

*Use and Re-Use of
Respirators Used Against
Infectious Aerosols*

Overview

- **Review historical basis of respirator disinfection**
- **Review literature on microorganism viability and reaerosolization as it relates to respirator re-use**

Respirator Contamination Concerns

- **Originally**
 - **By the respirator wearer**
 - **Inside of respirator**
- **Recently**
 - **Exposure to bioaerosols**

Solutions

- To prevent “spreading” disease from a respirator
- Personal use w/ cleaning as needed
- Multiple users
 - Cleaning and disinfection of before the respirator is reassigned
 - Replacement of filters
 - “Disposable” respirators

Recommended Disinfectants or Sanitizers

- **Recommendations from food service**
 - **Hypochlorite solution (50 ppm, 2 min.)**
 - **Aqueous iodine solution (50 ppm, 2 min.)**
 - **Quaternary ammonium solution (200 ppm, 2 min.)**

Concerns

- “Spreading” disease from handling a contaminated respirator
- Contamination of respirators by exposure to bioaerosols
 - Filter
 - Straps, valve covers, etc.

Contamination Concerns

- **Dispose of respirator**
- **“Reusable” Respirator maintenance**
 - **Respirator handling**
 - **Touch**
 - **Reaerosolization**
 - **Degree of filter loading**
 - **Most work done with what might be considered to be “high” filter loading**

Concerns continued

- Knowledge of how the disease is transmitted
- Survivability on respirator/respirator filter
 - Most work done with bacteria
 - Little or no work with viruses

Disinfectant

- **Effective against the bioaerosol**
- **No harm to the wearer**
- **No harm to the respirator material**

Infectious Aerosol Requirements

- **Handling precautions**
- **Cleaning and disinfection**
- **Storage**
 - **For infectious aerosols, plastic bag may not be best option**
 - **Paper bags have been used to let the respirator dry out**

Re-use

- **Re-use guidelines in NIOSH pub. # 96-101**
 - **For filter, based on loading**
 - **If no oil mist, limited by hygiene, damage, and breathing resistance**
 - **May be reused as long as respirator is functional**
- **Studies have shown:**
 - **Properly fitted filtering facepiece respirators may be reused several times during a day (AIHCE, 2001)**
- **Re-use may be more dependent upon infection control procedures**

Re-use

- WPF studies
- 4 separate situations indicate no significant differences in performance over the course of a shift
- No significant effect from:
 - redonning
 - slippage, change in fit
- Time of day or duration of use was not associated with a difference in performance

Brosseau et al., 1997

- **Experimental concentrations were probably higher than those in work settings**
- **Results implied bacteria can remain viable on filters for several days**
- **Implications for reuse, handling and disposal of respirators**
 - **Training to recognize when exposures might require immediate disposal of respirators**

Reponen et al., 1999

- *Mycobacterium smegmatis* (surrogate for MTB)
- “N95 respirators”
- Tested for survival 1 to 9 days after loading
- Bacteria unable to grow on filters
- Bacteria survived up to 3 days, even under ideal growth conditions

Wang et al., 1999

- **Bacteria**
 - *Pseudomonas fluorescens*
 - *Bacillus subtilis*
- **NIOSH certified “polypropylene” respirator filters**
- **Bacteria were unable to grow**
- **Both bacteria survived**
 - *P. fluorescens* < 3 days
 - *B. subtilis* > 13 days
- **Suggests**
 - **Spore forming bacteria may have greater viability than vegetative bacteria**

Johnson et al., 1998

- TB simulant
- Tested 6 models of filtering facepiece respirators
- Stored at room temperature in a Zip-lok™ bag for 28 days
- No more viable organisms were recovered after day 7
- Internal contamination appeared from environmental bacteria thought to be due to handling (removal from bag to sample)
- Concluded that respirators may be reused over time with little risk over a week's time of internal contamination provide the respirator is carefully handled and stored (handle by non-filter components)

Pasanen et al., 1993

- **Loaded 2 High efficiency filters**
 - **85% fiberglass, 15% cellulose**
 - **15% fiberglass, 85% cellulose**
- **Loaded with microorganisms**
 - **Cow barn (8 hr/day, 2 weeks)**
 - **Waste water treatment plant (continuously for 1 week)**
- **Stored @ 98% RH, 35 days**
- **Attributed growth to storage in humid environment**

Pasanen et al., 1994

- 2 High efficiency filters
 - 85% fiberglass, 15% cellulose
 - 15% fiberglass, 85% cellulose
- Filters inoculated w/ *Stachybotrys atra*
- Stored at 3 RH ranges, 78 – 100% for 86 days
- *S. atra* grows and produces toxins on cellulose filters @ high RH conditions
- Stated that these conditions probably do not occur during normal respirator use and storage

Re-aerosolization of Microorganisms

- The process by which any aeriually deposited material can be re-suspended
 - High air flow back through the filter (cough or sneeze)
 - Handling
- Size of re-suspended particles may be different from that of the deposited particles
- 2 studies

Qian et al., 1997

- Measured reaerosolization of *M. tuberculosis* surrogates and other test particles
- 3 models of N95 respirators
- Re-entrainment air velocity 300 cm/sec
- Re-aerosolization into dry air significant only for larger test particles
- No re-aerosolization at RH levels > 35%

Qian et al., 1997

- **Concluded that reaerosolization of collected TB bacteria and other particles < a few μm in size is insignificant at conditions encountered in respirator wear**
- **Speculated that conclusions were valid for other fibrous filters as well**

Kennedy & Hinds, 2004

- **Used 1 μ m PSL particles to simulate anthrax spores**
- **Measured release of particles from respirators dropped 3 feet onto a hard surface**
- **Two brands of N95 disposable respirators**
- **Conclusions**
 - **Small, but consistent fraction of 1 μ m particles captured by a disposable respirator can be released into the air**
 - **Fraction release ranged from 0 to 0.5%**
- **Suggests caution in handling and disposing of respirators contaminated with anthrax spores**

Re-use

- **Some bacteria and fungi can survive on respirator filters**
- **May be dependent on:**
 - **Organism**
 - **Filter material,**
 - **Storage conditions**
- **Unclear as to its implications on reuse and storage**
 - **Daily filter or respirator disposal**
 - **Knowledge of disease transmission for agent of interest**

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