Efficacy of Engineering Controls in Reducing Occupational Exposure to Aerosolized Pentamidine*

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Aerosolized pentamidine administration may pose potential risks to health care workers exposed to fugitive drug and to infectious respiratory pathogens (eg, tuberculosis) generated by pentamidine-induced cough. Classic infection control methods may be applied to this problem, although the effectiveness of these measures in mitigating environmental pentamidine exposure is unknown. Lack of data fully characterizing pentamidine's mechanism of action or potential mutagenicity, carcinogenicity, or teratogenicity raises concern and suggests worker exposure and environmental contamination be minimized. We report herein on the efficacy of an aerosol containment hood in containing fugitive pentamidine aerosol during administration.

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AP = aerosolized pentamidine; HEPA = high-efficiency particulate air

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Reduction of Exposure to Aerosolized Pentamidine (McDiarmid et al)
sample analysis, laboratory blanks, field blanks, and spike samples. Recovery efficiency of the procedure was also determined to be greater than 80 percent. These steps were taken as part of the quality assurance for the analytical procedure.

Potential interference with pentamidine UV absorbance from albuterol, a bronchodilating drug sometimes given to patients to dilate the bronchi during pentamidine treatment, was considered. However, albuterol was evaluated and found to have no absorbance at 262 nm.

The engineering controls set in place include two containment hoods (Microbil Safety Hood, Laminar Flow Inc, Ivyland, Fa) and redesign of the treatment room ventilation system. (Similar containment hoods are available from other manufacturers of horizontal laminar flow clean air benches and laminar flow biologic safety cabinets.) The hoods used are reversed flow, horizontal laminar flow cabinets (Fig 1, 2) that rely on high-efficiency particulate air (HEPA) filters to capture chemical and microbial particulates. The HEPA filter was factory tested by DOP test to be 99.99 percent efficient in trapping particles greater than and less than 0.3 μm. The hoods were certified to be leak free after installation. The face velocity of the exhaust air was adjusted to 100 FPM at the exterior edge of the plastic hood. Although the exhaust of the air could be safely recirculated into the room, the exhaust hoods used in this study were captured by a canopy hood (thimble connection) and vented outdoors (Fig 1). The ventilation for the treatment room was renovated to provide a minimum of 20 air changes per hour with no air recirculation, and to assure that the pentamidine treatment area had a negative pressure differential relative to the surrounding areas.

In operation, the patient was seated in front of the containment hood with face and shoulders just inside the front opening (Fig 2). Room air is drawn from behind the patient and pulled horizontally through the filters. Particulate free air is exhausted from the top of the hood.

RESULTS
Prior to establishing engineering controls, the airborne concentration for the treatment room samples ranged from the limit of detection 0.00033 mg/m^3 to 0.04500 mg/m^3 with 11 (85 percent) of 13 samples registering a pentamidine concentration above the limit of detection. The personal samples collected had airborne concentrations ranging from the limit of detection to 0.01800 mg/m^3 with five of eight pentamidine samples registering concentrations exceeding the detection limit. These samples were collected on eight different days with the number of treatments varying between 8 and 17 per day. After establishing

Table 1—Air Sampling Results for Pentamidine*

<table>
<thead>
<tr>
<th>Sample Type</th>
<th>No. of Samples &gt;LD</th>
<th>Range of Values (Pentamidine mg/m^3)</th>
<th>No. of Samples &gt;LD</th>
<th>Range of Values (Pentamidine mg/m^3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td>11/13 (85%)</td>
<td>&lt;LD-0.045</td>
<td>0/7 (0%)</td>
<td>&lt;LD</td>
</tr>
<tr>
<td>Personal</td>
<td>5/8 (63%)</td>
<td>&lt;LD-0.018</td>
<td>0/7 (0%)</td>
<td>&lt;LD</td>
</tr>
</tbody>
</table>

*1 = LD = limit of detection = 0.00033 mg/m^3.
engineering controls, the area and personal samples were again collected on seven different days with the number of treatments varying from 3 to 13 per day. Airborne concentrations below the limit of detection were determined for all samples. Results of the air sampling are displayed in Table 1.

**DISCUSSION**

This report documents the efficacy of engineering controls in mitigating fugitive pentamidine emissions. No pentamidine was detectable in area or personal samples after the containment hoods were installed. Problems inherent in the filter media used for the sampling preclude any quantitative determination of the effectiveness of the engineering controls. Based on qualitative evaluation, however, the controls were successful in capturing fugitive emissions. Further evaluation of sampling media and elution techniques for these other media are being conducted.

The use of the containment hoods in conjunction with the redesign of the ventilation system is a viable method for the containment of fugitive emissions of pentamidine given in aerosolized treatment of ambulatory patients. Furthermore, the design of the booths used in this study allows for continued contact between the patient and the medical staff. This type of engineering control is a primary element in mitigating an aerosol exposure. While we did not assess the effect of ventilation changes on control of infectious particles, it is probable that a reduction in risk of tuberculosis and other respiratory pathogen transmission also occurred.

Engineering controls, though effective, do not eliminate the need for personal protective equipment when dealing with potentially hazardous drugs. Although there are presently no guidelines from regulatory agencies regarding personal protective equipment during AP administration, our institution recommends that medical staff wear gowns, eye protection, and disposable respirators (NIOSH/MSHA disposable dust/mist respirator). Reconstituting pentamidine as a nebulized solution in the pharmacy in a containment hood also minimized nurse and respiratory therapist exposure and minimizes surface contamination in the clinic. Educating workers about potential risks and unknowns of exposure, and handling procedures can be carried out as part of the Occupational Safety and Health Administration (OSHA) mandated hazard communication (right-to-know) training already required in hospitals.

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**REFERENCES**

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