Maintenance for Infection Prevention
Andrew Streifel, University of Minnesota
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Regulatory Resources to be Incorporated:
External Jurisdiction:
Includes all applicable building codes and:
- CDC Guidelines for Environmental Infection Control
- MDH: Minnesota Department of Health also expects the facility to be aligned with current CDC and AIA standards.
- OSHA & NIOSH
- Association for the Advancement of Medical Instrumentation (AAMI)
- Association for Professionals in Infection Control and Epidemiology (APIC)
- Centers for Medicare and Medicaid Services (CMS)
- Health Care Resource Services Administration

Current Regulations and Guidelines
- Joint Commission on Accreditation of Healthcare Organizations
- Guidelines for the Design and Construction of Hospital and Health Care Facilities (mandated by state law)
- CDC - Guidelines on Environmental Infection Control
- State Licensure (in many states)
- HRSA - Healthcare Resource Services Administration
- NIOSH - Protecting Building Environments

The Joint Commission
- A Private Not-for-profit Organization
- Environment of Care Standards on Utilities Management EC.7.10
- Environment of Care Standards on Construction Risk Assessment EC8.30
- New in 2006, unannounced surveys
- Continued use of an engineering surveyor for all hospitals over 200 beds
- National Patient Safety Goal on Infection Control

The Joint Commission - EC.8.30
- Demolition, Construction, or Renovation
- Proactive Risk Assessment
- Identify hazards that could potentially compromise patient care
- Address impact on:
  - Air quality requirements
  - Infection control
  - Utility requirements
  - Noise and vibration
  - Emergency procedures

TJC-EC7.10
- Infection Control Systems
- Utilities
- Ventilation
- Plumbing
- Functionality

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AIA 2006 Guidelines for Design and Construction of Hospitals & Health Care Facilities

- Latest in a 60-year series of guidelines specific for design and construction of hospital and other health care facilities
  - Nursing Facilities; Outpatient Facilities
  - Rehabilitation Facilities; Psychiatric Hospitals
  - Mobile, Transportable, and Relocatable Units
  - Hospice Care; Assisted Living
  - Adult Day Care Facilities
  - Glossary Tables

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

AIA 2006 Guidelines for Design and Construction of Hospital & Health Care Facilities

- Consensus document; developed by
  - Engineers, architects, clinicians
  - Representatives of professional organizations
  - e.g. AIA, ASHRAE, ASHE, APIC, JCAHO
  - 23 AHJs: representatives [Authorities having jurisdiction]
  - Dept Health and Human Services (HHS)
  - CDC and NIOSH
- Regulatory document
  - Over 40 states and local healthcare licensing agencies have adopted into their standards
  - JCAHO accreditation reference AIA
- 2006 version Infection Control Risk Mitigation Recommendation
  - 2010 comment period

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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

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Maintenance & Environmental Infection Control

- Air
- Water
- Hazardous items

Healthcare Air Quality

- Fungi
  - Common with body temperature incubation
- Bacteria
  - Human shed microbes
- Virus
  - Embedded virus in sputum droplet nuclei
- Particles
  - Surrogate real time measurement

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Negative Pressure Room for Airborne Infection Isolation

Intended usages:
- procedure/treatment
- bronchoscopy rooms
- autopsy
- immune compromised patients
- operating rooms

Verification of Special Ventilation Rooms
Commissioning Guidelines

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Minimum Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Changes per hour</td>
<td>&gt;12</td>
</tr>
<tr>
<td>Filtration</td>
<td></td>
</tr>
<tr>
<td>- supply</td>
<td>90% dust spot</td>
</tr>
<tr>
<td>- return</td>
<td>99.97% @0.3um</td>
</tr>
<tr>
<td>- toilet</td>
<td>100% exhaust</td>
</tr>
<tr>
<td>- toilet</td>
<td>back through filter</td>
</tr>
<tr>
<td>Supply vs exhaust offset</td>
<td>&gt;125cfm</td>
</tr>
<tr>
<td>Airflow direction</td>
<td>in/out</td>
</tr>
<tr>
<td>Pressure differential</td>
<td>&gt;0.01&quot; W.G.</td>
</tr>
<tr>
<td>Minimal room leakage</td>
<td>&lt;0.5 sq. ft</td>
</tr>
</tbody>
</table>

What is wrong with this picture??
Flexible duct not properly installed caused condensation & mold

Ventilation deficiencies can affect airflow direction

Buildings age when the ventilation is turned on

Which duct moves more air?

