A patient-worn, portable negative pressure system: an effective alternative to a negative pressure isolation room in mitigating fugitive emissions of nebulized Pentamidine

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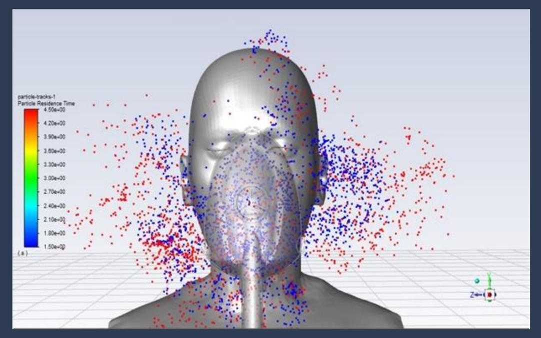
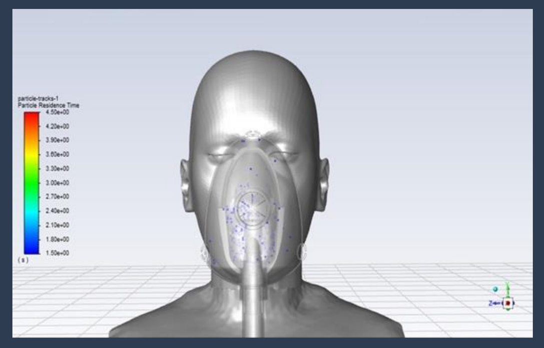
Background

Aerosolized Pentamidine is used in the treatment and prevention of *Pneumocystis carinii pneumonia* (PCP). Pentamidine is considered a hazardous drug, and when aerosolized can create an occupational exposure risk to the healthcare personnel (HCP) due to its embryotoxic and respiratory irritant effects. A high prevalence of pulmonary Tuberculosis (TB) in patients with PCP, coupled with the inherent difficulty in diagnosing TB, can present an additional risk of the inadvertent nosocomial spread of TB when administered to the undiagnosed patient. Aerosolized Pentamidine is therefore typically administered in a negative pressure airborne isolation room equipped with high air-exchange ventilation and HEPA filtered exhaust (AIIR). Limitations and challenges imposed of AIIR's have necessitated the evaluation of alternative methods of mitigation such as a portable negative pressure system (PNPS). The portability of such a system may expand areas of treatment where Pentamidine can be safely administered. This study aimed at comparing the effectiveness of a patient-worn PNPS in reducing fugitive emissions generated during an aerosol treatment of Pentamidine to one performed in an AIIR.

