Evaluation of ventilation during partial shutdown of a hospital heating, ventilation, and air conditioning system for maintenance

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To the Editor—Heating, ventilation, and air conditioning (HVAC) systems in healthcare facilities maintain the indoor air temperature and humidity at comfortable levels and provide adequate ventilation to control odors and reduce risk for transmission of airborne pathogens.[1,2] Failure of the HVAC system or a temporary shutdown for maintenance could subject patients and staff to increased risk for exposure to airborne contaminants. However, limited information is available on the infection control implications of temporary HVAC shutdowns.[3] Therefore, we assessed ventilation during maintenance of the HVAC system in our hospital requiring 2 temporary shutdowns of the air handling system supplying one-half of the building.

The Cleveland VA Medical Center is a 215-bed hospital with 6 floors. The HVAC system has 2 central air-handling units providing ventilation to the east and west sides of the hospital, respectively. The air handling unit for the east side of the building was shut down for maintenance for ∼8 hours on both March 25, 2023 (episode 1) and May 20, 2023 (episode 2). Patient room occupancy was ≥85% during the shutdown periods. The bathrooms, negative-pressure rooms (N = 15), and soiled utility rooms have dedicated exhaust systems that remained operational during the shutdown, potentially providing negative pressure to facilitate movement of air from the ventilated to the nonventilated side of the building. During the initial shutdown, the air handler was able to vent some recirculated air to the outside, potentially providing additional negative pressure to facilitate air movement to the nonventilated areas. Supplementary Figures 1 and 2 (online) provides illustrations of the impact of each shutdown.

As part of a risk assessment conducted by the infection control and engineering teams, portable carbon dioxide monitors (IAQ-MAX CO_2 Monitors, CO2Meter, Ormond Beach, FL) with continuous data logging capability were placed in 4 patient rooms and 3 nursing stations before, during, and after each shutdown on the affected side of the building. A carbon dioxide monitor was also carried during work rounds by a team of physicians during the shutdowns and on the following days when the HVAC system was operating normally. The devices were calibrated daily in outdoor air according to the manufacturer's recommendations. Carbon dioxide readings >800 ppm were considered an indicator of suboptimal ventilation.[1,4–7]

As an additional means to assess ventilation, clearance of aerosol particles was assessed in 3 affected patient rooms during each shutdown versus in 3 rooms on the same wards after return to normal ventilation.[3] A Preval sprayer (Nakoma Products, Indianapolis, IN) aerosol-based spray system was used to release 6 mL 5% NaCl over 15 seconds in a central location in the room. A 6-channel particle counter (Fluke 983, Fluke, Everett, WA) was used to obtain particle-count readings of 1–10-µm particles at baseline and at 5-minute intervals until particle counts returned to approximately baseline levels or for up to 40 minutes. Readings were obtained with the door open and closed.

During both HVAC shutdowns, observers in the hallways leading to the nonventilated wards could feel currents of airflow moving from the ventilated side of the building to the nonventilated wards. Carbon dioxide levels remained consistently <500 ppm at nursing stations during both shutdown episodes and in patient rooms during the first shutdown. However, carbon dioxide levels rose from ∼450 ppm to ∼600 ppm (peak 616 ppm) during the second shutdown and decreased to ∼450 ppm after the HVAC system resumed operation (Supplementary Fig. 3 online).

During physician work rounds, carbon dioxide levels remained<800 ppm in patient rooms except in 1 patient room during the second shutdown when 5 people were present in the room for >10 minutes with the door closed (peak carbon dioxide level, 846 ppm). In physician-team work rooms, carbon dioxide levels rose above 800 ppm during both shutdowns when 5–6 people were present with the door closed (peak level, 867 ppm during the second shutdown). Carbon dioxide levels remained <800 ppm in the physician work rooms and in all patient rooms during rounds when the HVAC system was operating normally.

