Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

These results suggest that oxygen should preferentially be entrained via the dedicated port in the Noninvasive Ventilator, as this allows greater control of delivered FiO_2. It is difficult to deliver an FiO_2 <90% when entraining via the filter, which may be too high for some patients. In addition, patient-specific breathing mechanics make predicting FiO_2 uncertain when delivered via the filter. Our results given here can be used to estimate FiO_2 with a given CPAP, oxygen flow rate, and mode of ventilation. However, different Noninvasive Ventilator machines and patient settings may result in different relationships, so we suggest creation of a look-up table for each set up to allow clinicians to set an estimated FiO_2 using a given flow rate and CPAP. This will only work however, when oxygen is supplied via the Noninvasive Ventilator port.

Declarations of interest

The authors declare that they have no conflicts of interest.

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Are aerosol-generating procedures safer in an airborne infection isolation room or operating room?

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Keywords: aerosol-generating procedure; COVID-19; isolation room; operating room; safety; tracheal intubation

Editor—One of the most important considerations for healthcare workers in the midst of the coronavirus disease 2019 (COVID-19) pandemic is the location in which aerosol-generating procedures are performed for patients with suspected or known COVID-19. Aerosol-generating procedures include ventilation through a facemask, tracheal intubation, and tracheal extubation. For non-surgical patients, a negative-pressure airborne infection isolation room is the preferred location for performing aerosol-generating procedures, because the negative pressure reduces droplet and aerosol transmission from within the isolation room to the environment outside.[1] For surgical patients with suspected or known COVID-19, the ASA[1] also recommends 'perform [ing] procedures in an airborne infection isolation room rather than in an operating room.' Some readers may interpret the ASA recommendation to imply increased safety when performing aerosol-generating procedures in an airborne infection isolation room compared with an operating room. However, there is limited evidence regarding the safety of healthcare workers within these two locations in terms of aerosol exposure and exposure time. Using an airway manikin model setup,[2] we compared aerosol exposure and time by measuring particle concentrations during and after saline nebulisation in a positive pressure operating room and a negative pressure airborne infection isolation room.

We simulated aerosol exposure during intubation using a nebuliser (Airlife Misty Max 10 Disposable Nebulizer, CareFusion, San Diego, CA, USA) to nebulise saline into aerosol droplets with a median size of 1.6 μm into the trachea of an airway manikin placed in the centre of a room.[2] The aerosolised droplets generated are comparable in diameter to aerosolised COVID-19 droplets (which have two size ranges: 0.25–1 μm and >2.5 μm).[3] Using a particle counter (Digital PM2.5 Air Quality detector, Geekcreit, Banggood, Guangzhou, China), particle concentrations (μg m^{-3}) of particulate matter with diameter <1 μm (PM_1), <2.5 μm ($PM_{2.5}$), and <10 μm (PM_{10}) were measured. One particle counter was placed 30 cm directly above the manikin to simulate the proceduralist's location and exposure during tracheal intubation with direct laryngoscopy,[2] and the other particle counter was placed immediately outside the closed door to detect aerosol leakage outside the room. During pilot experiments, particle concentrations returned to baseline (0 μg m^{-3}) within ~10 min in both rooms upon discontinuation of the nebuliser. Thus, we decided to measure particle concentrations every second for

