APIC State-of-the-Art Report: The role of infection control during construction in health care facilities

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

This report reviews issues the infection control professional should consider related to construction and renovation projects in health care facilities. Preventing transmission of infectious agents to vulnerable patient populations, health care workers, and visitors remains an important component of infection control programs. Environmental dispersal of microorganisms during construction, resulting in nosocomial infections, has been described previously, and select examples are provided in Table I as a reminder that there is a solid, scientific basis for these concerns. Environmental airborne contaminants and infectious agents are closely related to water and moisture-related conditions and figure prominently in construction activity. Weems et al have established construction activity as an independent variable for infectious risks in such circumstances. Construction-related outbreak literature will not be revisited in detail; however, pertinent citations will identify resources as appropriate. (AJIC Am J Infect Control 2000;28:156-69)

Section I outlines the broad semiregulatory foundation for direct infection control participation in strategic planning for construction. Section II describes initial steps of planning through policy development, and suggests initial, basic elements for inclusion. Section III examines the infection control implications of the process in detail and is structured on the typical stages of construction. Section IV addresses common questions related to remediation after environmental emergencies or special structural design issues that remain somewhat controversial or unresolved. Recommendations are provided from a variety of reasonable and practical sources not always available as published controlled studies. Section V identifies a number of future research areas that remain important challenges. Terms and abbreviations used frequently throughout the text are highlighted in Table II.

I. CURRENT BASIS OF STRATEGIC PLANNING AND THE ROLE OF INFECTION CONTROL

AIA Guidelines

The current authority for construction design for federal and state health care providers is the 1996–1997 edition of the *Guidelines for Design and Construction of Hospitals and Health Care Facilities*. The American Institute of Architects (AIA) Academy of Architecture for Health publishes this consensus document with concurrence from the US Department of Health and Human Services. Many states adopt the Guidelines in their entirety as minimum standards for design and construction.[19] Prior editions of the Guidelines required construction and renovation assessments during project planning related to specific risks. The new AIA Guidelines strongly support infection control input at the initial stages of planning and design by requiring a new element termed an Infection Control Risk Assessment (ICRA) for broad and long-range involvement of infection control/epidemiology leadership.[19]

The AIA Guidelines state that "Design and planning for such [renovation and new construction] projects shall require consultation from infection control and safety personnel. Early involvement in the conceptual phase helps ascertain the risk for susceptible patient and disruption of essential patient services." Each subsequent section requires an ICRA (eg, numbers and type of isolation rooms) and is predicated upon an "infection control risk assessment" by the infection control committee or a multidisciplinary group designated for that purpose. An ICRA provides for strategic, proactive design to mitigate environmental sources of microbes and for prevention of infection through architectural design (eg, handwashing facilities, separation of patients with communicable diseases), as well as specific needs of the population served by the facility.

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Table 1. Selected events of nosocomial infection associated with the dispersal of microorganisms during construction

Year, author	Organism	Population	Epidemiologic factors
Airborne			
1976 Aisner et al[1]	*Aspergillus* spp	Acute leukemia	Fireproofing insulation
1982 Lentino et al[2]	*Aspergillus* spp	BMT; renal	Road construction; window air conditioners
1985 Krasinski et al[3]	*Rhizopus*; *Aspergillus*	Neonatal	False ceiling
1987 Streifel et al[4]	*Penicillium* spp	BMT	Rotted wood cabinet
1987 Weems et al[5]	*Rhizopus; Mucor* sp;	Hematologic BMT	Construction activity
1990 Fox et al[6]	*Penicillium* sp; *Cladosporium* sp	OR	Ventilation duct fiberglass insulation
1991 Arnow et al[7]	*Aspergillus* sp	Cancer-melanoma	Tiles; humidified cell incubators; air filters
1993 Flynn et al[8]	*Aspergillus terreus*	ICU	ICU renovation; elevators
1994 Gerson et al[9]	*Aspergillus* sp	General	Carpeting
1995 Alvarez et al[10]	*Scedosporium prolificans* (*inflatum*)	Neutropenic hematology	Construction, presumed environmental
1996 Pittet et al[11]	*Aspergillus* sp	COPD	Air filter replacement
Waterborne			
1976 Haley et al[12]	*Legionella* spp	Immunosuppressed	Soil; water
1980 Dondero et al[13]	*Legionella* spp	Adults, employees	Cooling towers
1980 Crane et al[14]	*Pseudomonas paucimobilis*	ICU	Potable water used to fill flush water bottles
1985 Claesson et al[15]	Group A *Streptococcus*	Maternity	Shower head
1993 Sniadeck et al[16]	*Mycobacterium xenopi*	Endoscopy-pseudo	Potable water; scopes
1997 Dearborn et al[17]	*Stachybotrys atra*	Infants	Water-damaged homes
1997 Fridkin et al[18]	*Acremonium kiliense*	Ambulatory surgery	Vent system humidifier

BMT, Bone marrow transplant; *OR*, operating room; *ICU*, intensive care unit; *COPD*, chronic obstructive pulmonary disease.

To carry out an ICRA in the design phase, AIA identifies a multidisciplinary planning group that should involve, at minimum, the health systems' infection control/epidemiology department, the infection control committee (or committee charged with development and review of the infection control policy), and administrators representing special program needs. The planning group's charge is to consider communicable disease prevalence in the community while recognizing the importance of disease variation and distribution across geographic regions and to weigh the availability of public support agencies, as well as to consider the needs of health systems that manage patients with communicable disease, patients who are severely immunosuppressed, or both.

Implementation

The role of infection control is multifaceted and will be required throughout and after completion of the construction project. Infection control staff members provide important leadership and a communication link with program administrators, architects, and engineers. Completion of an ICRA is only the first step; input also is needed in early stages of project design as well as during later blueprint reviews. For example, early coordination with facility management during construction phase identifies necessary support structures required to prevent and control airborne contamination, thus avoiding costly rework or redesign. Newer design challenges include "retrofitting" older buildings into offices and clinics to meet needs for patient examination and instrument cleaning rooms, laboratories, and storage. In the absence of clear-cut rules or regulations, infection control staff members serve to bridge gaps with health agencies and facility administration regarding infection control guidelines and essential design features needed for safe practice. The ICRA sets the scene for involving infection control and supports continuing implementation of infection control principles.[20-33]

II. CONSTRUCTION AND RENOVATION POLICY

A comprehensive construction and renovation policy (CRP) operationalizes the facility's ICRA, ensures management's understanding of the ICRA, and specifies essential participants. A well-designed policy will ensure timely notification of the infection control professional and designated committee(s) for early program planning efforts. In addition, the CRP calls for infection control to evaluate the project from conception through completion and supports a systematic approach for project management. The policy should be submitted for approval by the facility's board of trustees and reviewed/approved periodically.

Elements

Numerous publications have identified a common set of elements to address the planning, designing, and

Table 2. Terms and abbreviations

Term or abbreviation	Description
AIA Guidelines	American Institute of Architects: 1996–1997 Guidelines for Design and Construction of Hospitals and Healthcare Facilities
AII	Airborne infection isolation room (old isolation room)
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers Inc
BMT	Bone marrow transplant
CFU/m^3	Colony forming units per cubic meter (of air)
CRP	Construction and renovation policy
HEPA-filter	High efficiency particulate air filters (99% of .3 micron size particles)
High efficiency	Filtration at 95% efficiency
HVAC	Heating ventilation air conditioning (air handler or air handling unit)
ICRA	Infection control risk assessment
LDRP	Labor/delivery/recovery/postpartum
PE	Protected environment (old protective isolation room)
PPE	Personal protective equipment
SSI	Surgical site infection
UVGI	Ultraviolet germicidal irradiation
VAP	Ventilator-associated pneumonia

monitoring processes. These topics are grouped and itemized below, though many options for development and effective implementation of each have been described in the literature.[20-34]

- Authority and responsibility for establishing internal and subcontractor coordination of (1) construction preparation and demolition; (2) intraconstruction operations and maintenance; (3) project completion and postconstruction cleanup; and (4) monitoring
- Authority and communication lines to determine if or how patient unit closure will occur
- Planning for air handling and water systems/plumbing as appropriate
- Expectations for contractor accountability in the event of breaches in infection control practices and related written agreements
- Patient area risk assessment; criteria for emergency work interruptions (stop and start processes)
- Education: for whom and by whom
- Occupational health expectations for subcontractors before start, as needed
- Traffic patterns for patients, health care workers, and visitors
- Transport and approval for disposal of waste materials
- Emergency preparedness plans for major utility failures with infection control implications, including location and responsibilities.