What ways do we have to monitor airflow and pressure?

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Removal Efficiency In-Situ by Particle Size and Resistance to Flow

Direction of Airflow

Before

After

Particle Counter

Depiction of particle counts before and after filtration in air handling system

Examples of data interpretation for particle reduction in various filtered efficiencies:

<table>
<thead>
<tr>
<th>Filter Type</th>
<th>Outside PC</th>
<th>After PC</th>
<th>Percent Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>MERV 12</td>
<td>12000</td>
<td>24000</td>
<td>80%</td>
</tr>
<tr>
<td>MERV 14</td>
<td>12000</td>
<td>24000</td>
<td>80%</td>
</tr>
<tr>
<td>MERV 16</td>
<td>12000</td>
<td>24000</td>
<td>80%</td>
</tr>
</tbody>
</table>

Note: Optical Particle Counters Are Reported As Particles Per Cubic Foot. **PC = particle counts  * MERV = minimum efficiency rating value (current ASHRAE rating system)

Performance Evaluation Filtration in Air Handling Systems

- Filtration at 90% rating consider evaluation of filter bank when when the measured efficiency is below 80%.

Saravia, et al, AJIC, June 2007
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Schematic to match ventilation parameters in Airborne Isolation Rooms

<table>
<thead>
<tr>
<th>Ward</th>
<th>Code</th>
<th>Ventilation Type</th>
<th>Ducts</th>
<th>Airflow</th>
<th>Monitor</th>
<th>Type</th>
<th>Room</th>
<th>Ward</th>
<th>Airquality</th>
</tr>
</thead>
<tbody>
<tr>
<td>AII</td>
<td>0.26F</td>
<td>single</td>
<td>10</td>
<td>.06</td>
<td>true</td>
<td>sugg</td>
<td>AII</td>
<td>AII</td>
<td>AII</td>
</tr>
<tr>
<td>AII</td>
<td>0.21F</td>
<td>single</td>
<td>10</td>
<td>.21</td>
<td>true</td>
<td>sugg</td>
<td>AII</td>
<td>AII</td>
<td>AII</td>
</tr>
</tbody>
</table>

Airborne Infection Isolation Room Inventory
UMMC-Fairview

Objective analysis of critical environments: pressure and particles

Validation of ventilation air from a BMT room
- Low particle counts
- High pressure

Validation of filters at the point of use
- Particle count scan
- Check filter installation

EXISTING CONDITIONS ASSURANCE

Essential Surveillance Parameters

- Room air exchanges per hour
  - Each air exchange reduces particles about 66%
  - All and PE rooms at >12 ac/hr
- Pressure control for All & PE rooms
  - Air velocity to create 0.01 inch w.g. (2.5 Pascales)
  - Air velocity 0.01" wg=120 lpfm, 0.01" wg=400 lpfm, 0.1" wg= 1300 lpfm
  - Design for >125 cfm offset for supply versus exhaust
  - Minimal leakage < 0.5 ft.
- Filtration supply to PE rooms & exhaust from All rooms
  - Particle reduction to include both viable and nonviable particles
  - Rank order reduction of particles from dirty to cleanest areas
  - Non viable particles can be analyzed real time

Air Quality Surveillance
University of Minnesota Medical Center-Fairview

Airborne Fungi and Ventilation Parameters

<table>
<thead>
<tr>
<th>Filtration local</th>
<th>cfu/m^3</th>
<th>Temp</th>
<th>% filtration</th>
</tr>
</thead>
<tbody>
<tr>
<td>- U of MN 1962</td>
<td>706</td>
<td>35C</td>
<td>none</td>
</tr>
<tr>
<td>- U of MN 1982</td>
<td>82</td>
<td>35C</td>
<td>40</td>
</tr>
<tr>
<td>- U of MN 2002</td>
<td>3.6</td>
<td>35C</td>
<td>90</td>
</tr>
</tbody>
</table>

Infection Control Ventilation Parameters

- Air exchanges
- Pressure differential
- Airflow direction
- Particle management

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Improving Performance of HVAC Systems to Reduce Exposure to Aerosolized Infectious Agents in Buildings: Recommendations to Reduce Risks Posed by Biological Attacks

If facilities can demonstrate control will employees have confidence to come to work during infectious disease event?

