

Environment of Care

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DISCLOSURES

2023

- **Consultations**
 - PDI (Professional Disposables International)
- **Honoraria**
 - PDI
- **Other**
 - Kinnos, Ideate Medical

Environment of Care

- CBIC-14 questions. Will test knowledge of the following:
 - Environmental Safety
 - ◆ Recognize and collaborate on process for a safe care environment: HVAC, water pathogen, laundry, waste management, environmental cleaning/disinfect
 - ◆ Collaborate on evaluation/monitoring of environmental CD practices
 - ◆ Monitor for environmental pathogens (e.g., *Legionella*, *Aspergillus*)
 - Recognize and monitor elements for safe care environment
 - ◆ Evaluate infection risks and make recommendations during planning, design, and phases of construction
 - ◆ Risk mitigation during construction, renovation and maintenance (pressure, barriers)

Environment of Care

Monitor Elements for Safe Care Environment

- HVAC (pressure)
- Airborne fungal outbreaks
- Construction and renovation
- Water as a source of pathogens
- *Legionella* and *Aspergillus*
- Environmental cleaning and disinfection (CD)
- Laundry
- Regulated waste

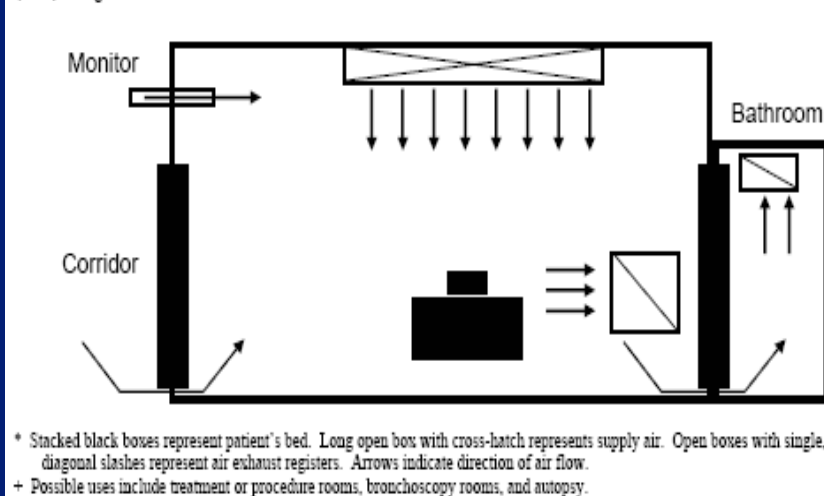


Differential Pressure

- Differential pressure between two rooms prevents pathogens from entering or exiting one room and going into the other
 - Positive pressure-keeps contaminants/pathogens out. Created by pumping more air into a room (250 CFM) than exhausting (200 CFM)
 - Negative pressure-keeps contamination/pathogens from escaping. Created by exhausting air out of the room at a higher rate (250 CFM) than supply air (200 CFM)

Environmental Infection Control for Special Health Care Settings

Figure 3. Example of negative-pressure room control for airborne infection isolation (AII)* + §¶

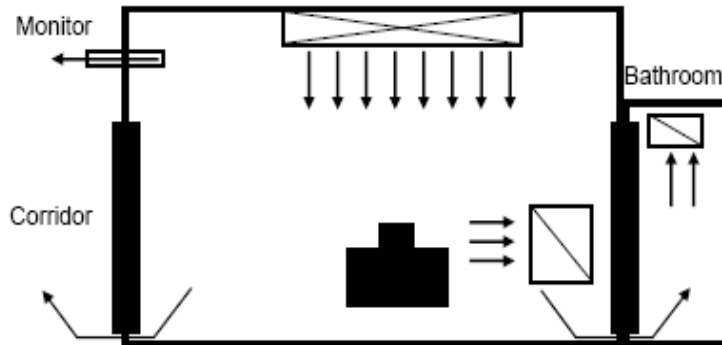


SPECIAL HEALTHCARE SETTINGS (Airborne Infection Isolation-AII)

- Planning new or renovating AII units
 - **Directed airflow:** exhaust air to the outside, away from air-intake and populated areas (IC)
 - **Well-sealed room** (IB)
 - **Room-air pressure:** Maintain continuous negative room with respect to corridor; monitor air pressure periodically (IB).; install self-closing doors (IC)
 - **Room-air changes:** Maintain at ≥ 12 per hour (IB)

Environmental Infection Control for Special Health Care Settings

Figure 2. Example of positive-pressure room control for protection from airborne environmental microbes (PE)* + §



* Stacked black boxes represent patient's bed. Long open box with cross-hatch represents supply air. Open boxes with single, diagonal slashes represent air exhaust registers. Arrows indicate directions of air flow.

+ Possible uses include immunocompromised patient rooms (e.g., hematopoietic stem cell transplant or solid organ transplant procedure rooms) and orthopedic operating rooms.

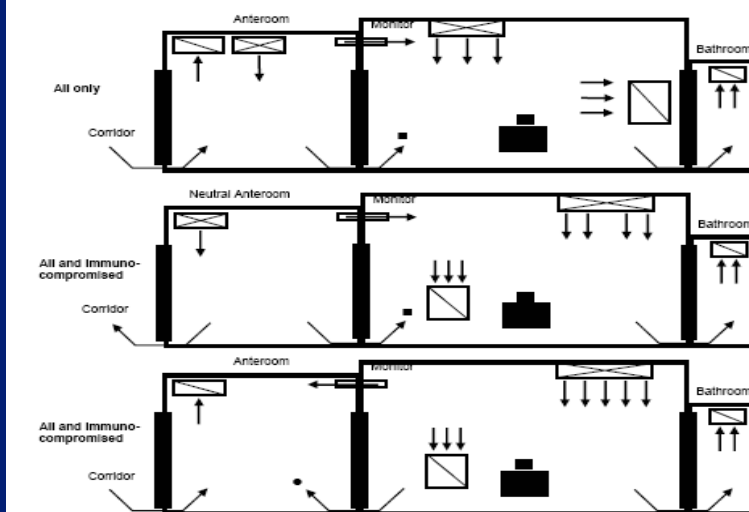
SPECIAL HEALTHCARE SETTINGS

High Risk Patients (PE, Solid Organ Transplants, Neutropenic)

- Planning new units for high-risk patients
 - **Air-filtration:** Install HEPA filters (99.97% efficient in filtering 0.3 μ -sized particles) either centrally or point of use (IB)
 - **Directed airflow:** Place air-intake and exhaust ports so that room air flows across patient's bed and exits on opposite side of the room (IC)
 - **Well-sealed room** (IB)
 - **Room-air pressure:** Maintain room at positive pressure with respect to corridor (IB)
 - **Room-air changes:** Maintain at ≥ 12 per hour (IC)

Environmental Infection Control for Special Health Care Settings

Figure 4. Example of airborne infection isolation (AII) room with anteroom and neutral anteroom* + §



* The top diagram indicates air flow patterns when patient with only airborne infectious disease occupies room. Middle and bottom diagrams indicate recommended air flow patterns when room is occupied by immunocompromised patient with airborne infectious disease. Stacked black boxes represent patient beds. Long open boxes with cross-hatches represent supply air. Open boxes with single, diagonal slashes represent air exhaust registers. Arrows indicate directions of air flow.





Minimum Efficiency Reporting Value

What does a MERV Rating mean to me?

The acronym MERV stands for "Minimum Efficiency Reporting Value." MERV ratings are used to rate the ability of an air cleaner filter to remove dust from the air as it passes through the filter. MERV is a standard used to measure the overall efficiency of a filter. The MERV scale ranges from 1 to 16, and measures a filter's ability to remove particles from .30 to 10 microns in size. To give you an idea of the scale of a micron, 100 microns is about the thickness of a piece of paper or a human hair. Filters with higher ratings not only remove more particles from the air, they also remove smaller particles.

MERV ratings are determined by adding particles of varying sizes into a controlled testing environment. The particles are added upstream of the test filter and a laser particle counter samples the air before it enters the filter and after it leaves the filter. The two particle counts are compared to calculate the Particle Size Efficiency of the tested filter. Once this is determined, a MERV Parameters chart is used to determine the MERV rating.

Minimum Efficiency Reporting Value

MERV 14 for OR

MERV Rating Chart

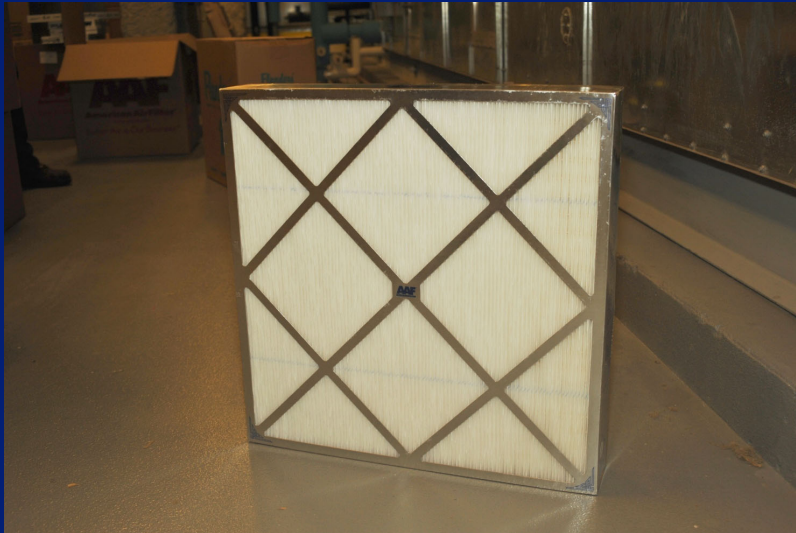
MERV Rating	Dust Spot Efficiency*	Typical Controlled Contaminant	Applications	Air Filter Type
1	<20%	>10.0 micron Particle Size	Minimal Filtration	Throwaway - Disposable fiberglass or synthetic panel filter Washable - Aluminum mesh Electrostatic - Self charging woven panel filter
2	<20%		Residential	
3	<20%		Window A/C Units	
4	<20%			
5	<20%	3.0-10.0 micron Particle Size	Commercial Buildings	Pleated Filters - Disposable, extended surface area, thick with cotton-polyester blend media, cardboard frame Cartridge Filters - Graded density viscous coated cube or pocket filters, synthetic media Throwaway - Disposable synthetic panel filter
6	<20%	Mold Spores, Hair Spray, Fabric Protector, Dusting Aids, Cement Dust, Pudding Mix	Better Residential	
7	25-30%		Industrial Workplace	
8	30-35%		Paint Booth Inlet	
9	40-45%	1.0-3.0 micron Particle Size	Better Commercial	Bag Filter - Nonsupported microfine fiberglass or synthetic media, typically 6" - 36" deep, 6 - 12 pockets Box Filter - Rigid style cartridge filters typically 4" - 12" deep may use lofted or paper media
10	50-55%	Legionella, Humidifier Dust, Lead Dust, Milled Flour, Auto Emissions, Welding Fumes	Superior Residential	
11	60-65%		Hospital Laboratories	
12	70-75%		Welding Booth Inlet	
13	89-90%	.30-1.0 micron Particle Size	Superior Commercial	Bag Filter - Nonsupported microfine fiberglass or synthetic media, typically 6" - 36" deep, 6 - 12 pockets Box Filter - Rigid style cartridge filters typically 4" - 12" deep may use lofted or paper media
14	90-95%	All Bacteria, Most Tobacco Smoke, Propriet Nuclei (Sneeze)	General Surgery	
15	>95%		Hospital Rooms	
16	>95%		Smoking Lounge	

* Dust spot efficiency measures a filter's ability to remove large particles, those that tend to soil building interiors.

