Infectious Disease Aerosol Exposures With and Without Surge Control Ventilation System Modifications

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INTRODUCTION: The U.S. Veterans Health Administration is interested in studying strategies to safely create whole floor negative pressure isolation spaces for surge capacity using engineering ventilation system controls. To help better understand the transport of airborne infectious disease organisms in hospital environments when surge control strategies are implemented, tests were conducted in a recently decommissioned hospital during a one-week period.

METHODS: This study involved releasing an aerosol of synthetic aliphatic hydrocarbon (polyalphaolefin, PAO) into the air at bed height in a standard patient room with the hallway door closed. Tests were conducted under two ventilation operating modes; unmodified (normal) and modified (whole floor negative air pressure) ventilation operation mode. The whole floor negative air pressure operation mode was achieved by reducing the constant volume flowrate of 100% outdoor air to the floor by one half while maintaining the exhaust air flowrate. Size-segregated concentrations of particles were measured with optical particle counters. We calculated the hallway protection efficiency directly from the aerosol concentration data measurements in the patient room and the adjacent hallway.

RESULTS: The average hallway protection efficiencies were relatively high for both ventilation system operation modes; 99.8% and greater than 99.7% for 1.0 µm and 2.5 µm particles respectively in the unmodified (normal) operation mode and 99.1% and 98.9% respectively in the modified (whole floor negative air) operation mode. We note that the difference in the measured average hallway protection efficiencies were slightly lower with the ventilation system in the modified (whole floor negative air) operation mode than the unmodified (normal) operation mode, and this difference was statistically significant (i.e. $p < 0.0001$). This may be explained by the 52% reduction in the outdoor air ventilation being supplied to the hallway during the modified (whole floor negative air) operation mode.

CONCLUSIONS: The average hallway protection efficiencies remained relatively high (> 98%) when the ventilation system was modified for whole floor negative pressure. While the ventilation modifications (i.e. -1 cfm to -14 cfm net airflow into the patient room) should have little significant impact on the transport of air from Patient Room to the hallway, the 52% decrease in the hallway outdoor air ventilation rate allows the aerosol that is transported out of Patient Room to develop into a higher hallway aerosol concentration and thus a lower hallway protection efficiency.