Environmental Infectious Disease Management in Healthcare Facilities
Dr. Andrew Streifel, University of Minnesota
A Webber Training Teleclass

Guidelines for Environmental Infection Control in HCF
- Seven major areas covered:
  - Air
  - Water
  - Environmental Services
  - Environmental Sampling
  - Laundry and Bedding
  - Animals in Healthcare Facilities
  - Regulated Medical Waste
- MMWR 6-03 was partial document
- 249 pg. with >1400 citations
- Appendices A – F

Guideline for Environmental Infection Control
Centers for Disease Control & Prevention
Heating, Ventilation & Air Conditioning
- Air handling systems in health care facilities
- Construction, renovation, remediation, repair and demolition
- Infection control and ventilation requirements for protective environments
- Infection control and ventilation requirements for airborne infection isolation
- Infection control and ventilation requirements for operating rooms

Ventilation Control in Hospital
- Airborne Infection Isolation & Protective Environment
  - outage control (planned or emergency)
  - ventilation assurance
    - air changes per hour - (6 to 15)
    - HEPA filtration - (90% to 99.97%)
    - pressurization - (2.5 Pascal’s = 0.01”wg)
    - monitoring
- Construction barriers
  - external project protection
  - internal barrier types
  - controlled airflow direction
  - monitoring

Human Source Airborne Infectious Diseases
- Tuberculosis
- Chicken pox
- Disseminating H. zoster
- Measles
- Smallpox
- Droplet nuclei <5μm particles

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Fungi in the World
• >100,000 species
• about 100 human pathogens
• mostly skin pathogens
• small spores penetrate lungs
• essential to our survival

Aspergillus fumigatus
• prolific spore production

Costs of Aspergillosis
• In 1996 dollars, average cost $62,426
  – Range $52,670 - $72,181
• Often as a secondary diagnosis (73%)
  – Respiratory, neoplastic and HIV most common
  primary diagnosis
• Increased length of stay
  – Average hospitalization 17.3 days
  – Range 16.1 – 18.6 days
• Costs don’t include mortality

Common material such as gypsum board will grow mold. Some species are opportunistic infectious agents
- Aspergillus species
  – A. fumigatus, A. flavus,
  – A. terreus and A. niger

Mold digests cellulose for a source of cellulose. Add water to most organic material and mold will grow with water content >25% and a RH >95%

Selected Aspergillosis References
• Arnow
  – 1978 - internal construction with little control
  – 1991 - lack of maintenance with internal sources
• Sandhi
  – 1984 - external construction/defective air system
• Rhame
  – 1984 - natural ventilation
• Patterson
  – 1999 - Dumb weighter construction minimal barriers
• Thio
  – 2000 - depresurized protective rooms & building
• Hahn
  – 2002-differences in filter efficiencies & moldy material

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Refrinements of Environmental Assessment during an Outbreak Investigation of Aspergillosis Leukemia & BMT Unit, Thio, C. et al, ICHE. 2000

- 21 cases of invasive aspergillosis
- Depressurized oncology rooms 12/25 (-0.1 to -5.8 Pascal's)
- Sampling air did not detect A. flavus with 160 liters but 10/40 high volume samples (1400 liters) did detect
- Interventions: N95 masks, wet buffing, pressure management, portable filtration
- Ventilation not the source but construction due to:
  - Doors, poorly sealed windows
- Recommendation: novel protection, assess environment, >1000 liter/sample, comparison samples

Efficacy of HEPA Filtration in Preventing Aspergillosis in Immune-compromised Patients... Hahn, T. et al. ICHE. 2002

- 10/55 pts July to December 1992 developed invasive aspergillosis compared to 0/36 pts January to June 1992
- Leukemia patients not on BMT ward but regular rooms
- High volume (1700 liters) detected Aspergillus in air of regular rooms but not on BMT ward
- Regular room @ 90% filtration yet >150 cfu/m3 total fungi
  - compared to < 4 cfu/m3 on BMT ward BMT had 99.97% filters
- Contamination source on non-BMT was wet insulation which developed and infected patients
- Conclusion was to use HEPA filtration and maintain protective conditions albeit not as stringent as the BMT patient

