Infection Preventionists Role With Environmental Microbial Hazards

Greater Omaha APIC Conference

August 9, 2019

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Objectives

1. Identify opportunities for Infection Preventionists to consult with Industrial Hygienists based upon the infection control risk assessment findings.

2. Examine interventions that can be implemented into the infection control plan to mitigate environmental hazards.

No conflict of interest to disclose

What’s all the concern about with construction?

Architects and engineers may not understand the workflow of the areas they are designing

Many healthcare executives may not understand the importance of Infection Preventionists in the realm of space design and construction

Many Infection Preventionists are uncomfortable with their role in construction and view their input as minor

The truth of the matter…

HEALTH

F.D.A. Details Contamination at Pharmacy

By SABRINA TAVERNISE and ANDREW POLLACK OCT. 26, 2012

204

RELATED COVERAGE

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CBS NEWS

NEWS SHOWS LIVE

Seattle Children's Hospital mold infections leave one dead, force closure of most operating rooms

Contaminants introduced into the healthcare environment

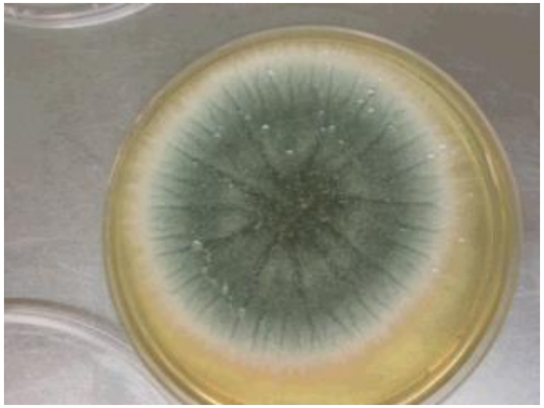
- During construction or renovation
  - Materials exposed to weather elements
  - Dust, debris containing mold are released if the ICRA plan is poorly executed

    i.e. above ceiling work, wall demo, removal of millwork
- Through openings in the building envelope (doors, windows, openings) or building pressurization
- Through the HVAC system
- Through moisture intrusion (flooding, high humidity)
- Through the water distribution system
- Excavation adjacent to air intake of occupied facilities

Environmental Contaminants

Mold is ubiquitous and usually found in spore form

- If conditions are favorable, spores will germinate and form reservoirs



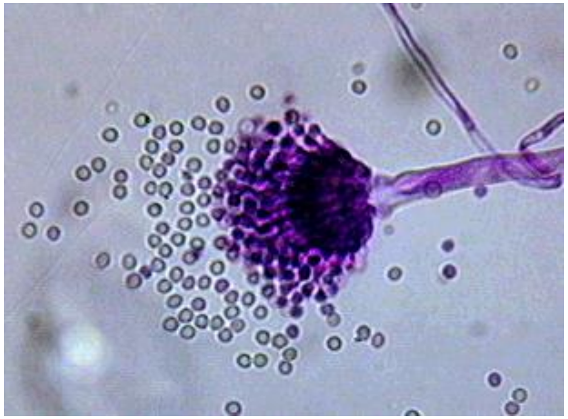
Minimum requirements for mold growth

- Moisture (humidity, flood)
- Temperature
- nutrients

Construction Related Pathogens

- Aspergillus, Fusarium, Mold, Mucor, Penicillium, Rhizomucor, Rhizopus , Stachybotrys
- Cause superficial, locally invasive, and disseminated infections

Aspergillus species



Found in nature

Found in plaster, sheetrock and dust

Grows in damp materials/settings

Can cause illness or even death in some “at risk” individuals

- Infants
- Elderly
- Immunocompromised

Invasive disease

- Spreads rapidly to brain, heart, bone, kidney or skin
- Invasive pulmonary aspergillosis occurs only in people with diseases affecting the immune system (cancer, BMT)
- May be fatal

Roles and Responsibilities

Industrial Hygienist

- Provide consultation, technical advice
- Respond to inquiries about occupational and environmental health exposure issues
- Provide training and technical support
- Serve as subject matter experts
- Provide guidance
- Does not replace the IPs role

Infection Preventionist

- Acquire knowledge – Learn the construction language
- Educate, Raise awareness - Start with executives (buy-in), hospital staff, contractors
- Collaborate – ICRA team members
- Communicate – speak up, do not feel intimidated
- Guide – provide expertise
- Oversight – ensure all procedures and protocols are followed
- Inspect and verify – prior, during, and after construction

When do Infection Preventionists consult Industrial Hygienists?

