SYNOPSIS

KEY POINT SUMMARY

OBJECTIVES

To evaluate ventilation performance in an ED isolation room in order to propose ideal design solutions for enhanced airborne contamination removal.

Ventilation performance evaluation of a negative-pressurized isolation room for emergency departments

Wang, F., Permana, I., Chaerasari, C., Lee, K., Chang, T., Rakshit, D., 2022 | Healthcare, Volume 10, Issue 2, Page(s) 193

Key Concepts/Context

Since the emergence of COVID-19, healthcare facilities are expected to be well equipped and flexible in their efforts to both treat patients and protect staff. Emergency Department (ED) isolation rooms are considered a potentially effective way to protect both staff and infected patients; however, further research is needed to understand how best to design an isolation room for an ED. This study suggests placing exhaust air grilles behind the patient's head to enhance airborne contaminant removal.

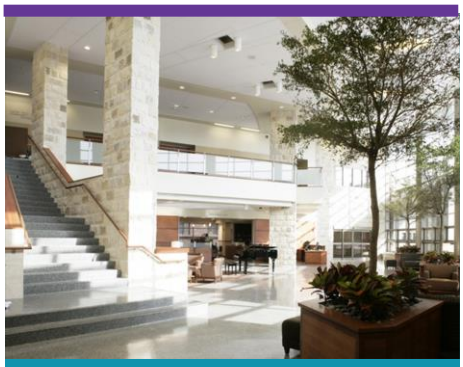
Methods

This study employed computational fluid dynamics (CFD) simulations, which were used to simulate and predict the behavior of both ambient airflow and airborne contaminants that would be exhaled by patients within the ED isolation room. The field measurement data involved in the CFD simulations were diffuser location, temperature, airflow rate (CMH), air changes per hour (ACH), and pressure (Pa).

The total volume of the ED isolation room in which the simulations were performed measured around 16.9 meters cubed (m^3). The room featured ceiling diffusers near the entrance door and across from the patient's bed.

The primary goal of these CFD simulations was to assess the most effective contaminant removal locations for the exhaust grilles in order to improve the ventilation system's overall performance. Four different "cases" or scenarios in which the exhaust grilles were moved to different locations were tested:

- Case 1: Also known as the baseline case that conforms to ASHRAE/CDC guidelines, where the exhaust air grille is placed roughly 300 millimeters (mm) above the floor on a wall near the left side of the patient bed
- Case 2: Identical to case 1, except the grille is on the other (right) side of the patient's bed



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- Case 3: Two wall-mounted grilles are placed beside the patient's head with the total exhaust airflow rate remaining the same as the baseline case.
- Case 4: One grille located behind and just above the patient's head, about 1000 mm from the floor.

Findings

The CFD results indicated that the location of the exhaust grille did indeed significantly impact the ventilation system's overall performance in terms of diluting airborne contaminants.

Out of the four cases investigated, the most effective exhaust grille location was in case 4, in which the grille was behind and just above the patient's head, about 1000 mm from the ground. In this scenario, the lowest concentration of contaminants was around 417 parts per million (ppm). This placement was also found to be the most effective at diluting contamination concentrations when the background concentration levels were set to 400 ppm.

Beyond the concentration results, it was found that placing the exhaust grille just above the head of the patient bed would also meet the American Society of Heating, Refrigerating and Air-Condition Engineers (ASHRAE) and Centers for Disease Control and Prevention (CDC) guideline's temperature requirement of 22° C, as well as the pressure requirements of -10 Pa. The authors suggest that these results imply that the location of the grille in case 4 is in fact a more effective design than those required by the guidelines; placing the exhaust grille 1000 mm above the ground just above the head of the patient bed results in fewer airborne contaminants than placing the grille closer to the ground on the side of the patient bed.

Limitations

The results from this study were drawn entirely from simulated scenarios and numerical calculations derived from these simulations; results may have varied significantly if real-world tests had been conducted under similar conditions. Multiple variables such as differences in patient biometrics and health conditions as well as differing room sizes could not be accounted for in the simulation's design.

Design Implications

This study suggests that placing ED isolation room exhaust grilles above the head of patient beds at a height of about 1000mm could be the most effective way to optimize the performance of ventilation systems.

And Also...

This study features helpful schematic diagrams of the ED isolation room involved in the research, showing the different placements of the exhaust grilles and the related airflow patterns.