INFECTION CONTROL RISK ASSESSMENT

- Recognizes risk to patients from ongoing construction, renovation and maintenance
- Implements safety measures to prevent exposure to common environmental hazards
- Provides guidance for surveillance of project and patients
- Multiple methods situation dependent to comply with safety measures for infection control

Summary of Outbreak Analysis

- Environmental disruption causes release of opportunistic microbes
- Lack of adequate ventilation
- Point source of microbial contamination
- Minimal protective measures
- Institution of protective measures reduces infection: construction management, masking, filtration, pressure control and procedural practice
- Infection Control Risk Assessment is necessary for patient risk reduction

Using an ICRA Matrix

1. Type of Project Activity
2. Patient Risk Groups
   - Immunocompromised
   - Invasive procedures/devices
3. Class of IC Precautions
   - Based upon parameters "IC Permit" assists documentation

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Sample ICRA Matrix

<table>
<thead>
<tr>
<th>PATIENT Risk Group</th>
<th>TYPE A</th>
<th>TYPE B</th>
<th>TYPE C</th>
<th>TYPE D</th>
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</thead>
<tbody>
<tr>
<td>LOW Risk Group</td>
<td>I</td>
<td>II</td>
<td>II</td>
<td>III / IV</td>
</tr>
<tr>
<td>MEDIUM Risk Group</td>
<td>I</td>
<td>II</td>
<td>III</td>
<td>IV</td>
</tr>
<tr>
<td>HIGH Risk Group</td>
<td>I</td>
<td>II</td>
<td>III / IV</td>
<td>IV</td>
</tr>
</tbody>
</table>

ICRA Matrix at www.ashe.org
Internal Construction Risk Factor

- Dust containment, removal and moisture control
  - Educate construction workers and staff
  - Prepare the site
  - Notify staff, visitors, patients re: precautions
  - Relocating patients and moving staff as needed
  - Monitoring for adherence to infection control
  - HVAC system maintenance; water system
  - Daily clean-up and removal of debris

Control: Dust Containment

How would you handle this ceiling tile?

Portable containment on BMT unit

Filter verification

Portables filters
  - Airflow direction
  - Noise levels
  - Adaptability

Goal is to provide pressure differential and dilution ventilation to control respective airborne hazards.

Phasing plan for carpet removal

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Filter in barrier
• dilution vent
• depressurization

A good idea may not work if the window is not sealed.

Negative pressure machine

EXTERNAL CONSTRUCTION MANAGEMENT
• Verification of existing protective ventilation
• Control of building entrances
• Window infiltration
• Utility tunnel access to construction
• Building tie-ins
• Employee training
• Street cleaning
• Emergency response

Filters not set in housing leak allowing particle bypass

Plugged air intake causes? decreased airflow

Building tie-in planning
Where are the air intakes?

Solutions for issues
• fan outage during penetration
• worker access control
• airflow control
• communication

Building tie-ins can be problematic
• noise & vibration
• relocate patients
• air infiltration
• barrier management

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Ventilation Outage Planning

- Planned maintenance outages
  - critical areas - time limits
  - combining tasks for efficiency
  - patient protection
- Emergency Outages
  - backup motors, fan belts, bearings, etc.
  - redundant systems in critical areas
  - portable filtration contingencies

Emergency Planning for Physical Plant Disruption

- Develop contingencies for:
  - critical ventilation
  - water supply
  - loss of steam
- Water damage control
  - notification process
  - drying time < 72 hours
  - remediation precautions if moldy
  - certification after clean-up in critical areas

Buildings age when the ventilation is turned on

CAUSES OF VENTILATION DEFICIENCIES
- PLUGGED FILTERS
- PLUGGED TEMP CONTROL COILS
- DUCT LEAKAGE
- DUST ON FAN BLADES
- FAN BELT SLIPPAGE
- UNCALIBRATED CONTROL EQUIPMENT
- DIGITAL CONTROLS
- PNEUMATIC CONTROLS
- TEMPERATURE
- HUMIDITY SENSOR
- RECEIVER CONTROL

What is wrong with this picture??

