UNIVERSITY of NEW HAMPSHIRE

Preventing Aerosols in the Laboratory

Introduction

Aerosols are small solid or liquid particles that are suspended in the air. An aerosol with a diameter of 5 µm (micrometers) or less can remain airborne for a long period of time, spread wide distances, and is easily inhaled. Particles with a diameter larger than 5 µm tend to settle more rapidly.

Approximately 65% of laboratory acquired infections are caused by aerosols of pathogenic microorganisms.[1] The most common way to be exposed to these aerosols is through the inhalation route.

To minimize the generation of aerosols, standard microbiological practices should always be employed. All procedures should be conducted with care to prevent the generation of aerosols.

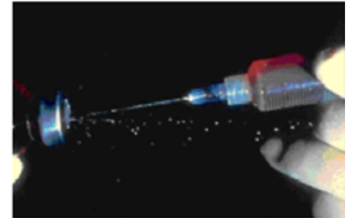
Aerosol-Producing Devices and Activities

There are numerous procedures and devices which can result in the generation of aerosols. Here are some examples of laboratory procedures that may produce aerosols:

- animal or human necropsy;
- blowing out pipettes;
- breakage of culture containers;
- cage cleaning and changing animal bedding;
- carelessly removing protective gloves;
- dropping culture containers;
- harvesting infected material;
- intranasal inoculation of animals;
- flaming inoculating needles, slides or loops;
- freeze-drying specimens;
- inserting a hot loop into a culture;
- opening lyophilized cultures, culture plates, ampoules, tubes and bottles;
- pipetting;
- pouring liquids;
- removing stoppers;
- stirring liquids; and
- streaking innoculum.

In addition, there are many devices that, if used incorrectly, may create aerosols, including:

- blenders and vortexers;
- bottles and flasks;
- cell sorters;
- centrifuges;
- French press;
- homogenizers;
- needles and syringes;
- pipettes;
- pressurized vessels;
- rubber stoppers;
- shakers;
- sonicators; and
- vacuum and aspirating equipment.



Concentration and Particle Size of Aerosols Created During Representative Laboratory Techniques [2]

Operation	Viable Colonies [a]	Particle Size (µm) [b]
Use of sonicator	6.3	4.8
Mixing culture with pipette	6.6	2.3
Use of blender with top on	119.6	1.9
Carefully opening lyophilized cultures	134.0	10.0
Dropping lyophilized cultures	4838.0	10.0

a = Mean diameter of viable colonies per cubic foot of air sampled.
b = Mean diameter of the particle.

Safe Work Practices

The generation and dispersal of aerosols must be minimized and controlled. Using safe work practices, with the appropriate engineering controls, is the primary way to minimize the creation of, and exposure to, aerosols.

A certified biological safety cabinet (class I or II) is the primary barrier to protect personnel from aerosols. Other safety devices may include safety centrifuges with automatic locking mechanisms, safety centrifuge cups, safety blenders, and safety sonicators.

[1] Sulkin, S.E., and R.M. Pike. 1951. Survey of Laboratory Acquired Infections. *Am. J. Public Health* 41:1-13.
[2] Kenny, M.T., and Sabel, F.L. 1968. Particle Size Distribution of *Serratia marcescens* Aerosols Created During Common Laboratory Procedures and Simulated Laboratory Accidents. *Appl. Microbiol.* 16:1146-1150.

Procedures for Centrifuges

There are many activities associated with centrifuges that may create significant amounts of infectious aerosol, including:

- filling centrifuge tubes;
- removing plugs or caps from tubes after centrifugation;
- removing supernatant;
- re-suspending sedimented pellets;
- breakage of tubes during centrifugation; and
- centrifugation itself.

Follow these steps to prevent the generation of aerosols in centrifuges:

1. Routinely inspect the centrifuge to ensure there is no leakage.
2. Do not overfill centrifuge tubes.
3. Wipe the outside of the tubes with an appropriate disinfectant after they are filled and sealed.
4. Centrifuge inside a biological safety cabinet. If a biological safety cabinet is not available, internal aerosol containment devices (e.g., sealed canisters, safety cups or buckets with covers, heat sealed tubes or sealed rotors) should be used.
5. Remove aerosol containment devices and open them in a biological safety cabinet. If a biological safety cabinet is unavailable, a minimum of 10 minutes settling time should be allowed before opening.

Procedures for Blending

1. Do not use glass blenders.
2. Use a blender designed to prevent leakage. If a leak-proof blender is not available, regularly inspect the bottom of the blender for leakage.
3. Operate the blender in a biological safety cabinet or place a towel moistened with disinfectant over the top of the device.
4. Allow aerosols to settle for at least 5 minutes before opening blender.
5. Autoclave or disinfect all equipment promptly after use.

Procedures for Sonication

1. Regularly inspect the sonicator for leakage.
2. Operate the device in a biological safety cabinet or place a towel moistened with disinfectant over the top of the device.

Procedures for Lyophilizing

1. Regularly inspect the lyophilizer for leakage.
2. Operate the device in a biological safety cabinet or place a towel moistened with disinfectant over the top of the device.
3. Filter lyophilizer vacuum pump exhaust through HEPA filters or vent into a biological safety cabinet.

Procedures for Pipetting

1. If possible, pipette all infectious material in a biological safety cabinet.
2. Drain the pipette with the tip against the inner wall of the receiving vessel. Never forcibly expel any hazardous material from a pipette.
3. Use care when removing the bulb to prevent aerosolizing any remaining fluid in the pipette tip.
4. Place reusable pipettes horizontally in a pan filled with enough liquid disinfectant to completely cover them.
5. Mechanical pipetting devices are used. Mouth pipetting is prohibited.

Other Safety Precautions

- Minimize air bubbles when filling a syringe. Place a pad moistened with disinfectant over the tip of the needle when expelling air. Perform work in a biological safety cabinet whenever possible.
- Use a shielded electric incinerator or hot bead sterilizer to sterilize inoculating loops. Disposable plastic loops and culture needles are good alternatives to open flames.
- If a spill occurs that may generate aerosols, leave the area, close the door, wait 30 to 60 minutes to allow dissipation of aerosols.
- Wear gloves when handling infectious materials or infected animals.
- Follow the guidelines outlined in the CDC/NIH document, "Biosafety in Microbiological and Biomedical Laboratories" online at:

  www.cdc.gov/OD/OHS/biosfty/bmbl4/bmbl4toc.htm

- If aerosol production cannot be prevented or contained, contact the UNH Office of Environmental Health and Safety to determine if a respirator is required.