Process

The CRP must ensure continuous input from infection control into the structural design process to identify appropriate and timely infection control practices. The CRP should require:

- routine submission of scheduled project lists from facility management to infection control, enabling infection control to be proactively aware of projects and to anticipate infection control needs.
- submission of an "infection control (IC) permit" or "project approval signature block" before the beginning of projects, beyond required project lists.[31] Formats may range from simple checklists to questionnaires designed to assist staff members in assessing risks and identifying prevention strategies.
- submission of an IC permit designed to assess the complexity of the project as a matrix of risk groups (patients and environment).

The score determines needed interventions based on:

- construction activity—project complexity in terms of dust generation and duration of activity.
- patients—assessment of the population at risk and location in terms of invasive procedures.

The matrix grid format immediately leads to identifying:

- number and types of necessary controls and IC interventions.
- signatures of all parties, thus providing accountability for the mutually agreed upon plan.[31]

III. INFECTION CONTROL IMPLICATIONS FOR CONSTRUCTION AND RENOVATION

Planning—design and preconstruction

IC participation is critical in the initial planning and approval meetings during the design phase. Issues frequently addressed include budget, space constraints including storage and equipment cleaning areas, air-handling units, handwashing facilities, appropriate fin-

ishes, specific products with infectious implications, and applicable regulations. Infection control professionals (ICPs) should be prepared to support their position and recommendations with published citations whenever feasible, especially when a recommendation is not budget neutral.[20,21,26,33-35] ICPs frequently work with consultants during the planning phase, including architectural and construction companies in a "partnering" process. Consulting an environmental expert might also be necessary if the size and complexity of construction provides considerable risk to highly susceptible patients because of location, prolonged time of construction, work conducted over continuous shifts, and likelihood of air handlers sustaining frequent interruptions. These variables increase risks to patients and personnel and may require monitoring. If appropriate, budgets for environmental consultants and anticipated testing or environmental monitoring needs to be considered at the earliest stage of planning.

Design and structure. IC should ensure that major design components are addressed as appropriate and justified by relevant guidelines, standards, codes, and regulations.[19,24,36-48] Guidance for many elements is described in the resources already referenced; asterisked items below are requirements for new construction addressed in the 1996–1997 AIA Guidelines.[19] Major design components that need to be addressed include:

- Design to support IC practice.*
- Design, number, and type of isolation rooms (ie, airborne infection isolation [AII] or protective environment [PE]).* (AIA Guidelines outline the design characteristics for AII, including no requirement for anterooms, nor support for "reversible" ventilation [ie, rooms "switched" from negative to positive air pressure]; the AIA appendix provides suggestions for PE design.[19-21] These designs are deliberately consistent with Centers for Disease Control and Prevention guidelines regarding tuberculosis and pneumonia.[38,39])
- Heating, ventilation, and air conditioning systems (HVAC), including recommended ventilation and filtration charts.*
- Mechanical systems involving water supply and plumbing.*
- Number, type, and placement of handwashing fixtures,* clinical sinks,* dispensers for handwashing soap,* paper towels, and lotion.
- Sharps disposal unit placement.
- Accommodation for personal protection equipment.*
- Surfaces: ceiling tiles, walls, counters, floor covering, and furnishings.*
- Utility rooms: soiled, clean, instrument processing, holding, workrooms.*
- Storage of movable and modular equipment.

Preparation for demolition and construction. The project teams provide ongoing planning and monitoring during area preparation and throughout the demolition, construction, cleanup, preparation for return to service, and final project review.[19,21,26,34,42,43] Before construction begins, the focus of preparations should be on isolation of the construction/renovation area. Some sources categorize projects in terms of minor or major risk based on the level of needed barriers; checklists are developed accordingly.[26,28-34,49-51]

Type and extent of construction. Project complexity varies with time, numbers of workers, whether contractors work continuous shifts, scope and degree of activity (high or low dust generation), and proximity to patients with varying degrees of risk for infection. Internal renovations may require as much consideration as external construction. Patient areas or units that cannot be closed or that are adjacent to a major renovation require special planning, (eg, operating room additions adjacent to an active surgical suite). These situations may justify environmental monitoring beyond visual inspection to detect increased airborne contamination and to plan interventions.[5,21,25,28-30,39,51-54]

External excavation is ideally conducted during off-hours so that air handlers can be shut down and sealed; the goal is to protect the intake as much as possible. Small projects require similar planning and vary by degree, but preparation still requires early communication with facility management. Specific educational needs (eg, Occupational Safety and Health Administration [OSHA]) regulations and health issues for patients and workers need to be addressed. A summary of common issues is provided below within 3 major categories of tasks; items will vary by facility, but the final customized list should be appended to the CRP.[5,21,22,26,33,43,49,51]

Dust and debris control.

- Medical waste containers (sharps or other medical regulated waste): These should be removed by the facility before start of the project.
- Barrier systems: The area should be isolated, as the project requires. Small, short duration projects generating minimal dust may use fire-rated plastic sheeting, but should be sealed at full ceiling height with at least 2-foot overlapping flaps for access to entry. Any project that produces moderate to high levels of dust requires rigid, dust-proof, and fire-rated barrier walls (eg, drywall) with caulked seams for a tight seal. Large, dusty projects need an entry vestibule for clothing changes and tool storage. The entry area should have gasketed doorframes; tight seals should be maintained at the full perimeter of walls and wall penetrations. An inter-

im plastic dust barrier may be required to protect the area while the rigid impervious barrier is being constructed. Cleaning is required at completion of the barrier construction; plans should also describe a terminal barrier removal process that minimizes dust dispersal.[33,34,43]

- Traffic control: Designated entry and exit procedures must be defined. Egress paths should be free of debris; designated elevators should be used during scheduled times; and only authorized personnel should be allowed to enter the construction zone. Signage should direct pedestrian traffic away from the construction area and materials.[5,21,26,34]
- Demolition: Debris should be removed in carts with tightly fitted covers, using designated traffic routes. Efforts should be made to minimize use of elevators with transport during the lowest period of activity. Debris should be removed daily and at times specified by agreements. If chutes are used to direct debris outside, HEPA-filtered negative air machines should be used, and the chute opening should be sealed when not in use. Filters should be bagged and sealed before being transported out of the construction area.[5,21,22,33]
- Exterior windows: Windows should be sealed to minimize infiltration from excavation debris.
- Visual monitoring: Compliance with barrier maintenance includes education of staff for simple clues (eg, accumulation of visible dust evidenced by footprints, opened doors/windows evidenced by presence of insects and flies, wet ceiling tiles, etc).[21,26,55]

Ventilation and environmental control.