Environmental assessment & opportunities

- Construction rounds
- Moisture intrusion events
- Project in high risk settings and population

What monitoring tools are available to you?

- Particle testing
- Air sampling
- Moisture sensor – drywall

Level of experience

Available expert guidance

CDC Environmental Infection Control Guidelines (Last update: April 2019)

Particulate sampling –
- Commonly used to compare indoor (clean) to outdoor (dirty) air
- Absence of air quality and action level standards

Air Sampling –
- Controversial due to unresolved technical limitations and need for substantial lab support
- Lack of standards linking fungal spore levels with infection rates (no safe level of exposure)

No recommendation is offered on routine microbiologic air sampling before, during, or after construction or before or during occupancy of areas housing immunocompromised patients. (Unresolved Issue)

Investigators have suggested the following limits for aspergillosis outbreaks:
- 15 CFU/m^3 for gross colony count of fungal organisms
- <0.1 CFU/m^3 for *Aspergillus fumigatus* and other opportunistic fungi for HEPA filtered areas

Assessing Indoor Air Quality

Particulate Sampling

Hand held laser particulate counter

- Instrument calibrated in accordance with ISO requirements

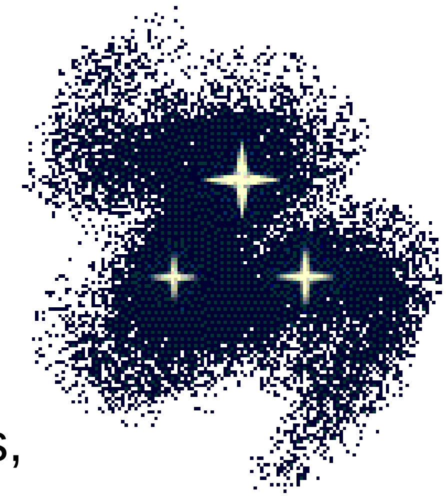
Air Sampling

Quantitative fungal air cultures

- Andersen single stage N6
- Sabourauds Dextrose agar used for fungal cultures

Air Particulate Sampling

Air Particles



- Large dust particles travel in straight lines
- Small spore particles travel on air currents
  - Spores can stay suspended minutes/hour
  - Settling rates vary based upon air movements, air exchange rates, and source strengths
- Particles
  - Collide with gas molecules & deflect
  - Fibers can grab particles by electric charge
- Air takes the route of least resistance
- Construction dust associated with 5.0 to 10.0 micron size particles

Air Particulate Testing

Determined by high risk population near project, large project scope or the project is occurring within a patient unit.

- Measure baseline particles before project starts–
  - outside (comparative high particle count)
  - construction site (comparative high particle count)
  - occupied spaces adjacent to barriers (lower counts)
- Establish the 'norm' prior to construction activity
- Measure routinely during project to validate dust mitigation
  - Identifies a change in the project or integrity of barriers

ICRA Compliance

ICRA Complinace

Air Sampling
Microbial Commissioning

Nebraska Medicine

Fred & Pamela Buffett Cancer Center
Grand Opening May, 2017

Patient Care Services –

- 36 bed Hematopoietic Stem Cell Transplant Unit
- 12 bed Intensive Care Unit
- 24 bed Progressive Care Unit
- 36 bed Medical-Surgical Unit
- Airborne isolation rooms

Surgical Suites

Infusion Center

Outpatient Clinic – procedural areas

Pharmacy – compounding area

All Ancillary Support Services

Clean Room Standards

ISO 14644-1: 2015 Cleanroom Standard - International Standards Organization (ISO)

