Construction Issues in Healthcare: Challenges and Strategies

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Session Objectives

1. Provide at least one example of an infectious microbe spread by each major route.
2. List at least two instruments that may be used to evaluate parameters during construction and renovation projects in the HC environment.
3. Identify at least one method to reduce risk of infectious spread by each route.
Our Evolving Healthcare (HC)

- Over 6000 hospitals; > 1 M beds in US
- Shifts in services -> 75% to outpatient
- Aging population = demand LTCF & SNF
- ~ 2M HC associated infections/yr
- ~ 90,000 deaths/yr
- ~ 5,000 related to environmental microbes
Our Evolving HC Settings

- Technology & knowledge ↑
- Persons at risk ↑
  - Immunocompromised
  - Many causes; may not be obvious
    - disease, medication, infection, chemicals, radiation, personal factors
    - changes with time
  - Those in hospitals are “sicker”
  - Treatment in ambulatory settings
  - Invasive devices and procedures
Levels of Immunity

😊 Healthy person
- Chronic obstructive pulmonary disease
- Diabetes
- Steroids
- Cancer - solid tumor
- HIV infection-end stage of spectrum
- Organ transplant
  - Kidney/heart
  - Lung/liver
- Malignancy - leukemia/lymphoma
😊 Bone marrow transplant (BMT) allograft
Guideline for Preventing Opportunistic Infections Among Hematopoietic Stem Cell Transplant Recipients

- From CDC, ID Society of America, American Society of Blood & Marrow Transplantation
- HSCT = hematopoietic stem cell transplant
- Increasingly used Tx neoplastic diseases, hematologic disorders, immunodeficiency syndromes, congenital enzyme deficiencies, & autoimmune disorders (e.g., SLE or MS)
- About 20,000 HSCTs were done in 1998
- HSCT recipients are presumed immunocompetent at 24 months after HSCT if they:
  - are not on immunosuppressive therapy
  - do not have graft-versus-host disease (GVHD)
Guideline for Preventing Opportunistic Infections Among Hematopoietic Stem Cell Transplant Recipients - MMWR 2000

FIGURE. Phases of opportunistic infections among allogeneic HSCT recipients
HC Facility Challenges

- HC is highly regulated
- Resources extremely limited
- Buildings need repair & remediation
- Environmental disturbances from daily operations → major projects
- Aging equipment, deferred maintenance, & natural disasters = “opportunities” for microbes
Infection Control Basics

• Microbial Routes
  - Airborne
  - Waterborne
  - Surface Transfer

• IC approach is similar to IH tenets
  - Anticipate
  - Recognize
  - Evaluate
  - Control
A Few Basic [Proposed] Terms

- **Pathogen** - a microbe capable of causing host damage; [classical & opportunistic pathogens] damage = direct microbial action or host immune response
- **Virulence** - relative capacity of microbe to cause damage in host
- **Virulence factor** - component of a pathogen that damages the host


AIHce 2004 - Streifel & Wideman
Airborne Routes: People

- Reservoir = lungs, nose, mouth
- Respiratory spread
  - droplet nuclei = remain suspended
  - respiratory secretions = close range
Airborne Particles

- Disruptions
- Housekeeping, maintenance, renovation and construction activities
- Consider internal & external sources
- Amplification opportunities
Airborne Infectious Agents

- Tuberculosis (TB)
- Chickenpox
- Zoster “shingles”
  - in certain patients
- Measles
- Certain bioterrorism agents
Aspergillus: *A. fumigatus*, et al
Aspergillus fumigatus
**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

Dasbach et al, *Clinical Infectious Diseases* 2000;31:1524-8
Fungal Infections Kill
Waterborne Routes

- Direct contact (hydrotherapy)
- Ingestion of water (drinking water, ice)
- Indirect contact (improperly reprocessed medical device)
- Inhalation of aerosols (showers)
- Aspiration - contaminated water
Waterborne Microbes