- Air system flow: It should be determined whether the construction area uses fresh/outside or recirculated air; filters should be added or return vents covered as needed with filter material or plastic. Air must flow from clean to dirty areas.[19,20,21,33,34,43]
- Negative air pressure: The air within the construction area must be negative with respect to surrounding areas and with no disruption of air systems of adjacent areas. Constant negative pressure within the zone should be monitored with an alarmed device, which must be maintained and monitored by construction personnel. Exhaust from construction air should be directed outside with no recirculation if possible. If the exhaust must tie into a recirculated air system, a pre-filter and high efficiency filter (95%) should be used before exhaust to prevent contamination of the ducts. Fans should be turned off before opening ductwork and necessary interruptions (eg, fire drills) should be planned for to minimize risk.[20–22,33,34,43,51]
- Adjacent areas: The status of sealed penetrations and intact ceilings should be verified.
- Air exchange rates and pressure relationships: It should be verified that the facility can:
  - maintain proper rates in critical areas near construction activity.
  - ensure air is not being recirculated without filtration from the construction area elsewhere.
  - provide accountability for and frequency of testing air pressure throughout the project.[20–22,26,33]
- Vibration or disturbances: Drilling and other sources of vibration have potential to dislodge dust collected above suspended or false ceilings; vibrations loosen corrosion within water pipes as well. Plans should require vacuuming of affected areas and flushing debris from water systems before reoccupancy.[5,21,50,55,56]
- Specification of temperature and humidity ranges: Determine limits as appropriate.[20–22,35]
- Monitoring must consider risks of malfunction or complete loss of utilities. Both visual cues and particulate air monitoring may be used. The type and frequency of monitoring, evaluation of results, and follow-up action by designated parties are essential to planning.[20,21,26,33,57]

Contamination of patient rooms, supplies, equipment, and related areas.

- Worksite garb: Contractor personnel clothing should be free of loose soil and debris before leaving the construction area. If protective apparel is not worn, a HEPA-filtered vacuum should be used to remove dust from clothing before leaving the barricade. Personal protective equipment (eg, face shields, gloves, respirators) are worn as appropriate. Contractors entering invasive procedure areas should be provided with disposable jump suits and head and shoe coverings. Protective clothing should be removed before exiting the work area. Tools and equipment should be damp wiped before entry and exit from the work areas.[20–22,26,33]
- Barriers around construction should be monitored to maintain protection of in-use patient care areas as described. Patient doors adjacent to construction area should be kept closed, with appropriate traffic control.[20–22,26]
- Storage should be designated for construction materials.[22,33,43]
- Contractor cleaning: The construction zone should be maintained in a clean manner by contractors and swept or HEPA-vacuumed daily or more frequently as needed to minimize dust. Adjacent areas should be damp mopped daily or more frequently as needed. Walk-off mats may minimize tracking of heavy dirt and dust from construction areas.[21,26,33,43]

- Facility cleaning: Contracts should clearly specify responsibilities and expectations for routine and terminal cleaning before opening the newly renovated or construction zone.[21,22,25,51]

Intraconstruction and the role of IC. Once renovation or construction has begun, the ICP should be available to provide maintenance and operational input. Frequency of input or meetings will depend on the scope of the project. Specific concerns need to be customized in each project and include IC practices, education, and monitoring. The ICP is vital in educating and supporting "users/owners" to manage their area under construction (eg, educating staff members on how to monitor their own performance as much as possible). In more complex projects, the ICP may assist directly or make provisions for items already outlined. A number of areas involving specific ICP involvement are discussed below.

Environmental rounds. An efficient method to integrate key IC and life safety issues is the use of rounds, using simple checklists based on the items addressed above. ICPs can advise or participate in rounds, which should be scheduled as often as necessary and include a variety of observable "indicators" such as barriers (doors, signage), air handling (windows closed), project area (debris, cleaning), traffic control, and dress code. It may be necessary on occasion to schedule rounds after normal hours or on weekends if that is when construction or renovation is scheduled.[20-22,26,33,34,43,49,51]

Outcome or process measures. Projects may be approached as performance improvement initiatives using outcome measures (eg, surgical site infection rates) or process measures (measuring compliance) using visual observations, airborne particulate monitors, satisfaction surveys, etc.[51-54]

Impact on special areas. Patients requiring AII need close monitoring to ensure negative pressure relationships are maintained, particularly when there is potential for disruption of pressure relationships.[20,21,58-61] Intake areas such as emergency departments need planning to triage potentially infectious patients.[19,45,62] If highly susceptible patients cannot be relocated, indicators should be identified to trigger planned intervention.[5,21,25,26-29,33,52-54] Immunosuppressed populations in bone marrow transplantation units or protected environments, intensive care units, etc, require special planning. The goal is to minimize patient exposure to major construction activity; therefore, nonemergency admissions should be avoided during periods of major excavation. If delaying admissions is not an option, patients should be located in areas as remote as possible from construction activity.[20,21,26]

Patient location and transport. Health care providers should plan patient care activities to minimize exposure to construction sites.[20-21] At least one study found that critically ill, ventilator-dependent patients transported from the ICU for diagnostic or therapeutic procedures was an independent risk factor for development of ventilator-associated pneumonia.[63] To decrease exposure for patients during construction activities the following should be considered:

- Provide treatment in the patient's room.
- Transport via an alternate route.
- Schedule transport or procedures during periods with minimal construction activity.
- Minimize waiting and procedure times near construction zones.
- Mask patient or provide other barriers (eg, covering open wounds) based on patient's clinical status.

Interruption of utility services. Utility services may be interrupted during any type of construction. Infectious agents may contaminate air-handling units, medical vacuum, and water systems after planned or unplanned power disruptions. IC provides input into emergency preparedness to reduce the potential risks of contamination.[20-22,42,57] Response plans should include assessment of the population at risk and cleanup should focus on steps to prevent, detect, and reduce risk from infectious hazards. For example, as power is reestablished after an interruption, dampers and fans of air handling units resume operation. Dust and particulate matter released during this process may transmit allergenic or infectious agents such as *Aspergillus* sp to patients and staff.[3,5,20-22,26,33,50,64] Therefore, IC policies for areas in which invasive procedures are performed should require sufficient time to clear the air of potential contaminants before resuming the room(s) use. Ventilation time should be based on the number of air changes per hour required by the area. The National Institute for Occupational Safety and Health (NIOSH) chart for removal efficiency of airborne contaminants may provide guidance, but its use should be tempered by its assumptions.[39] In the event of major contamination of patient care areas, plans should specify responsibilities for these decisions as well as for intensified cleaning, environmental surveillance of airborne infectious agents, and restriction of water use until testing or flushing determines safe usage.

Worker risk assessment and education. Health risk evaluations for potential exposures depend on the type of construction planned. Facility staff overseeing or working with outside contractors should assist in determining potential environmental risks for facility workers or contractors. Policies should include provisions for training and by whom (facility or contractor). Training must be appropriate to the task (eg, staff entering air systems for preventive maintenance [changing filters] should be alerted to the potential for

airborne dust containing spores of microorganisms and arrange to first turn off fans and don a mask). Staff members working in sanitary or septic sewage systems, drainage pipes, etc, should be alerted to the risks of moisture and fungal contamination.[20–22,57,65–67] Agreements should be developed appropriate to the project regarding provisions for pertinent health protection, vaccinations, tuberculosis assessment/PPD skin testing, or related education before workers begin construction. Requirements will vary with degree of environmental risk and proximity to patient population.