- Most used standard in Pharma and Electronics controlled environment

USP 797 - Pharmaceutical cleanroom classification for compounding sterile preparations

FS209E - U.S. Federal Standard 209 E

- U.S. General Services Administration (GSA) retired the standard in 2001, superseded by ISO 14644, but it is still widely accepted

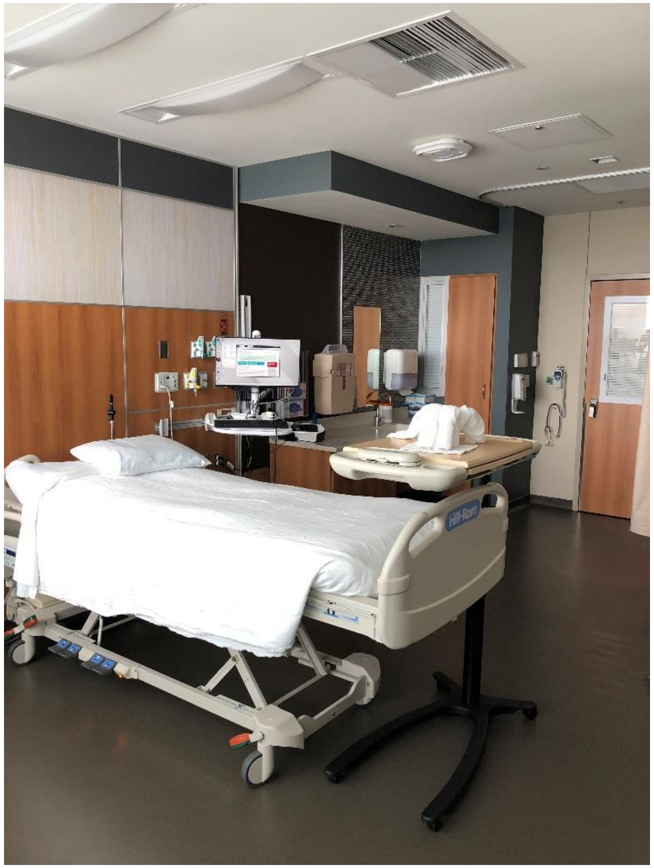
Features of a Clean Room

- Provide a secure environment with controlled air filtration lowering the contamination risks
- Maintain particulate-free air through the use of HEPA air filtration
- Classified according to the number and size of particles permitted per volume of air in a specified amount of time
- Design of air distribution system includes the downstream air return
  – Air flow is unidirectional
  – <u>Vertical flow rooms</u> – use of low wall air returns around the perimeter of the zone
  – <u>Horizontal flow rooms</u> – the use of air returns at the downstream boundary of the air flow process

Air Distribution and Directional Flow

Vertical Flow: Surgery Suite

Patient Room



Clean Room Classifications

- Cleanrooms are classified according to the number and size of non-viable particles permitted per volume of air
- Classifications use **non-viable** particle measurements
  – Rationale: The fewer particulates present in a clean room the less likely it is that airborne microorganisms will be present
- ISO 14644-1 requires specific particle counts to classify the cleanroom
  – Sampling plans use several randomized locations allowing for different particle concentration levels in different parts of the cleanroom
  – 5.0 micron size particles are allowable for ISO class 6-9 only

Class	Maximum particles/m³ [a]						FED STD 209E equivalent
	≥0.1 µm	≥0.2 µm	≥0.3 µm	≥0.5 µm	≥1 µm	≥5 µm	
ISO 1	10[b]	[d]	[d]	[d]	[d]	[e]	
ISO 2	100	24[b]	10[b]	[d]	[d]	[e]	
ISO 3	1,000	237	102	35[b]	[d]	[e]	Class 1
ISO 4	10,000	2,370	1,020	352	83[b]	[e]	Class 10
ISO 5	100,000	23,700	10,200	3,520	832	[d,e,f]	Class 100
ISO 6	1,000,000	237,000	102,000	35,200	8,320	293	Class 1,000
ISO 7	[c]	[c]	[c]	352,000	83,200	2,930	Class 10,000
ISO 8	[c]	[c]	[c]	3,520,000	832,000	29,300	Class 100,000
ISO 9	[c]	[c]	[c]	35,200,000	8,320,000	293,000	Room air

[a] All concentrations in the table are cumulative, e.g. for ISO Class 5, the 10 200 particles shown at 0,3 µm include all particles equal to and greater than this size.

