‘Eggcrate UV’: A Novel Ultraviolet Germicidal Irradiation System for Air Disinfection in Occupied Rooms

Sonya Milonova
Research Fellow, Harvard School of Public Health
milonova@hpsh.harvard.edu

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One third of the world's population is infected with tuberculosis. TB is the leading killer of HIV infected people. It is the cause of death for nearly 1.5 million people each year.

Nosocomial Transmission of Extensively Drug-Resistant Tuberculosis in a Rural Hospital in South Africa

Neel R. Gandhi1,2, Darren Weissman1, Prashini Moodley3, Melissa Ramathai3, Inga Elson3, Barry N. Kreiswirth4, Barun Mathema4, Elena Shashkina4, Richard Rothenberg5, Anthony P. Moll6, Gerald Friedland7, A. Willem Sturm3 and N. Sarita Shah1

+ Author Affiliations

Correspondence: Neel Gandhi, MD, 1518 Clifton Road, CNR 3031, Department of Epidemiology, Rollins School of Public Health, Atlanta, GA 30322 (neelgandhi@alumni.williams.edu).

Abstract

**Background.** Extensively drug-resistant tuberculosis (drug-resistant tuberculosis) is a global public health threat. This review addresses the current state of the field, reviews recent advances, and outlines strategies for future research. The use of multidisciplinary approaches is crucial for investigating outbreaks and developing targeted interventions. Combining epidemiological, clinical, and molecular strategies will be necessary to control and prevent similar outbreaks in the future.

**Methods.** Review of the literature on drug-resistant tuberculosis outbreaks, with a focus on those with multidisciplinary approaches.

**Results.** The combination of epidemiological, clinical, and molecular strategies has been successful in several outbreaks, including one in a prison in New York State in 1991. The outbreak in South Africa highlights the need for continued monitoring and research to understand and prevent similar outbreaks.

**Conclusion.** Multidisciplinary approaches are essential for investigating and controlling drug-resistant tuberculosis outbreaks. Continuous monitoring and research are necessary to prevent similar outbreaks in the future.


**Outbreak of multi-drug-resistant tuberculosis in a New York State prison, 1991.**

Valway SE1, Richards SB, Kovacovich J, Greifinger RB, Crawford JT, Dooley SW.
Compared to other engineering controls—such as ventilation, air filtration, and negative pressure—ultraviolet germicidal irradiation (UVGI) has the lowest relative cost, most rapid disinfection time, easiest installation, lowest maintenance, and no noise.
Upper-Room UVGI

Fan(s) assure adequate air mixing

UVGI fixture

UV-C rays

Warm, contaminated air rises

Disinfected air displaced

>2 m
## Limitations

**Fixture efficiency: 0.6 – 6%**

- Louvers designed to limit irradiance in the lower room absorb most of the UV

**Unsafe installation**
- Highly reflective ceilings
- Lack of trained commissioners

<table>
<thead>
<tr>
<th></th>
<th>Total Electrical Input</th>
<th>UV Input</th>
<th>UV Output from Fixture</th>
<th>UV Efficiency (UV Output/UV Input)</th>
<th>Total Efficiency (UV Output/Total Input)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Model A</strong></td>
<td>110 W</td>
<td>36.7 W</td>
<td>0.22 W</td>
<td>0.6%</td>
<td>0.2%</td>
</tr>
<tr>
<td><strong>Model B</strong></td>
<td>25.6 W</td>
<td>8.53 W</td>
<td>0.49 W</td>
<td>5.7%</td>
<td>1.9%</td>
</tr>
</tbody>
</table>
Eggcrate UVGI

HSPH Rooftop Test Chamber
Objectives

1) Compare percent *Mycobacterium parafortuitum* inactivated with:
   - Two louvered fixtures, no eggcrates
   - Two un-louvered fixtures with small eggcrates
   - Two un-louvered fixtures with big eggcrates

2) Compare lower-room (5’8” or 1.7 m) irradiance for ensuring occupant safety

“Small” eggcrates:
14.6 mm x 14.6 mm x 7.8 mm

“Big” eggcrates:
50.8 mm x 50.8 mm x 50.8 mm
Percent *M. parafortuitum* Inactivated

- Louvered Fixtures
- Small Eggcrates
- Big Eggcrates
Equivalent Air Changes per Hour *

* With 6 ACH provided by ventilation
Lower Room Irradiance

Average Max

Irradiance (µW/cm²)

- Louvered Fixtures
- Small Eggcrates
- Big Eggcrates
Conclusions

Eggcrate UVGI creates a high-intensity upper room and low-intensity lower room

- Highly effective against aerosolized mycobacteria
- Safe for lower room occupants

Applications

- Tuberculosis, influenza, bioterrorism, future airborne threats

Further research

- Angled eggcrate cells
- Maximizing vertical air mixing (eggcrates increase air flow resistance)
- UV-C light-emitting diodes (LEDs)
Questions?

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