Documentation of health/training issues. As agreements are completed, they should provide evidence that workers have received appropriate health protection as noted above and should include the following information:

- Facility exposure control plan(s) for IC, hazardous chemicals, and life safety.
- How to seek help and report exposures (eg, first aid location and initial steps to report exposures).
- Use of particulate respirators or other PPE.
- Risk prevention for unexpected safety issues, such as noxious fumes, asbestos, etc.[22,66,67]

The facility should be satisfied that provisions have been made for effective IC education designed to address facility-specific needs related to potential infectious risk exposures as described above.[45–48]

Postconstruction and cleanup

Project checklists. Check-off lists of expected practices identified at the beginning of the project should be reviewed for items agreed upon before the area is returned to full service or patient occupancy. A useful tool during review is the contractor's "punchlist" that will ensure missed details have been addressed (eg, installations of soap dispensers or designated types of handwashing/sink controls).[33,34]

Postconstruction agreements. Cleanup agreements (eg, cleaning, air balancing, filter changes, flushing of water systems, etc) and other utility service checks/cleaning must be established in the early planning phase as discussed in Section II. These include at minimum[33,34]:

- Contractor cleaning to include area clearance, cleaning, and decontamination/wipedown.
- Cleaning after removal of partitions around construction area, minimizing dust production.
- Facility-based routine/terminal cleaning before returning area to service.
- Provision of time frames for facility review (eg, 2 weeks) after completion of the project to ensure all issues were addressed properly.[33,34]
- Systematic review of outcomes in the facility's designated review process, whether by contract or committee structure. Items may range from sealed cabling/electrical penetrations and ceiling tile replacements to the completed punchlist.
- Cleaning and replacement of filters and other equipment if affected by major or minor disruptions or conditions that could have contaminated the air or water supply.[4,23,33,68,69]

Steps before occupancy: Checklists specific to the project should be developed for a walk-through just before occupancy. Core IC issues for inclusion are listed below as applicable. The designated team should do the following:

- Check that sinks are properly located and functioning.
- Verify that sinks in critical patient care areas have properly functioning fixtures.
- Check for the presence/absence of aerators in these fixtures according to facility policy.
- Test whether soap and towel dispensers are filled and functioning.
- Check whether surfaces in procedure/service areas are appropriate for use (eg, smooth, nonporous, water-resistant).
- Verify that air balancing has been completed according to specifications.
- Test whether air flows into negative pressure rooms or out of positive pressure rooms.

Monitoring activities during construction[20,23]

There are currently no recommendations for routine environmental culturing during construction. Enhanced targeted patient surveillance (eg, respiratory illnesses consistent with aspergillosis or legionellosis) near construction areas should be part of the ICRA. Other control measures previously discussed need to be continuously monitored.

However, when an outbreak associated with construction is suspected or identified, water or air sampling may be indicated. It is vitally important to establish a hypothesis with clear and measurable goals. Culturing or sampling procedures should be defined before initiation (eg, asbestos, fungal, or particulates). Sampling procedures relative to the suspected agent(s) and sources should be used. The investigator must be cognizant of the many pitfalls associated with the interpretation of environmental data. Therefore, as part of the investigation planning, it is important to establish parameters for interpreting collected data.*

IV. ENVIRONMENTAL EMERGENCIES AND REMEDIATION

Environmental emergencies may occur during construction disruptions; when they occur, timely IC con-

*References 5, 6, 23, 25, 27–29, 38, 41, 45, 51–53, 56, 59, 70-75

sultation is critical. Practical applications of IC principles, generalized from experience in related industries, are offered here within stated limitations. In addition, other structural design issues which lack support if AIA Guidelines or scientific studies will be addressed.

Contamination of ventilation in surgical suites or other invasive areas

Sealing and air intakes. If nearby drilling or excavation occur during surgical activity, it is critical to check for tight room sealing to reduce the potential for air and water leakage. Because operating rooms usually have separate air handlers, the air intakes should be located to determine need for additional protection or sealing during periods of highest construction activity.[20-22,35,51,52]

Operating room ventilation and tuberculosis. AIA guidelines recommend bronchoscopy procedures be performed in treatment rooms meeting AII room ventilation requirements or in a space that exhausts directly to the outside. Optimum methods for managing patients with active tuberculosis requiring urgent surgical intervention have not yet been determined. However, the number of operating room air changes provides increased dilution of potential contaminants. NIOSH ventilation charts are included in the Centers for Disease Control and Prevention 1994 Guidelines and may assist in calculating percentages of particles removed by time and ventilation rates; this offers some guidance for the time needed to air a room, but the underlying assumptions need study as noted earlier.[39] Modifying the pressure relationships of the room to neutral or negative risks overall pressure imbalances, has not been studied for effectiveness, and is not recommended by the AIA.[19]

Air handlers, ducts, and filters. If air handlers are replaced, old ducts must be replaced or cleaned, and the issue should be treated as fundamental to the projected budget. Contaminated ducts have been implicated in outbreaks (eg, the operating room outbreak caused by *Penicillium* reported by Fox et al.[6] The American Society of Heating, Refrigerating, and Air Conditioning Engineers Inc is including language in HVAC system surface standards to prevent future duct lining problems.[40] Experiences vary, but it is important to clean ducts filled with debris observed during inspections, especially on the return air ducts. Hermann and Streifel recommend semiannual inspections of air-handling units for filter integrity.[75] However, definitive evidence specifying frequency of preventive cleaning is lacking.

Water contamination

Water contamination risks and prevention strategies are addressed in multiple sources.[20-23,57,65,76-77] IC should focus on maintaining a dynamic water flow that meets local standards. Water pressure "shock" may send a surge of debris when pressure loss is restored after a rupture.[78] Massive amounts of loosened scale may be released when domestic valves are returned to service after being off during construction or disruptions. If decontamination is necessary, systematic flushing of the water system assists in removing debris shaken loose by drilling or disruptions.

- *Legionella* sp: If testing is warranted because of high-risk populations and suspicion of *Legionella* sp exposure in the facility, major intervention methods should include chlorinating, hot water flushing, or copper-silver ionization treatment.[69,79-82] The last appears to have advantages over prior methods because of penetration of biofilms and reduced pipe corrosion; concerns for heavy metal (silver ions) accumulation remain and warrant additional study.[73,83]
- Fungus: Water seepage and damage are difficult to manage in an occupied building.[69] Reports of moisture/water sources leading to airborne spread of infectious agent(s) have been cited.[17,18,84] Several suggestions for detection and treatment are offered.[4,33,68] Prevention of fungal growth takes on increased importance after any type of flooding or utility failure related to water. Brace and Streifel have both published useful case studies and similar information is available from on-line sources.[33,34] Suggested cleanup protocols after water exposure are summarized here, but the basic approach is one of identifying moisture, followed by cleaning and thorough drying of surfaces.

General remediation procedure after water contamination. A systematized approach to prevent fungal growth in buildings caused by floods, roof leaks, sewage backup, steam leaks, and groundwater infiltration includes the following steps, modified according to the extent of damage sustained[33,34]:

- Inventory of water-damaged areas of the building, materials, and furnishings, paying particular attention to carpeting under cabinets and furnishings.
- Use of moisture meters (electronic wet test meter) to identify extent of water damage to drywall.
- Environmental sampling to monitor stages of cleanup and remediation.
- Removal of materials within 24-48 hours of water damage.
- Decontamination by spraying with chlorine-based mist or diluted bleach, followed by drying.
- Ventilation balancing to reduce supply air volume to effect a negative air pressure area, sealing off area with tape, and checking airflow with a smoke stick. Mobile HEPA machines may assist in provid-

ing the needed negative air balance in areas being remediated.

- Wall areas to be treated are identified and opened (eg, strip off vinyl covering) for drying.
- Decontamination of opened wall area is accomplished with 1:9 dilution of copper-8-quinolinolate compound, using a pressurized spray pump.[33,52]
- Remove surface soil with a detergent (eg, diluted tri-sodium phosphate), followed by use of a liquid disinfectant (eg, diluted bleach).
- Ceilings are vacuumed with a HEPA filtered vacuum cleaner. Walls and ceiling are closed and covered with standard wall finishing materials when the area is completely dry. Brace reported filling the spaces with aerosol foam; Streifel did not.[33,34]

Surfaces: design or disruption/damage issues

Design. Ideally, surfaces are designed to include cleanability; problems can be avoided if surfaces near plumbing fixtures are smooth, nonporous, and water-resistant.[19,85] Operating and delivery rooms, isolation and sterile processing areas also need smooth finishes, free of fissures or open joints and crevices that retain or permit passage of dirt particles. After disruptions, care should be taken to note penetrations (ducts, pipes), with attention to proper replacement, including tight seals.[19–23]

Flooding accidents. Cleaning and decontamination are required for major leaks occurring from the outside, such as broken pipes containing potable water or sprinkler water systems with added chemicals (ethylene glycol). Specific suggestions are itemized below for ceilings, walls, floors, and carpeting.

