Negative pressure booth with HEPA filter reduces the risk of airborne infection associated with transoesophageal echocardiography

T. Machino¹, K. Watabe², Y. Imura², N. Kawamatsu¹, K. Sato¹, M. Yamamoto¹, T. Ishizu¹, Y. Kawakami¹

¹University of Tsukuba, Ibaraki, Japan
²Ibaraki CIC laboratory, Hitachiota, Japan

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Background: The pandemic of coronavirus infection 2019 has persisted, despite reductions in disease severity and deaths. Transoesophageal echocardiography (TOE) is one of the aerosol-generating procedures and increases the risk of airborne infection. However, the effective strategy to reduce the risk has not been fully established.

Purpose: To evaluate the effectiveness of negative-pressure booth with high-efficiency particulate air (HEPA) filter in control of aerosol generated by TOE.

Methods and Results: In the TOE examination room, we installed negative-pressure booth. This booth has an air supply port on the ceiling and exhaust port on the head side of examination table, and the airflow is controlled by a push-pull method (Figure 1). The air changes per hour (ACH) for the entire room was only 8, but 38 inside the booth, meeting the CDC recommended standard for airborne infection isolation room (ACH ≥ 12). Visualization of the airflow by laser light scattering showed that the airflow in the booth bent the trajectory of particulates produced by the patient's cough and sent them to the exhaust port (Figure 2A). The size-specific quantifications for >0.3μm-, >0.5μm-, >1.0μm-diameter particles by a particle counter revealed that the peak particle concentrations within the booth were reduced by approximately 70% after 7 min of ventilation (Figure 2B) in unattended situation. In clinical setting, we monitored particle counts during TOE in 70 cases. Echocardiologists were at greater risk of aerosol exposure than assistants. Multiple regression analysis revealed that patients' discomfort level during TOE and less experienced echocardiologists were independently correlated with increased particle counts (β=0.376, p=0.003 and β=0.355, p=0.005, respectively). However, aerosols generated in the early time of TEE were almost eliminated by the end of the examination by negative pressure booth.

Conclusion: The negative pressure booth effectively and quickly reduces small particles equating aerosols. It might be effective to reduce the risk of airborne infection and shorten the patients turnover time of TOE room even in the pandemic of infectious diseases.

Figure 1

Negative pressure booth with HEPA filtered ventilation system
Figure 2

A. Airflow visualization by laser light scattering

B. Particle removal performance of the booth

- Approximately 70% reduction of particles
- Number of particles (0.1 cfu)
- Time after starting the ventilation system (min)