GUIDELINES FOR ENVIRONMENTAL INFECTION CONTROL IN HEALTH-CARE FACILITIES, 2003

William A. Rutala, Ph.D., M.P.H., C.I.C.

Director, Statewide Program for Infection Control and Epidemiology and Professor of Medicine, University of North Carolina at Chapel Hill, NC, USA

Former Director, Hospital Epidemiology, Occupational Health and Safety, UNC Health Care, Chapel Hill, NC

Sources of Healthcare-Associated Pathogens

Weinstein RA. Am J Med 1991:91 (suppl 3B):179S

- Endogenous flora (SSI, UTI, CLABSI): 40-60%
- Exogenous: 20-40% (e.g., cross-infection via contaminated hands [staff, visitors])
- Other (environment): 20%
  - Medical devices/inanimate objects
  - Contact with environmental surfaces (direct and indirect)

GUIDELINE FOR ENVIRONMENTAL INFECTION CONTROL IN HEALTHCARE FACILITIES

- Review recommendations for:
  - Air
  - Water
  - Environmental Services
  - Environmental Sampling
  - Laundry and Bedding
  - Animals in Healthcare Facilities
  - Regulated Medical Waste

GUIDELINE FOR ENVIRONMENTAL INFECTION CONTROL IN HEALTHCARE FACILITIES

- Ranking of Recommendations
  - Category IA-strongly recommended and strongly supported by studies
  - Category IB-strongly recommended and supported by some studies and strong theoretical rationale
  - Category IC-required by regulatory agencies
  - Category II-suggested for implementation

MECHANISMS OF TRANSMISSION

- Contact
  - Direct (actual physical contact between source and patient)
  - Indirect (transmission from source to patient through an intermediate object)
  - Droplet (transmission $\leq$3 feet)
- Airborne (true airborne phase of transmission)

MECHANISMS OF TRANSMISSION

- Common vehicle-source is common to those who acquire the disease
  - Food
  - Water
  - Medications
  - Blood
  - Equipment
- Arthropod-borne

GUIDELINE FOR ENVIRONMENTAL INFECTION CONTROL IN HEALTHCARE FACILITIES

- Review recommendations for:
  - Air
  - Water
  - Environmental Services
  - Environmental Sampling
  - Laundry and Bedding
  - Animals in Healthcare Facilities
  - Regulated Medical Waste

NOSOCOMIAL AIRBORNE FUNGAL INFECTIONS

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

Review of Fungal Outbreaks

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

Review of Fungal Outbreaks and Infection Prevention in Healthcare Settings During Construction and Renovation

Hajime Kanamori,[1,2] William A. Rutala,[1,2] Emily E. Sickbert-Bennett,[1,2] and David J. Weber[1,2]

[1]Hospital Epidemiology, University of North Carolina Health Care, and [2]Division of Infectious Diseases, University of North Carolina School of Medicine, Chapel Hill

Hospital construction and renovation activities are an ever-constant phenomenon in healthcare facilities, causing dust contamination and possible dispersal of fungal spores. We reviewed fungal outbreaks that occurred during construction and renovation over the last 4 decades as well as current infection prevention strategies and control measures. Fungal outbreaks still occur in healthcare settings, especially among patients with hematological malignancies and those who are immunocompromised. The causative pathogens of these outbreaks were usually *Aspergillus* species, but Zygomycetes and other fungi were occasionally reported. *Aspergillus* most commonly caused pulmonary infection. The overall mortality of construction/renovation-associated fungal infection was approximately 50%. The minimal concentration of fungal spores by air sampling for acquisition of fungal infections remains to be determined. Performing infection control risk assessments and implementing the recommended control measures is essential to prevent healthcare-associated fungal outbreaks during construction and renovation.

Keywords. fungal outbreaks; *Aspergillus*; healthcare-associated infections; construction; renovation.

Review of Fungal Outbreaks

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

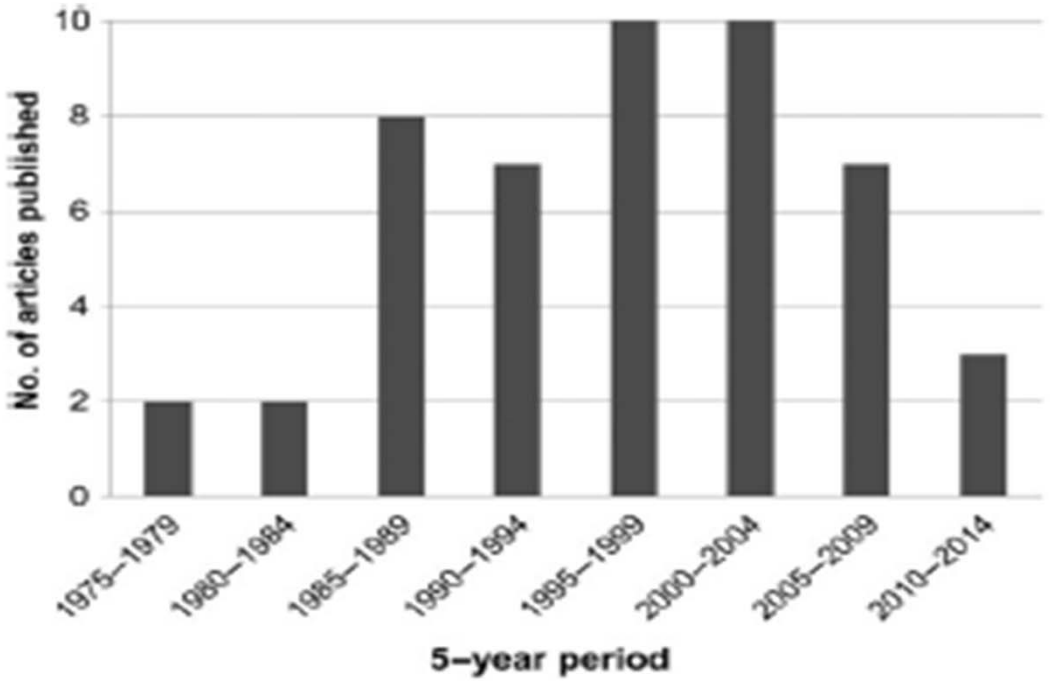


Figure 1. Trend of fungal outbreaks and infections associated with construction, renovation, and demolition.