Nebulizer without source capture



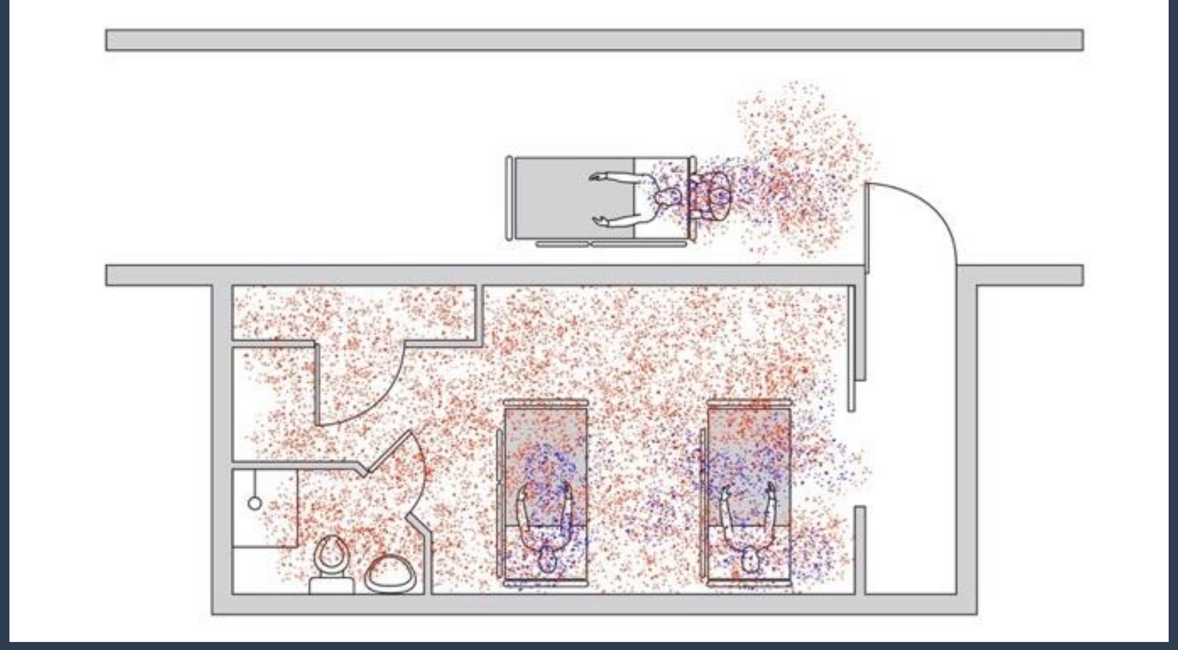
Nebulizer with source capture



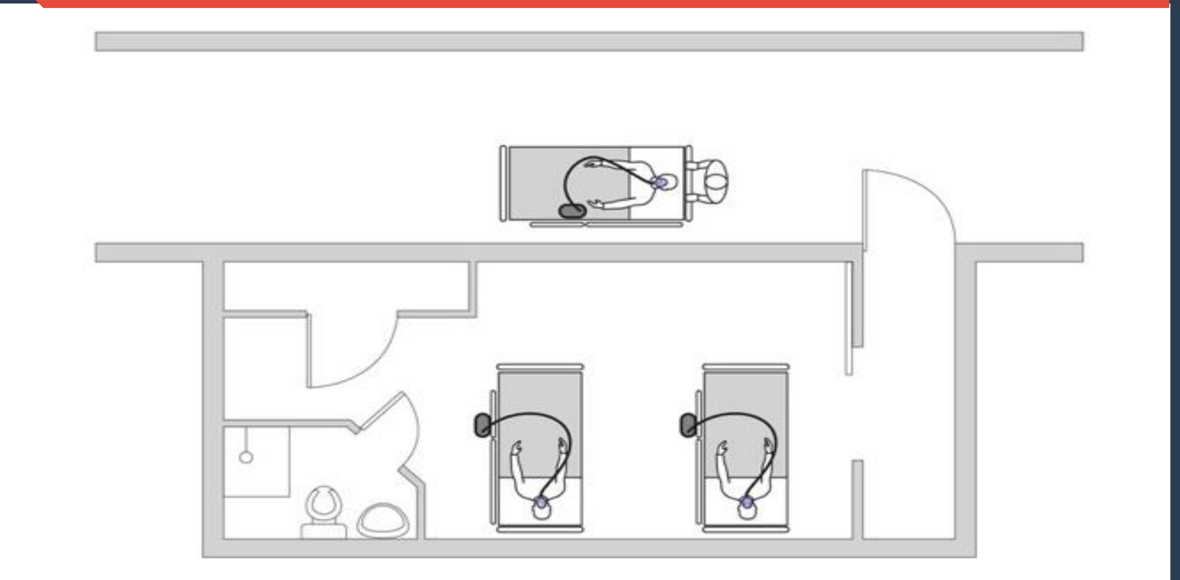
Methods

Utilizing an experimental and control model, a series of nebulized Pentamidine treatments were performed utilizing a human airway manikin in an AIIR. A personal sampling pump (PSP) with filter was used to capture fugitive emissions of Pentamidine. The experimental arm assessed the effects of the PNPS's mitigation of fugitive Pentamidine emissions. In contrast, the control arm measured the effect of the AIIR with exhaust ventilation. Samples of both baseline and, and in a worse-case scenario, that of a standard treatment room without ventilation. Using high performance liquid chromatography (HPLC), the airborne concentration (mg/m^3) of fugitive Pentamidine was measured for both the experimental and control arms.