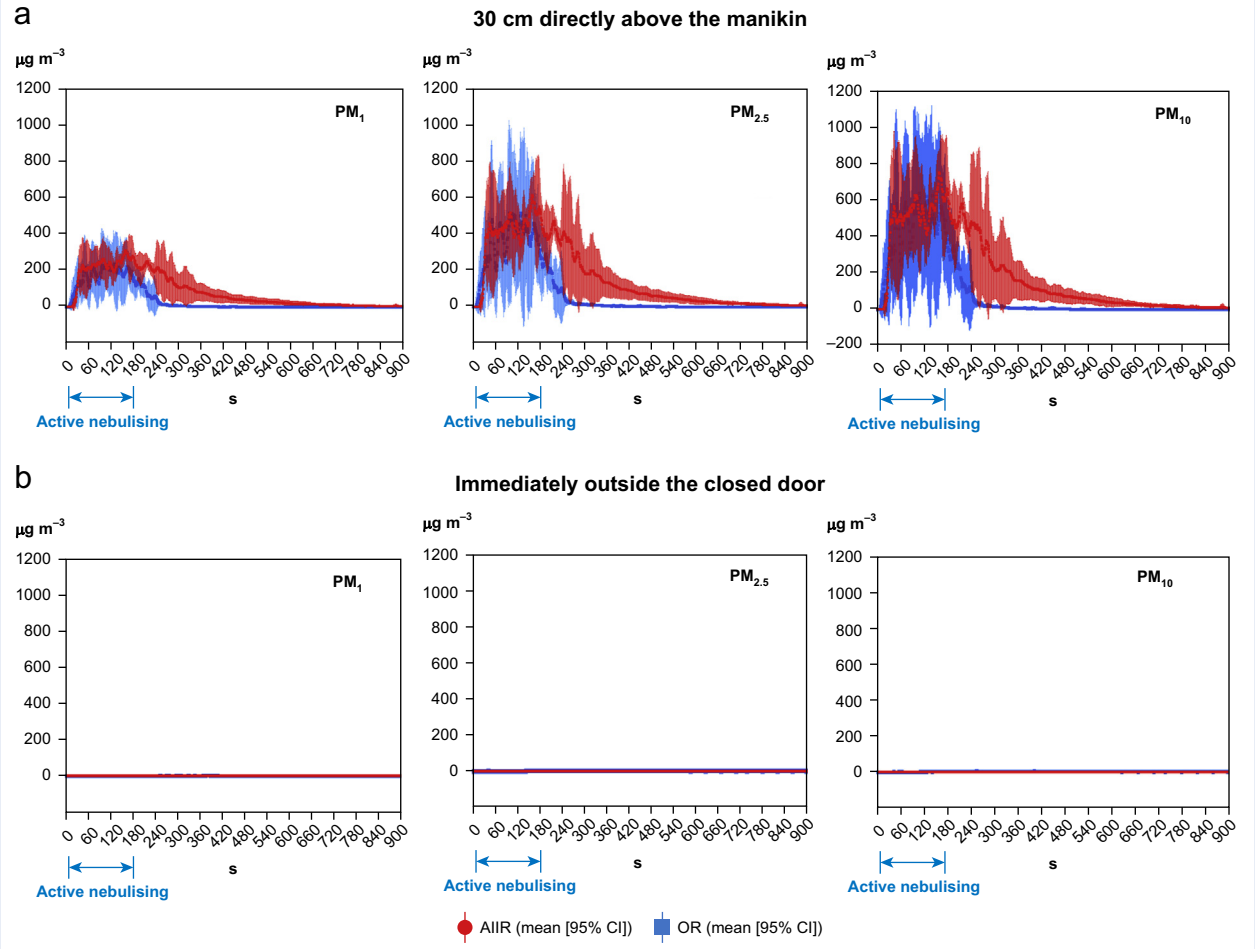

Fig. 1. Aerosolised particle concentrations of different diameter sizes in a standard operating room (blue solid square: mean [95% CI]) and negative pressure airborne infection isolation room (red solid circle: mean [95% CI]) during simulation study. Five measurements were performed (a) at 30 cm above the manikin's head and (b) immediately outside the closed door. PM: particle concentrations (μg m^{-3}) were recorded for particulate matter diameter sizes: (left) PM1: <1 μm, (middle) PM2.5: <2.5 μm, (right) PM10: <10 μm. AIIR, airborne infection isolation room; CI, confidence interval; OR, operating room.

20 min in the following sequence: (a) at time 0 min the nebuliser was activated for 3 min to simulate passive breathing during ventilation through a facemask and tracheal intubation; (b) at time 3 min the nebuliser was discontinued to simulate a secured airway; and (c) measurements continued for 17 min to ensure particle concentrations reached baseline levels. The measurement protocol was performed and repeated consecutively under the same conditions five times. Preceding initiation of any measurements in both rooms, doors were closed for 30 min and the temperature was set and maintained at 22°C. The doors remained closed until all measurements were completed. The mean particle concentrations and their 95% confidence intervals are plotted in Fig 1.

