Efficacy studies for inactivation of influenza virus in aerosols

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The Issue

- Surgical Infection: 200000–300000 cases per year
- Infection spread in public places

http://newsroom.cumc.columbia.edu/blog/2013/10/16/narrow-spectrum-uv-light-may-reduce-surgical-infections/
https://smhs.gwu.edu/surgery/sites/surgery/files/styles/1170-x-variable/public/Surgery-banner_770x320.png?itok=t0pD8Ba
https://media.licdn.com/mpr/mpr/p/1/000/285/069/07f8d76.jpg
UV Sterilization

- UV light damages DNA to inactivate the cell.
Drawbacks

- Carcinogenic and cataractogenic.

![Safety Sign and Goggles](http://www.safetysign.com/images/catlog/product/large/H1511.png)
222nm UVC

- Far-UVC radiation at 222nm from krypton-chlorine excimer lamps may eliminate these safety issues.
Absorption

Buonanno M, Xu Y. Efficacy studies for inactivation of influenza virus in aerosols.
Bacteria and Viruses

- Bacteria or virus <1μm, compared to 10–25μm for human cells.

[Link to source](http://newsroom.cumc.columbia.edu/blog/2013/10/16/narrow-spectrum-uv-light-may-reduce-surgical-infections/)
Efficacy in Aerosols

[Image of a person sneezing, a British Airways aircraft, and medical equipment with purple light]
Aerosol UV Exposure Chamber

Need to control:
- Aerosol
- Temperature
- RH
- Flow rate

Need:
- Laminar flow
- UV transparent windows
- Some way of measuring particle size and virus survival.
Aerosol UV Exposure Chamber

- Virus Input
- Baffle
- Nebulizer
- UV-Exposure Area
- Temperature & Relative Humidity Meter
- Virus Outputs
- Particle Sizer
- BioSamplers
- Pump
Aerosol production
UV Exposure Area

Aerosol Exposure Chamber

Virus Input

Baffle

Nebulizer

Temperature & Relative Humidity Meter

UV-Exposure Area

Virus Outputs

Particle Sizer

BioSamplers

Pump
Sampling
Aerosol UV Exposure Chamber

- C – Nebulizer
- D – Baffles
- E – RH meter
- F – Window
- H – Particle sizer
- I – Bio samplers
Additions

- A – Conical bubble flask
- B – Desiccator
- C – Nebulizer
- D – Baffles
- E – RH meter
- F – Window
- G – Pressure gauge
- H – Particle sizer
- I – Bio samplers
Additions: RH control system
Future Additions

- A – Conical bubble flask
- B – Desiccator
- C – Nebulizer
- D – Baffles
- E – RH meter
- F – Window
- G – Pressure gauge
- H – Particle sizer
- I – Bio samplers
Particle Size Range

### Preliminary Testing

<table>
<thead>
<tr>
<th>Controlled Variables:</th>
</tr>
</thead>
<tbody>
<tr>
<td>RH Inside Box / %: 44</td>
</tr>
<tr>
<td>Wet Inlet Flow Rate / SCFH: 0</td>
</tr>
<tr>
<td>Dry Inlet Flow Rate / SCFH: 32</td>
</tr>
<tr>
<td>Nebulizer Flow Rate / LPM: 10</td>
</tr>
<tr>
<td>Chamber Pressure / atm: -0.02</td>
</tr>
<tr>
<td>Flow Rate Out / SCFH: 42</td>
</tr>
<tr>
<td>Sample Time / min: 1</td>
</tr>
<tr>
<td>Nebulizer &quot;Name&quot;: D</td>
</tr>
<tr>
<td>Nebulizer Liquid: water</td>
</tr>
<tr>
<td>Nebulizer Fill Level / ml: 75</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Measured Results:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particle Range (microns)</td>
</tr>
<tr>
<td>-------------------------</td>
</tr>
<tr>
<td>0.3-0.5</td>
</tr>
<tr>
<td>0.5-0.7</td>
</tr>
<tr>
<td>0.7+</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

- Controlled variables:
  - Wet air flow rate
  - Dry air flow rate
  - Nebulizer flow rate
  - Flow rate out
  - Sampling time
  - Nebulizer liquid and volume
HBSS produces larger particles than water.
Changing liquid volume in nebulizer has a small effect.
RH has significant effect

Water Particle Distribution at 37% RH

Water Particle Distribution at 60% RH
Flow rate into nebulizer has a large effect on particle distribution. Here are the results:

**Particle Distribution with 10LPM Nebulizer Flow Rate**
- 0.3-0.5
- 0.5-0.7
- 0.7+

**Particle Distribution with 12LPM Nebulizer Flow Rate**
- 0.3-0.5
- 0.5-0.7
- 0.7+
To Do

- Incorporate lamp
- Install into fume hood
- Run with virus
- Sterilization procedures
- Experimental procedures
- Measure dosage given by lamp

To be continued...
References


- Monochromatic 222 nm UV light: Development of a safe, cost-effective technology for the efficient reduction of bacterial and viral infection and transmission


Image Credits

In order of appearance:

- https://media.licdn.com/mpr/mpr/p/1/000/285/069/07f8d76.jpg
- http://i2.mirror.co.uk/incoming/article6423151.ece/ALTERNATES/s510b/JS26419395.jpg

All other images are my own.
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- Columbia University and Nevis Labs

Thanks for all your hard work!

Any Questions?