

Abstract

Operating rooms (ORs) have a higher pressure compared to its surroundings to prevent air entering the OR. In addition, ORs are designed to have a laminar airflow (LAF) system to prevent the spread of contaminants that may arise from either hospital personnel or the patient. However, a door-opening results in the rapid depressurization of the OR and disrupts the airflow which may cause an undesirable spread of airborne contaminants. The onset of Coronavirus Disease 2019 (COVID-19) caused by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) introduced a new problem as the primary spread of COVID-19 is through airborne particles. An OR at Montefiore Hospital was used to create computational fluid dynamic (CFD) models to analyze airflow patterns and track COVID-19 particles released from a surgical patient's mouth. A free-standing high efficiency particulate air (HEPA) filter was later included to study additional COVID-19 risk outcomes. Scenarios involving door openings showed bulk airflow moving toward the opened door. Particles followed the bulk airflow resulting in a larger spread of contaminated particles which put the staff at a higher risk of contracting COVID-19. Inclusion of a free-standing HEPA filter showed an increase of velocity up to 44% at the patient door and 10% at the staff door in certain door opening scenarios. The effect of the free-standing HEPA filter increased airflow near the doorways and away from the patient and staff, but also showed a larger spread of particles. On average, outlet vents dropped below the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) minimum for 0.6 seconds in any case with a door opening event, regardless of the inclusion of a free-standing HEPA filter. However, the inclusion of the free-standing HEPA filter shortened the time under ASHRAE standards, by 0.2 seconds on average. Additionally, the free-standing HEPA filter was most effective if the airflow patterns produced by the LAF system were not disrupted. In all cases, door opening scenarios caused a greater amount of COVID-19 particles to be airborne, which increased the risk of the staff contracting COVID-19.