Water Systems in Healthcare

- Drinking water
- Kidney dialysis
- Laboratory
- Therapeutic
- Cooling
- Fire management

Municipal Water Quality

- Debris & color
- Bacteria
- Fungi
- Virus

Water Usage
- Drinking
- Dialysis
- Laboratory
- Process

CDC Environmental Infection Control-6/6/2003

<table>
<thead>
<tr>
<th>Hemodialysis Fluid</th>
<th>Maximum total hematocrit (E/hr. mL)</th>
<th>Maximum endotoxin level (E/ml.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preop standard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injection solution</td>
<td>280</td>
<td>No standard</td>
</tr>
<tr>
<td>Dialysate</td>
<td>280</td>
<td>No standard</td>
</tr>
<tr>
<td>Preop standard**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injection solution</td>
<td>280</td>
<td>2</td>
</tr>
</tbody>
</table>

Changes out of water treatment system needs coordination and quality control.

Non-Tuberculous Mycobacteria: Infections or Colonization

<table>
<thead>
<tr>
<th>Implicated Environmental Vehicle</th>
<th>Mycobacterium spp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inadequately sterilized medical instruments</td>
<td>M. abscessus, M. chelonae, M. fortuitum</td>
</tr>
<tr>
<td>Potable water, ice</td>
<td>M. avium complex (MAC), M. fortuitum, M. ulcerans</td>
</tr>
<tr>
<td>Hydrotherapy tanks and pools</td>
<td>M. chelonae, M. fortuitum, M. marinum</td>
</tr>
<tr>
<td>Reprocessed dialyzers</td>
<td>M. chelonae</td>
</tr>
<tr>
<td>Shower aerosols</td>
<td>M. fortuitum</td>
</tr>
</tbody>
</table>

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Non-Tuberculous Mycobacteria: Pseudo-Outbreaks

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Potable water used during bronchoscopy, instrument reprocessing</td>
<td>M. chelonae</td>
</tr>
<tr>
<td>Potable water, ice</td>
<td>M. fortuitum, M. gordonae, M. kansasii, M. terrae, M. xenopi</td>
</tr>
<tr>
<td>Intrinsically-contaminated laboratory solution</td>
<td>M. gordonae</td>
</tr>
</tbody>
</table>

Chloramine levels in Minneapolis near the hospital

Biofilm on the inside of plumbing fixtures

EPIDEMIOLOGICAL CURVE FOR BLOOD ISOLATES RECOVERED FROM BONEMARROW TRANSPLANTS

Paradigm shifts to include biofilm in water systems

Shower can be sources of microbes. Avoid stagnant water by draining hoses and offering reminders.

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Healthcare-associated Outbreaks of Legionellosis

- Contaminated aerosols
- Exposure to aerosols produced from:
  - Cooling towers
  - Showers, aerators
  - Faucets
  - Respiratory therapy equipment
  - Room-air humidifiers
  - Decorative fountains

Colonization of Man-made Aqueous Environments

- Temperatures of 25º - 42º C (77º - 107.6º F)
- Stagnation; dead legs
- Scale and sediment
- Presence of certain free-living aquatic amobae that can support intracellular growth of Legionella

**PREVENTION AND CONTROL**

- CULTURE WATER FOR LEGIONELLA
  - IF FOUND CULTURE PATIENTS
  - RETROSPECTIVE EPIDEMIOLOGY
  - WATER SYSTEM DECONTAMINATION

- FOLLOW HIGH RISK PATIENT
  - IF FOUND IN PATIENT WITH NOSOCOMIAL PNEUMONIA
  - INSTITUTE SEARCH FOR WATER SOURCE
  - MAINTAIN COOLING TOWERS AND USE STERILE WATER FOR NEUROSURGERY

- MAINTAIN POTABLE WATER
  - >60º OR <40º RECIRCULATION IDEAL
  - HEATED WATER AT 1-290ºL FREE RESIDUAL CHLORINE

**Drinking Water System Disinfection**

- superheat and flush
  - 15°F (9ºC)
- hypochlorination
  - continuous 2–4 ppm free chlorine residual
  - booster injection 1/2 ppm
- instantaneous steam heating
  - blend water and recirculate
- ultraviolet light
  - no residual
  - maintenance essential
- Ozone
  - effective microbicidic
  - no residual
- Metal ions
  - silver & copper
  - electrostatic stress effect cell death