Ceiling tiles/porous materials. Water leaks or floods that wet acoustical ceiling tiles or fireproofing and filter materials may produce reservoirs of fungal spores.[1,32,34,52]

- If major water damage has occurred and porous tiles were not removed within 24-48 hours, tiles should be discarded/replaced.
- If tiles are nonporous, or if moisture is a result of small steam leaks, tiles can be cleaned with dilute bleach and air dried before replacement.[33]

Walls. When replacement options exist, the ICP should consider that smooth paint surfaces are easier for cleaning.[19,85] (The potential for antimicrobial effects present in copper paints has been published.[86] However, concerns for unknown efficacy and potential long-term toxicity have yet to be characterized and validated before efficacy can be established.[87]) Vinyl wall coverings risk moisture problems from condensation and have potential for fungal growth on the substrate. Wall cleaning under different conditions is based on the protocol described earlier:

- Water damage addressed in less than 24 hours: Vinyl-covered drywall laths/plaster/plasterboard should be stripped and examined. Portions of drywall may need to be removed to determine the extent of damage with a moisture meter. In some cases, especially if minor water damage was sustained, only minimal cleaning may be required.
- Water damage not addressed within 24–48 hours: If major flooding has occurred and material has not been removed within 24–28 hours, there is increasing probability that damage has already led to microbial growth, and more extensive effort may be required.
- Removal should be done under controlled conditions (area sealed off and removal done under negative air pressure).
- Water-soaked areas should be removed approximately 12 in above water mark and discarded, while allowing opened areas to dry.
- Hard surfaces are cleaned with diluted bleach solution without rinsing.
- Area may be sprayed from top to bottom with a dilution of copper-8-quinolinolate compound.[33,34,52]
- Wall is sealed and finished with standard materials after installing new 12 in wall piece.[33,34]

Floors. Desirable features include surfaces easily cleaned and wear-resistant according to usage. For example, if the floor is subject to frequent wet-cleaning methods, it should not be physically affected by germicidal disinfectants. Floor surfaces subject to traffic when wet (eg, kitchens) should have nonslip surfaces and be resistant to food acids (to avoid discoloration), and the perimeters should be tightly sealed.[20,21,85] After water disruptions, the perimeter should be closely examined for signs of long-standing moisture and possible fungus contamination.

Carpeting. Esthetic considerations related to stains and odor control support recommendations to avoid carpeting in areas of frequent spillage or heavy contamination; however, carpets have not generally been associated with nosocomial infection.[88–90] Carpets require regular vacuuming, shampooing, or extraction depending on use, material, and degree of soiling; cleaning should follow manufacturers' directions for proper cleaning materials, dilution (due to potential for discoloration), and frequency of cleaning techniques.[55,88] Contamination of carpeting after saturation with water or during demolition has been reported as a reservoir for nosocomial fungal infection.[9,91]

- Major damage from flooding: Carpeting and padding exposed to sewage should be discarded and the area disinfected with diluted bleach. If it is wet from steam or water leaks for greater than 24-48 hours, it is potentially already contaminated

with fungi and may need to be discarded. If it is wet from steam or potable water leaks, but for *less than 24–48 hours,* protocols require cleaning and disinfection principles similar to those described earlier:

- Remove furniture, extract with water, shampoo with diluted surfactant/detergent.
- Soak with diluted bleach solution (1:10); rinse and extract with clean water to remove bleach; commercial steam cleaning is an alternative to bleach.
- Dry within 12–24 hours of treatment using floor or exhaust fans to aid in drying.[33]

Furnishings, fixtures, and equipment

Furniture. Modular furniture not easily moved should be installed on raised platforms or suspended in some manner to achieve a minimum 6-in to 12-in clearance from the floor to pull out for cleaning or to clean underneath. Attention must be paid to storage units with electrical or computer connections.[85]

Upholstered furniture should be treated the same as carpeting (including disposal) in the event of major soaking and contamination as a result of floods, leaks, or sewage. If it is affected by only steam moisture, it can be dried. Hardwood with intact laminate can be cleaned and disinfected with dilute bleach. If laminated furniture that has exposed particle board beneath the surface or other furniture composed of pressed wood or chip board becomes soaked, it should be discarded.[33]

Handwashing facilities/sinks. This section merits consideration primarily for design and cleaning issues; but plumbing disruptions or lack of preventive maintenance pose risks of contamination as well.

- Number and design: AIA Guidelines for new construction recommend the minimum number of handwashing facilities for patient rooms as one in the toilet room; they recommend handwashing facilities in the patient room only when the toilet room serves more than 2 beds.[19] Having a sink in a patient/resident room and in the toilet room (whether private or shared) supports essential IC practices. Whereas there is support for the ideal, IC plays a critical role in recommending proper placement of handwash facilities, and in both rooms.[85] In addition, IC support for a sink standard of minimum dimensions may prevent installation of small "cup" sinks that challenge proper handwashing.[85] AIA guidelines describe permissible types of controls for handwashing facilities in various areas.[19,21]
- Placement: Improper placement can add to the environmental reservoir of contaminants. Sinks need to be convenient and accessible, but nearby surfaces should also be nonporous to resist fungal growth.[33,85] One source recommends a minimum distance of 15 ft from all inpatient beds/bassinets and 25 ft from outpatient chairs, stretcher, and treatment areas to ensure access.[85] Handwashing facilities should also be situated to avoid splashing (suggesting at least 36 in from patients or clean supplies), or equipped with a splash guard to avoid splash contamination.[85]
- Cabinets: Areas beneath sinks should not be considered storage areas due to proximity to sanitary sewer connections and risk of leaks or water damage. Clean or sterile patient items should be not be placed beneath sanitary sewer pipe connections or stored with soiled items; cleaning materials are the only items acceptable to be stored under sinks, from a regulatory aspect.[85] Facilities may develop design standards excluding storage space beneath sinks, thus preventing misuse and need for cleaning. As noted earlier, cabinet construction materials need to be nonporous to resist fungal growth.
- Aerators: Aerated sink faucets located near patients, particularly in intensive care units, may be a risk because of their ability to enhance growth of waterborne microorganisms. The faucet aerator has been identified as a reservoir and possible source of infection within the hospital. Rutala notes that the most convincing evidence for the role of faucet aerators is provided by Fierer et al (1967). In this study, premature infants became infected with *Pseudomonas aeruginosa* from delivery room resuscitation equipment contaminated by a faucet aerator.[87] Rutala concludes that the degree of importance of aerators as reservoirs for nosocomial pathogens remains unknown. Because *Legionella* sp grow well in the sediment formed in aerators, Freije recommends aerator removal.[50] Proper sink design and dimensions can reduce splashing and risks of general contamination, while eliminating concerns for aerators completely.

Flush sinks/hoppers. Clinical sinks are frequently located in soiled utility rooms for disposal of body fluids and liquids but warrant similar considerations for moisture and contamination.[92] Splash guards are valuable but inclusion may depend on sink usage and design. If staff members are not routinely required to use face protectors, a splash guard should be required.