Review of Fungal Outbreaks

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

Table 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.[a] (%)
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)

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

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	*Aspergillus* infection (lung, pharyngeal, or maxillary sinus)	*Aspergillus* spp. (predominantly *A. niger*, *A. flavus*, *A. fumigatus*)	Fireproofing material sprayed wet during construction	Unknown	Unknown	Unknown
Arnow, 1978 [6]	Immunosuppression (renal transplant)	3	1	*Aspergillus* infection (lung)	*A. fumigatus*, *Aspergillus* 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 *Aspergillus* infection (lung)	*A. flavus*	Construction, defective ventilation and air filtration	8 *A. flavus*/positive room, control 1 *A. flavus*/positive room-settle plates	Unknown	Pre-filters and filters in ventilation system replaced
Lentino, 1982 [7]	Immunosuppressed patients with renal allograft recipients or hematologic malignancy	10	4	Invasive *Aspergillus* infection (lung)	*Aspergillus* sp.	Road construction for access to the new hospital, contaminated window air conditioners in renal transplantation ward	400–2800 *Aspergillus* spores/cm^2 from air conditioner filter	Unknown	Unknown
Krasinski, 1985 [9]	Premature infants	2	2	Fungal infection (lung)	*Aspergillus* sp., Zygomycetes, *Rhizopus indicus*	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	*Aspergillus* infection (disseminated)	*A. flavus*, *A. fumigatus*, *A. niger*, *Aspergillus* sp.	Hospital renovation and construction	5.9 ± 0.7 *Aspergillus*/m^3 inside construction site compared to 1.2 *Aspergillus*/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 *Aspergillus* infection (lung)	Unknown	Building work installing a laminar air flow system to the unit	133 cfu/m^3 of *A. fumigatus* in the BMT unit during building work	Unknown	Laminar air flow isolation
Humphrey	Severe patients in	2	2	Invasive	*A. fumigatus*	Building work in an area	Sampling after	Unknown	Improved hospital design

NOSOCOMIAL ASPERGILLOSIS IN OUTBREAK SETTINIGS

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-hemotologic 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*

UNDERLYING CONDITIONS IN PATIENTS WITH NOSOCOMIAL ASPERGILLOSIS

	No. of Patients	Mortality (%)
Hematologic malignancy	299	57.6
Solid organ transplant		55.9
ℓ Renal transplant	36	
ℓ Liver transplant	8	
Other immunocompromised		52.3
ℓ High-dose steroid therapy	15	
ℓ Neonates	5	
ℓ Other malignancy	4	
ℓ Chronic lung disease	2	
ℓ ICU patients (“high-risk”)	2	
ℓ No exact classification possible	49	
Patients without severe immunodeficiency		39.4
ℓ Thoracic surgery	25	
ℓ Cataract surgery	5	
ℓ ICU patients (“low risk”)	5	
ℓ Other surgery patients	3	
TOTAL	458	55.0


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*


NOT AN EXIT
CONSTRUCTION SITE
DO NOT ENTER

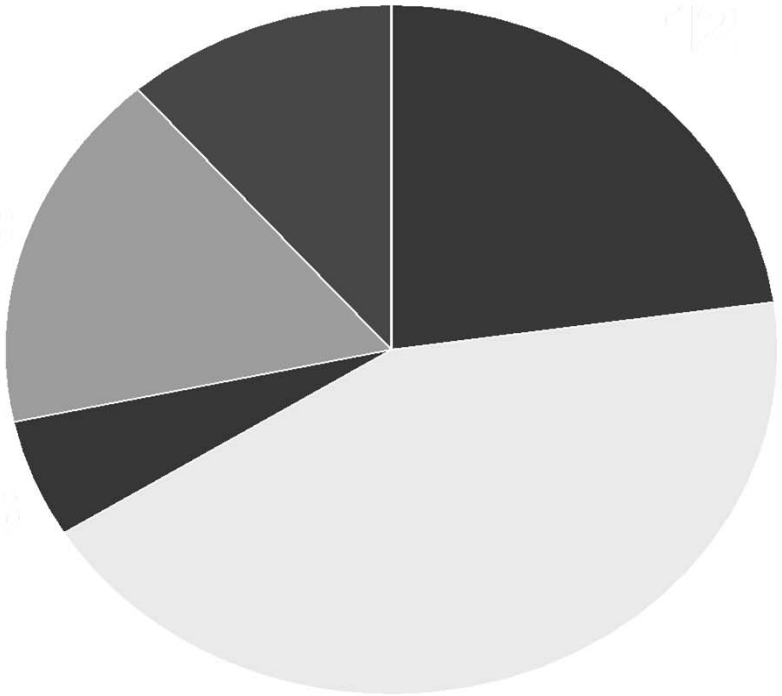
Aspergillus

- *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

Medically-Important Mycotic Agents

Aspergillus fumigatus

NOSOCOMIAL ASPERGILLOSIS IN OUTBREAK SETTINGS



Vonberg R-P, Gastmeier P. J Hosp Infect 2006;63:246-54

Characteristics of Patients and Causative *Aspergillus spp* in Nosocomial Outbreaks

Vonberg, Gastmeier. JHI 2006. 63:245

Table I Characteristics of patients and causative *Aspergillus* spp. in nosocomial outbreaks

Author (year, country)	Patient group (*N* patients)	Patients (*N* fatal)	Primary site of infection (*N*)	Clinical *Aspergillus* spp. isolates (*N*)
Gage *et al.* (1970, USA)[53,54]	T-SURG (4)	4 (3)	Endocarditis (4)	*fumigatus* (3); *glaucus* (1)
Burton *et al.* (1972, USA)[55]	RTX (4)	4 (0)	LRTI (4)	*fumigatus* (4)
Rose (1972, USA)[39]	HEMA (?); others (?)	Total: 23 (total: 12)	LRTI (23)	*fumigatus* (≥12)
Aisner *et al.* (1976, USA)[40]	HEMA (8)	8 (≥3)	LRTI (7); sinusitis (1)	Unknown (8)
Kyriakides *et al.* (1976, USA)[56]	RTX (3)	3 (1)	LRTI (3)	*fumigatus* (3)
Arnow *et al.* (1978, USA)[57]	RTX (3)	3 (1)	LRTI (2)	*fumigatus* (3)
Mahoney *et al.* (1979, USA)[58]	HEMA (5)	5 (3)	Sinusitis (3); LRTI (2)	*fumigatus* (1); unknown (4)
Lentino *et al.* (1982, USA)[49]	RTX (7); HEMA (3)	Total: 10 (total: 4)	LRTI (10)	Unknown (10)
Sarubbi *et al.* (1982, USA)[59]	HEMA (?); others (?)	Total: 22 (total: 1)	LRTI (1)	*flavus* (22)
Gustafson *et al.* (1983, USA)[60]	RTX (9)	9 (7)	LRTI (8); epidural abscess (1)	*fumigatus* (3); unknown (6)
Gerson *et al.* (1984, USA)[61–63]	HEMA (15)	15 (?)	LRTI (15)	Unknown (15)
Grossman *et al.* (1985, USA)[64]	HEMA (6)	6 (0)	Skin infection (6)	*flavus* (3); *fumigatus* (2); *niger* (1)
Krasinski *et al.* (1985, USA)[65]	Neonates (1)	1 (1)	Skin infection (1)	Unknown (1)
Rotstein *et al.* (1985, USA)[66,67]	HEMA (10)	10 (10)	LRTI (9); sinusitis (1)	*fumigatus* (7); *flavus* (3)
Opal *et al.* (1986, USA)[68]	HEMA (7); steroids (3); ONCO (1)	7 (7) 3 (3) 1 (1)	LRTI (11)	*flavus* (4); *fumigatus* (1); *niger* (1); unknown (5)
Allo *et al.* (1987, USA)[69]	HEMA (9)	9 (2)	Skin infection (9)	*flavus* (8); unknown (1)
Perraud *et al.* (1987, France)[70,71]	HEMA (22)	22 (18)	LRTI (22)	*fumigatus* (22)
Ruutu (1987, Finland)[72,73]	HEMA (8)	8 (8)	LRTI (8)	*fumigatus* (8)
Sherertz *et al.* (1987, USA)[3]	HEMA (14)	14 (13)	LRTI (14)	*fumigatus* (?); *flavus* (?)
Weems *et al.* (1987, USA)[74]	HEMA (3)	3 (3)	LRTI (3)	Unknown (3)
Harvey *et al.* (1988, UK)[75]	ICU patients low risk (2);	2 (2)	Endocarditis (3)	*fumigatus* (≥3)

