Evaluation Criteria for Bioaerosol Samplers

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Abstract

Humans contract a variety of serious diseases through inhalation of infectious aerosols. Thus, the importance of monitoring air for microbial or toxic content is recognized in the clinical, occupational, and biodefense arenas. However, accurate monitoring of potentially contaminated environments can be hampered by selection of aerosol samplers with inadequate performance for the intended task. In this study, 29 aerosol samplers were evaluated based on their respective air flow, size, weight, power consumption, and efficiency in sampling particles with size ranges within the respirable range. The resulting data demonstrates that sampling air flow and efficiency vary widely, and cannot be predicted from the physical characteristics of air samplers, and hence, that proper selection of air samplers should be more involved than shopping for a device based on the limited characteristics that are published. The findings are summarized in an approach to rationally select bioaerosol samplers for use in the monitoring of infection control and environmental biomonitoring. The presented data demonstrates that inadequate selection of air samplers could result in a failure to collect germs or toxins and thus, underestimate the risk and provide a false sense of security in contaminated health care settings and environments contaminated with infectious or toxic aerosols.

Introduction

Several major human infectious diseases are transmitted through aerosolized germs. These include bacterial diseases such as tuberculosis and inhalation anthracis, viral diseases such as influenza and chickenpox, and systemic mycosis like coccidioidomycosis and paracoccidioidomycosis. Aerosol sampling is an essential tool for the detection of these and other infectious organisms that are spread through the inhalation of contaminated air. The importance of collecting particles from air for the identification of airborne microorganisms has been recognized for many decades, but technical difficulties in the sampling of bioaersols with high efficiency hinder the performance of infection control programs. The goals of this study were to evaluate characteristics of a large segment of available aerosol samplers toward advancing a rational for selection of the products most adequate for particular applications in monitoring and controlling infectious diseases.

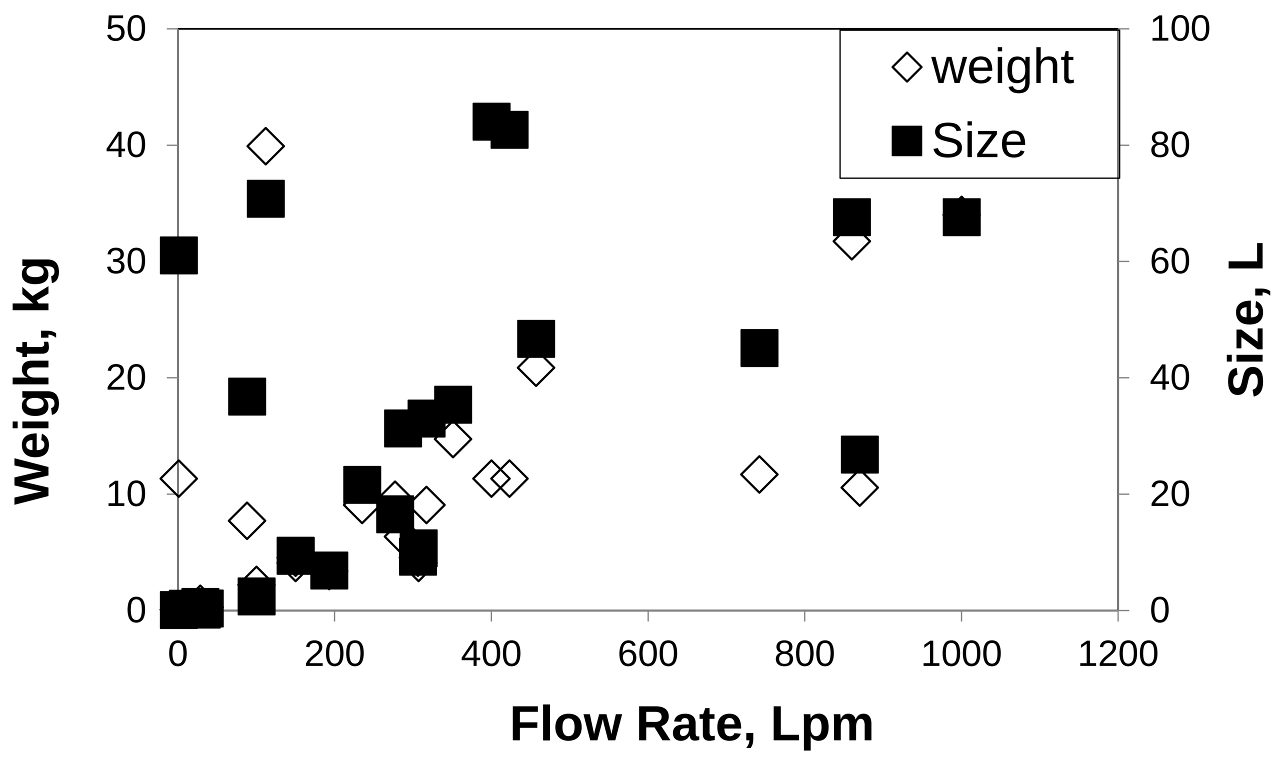

Figure. 1 Aerosol samplers' weights (kg), sizes (L), and flow rates, liters per minute (Lpm) are shown as a graph

