world. The rapid spread of this disease involves viral transmission via the respiratory and extra respiratory routes. Wang et al.[1] reported the SARS-CoV-2 was most often detected in the respiratory tract, especially in the lower respiratory tract. Live SARS-CoV-2 has also been detected in feces; thus, the virus may also be transmitted via the fecal route. Several studies[2–7] have shown that SARS-CoV-2 was transmitted between people through respiratory droplets. Droplet transmission occurs when a person is in close contact with an infected person who has respiratory symptoms, including sneezing and coughing, resulting in a high chance of normal upper respiratory tract mucosa and normal conjunctiva exposure to potentially infected droplets. Contact transmission can occur via direct contact with an infected person or indirectly via contact with fomite objects in the immediate environment around the infected person.[8]

A number of personal protective devices (PPEs) have been developed for transmission prevention that act as barriers between infected patients and healthcare providers. A novel "endoscopy salon" was instantly developed to reduce respiratory droplet transmission during the endoscopic examination at the ear, nose, and throat clinic. The "endoscopy salon" is comprised of a hooded salon hair dryer, a plastic sheath, and a silicone nipple. The plastic sheath, which acts as a protective shield between patients and healthcare providers, was attached to the rim of the hooded hair. A silicone nipple was inserted through the plastic sheath as a port for nasal endoscopy and flexible optic laryngoscopy. An additional benefit of the hooded hair dryer is heat production that may kill the virus after use. The World Health Organization (WHO) has reported that SAR-CoV-2 is killed around 10,000 units by heat at a temperature of 56 C for 15 min[9]; therefore, the heat production from the hooded hair dryer should also be investigated. However, as the air blowing from the hooded hair dryer during cleaning may help the organism to spread, the bottom of the hood must be covered with a plastic bag to simulate a closed system. The present study was conducted to evaluate this novel "endoscopy salon" device for reducing the transmission of respiratory disease. The study had three aims: to assess the prevention of respiratory droplet spread, the heat production effects on viral viability, and the disinfection adequacy after use.

Materials and Methods

The hooded salon hair dryer was modified with the attachment of a plastic sheath of about 60 × 85 cm and a silicone nipple (►**Fig. 1**). This modified device was developed with the aim to serve as the barrier for respiratory droplet transmission between patients and healthcare providers (►**Fig. 2**).

Fig. 1 The "endoscopy salon" was created with a hooded hair dryer, a 24 × 34-inch plastic sheath, and a silicone nipple. The plastic sheath was attached at the bottom of the hood of the hair dryer. The silicone nipple was inserted and attached through the plastic sheath as a port for nasal endoscopy and fiber optic laryngoscopy.

1. Controlling droplet spreading assessment

To simulate forceful coughing, we placed a small balloon filled with 10 ml of dilutional fluorescent dye in a

Fig. 2 The "endoscopy salon" in use demonstrated the endoscope insert via the port to access to the patient behind the plastic sheath.

mannequin's oropharynx. The balloon was inflated with air through tubing inside the mannequin until it exploded during a nasal endoscopic examination. The scene was illuminated with black light to visualize the spread of the fluorescent dye. After cleaning the mannequin and the surrounding area, the experiment was repeated with the "endoscopy salon" for droplet spread comparison.

2. Heat production

A thermocouple was used for measuring the temperature in the hooded hair dryer. The four probes of the thermocouple were placed in different positions in the hood. The first probe was placed on the left and the second one was placed on the right side of the interior hood, and both 10 cm from the center. The third probe was placed in the front, and the last one was placed in the rear of the interior hood, and both 20 cm from the center. The maximum heat production of the "endoscopy salon" was observed and recorded every minute until the temperature was steady state. The average temperature from the four probes was analyzed.