Fungal Outbreaks and Infections Associated with Construction, Renovation and demolition, 1975-2014

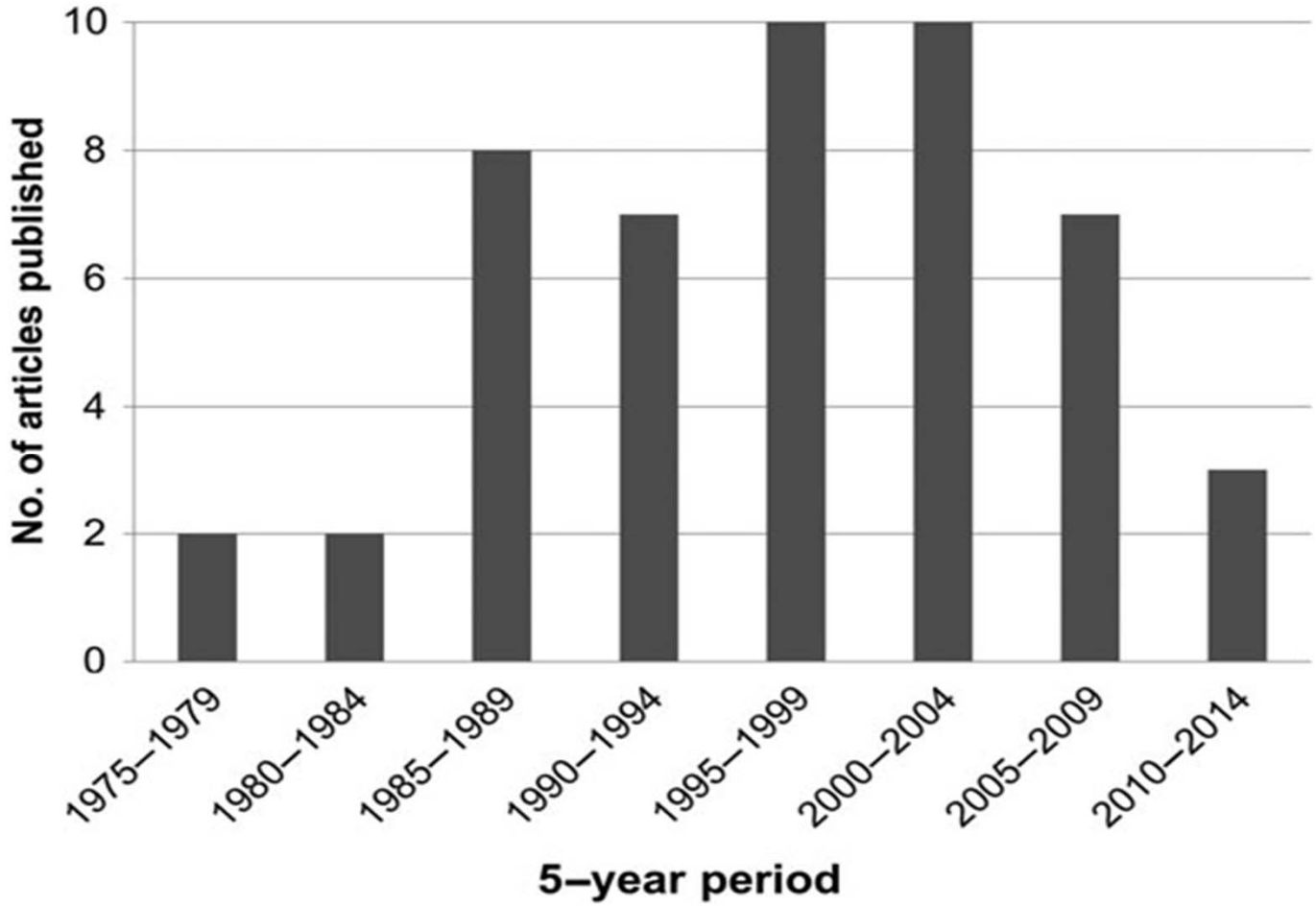
Kanamori, Rutala, Sickbert-Bennett, Weber. Clin Infect Dis 2015;61:434

Table 1 continued.