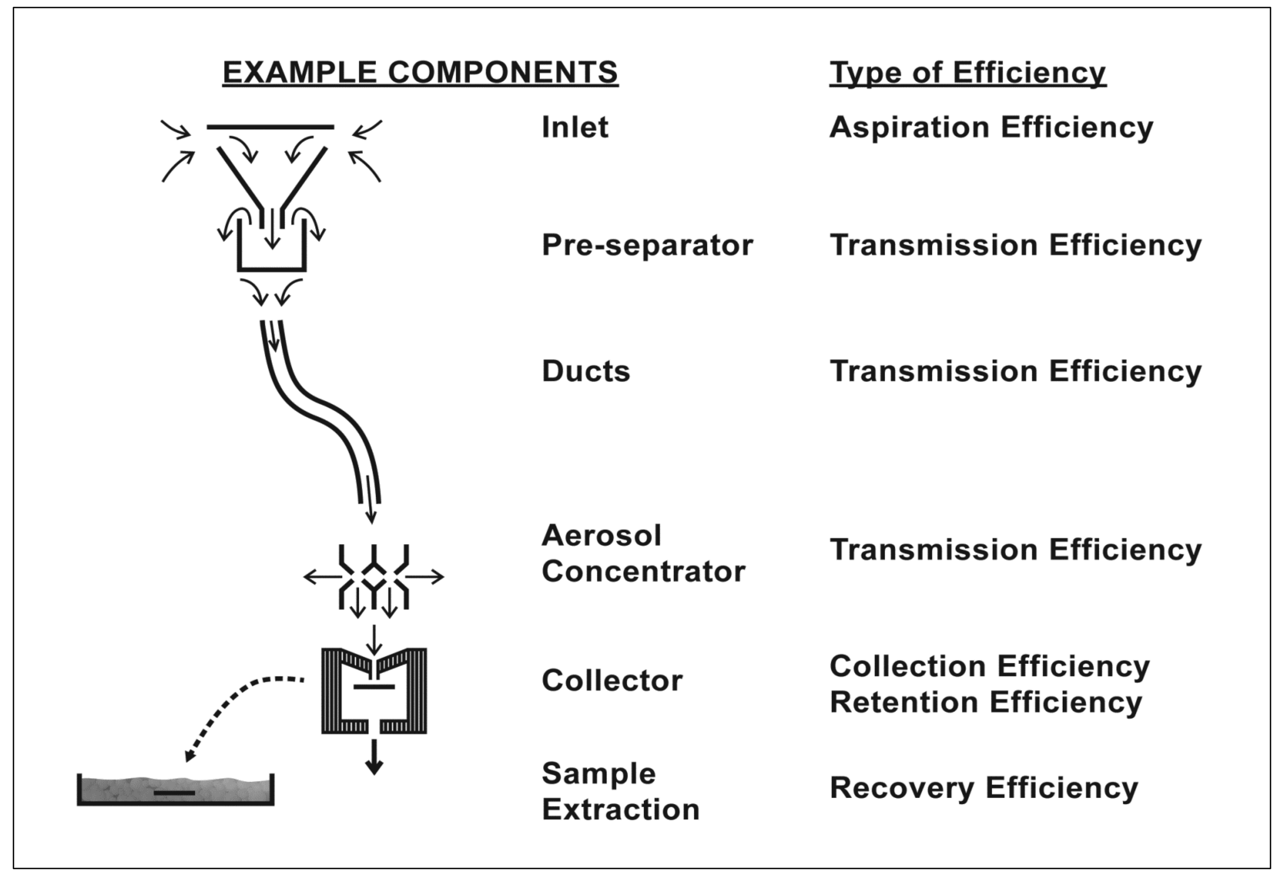

Figure 2. Basic features of an aerosol sampler

CHARACTERISTICS	APPLICATIONS OUTDOOR	APPLICATIONS INDOOR
Weather Protection	Rain Cap/Bug Screen	Not Needed
π (Efficiency X Flow rate)	HIGHEST	
Noise	Secondary	Low
Size/Weight	Smallest/Lowest	
Sample Type	Dry	Dry or Wet
Power	Battery	AC
Sampling Period	Longest	Secondary

Table 1. Aerosol Sampler Characteristics to Consider in Selecting Outdoor and Indoor Aerosol Samplers

Results

This study summarizes the analysis of 29 aerosol samplers, providing a criterion to select appropriate samplers for particular requirements. The data presented demonstrates that sampling air flow and sampling efficiency cannot be predicted from the characteristics of air samplers, and hence, that proper selection of air samplers should be more involved than just shopping for a device based on the limited characteristics provided by the manufacturers. The presented data demonstrates that improper selection of air samplers could result in a failure to collect germs or toxins in the respirable range and thus underestimate the true risk, creating a false sense of security under circumstances that could result in unnecessary loss of life as in contaminated health care settings, or in other environments that are accidentally or purposely contaminated with infectious or toxic aerosols.