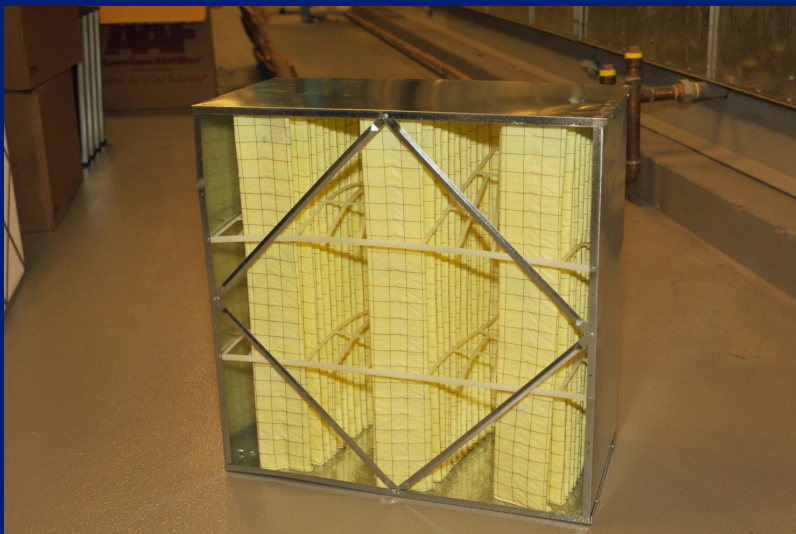
Heating, Ventilation and Air Conditioning MERV 8 (30-35% in 3-10u)



Heating, Ventilation and Air Conditioning MERV 11 (60-65% in 1-3u)

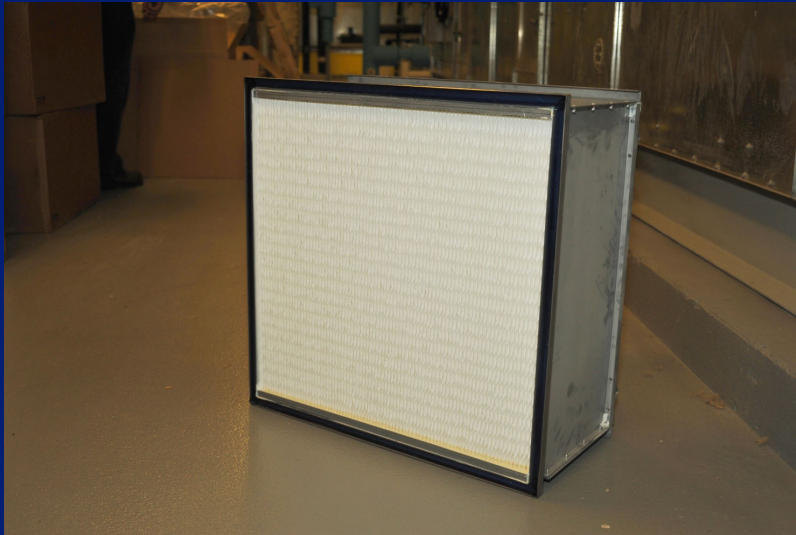


Heating, Ventilation and Air Conditioning MERV 14 (90-95% in 0.3-1u)



Heating, Ventilation and Air Conditioning

HEPA (High Efficiency Particulate Air)



- Which of the following minimum efficiency reporting values (MERV) is sufficient to meet the minimum operating room (OR) standards for air filtration
- A. MERV 10
- B. MERV 12
- C. MERV 14
- D. MERV 16

- Which of the following minimum efficiency reporting values (MERV) is sufficient to meet the minimum operating room (OR) standards for air filtration
- A. MERV 10
- B. MERV 12
- C. MERV 14 (minimum standard in OR is 90%, which equates to a MERV of 14)
- D. MERV 16

Heating, Ventilation and Air Conditioning

Activated Carbon Filter-removes organic compounds and odors



Heating, Ventilation and Air Conditioning Supply Air to Hospital Patient Rooms



Heating, Ventilation and Air Conditioning Exhaust Fans on Roof



Environment of Care

Monitor Elements for Safe Care Environment

- HVAC (pressure)
- Airborne fungal outbreaks
- Construction and renovation
- Water as a source of pathogens
- *Legionella* and *Aspergillus*
- Environmental cleaning and disinfection (CD)
- Laundry
- Regulated waste

Review of Fungal Outbreaks

Kanamori, Rutala, Sickbert-Bennett, Weber. CID. 2015;61:433

Table 2. Fungal Infections and Associated Mortality by Each Underlying Disease During Construction, Renovation, or Demolition

Underlying Diseases	No. of Articles Published	No. of Patients Infected	No. of Patients Died	Mortality, No.* (%)
Hematologic malignancies or bone marrow transplant	26	414	148	131/288 (45.5)
Other malignancies, transplant, and/or immunosuppressed patients	13	105	38	38/60 (63.3)
Patients in intensive care unit	3	8	2	2/4 (50)
Rheumatology patients	2	6	4	4/6 (66.7)
After surgery	2	8	1	1/8 (12.5)
Premature infant	2	3	2	2/3 (66.7)
Nephrology and dialysis patients	1	3	2	2/3 (66.7)
Total	49	547	197	180/372 (48.4)

* Articles in which the number of patients infected or died was unknown were excluded for mortality calculation.

AIRBORNE FUNGAL OUTBREAKS

Requirements

- Susceptible host
- Reservoir
- Source
- Infecting dose inhaled (most dependent on concentration of fungi in the air)

MOST COMMON PATHOGENS ASSOCIATED WITH CONSTRUCTION OR RENOVATION OUTBREAKS

- *Aspergillus* spp. (by far most important)
- Zygomycetes
- Other fungi
- Miscellaneous

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NOSOCOMIAL ASPERGILLOSIS IN OUTBREAK SETTINGS

Vonberg, Gastmeier. JHI 2006. 63:245

- 53 studies with 458 patients
- 356 patients (78%) were lower respiratory tract
- *Aspergillus fumigatus* (154) and *A. flavus* (101)
- Underlying disease-hematologic malignancies 299 (65%)
- Overall fatality rate in these 299 patients (57.6%)
- Construction or demolition probable/possible source-49%; virtually all outbreaks attributable to airborne source, usually construction
- Patients at risk should not be exposed to *Aspergillus*

Medically-Important Mycotic Agents

Aspergillus fumigatus



AIRBORNE FUNGAL OUTBREAKS

Portal of Entry	Number of Outbreaks
Respiratory tract	27
Skin	7
Operative site	3
Peritoneal dialysis catheter	1
Mixed	1
Not stated	2

Review of Fungal Outbreaks

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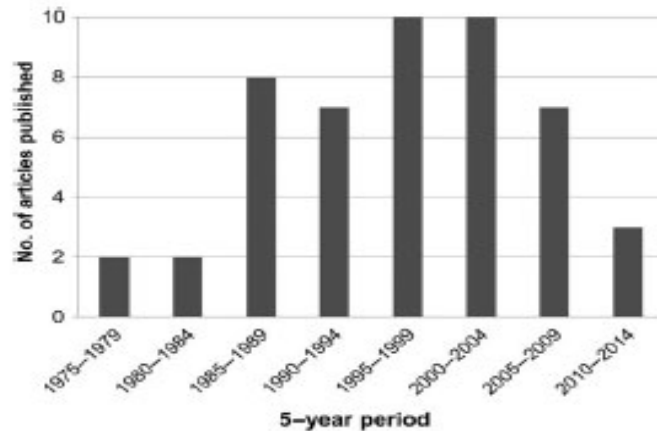


Figure 1. Trend of fungal outbreaks and infections associated with construction, renovation, and demolition.

Review of Fungal Outbreaks

Kanamori, Rutala, Sickbert-Bennett, Weber. CID. 2015;61:433

Table 1. Characteristics of Fungal Outbreaks and Infections Associated With Construction, Renovation, and Demolition

Author, Year	Patient Population	No. of Patient Infected	No. of Patient Deaths	Type of Infection (Site)	Type of Fungi	Reservoir or Source	Airborne Fungal Level(s)	Molecular Typing	Control Measures
Aisner, 1976 [5]	Cancer patients	8	Unknown	<i>Aspergillus</i> infection (lung, pharyngeal, or maxillary sinus)	<i>Aspergillus</i> spp. (predominantly <i>A. niger</i> , <i>A. flavus</i> , <i>A. fumigatus</i>)	Fireproofing material sprayed wet during construction	Unknown	Unknown	Unknown
Arrow, 1978 [6]	Immunosuppression (renal transplant)	3	1	<i>Aspergillus</i> infection (lung)	<i>A. fumigatus</i> , <i>Aspergillus</i> sp.	Renovation, spores on dust from false ceiling tiles above transplant unit	Airborne spores >200 cfu below renovation	Unknown	Impermeable plastic barriers, immunosuppressed patients moved to other floors, horizontal surfaces, vacuumed, damp mopped, and dusted
Sarubbi, 1982 [8]	Hospitalized patients (acute nonlymphocytic leukemia for 1 infected)	1	1	Invasive <i>Aspergillus</i> infection (lung)	<i>A. flavus</i>	Construction, defective ventilation and air filtration	8 <i>A. flavus</i> /positive room, control 1 <i>A. flavus</i> /positive room-settle plates	Unknown	Pre-filters and filters in ventilation system replaced
Lentini, 1982 [7]	Immunosuppressed patients with renal allograft recipients or hematologic malignancy	10	4	Invasive <i>Aspergillus</i> infection (lung)	<i>Aspergillus</i> sp.	Road construction for access to the new hospital, contaminated window air conditioners in renal transplantation ward	400-2800 <i>Aspergillus</i> spores/cm ³ from air conditioner filter	Unknown	Unknown
Krasinski, 1985 [9]	Premature infants	2	2	Fungal infection (lung)	<i>Aspergillus</i> sp., <i>Zygomycetes</i> , <i>Rhizopus indicus</i>	Renovation of adjacent special care unit and demolition of wall, mold in dust above a false ceiling	0.88 fungi per hour per settle plate compared to 0.22 fungi per hour per settle plate in construction free area	Unknown	Patients moved from area of construction, additional dampers placed in air ducts, impervious dust barriers erected, area above false ceiling and ventilation ducts vacuumed, replaced HEPA filters, air ducts and environmental surfaces disinfected
Opal, 1986 [10]	Immunocompromised (lymphoreticular malignancy, high-dose corticosteroid therapy or disseminated carcinoma)	11	11	<i>Aspergillus</i> infection (disseminated)	<i>A. flavus</i> , <i>A. fumigatus</i> , <i>A. niger</i> , <i>Aspergillus</i> sp.	Hospital renovation and construction	5.9 ± 0.7 <i>Aspergillus</i> /m ³ inside construction site compared to 1.2 <i>Aspergillus</i> /m ³ outside construction site	Unknown	Copper-8 quinolinolate, airtight plastic and dry wall barriers about the construction site, HEPA filters in patients room, and negative pressure in construction area
Barnes, 1989 [14]	Children undergoing BMT	6	6	Invasive <i>Aspergillus</i> infection (lung)	Unknown	Building work installing a laminar air flow system to the unit	133 cfu/m ³ of <i>A. fumigatus</i> in the BMT unit during building work	Unknown	Laminar air flow isolation
Munoz-Gomez, 2009 [15]	Seven patients in	2	2	Invasive	<i>A. fumigatus</i>	Building work in a room	5.0 cfu/m ³ after	Unknown	Improved humidification