Whirlpool or spa-like (Jacuzzi) bathing facilities. Various types of bathing facilities are now available for mothers in birthing rooms; recommendations for cleaning have been compared with hydrotherapy tanks and equipment cleaning procedures.[93] However, plumbing for Jacuzzi tubs or similar spa-like tubs have longer piping with higher siphons, resulting in risks for trapped contaminated water after apparent draining;

the trapped water may be flushed into the tub with its next use. Communication with state regulators, cleaning and disinfecting the tub and jets with specific spa-cleaning products, and proper draining and flushing sequences are essential when considering installation.[92-95]

Eyewash stations. OSHA directs proper use and placement of eyewash stations with distance determined by the pH of the involved chemicals. Source water in stationary eyewash stations may stand unused in the incoming pipes at room temperature for long periods, providing a reservoir for potential pathogens.[87] After a report of Acanthamoeba in eyewash stations, OSHA issued a bulletin recommending cleaning and disinfection methods.[96] The schedule follows the American National Standards Institute Z358-1981 recommendations for flushing the system 3 minutes each week.[44]

Placement of sharps containers. Location of disposal containers should consider ease of visibility to avoid overfilling and should be within easy horizontal reach of the user. Systems should have secure locking and enable easy replacement. When containers are fixed to a wall, the vertical height should allow the worker to view the opening or access the container. NIOSH recommendations suggest ergonomic considerations for installation heights or creative approaches for specialty areas.[97] Sufficient temporary storage space for filled containers must be in design planning.[47,92]

V. RESEARCH NEEDS

The role of IC continues to expand and interacts closely with safety and occupational health functions. Studies from indoor air quality research have an increasing impact on current practice. Industrial experiences continue to be evaluated for health care facility application. Some items identified throughout the text but not yet resolved are summarized below and offered for consideration:

- Surgical suite contamination: Many issues remain unanswered and require further study including the effectiveness of laminar air flow, ultraviolet germicidal irradiation, and the approach to managing *Mycobacterium tuberculosis* or other airborne pathogens in the operating room. Designs of future operating rooms to control all sources of environmental contamination are being studied in current IAQ building research.[98]
- Surgical suite air handling systems: Certification and recertification requirements for operating room air handling systems remain unresolved. Frequency of testing HEPA filters, systems, and air pressure balancing for operating rooms has not been determined or recommended.
- Ambulatory care sites: There is a need to identify optimal engineering controls for current ambulatory care surgery settings to improve outcomes; there is also need for further delineation of the role of mobile HEPA units, UVGI, etc, in clinics and nontraditional care settings, especially for highly susceptible, ambulatory patients.
- Fans: Concerns have been raised regarding use of fans in patient care areas. No studies or regulations have directly addressed this issue in terms of infection risk(s).
- Aerators: The degree of risk associated with aerator installation has not yet been determined and may be resolved by examining other methods of water purification or sink design.
- Plumbing and preventive maintenance systems: Better methods to reduce or eliminate *Legionella* sp. contamination in potable water systems continue to be sought. In the setting of continued low-level contamination, determination of the dose-response relationship from potable water exposures resulting in disease remains elusive. This remains key to preventive water system treatments, as well for clearer indications for environmental surveillance cultures.
- Role and methods of air monitoring: A number of major issues need clarification including (1) determination of electronic versus other sampling methodologies, and (2) need for standards and guidelines for sampling designs according to circumstances and related methodologies (eg, total particulate versus bioparticulates). The development of standards for certain patient care areas needs correlation to disease outcomes.
- Efficacy of remediation protocols: Controlled studies on the efficacy and safety of current or newer antifungal treatments after severe water damage are needed. Clearer determinations regarding the safety of damaged drywall left in place, versus its removal, needs further elaboration. Other studies are needed to determine the efficacy and safety of other types of materials for remediation.
- Ventilation and pressure relationships: Whereas the need for negative air pressure is clear, new studies are needed to determine the ideal room pressure differential related to actual infectious agent transmission and risk for developing actual disease. This is an area beginning to be addressed.[99]

In conclusion, the role of IC/epidemiology in construction and renovation remains a challenging and exciting one and is the ultimate demonstration of its multidisciplinary nature. Interaction and integration of efforts with other disciplines enables disease prevention for patients and health care workers to remain the

focus and driving force during construction/renovation processes.

References

1. Aisner J, Schimpff SC, Bennett JE, Young MV, Wirnik PH. *Aspergillus* infections in cancer patients: association with fireproofing materials in a new hospital. JAMA 1976;235:411–12.
2. Lentino JR, Rosenkranz MA, Michaels JA, Kurup VP, Rose HD, Rytel MW. Nosocomial aspergillosis: a retrospective review of airborne disease secondary to road construction and contaminated air conditioners. Am J Epidemiol 1982;116:430–7.
3. Krasinski K, Holzman RS, Hanna B, Greco MA, Graff M, Bhogal M. Nosocomial fungal infection during hospital renovation. Infect Control Hosp Epidemiol 1985;6:278–82.
4. Streifel AJ, Stevens PP, Rhame FS. In-hospital source of airborne *Penicillium* species spores. J Clin Microbiol 1987;25:1–4.