- Legionella spp.
- Pseudomonas spp.
- Aeromonas spp.
- Other gram negative bacteria
- Mycobacteria (TB & NTM)
- Yeasts and other fungi
- Parasites
  - The BUG that made Milwaukee famous
  - Amoeba
Waterborne Infections

- Many cases cited
- Causes vary
- Single case vs. outbreak
- Distinguish healthcare associated (nosocomial) from community acquired infection
  - Determine source: supply vs. healthcare facility vs. reservoir
- Many unrecognized cases
- Biofilms protect & insulate
Surface Routes

- Non-intact skin
- Injection & inoculation
- Fomite transfer
- Self-inoculation (e.g., mucous membranes)
Surface Microbes

- **Bloodborne Pathogens**
  - Hepatitis B & C, HIV
- **Bacteria** - various types
  - Gram positive & gram negative; spores
  - May or may not be “pathogenic”
  - Cleaning & disinfection, as appropriate
- **Fungi, algae** - difficult to remove
Anticipation

• Healthcare facilities are unique
  - Protect persons (patients, workers, visitors, others) plus our facility
  - Microbes are there; will they cause morbidity (illness) or mortality (death)?
  - Persons at risk don’t wear a sign nor are they necessarily in a bed
  - Daily operations through major projects disrupt environment

• How do we recognize?
• Best method(s) to evaluate?
• What and how can we control?
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
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
### 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>
</tr>
</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>
<tr>
<td>HIGHEST Risk Group</td>
<td>II</td>
<td>III / IV</td>
<td>III / IV</td>
<td>IV</td>
</tr>
</tbody>
</table>
Control Methods

• Infection Control Risk Assessment (ICRA) team approach
• Design decisions
• Expectations to contractors
• Education & training
• Equipment for the job
• Instruments for measuring
• Surveillance = outcome & process
• Communication
• Documentation
People: Control Measures

Recognize potential disease (e.g., TB)

Airborne Infection Isolation (AII)

- NPV required (HVAC)
  - Daily testing (OSHA-TB)
  - Label ductwork
  - Local exhaust-procedures

- Healthcare workers
  - Skin testing / evaluation
  - Respiratory protection
  - Training & education

- Mask source = patient

CDC
Protect the Patient and Environment

CAUTION
DO NOT TURN FAN #5-10 OFF
SHUTDOWN MUST BE CLEARED
THRU THE O.R. SUPERVISOR
ENGINEERS AND CBAS

Protect the Worker and Environment

AIRBOURNE ISOLATION
ROOMS EXHAUST INTO
THIS PLENUM. USE
PROTECTIVE GEAR
IF ENTERING.
ENGS. ⇒ 3-3663
**AII Pressure > 0.01 “wg (2.5 Pa)**

Per CDC/HICPAC Guidelines Environmental IC

**Isolation Rooms:**
Design, Assessment, and Upgrade

**Tuberculosis Exposure Control Plan:**
Template for the Clinic Setting

**Negative pressure = air into room**
Clean to dirty air flow

AIHce 2004 - Streifel & Wideman
Example Two “ganged” Anteroom

Two rooms ganged with shared anteroom
- must emphasize separate storage
- control/monitoring

If allowed
- PPE & contaminated items must be kept separate
Protective Isolation (PI)
Compromised Patient with Infection

- pressure differential @ >2.5 Pascal's or 0.01"w.g. ideal at 0.03"wg 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 Usages
immune compromised patient rooms
operating rooms (OR)
Airborne Infection Isolation Room with Anteroom

- pressure differential @ 2.5 Pascal’s or 0.01” w.g.,
- sealed room with about 0.5 sq. ft leakage
- greater than 125 cfm airflow differential Supply vs Exhaust
- clean to dirty airflow
- monitoring
- >12 air exchanges per hour new or 6 ac/hr renovation
- anteroom airflow patterns
## Air changes/hour (ACH) and time required for airborne-contaminant removal