Aspergillus

- ❑ *Aspergillus* spores are **ubiquitous** (soil, fruits, vegetables, dust, decaying organic matter) in the environment
- ❑ **Conidia may travel long distances** as airborne particles and are inhaled by humans (several hundred spores each day)
- ❑ In most healthy persons, **spores are removed by innate defense mechanisms (macrophages)**
- ❑ **Severely immunocompromised (IC) hosts** (hematologic, solid organ transplant) **a serious complication**
- ❑ Air is normally the route of fungal spore transmission



8 cases of invasive fungal sinusitis (6 *A. flavus*, 1 *A. fumigatus*, 1 *Rhizopus*) and 5 deaths; release of fungal spores from soil reservoirs during construction; cultures of air and dust during the construction period grew *Aspergillus* . Lueg et al. 1996



AIRBORNE FUNGAL OUTBREAKS

- Shown to increase the amount of airborne fungal spores dramatically (and in consequence increases the risk of *Aspergillus* infection in susceptible patients)
 - Internal renovation/construction/excavation-construction is a never-ending phenomenon
 - Ceiling access
 - Contaminated or defective air supply
- Minimal airborne concentration of *Aspergillus* necessary to cause infection in IC patients remains unknown

CONSTRUCTION OR RENOVATION¹

- When planning construction, demolition, and renovation activities in and around the facility, assess whether patients at high-risk for aspergillosis are likely to be exposed to high ambient-air spore counts of *Aspergillus* spp., and if so develop a plan to prevent such exposure {IA}
- During construction, demolition, or renovation activities construct impermeable barriers between patient-care and construction areas to prevent dust from entering the patient-care areas {IB}
- Direct pedestrian traffic that come from construction areas away from patient-care areas to limit the opening and closing of doors or other barriers that might cause dust dispersion {IB}
- Must participate at all levels of a construction project (CBIC)

¹Tablan OC, et al. Guidelines for preventing health-care-associated pneumonia, 2003





CONSTRUCTION OR RENOVATION¹

- ❑ Establish a multidisciplinary team that includes infection-control staff to coordinate demolition, construction and renovation {IB, IC}
- ❑ Educate construction and healthcare staff in immunocompromised patient-care areas regarding airborne infection risks associated with construction and preventive measures {IB}
- ❑ Incorporate mandatory adherence agreements for infection control into construction contracts {IC}
- ❑ Establish and maintain surveillance for airborne environmental disease (e.g., aspergillosis) as appropriate during construction {IB}

¹Guideline for environmental infection control in health-care facilities, 2003

CONSTRUCTION OR RENOVATION¹

- Implement infection-control measures during construction, renovation, maintenance, demolition, and repair {IB, IC}
 - Before the project gets underway, perform an ICRA to define the scope of the project and need for barrier measures {IB, IC}
 - ◆ Determine if immunocompromised patients may be at risk for exposure and develop a contingency plan to prevent exposures
 - Implement infection-control measures for external demolition and construction {IB}
 - ◆ Determine if facility can operate on recirculated air; if feasible, seal off adjacent air intakes
 - ◆ If not feasible, check and replace low-efficiency filters as needed
 - ◆ Seal windows and reduce outside air intrusion

¹Guideline for environmental infection control in health-care facilities, 2003

CONSTRUCTION OR RENOVATION¹

- Implement infection-control measures during construction, renovation, maintenance, demolition, and repair {IB, IC}
 - Implement infection-control measure for internal construction {IB, IC}
 - ◆ Construct barriers to prevent dust from entering patient-care areas
 - ◆ Block and seal off return air vents (if needed)
 - ◆ Implement dust control measures; divert pedestrian traffic
 - ◆ Relocate patients adjacent to work zone (depending on their immune status)

¹Guideline for environmental infection control in health-care facilities, 2003

CONSTRUCTION OR RENOVATION¹

- Implement infection-control measures during construction, renovation, maintenance, demolition, and repair {IB, IC}
 - Perform engineering and work-site related infection control measures as needed for internal construction and renovations
 - ◆ Ensure proper operation of the air-handling system
 - ◆ **Create and maintain negative pressure in work zones-CBIC**
 - ◆ Monitor negative air flow inside of rigid barriers
 - ◆ Monitor barriers; repair gaps and breaks in barriers
 - ◆ Direct pedestrian traffic away from work zones
 - ◆ Provide designated travel routes for construction crew
 - ◆ Clean work zones daily
 - ◆ Clean and replace air filters

¹Guideline for environmental infection control in health-care facilities, 2003

CONSTRUCTION OR RENOVATION¹

- No recommendation is offered on routine microbiologic air sampling, before, during, or after construction {unresolved}
- If a case of healthcare-acquired aspergillus airborne fungal infection occurs during construction, implement appropriate measures {IB}
- If there is epidemiologic evidence of ongoing transmission of fungal disease, conduct an environmental assessment to determine and eliminate the source {IB}
- If air-supply systems to high-risk areas are not optimal use portable, industrial-grade HEPA filters on temporary basis {II}

INFECTION CONTROL RISK ASSESSMENT (ICRA)

- ICRA is an multidisciplinary, organizational, documented process that after considering the facility's patient population and type of construction project (non-invasive to major demolition):
 - Focuses on reduction of risk from infection
 - Acts through phases of facility planning, design, construction, renovation, facility maintenance and
 - Coordinates and weights knowledge about infection, infectious agents, type of construction project and care environment permitting the organization to anticipate potential impact

STEP 1: IDENTIFY TYPE OF CONSTRUCTION PROJECT

TYPE A	Inspection and Non-Invasive Activities. Includes, but is not limited to: <ul style="list-style-type: none">▪ removal of ceiling tiles for visual inspection only, e.g., limited to 1 tile per 50 square feet▪ painting (but not sanding)▪ wallcovering, electrical trim work, minor plumbing, and activities which do not generate dust or require cutting of walls or access to ceilings other than for visual inspection.
TYPE B	Small scale, short duration activities which create minimal dust Includes, but is not limited to: <ul style="list-style-type: none">▪ installation of telephone and computer cabling▪ access to chase spaces▪ cutting of walls or ceiling where dust migration can be controlled.

STEP 1: IDENTIFY TYPE OF CONSTRUCTION PROJECT

TYPE C	<p>Work that generates a moderate to high level of dust or requires demolition or removal of any fixed building components or assemblies</p> <p>Includes, but is not limited to:</p> <ul style="list-style-type: none"> ▪ sanding of walls for painting or wall covering ▪ removal of floorcoverings, ceiling tiles and casework ▪ new wall construction ▪ minor duct work or electrical work above ceilings ▪ major cabling activities ▪ any activity which cannot be completed within a single workshift.
TYPE D	<p>Major demolition and construction projects</p> <p>Includes, but is not limited to:</p> <ul style="list-style-type: none"> ▪ activities which require consecutive work shifts ▪ requires heavy demolition or removal of a complete cabling system ▪ new construction.

STEP 2: IDENTIFY PATIENT RISK

Low Risk	Medium Risk	High Risk	Highest Risk
<ul style="list-style-type: none"> ▪ Office areas 	<ul style="list-style-type: none"> ▪ Cardiology ▪ Echocardiography ▪ Endoscopy ▪ Nuclear Medicine ▪ Physical Therapy ▪ Radiology/MRI ▪ Respiratory Therapy 	<ul style="list-style-type: none"> ▪ CCU ▪ Emergency Room ▪ Labor & Delivery ▪ Laboratories (specimen) ▪ Medical Units ▪ Newborn Nursery ▪ Outpatient Surgery ▪ Pediatrics ▪ Pharmacy ▪ Post Anesthesia Care Unit ▪ Surgical Units 	<ul style="list-style-type: none"> ▪ Any area caring for immunocompromised patients ▪ Burn Unit ▪ Cardiac Cath Lab ▪ Central Sterile Supply ▪ Intensive Care Units ▪ Negative pressure isolation rooms ▪ Oncology ▪ Operating rooms including C-section rooms

STEP 3: MATCH RISK GROUP WITH CONSTRUCTION TYPE

Patient Risk Group	Construction Project Type			
	TYPE A	TYPE B	TYPE C	TYPE D
LOW Risk Group	I	II	II	III/IV
MEDIUM Risk Group	I	II	III	IV
HIGH Risk Group	I	II	III/IV	IV
HIGHEST Risk Group	II	III/IV	III/IV	IV

Note: Infection Control approval will be required when the Construction Activity and Risk Level indicate that **Class III** or **Class IV** control procedures are necessary.

INFECTION CONTROL BY CLASS

During Construction Project		Upon Completion of Project	
CLASS	<ol style="list-style-type: none"> 1. Execute work by methods to minimize raising dust from construction operations. 2. Immediately replace a ceiling tile displaced for visual inspection 	CLASS	<ol style="list-style-type: none"> 1. Clean work area upon completion of task.
	<ol style="list-style-type: none"> 1. Provide active means to prevent airborne dust from dispersing into atmosphere. 2. Water mist work surfaces to control dust while cutting. 3. Seal unused doors with duct tape. 4. Block off and seal air vents. 5. Place dust mat at entrance and exit of work area 6. Remove or isolate HVAC system in areas where work is being performed. 		<ol style="list-style-type: none"> 1. Wipe work surfaces with cleaner/disinfectant. 2. Contain construction waste before transport in tightly covered containers. 3. Wet mop and/or vacuum with HEPA filtered vacuum before leaving work area. 4. Upon completion, restore HVAC system where work was performed.

INFECTION CONTROL BY CLASS

During construction

After construction

CLASS III

1. Remove or Isolate HVAC system in area where work is being done to prevent contamination of duct system.
2. Complete all critical barriers i.e. sheetrock, plywood, plastic, to seal area from non work area or implement control cube method (cart with plastic covering and sealed connection to work site with HEPA vacuum for vacuuming prior to exit) before construction begins.
3. Maintain negative air pressure within work site utilizing HEPA equipped air filtration units.
4. Contain construction waste before transport in tightly covered containers.
5. Cover transport receptacles or carts. Tape covering unless solid lid.