[b] These concentrations will lead to large air sample volumes for classification. Sequential sampling procedure may be applied; see Annex D.

[c] Concentration limits are not applicable in this region of the table due to very high particle concentration.

[d] Sampling and statistical limitations for particles in low concentrations make classification inappropriate.

[e] Sample collection limitations for both particles in low concentrations and sizes greater than 1 µm make classification at this particle size inappropriate, due to potential particle losses in the sampling system.

[f] In order to specify this particle size in association with ISO Class 5, the macroparticle descriptor M may be adapted and used in conjunction with at least one other particle size. (See C.7.)

Table accessed on June 11, 2018 https://en.wikipedia.org/wiki/Cleanroom

ISO Classifications & settings

ISO 1 = Cleanest room possible

(nanotechnology)

ISO 5 = Critical area in immediate proximity of exposed sterilized containers (USP 797)

ISO 6-8 considered cleanrooms

ISO 7 = Area immediately adjacent to the aseptic processing line under dynamic conditions (USP 797)

ISO 8 = Supporting area or clean room area used as an ante room for PPE donning (USP 797)

ISO 9 = Ordinary room air

Viable Particulates – Microbial Air Sampling

USP 797 requirements

- All viable air sampling must be volumetric by impaction on a media plate
- Settle plates are not permitted
- Multiple locations are required for air sampling
- Recommend sampling around contamination-prone areas

Viable colony counts that are considered elevated or actionable are as follows:

- ISO Class 5 = Active airborne >1 CFU/m^3
- ISO Class 7 = Active airborne >10 CFU/m^3
- ISO Class 8 = Active airborne >100 CFU/m^3

ISO Classifications applied to non-traditional clean rooms in hospitals

Gormley, T., et al. (2017). Methodology for analyzing environmental quality indicators in a dynamic operating room environment. AJIC. 45, 354-359.

- Adapted ISO standards to compare 3 ORs in 2 states as no building code standards exist related to air particles and air sampling
- Clean space assessment using air particle, air sampling and ISO standards
- ORs were equivalent to ISO Class 7 and 8

Holy & Matouskova (2012). The importance of clean rooms for the treatment of haemoto-oncological patients. Contemporary Oncology. 16(3), 266-272.

- Discusses the application of FS209E (ISO class) standards to clean rooms for the care of haemoto-oncological patients

Environmental Readiness for Air Sampling

- All surfaces in patient care areas terminally clean by Environmental Services (3 separate times)
  - All areas thoroughly clean and dust-free
- Minimum number of boxes
- No outside shipping boxes in patient care areas
- Activity restricted for 24 hours in all areas planned for air cultures
- HVAC operating at normal capacity (not on setback mode) continuously for at least 24 hours after final clean and prior to collecting air cultures