<table>
<thead>
<tr>
<th>ACH+</th>
<th>99% efficiency</th>
<th>99.9% efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>138</td>
<td>207</td>
</tr>
<tr>
<td>4</td>
<td>69</td>
<td>104</td>
</tr>
<tr>
<td>6</td>
<td>46</td>
<td>69</td>
</tr>
<tr>
<td>8</td>
<td>35</td>
<td>52</td>
</tr>
<tr>
<td>10</td>
<td>28</td>
<td>41</td>
</tr>
<tr>
<td>12</td>
<td>23</td>
<td>35</td>
</tr>
<tr>
<td>15</td>
<td>18</td>
<td>28</td>
</tr>
<tr>
<td>20</td>
<td>14</td>
<td>21</td>
</tr>
<tr>
<td>50</td>
<td>6</td>
<td>8</td>
</tr>
</tbody>
</table>

This table is revised from Table S3-1, 1994 CDC TB Guidelines & has been adapted from the formula for the rate of purging airborne contaminants presented in reference 1435. + Shaded entries denote frequently cited ACH for patient-care areas. § Values were derived from the formula:

\[
t_2 - t_1 = - \left[ \ln \left( \frac{C_2}{C_1} \right) / \left( \frac{Q}{V} \right) \right] \times 60, \text{ with } t_1 = 0 \text{ and where}
\]

- \( t_1 \) = initial timepoint in minutes
- \( t_2 \) = final timepoint in minutes
- \( C_1 \) = initial concentration of contaminant
- \( C_2 \) = final conc. of contaminant
- \( C_2 / C_1 = 1 - \text{removal efficiency} / 100 \)
- \( Q \) = air flow rate in cubic feet/hour
- \( V \) = room volume in cubic feet
- \( Q / V = ACH \)
Room Leakage Areas

- Airflow leakage occurs around:
  - plumbing connections
  - medical gases
  - electrical/video connection
  - lighting
  - ceilings
  - windows/doors
  - door cracks
  - in wall mounted fixtures
Differential room airflow vs. differential pressure for various room leakage areas. Small changes in differential airflow make drastic pressure differences in a very “tight” room. Source: Landis & Staefa.
Bone Marrow Transplant Unit
Air Pressure Evaluation
1996 & 1997

PASCAL'S
(250 Pa = 1.0" w.g.)
Filters - Variety of Types

- Pleated
- Multi-pocket Bag
- HEPA in ductwork
- Filter frames for filter media

Typical "Furnace Filters"
## Commercial Filter Evaluation Using Outside Air: Fungal CFU

<table>
<thead>
<tr>
<th>Filters</th>
<th>Efficiency</th>
<th>Test Method</th>
<th>% Fungal Particle Efficiency</th>
<th>Total CFU at 37 °C</th>
<th>Aspergillus fumigatis</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Air Filter (AAF)</td>
<td>90 – 95%</td>
<td>dust spot</td>
<td></td>
<td>99.92</td>
<td>--</td>
</tr>
<tr>
<td>Farr Rigi Flow 200</td>
<td>90 – 95%</td>
<td>dust spot</td>
<td></td>
<td>99.6</td>
<td>99.8</td>
</tr>
<tr>
<td>AAF – Biocel</td>
<td>95%</td>
<td>0.3 μ</td>
<td></td>
<td>99.8</td>
<td>100</td>
</tr>
<tr>
<td>Air Guard M-500</td>
<td>95%</td>
<td>0.3 μ</td>
<td></td>
<td>99.99</td>
<td>99.99</td>
</tr>
<tr>
<td>AAF – Magna Media</td>
<td>99.97%</td>
<td>0.3 μ</td>
<td></td>
<td>99.99</td>
<td>99.99</td>
</tr>
<tr>
<td>Astrocel I</td>
<td>99.97%</td>
<td>0.3 μ</td>
<td></td>
<td>99.99</td>
<td>99.99</td>
</tr>
<tr>
<td>Air Guard M-1220</td>
<td>99.97%</td>
<td>0.3 μ</td>
<td></td>
<td>99.99</td>
<td>99.99</td>
</tr>
</tbody>
</table>
## Filter Efficiency and Particle Counts