1. Do not remove barriers from work area until completed project is inspected by the owner's Safety Department and Infection Prevention & Control Department and thoroughly cleaned by the owner's Environmental Services Department.
2. Remove barrier materials carefully to minimize spreading of dirt and debris associated with construction.
3. Vacuum work area with HEPA filtered vacuums.
4. Wet mop area with cleaner/disinfectant.
5. Upon completion, restore HVAC system where work was performed.

INFECTION CONTROL BY CLASS

During construction

After construction

CLASS IV

1. Isolate HVAC system in area where work is being done to prevent contamination of duct system.
2. Complete all critical barriers i.e. sheetrock, plywood, plastic, to seal area from non work area or implement control cube method (cart with plastic covering and sealed connection to work site with HEPA vacuum for vacuuming prior to exit) before construction begins.
3. Maintain negative air pressure within work site utilizing HEPA equipped air filtration units.
4. Seal holes, pipes, conduits, and punctures.
5. Construct anteroom and require all personnel to pass through this room so they can be vacuumed using a HEPA vacuum cleaner before leaving work site or they can wear cloth or paper coveralls that are removed each time they leave work site.
6. All personnel entering work site are required to wear shoe covers. Shoe covers must be changed each time the worker exits the work area.

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2. Remove barrier material carefully to minimize spreading of dirt and debris associated with construction.
3. Contain construction waste before transport in tightly covered containers.
4. Cover transport receptacles or carts. Tape covering unless solid lid.
5. Vacuum work area with HEPA filtered vacuums.
6. Wet mop area with cleaner/disinfectant.
7. Upon completion, restore HVAC system where work was performed.

INFECTION CONTROL RISK ASSESSMENT (ICRA)-CBIC

- Which of the following is an ICRA element related to building design features:
 1. An assessment of the specific construction hazards and the determination of protection levels for those hazards
 2. The impact of a water outage during construction activity
 3. The number of airborne infection isolation (AII) rooms and where they will be located in the facility
 4. A plan on where to relocate patients during construction

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- Which of the following is an ICRA element related to building design features:
 1. An assessment of the specific construction hazards and the determination of protection levels for those hazards
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 3. The number of airborne infection isolation (AII) rooms and where they will be located in the facility
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CBIC-ICRA

- Your organization is planning a major construction project. You have been asked to complete the Infection Control Risk Assessment (ICRA) by the project manager. You explain that:
 1. It is his job to complete the ICRA
 2. The construction company will complete the ICRA
 3. An ICRA is not needed for the project
 4. The ICRA must be conducted by a committee with expertise in a variety of areas

CBIC-ICRA

- Your organization is planning a major construction project. You have been asked to complete the Infection Control Risk Assessment (ICRA) by the project manager. You explain that:
 1. It is his job to complete the ICRA
 2. The construction company will complete the ICRA
 3. An ICRA is not needed for the project
 4. The ICRA must be conducted by a committee with expertise in a variety of areas

OTHER STEPS

1. Identify areas surrounding the project area, assess impact
2. Identify the specific sites of activity (e.g., patient rooms)
3. Identify issues related to: ventilation, plumbing, electrical in terms of possible outages
4. Identify containment measures using prior risk assessment
5. Consider possible water damage
6. Work hours: Can work be done during non-patient care hours?
7. Develop plans for the proper handwashing sinks
8. Develop plans for use of clean and soiled utility rooms
9. Communicate with project team: traffic flow, housekeeping, debris removal

SUMMARY

- Outbreaks of aspergillosis and other fungi continue to occur in US healthcare facilities
- Highly immunocompromised patients are at highest risk
- Most are related to construction and renovation
- Appropriate implementation of CDC/HICPAC guidelines can prevent healthcare-associated infection
- Use of ICRA is a logical method to plan for construction and renovation projects

SURVEILLANCE¹

- Maintain a high index of suspicion for healthcare-associated pulmonary aspergillosis in severely immunocompromised patients (ANC <500/mm³ for 2 weeks or <100/mm³ for 1 week)(IA)
- Surveillance cultures
 - Do NOT perform routine, periodic cultures of nasopharynx (IB)
 - Do NOT perform routine, periodic cultures of equipment or devices used for respiratory therapy, PFTs, or dust in rooms of HSCT recipients (IB)
 - NO recommendation for routine microbiologic air sampling before, during, or after facility construction or renovation (Unresolved)
- Perform routine surveillance of the ventilation status of PEs: room air exchanges, pressure relations, filtration efficacy (IB)

¹Tablan OC, et al. Guidelines for preventing health-care-associated pneumonia, 2003

PREVENTION

- Well designed and maintained ventilation system
 - Appropriate placement of intake ducts
 - Filter all hospital air (90-95% efficient filters)
 - Maintain filter integrity
 - Maintain appropriate pressure relationships
 - Proper maintenance of fans and filters
- Review all construction and renovation activities
- HEPA filters in HVAC in “high” risk areas

PREVENTION

- Procedures during construction and renovations
 - Seal hospital construction areas behind impervious barriers
 - Clean construction area daily (i.e., remove dust)
 - Assure that ventilation system does not transport dust from inside construction area to other locations
 - Move immunocompromised patients from adjacent areas
 - Thoroughly clean construction area prior to patient use
 - Conduct surveillance for airborne fungal infections
 - Avoid transporting construction material through patient areas

AIR-HANDLING SYSTEMS IN HCF

- Ensure HVAC filters are properly installed and maintained (IB)
- Monitor areas with special ventilation (All, PE) for ACH and pressure differentials (IB)
- Inspect filters periodically (IC)
- Ensure intakes (>6 ft above ground) and exhaust outlets (>25 ft from intake) are located properly (IC)

Heating, Ventilation and Air Conditioning

Filter Bank of MERV 8



AIR-HANDLING SYSTEMS IN HCF

- ❑ Do not use through-the-wall ventilation units (air induction ventilation) for PE (IC)
- ❑ Seal windows with centralized HVAC, especially PE areas (IB, IC)
- ❑ Do not shut down HVAC for other than required maintenance, filter changes, and construction (IB, IC); coordinate to allow relocation of IC (IC)
- ❑ Keep emergency doors and exits in PE (protective environments) closed (II)

Windows Closed



AIRBORNE FUNGI AT UNC HEALTH CARE, 2013

- Air sampling conducted using large volumes (>1000L) to increase likelihood of detecting a low level of spores
- BMTU Air Sampling
 - 1 fungal colony (no *Aspergillus*)
- Outside Air Sampling
 - 85 fungal colonies-100L (850 fungal colonies in 1000L)

CONSTRUCTION, RENOVATION, REPAIR

- Establish a multi-disciplinary team to coordinate construction (IB,IC)
- Educate both the construction team and healthcare staff in IC patient-care areas about the airborne infection risk (IB)
- Incorporate mandatory adherence agreements for infection control into construction contracts (IC)

CONSTRUCTION, RENOVATION, REPAIR

- Using active surveillance, monitor for airborne infections in IC patients (IB)
- Implement infection control measures: define the need for barriers (IB), ensure proper operation of the HVAC system (IB), implement dust control measures (IB), relocate IC patients as needed (IB), clean work zones daily (IB), create negative pressure in work areas relative to adjacent patient-care areas (IB), provide crews with designated entrances, corridors, elevators (IB)

SPECIAL HEALTHCARE SETTINGS

High Risk Patients (PE, Solid Organ Transplants, Neutropenic)

- Do not routinely use laminar airflow (100-400 ACH) in PE (II).
- Minimize exposure of high-risk patients to activities that might cause aerosolization of fungal spores (e.g., vacuuming, disruption of ceiling tiles) (IB)
- Patients leave their room, provide respiratory protection (e.g., N95, surgical mask) (II)
- Minimize time the IC patients are outside their rooms for diagnostic procedures and other activities (IB)

SPECIAL HEALTHCARE SETTINGS

(Operating Rooms)

- Infection control measures for operating rooms
 - **Room-air pressure:** Maintain positive-pressure ventilation with respect to corridors and adjacent areas (IC)
 - **Room-air changes:** Maintain at ≥ 15 per hour (IC) with at least 3 ACH of fresh air (20 AC/hr per FGI)
 - **Directed Airflow:** Introduce air at the ceiling and exhaust air near the floor (IC)
 - **Doors:** Keep room doors closed except for essential personnel, patients, equipment; limit entry to essential personnel (IB)

CBIC-Operating Room Air

- Which of the following would be an acceptable route for diffusion of air in an OR?
 1. Laminar airflow with the supply over the surgical table and an exhaust in the floor in the center of the room
 2. Laminar airflow with a supply over the surgical table and an exhaust near the floor at the periphery of the room
 3. Noninductional unidirectional infusion of air with a supply over the surgical table and an exhaust in the floor in the center of the room
 4. Noninductional unidirectional infusion of air with a supply over the surgical table and an exhaust near the floor at the periphery of the room

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 4. Noninductional unidirectional infusion of air with a supply over the surgical table and an exhaust near the floor at the periphery of the room

SPECIAL HEALTHCARE SETTINGS

(TB in Operating Rooms)

- If possible, last case of the day to allow for maximum removal of air contaminants (II)
- OR personnel should use **N95 respirators** (IC)
- **Intubate in the OR All** (IB); extubate in All (IB); keep OR door closed after intubation until 99.9% air contaminants are removed (IC)
- Use portable HEPA if the ACH does not meet specifications for negative pressure (II)

Portable HEPA Units

Rutala et al. ICHE 1995;16:391

Can rapidly reduce levels of airborne particles (0.3μ , for example, 90% in ~5 m); used in construction worksite and reduce risk to TB exposure.



SUMMARY

- Airborne fungal infections cause significant morbidity and mortality for immunocompromised patients
- Despite understanding of the usual sources and reservoirs of these pathogens outbreaks continue to occur
- Well-designed and maintained ventilation systems and use of proper infection control techniques during construction will prevent most fungal outbreaks

SUMMARY

- Surveillance is key to early detection of outbreaks
- In the event of an outbreak careful evaluation of cases and an environmental evaluation will usually uncover a correctable cause
- New tools of molecular epidemiology may prove useful to link specific reservoirs with outbreaks

Environment of Care

Monitor Elements for Safe Care Environment

- HVAC (pressure)
- Airborne fungal outbreaks
- Construction and renovation
- Water as a source of pathogens
- *Legionella* and *Aspergillus*
- Environmental cleaning and disinfection (CD)
- Laundry
- Regulated waste