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
Brincker, 1991 [18]	Acute leukemia	10	4	*Aspergillus* infection (lung)	Unknown	Indoor building renovation, Increased spores in ward locations with heavy traffic of patients and staff	At least 11.2 *Aspergillus* per 24h-settle plate	Unknown	Unknown
Flynn, 1993 [20]	BMT recipients, acute myeloid leukemia, or disseminated choriocarcinoma	4	4	*Aspergillus* infection (lung)	*A. terreus*	Hospital renovation, entry of fungal organisms from corridors, stairwells, elevator, shafts serving the ICU and renovation areas due to the negative air pressure gradient	Fungal spores >71/m^3 at elevator shafts during renovation	Unknown	Reestablished positive pressure and unidirectional airflow
Iwen, 1994 [22]	Neutropenic patients who underwent high-dose chemotherapy	5	Unknown	Invasive *Aspergillus* infection (unknown)	*A. fumigatus*, *A. flavus*	Hospital construction, increase in molds in the air occurred in the patient rooms and corridor adjacent to construction staging area, windows in the adjacent corridor as the most likely source of mold contamination	0.14 cfu fungi per hour per settle plate (before construction) to 0.40 cfu fungi per hour per settle plate (after construction)	Unknown	Special care unit closed to incoming patients, window casements, plumbing penetrations, electrical outlets, and other sources for potential air leaks visually examined and sealed, HEPA filters replaced, each room terminally cleaned with subsequent follow-up testing by air-settling plates
Buffington, 1994 [21]	Acute leukemia or aplastic anemia	7	6	Invasive *Aspergillus* infection (unknown)	*A. flavus*, *A. fumigatus*, *Aspergillus* sp.	Construction activity, staff and visitors frequently walking through breezeway by the construction	Unknown	Randomly amplified polymorphic DNA (6 different pattern, similar pattern banding from case patient, healthcare worker, and environmental source)	Laminar air flow rooms with HEPA filters, air intake ducts decontaminated with formaldehyde vapor
Loudon, 1994 [23]	Hematologic malignancies (acute lymphoblastic leukemia, acute myeloid leukemia, lymphoma, Hodgkin's disease)	7	5	Invasive *Aspergillus* infection (lung)	*A. fumigatus*, *A. flavus*	Extensive building work was ongoing on the ground floor beneath the hematology unit, *Aspergillus* for showerhead	Unknown	Silver staining of sodium dodecyl sulphate-polyacrylamide gels, immunoblot fingerprinting, and random amplification of polymorphic DNA (3 cases indistinguishable)	Itraconazole prophylaxis

Fungal Outbreaks and Infections Associated with Construction, Renovation and Demolition, 1975-2014

Kanamori, Rutala, Sickbert-Bennett, Weber. Clin Infect Dis 2015;61:434



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

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

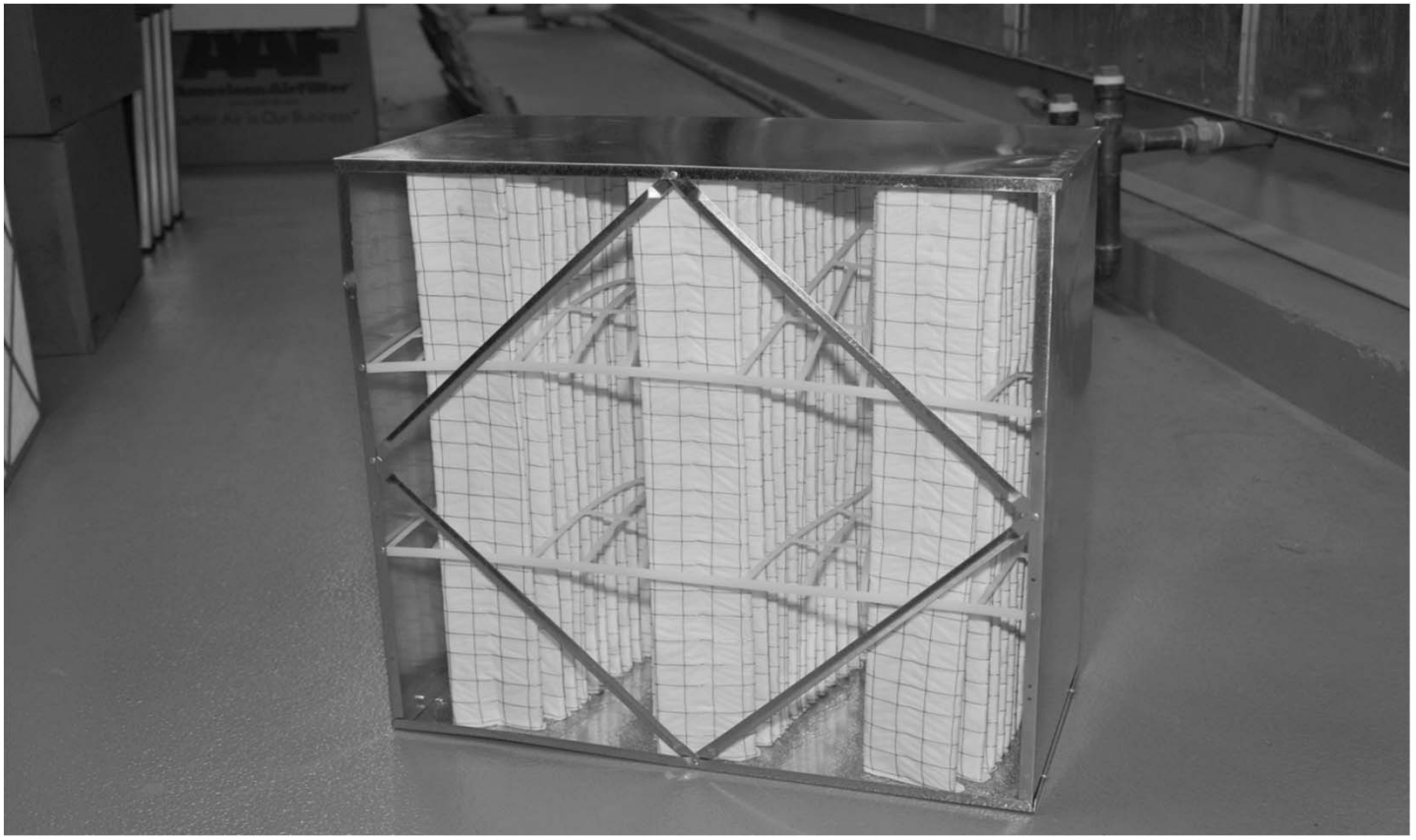
AIRBORNE FUNGI AT UNC HEALTH CARE, 2013

- 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)

Heating, Ventilation and Air Conditioning

Four HVAC Systems In Cancer Hospital

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



RELEVANT GUIDELINES

- 2003: Guidelines for preventing health-care-associated pneumonia (HICPAC)
- 2003: Guidelines for environmental infection control in health-care facilities (CDC, HICPAC)
- 2000: Guidelines for preventing opportunistic infections among hematopoietic stem cell transplant recipients (CDC, IDSA, ASBMT)
- American Institute of Architects Academy of Architecture for Health. Guidelines for Design and Construction of Hospital and Health Care Facilities , 2006. (telephone #: 888-272-4115)
- Construction and Renovation, 3rd Edition ,and Infection Prevention for Construction DVD, Association for Professionals in Infection Control and Epidemiology, 2007 ($173 member price) APIC store: www.apic.org/
- APIC Text of Infection Control and Epidemiology, 3rd ed. Association for Professionals in Infection Control and Epidemiology, 2009. www.apic.org/
- ASHRAE - American Society of Heating, Refrigeration and Air Conditioning Engineers

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

MATCH RISK GROUP WITH CONSTRUCTION TYPE

	Construction Project Type			
Patient Risk Group	**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	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.	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 Dept. 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.

