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BRIEF COMMUNICATION

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Conversion of positive-pressure cardiac catheterization and electrophysiology laboratories to a novel 2-zone negative-pressure system during COVID-19 pandemic

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Abstract

During coronavirus disease-2019 (COVID-19) pandemic, there continues to be a need to utilize cardiac catheterization and electrophysiology laboratories for emergent and urgent procedures. Per infection prevention guidelines and hospital codes, catheterization and electrophysiology laboratories are usually built as positive-pressure ventilation rooms to minimize the infection risk. However, patients with highly transmissible airborne diseases such as COVID-19 are best caredfor in negative ventilation rooms to minimize the risk of transmission. From a mechanical and engineering perspective, positive-pressure ventilation rooms cannot be readily converted to negative-pressure ventilation rooms. In this report, we describe a novel, quick, readily implantable, and resource-friendly approach on how to secure air quality in catheterization and electrophysiology laboratories by converting a positive-pressure ventilation room to a two-zone negative ventilation system to minimize the risk of transmission.

KEYWORDS

COVID-19, electrophysiology laboratory, infection prevention, ventilation

Cardiac catheterization and electrophysiology laboratories are usually built as positive-pressure ventilation rooms to minimize the risk of infection, similar to operating rooms. However, proper and safe care of patients who require respiratory isolation is best performed in negative-pressure ventilation rooms. Recent guidelines provided helpful information on the care of suspected or confirmed patients with coronavirus disease-2019 (COVID-19) in the cardiac catherization and electrophysiology laboratories.[1,2] However, measures for proper ventilation of the laboratories have not been well characterized. In the wake of COVID-19 pandemic, ventilation of catheterization and electrophysiology laboratories poses a challenge as reversal of ventilation pressure to negative is usually not readily feasible due to engineering and mechanical constraints.

This prompted us to develop a novel approach to minimize the in-house transmission risk. A multidisciplinary team including, infection prevention, nursing, mechanical, ventilation, and building engineers was established to convert laboratories to safely accommodate suspected or confirmed patients with COVID-19. First priorities were identified as follows:

1. Selection of the proper laboratories based on physical separation from the other laboratories, patient care areas, staff and waiting rooms, and proximity to the main hallways and patient elevators.
2. Proper equipment of the laboratory with imaging and other systems to facilitate care of broadest range of structural heart or electrophysiology conditions in patients with COVID-19.

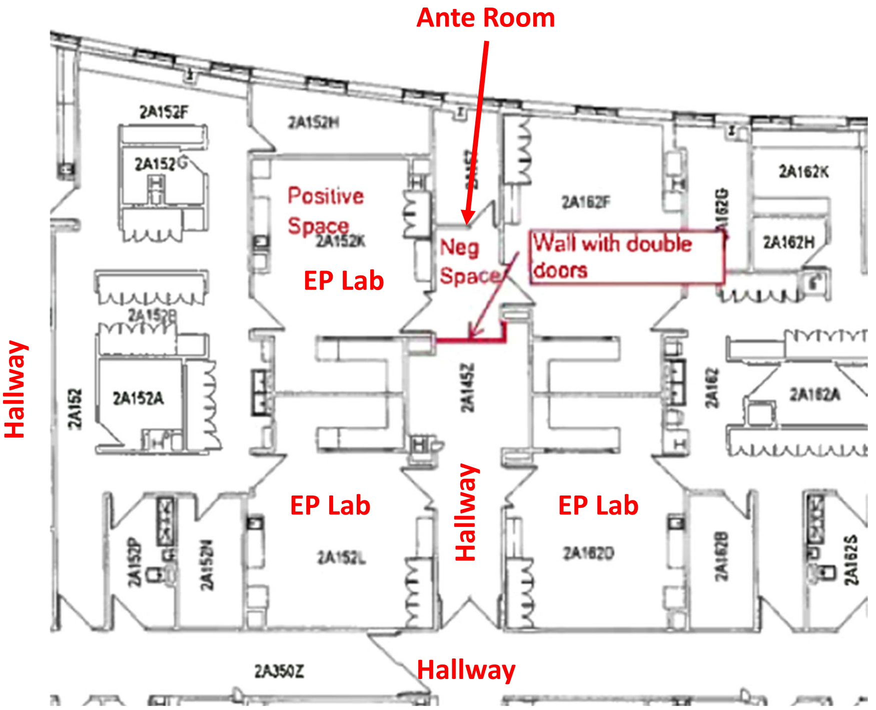

FIGURE 1 Blueprint of the EP laboratories. Four of the six laboratories are shown. An anteroom was created in the hallway between the two laboratories. Cardiac catheterization laboratories were modified exactly the same. EP, electrophysiology

3. Location and build of the laboratory that would be most conducive to modification of the ventilation system.
4. A simple, readily feasible, quick, and resource-friendly construction process.