Water As A Source of Nosocomial Outbreaks



WATER AS A SOURCE OF NOSOCOMIAL OUTBREAKS

WATER RESERVOIRS

Rutala, Weber. ICHE 1997;18:609

TABLE
WATER AS A RESERVOIR OF NOSOCOMIAL PATHOGENS

Reservoir	Associated Pathogen(s)	Transmission	Importance*	Prevention and Control
Potable water	<i>Pseudomonas</i> , <i>Mycobacteria</i> , <i>Legionella</i>	Contact	Moderate	Follow public health guidelines
Sinks	<i>Pseudomonas</i>	Contact, droplet	Low	Use separate sinks for handwashing and disposal of contaminated fluids
Faucet aerators	<i>Pseudomonas</i>	Contact, droplet	Low	No precautions necessary at present
Showers	<i>Legionella</i>	Inhalation	Low	Prohibit use in immunocompromised patients
Ice and ice machines	<i>Legionella</i> , <i>Enterobacter</i> , <i>Pseudomonas</i> , <i>Salmonella</i> , <i>Cryptosporidia</i>	Ingestion, contact	Moderate	Periodic cleaning; use automatic dispenser (ie, avoid open chest storage compartments in patient areas)
Eyewash stations	<i>Pseudomonas</i> , <i>Legionella</i> , <i>Ameba</i>	Contact	Low	Have available sterile water for eye flush or weekly (or monthly) flush eyewash stations
Dental-unit water systems	<i>Pseudomonas</i> , <i>Legionella</i> , <i>Sphingomonas</i> , <i>Acinetobacter</i>	Contact	Low	Clean water systems
Dialysis water	Gram-negative bacilli	Contact	Moderate	Follow guidelines: dialysate $\leq 2,000$ organisms/mL; water ≤ 200 organisms/mL

Healthcare Outbreaks Associated with Water Reservoir

Kanamori, Weber, Rutala. Clin Infect Dis 2016;62:1423

Clinical Infectious Diseases

INVITED ARTICLE

HEALTHCARE EPIDEMIOLOGY: Robert A. Weinstein, Section Editor



Healthcare Outbreaks Associated With a Water Reservoir and Infection Prevention Strategies

Hajime Kanamori,^{1,2} David J. Weber,^{1,2} and William A. Rutala^{1,2}

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Hospital water may serve as a reservoir of healthcare-associated pathogens, and contaminated water can lead to outbreaks and severe infections. The clinical features of waterborne outbreaks and infections as well as prevention strategies and control measures are reviewed. The common waterborne pathogens were bacteria, including *Legionella* and other gram-negative bacteria, and nontuberculous mycobacteria, although fungi and viruses were occasionally described. These pathogens caused a variety of infections, including bacteremia and invasive and disseminated diseases, particularly among immunocompromised hosts and critically ill adults as well as neonates. Waterborne outbreaks occurred in healthcare settings with emergence of new reported reservoirs, including electronic faucets (*Pseudomonas aeruginosa* and *Legionella*), decorative water wall fountains (*Legionella*), and heater-cooler devices used in cardiac surgery (*Mycobacterium chimaera*). Advanced molecular techniques are useful for achieving a better understanding of reservoirs and transmission pathways of waterborne pathogens. Developing prevention strategies based on water reservoirs provides a practical approach for healthcare personnel.

Keywords. waterborne outbreaks; healthcare-associated infections; water; outbreaks.

Healthcare Outbreaks Associated with Water Reservoir

Kanamori, Weber, Rutala. Clin Infect Dis 2016;62:1423

Table 2. Summary of Key Issues and Infection Prevention Strategies Against Waterborne Outbreaks by Major Water Reservoir in Healthcare Settings

Reservoir	Key Issues	Infection Prevention Strategies
Potable water, tap water, and hospital water systems	Potable water is not sterile, and pathogenic waterborne organisms may exist in potable water at acceptable levels of coliform bacteria (<1 coliform bacterium/100 mL). Healthcare-associated outbreaks have been linked to contaminated potable water. Semicritical devices are often rinsed with potable water, which may lead to contamination of the equipment and subsequent healthcare-associated infections. Common pathogens include nonenteric gram-negative bacilli (eg, <i>Pseudomonas aeruginosa</i>), <i>Legionella</i> , NTM.	Follow public health guidelines. Hot water temperature at the outlet at the highest temperature allowable, preferably >51°C. Water disruptions: post signs and do not drink tap water. Maintain standards for potable water (<1 coliform bacterium/100 mL). Rinse semicritical equipment with sterile water, filtered water, or tap water followed by alcohol rinse. Some experts have recommended periodic monitoring of water samples for growth of <i>Legionella</i> . <i>Legionella</i> eradication can be technically difficult, temporary, and expensive. Potential methods of eradication include filtration, ultraviolet, ozonation, heat inactivation (>60°C), hyperchlorination, and copper-silver ionization (>0.4 ppm and >0.04 ppm, respectively).
Sinks	Colonization of sinks with gram-negative bacilli has been reported. Some studies demonstrate a transmission link between a colonized sink and infected patients. Some studies describe that multidrug-resistant gram-negative bacilli are associated with contaminated sinks. Gram-negative bacilli can survive wet environments, including sinks, for a long time (>250 d). Transmission can be caused by splashing of water droplet from contaminated sinks to hands of healthcare personnel, followed by transient colonization of hands. Common pathogens include gram-negative bacilli (eg, <i>Pseudomonas</i> , <i>Acinetobacter</i> , <i>Serratia</i>).	Use separate sinks for handwashing and disposal of contaminated fluids. Decontaminate or eliminate sinks as a reservoir if epidemic spread of gram-negative bacteria via sinks is suspected.
Faucet aerators	Faucet aerators may serve as a platform for accumulation of waterborne pathogens. Potential pathogens include <i>Pseudomonas</i> , <i>Stenotrophomonas</i> , and <i>Legionella</i> .	Routine screening and disinfection or permanent removal of all aerators are not warranted at present. No precautions necessary at present. For <i>Legionella</i> outbreaks, clean and disinfect faucet aerators in high-risk patient areas periodically, or consider removing them in the case of additional infections.
Showers	Some outbreaks are linked to contaminated shower heads or inhalation of aerosols. Potential pathogens include <i>Legionella</i> , <i>Pseudomonas</i> , NTM, group A <i>Streptococcus</i> , and <i>Aspergillus</i> .	Prohibit use of showers in neutropenic patients. Control <i>Legionella</i> colonization of potable water.
Ice and ice machines	Patients can acquire pathogens by sucking on ice, ingesting iced drinks, or use of contaminated ices for cooling medical procedure and patients' skin. Large outbreaks occurred when ice machines have become contaminated and ice used for cooling drinking water. Common pathogens include <i>Pseudomonas</i> , <i>Enterobacter</i> ,	Do not handle ice by hand. Do not store pharmaceuticals or medical solutions on ice for consumption. Use automatic dispenser rather than open chest storage compartments in patient areas. Clean and disinfect ice storage chests regularly.

Healthcare Outbreaks Associated with Water Reservoir

Kanamori, Weber, Rutala. Clin Infect Dis 2016;62:1423

Eyewash stations	Stationary and portable eyewash stations may not be used for months or years. The water source may stand in the incoming pipes at room temperature for a long period. Pathogens, including <i>Pseudomonas</i> , <i>Legionella</i> , amoebae, and fungi, could be transmitted.	Use sterile water for eye flush or regularly (eg, monthly) flush eyewash stations.
Dental-unit water systems	Potable water usually supplies dental units. Water delivered to dental devices (eg, dental handpieces and air/water syringes) as well as dental unit water lines may be contaminated. Immunocompromised patients may be at risk for infection. Pathogens, including <i>Sphingomonas</i> , <i>Pseudomonas</i> , <i>Acinetobacter</i> , <i>Legionella</i> , and NTM, have been recovered from water supplies in dental units.	Clean dental water systems. Flush with water and disinfectant solution, or use of clean-water systems that put sterile water into the dental unit. Flush dental instruments with water and air for 20–30 sec from any dental device connected to the dental water system that enters the patient's mouth (eg, handpieces). Ensure that water in dental unit meets standards (<500 CFU/mL).
Dialysis water	Excessive levels of gram-negative bacilli in the dialysate were responsible for pyrogenic reactions in patients or bacteremia, which was caused by bacteria or endotoxin entry into the blood from the contaminated dialysate.	Follow AAMI standards for quality assurance performance of dialysis devices. Disinfect water distribution system on a regular basis. Perform microbiological testing and endotoxin testing for water in dialysis settings regularly. Maintain dialysis water (input) <200 CFU/mL and dialysate (output) <200 CFU/mL per CMS.
Water and ice baths	Contaminated water baths were used to thaw or warm blood products (fresh plasma, cryoprecipitate) or peritoneal dialysate bottles, followed by contamination of the infusates occurred during preparation. Contaminated ice baths were used to cool syringes or bottles of saline in measuring cardiac output. Potential pathogens include <i>Pseudomonas</i> , <i>Acinetobacter</i> , <i>Burkholderia</i> , <i>Staphylococcus</i> , and <i>Ewingella</i> .	Consider routine cleaning, disinfection, and changing of water in water baths. Add germicide to water bath or use plastic overwrap of blood products and keep the surfaces dry. Use sterile water in ice baths (or at room temperature) used for thermomodulation catheters.

1430 • CID 2016;62 (1 June) • HEALTHCARE EPIDEMIOLOGY

Healthcare Outbreaks Associated with Water Reservoir

Kanamori, Weber, Rutala. Clin Infect Dis 2016;62:1423

Reservoir	Key Issues	Infection Prevention Strategies
Bathing, tub immersion, and hydrotherapy	Tub immersion used in hospitals for physical hydrotherapy and for cleaning of burn wounds can cause cross-transmission, transmission from environmental reservoirs, or autotransmission. Skin infections such as folliculitis and cellulitis occurred related to water immersion. Water contamination of central venous catheters during bathing was related to bloodstream infection. Potential pathogens include <i>Pseudomonas</i> , <i>Enterobacter</i> , <i>Citrobacter</i> , <i>Acinetobacter</i> , <i>Legionella</i> , <i>Alcaligenes</i> , and NTM.	Adhere strictly to proper disinfection of tub between patients. Drain and clean tanks and tubs after use of each patient, and disinfect surfaces and components according to the manufacturer's instructions. Add disinfectant to the water: 15 ppm in small hydrotherapy tanks and 2–5 ppm in whirlpools per CDC. Disinfect after using tub liners. Cover catheter sites with transparent occlusive dressing.
Toilets	Transmission can be caused by aerosolization of fecal bacteria via flushing or surface contamination by fecal bacteria. Transmission could happen in healthcare facilities caring for mentally or neurologically impaired patients, or children. Potential pathogens include enteric bacteria, <i>Pseudomonas</i> , <i>Clostridium difficile</i> , and norovirus.	Facilitate good handwashing practices. Maintain clean surfaces with disinfectants. Clean bowl with a scouring powder and a brush. No reason to pour disinfectant into bowl. Separate toilet bowl from clean hospital surfaces.
Flowers and vases	Flower vases and potted plants are heavily colonized with potential pathogens, including <i>Acinetobacter</i> , <i>Klebsiella</i> , <i>Enterobacter</i> , <i>Pseudomonas</i> , <i>Serratia</i> , <i>Burkholderia cepacia</i> , <i>Aeromonas hydrophila</i> , and <i>Flavobacterium</i> . No healthcare-associated outbreaks directly linked to flower vases or potted plants have been reported.	Prohibit fresh flowers and potted plants in the rooms of immunocompromised and ICU patients. Or add antimicrobial agent to vase water and disinfect vases after use.
Electronic faucets	Electronic faucets were likely to be contaminated by several waterborne pathogens than handle-operated faucets. Issues associated with electronic faucets include a longer distance between the valve and the tap, resulting in a longer column of stagnant, warm water, which favors production of biofilms; reduced water flow; reduced flushing effect (growth favored); valves and pipes made of plastic enhances adhesion of <i>P. aeruginosa</i> .	Electronic faucets need to be designed so that they do not promote the growth of microorganisms. No guideline (but some authors have recommended) to remove electronic faucets from high-risk patient care areas (eg, BMTU). Some have recommended periodic monitoring of water samples for growth of <i>Legionella</i> .
Decorative water wall fountains	<i>Legionella pneumonia</i> cases associated with decorative water fountain were reported. There is an unacceptable risk in hospitals serving immunocompromised patients (even with standard maintenance and sanitizing methods).	Avoid installation, especially in healthcare facilities serving immunocompromised patients or in areas caring for high-risk patients. Perform maintenance regularly and monitor water safety strictly unless removed.
Heater-cooler units	Healthcare-associated <i>Mycobacterium chimaera</i> outbreak due to heater-cooler units during cardiac surgeries as a water source has been recently reported. Airborne transmission from contaminated heater-cooler unit water tanks.	Ensure that heater-cooler units are safe and properly maintained according to the manufacturer's instructions. Enhance vigilance for NTM infections in patients after cardiac surgeries using heater-cooler devices. If NTM infections are suspected, review microbiology database (NTM-positive cultures) and medical records of surgical procedures within several years after cardiac surgeries.
Miscellaneous	Potential reservoirs include distilled water or containers (outbreaks with <i>Enterobacter cloacae</i> and <i>B. cepacia</i>), wash basins (<i>Salmonella urbana</i> infection), <i>Typhosporon asahi</i> infection, <i>Legionella pneumonia</i> , intra-aortic balloon pump (<i>B. cepacia</i> bacteremia), humidifier water in ventilator systems (<i>Acetomoniium kiliense</i> postoperative endophthalmitis), water cooler (gastrointestinal illness), holy water (<i>Acinetobacter baumannii</i> infection), deionized water (<i>Exophiala jeikei</i> infection), water-damaged plaster (mucormycosis), water bath (<i>Legionella pneumonia</i>), water-saving device (<i>P. aeruginosa</i> infection), rinse water during endoscope reprocessing (gram-negative bacteria).	Consider control measures based on risk assessment by each reservoir when available.