5. Weems JJ Jr, Davis BJ, Tablan OC, Kaufman L, Martone WJ. Construction activity: an independent risk factor for invasive aspergillosis and zygomycosis in patients with hematologic malignancy. Infect Control 1987;8:71–5.
6. Fox BC, Chamberlin L, Kulich P, Rae EJ, Webster LR. Heavy contamination of operating room air by *Penicillium* species: identification of the source and attempts at decontamination. AJIC Am J Infect Control 1990;18:300–6.
7. Arnow PM, Sadigh MC, Weil D, Chudy R. Endemic and epidemic aspergillosis associated with in-hospital replication of *Aspergillus* organisms. J Infect Dis 1991 Nov;164:998–1002.
8. Flynn PM, Williams BG, Hethrington SV, Williams BF, Giannini MA, Pearson TA. *Aspergillus terreus* during hospital renovation [letter]. Infect Control Hosp Epidemiol 1993;14:363–5.
9. Gerson SL, Parker P, Jacobs MR, Creger R, Lazarus HM. Aspergillosis due to carpet contamination [letter]. Infect Control Hosp Epidemiol 1994;15:221–3.
10. Alvarez M, Lopez Ponga B, Raon C, Garcia Gala J, Porto MC, Gonzales M, et al. Nosocomial outbreak caused by *Scedosporium prolificans (inflatum)*: four fatal cases in leukemic patients. J Clin Microbiol 1995;33;3290–5.
11. Pittet D, Huguenin T, Dharan S, Sztajzel-Boissard J, Ducel G, Thorens JB, et al. Unusual case of lethal pulmonary aspergillosis in patients with chronic obstructive pulmonary disease. Am J Respir Crit Care Med 1996;154(2 Pt1):541–4.
12. Haley CE, Cohen ML, Halter J, Meyer RD. Nosocomial legionnaires' disease: a continuing common-source epidemic at Wadsworth Medical Center [abstract]. Ann Intern Med 1979;90:583–6.
13. Dondero TJ Jr, Rendtorff RC, Mallison GF, Weeks RM, Levy JS, Wong EW, et al. An outbreak of legionnaires' disease associated with a contaminated air-conditioning cooling tower. N Engl J Med;302:365–70.
14. Crane LC, Tagle LC, Palutke WA. Outbreak of *Pseudomonas paucimobilis* in an intensive care facility. JAMA 1981;246:985–7.
15. Claesson BEB, Claesson UL-E. An outbreak of endometritis in a maternity unit caused by spread of group A streptococci from a showerhead. J Hosp Infect 1995;6:304–11.
16. Sniadeck DH, Ostroff SM, Karlix MA, Smithwick RW, Schwartz B, Sprauer MA, et al. Nosocomial pseudo-outbreak of *Mycobacterium xenopi* due to contaminated potable water supply: lessons in prevention. Infect Control Hosp Epidemiol 1993;14:637–41.
17. Dearborn DG, Infeld MD, Smith PG, Brooks LJ, Carroll-Pankhurst DC, Kosik R, et al. Update: pulmonary hemorrhage/hemosiderosis among infants. MMWR Morb Mortal Wkly Rep 1997;46(2)33–5.
18. Fridkin SK, Kremer FB, Bland LA, Padhye A, McNeil MM, Jarvis WR. *Acremonium kiliense* endophthalmitis that occurred after cataract extraction in an ambulatory surgical center and as traced to an environmental reservoir. Clin Infect Dis 1996;22:222–7.
19. American Institute of Architects Academy of Architecture for Health. 1996–1997 guidelines for design and construction of hospitals and healthcare facilities. Washington (DC): The American Institute for Architects Press; 1996.
20. Bartley J. Air (HVAC/Laminar Flow). In: Olmsted R, editor. APIC: infection control and applied epidemiology: principles and practice. 1996. St Louis (MO): Mosby; 1996. p. 103:1–9.
21. Bartley J. Construction. In: Olmsted R, editor. APIC: infection control and applied epidemiology: principles and practice. 1996. St Louis (MO): Mosby; 1996. p. 104:1–6.
22. Streifel AJ. Maintenance and engineering; biomedical engineering. In: Olmsted R, editor. APIC: infection control and applied epidemiology: principles and practice. 1996. St Louis (MO): Mosby; 1996. p. 111:1–7.
23. Bartley J. Water. In: Olmsted R, editor. APIC: infection control and applied epidemiology: principles and practice. 1996. St Louis (MO): Mosby; 1996. p. 118:1–4.
24. McDonald L. Regulatory/accrediting/guideline setting agencies. In: Olmsted R, editor. APIC: infection control and applied epidemiology: principles and practice. 1996. St Louis (MO): Mosby; 1996. p. 121:1–4.
25. Haberstich N. Prevention of infection during major construction and renovation in the surgery department of a large hospital. AJIC Am J Infect Control 1987;15:36A–38A.
26. Carter CD, Barr BA. Infection control issues in construction and renovation. Infect Control Hosp Epidemiol 1997;18:587–96.
27. Turner G, Sumner R, Ornelas L, Martin M. Controlling construction dust in the hospital environment; a quality improvement project [abstract]. AJIC Am J Infect Control 1995;23:115.
28. Brown S, Detzler L, Myers J, Swift S. The impact of environmental controls and air quality monitoring on surgical site infection rates during operating room construction [abstract]. AJIC Am J Infect Control 1996;24:140.
29. Gartner K, Blank M, Volosky R. Keeping the air clean—lessons from a construction project [abstract]. AJIC Am J Infect Control 1996;24:111.
30. Kennedy V, Barnard B, Hackett B. Use of a risk matrix to determine level of barrier protection during construction activities [abstract]. AJIC Am J Infect Control 1996;24:111.
31. Kennedy V, Barnard B, Hackett B. Use of a risk matrix to determine level of barrier protection during construction activities. Hosp Infect Control 1997;2:27–8.
32. Harvey MA, Critical care-unit bedside design and furnishing: impact on nosocomial infections. Infect Control Hosp Epidemiol 1998;19:597–601.
33. University of Minnesota Extension Service, University of Minnesota Building Research Consortium, IAQ Project, Department Env. Health and Safety. Health Care Construction and IAQ, Minneapolis (MN): Sept 15–16, 1997. Components available from: URL: *http://www.dehs.umn.edu/*.
34. Brace SE. Infection control during construction: planning is key. Healthcare Facilities Management Series (#094300). Chicago (IL): ASHE of American Hospital Association; 1993.
35. Bartley J. Environmental control: operating room air quality. Today's OR Nurse 1993;15:11–7.
36. American Society of Heating, Refrigerating and Air Conditioning Engineers. Systems and equipment handbook. Air cleaners for particulate contaminants. Atlanta (GA): ASHRAE Inc; 1996. p. 24.9–24.11.
37. Health Care Finance Administration. Medicare and Medicaid programs; hospital conditions of participation 1986. Baltimore (MD): Department of Health and Human Services; 1986.
38. Tablan OC, Anderson LJ, Arden NH, Butler BR, McNeil MM, the