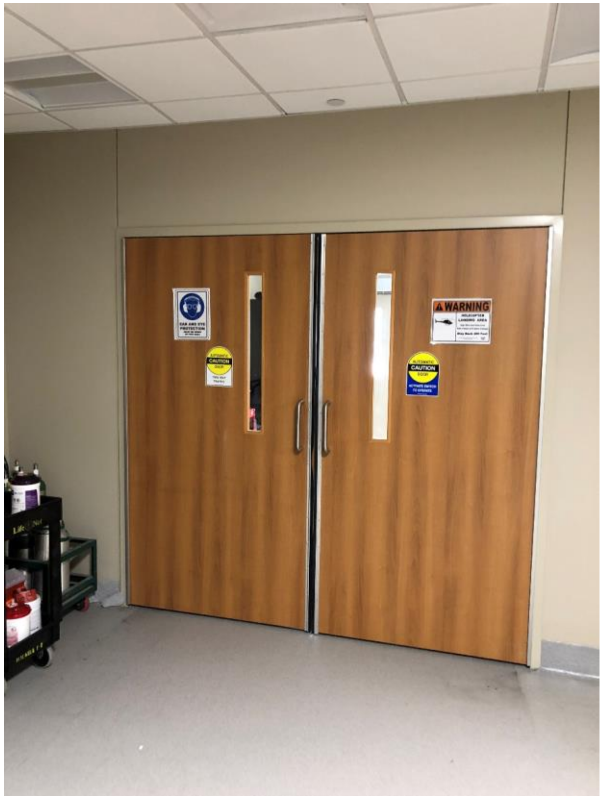
Initial Particle Counts & Cultures

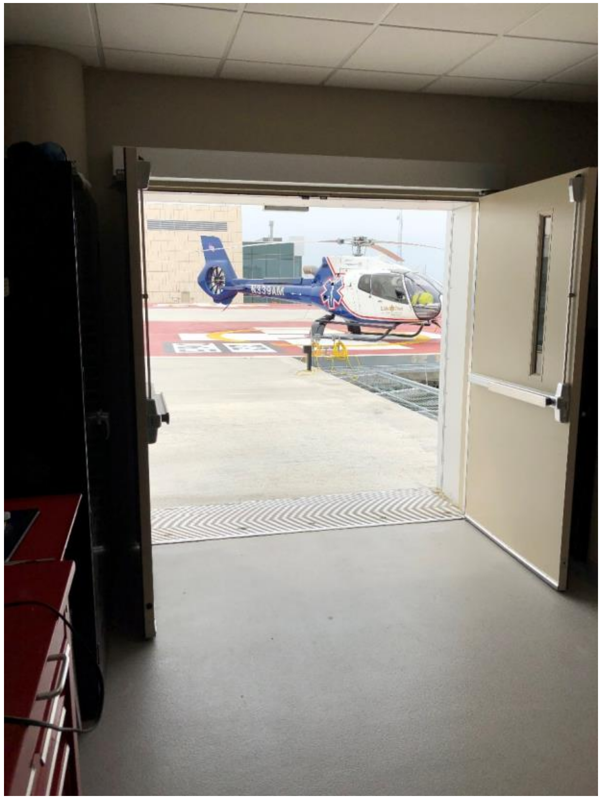
Location	Particle count (5 micron)	Culture (cfu/m^3)
Outdoor	918	ND
East Elevator (3 floors)	240- 2120	23-28
Center Elevator (3 floors)	252- 2360	51-65
6th floor room (5 rms)	30- 1175	0-2
7th floor (5 rms)	40-866	0- 17
7th floor hallway	1670	17

