SMNR 56: Humidity IS Health

The Impact of Steam Humidification on Influenza Virus in Preschool Classrooms

Learning Objectives

1. Understand the role of proper indoor humidification in improving health and cognitive functioning
2. Understand that proper indoor humidification can be an intervention to prevent seasonal influenza spread in preschools
3. Understand how to properly design a high-pressure fogging system for health-care applications both for humidification and energy saving
4. Understand how to estimate the break-even point of the most common steam and adiabatic humidification systems

Cost of Influenza

- $10.4 billion a year in direct medical expenses
- $16.3 billion in lost earnings annually
- $87 billion a year total economic burden


Acknowledgements

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Department of Pediatric and Adolescent Medicine
Infectious Diseases small grant program

*commercial brand (potential COI)
Absences negatively impact education & learning

- Chronic absenteeism, missing ≥10% of school days within a year for any reason predicts low student achievement.²
- A study in North Carolina found 22% of chronic absences were due to respiratory illnesses.³

Questions we sought to answer:

Impact of humidity on:
1. viral transmission (presence and quantity)
   - air particles
   - fomites (paper wrapped objects)
2. survivability of influenza
   - How infectious?
3. Influenza Like Illness (ILI) and absences of students

Influenza avoids humidity

- Influenza A incidence peaks during winter in temperate regions
- Absolute humidity (AH) accounts for 50% of the variability in transmission and 90% of the variability in survival of influenza⁴ (reanalysis of guinea pig data⁵)

How do we do that?

- Influenza is difficult to find in the environment
- But Swiss bank notes extend survival

The Big Question

Unknown question:

Does low humidity in the winter increase transmission and survival of influenza in a classroom environment?

Hypothesis:

Increasing the relative humidity of classrooms to 40-60% will reduce the capacity of influenza to survive on classroom surfaces, or spread between classmates as aerosols.

The Method

Sample Preparation

Wrap

Assemble
Outdoor absolute humidity predicts MN hospitalized influenza cases

**Sample Collection (Aldrich preschool)**
- Morning preschool classes (students ages 3-5) in rooms
- Wrap additional classroom objects (if needed)
- Calibrate air sampler pumps
- Run 150 minutes (during class)
- Unwrap school objects
- Collect wrapped objects
- Measure air particle sizes

**Sample Processing**
- Dust paper with fingerprinting powder
- Remove fingerprint (+) pieces
- Place paper into media
- Disassemble air samplers
- Add media to tubes
- Place filter into media
- Vortex, incubate & centrifuge
- Isolate viral RNA
- RT-PCR
- Identify Flu A+
- Infectivity assay (electrical impedance)

We were able to raise the absolute humidity of identical preschool classrooms

- Absolute humidity trough
- Peak cases
- MN Dept of Health
- North American Land Data Assimilation System (NLDAS) project

We were able to raise the absolute humidity of identical preschool classrooms

**Flu A positive**
- Control % positive
- Humidified % positive
- Odds Ratio

<table>
<thead>
<tr>
<th>Flu A positive</th>
<th>Control % positive</th>
<th>Humidified % positive</th>
<th>Odds Ratio *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fomites</td>
<td>22.1</td>
<td>18.0</td>
<td>.51 *</td>
</tr>
<tr>
<td>Air (total)</td>
<td>18.3</td>
<td>11.7</td>
<td>.51 *</td>
</tr>
</tbody>
</table>

An odds ratio <1 means reduced likelihood of finding flu positive sample in humidified rooms compared to control rooms.

Reduction in presence of flu in humidified classrooms for both fomites (surfaces) and air samples.

Control = not humidified

There were less Influenza A genomes in humidified rooms

Less flu is present on fomites and in the air in humidified rooms

Control = not humidified

* = differences between groups are real
Environmental samples from humidified rooms demonstrate less infectivity

<table>
<thead>
<tr>
<th>Sample Type</th>
<th>Assay</th>
<th>% positive</th>
<th>Control</th>
<th>Humidified</th>
<th>OR, p&lt;0.05 CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed (fomites and air)</td>
<td>Electrical impedance</td>
<td>48</td>
<td>17</td>
<td>27</td>
<td>18</td>
</tr>
</tbody>
</table>

More virus is “alive” in the control room than in the humidified room

Control = not humidified

Does humidification result in less Flu like illness?

- During the period of elevated humidity (from 2/25 through end of study 3/31) there was a total of 10 influenza like illnesses from absent students
  - 7 were from control rooms
  - 3 were from humidified rooms

Summary

- We achieved elevated humidity in rooms with humidifiers compared to control rooms

Humidified rooms had:
  - A significant decrease in % total air samples containing Influenza A
  - Trend toward decreased % of paper samples containing Influenza A
  - A significant reduction in Influenza A presence for total air and paper samples
  - Fewer samples that were infectious in cell culture (electrical impedance assay)
  - Less flu like illnesses

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- NIOSH

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- Aldrich
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References


Questions?

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