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Legionella Control with Chlorination
- In 1990 - 23% of municipalities with >50,000 people used mono chloramine disinfection
- Advantages:
  - does not form trihalomethanes
  - heat stable
  - more effective at penetrating biofilm
- Hospitals with outbreaks of Legionellosis predominately >200 beds
  - >73% of those hospitals have a transplant program
  - >51 outbreaks in hospitals with free available chlorine
  - only one outbreak with mono chloramine
- Chlorine dioxide
  - local production for legionella management (PCU area or whole hospital?)
  - long term disinfection Royal Infirmary Glasgow Scotland (10 years)

Cooling Tower Concerns
- Cooling towers provide ideal environments for Legionella spp. growth
- Locate cooling towers to minimize intake of drift aerosols into the ventilation system
- Perform maintenance cleaning and treatment as per manufacturer’s instructions and other available guidance
- Clean and treat before seasonal start-up

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

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Flashing on the roof protects from water buildup.

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.

Roof drain
Preventative Maintenance is Infection Control

Microbes recovered:

Will this work?

Mold Growth Management

- Mold growth
  - About 4 hours with ideal conditions
  - Mycelial growth
  - Sporulation about 72 to 96 hours
  - Dissemination of spores

- Mold Growth Conditions
  - About 25% water content
  - Approximately 95% relative humidity

- Interrupt growth
  - Reduce moisture
  - Resistant substrate

Water related incidences
At University of Minnesota Medical Center, Fairview from 11/21/06 to 11/20/07

1364 total water events

- 612 toilet plugged
- 47 showers plugged
- 41 shower leaking
- 32 sink leaking
- 22 water leaks

71 water events in Bone Marrow Transplant (BMT)

- 20 toilet plugged
- 20 sink plugged

Mold Growth Management

Moisture meters are useful decision makers for water damage mold prevention

- Keep moisture content <20%
- Maintain air movement
- Remove moisture
- Physical evaporation

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

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**Water leak in Peds Oncology**
- Drips first noted
- Detection with IR camera
- Mold discovery
- Water source
- Drying assurance
- Remediation
- Cleanup

**Process for Mold Remediation & Mitigation**
- Recognize and identify mold by smell or sight
- Document the scope of the problem
- Find and eliminate source of moisture
- Dry and maintain an environment free of excess moisture
- Remove and replace saturated building materials
- Assess situation & evaluate if pesticide treatment is needed
- Wipe, scrape and clean visible mold from affected area
- Paint, coat or seal building material when conditions indicate
- Treat mold with labeled pesticide and/or
- Consult an expert for best practice

### JCAHO ENVIRONMENT OF CARE

**UTILITY MANAGEMENT**

- **EC.7.10.15** – Management of Water Systems
  - LAB, DIALYSIS, MUNICIPAL, PROCESS, EMERGENCY
- **EC.7.10.16** – Management of Ventilation Systems
  - SUPPLY, RETURN, EXHAUST, LOCAL
- **EC.7.30.4** - Testing of Infection Control Support Equipment
  - METHODS, PARAMETERS, LIMITS, CORRECTION

### Hospital Maintenance for Infection Prevention

- Maintenance essential to the sustainability of the HCF.
- Maintenance of ventilation, water fixtures and water damage will help assure control of critical patient care facilities.
- "Out of sight: Out of mind" bad indicator of potential problems.
- Infection Prevention & Control must team with facilities management for environmental safety priorities.

### The Next Few Teleclasses

<table>
<thead>
<tr>
<th>Date</th>
<th>Title</th>
<th>Speaker</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 Oct</td>
<td><strong>EC.7.10.15</strong> – Management of Water Systems: Lab, Dialysis, Municipal</td>
<td>Dr. Brenda Riepe, Oregon Department of Health and Mental Health</td>
</tr>
<tr>
<td>20 Oct</td>
<td><strong>EC.7.10.16</strong> – Management of Ventilation Systems: Supply, Return</td>
<td>Dr. Mark Wiltz, University of Leeds</td>
</tr>
<tr>
<td>4 Nov</td>
<td>Testing of Infection Control Support Equipment: Gas Sampling</td>
<td>Dr. Andrew Streifel, University of Minnesota</td>
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</table>

### 2009 Teleclass Schedule...

**Watch This Space**

www.webbertraining.com/schedulep1.php

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