<table>
<thead>
<tr>
<th>ASHRAE Filter Rating (Estimated Minimum Efficiency Reporting Value, MERV)</th>
<th>ASHRAE Filter Rating (Estimated Dust Spot, % efficiency)</th>
<th>Expected Reduction of Ultrafine Particles (%)</th>
<th>Measured Concentration of Ultrafine Particles pt/cm³</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>No Filter (Ambient)</td>
<td>0</td>
<td>10,000</td>
</tr>
<tr>
<td>N/A</td>
<td>HEPA</td>
<td>100</td>
<td>&lt;1</td>
</tr>
<tr>
<td>15</td>
<td>95</td>
<td>90-93</td>
<td>700-1,000</td>
</tr>
<tr>
<td>14</td>
<td>90-95</td>
<td>85</td>
<td>1500</td>
</tr>
<tr>
<td>11</td>
<td>60</td>
<td>35-40</td>
<td>6,000-6,500</td>
</tr>
<tr>
<td>9</td>
<td>40</td>
<td>20-30</td>
<td>7,000-8,000</td>
</tr>
<tr>
<td>8</td>
<td>&lt;30</td>
<td>10-20</td>
<td>8,000-9,000</td>
</tr>
</tbody>
</table>

**Measured removal efficiency should be within 10% of the expected values.**
Testing For Filter Inefficiency

“in situ” filter testing with condensation particle counter
Causes of “Filtration Failure”

- Gasket seals or failure; missing gaskets
- Duct leakage
- Clogged, damaged, or incorrect filters
- Dust on fan blades
- Fan belt slippage
- Plugged/dirty temperature control coils
- Uncalibrated control equipment
  - Temperature sensors, thermostat, humidity control, receiver controls
- High air velocity
Filter Action Summary

- Filters do not act like sieves
- Single fiber mechanisms
  - Impaction increases with increasing \(d\) or \(U\)
  - Diffusion increases with decreasing \(d\) or \(U\)
  - Interception increases with increasing \(d\)
- Consider particle diameter for minimum efficiency
- Efficiency and resistance increase with loading (to a point)

\[d = \text{diameter of particle}; \ U = \text{face velocity} = \frac{Q}{A}\]
Particle counters tell the rank order
Pressure gauges give air velocity
Balancing hoods verify air exchanges

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

- Pressure management
  - Barrier airflow control
  - > 0.01"wg (>2.5 Pascals)
- Transport
  - Personnel and materials
  - Track dirt
- Water damage protocols
  - Water resistant materials
  - Early detection
- Training
  - Supervisors and workers
  - Area tenants
Control: Dust Containment
Portable Containment
Control – Negative Pressure
Sampler criteria
- high volume
- lab friendly
- culture methods
Unresolved Issues and Microbiologic Air Sampling

- Unknown incubation period for IPA
- Infectious dose for *Aspergillus* spp. is unknown
- Lack of standard sampling protocols
- Variability & sensitivity of sampling devices
- Lack of details re: sampling makes comparison of results with other outbreaks difficult
- Lack of correlation between fungal strains in clinical specimens & those found in the environment
Reasons to Sample Air

• Preoccupancy verification of ventilation & cleanliness
  – establish baseline data (based on particle removal)
  – BMTU, ORs, NICU, other critical areas

• Post infection evaluation (outbreak?)
  – verification of baseline data
  – rule out ventilation as source
  – discover source of infectious fungi (reservoir?)

• Routine surveillance
  – not recommended (CDC)
  – provides assurance of status quo
  – may be useful for finding deviations in baseline data
Definitions

- cfu = colony forming units
- \( m^3 = \) cubic meter of air
- \( 28.3 \) liters = \( 1 ft^3 \)
- \( 35.3 ft^3 = 1.0 m^3 \)
- homogeneous population = majority of isolates same
- heterogeneous population = mixture of isolates
- viable = living organism
- nonviable = not capable of reproducing
- aggressive = sampling while disturbing the environment
- quiescent (passive) = sampling not disturbing environment
- thermotolerant = likes >35C temperature for growth
- room temperature = growth incubation at 25C
Spores collected for identification by light microscopy = difficult to distinguish between Aspergillus & Penicillium species