SURVEILLANCE[1]

- Maintain a high index of suspicion for healthcare-associated pulmonary aspergillosis in severely immunocompromised patients (ANC <500/mm^3 for 2 weeks or <100/mm^3 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)

[1]Tablan 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

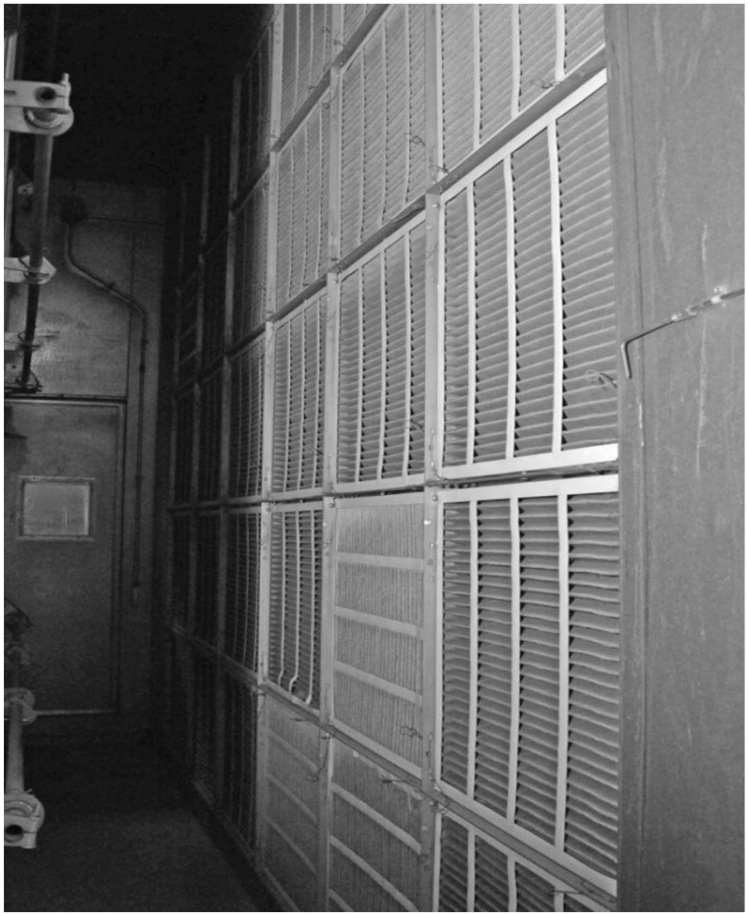
- Procedures during construction and renovations
  - Seal hospital construction areas behind impervious barriers
  - Clean construction area daily (i.e., remove dust)
  - Assure that ventilation system does not transport dust from inside construction area to other locations
  - Move immunocompromised 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 (AII, 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

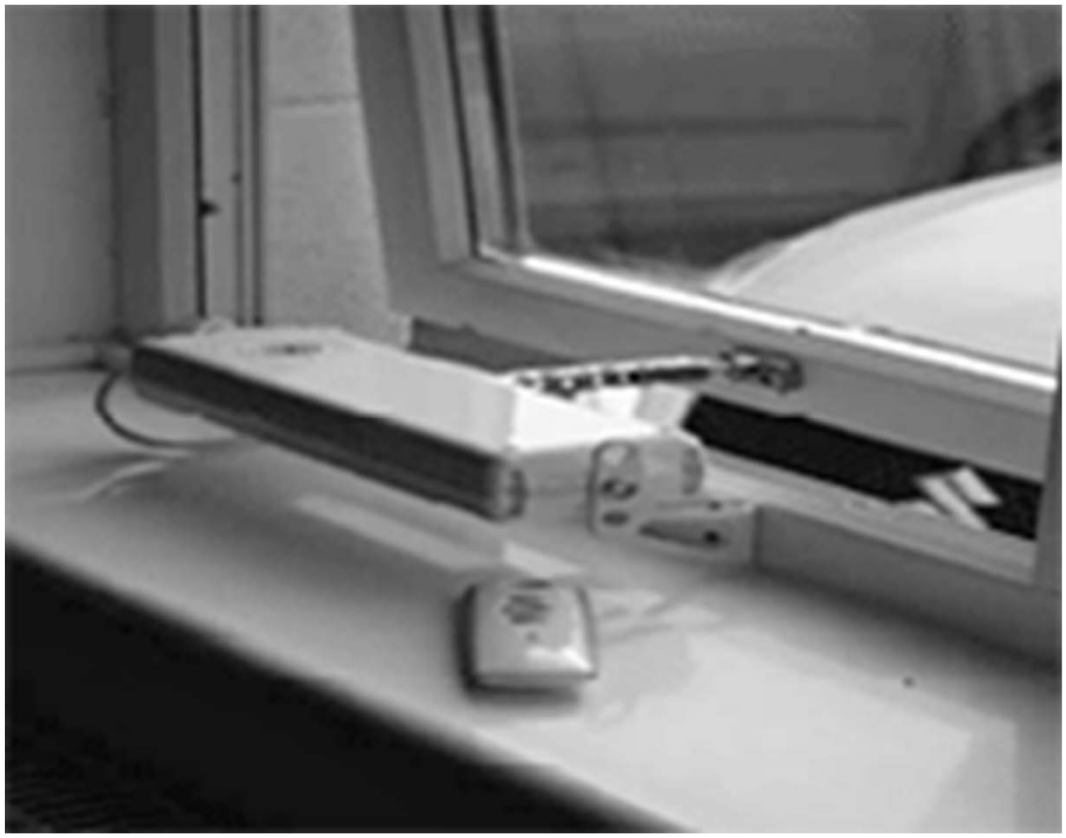
Filter Bank of MERV 8



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



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)

- Planning new units for high-risk patients
  - **Air-filtration:** Install HEPA filters (99.97% efficient in filtering 0.3µ-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 $\geq$12 per hour (IC)

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 (eg, vacuuming, disruption of ceiling tiles) (IB)
- Patients leave their room, provide respiratory protection (eg, N95, surgical mask) (II)
- Minimize time the IC patients are outside their rooms for diagnostic procedures and other activities (IB)

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 $\geq$12 per hour (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)