WATER RESERVOIRS

- Potable water
- Sinks
- Faucet aerators
- Showers
- Tub immersion
- Toilets
- Dialysis water
- Ice and ice machines
- Water baths
- Flowers
- Eye wash stations

Sinks-CBIC

- Which of the following recommendations should be made to reduce the risk of infection from sinks in patient care areas?
 1. Sink basins should be deep enough to prevent splashing of water onto nearby patient care items
 2. Sink faucets should be located such that the flow of water hits the drain directly
 3. Sinks should be placed within two feet of the point of care to encourage frequent hand hygiene
 4. Aerators should be installed on faucets to minimize the amount of splash in the sink

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LEGIONELLA: EPIDEMIOLOGY

- 10,000 - 40,000 cases/yr (1-5% of adult pneumonia)
- Reservoir: Ubiquitous in aquatic environments
- Associated with devices that produce potable or non-potable water aerosols (e.g., cooling towers, evaporative condensers, showers, faucets, decorative water fountains, whirlpool baths, ice machines, medication nebulizers, nasogastric feedings diluted in tap water)
- Transmission: Inhalation of aerosols (no person-to-person transmission)

CONTROLLING WATERBORNE MICROORGANISMS

□ Water Systems in HCF

- Hot water temp at the outlet at the highest temp allowable, preferable >124°F (IC)-CBIC
- When state regulations do not allow hot water temp >120°F, chlorinate the water or periodically increase >150°F (II)
- Water disruptions: post signs and do not drink tap water (IB, IC)

LEGIONELLA What's in your water?



LEGIONELLA: CONTROL MEASURES

- Establish surveillance system to detect Legionnaires disease (IB); provide clinicians with lab tests (e.g., urine antigen, DFA, culture)
- No recommendation on culturing water in HCF that do not have patients at high-risk for *Legionella* (transplant)(unresolved issue)
- One laboratory-confirmed case of *Legionella*, or two cases suspected in 6 mo in facility that does not treat IC patients, conduct epidemiological investigation (IB).

LEGIONELLA: CONTROL MEASURES

- One case in immunocompromised patient, conduct a combined epidemiological and environmental investigation (IB)
- If evidence of HA transmission, conduct environmental investigation to determine source: collect water samples from potential source of aerosolized water and subtype isolates of *Legionella* from patients and environment (IB)
- If source identified, institute water system decontamination (IB) and assess the efficacy of implementing control measures (IB)
- Culturing for *Legionella* in water from transplant units can be performed as part of comprehensive strategy (II)

LEGIONELLA: CONTROL MEASURES

- If *Legionella* spp are detected in water of a transplant unit, do the following:
 - Decontaminate the water supply (IB)
 - Restrict immunocompromised patients from showers (IB)
 - Use non-contaminated water for sponge baths (IB)
 - Provide sterile water for drinking, tooth brushing (IB)
 - Do not use water from faucets in patient rooms (IB)

Water Wall Fountains and Electronic Faucets



Water Walls Linked to Legionnaires'

- Palmore et al. ICHE 2009;30:764
 - 2 immunocompromised patients exposed to decorative fountain in radiation oncology; isolates from patients and fountain identical; disinfection with ozone, filter and weekly cleaning
- Houpt et al. ICHE 2012;33:185
 - Lab-confirmed Legionnaires disease was dx in 8 patients; 6 had exposure to decorative fountain (near main entrance to hospital); high counts of *Legionella pneumophila* 1 despite disinfection and maintenance

Water Walls and Decorative Water Fountains

Present unacceptable risk in hospitals serving immunocompromised patients (even with standard maintenance and sanitizing methods).

CBIC-water not stagnant, prevent aerosolization, routine maintenance

Environment of Care

Monitor Elements for Safe Care Environment

- HVAC (pressure)
- Airborne fungal outbreaks
- Construction and renovation
- Water as a source of pathogens
- *Legionella* and *Aspergillus*
- Environmental cleaning and disinfection (CD)
- Laundry
- Regulated waste

Noncritical Medical Devices

Rutala et al. AJIC 2016;44:e1; Rutala, Weber. Env Issues NI, Farber 1987



- Contact: intact skin (noncritical medical devices, surfaces)
- Transmission: secondary transmission by contaminating hands/gloves via contact with the environment and transfer to patient
- Control measures: hand hygiene and low-level disinfection
- Noncritical devices (stethoscopes, blood pressure cuffs, wound vacuum), **rare outbreaks**

Environmental Contamination Leads to HAIs

Weber, Kanamori, Rutala. Curr Op Infect Dis 2016;29:424-431



- Evidence environment contributes
- Role-MRSA, VRE, *C. difficile*
- Surfaces are contaminated~25%
- EIP survive days, weeks, months
- Contact with surfaces results in hand contamination
- Disinfection reduces contamination
- Disinfection (daily) reduces HAIs
- Rooms not adequately cleaned

Admission to Room Previously Occupied by Patient C/I with Epidemiologically Important Pathogen

Weber, Kanamori, Rutala. Curr Op Infect Dis 2016;29:424-431



- Results in the newly admitted patient having an increased risk of acquiring that pathogen by 39-353%
- For example, increased risk for *C. difficile* is 235% (11.0% vs 4.6%)



Effective Surface Decontamination

Product and Practice = Perfection

PROPERTIES OF AN IDEAL DISINFECTANT

Rutala, Weber. Infect Control Hosp Epidemiol. 2014;35:855-865

- ❑ **Broad spectrum**-wide antimicrobial spectrum
- ❑ **Fast acting**-should produce a rapid kill
- ❑ **Remains Wet**-meet listed kill/contact times with a single application
- ❑ **Not affected by environmental factors**-active in the presence of organic matter
- ❑ **Nontoxic**-not irritating to user
- ❑ **Surface compatibility**-should not corrode instruments and metallic surfaces
- ❑ **Persistence**-should have sustained antimicrobial activity
- ❑ **Easy to use**
- ❑ **Acceptable odor**
- ❑ **Economical**-cost should not be prohibitively high
- ❑ **Soluble (in water) and stable (in concentrate and use dilution)**
- ❑ **Cleaner (good cleaning properties) and nonflammable**

Key Considerations for Selecting the Ideal Disinfectant for Your Facility

Rutala, Weber. Infect Control Hosp Epidemiol. 2014;35:855-865

Consideration	Question to Ask	Score (1-10)
Kill Claims	Does the product kill the most prevalent healthcare pathogens	
Kill Times and Wet-Contact Times	How quickly does the product kill the prevalent healthcare pathogens. Ideally, contact time greater than or equal to the kill claim.	
Safety	Does the product have an acceptable toxicity rating, flammability rating	
Ease-of-Use	Odor acceptable, shelf-life, in convenient forms (wipes, spray), water soluble, works in organic matter, one-step (cleans/disinfects)	
Other factors	Supplier offers comprehensive training/education, 24-7 customer support, overall cost acceptable (product capabilities, cost per compliant use, help standardize disinfectants in facility)	

Note: Consider the 5 components shown, give each product a score (1 is worst and 10 is best) in each of the 5 categories, and select the product with the highest score as the optimal choice (maximum score is 50).

LOW-LEVEL DISINFECTION FOR NONCRITICAL EQUIPMENT AND SURFACES (EPA-Registered-CBIC)

Rutala, Weber. Infect Control Hosp Epidemiol. 2014;35:855-865

Exposure time \geq 1 min

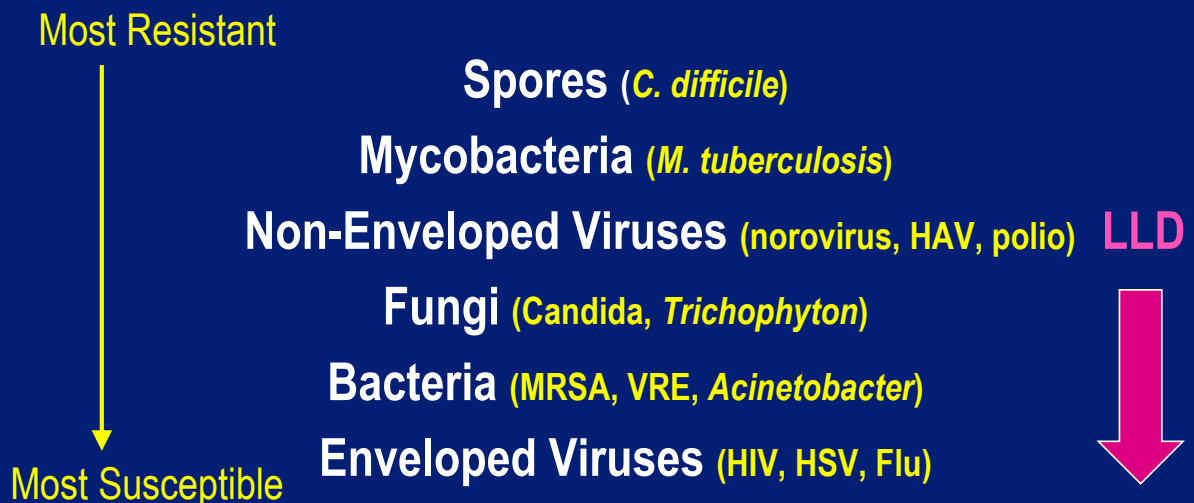
Germicide	Use Concentration
Ethyl or isopropyl alcohol	70-90%
Chlorine	100ppm (1:500 dilution)
Phenolic	UD
Iodophor	UD
Quaternary ammonium (QUAT)	UD
QUAT with alcohol	RTU
Improved hydrogen peroxide (HP)	0.5%, 1.4%
Peracetic acid with HP (<i>C. difficile</i>)	UD