Culture & microscopic evaluations should be used for clinical area(s) clearance

- Long term sampling (2 liters/min)
- Not size selective
- Drying out; nonviable spore counts
- Many spores not ID’d to genus
- Rank order determination
Baseline Data Development in Healthcare Air Sampling

- Provides verification of filtration efficacy
  - Should show relative drop of viable/non-culture particles
  - Should show > 90% drop of particles for 90% efficient filters
  - Non-cultured particle analysis should use > 0.5 µm particle size

- Provides micro-flora verification in affected space
  - Air is not sterile; should reflect isolates similar to outside
  - Baseline should compare data from indoor space & outdoors

- Baseline data is best established pre-occupancy
  - Ventilation systems should be working according to specs
  - Testing should be finished & specified ventilation parameters assured
  - Ideally sampling should be conducted before occupancy to avoid variables
Interpretation of Data

• **Rank order analysis**
  - Lowest counts in areas with best filtration
  - Comparison necessary with outdoor control

• **Qualitative analysis**
  - Pathogen recovery (Aspergillus)
  - Homogeneous population (v. heterogeneous)

• **Indoor / Outdoor ratio**
  - I/O <1 normal (seasonal considerations)
  - I/O >1 potential problem

• **Temperature selectivity**
  - Pathogens grow best at >35º C
  - Filtration efficacy determined at 25º C
Exposure Variation

Seasonal variation is dependant on the climate and local flora.

Local sources can create high dose-short term exposures.
Indoor variation is dependant on local sources & filtration.

Mold growth caused the I/O ration to be >1.

What did water do under this sink?

FIG. 1. Weekly mean total thermotolerant airborne fungi.
### Example of Air Particle Analysis Using Condensate Particle Counter

<table>
<thead>
<tr>
<th></th>
<th>Particles/cc</th>
<th>Pressure (Pascals)</th>
<th>Filter efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside</td>
<td>8500</td>
<td>na</td>
<td></td>
</tr>
<tr>
<td>Lobby</td>
<td>1500</td>
<td>na</td>
<td>90%</td>
</tr>
<tr>
<td>BMT area corridor</td>
<td>450</td>
<td>(+) 4-10</td>
<td>99.97%</td>
</tr>
<tr>
<td>-21/32 rooms</td>
<td>&lt;10</td>
<td>(+) 6.8-30</td>
<td>99.97%</td>
</tr>
<tr>
<td>-9/32 rooms</td>
<td>10-80</td>
<td>(+) 8.6-17</td>
<td>99.97%</td>
</tr>
<tr>
<td>-2/32 rooms</td>
<td>&gt;500</td>
<td>(+) 11 &amp; 12</td>
<td>99.97%</td>
</tr>
<tr>
<td>Diffusers</td>
<td>0-1</td>
<td>na</td>
<td>99.97%</td>
</tr>
<tr>
<td>Radiation therapy</td>
<td>1000</td>
<td>na</td>
<td>90%</td>
</tr>
<tr>
<td>Adjacent bldg.</td>
<td>5300</td>
<td>na</td>
<td>50%</td>
</tr>
</tbody>
</table>

### Demonstrates rank order and pressure
Summary: Measurements

- **Airborne particles**
  - filter efficacy: compare with other areas & outside
  - activity factor around construction
  - beware of internal nuisance sources of particles

- **Pressures**
  - provides airflow intensity for clean to dirty airflow
  - pressure is a measure of air velocity
    - 0.001"wg = 100 linear ft/min
    - 0.01" wg = 400 lfm
    - 0.1" wg = 1300 lfm

- **Air exchanges**
  - purge rate with clean air
  - air changes correlate with % particle reduction
  - 12 ACH = 99.9% reduction in 35 minutes
  - how long to wait to remove contagious particles?
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
Damage Due to Water Intrusion