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Negative Pressure Room for Airborne Infection Isolation
- Negative pressure greater exhaust than supply air volume
- Pressure differential > 2.5 Pascal's or 0.01"w.g.
- Airflow differential > 125 cfm
- Sealed room, with about 0.5 sq. feet leakage
- Clean to dirty airflow
- >12 air exchanges per hour new or 6 ac/hr renovation
- Monitoring
- Exhaust to outside or HEPA filtered if recirculated

Intended usage's:
- Procedure/treatment rooms
- Bronchoscopy rooms
- Autopsy
- Emergency rooms

Positive Pressure Room Control for Protection From Airborne Environmental Microbes
- Pressure differential > 2.5 Pascal's or 0.01"w.g. ideal at 0.03"w.g or 8 Pascal's range from 2.5 to 8.0 Pa
- Positive pressure greater supply than exhaust air volume
- Greater than 125 cfm airflow differential supply vs exhaust
- Sealed room, about 0.5 sq. feet leakage
- Clean to dirty airflow
- Monitoring
- >12 air exchanges per hour
- Recirculate air back through filters

Intended usage's:
- Immune compromised patient rooms
- Operating rooms

Water Damage Management
- Reactive
  - Respond to water incident
  - Determine extent of water damage
  - Cut out or dry
- Proactive
  - Water resistant material
  - Preservative application
  - Proper installation

These parameters should be kept stable and should be checked when changes or adjustments are made in HVAC system.

Healthcare Construction: Case Studies in Medical Facilities
Moldy Sheetrock

Healthcare Construction: Case Studies in Medical Facilities
Mold Contaminated Wall Cavity
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**Fungal growth**

Water damage in relatively common in the janitor’s closet. Water resistant materials will prove to be value added to construction and renovation. Inspections should evaluate these water damage issues.

**Water Intrusion Algorithms**

Water Intrusion Algorithms are useful decision makers for water damage mold prevention.

- Keep moisture content <20%
- Maintain air movement
- Remove moisture physically
- Evaporation

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**Leak site**

Even when rock is off the slab mold can grow when the water comes from above and is sealed behind the vinyl coving.

**Contamination area defined**

Keep the rock off the slab!

Wet test meter
- decision maker
- find the wetness
- drying time
- <72 hrs
- <20% moisture content

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**Microbes recovered:**

Fitting floors during cleaning & non integral coving causes sheet rock to get wet and promote mold.

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**Moisture meters**

- Use moisture meters during cleaning to detect wetness.
- Keep moisture content <20%
- Maintain air movement
- Remove moisture physically
- Evaporation

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**Water Intrusion Algorithms**

- Know which moisture meter to use
- Dry it out <72 hrs
- Move occupants if possible

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Source management of infectious diseases

- Airborne spread of infectious bacteria are relatively rare. Virus more common.
- Understand the difference of potential sources
- Environmental airborne fungi are common in some locations
- Immune compromised patients becoming more prevalent.
- Engineering controls help to minimize exposures to water bacteria and environmental mold.

Infectious Disease Management in Healthcare

- Complex balance of mechanical and operational issues
- Ventilation control essential to protect patients & personnel
- Source management of infectious agents essential
- Recognition of sources important for control
- Protective measures needed for prevention of infection
- Infection control risk assessment is a tool for proper means and methods in healthcare environment

Free Teleclasses in July & August

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<th>Date</th>
<th>Topic</th>
<th>Speaker</th>
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<td>Infection Surveillance in the UK</td>
<td>Dr. Allan Johnson</td>
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<tr>
<td>July 27</td>
<td>Dermal Absorption of Alcohol Disinfectants</td>
<td>Dr. Axel Kramer</td>
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<tr>
<td>August 17</td>
<td>Avian Influenza – South Pacific Perspective</td>
<td>Dr. Lance Jennings</td>
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<td>August 24</td>
<td>How to Assess the Risk of Disease Transmission When There is a Failure to Follow Recommended Disinfection and Sterilization Principles</td>
<td>Dr. William Rutala</td>
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