UD=Manufacturer's recommended use dilution; others in development/testing-electrolyzed water; polymeric guanidine; cold-air atmospheric pressure plasma (Boyce Antimicrob Res IC 2016. 5:10)

Cleaning solution container must be labeled with the chemical content, name and expiration date. No "topping off". CBIC

Microbiological Disinfectant Hierarchy

Rutala WA, Weber DJ, HICPAC. www.cdc.gov



MOST PREVALENT PATHOGENS CAUSING HAI

Rutala, Weber. Infect Control Hosp Epidemiol. 2014;35:855-865; Weiner et al ICHE 2016;37:1288

Most prevalent pathogens causing HAI (easy to kill)

- *E. coli* (15.4%)
- *S. aureus* (11.8%)
- *Klebsiella* (7.7%)
- Coag neg Staph (7.7%)
- *E. faecalis* (7.4%)
- *P. aeruginosa* (7.3%)
- *C. albicans* (6.7%)
- *Enterobacter* sp. (4.2%)
- *E. faecium* (3.7%)

Common causes of outbreaks and ward closures (relatively hard to kill)

- *C. difficile* spores
- Norovirus
- Rotavirus
- Adenovirus

EFFECTIVENESS OF DISINFECTANTS AGAINST MRSA AND VRE

Rutala WA, et al. Infect Control Hosp Epidemiol 2000;21:33-38

TABLE 2
DISINFECTANT ACTIVITY AGAINST ANTIBIOTIC-SUSCEPTIBLE AND ANTIBIOTIC-RESISTANT BACTERIA

Product	Log ₁₀ Reductions							
	VSE		VRE		MSSA		MRSA	
	0.5 min	5 min	0.5 min	5 min	0.5 min	5 min	0.5 min	5 min
Vesphene IIse	>4.3	>4.3	>4.8	>4.8	>5.1	>5.1	>4.6	>4.6
Clorox	>5.4	>5.4	>4.9	>4.9	>5.0	>5.0	>4.6	>4.6
Lysol Disinfectant	>4.3	>4.3	>4.8	>4.8	>5.1	>5.1	>4.6	>4.6
Lysol Antibacterial	>5.5	>5.5	>5.5	>5.5	>5.1	>5.1	>4.6	>4.6
Vinegar	0.1	5.3	1.0	3.7	+1.1	+0.9	+0.6	2.3

Abbreviations: MRSA, methicillin-resistant *Staphylococcus aureus*; MSSA, methicillin-susceptible *S. aureus*; VRE, vancomycin-resistant *Enterococcus*; VSE, vancomycin-susceptible *Enterococcus*. Data represent mean of two trials (n=2). Values preceded by ">" represent the limit of detection of the assay. Assays were conducted at a temperature of 20°C and a relative humidity of 45%. Results were calculated as the log of Nd/No, where Nd is the titer of bacteria surviving after exposure and No is the titer of the control.

Best Practices in Disinfection of Noncritical Surfaces in the Healthcare Setting: A Bundle Approach

NL Havill AJIC 2013;41:S26-30; Rutala, Weber. AJIC 2019;47:A96-A105

A Bundle Approach to Surface Disinfection (prevents infection to new patient)

- Develop policies and **procedures**
- Select cleaning and disinfecting **products**
- **Educate** staff-environmental services and nursing
- Monitor **compliance** (thoroughness of cleaning, product use) and feedback
- Implement “**no touch**” room decontamination technology and monitor compliance (and new strategies)

Blood Pressure Cuff Non-Critical Patient Care Item



© Healthwise, Incorporated

Surface Disinfection

Noncritical Patient Care

Rutala, Weber, HICPAC. CDC 2008. www.cdc.gov

- Disinfecting Noncritical Patient-Care Items
 - Process noncritical patient-care equipment with a **EPA-registered disinfectant** at the proper use dilution and a **contact time of at least 1 min**. *Category IB*
 - Ensure that the frequency for disinfecting noncritical patient-care surfaces be done minimally when **visibly soiled and on a regular basis** (such as after each patient use or once **daily** or once weekly). *Category IB*



Surface Disinfection

Environmental Surfaces

Rutala, Weber, HICPAC. CDC 2008. www.cdc.gov

- Disinfecting Environmental Surfaces in HCF
 - **Disinfect** (or clean) housekeeping surfaces (e.g., floors, tabletops) **on a regular basis** (e.g., daily, three times per week), **when spills occur, and when these surfaces are visibly soiled**. *Category IB*
 - Use disinfectant for housekeeping purposes where: uncertainty exists as to the nature of the soil on the surfaces (blood vs dirt); or where uncertainty exists regarding the presence of multi-drug resistant organisms on such surfaces. *Category II*

**It appears that not only is disinfectant
use important but how often is
important**

Daily disinfection vs clean when soiled

ALL “TOUCHABLE” (HAND CONTACT) SURFACES SHOULD BE WIPED WITH DISINFECTANT

“High touch” objects only recently defined (no significant differences in microbial contamination of different surfaces) and “high risk” objects not epidemiologically defined. Cleaning and disinfecting is one-step with disinfectant-detergent. No pre-cleaning necessary unless spill or gross contamination.

OSHA BBP-Housekeeping Practices

- Initial clean-up of blood or OPIM shall be followed with the use of an EPA-approved hospital disinfectant chemical germicide that has either a tuberculocidal or HIV/HBV label claim or a solution of 5.25% sodium hypochlorite (household bleach) diluted between 1:10 and 1:100 with water. **1:100 on nonporous surface-CBIC**
- Equipment contaminated with blood or OPIM shall be decontaminated if possible prior to servicing or shipping

Evaluation of Hospital Floors as a Potential Source of Pathogen Dissemination

Koganti et al. ICHE 2016. 37:1374; Deshpande et al. AJIC 2017. 45:336.

- Effective disinfection of contaminated surfaces is essential to prevent transmission of epidemiologically-important pathogens
- Efforts to improve disinfection focuses on touched surfaces
- Although floors contaminated, limited attention because not frequently touched
- Floors are a potential source of transmission because often contacted by objects that are then touched by hands (e.g., shoes, socks)
- Non-slip socks contaminated with MRSA, VRE (Mahida, J Hosp Infect. 2016;94:273)

Recovery of Nonpathogenic Viruses from Surfaces and Patients on Days 1, 2, and 3 After Inoculation of Floor Near Bed

Koganti et al. ICHE 2016. 37:1374

- Found that a nonpathogenic virus inoculated onto floors in hospital rooms disseminated rapidly to the footwear and hands of patients and to high-touch surfaces in the room
- The virus was also frequently found on high-touch surfaces in adjacent rooms and nursing stations
- Contamination in adjacent rooms in the nursing station suggest HCP contributed to dissemination after acquiring the virus during contact with surfaces or patients
- Studies needed to determine if floors are source of transmission

Disinfection of Noncritical Surfaces Bundle

□ Develop policies and procedures

- Standardize C/D patient rooms and pieces of equipment throughout the hospital
- All touchable hand contact surfaces wiped with disinfection daily, when spills occur and when the surfaces are visibly soiled.
- All noncritical medical devices should be disinfected daily and when soiled
- Clean and disinfectant sink and toilet
- Damp mop floor with disinfectant-detergent (CBIC-detergent)
- If disinfectant prepared on-site, document correct concentration
- Address treatment time/contact time for wipes and liquid disinfectants (e.g., treatment time for wipes is the kill time and includes a wet time via wiping as well as the undisturbed time).

Effective Surface Decontamination

Product and Practice = Perfection

Best Practices in Disinfection of Noncritical Surfaces in the Healthcare Setting: A Bundle Approach

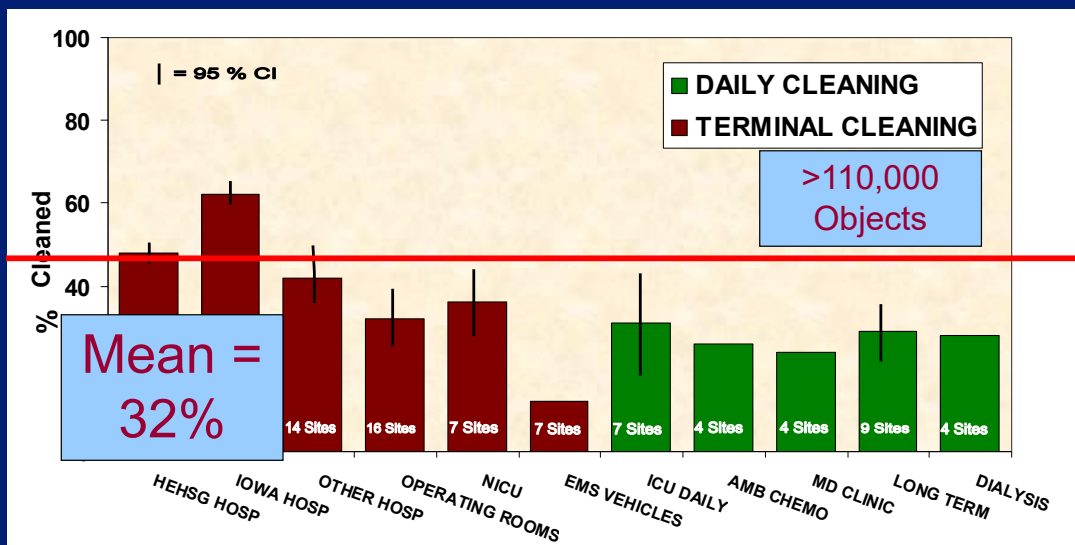
NL Havill AJIC 2013;41:S26-30; Rutala, Weber. AJIC 2019;47:A96-A105

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Thoroughness of Environmental Cleaning