SPECIAL HEALTHCARE SETTINGS

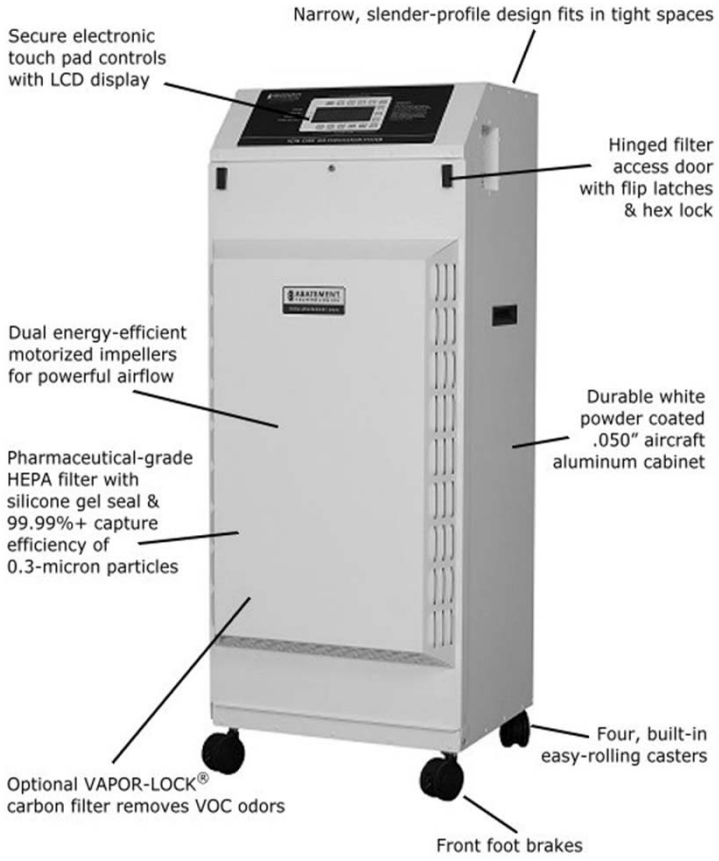
(TB in Operating Rooms)

- If possible, last case of the day to allow for maximum removal of air contaminates (II)
- OR personnel should use N95 respirators (IC)
- Intubate in the OR or AII (IB); extubate in AII (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

GUIDELINE FOR ENVIRONMENTAL INFECTION CONTROL IN HEALTHCARE FACILITIES

- Review recommendations for:
  - Air
  - Water
  - Environmental Services
  - Environmental Sampling
  - Laundry and Bedding
  - Animals in Healthcare Facilities
  - Regulated Medical 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	*Pseudomonas, Mycobacteria, Legionella*	Contact	Moderate	Follow public health guidelines
Sinks	*Pseudomonas*	Contact, droplet	Low	Use separate sinks for handwashing and disposal of contaminated fluids
Faucet aerators	*Pseudomonas*	Contact, droplet	Low	No precautions necessary at present
Showers	*Legionella*	Inhalation	Low	Prohibit use in immunocompromised patients
Ice and ice machines	*Legionella, Enterobacter, Pseudomonas, Salmonella, Cryptosporidia*	Ingestion, contact	Moderate	Periodic cleaning; use automatic dispenser (ie, avoid open chest storage compartments in patient areas)
Eyewash stations	*Pseudomonas, Legionella, Ameba*	Contact	Low	Have available sterile water for eye flush or weekly (or monthly) flush eyewash stations
Dental-unit water systems	*Pseudomonas, Legionella, Sphingomonas, Acinetobacter*	Contact	Low	Clean water systems
Dialysis water	Gram-negative bacilli	Contact	Moderate	Follow guidelines: dialysate ≤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]

[1]Division of Infectious Diseases, University of North Carolina School of Medicine, and [2]Hospital Epidemiology, University of North Carolina Health Care, Chapel Hill

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, *Pseudomonas aeruginosa*), *Legionella*, 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 *Legionella*. *Legionella* eradication can be technically difficult, temporary, and expensive. Potential methods of eradication include filtration, ultraviolet, ozonization, 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, *Pseudomonas*, *Acinetobacter*, *Serratia*).	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 *Pseudomonas*, *Stenotrophomonas*, and *Legionella*.	Routine screening and disinfection or permanent removal of all aerators are not warranted at present. No precautions necessary at present. For *Legionella* 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 *Legionella*, *Pseudomonas*, NTM, group A *Streptococcus*, and *Aspergillus*.	Prohibit use of showers in neutropenic patients. Control *Legionella* 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 *Pseudomonas*, *Enterobacter*,	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 *Pseudomonas*, *Legionella*, 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 *Sphingomonas*, *Pseudomonas*, *Acinetobacter*, *Legionella*, 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 *Pseudomonas*, *Acinetobacter*, *Burkholderia*, *Staphylococcus*, and *Ewingella*.	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 thermodilution catheters.

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 *Pseudomonas*, *Enterobacter*, *Citrobacter*, *Acinetobacter*, *Legionella*, *Alcaligenes*, 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, *Pseudomonas*, *Clostridium difficile*, 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 *Acinetobacter*, *Klebsiella*, *Enterobacter*, *Pseudomonas*, *Serratia*, *Burkholderia cepacia*, *Aeromonas hydrophila*, and *Flavobacterium*. 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 *P. aeruginosa*).	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 *Legionella*.
Decorative water wall fountains	*Legionella* pneumonia 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 *Mycobacterium chimaera* 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 *Enterobacter cloacae* and *B. cepacia*), wash basins (*Salmonella urbana* infection, *Trichosporon asahii* infection, *Legionella* pneumonia), intraaortic balloon pump (*B. cepacia* bacteremia), humidifier water in ventilator systems (*Acremonium kiliense* postoperative endophthalmitis), water cooler (gastrointestinal illness), holy water (*Acinetobacter baumannii* infection), deionized water (*Exophiala jeanselmei* fungemia), water-damaged plaster (mucormycosis), water birth (*Legionella* pneumonia), water-saving device (*P. aeruginosa* 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