Identifying the purpose of sampling and the subsequent analysis methods must be carefully established since these requirements will dictate the selection of an adequate sampler. Specific applications will require certain "environmental characteristics" of the sampler that will impact the sampler selection. These design characteristics are all important but not sufficient to assure the desired performance in aerosol sampling.

In many cases the sampler air flow rate has been the first consideration during selection of an aerosol sampler among all available products in the market. The data that we obtained did not support a direct correlation among key design characteristics and device performance among the 29 aerosol samplers. Size, weight and even sampling air flow rate were not predictive of particle sampling efficiency and thus overall performance. These findings highlight the need for a careful evaluation and judicious selection of aerosol samplers, involving multiple and simultaneous decisions on numerous variables associated to the device design and performance. At least as important as the flow rate delivered by a device is its sampling efficiency as this parameter can range from 15% to 93% and affect the amount of collected particles (calculated as: $\pi = Q \times \eta$). After the combined consideration of air flow and sampling efficiency, final thoughts should be given to the interaction among power requirements, collection media, and sampling duration as related to the environmental conditions required in which sampling will occur.

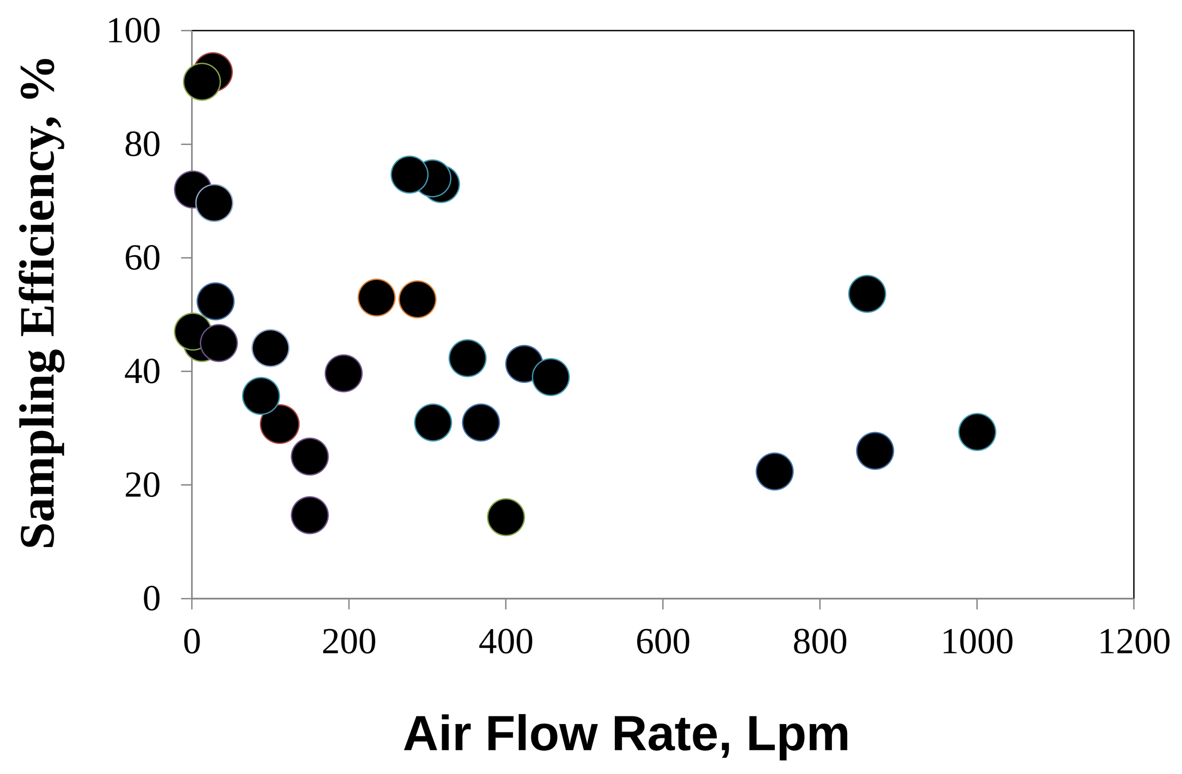

Figure 3. Sampling efficiencies (%) as a function of air flow rate (Lpm) are shown in the graph

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