Carling et al. ECCMID, Milan, Italy, May 2011



Practice* NOT Product

*surfaces not wiped

MONITORING THE EFFECTIVENESS OF CLEANING

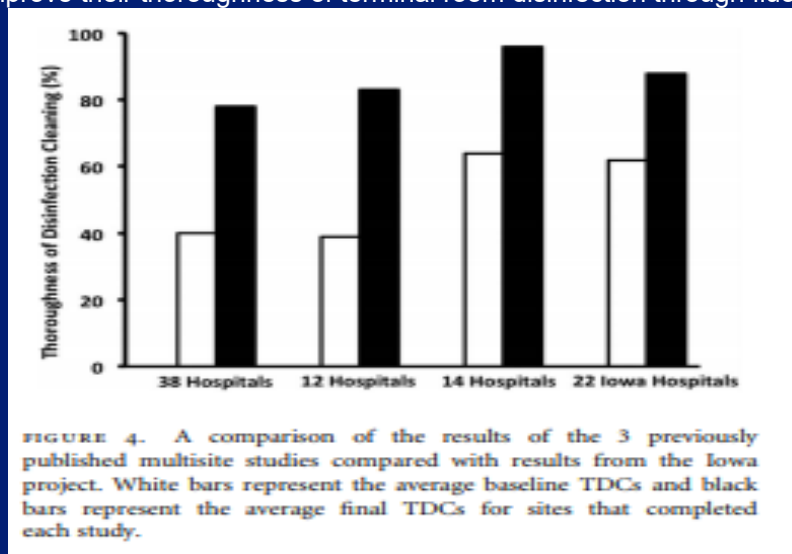
Cooper et al. AJIC 2007;35:338

- Visual assessment-not a reliable indicator of surface cleanliness
- **ATP bioluminescence**-measures organic debris (each unit has own reading scale, <250-500 RLU)
- Microbiological methods-<2.5CFUs/cm²-pass; can be costly and pathogen specific (**CBIC-most reliable**)
- **Fluorescent marker-transparent, easily cleaned, environmentally stable marking solution that fluoresces when exposed to an ultraviolet light** (applied by IP unbeknown to EVS, after EVS cleaning, markings are reassessed)

Thoroughness of Environmental Cleaning

Carling and Herwaldt. Infect Control Hosp Epidemiol 2017;38:960–965

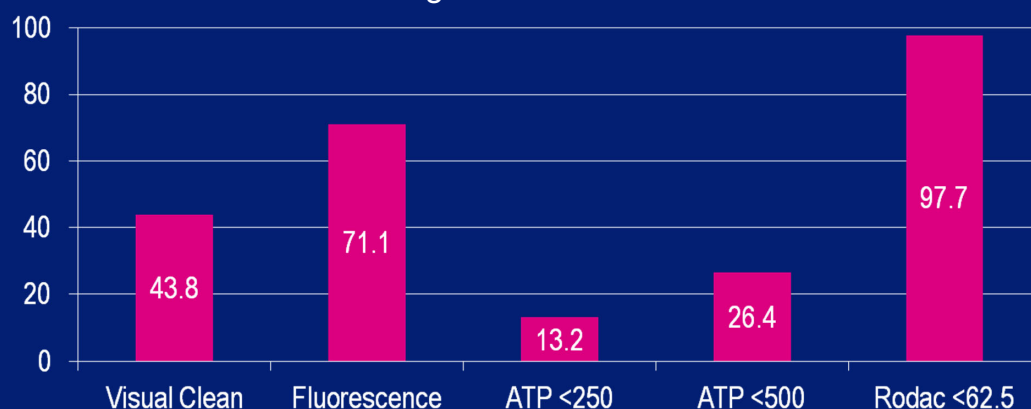
Hospitals can improve their thoroughness of terminal room disinfection through fluorescent monitoring



Percentage of Surfaces Clean by Different Measurement Methods

Rutala, Kanamori, Gergen, Sickbert-Bennett, Huslage, Weber. APIC Poster 2017.

Fluorescent marker is a useful tool in determining how thoroughly a surface is wiped and mimics the microbiological data better than ATP



DAILY CLEANING/DISINFECTING PRACTICES

Hota et al. J Hosp Infect 2009;71:123

- Cleaning should be from the cleanest to dirtiest areas (the bathroom will be cleaned last followed by the floor)
- Change cleaning cloths after every room and use at least 3 cloths per room; typically 5-7 cloths
- Do not place cleaning cloth back into the disinfectant solution after using it to wipe a surface
- Daily cleaning of certain patient equipment is the responsibility of other HCP (RC, nursing). Surfaces should be wiped with a clean cloth soaked in disinfectant

CBIC-Environmental Services

- You have been asked to do an in-service for Environmental Services on cleaning procedures. Which of the following is the best practice for cleaning a patient room:
 1. Clean the patient zone first, and then the perimeter of the room
 2. Clean the perimeter of the room first, and then the patient zone
 3. Clean items that are low to the floor and then work your way up to higher items
 4. Clean items that are higher up first, and then work your way down to lower items
 - a. 1,3
 - b. 2,3
 - c. 1,4
 - d. 2,4

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 - d. 2,4

Answer: 2,4 (least soiled moving toward most soiled; surfaces higher up cleaned first)

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These interventions (effective surface disinfection, thoroughness indicators) not enough to achieve consistent and high rates of cleaning/disinfection

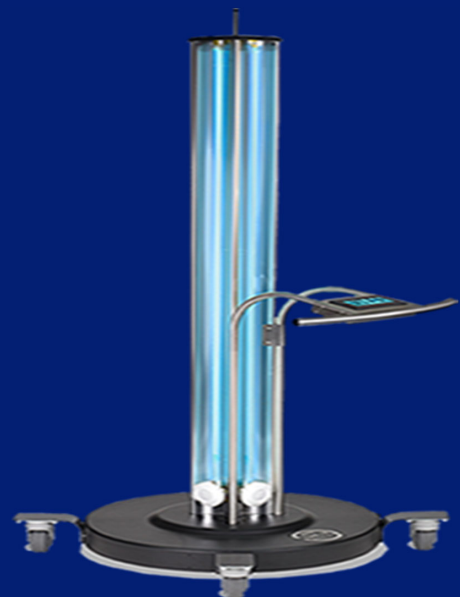
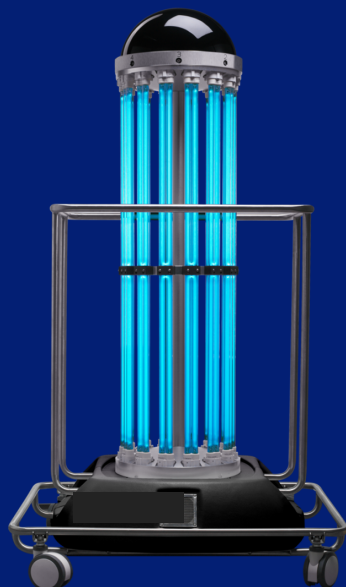
No Touch

(supplements but do not replace surface cleaning/disinfection)

“NO TOUCH” APPROACHES TO ROOM DECONTAMINATION

(UV/VHP~20 microbicidal studies, 12 HAI reduction studies; will not discuss technology with limited data)

Weber, Kanamori, Rutala. Curr Op Infect Dis 2016;29:424-431; Weber, Rutala et al. AJIC; 2016;44: e77-e84; Anderson et al. Lancet 2017;389:805-14; Anderson et al. Lancet Infect Dis 2018;June 2018.



UV vs VHP

- Which technology is effective at disinfecting all surfaces and supplies in the room? **CBIC**

Enhanced Disinfection Leading to Reduction of Microbial Contamination and a Decrease in Patient Col/Infection

Anderson et al. Lancet 2017;289:805; Rutala et al. ICHE In press.

	Standard Method		Enhanced method	
	Quat	Quat/UV	Bleach	Bleach/UV
EIP (mean CFU per room) ^a	60.8	3.4	11.7	6.3
Reduction (%)		94	81	90
Colonization/Infection (rate) ^a	2.3	1.5	1.9	2.2
Reduction (%)		35	17	4

All enhanced disinfection technologies were significantly superior to Quat alone in reducing EIPs. Comparing the best strategy with the worst strategy (i.e., Quat vs Quat/UV) revealed that a reduction of 94% in EIP (60.8 vs 3.4) led to a 35% decrease in colonization/infection (2.3% vs 1.5%). Our data demonstrated that a decrease in room contamination was associated with a decrease in patient colonization/infection. First study which quantitatively described the entire pathway whereby improved disinfection decreases microbial contamination which in-turn reduced patient colonization/infection.

MICROBIOLOGIC SAMPLING OF THE ENVIRONMENT

- ❑ Do not conduct random microbiological sampling of air, water, and surfaces (IB)
- ❑ When indicated, conduct microbiologic sampling as part of an epidemiologic investigation (IB)
- ❑ Limit microbiologic sampling for QA to: biological monitoring, dialysis water, or evaluation of infection control measures (IB)

Environment of Care

Monitor Elements for Safe Care Environment

- ❑ HVAC (pressure)
- ❑ Airborne fungal outbreaks
- ❑ Construction and renovation
- ❑ Water as a source of pathogens
- ❑ *Legionella* and *Aspergillus*
- ❑ Environmental cleaning and disinfection (CD)
- ❑ Laundry
- ❑ Regulated waste

LAUNDRY AND BEDDING

- Although fabrics in healthcare facilities can be a source of large numbers of microorganisms 10^6 - 10^8 CFU/100 cm², the risk of disease transmission during the laundry process appears to be negligible
- OSHA defines contaminated laundry as “soiled with blood or OPIM or may contain sharps”

LAUNDRY AND BEDDING

- Bag or contain contaminated laundry at the point of use (IC)
- Do not sort or pre-rinse fabrics in patient-care areas (IC)
- Do not conduct routine microbiological sampling of clean linens (IB)
- Use sterilized linens, drapes, and gowns for situations requiring sterility (IB)
- Use hygienically clean textiles (i.e., laundered) in NICU (IB)

LAUNDRY AND BEDDING

- If hot-water laundry cycles are used, wash with detergent in water **at least 160°F for at least 25 min (IC)-CBIC**
- If low-temperature (<160°F) cycles are used, use chemicals suitable for low temperature washing at proper use concentration (II)
- Package, transport and store clean fabrics by methods that ensure their cleanliness and protect them from dust and soil (II)
- **CBIC-Clean and dirty linens can be transported together in the same vehicle if they are clearly separated (e.g., barriers)**

LAUNDRY AND BEDDING

- Clean and disinfect mattress covers by using disinfectants that are compatible (IB)
- Keep mattresses dry (IB)
- Replace mattress if they become torn (II)
- Air-fluidized beds: change the polyester filter sheet at least weekly (II); clean/disinfect the polyester filter thoroughly, especially between patients (IB)

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- Environmental cleaning and disinfection (CD)
- Laundry
- Regulated waste

REGULATED MEDICAL WASTE (RMW)

- Major categories of RMW: microbiology; pathology; bulk blood; sharps (II)
- Develop a plan for collection and disposal of RMW (IC)
- Sharps into puncture-resistant containers (IC)
- Biosafety levels 1 and 2 should autoclave on-site (II); BL 3 must autoclave/incinerate (II)
- Decontaminate blood VHF before disposal (IC)

Environment of Care

□ CBIC-14 questions. Will test knowledge of the following:

■ Environmental Safety

- ◆ Recognize and collaborate on process for a safe care environment: HVAC, water pathogen, laundry, waste management, environmental cleaning/disinfect
- ◆ Collaborate on evaluation/monitoring of environmental CD practices
- ◆ Monitor for environmental pathogens (e.g., *Legionella*, *Aspergillus*)

■ Recognize and monitor elements for safe care environment

- ◆ Evaluate infection risks and make recommendations during planning, design, and phases of construction
- ◆ Risk mitigation during construction, renovation and maintenance (pressure, barriers)

Thank you