Characterization of a Nose-Only Inhalation Exposure System for Bacillus anthracis Murine Studies

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Abstract

A nose-only inhalation exposure system was developed, characterized, and demonstrated. The exposure system consists of an aerosol generator, sampling, and delivery line, a plenum, an aerosol characterization platform and an air handling system. It was operated at a negative pressure of approximately 46 inches water column inside a Class II Type A1 laminar cabinet (The Baker Company, Houston, TX). Bacillus anthracis Sterne challenge aerosols were generated using a Carbomax two-stage nebulizer (RCI, Inc., Walhalla, SC) and dried and mixed with dextran air. Flow rates were adjusted through a delivery line into the 2-port radial plenum (Pro-Products, LLC, Albuquerque, NM). The aerosol characterization platform consists of a Nanoparticle Sizer (TSI Inc., Shoreview, MN), Micronex pre-nepolarizer (Casella CEL, Kempten Bedford, England), and glass and tandem dual impingers. Inhaled aerosol collection pipes were used to interface the aerosol characterization platform with the plenum. All aerosols and suspended air were neutralized through mass flow and pressure controllers (TM Scientific, Inc., Thousand, CA) or calibrated mass unit. The inhalation exposure system was characterized by determining the target concentration, particle size distributions, time-to-concentration (Tt), and plume uniformity. A target aerosol concentration of 8544 ccf/L (300 BSL-3) was achieved repeatedly with a standard deviation of less than 3%. The geometric standard deviation of the challenge aerosol was 1.28 ± 0.05. At target concentration levels, plume Tt was 5 ± 3 minutes and spatial uniformity was ±7%

System Configuration

Figure 1. Inhalation Exposure System Schematic and Pictures.

Figure 2. Inhalation Exposure Plenum with Positive Flow-By™ Rodent Restrainer Tubes.

Figure 3. Aerosol Concentration Profile

Figure 4. Aerosol Particle Size Distribution

Figure 5. Aerosol Concentration Range-Finding.

Figure 6. Murine Inhaled Dose Estimates.

Figure 7. Real-time Concentration Versus Time "Fingerprints".

Figure 8. Plenum Uniformity Filter Sample Locations

Table 1. Plenum Uniformity Filter Sample Data

After the target aerosol concentration was established, uniformity of the challenge atmosphere was determined. Temporal variations (CVtemp) were calculated from three filter samples that were collected sequentially from the reference sample port location. R. Total variation (CVtot) was calculated from three filter samples collected simultaneously from sample port locations, F1, F2, and F3, plus one reference sample. Sample port locations are given in Figure 8. Filter sample collection data is presented in Table 1. Spatial variation (CVsp) was 6.3% as calculated using the equation:

CVsp(%) = CVtot(%) - CVtemp(%)

References

5. Measurement of the Respiratory Volumes of Laboratory Animals. Am J Physiol. 1911. 29:

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