Computational Studies for Enhanced Air Sanitization in Indoor Environments

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Introduction

The importance of studying aerosol transmission in hospitals cannot be overstated, as these environments are particularly vulnerable to the spread of infectious diseases. Effective air hygiene in hospitals is crucial for protecting both patients and healthcare workers from airborne pathogens. One key component is effective air movement, as donors generate infectious aerosols that enter the breathing zone. Delivering sanitized air effectively to the breathing zone and moving infectious aerosols out of it greatly assists in mitigating aerosol transmission risk. This effectiveness is especially important in hospitals, where a group of people (e.g., doctors, nurses, or patient family) gathering around a donor can reduce the local air movement driven by the hospital Heating, Ventilation, and Air Conditioning (HVAC) system alone.

This study demonstrates the efficacy of additional air-sanitizing devices used alongside the hospital HVAC system to increase air movement within the breathing zone, thereby reducing aerosol transmission risk in hospital environments. Using Computational Fluid Dynamics (CFD) models and field measurements, the study simulated scenarios with and without these devices, showing a significant reduction in infectious aerosol concentrations in the breathing zone, especially when a group of people is gathered around the patient.

Method

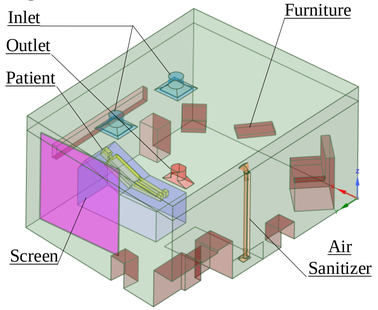
Geometry of Study

We investigated a single patient room at SUNY Upstate Medical University Simulation Center. Two scenarios were simulated: ① only the donor patient and ② with a "team" of five doing rounds in a semicircle around the bed. Air-sanitizer is thetaOne a commercial product from tomPhyzx.LLC.

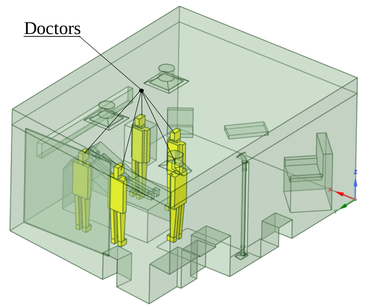
Single Patient Room @ SUNY Upstate Medical University Simulation Center

thetaOne air-sanitizer

Modeling



Scenario ①



Scenario ②

Room Condition
•Air Change Rate: 6 air changes per hour (ACH)
Patient Condition
•Breathing Rate: 10 liters per minute
Air-Sanitizer
•Efficiency: Assumes 100% disinfection efficiency
•Flow Rate: 0.0745 kg/s (130 CFM)
Calculation Setup
•State: Steady
•Type: Pressure-based
•Turbulence Model: SST-kω
•Buoyancy : Boussinesq Approximation
Mesh Size
•Scenario ①: ~17 million elements
•Scenario ②: ~23 million elements

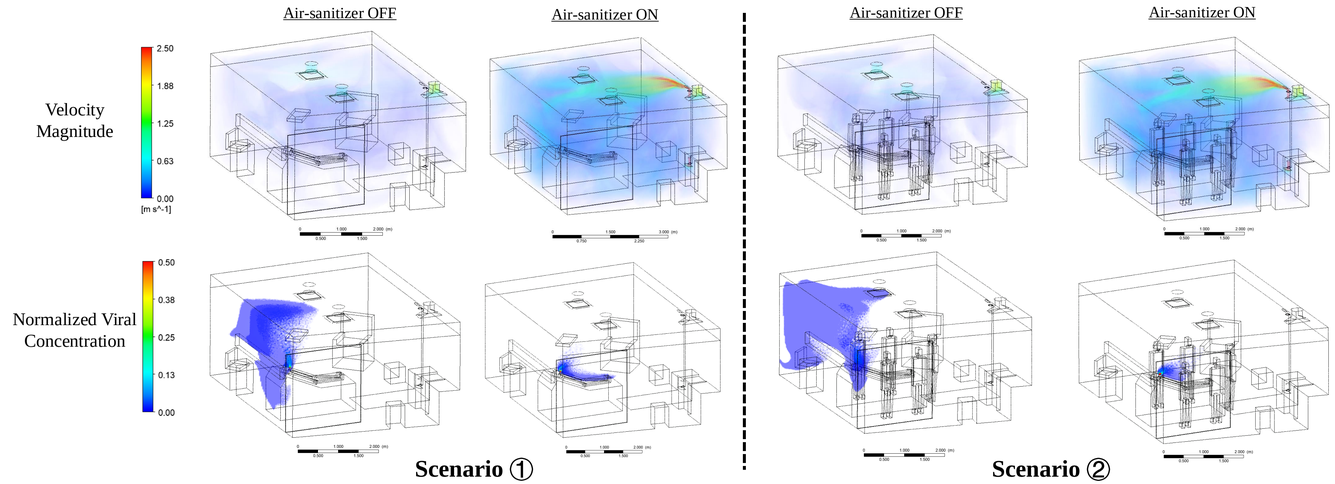
Results

For the case of a patient alone:

- **194% greater** average velocity in the **space** with the air-sanitizer turned on, especially **217% higher** in the **breathing zone**.
- **66% lower** average pathogen count in the **space** with the air-sanitizer turned on, particularly **68% lower** in the **breathing zone**.

For the case of a patient with a team of five doctors:

- **182% greater** average velocity in the **space** with the air-sanitizer turned on, especially **198% higher** in the **breathing zone**.
- **65% lower** average pathogen count in the **space** with the air-sanitizer turned on, especially **66% lower** in the **breathing zone**.



Scenario ① **Scenario ②**

Conclusions

The simulations conducted reveal the air-sanitizer significantly enhances air movement, effectively doubling the airflow within the space. This increased air movement, coupled with the air sanitization, resulted in a substantial reduction in pathogen concentration throughout the room, particularly in the breathing zone. These findings underscore the importance of air sanitization and improved air movement in reducing airborne pathogens in healthcare environments.

Scan for updates of this study

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