3. Assessment cleaning process

For disinfection, the plastic sheath at the bottom of the hood was designed to be single-use. The silicone nipple was re-sterilized with a 2% solution of activated glutaraldehyde for 15 minutes. For the hooded hair dryer, we experimented with four common upper aerodigestive tract organisms; *Herpes Simplex Virus, Escherichia coli, Candida albicans*, and *Aspergillus spp.* In order to estimate the sample size of organisms for preparing the specimens, the amounts of *Herpes Simplex Virus, Escherichia coli,* and *Candida albicans* were calculated with the equation[10] below:

$$\text{Organism titer}\left(\frac{\text{PFU or CFU}}{\text{mL}}\right)=\frac{\text{Average of organisms number (PFU or CFU)}\times\text{dilution factor}}{\text{volume of applied organism (mL)}}$$

Aspergillus spp. was counted with spores by the hemocytometer technique; therefore, we used another equation[11,12]:

$$\text{Aspergillus spores}\left(\frac{\text{spores}}{\text{mL}}\right)=\frac{\text{Number of spores per filed}\times\text{dilution factor}\times\text{hemocytometer constant}}{\text{Number of field count}}$$

Each organism was applied to a 1 cm diameter area on a plastic test plate. We used the three applications for each organism. Firstly, culture from the control application sample was taken to count the number of viable organisms before cleaning. For cleaning, the plastic dishes were scrubbed to imitate the cleaning procedure inside the hooded hair dryer with Posequat Pad (Pose Health Care Limited, Bangkok, Thailand), and then the plastic plates were placed in the hooded hair dryer at maximal temperature. When the heat of the "endoscopy salon" was turned on, the bottom of the hood was closed with the same plastic sheath to prevent organisms from being spread by the air blower and to enhance heat inside the hood. After cleaning with maximal heat for 15 minutes, the plastic sheath was then removed because of its denaturing, and the culture from the three application areas of each organism was repeated for assessing the efficacy of the disinfection technique. The study was approved by the local ethics research committee (HE631258).

Results

Droplet Spread

Without using the "endoscopy salon", fluorescent dye droplets were spread from a mannequin's mouth to the clothes of the care provider and the floor around the mannequin (►**Supplementary Material Video 1A**). The furthest distance of reached by dye droplets was on the floor, 170 cm from the mannequin's mouth; on the other hand, no dye droplets were observed to spread outside of the plastic sheath when the "endoscopy salon" was used (►**Supplementary Material Video 1B**).

Supplementary Material Video 1

Comparison of fluorescent dye droplets spreading from a mannequin' s mouth without (**Video 1A**) and with use of the "endoscopy salon" (**Video 1B**).
Online content including video sequences viewable at: https://www.thieme-connect.com/products/ejournals/html/10.1055/s-0041-1730305.

Heat Production

The temperature within the "endoscopy salon" hood started at 24.8 °C when the hair dryer was first turned on. The temperature increased until it reached 56.3 °C, after 10 mins, and then continued to increase slowly until it plateaued at 59.5 °C, after 21 mins (►**Fig. 3**). Furthermore, the temperature within the hood during the cleaning process with the plastic bag attached to reduce organism dispersal averaged 79.8 ± 3.1 °C.

Cleaning Process

For assessment of the cleaning technique, the control cultures before cleaning demonstrated positive for *Herpes Simplex Virus, Escherichia coli, Candida albicans,* and *Aspergillus spp*. After cleaning with wipes and heat for 15 min, all plate agars showed negative for all organisms, and the hemocytometer showed no spores of *Aspergillus spp.* (►**Fig. 4**).

Discussion

Numerous PPE devices have been developed in this COVID19 global health crisis for facilitating medical healthcare and preventing viral transmission. The "endoscopy salon" is a novel barrier device for respiratory droplet transmission between patients and healthcare providers during nasal endoscopic and fiber optic laryngoscopic procedures. This concept is similar to the aerosol box developed by Lai HY.[13] The aerosol box was made of transparent acrylic or polycarbonate sheeting. The original box design was based on a cuboidal shape with two circular ports for the arms. The simulated coughing in the aerosol box was experimented by