- Management of wet, porous building materials, furniture, carpeting:
  - Remove porous building materials and replace if they cannot dry out within 72 hours (I.e., > 20% moisture as measured by moisture meter)
  - Wet down carpeting with a low-level disinfectant prior to removal; allow supporting structure underneath to dry out; replace tiles or carpeting
  - Wood furniture removed for drying, sanding as needed and re-varnishing; replace cloth furnishings
Construction-Related Roof Leak

Construction schedules: difficult to coordinate
Roofer behind schedule while sheetrock ahead

Water damage requires immediate response
What is the difference in these shaft walls?
- Luck?
- Better materials?
- Construction mgmt?
- All of the above?
Moisture Meter
- decision maker
- find the wetness
- drying time
- <72 hrs
IR Thermometer Can Detect Wetness

Warm surface

Cool surface
Temporary Drying Unit
Leaking Roof Water Damage Area

Water Migrated to Various Locations

Water Accumulated in the Floor Rail
Worker with Respiratory Protection and Protective Clothing

Worker Protection for Cleaning Wall Cavity

HEPA Vacuuming
## Water Damaged Patient Care Unit
### Horizontal Surface Contact Sampling

<table>
<thead>
<tr>
<th>Date</th>
<th>No. plates</th>
<th>Total fungi</th>
<th>A. Fumigatus</th>
</tr>
</thead>
<tbody>
<tr>
<td>09/15/94</td>
<td>8</td>
<td>&gt;265</td>
<td>155</td>
</tr>
<tr>
<td>09/27/94</td>
<td>8</td>
<td>65</td>
<td>5</td>
</tr>
<tr>
<td>10/09/94</td>
<td>8</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>11/04/94</td>
<td>4</td>
<td>27</td>
<td>1.5</td>
</tr>
<tr>
<td>11/18/94</td>
<td>4</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>12/07/94</td>
<td>4</td>
<td>&lt;1</td>
<td>0</td>
</tr>
<tr>
<td>12/08/94</td>
<td>6</td>
<td>1.3</td>
<td>0</td>
</tr>
<tr>
<td>12/14/94</td>
<td>7</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>12/15/94</td>
<td>7</td>
<td>1.2</td>
<td>0</td>
</tr>
<tr>
<td>12/20/94</td>
<td>6</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>12/22/94</td>
<td>7</td>
<td>1.3</td>
<td>0</td>
</tr>
</tbody>
</table>
Sheetrock & insulation wick up water

Find the water with a detector

Barrier up within 36 hrs
If you can't dry it
--> cut it out!!

Or keep the rock
off the slab!
Condensation and Other Moisture Sources

• **Source of moisture**
  - Internal or external

• **Internal source**
  - Leaks in plumbing
  - Stagnant water
  - Water features
  - Excess humidification chill water capacity

• **External source**
  - Windows, flashing
  - Landscaping
  - Depressurized building
Steel Girders Attract Condensation

Sheet Rock Gives the Asbestos Team a Workout

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Water Intrusion Algorithms

Furniture/Casework
- Categorize the type of water damage.
  - Clean water, e.g., potable sources
  - Steam
  - Uncontaminated, particulate-free water, doesn’t damage furniture or cabinets
  - Clean appropriately & monitor
  - Remove & discard under controlled conditions if water is dry

Carpet
- Categorize the type of water damage.
  - Clean water, e.g., potable sources
  - Steam
  - Uncontaminated, particulate-free water, doesn’t damage carpet
  - Remove & discard under controlled conditions if water is dry

Ceiling Tile
- Clean water, e.g., potable sources
  - Steam
  - Uncontaminated, particulate-free water, doesn’t damage ceiling
  - Remove & discard under controlled conditions if water is dry

Electrical
- Check by building inspector/electrician
  - Turn power off
  - Discard electrical circuit breakers, GFCI, fuses
  - Switches, outlets, electrical motors, lights fixtures can be opened & inspected for moisture & reused

Paper/Files
- Categorize the type of water damage.
  - Clean water, e.g., potable sources
  - Steam
  - Uncontaminated water (no contaminants
  - Place in frost-free & freeze

