ANALYZING ENVIRONMENTAL QUALITY CONTROLS TO ENHANCE ASEPSIS AND PREVENT DISEASE TRANSMISSION IN THE INTENSIVE CARE UNIT

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Intensive care unit (ICU) rooms that can provide the sterility and safety of procedure rooms, such as operating rooms, reduce risk associated with transporting patients to other areas in the hospital and can be a more efficient use of space. Patients are admitted to the ICU from a variety of locations, including the emergency department or another hospital, and the determination of ICU placement relies on several factors, including the need for additional procedures (1). The timeliness of critical care is of essence, such as in response to a Code Blue event, or if an OR is not available due to staffing or logistical issues. It is estimated that moving a critically ill patient within the hospital increases the chance of an adverse event occurring by 30-45 percent (2) (3) (4) (5).

Designing and engineering an ICU that is capable of seamlessly transitioning from unoccupied to occupied to procedure mode and back to occupied mode will increase the flexibility of the patient space and provide a more aseptic environment suitable for life saving procedures, or for the increasing number of procedures indicated for the ICU (6). Since skin cells shed from people in the space carry potentially pathogenic bacteria through the air which can settle on surgical instruments or open wounds (7), and eighty to ninety percent of wound infections culture bacteria also found in the air (8), addressing the asepsis of the airborne environment is critical. Therefore, the impact of this engineering control may improve outcomes by reducing the risk of wound site infections through improved environmental contamination control that emulates procedure room environments. One solution to designing a "procedure ready" ICU includes the ability of the heating, ventilation, and air conditioning (HVAC) system to change the air changes per hour (ACH) and pressurization of the room automatically. Providing a relay circuit through the Code Blue Alert system that signals the building automation controls to change room ACH and pressure can take the treatment room to 15 ACH with a positive pressure relationship to the corridor. After the Code Blue Alert is cancelled, a return to normal ventilation mode at 6 ACH with neutral pressurization can be achieved. Further reduction to an unoccupied, set back could conserve resources when the room is vacant of a patient. Since infection prevention can be overlooked or superseded by more imminent life-saving events, automated engineering environmental controls may provide a safer environment for the patient (9).

This study assessed Environmental Quality Indicators (EQI) and compared two air flow control systems in dynamic procedural environments (10). The air flow control systems compared were a variable air volume (VAV Box) and a Venturi type air valve (Venturi). Both VAV Box and Venturi were challenged with the release of controlled contaminants, Baker's yeast, *S. cerevisiae* (microbes) and tracer gas, sulfur hexafluoride (SF6), at a point of origin in the adjacent hallway. During each simulation, the initial room air flow control system was set at 3 ACH with the doors closed to simulate the unoccupied mode. To transition to occupied mode, the doors were opened and closed as the patient entered the room and the air changes increased to 6 ACH. A Code Blue simulation was initiated and the control systems entered procedure mode by increasing the air changes to 15 ACH and creating positive pressure to the corridor. Doors were opened and closed to simulate entry of additional support staff. Finally, at the conclusion of the procedure, the room returned to occupied mode at 6 ACH with neutral pressure.

In both VAV Box and Venturi simulations, significantly fewer microbes and less SF6 was detected inside the treatment room than at the point of release in the hallway, indicating that the concept of a procedure ready treatment room can reduce the amount of contaminant that enters the room (= $p<0.05$, Figure 1A and 2A, respectively). The Venturi simulation allowed 14 percent fewer microbes and an average of 60.5 percent less SF6 from entering the room than the VAV Box system (= $p<0.05$, Figure 1B and 2B, respectively). Furthermore, the Venturi system transitioned and stabilized between modes more than twice as fast as the VAV Box system for all transitions tested.

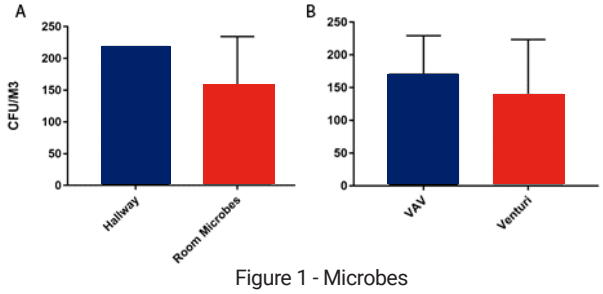

Figure 1 - Microbes

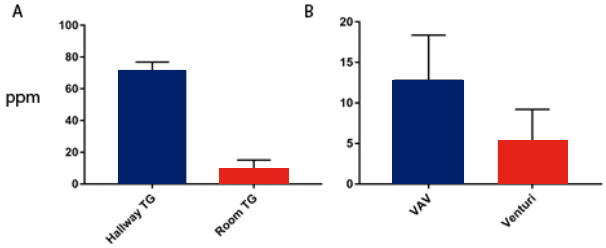

Figure 2 - SF6

In today's healthcare setting, there is an increasing drive to improve patient safety and clinical outcomes while simultaneously reducing the carbon footprint of the care facility, minimizing waste and preserving financial interest. This study demonstrates that a properly designed and engineered procedure ready ICU room reduces the necessity to move critically ill patients to operating rooms by changing the room's environment to mimic the protective environment of a procedure room quickly and effectively. The Venturi valve system outperformed the more conventional VAV Box by transitioning and stabilizing more quickly which provided better protection from contaminants in the hallway.

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