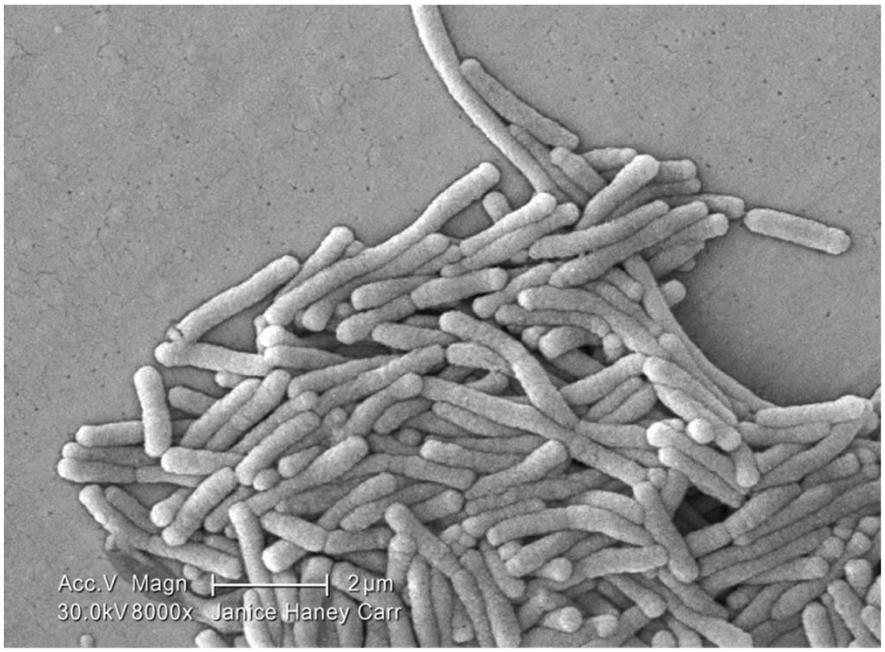
LEGIONELLA: EPIDEMIOLOGY

- 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^{o}F (IC)
  - When state regulations do not allow hot water temp >120^{o}F, chlorinate the water or periodically increase >150^{o}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 IC 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)

Facility Requirements to Prevent Legionella Infections

Facilities must develop and adhere to policies and procedures that inhibit microbial growth in building water systems that reduce the risk of growth and spread of *legionella* and other opportunistic pathogens in water.

DEPARTMENT OF HEALTH & HUMAN SERVICES
Centers for Medicare & Medicaid Services
7500 Security Boulevard, Mail Stop C2-21-16
Baltimore, Maryland 21244-1850

CMS
CENTERS FOR MEDICARE & MEDICAID SERVICES

Center for Clinical Standards and Quality/Survey & Certification Group

Ref: S&C 17-30-ALL

DATE: **June 02, 2017**

TO: State Survey Agency Directors

FROM: Director
Survey and Certification Group

SUBJECT: Requirement to Reduce *Legionella* Risk in Healthcare Facility Water Systems to Prevent Cases and Outbreaks of Legionnaires' Disease (LD)

Memorandum Summary

- ***Legionella* Infections**: The bacterium *Legionella* can cause a serious type of pneumonia called LD in persons at risk. Those at risk include persons who are at least 50 years old, smokers, or those with underlying medical conditions such as chronic lung disease or immunosuppression. Outbreaks have been linked to poorly maintained water systems in buildings with large or complex water systems including hospitals and long-term care facilities. Transmission can occur via aerosols from devices such as showerheads, cooling towers, hot tubs, and decorative fountains.

DIALYSIS WATER

- Excessive levels of gram-negative bacilli in the dialysate have been responsible for pyrogenic reactions in patients
- Hazard caused by bacteria or endotoxin gaining entrance into the blood from the dialysate

DIALYSIS WATER

Control Measures

- Sample dialysis water (input) monthly (IA)
  - Maintain water <200 bacteria/mL*
- Sample dialysate (output) monthly (IA)
  - Maintain water <2,000 bacteria/mL
- Perform endotoxin testing (IA)
- Disinfect water distribution system on a regular basis (monthly recocommended) (IA)

*AAMI (2014) has a lower water quality standard for dialysis water (<100 CFU/ml)

ICE AND ICE MACHINES

- Occasional source for nosocomial outbreaks
- Large outbreaks have developed when ice machines have become contaminated and ice used for cooling drinking water
- Typical pathogens
  - *Mycobacteria*
  - *Cryptosporidium*
  - *Salmonella*
  - *Legionella*

ICE AND ICE MACHINES

Control Measures

- Do not handle ice by hand (II)
- Use scoop to dispense ice and keep scoop on chain (not in ice bin)(II)
- Do not store pharmaceuticals or medical solutions on ice intended for consumption (IB)
- Limit access to ice-storage chests (II)
- Machines that dispense ice are preferred (II)
- Clean and disinfect ice-storage chests on a regular basis (eg, monthly)(II)

HYDROTHERAPY TUB

HYDROTHERAPY TANKS AND POOLS

- Used in hospitals for physical therapy for cleaning of burn wounds and birthing
- Skin infections have occurred related to water immersion
  - "Hot tube" folliculitis
  - Cellulitis (rare)
- Typical pathogens
  - Folliculitis: *Pseudomonas aeruginosa*
  - Cellulitis: *Citrobacter*

HYDROTHERAPY TANKS AND POOLS

- Drain after each patient, and disinfect surfaces and components per recommendations (II)
- Add disinfectant to the water: 15 ppm in small hydrotherapy tanks and 2-5 ppm in whirlpools (II)
- Disinfect after using tub liners (II)
- No recommendation for antiseptic in water during hydrotherapy session (unresolved)

DENTAL UNIT WATER

- Problem: Water delivered to dental handpieces and air/water syringes may become contaminated
- Contamination level = 10^2-10^6 microorganisms/ml
- Risk for disease acquisition most likely with immunocompromised patients
- Control measures (between patients)
  - Flush dental instruments with water and air for 20-30s from any dental device connected to the dental water system that enters the patient's mouth (e.g., handpieces)(II)
  - Ensure water in dental unit meets standards (<500 CFU/ml-EPA Drinking Water Standard)(IC)

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)

Electronic Faucets

A Possible Source of Nosocomial Infection?

Electronic Faucets

- Conserve water
- Conserve energy
- Hygienic
- Hands free
- Barrier free

Electronic (E) vs Handle-Operated (HO) Faucets

- 100% E vs 30% HO *Legionella* (no cases). Halabi et al. JHI 2001:49:117
- Significant difference HPC levels between brand A (32%) and B (8%) E compared to HO (11%). Hargreaves et al. 2001; 22:202
- No difference in *P. aeruginosa*. Assadian et al. ICHE. 2002;23:44.
- 73% E samples did not meet water std vs 0% HO
- 29% of water samples from E and 1% from HO yielded *P. aeruginosa*. Merrer et al. Intensive Care Med 2005;31:1715
- 95% E grew *Legionella* compared to 45% HO (water-disruption events). Syndor et al. ICHE; 33:235

Issues Associated with Electronic Faucets

- 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 *P. aeruginosa*)

Prevention Measures

- Electronic faucets constructed so they do not promote the growth of microorganisms
- A potential source of nosocomial pathogens
- No guideline (but some have recommended) to remove electronic faucets from at-risk patient care areas (BMTU)
- Some have recommended periodic monitoring of water samples for growth of *Legionella*
- More data are needed to establish role in HAIs

GUIDELINE FOR ENVIRONMENTAL INFECTION CONTROL IN HEALTHCARE FACILITIES

- Review recommendations for:
  - Air
  - Water
  - Environmental Services
  - Environmental Sampling
  - Laundry and Bedding
  - Animals in Healthcare Facilities
  - Regulated Medical Waste