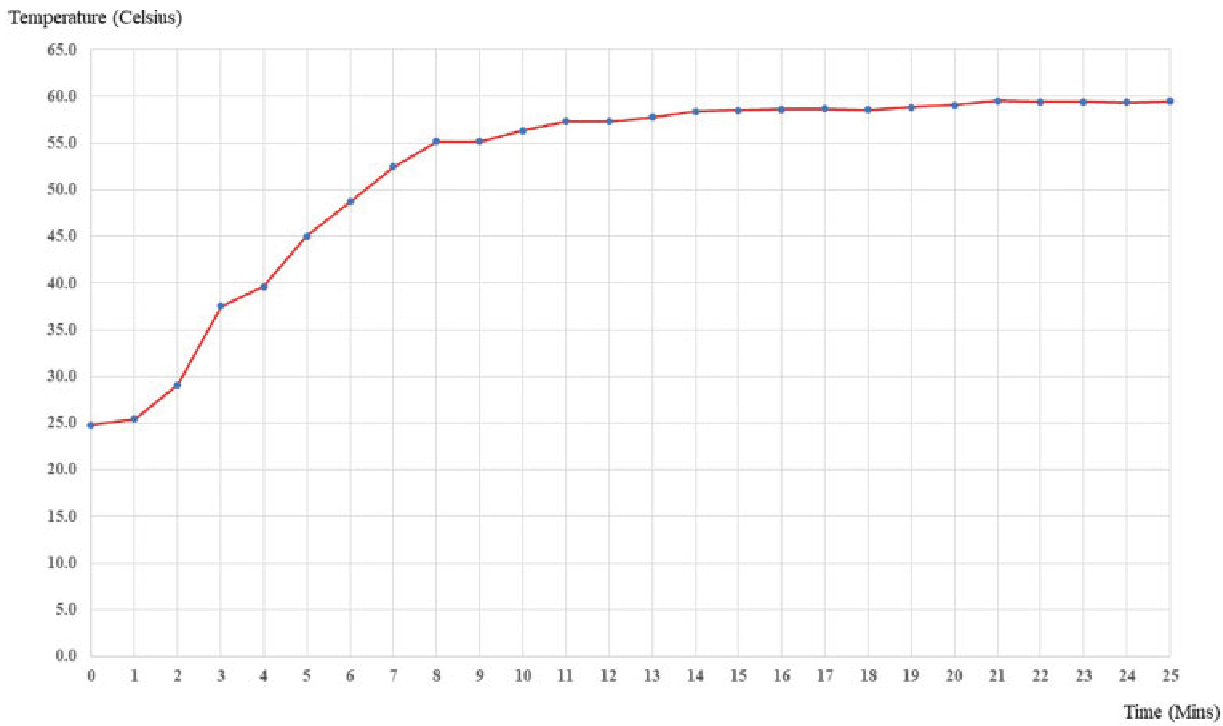

Fig. 3 The graph showed the heat production from the "endoscopy salon". The temperature started at 24.8 °C and then rapidly increased to 55.0 °C within 8 minutes. After that, the temperature slowly increased until the plateau level of 59.5°C at 21 minutes.