Sheetrock
- Categorize the type of water damage.
  - Clean water, e.g., potable sources
  - Steam
  - Uncontaminated water (no contaminants
  - Conduct testing to determine & eliminating contamination from sheet
Control - Waterborne

- Design - potable water; cooling towers
- Maintenance
- Temperature >140° F?
- Treatment of water
  - Municipal source
  - In-hospital treatment
- Source recognition
  - Water reservoirs
  - Dead-legs & dormant
- Flushing pre-occupancy
Waterborne [Legionella] Transmission Steps

1. Survival in Reservoir
   Temp, pH, Nutrients, Microbial Associations

2. Amplification
   Microbial Associations
   Nutrients
   Biocides
   System Cleanliness

3. Dissemination
   (Aerosolization)

4. Transmission
   Humidity
   Droplet Size
   Distance

5. Susceptible Host
   Age, Disease, Immunodeficiency

6. Multiply in Human
   Virulence

7. Diagnosis
   Symptoms, Lab Tests, Surveillance

Risk Minimization (Prevention)

Adapted from Barbaree
ASHRAE 12-2000
Potable Water Treatment

- **Active disinfectant**
  - Chlorine Dioxide
  - Copper-Silver
  - Chloramine
  - Chlorine

- **Point of use**
  - Ultra Violet
  - Ozone
  - High Temperature

![Optimal temperature range for growth of Legionella (20°C - 50°C)](image-url)
Cooling Towers and Evaporative Condensers

- Locate cooling towers so that the drift is directed away from the air-intake system
- Design the towers to minimize the volume of aerosol drift
- Implement IC procedures for operational cooling towers
  - Drift eliminators, biocide, maintenance, decontamination
Control - Surfaces

- Responsibilities
  - Owner removes sharps, RMW, equipment, reservoirs
  - Protection for non-movable?
- Design choices
- Cleaning vs. disinfection
  - EPA approved?
  - Spills vs. routine
  - Compatible with surface
- Chemical/physical hazards
  - safety & risk hats
Swab samples
- not quantitative
- species ID for clearance

Surface samples can be used to determine if surfaces are clean or if organisms on the surfaces can be found in the air.
Surface contact media plates
• culture of surface
• test for cleaning
• potential surface/air connection

• demonstrates surface contamination
• APHA <25 cfu/plate satisfactory
• use rank order, qualitative and quantitative analysis
Considerations Surface Sampling

- Background - literature & present activities
  - e.g., preliminary results from epidemiological investigation
- Locations to sample?
- Collection method & equipment?
- Number of replicate samples needed?
- What controls or comparisons are required?
- Parameters for assay method & whether sampling = qualitative, quantitative, or both?
- Estimate of maximum allowable microbial numbers or types on surface[s] sampled?
- Some anticipation of a corrective action plan?
# Methods of Surface Sampling