TRANSMISSION

- Person to person
  - Airborne: Influenza
- Environment to person
  - Airborne: *Aspergillus*
- Person to environment to person
  - *Enterococcus* (VRE), *S. aureus* (MRSA)
- Person to fomite (e.g., bronchoscope) to person
  - Indirect contact: Tuberculosis (MDR-TB)

ENVIRONMENTAL SURFACES

- Disinfect noncritical medical equipment surfaces with a EPA-registered hospital disinfectant (II)
- Keep housekeeping surfaces visibly clean using an EPA-registered disinfectant (II) or detergent and water
- Clean walls, blinds, and window curtains when visibly soiled (II)
- Do not do disinfectant fogging (IB)
- Clean/disinfectant blood spills per OSHA (IC)
- Prepare cleaning solutions daily or as needed (II)

CARPETS

- Carpets are heavily colonized with potential pathogens (10^5 bacteria/sq in)
- No evidence that carpets influence healthcare-associated infections
- **Control measures:** avoid in high-traffic zones in patient-care areas or where spills are likely (IB), clean carpet periodically (II)

FLOWERS

- Flower vases and potted plants are heavily colonized with potential pathogens
  - Vase water colonized with 10^7 - 10^{10} bacteria/ml
- No outbreaks directly linked to flower vases or potted plants
- Control Measures: Flowers and potted plants need not be restricted from immunocompetent patients (II); designate the care of flowers and potted plants to staff not involved in patient care (II); do not allow fresh or dried flowers, or potted plants in patient-care areas for immunosuppressed patients (II)

SPECIAL PATHOGENS

(VRE, MRSA, *C. difficile*)

- Ensure compliance with disinfection procedures (IB)
- Pay special attention to cleaning and disinfecting high-touch surfaces (carts, charts, bedrails) (IB)
- With CP patients, use disposable items when possible (IB)
- Use appropriate handwashing and PPE during cleaning and disinfecting procedures (IB)

GUIDELINE FOR ENVIRONMENTAL INFECTION CONTROL IN HEALTHCARE FACILITIES

- Review recommendations for:
  - Air
  - Water
  - Environmental Services
  - Environmental Sampling
  - Laundry and Bedding
  - Animals in Healthcare Facilities
  - Regulated Medical Waste

MICROBIOLOGIC SAMPLING OF THE ENVIRONMENT

- History
  - Pre-1970, hospitals regularly cultured air and surfaces
  - By 1970, AHA advocated discontinuation because HAI not associated with levels of microbes in the air and surfaces; not cost-effective
  - In 1981, CDC recommended targeted sampling (eg, sterilizers and dialysis water)

MICROBIOLOGIC SAMPLING OF THE ENVIRONMENT

- Targeted microbiological sampling
  - Support of an investigation of an outbreak
  - Research
  - Monitor a potentially hazardous environmental condition
  - Quality assurance

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)

MICROBIOLOGIC SAMPLING OF THE ENVIRONMENT

- Select a high-volume sampler if level of microbial contamination are expected to be low (II)
- When sampling water, choose media and incubation temp to facilitate recovery (II)
- When conducting environmental sampling, document departures from standard methods (II)

GUIDELINE FOR ENVIRONMENTAL INFECTION CONTROL IN HEALTHCARE FACILITIES

- Review recommendations for:
  - Air
  - Water
  - Environmental Services
  - Environmental Sampling
  - Laundry and Bedding
  - Animals in Healthcare Facilities
  - Regulated Medical Waste

LAUNDRY AND BEDDING

- Although fabrics in healthcare facilities can be a source of large numbers of microorganisms 10^6-10^8 CFU/100 cm^2, 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^{o}F for at least 25 min (IC)
- If low-temperature (<160^{o}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)

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)

GUIDELINE FOR ENVIRONMENTAL INFECTION CONTROL IN HEALTHCARE FACILITIES

- Review recommendations for:
  - Air
  - Water
  - Environmental Services
  - Environmental Sampling
  - Laundry and Bedding
  - Animals in Healthcare Facilities
  - Regulated Medical Waste

ANIMALS

- General Infection Control
  - Minimize contact with animal saliva, urine, feces (II)
  - Practice hand hygiene after animal contact (II)
- Protection for Immunocompromised Patients
  - Conduct a case-by-case assessment to determine animal contact is appropriate (II)
  - No recommendation on pet visits to terminally IC patients outside their PE units (unresolved)

SERVICE ANIMALS

ANIMALS

- Service Animals
  - Avoid the use of nonhuman primates/reptiles (IB)
  - Allow service animals unless the animal creates a threat to other persons or interferes with the provision of services (IC)
  - If separated from handler, designate a responsible person to supervise (II)

PET THERAPY

ANIMALS

- Pet Visitation, Pet Therapy
  - Enroll animals that are fully vaccinated, healthy, clean, negative for enteric pathogens (II)
  - Ensure the animals are trained and supervised (II)
  - Conduct pet therapy in a public area of the facility (II)
  - Use routine cleaning protocols for surfaces (II)
  - Restrict animals from access to patients-care areas, ORs, isolation, PE, places where people eat (II)

ANIMALS

- Animals as patients in human HCF
  - If animal brought to HCF for care, avoid use of OR or area where invasive procedures are performed (II)
  - If reusable medical or surgical instruments are used in an animal procedure, restrict future use of these instruments to animals only (II)

GUIDELINE FOR ENVIRONMENTAL INFECTION CONTROL IN HEALTHCARE FACILITIES

- Review recommendations for:
  - Air
  - Water
  - Environmental Services
  - Environmental Sampling
  - Laundry and Bedding
  - Animals in Healthcare Facilities
  - Regulated Medical 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)

GUIDELINE FOR ENVIRONMENTAL INFECTION CONTROL IN HEALTHCARE FACILITIES

- Review recommendations for:
  - Air
  - Water
  - Environmental Services
  - Environmental Sampling
  - Laundry and Bedding
  - Animals in Healthcare Facilities
  - Regulated Medical Waste

Thank you

REFERENCES

- Weber DJ, Rutala WA. Environmental issues and nosocomial infections. In: Prevention and Control of Nosocomial Infections. Ed: Wenzel RP. 3rd Edition. Williams & Wilkins, 1997.
- Guideline for Environmental Infection Control in Healthcare Facilities, 2003. MMWR. 52: RR-10:1-44.
- Rutala WA and DJ Weber. 1987. Environmental issues and nosocomial infections. In Farber BF, editor: Infection control in intensive care. Churchill Livingstone, New York. pp. 131-172.