Figure 1 shows the clearance of aerosol particles over time in affected patient rooms during each of the shutdowns versus in patient rooms on the same wards after the HVAC system was functioning. With the HVAC system operating and the doors open, aerosol particles peaked at a relatively low level (3,721 particles per liter) and decreased to <1,000 particles per liter within 10 minutes. During both HVAC system shutdowns when the doors were open, aerosol particles peaked at substantially higher levels (>15,000) and cleared more slowly, requiring 15–35 minutes to decrease to <1,000 particles per liter. For both shutdown episodes, peak values were substantially higher, and clearance was slower when the doors to the patient rooms were closed. Particle counts were also higher and clearance was slower during the second shutdown versus the first shutdown.

In conclusion, temporary shutdown of an air handler for one-half of our hospital had only a modest impact on ventilation based on carbon dioxide monitoring and assessment of aerosol particle clearance. Substantial movement of air from the ventilated to the nonventilated side of the hospital may have substantially reduced the impact of the shutdown. Thus, our findings may not apply to situations in which the entire HVAC system is shut down. Our results suggest that keeping doors of occupied rooms open may be beneficial. Carbon dioxide monitoring and assessment of aerosol particle clearance may be useful tools to assess the impact of HVAC shutdowns.

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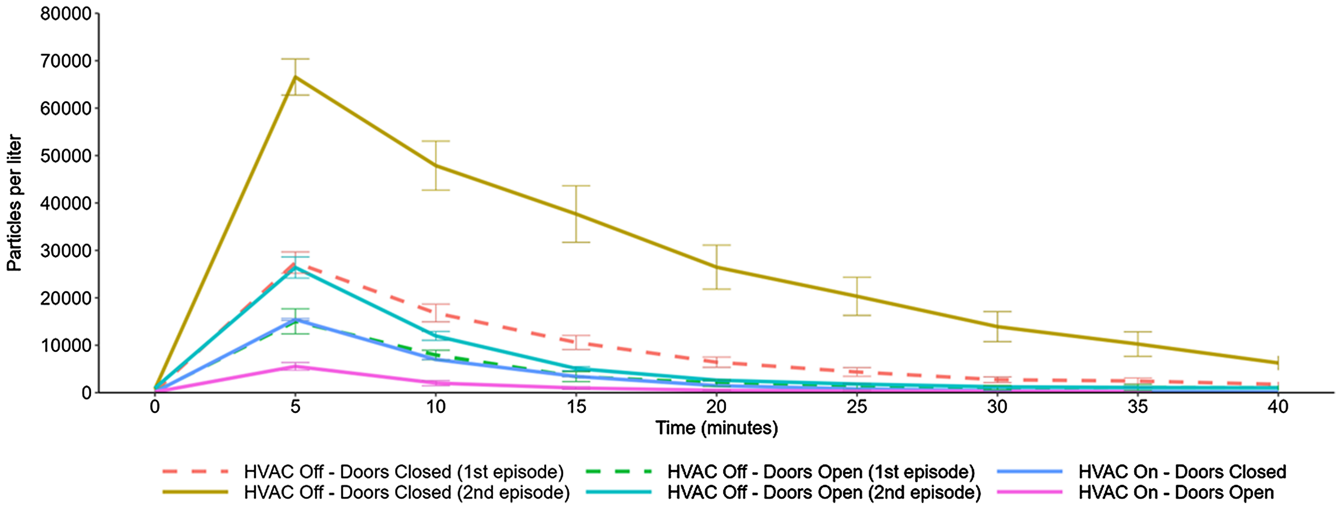

Figure 1. Clearance of 5% sodium chloride solution aerosol particles (1–10 μm in diameter) in patient rooms with the door open versus closed during periods when the heating, ventilation, and air conditioning (HVAC) system was off for maintenance versus on. During episode 1, the air handler was able to vent some recirculated air to the outside. Average results for 3 rooms for each test condition are shown. Error bars represent standard error.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/ice.2023.166

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Discordant antimicrobial susceptibility and polymerase chain reaction (PCR) testing in a *Klebsiella pneumoniae* isolate with a carbapenemase gene

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To the Editor—Rapid blood-culture identification techniques are increasingly common in hospitals across the United States. Rapid diagnostics can quickly identify resistance genes in bacteria that may otherwise have taken days to be identified, thus shortening the time until patients are placed on the appropriate

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