SYNOPSIS

KEY POINT SUMMARY

OBJECTIVES

To study the conditions of OR air pressure before and after a sliding glass door is opened, and when someone moves across the door's threshold.

Airflow patterns through a sliding door during opening and foot traffic in operating rooms

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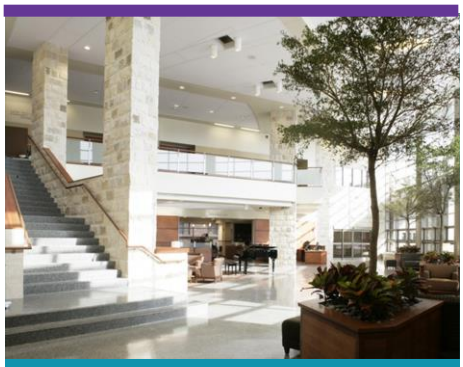
Key Concepts/Context

Operating rooms (ORs) often have higher air pressure than nearby rooms to prevent potentially contaminated air from entering the OR and causing infection. Opening the door during an operation may cause a change in pressure; further change in pressure may occur if a person moves through the door. This study suggests that even when sliding glass doors are used, pressure changes occur when the OR door is opened and if someone moves through the door.

Methods

This study took place in the primary OR suite (or surgical suite) at a university hospital which contained 18 ORs organized in six blocks. Three of the blocks contain two ORs, and the other three contain four ORs. The particular OR that was studied formed a group of four ORs, all of which shared an access hall. The access hall leads to the dirty area along with two staff preparation rooms. Each preparation room serves two ORs. Each OR had its own HVAC unit, while the areas shared by multiple ORs received air from another unit.

Instantaneous airflows were measured during the passage of a person through a sliding door in the OR while the HVAC system was operating under standard conditions. The authors used an ultrasonic anemometer (type WA-590 & TR-90T; Kaijo Sonic, Tokyo, Japan) to measure the magnitude and direction of the instantaneous air velocity in the doorway, and a digital camera (Canon 5D II, Canon EF 24-70 mm f/2.8 lens, full HD video, 1920 x 1080 px, 25 fps) to record flow visualizations. The flow visualizations were produced using a theater smoke machine.



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Three types of tests were conducted: 1) door opening/closing, 2) door opening, person enters the OR and closes door, and 3) door opening, person leaves the OR and closes the door. Velocity was measured at 24 different points on a plane 10 cm within the OR and parallel to the door. Each test concluded two minutes after a cycle of door opening and closing.

Findings

The results of this study show that before the sliding glass door opened, the OR maintained a positive pressure difference of 20 Pa when compared to the access hall, which helped prevent the entry of air from adjoining spaces. But the opening of the sliding door caused sudden decreases in differential pressure, meaning the containment effect was partially lost. Despite all preventive measures, and even though there was a greater amount of outgoing air (3.14 m^3) there was still a detectable amount of incoming air (0.33 m^3), even when no one passed through the door. The air primarily entered through the upper part of the door while most of the air left through the lower part.

The movement of a person through the doorway after it is open creates significant changes in airflow. The direction the person was traveling significantly influenced the exchange volume. When a person entered the OR, the volume of incoming air was greater on the side of the person closer to the doorframe, indicating that moving away from the doorframe might minimize the amount of incoming air. A person exiting also caused air to come into the OR, but to a lesser extent than the person entering the OR.

Overall, despite the preventive measures adopted (sliding door, air tightness, air exchange rates, positive pressure, and the reduction of the exhaust airflow rate during door operation), this study suggests that the coming and going of staff during an operation still causes air to enter the OR from outside. Although there is a net outflow, some air will still be able to enter when the door opens and closes.

in the road when driving. Another participant noted that they had not previously considered the connection between physical environment and mental health before the interview.

Limitations

This study used artificial smoke to help visualize airflow levels in and out of an OR; results may vary in cases of other airborne particles. The experiment was carried out in only one OR with one type of sliding door; the results may not apply broadly to the floor design of all OR units or the efficacy of all sliding glass doors, depending on their location.

Design Implications

While sliding glass doors and different HVAC system operations can help in reducing the airflow in and out of an OR, this study suggests that it is still best for the doors to remain closed during an operation. Designers might consider placing OR entrances and exits as far from the OR patient area as is feasibly possible to reduce potential infection.

And Also...

This article provides hyperlinks to supplementary material which includes videos of their airflow experiments.