Remediation

Problem: Helicopter port and particle entry into building

Solution: vestibule doors

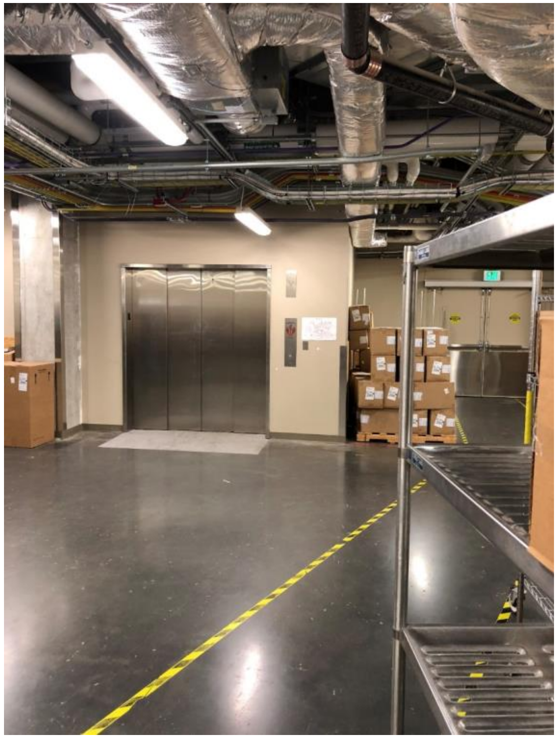




Remediation

Problem:
Loading dock
and particle entry

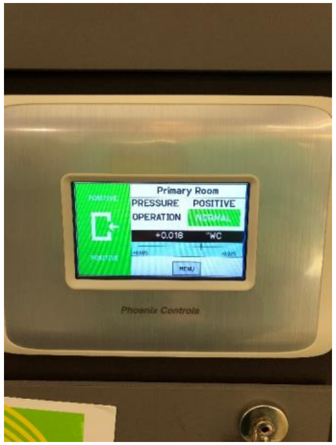
Solution: Confirm loading dock procedures and air curtain check



Remediation

Air pressure determination

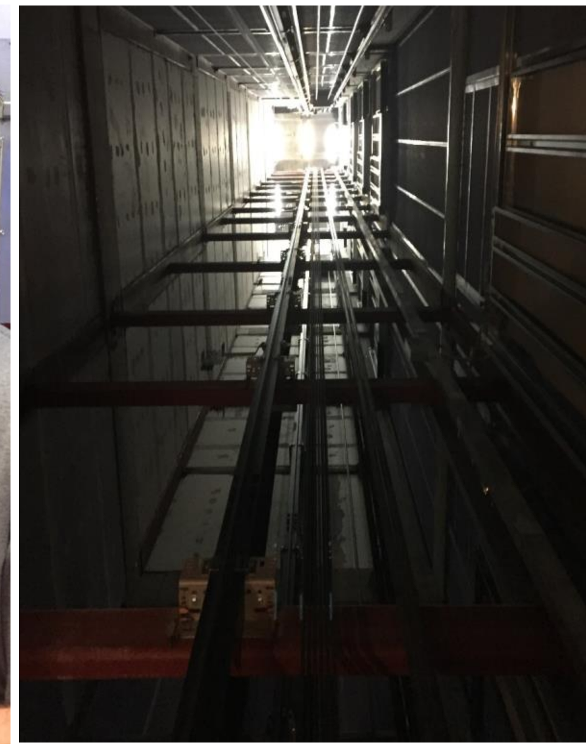
Positive flow out of patient care areas



Remediation

Problem: Elevator shafts

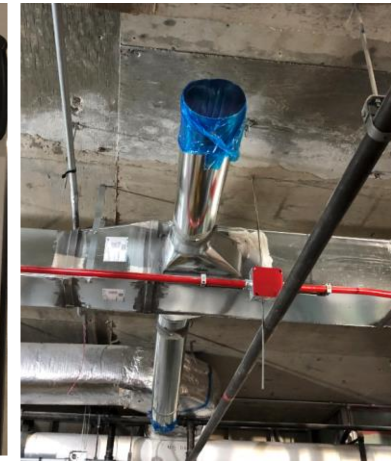
- Thoroughly cleaned with vacuum and moist towels x 2
- Roof hatch checked and weather tight
- Desperate times call for desperate measures – irradiated the problematic shaft



Remediation

Other actions:

- Thorough “terminal” cleaning
- Checked all air filters, duct work, and air handling equipment
- Sweeps added to stairwell doors, patient doors, nurse server gasket
- Stairwell fan coils inspected and cleaned
- Ceiling sealed, plenum pressurized



Location	CFU/m^3	Final 5.0 µm Particle Count (outdoor 2270)	Final ISO Classification
8th Floor – Med-Surg			
Patient Room	---	Not Applicable	
Corridor	---	120-380	ISO Class 7
Elevator Vestibule	---	820-1290	ISO Class 7
7th Floor - OHSCU			
Patient Room (5)	0-1.7	70-273	ISO Class 6
Corridor (Elevator)	0-5.3	70-130	ISO Class 6
Elevator Vestibule	12.3-26.5	1158-1170	ISO Class 7
6th Floor – ICU/Prog. CU			
Patient Room (2)	0	130-808	ISO Class 7
Corridor (Elevator)	35.3	123-380	ISO Class 7
Elevator Vestibule	19.4-35.3	1180-1596	ISO Class 7
2nd Floor			
Surgery	0-1.7	10-60	ISO Class 6
Pharmacy Comp.	0	10	ISO Class 6
Infusion Ctr – Procedure	8.8	10	ISO Class 6

Can air particles replace microbial air sampling?