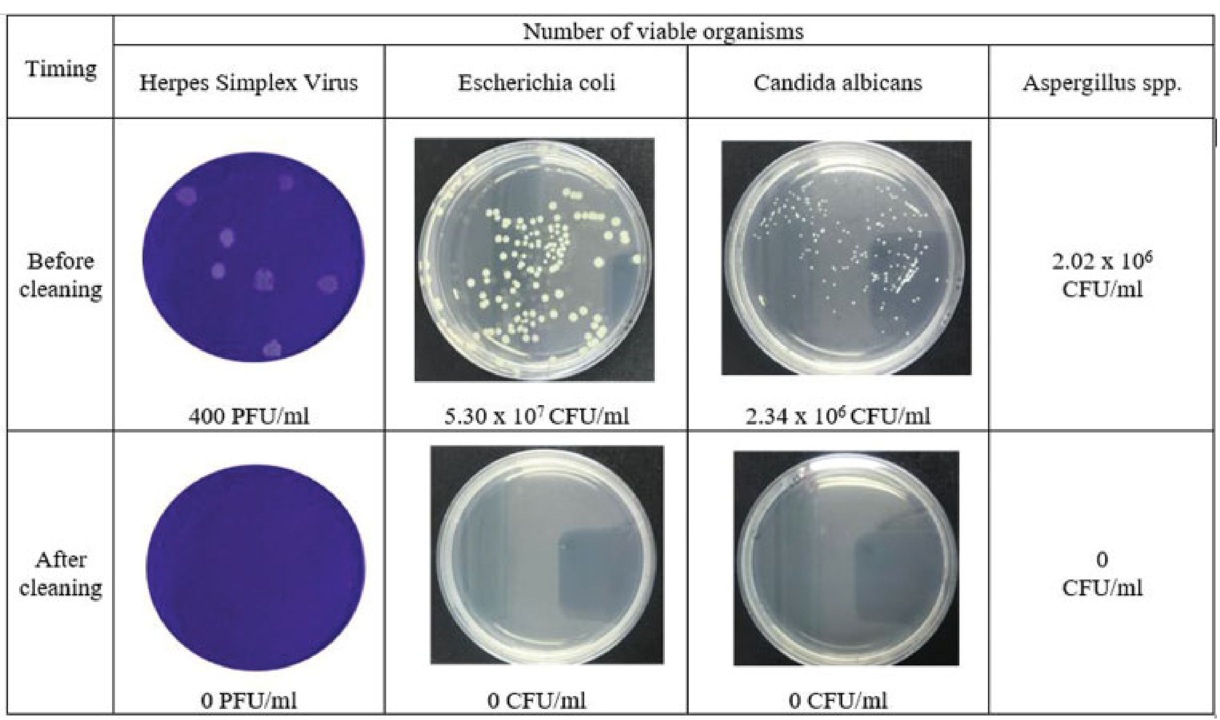

Fig. 4 Comparison of the number of viable organisms before and after cleaning. All plate agars showed negative for all organisms. For *Aspergillus spp.*, the hemocytometer showed no spores after the cleaning process.

Canelli et al.[14] They demonstrated no macroscopic dye droplet contamination outside the box. This result is similar to that of our study, which showed no fluorescent dye droplet spread from the hood of our "endoscopy salon," thus implying that it can control the respiratory droplet transmission. Furthermore, the "endoscopy salon" prevented contamination of the other parts of endoscopy equipment exposed to patients, including head camera and light cable unit. The health care providers held these parts outside of the hood. Only the rod lens passed through the rubber nipple port was exposed to the patient. This benefit allowed for easy disinfection. Possible limited endoscope movement was an initial concern due to passing the rod lens through the port; however, a non-rigid plastic sheath attached to the port made movement easy for facilitating the endoscopy examination. Although the plastic sheath was not rigid, it still provided a stable shape due to it being attached at the bottom of the hood. This was also comfortable for a patient sitting within the hood. Additionally, the “endoscopy salon” is mobile and not too large, and, therefore, it is suitable for use in limited space.

Regarding heat production, the “endoscopy salon” produced a maximum temperature of 59.5°C within 21 min; the higher temperature of 79.8°C was observed when using a plastic bag covering the bottom of the hood to create a closed system during the cleaning process. As SAR-CoV-2 has been reported to be killed by 15 minutes of exposure to a temperature of 56 °C,[9] our cleaning process should make our hood safe from coronavirus transmission. Four other transmission risk organisms (*Herpes Simplex Virus, Escherichia coli, Candida albicans,* and *Aspergillus spp*) showed negative culture after the cleaning process. Therefore, the “endoscopy salon” hood cleaning process showed acceptable re-sterilization. The cost of the device is for the hooded hair dryer, plastic sheath, and the silicone nipple (in our country, this is about 100 USD). However, the plastic sheath at the bottom of the “endoscopy salon” was a single use, which is a problem as it increases medical waste. Thus, further research is needed for endoscopy droplet spread control to eliminate this problem.

Conclusion

The properties of this “endoscopy salon” device have been demonstrated for reducing droplet spread during endoscopic procedures. Furthermore, the simple scrubbing and heating cleaning process also showed benefits in terms of reduction of disease transmission. However, assessing user and patient satisfaction are very important; therefore, this issue should be further investigated.

Conflict of Interests
The authors have no conflict of interests to declare.

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