We found similar aerosol exposure levels for the proceduralist in both the operating room and the airborne infection isolation room. However, mean particle concentrations returned to baseline (0 μg m^{-3}) within 70 s in the operating room and 560 s in the airborne infection isolation room upon discontinuation of the nebuliser. Based on this simulation, there is an ~eight-fold increase in mean aerosol exposure time in the airborne infection isolation room compared with the operating room. With the doors closed, particle concentrations outside the airborne infection isolation room and the operating room remained at baseline levels both during and after the aerosol-generating medical procedure, demonstrating no significant aerosol leakage outside either location.[3]

These findings can be partially explained by the different room ventilation system designs for the operating room and the airborne infection isolation room. Although the number of air changes per hour for operating rooms and airborne infection isolation rooms vary between hospitals and even within the same hospital, the minimum required air changes per hour for an operating room in the USA is 15 compared with 12 for an airborne infection isolation room as mandated by the 2018 Facilities Guideline Institute.[4] For this simulation, aerosol particle concentrations were measured in a positive-pressure operating room with air changes per hour of 27 and a negative-pressure airborne infection isolation room with air

changes of 12 per hour. The reduced air changes per hour in an airborne infection isolation room can also result in increased recirculation of aerosols, incomplete air mixing, and incomplete room air exchange.[5] In addition to prolonged aerosol exposure times, performance of aerosol-generating procedures in remote airborne infection isolation rooms have well recognised associated risks (i.e. unfamiliar equipment, limited resuscitation resources, crowded patient access, and increased hazards during transport to the operating room).[6] The main reason for recommendations that aerosol-generating procedures be performed in an airborne infection isolation room rather than in an operating room is to limit spread of viral aerosols outside the room, but there may be a greater risk of anaesthetists being exposed to viral aerosols when performed in an airborne infection isolation room than in the operating room. Before instituting any safety measures, clinicians and policy makers should objectively evaluate the dynamic behaviour of aerosols within their own operating room and airborne infection isolation room ventilation systems to maximise safety for their healthcare workers.

Declarations of interest

The authors declare that they have no conflicts of interest.

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Sevoflurane may not be a complete sigh of relief in COVID-19

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Keywords: COVID-19; ICU; malignant hyperthermia; sedation; sevoflurane; volatile anaesthetics

Editor—We read with interest the editorial by Nieuwenhuijs-Moeke and colleagues[1] on the use of sevoflurane as an ICU sedative in patients admitted with coronavirus disease 2019 (COVID-19). We were surprised that there was no mention of the potential for a fatal episode of malignant hyperthermia (MH) when using a volatile anaesthetic agent as a sedative in the ICU. Although rare, cases of MH triggered in the ICU do occur.[2] Unpublished data from the UK MH unit in Leeds show that there have been two patients referred in the past 5 yr after an MH episode as a result of exposure to a volatile anaesthetic agent in the ICU: in both cases the volatile anaesthetic was used to alleviate status asthmaticus. In one case the volatile anaesthetic was isoflurane, and in the other, sevoflurane. As reported,[3] sevoflurane is now the most common triggering agent in new cases referred to the UK MH unit, supplanting isoflurane. However, isoflurane remains the most common triggering agent over the past 30 yr.

We do not suggest that the possibility of an MH reaction should be the overriding factor in the choice of ICU sedative, but use of volatile anaesthetics in this setting should be accompanied by education of ICU staff in the recognition and management of an MH reaction.[4] Display of visual aids for diagnosis and management in the relevant bed space might also be considered (these can be downloaded from www.ukmhr.ac.uk). Furthermore, it should be noted that an MH reaction within the ICU may be more difficult to diagnose than in the operating theatre because of a high incidence of conditions that are associated with clinical features of MH