Since the laboratories could not be converted to negative-pressure rooms, an alternative plan was developed. In this model, the laboratory is still ventilated with positive pressure as usual. However, an anteroom is created immediately outside the laboratory to create a high-efficiency particulate air (HEPA)-filtered negative-pressure zone where the ventilation from the laboratory is exclusively directed in (Figure 1). The advantages of this system are:

1. The cleanliness of the air, including the air flow rates and pressure direction within the laboratory are still maintained according to the safety guidelines on infection control and building codes.[3]
2. The air is exhausted outside after HEPA-filtering, to protect the air handler from possible contamination and to prevent recirculation of any airborne infectious agents. Thereby, hallways and any other space on the floor are protected from contamination, particularly when the doors to the laboratory are opened.
3. A designated area for donning and doffing of personal protective equipment, before the anteroom, facilitates safe entry and exit to the anteroom. Masks must stay on until after leaving the anteroom since anteroom is a negative-pressure room. This is primarily important when aerosol-generating procedures, such as intubation for general anesthesia are being performed.

The anteroom was constructed with temporary doors that can remain open during regular operations and kept closed during care of suspected or confirmed patients with COVID-19:

1. Anteroom was constructed by partitioning the hallway between the two laboratories such that the same anteroom can serve both laboratories (Figures 1 and 2). Partitioning walls were constructed of metal studs and vinyl coated drywall.

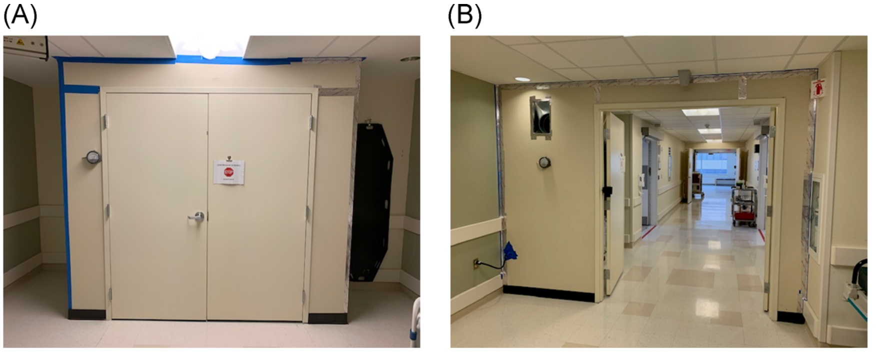

FIGURE 2 Anteroom is shown after the construction. Doors were closed in panel A, whereas panel B shows the anteroom doors open, facing the hallway

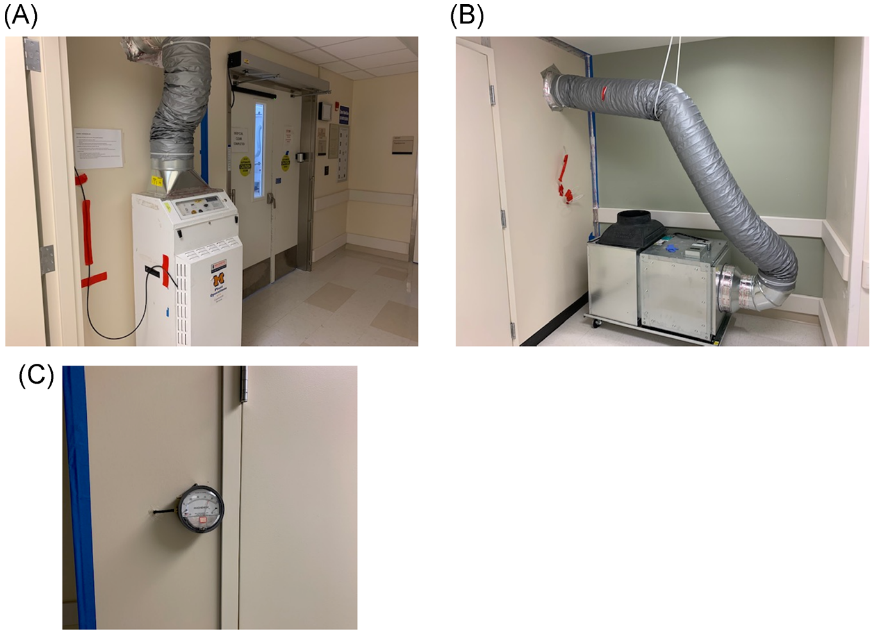

FIGURE 3 Shown are the HEPA-filter (panel A), ventilation exhaust unit (panel B), and the manometer showing the pressure within the anteroom (Panel C). HEPA, high-efficiency particulate air

2. A hollow metal frame was installed to support a pair of hollow metal doors. The active and inactive leaves were equipped with a passage set and a set of automatic flush bolts, respectively. Weather stripping and a door sweep were used to secure the seal. A manometer gauge was installed on the exterior of the anteroom to provide a visual indication of the negative pressure, which was maintained at 0.015 in. of water (Figure 3).[3]
3. A HEPA filtration unit was installed to clean the air. After HEPA-filtering all air flowing from the laboratory to the anteroom is exhausted to outside (Figure 3).

All of the construction was completed in 48 hours, and the laboratories were successfully utilized afterwards for suspected or confirmed patients with COVID-19. We believe that this is an effective and efficient way to provide care for patients with airborne infections such as COVID-19 in the catherization and electrophysiology laboratories. The system should also be readily applicable to any other positive-pressure patient care room, including operating rooms.

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