**Table 25. Methods of environmental-surface sampling**

<table>
<thead>
<tr>
<th>Method</th>
<th>Suitable for appropriate surface(s)</th>
<th>Assay technique</th>
<th>Procedural notes</th>
<th>Points of interpretation</th>
<th>Available standards</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample/rinse Moistened swab/rinse</td>
<td>Non-absorbent surfaces, corners, crevices, devices, and instruments</td>
<td>Dilutions; qualitative or quantitative assays</td>
<td>Assay multiple measures areas or devices with separate swabs</td>
<td>Report results per measured areas or if assaying an object, per the entire sample site</td>
<td>YES – food industry; NO – healthcare</td>
<td>1214, 1239-1242</td>
</tr>
<tr>
<td>Moistened sponge/rinse</td>
<td>Large areas and housekeeping surfaces (e.g., floors or walls)</td>
<td>Dilutions; qualitative or quantitative assays</td>
<td>Vigorously rub a sterile sponge over the surface</td>
<td>Report results per measured area</td>
<td>YES – food industry; NO – healthcare</td>
<td>1214, 1239-1242</td>
</tr>
<tr>
<td>Moistened wipe/rinse</td>
<td>Large areas and housekeeping surfaces (e.g., countertops)</td>
<td>Dilutions; qualitative or quantitative assays</td>
<td>Use a sterile wipe</td>
<td>Report results per measured area</td>
<td>YES – food industry; NO – healthcare</td>
<td>1214, 1239-1242</td>
</tr>
<tr>
<td>Direct immersion</td>
<td>Small items capable of being immersed</td>
<td>Dilutions; qualitative or quantitative assays</td>
<td>Use membrane filtration if rinse volume is large and anticipated microbiological concentration is low</td>
<td>Report results per item</td>
<td>NO</td>
<td>1214</td>
</tr>
<tr>
<td>Containment</td>
<td>Interior surfaces of containers, tubes, or bottles</td>
<td>Dilutions; qualitative or quantitative assays</td>
<td>Use membrane filtration if rinse volume is large</td>
<td>Evaluate both the types and numbers of microorganisms</td>
<td>YES – food and industrial applications for containers prior to fill</td>
<td>1214</td>
</tr>
<tr>
<td>RODAC*</td>
<td>Previously cleaned and sanitized flat, non-absorbent surfaces; not suitable for irregular surfaces</td>
<td>Direct assay</td>
<td>Overgrowth occurs if used on heavily contaminated surfaces, use neutralizers in the agar if surface disinfectant residuals are present</td>
<td>Provides direct, quantitative results; use a minimum of 15 plates per an average hospital room</td>
<td>NO</td>
<td>1214, 1237, 1259, 1243, 1244</td>
</tr>
</tbody>
</table>

* RODAC stands for “replicate organism direct agar contact.”

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**from CDC/HICPAC Guidelines Environmental IC**

AIHce 2004 - Streifel & Wideman
Specify Duct Cleanliness

  - A. Basic Level
  - B. Intermediate Level
  - C. Advanced Level
- Specify in contract

www.smacna.org

Photo courtesy of Rob Case, RCCS
Protection of HVAC ductwork in new installation

Photo courtesy of Rob Case, RCCS
Environmental Surveillance

- **Microbes**
  - Air, water, surfaces

- **Ventilation parameters**
  - Air exchanges
  - Pressure
  - Filtration

- **Construction & maintenance practice**
  - Intrusion recognition
  - Water response plan
  - Mold recognition & clean-up
  - Construction management
  - Emergency response
Caution:
Noise and vibration

Can cause distress for some patients/settings: premature neonates, heart attack, stroke, psychiatric, & pediatrics
APIC State-of-the-Art Report: The role of
infection control during construction in
health care facilities

Judene Mueller Bartley, MS, MPH, CIC

The Association for Professionals in Infection Control and Epidemiology, Inc. (APIC), is a multi-disciplinary organization of more than 12,000 healthcare professionals who practice infection control and epidemiology within a variety of healthcare settings.

This report addresses the infection control professional should consider related to construction and renovation projects in healthcare facilities. Preventing transmission of infectious agents to vulnerable patient populations, healthcare workers, and visitors remains an important component of infection control programs. Environmental disasters of microorganisms during construction, resulting in nosocomial infections, has been described by several researchers. This report will serve as a reminder that there is a solid, scientific basis for these concerns. Environmental airborne transmission of infectious agents is not only a concern, but contamination from dust and moisture-related conditions also figure prominently in construction activity. Weems et al have established construction activity as an independent variable for infections risks in such circumstances. Construction-related outbreaks literature will not be revisited in detail; however, pertinent citations will identify resources as appropriate. (AJIC Am J Infec Control 2000;28:156-69)
In Summary

• Understanding of concerns and controls assists the IH professional in working within our evolving healthcare industry
• Infection Control practice aligned with Industrial Hygiene
• Get to know the Infection Control Professional (ICP) in addition to other healthcare professionals
Were Objectives Met?

1. Provide at least one example of an infectious microbe spread by each major route.

2. List at least two instruments that may be used to evaluate parameters during construction and renovation projects in the HC environment.

3. Identify at least one method to reduce risk of infectious spread by each route.
Questions?

THANK YOU!

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