Room without PNPS



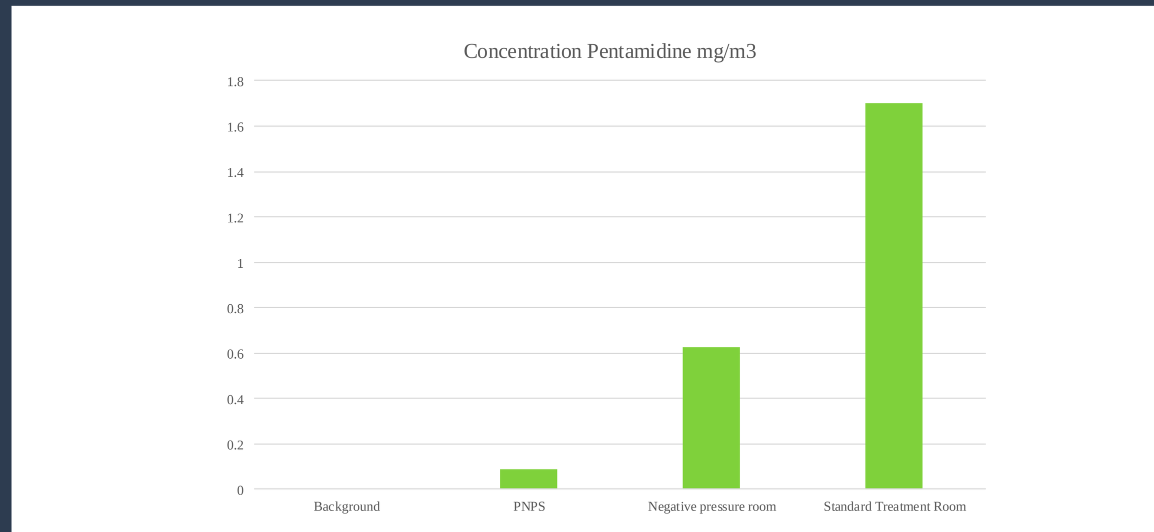
Room with PNPS

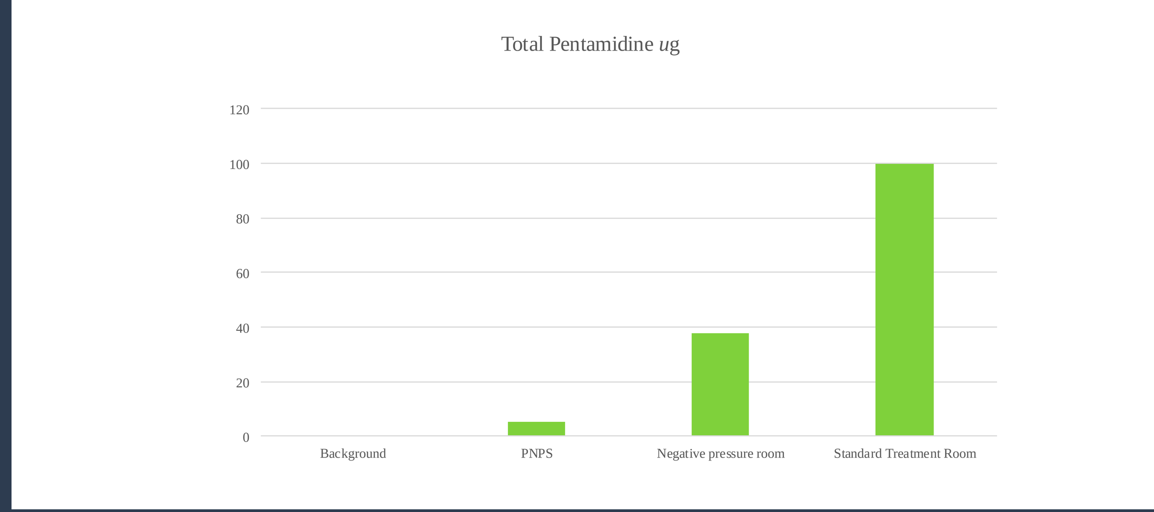


Results

The mean and standard deviation for Pentamidine concentration were calculated for the control and experimental conditions. A two-sample t-test was used to determine whether these values were significantly different. The experimental arm, utilizing the PNPS had a significantly lower mean concentration of fugitive Pentamidine (0.0876 mg/m^3) vs the control arm (AIIR) (0.622 mg/m^3). ($p=0.0111$). Background and standard treatment room concentrations were below the limits of detection (<0.025 mg/m^3) and 1.70 mg/m^3 respectively.

Sample	Condition	Air Volume	Total µg	Air Concentration mg/m3
1	Background	60 L	<1.5	<0.025
2	Experimental	60 L	3.3	0.055
3	Experimental	60 L	5.9	0.098
4	Experimental	60 L	6.4	0.11
5	Control	60 L	32	0.53
6	Control	60 L	43	0.72
7	Control	60 L	38	0.63
8	No Ventilation	60 L	100	1.70





Conclusions

The use of the PNPS reduced fugitive concentration of Pentamidine by 7-fold and 19-fold when compared to the AIIR and standard treatment rooms, respectively. The effect of a patient-worn local exhaust ventilation and filtration system may reduce the occupational exposure of HCP to nebulized Pentamidine Isethionate. The system offers an alternative to a negative pressure isolation room.

Clinical Implications

The capture of fugitive Pentamidine emissions at the source with a patient- worn, negative pressure system was superior to that of a standard negative pressure room. The use of such a system should reduce the occupational risks of exposure, during Pentamidine treatments, to the healthcare worker or respiratory therapist who is in the room with the patient. This study suggests that a portable, patient-worn negative pressure system is an alternative to negative pressure rooms for the safe administration of Pentamidine.

Portable Negative Pressure System

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