Landrin, A., Bissery, A., & Kac, G. (2005). Monitoring air sampling in operating theatres: Can particle counting replace microbiological sampling? Journal of Hospital Infection 61, 27-29.

- Methods of microbiological and particle counting did not correlate (p=0.06)
- No particle count value could be predictive of microbiological count higher than 5 CFU/m^3

Cristina, M.L., et al. (2012). Can particulate air sampling predict microbial load in operating theatres for arthroplasty? PLOS One, 7(12), e52809.

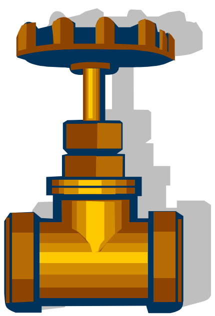
- No statistical significant correlation between microbial loads and particle counts for ≥0.5μm and >5.0μm particle size.
- Microbiological monitoring remains the most suitable method of evaluating air quality in operating rooms

Conclusions

- The correlation between air particle counts and microbial air sampling has yet to be established, therefore particle monitoring can not replace microbial monitoring
- The method recommended to measure hygienic air quality is the combination of air particle counts and microbial air sampling
- Applying ISO clean room standards to non-traditional clean room settings in a hospital is emerging in the literature

Water, Moisture, External Environment

Disease Transmission Associated with Potable Water Systems



- Disruption of water utility systems during construction or renovation can disrupt biofilm present in water delivery pipes
- Poses a threat to patients, including those far away from an active construction zone.
- Dead end pipes allow water to stagnate where microbes can grow to very high concentrations.

Potable Waterborne Pathogens

ORGANISM	SITE OF INFECTION	SOURCES OF INFECTION
Pseudomonas aeruginosa	Blood, catheter insertion site, lungs, urinary tract	Potable water, contaminated liquid solutions and disinfec-tants, endoscopes
Stenotrophomonas maltophilia	Blood (septicemia), pneumonia, urinary tract, wound infections skin, stools, throat, trachea, urine	Potable water, distilled water, contaminated liquid solutions and disinfectants
Acinetobacter baumannii	Skin, wound	Room humidifiers, distilled water, moisture in mechanical ventilators
Chryseobacterium spp.	Blood	Potable water (burn unit), ice machine
Non-tuberculous *Mycobac-teria* (NTM) species (avium and fortuitum)	Abscesses and wound infec-tions, disseminated	Hospital hot water system, shower
Legionella pneumophila (other species rarely cause disease)	Lung (pneumonia), sternal wound infection	Hospital hot water system
Aspergillus species and *Fusarium* species	Wound infection, disseminated disease	Hospital water system

Moisture Intrusion & Remediation

- Investigate and evaluate moisture & mold problems
  - Assess size of moldy area, consider hidden mold, repair small mold problems before they become large problems
- Communicate with building occupants at all stages of process; Plan Remediation
  - Dry wet, non-moldy materials within 48 hours to prevent mold growth; remove if drying delayed
  - Select clean-up methods for moldy items; discard moldy porous items that can't be cleaned
  - Use PPE, containment, negative air
  - Implement repair plan

External Excavation Precautions

- Excavation produces an enormous amount of dust
- Ideally conducted off-hours
  - Reduced traffic, opening of doors, restrict entrances
  - Reduces the amount of non-filtered air entering the building
- Protect air handler intake
- Moisten excavated soil
- Protect materials delivered for later use (shrink wrap)
- Address health issues of patients & employees
  - Face masks, tissues, hand sanitizer at entrances

Summary

- Environmental microorganisms can cause human disease
- Construction ICRA plan is critical in mitigating contaminants and microbial transmission risks
- Infection Preventionists and Industrial Hygienists play a role in protecting patients and employees from environmental hazards
- Infection Preventionists have variable experiences and expertise with environmental hygiene
- Partner with an Industrial Hygienist

Questions

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