Hospital Infection Control Advisory Committee. Guidelines for prevention of nosocomial pneumonia. AJIC Am J Infect Control 1994;22:247–92.

39. Centers for Disease Control and Prevention. Guidelines for preventing the transmission of *Mycobacterium tuberculosis* in health-care facilities, 1994. MMWR Morb Mortal Wkly Rep 1994;43(RR-13)29.
40. American Society of Heating, Refrigerating and Air Conditioning Engineers. Design considerations for controlling microbial growth. Atlanta (GA): ASHRAE Inc; BSR/ASHRAE 62-1989R Draft Aug 1996. Appendix M1–M4.
41. Occupational Safety and Health Administration. Legionnaires' disease. In: OSHA Technical Manual Section II: 7:1–46. Available from: URL: http://www.osha.slc.gov/Tech_Man_data/II_7.html.
42. Comprehensive Manual on Accreditation of Hospitals. Oakbrook (IL): Joint Commission on Accreditation of Hospitals and Healthcare Organizations Publications; 1997.
43. Kuehn TH, Gacek B, Yang CH, Grimsgud D, Janni KA, Streifel AJ, et al. Final report: ASHRAE 804-RP Phase I identification of contaminants, exposures effects and control options for construction/renovation activities. Atlanta GA: ASHRAE Inc; 1995.
44. American National Standard for Emergency Eyewash and Shower Equipment ANSI Z358.11990 Revision of ANSI Z358.1-1981. New York: ANSI; Oct 5, 1989.
45. Occupational Safety and Health Administration. Proposed rule for occupational exposure to tuberculosis. Fed Reg; 62: 54159–54308; 1997.
46. Garner J, Hospital Infection Control Practices Advisory Committee. Guideline for isolation precautions in hospitals. JAIC Am J Infect Control 1996;24:24–52.
47. Occupational Safety and Health Administration: Occupational exposure to bloodborne pathogens, final rule. (29 CFR 1910.1030), Fed Reg; 56:64175–64182; 1991.
48. Garner JS, Favero MS. Guideline for handwashing and hospital environmental control, 1985. National Technical Information Service (PB855-923404); 1985. p. 14.
49. Hansen W, editor. A guide to managing indoor air quality in health care organizations 1997. Oakbrook (IL): Joint Commission on Accreditation of Healthcare Organizations Publications; 1997.
50. Freije MA, Barbaree JM. *Legionellae* control in health care facilities: a guide for minimizing risk. Indianapolis (IN): HC Information Resources Inc.; 1996.
51. Rask D, Dziekan B, Swiencicki W, Heinsohn P, Walmsley D. Air quality control during renovation in health care facilities. In: Healthy buildings: solutions to global and regional concerns. Atlanta (GA): ASHRAE Inc Press; 1998.
52. Opal SM, Asp AA, Cannady PB Jr, Morse PL, Burton LJ, Hammer PG II. Efficacy of infection control measures during a nosocomial outbreak of aspergillosis associated with hospital construction. J Infect Dis 1986;153:634–7.
53. Overberger PA, Wadowsky RM, Schaper MM. Evaluation of airborne particulates and fungi during hospital renovation. Am Ind Hyg Assoc J 1995;56:706–12.
54. Johnson K, Cohen M. An occupied hospital under construction: the role of environmental cultures [abstract]. AJIC Am J Infect Control 1997;25:166.
55. Chou T. Environmental services. In: Olmsted R, editor. APIC: infection control and applied epidemiology: principles and practice. 1996. St Louis (MO): Mosby; 1996. p. 107:1–7.
56. Goetz AM, *Legionella* species. Olmsted R, editor. APIC: infection control and applied epidemiology: principles and practice. 1996. St Louis (MO): Mosby; 1996. p. 64:1–4.
57. McDonald M. Disaster response. In: Olmsted R, editor. APIC: infection control and applied epidemiology: principles and practice. 1996. St Louis (MO): Mosby; 1996. p. 106:1–7.
58. Humphreys H, Johnson EM, Warnock DW, Willats SM, Winter RJ, Speller DC. An outbreak of aspergillosis in a general ITU. J Hosp Infect 1991;18:167–7.
59. Iwen PC, Reed EC, Armitage JO, Bierman PJ, Kessinger A, Vose JM, et al. Nosocomial invasive aspergillosis in lymphoma patients treated with bone marrow or peripheral stem cell transplants. Infect Control Hosp Epidemiol 1993;14:131–9.
60. Kerr JR, Moore JE, Curran MD, Graham R, Webb CH, Lowery KG, et al. Investigation of a nosocomial outbreak of *Pseudomonas aeruginosa* pneumonia in an intensive care unit by random amplification of polymorphic DNA assay. J Hosp Infect 1995;30:125–31.
61. Lingnau W, Allerberger F. Control of an outbreak of methicillin-resistant *Staphylococcus aureus* (MRSA) by hygienic measures in a general intensive care unit. Infection 1994;Suppl 2: S135–S139.
62. Rutala WA, Weber DJ. Environmental interventions to control nosocomial infections. Infect Control Hosp Epidemiol 1995;16:442–3.
63. Kollef MI, Von Harz B, Prentice D, Shapiro SD, Silver P, St. John R, et al. Patient transport from intensive care increases the risk of developing ventilator-associated pneumonia. Chest 1997;112:765–73.
64. Weber SF, Peacock JE Jr, Do KA, Cruz JM, Powell BL, Capizzi RL. Interaction of granulocytopenia and construction activity as risk factors for nosocomial invasive filamentous fungal disease in patients with hematologic disorders. Infect Control Hosp Epidemiol 1990;11:235–42.
65. Weinstein SA, Health and Safety Programs In: Olmsted R, editor. APIC: infection control and applied epidemiology: principles and practice. 1996. St Louis (MO): Mosby; 1996. p. 108:1–8.
66. Bolyard EA, Tablan OC, Williams, WW, Pearson ML, Shapiro CN, Ditchman SD. Guideline for infection control in health care personnel, 1998. AJIC Am J Infect Control 1998;26:289-354.
67. Centers for Disease Control and Prevention. Immunization of health-care workers: recommendations of the Advisory Committee on Immunization Practices and the Hospital Infection Control Practices Advisory Committee. MMWR Morb Mortal Wkly Rep 1997;46(RR 18):1–42.
68. Streifel AJ. Aspergillosis and construction. In: Kundsin RB, editor. Architectural design and indoor microbial pollution. New York: Oxford University Press; 1988 p. 198–217.
69. Streifel AJ, Lauer JL, Vesley D, Juni B, Rhame FS. *Aspergillus fumigatus* and other thermotolerant fungi generated by hospital building demolition. Appl Environ Microbiol 1983;46:375–8.
70. Yu VL, Zeming L, Stout J, Goetz A. *Legionella* disinfection of water distribution systems: principles, problems and practice. Infect Control Hosp Epidemiol 1993;14:567–70.
71. Goetz A, Yu VL. Screening for nosocomial *Legionella*. AJIC Am J Infect Control 1991;19:623–33.
72. Palmgren U, Strom G, Blomquist G, Malmberg P. Collection of airborne micro-organisms on nuclepore filters, estimation and analysis—CAMNEA method [abstract]. J Appl Bacteriol 1986;61(5):401–6.
73. Buttner MP, Stetzenbach LD. Monitoring airborne fungal spores in an experimental indoor environment to evaluate sampling methods and the effects of human activity on air sampling [abstract]. Appl Environ Microbiol 1993;59:219–26.
74. Rath PM, Ansorg R. Value of environmental sampling and molecular typing of Aspergilli to assess nosocomial sources of aspergillosis. J Hosp Infect 1997;37:47–53.
75. Hermans RD, Streifel AJ. Ventilation designs. Proceedings of the Workshop on Engineering Controls for Preventing Airborne Infections in Workers in Healthcare and Related Facilities; 1993 July 14–16; Cincinnati, Ohio. NIOSH; 1994.
76. Marrie TJ, Haldane D, MacDonald S, Clarke K, Fanning C, Le Fort-Jost S, et al. Control of endemic nosocomial legionnaires' disease by using sterile potable water for high risk patients. Epidemiol Infect 1991;107:591–605.

77. Bert F, Maubec E, Bruneau B, Berry P, Lambert-Zechovsky N. Multi-resistant Pseudomonas aeruginosa outbreak associated with contaminated tap water in a neurosurgery intensive care unit. J Hosp Infect 1998;39:53–62.
78. Mermel LA, Josephson SL, Giorgio CH, Dempsey J, Parenteau S. Association of legionnaires' disease with construction: contamination of potable water? Infect Control Hosp Epidemiol 1995;16:76–81.
79. Yu VL. Prevention and control of *Legionella:* an idea whose time has come. Infect Dis Clin Pract 1997;6:420–1.
80. Goetz A, Yu VL. Copper-silver ionization: cautious optimism for *Legionella* disinfection and implications for environmental culturing. AJIC Am J Infect Control 1997;25:449–51.
81. Butler JC, Fields BS, Breiman RF. Prevention and control of *Legionella*. Infect Dis in Clin Pract 1997;6:458–64.
82. Muraca P, Yu VL, Goetz A. Disinfection of water distribution systems for *Legionella*: a review of application procedures and methodologies. Infect Control Hosp Epidemiol 1990;11:79–88.
83. Miuetzner S, Schwille RC, Farley A, Wald ER, Ge JH, States SJ, et al. Efficacy of thermal treatment and copper-silver ionization for controlling Legionella pneumophila in high-volume hot water plumbing systems in hospitals. AJIC Am J Infect Control 1997;25:452–7.
84. Johanning E, Biagini R, Hull D, Morey P, Jarvis B, Landsbergis P. Health and immunology study following exposure to toxigenic fungi (Stachybotrys chartarum) in a water-damaged office environment. Int Arch Occup Environ Health 1996;68:207–18.
85. Michigan Department of Consumer and Industry Services. Minimum design standards for health care facilities in Michigan. Lansing (MI): MDCIS; 1998.
86. Cooney TE. Bactericidal activity of copper and noncopper paints. Infect Control Hosp Epidemiol 1995;16:444–50.
87. Rutala WA. Water as a reservoir of nosocomial pathogens. Infect Control Hosp Epidemiol 1997;18:609–16.
88. Health Facilities Forum on Carpet in Health Care Facilities Series. Health facilities management. Chicago (IL): American Hospital Association; 1993;12:22–34; 1994;1:26–30; 1994;2:38–46.
89. Anderson RL, Mackel DC, Stoler BS, Mallison GF. Carpeting in hospitals: an epidemiological evaluation. J Clin Microbiol 1982;15:408–15.
90. Lumish, RM, Carpeting in hospitals: an infection control problem? JAMA 1989;261:2422.
91. Skoutelis AT, Westenfelder GO, Berkerdite M, Phair JP. Hospital carpeting and epidemiology of Clostridium difficile. AJIC Am J Infect Control 1994;22:212–7.
92. Schmidt EA. Medical waste. In: Olmsted R, editor. APIC: infection control and applied epidemiology: principles and practice. 1996. St Louis (MO): Mosby; 1996.
93. Baker C. Obstetric practice areas. In: Olmsted R, editor. APIC: infection control and applied epidemiology: principles and practice. 1996. St Louis (MO): Mosby; 1996. p. 93:1–7.
94. Dadswell JV: Managing swimming, spa and other pools to prevent infection. Commun Dis Rep 1996:6(2)R37–40.
95. Hollyoak V, Boyd P, Freeman R. Whirlpool baths in nursing homes: use, maintenance and contamination with *Pseudomonas aeruginosa*. Commun Dis Rep 1995:5(7)R102–104.
96. Miles J. Potentially hazardous amoebae found in eyewash stations. Hazard information bulletin. United States Department of Labor and Occupational Safety and Health Administration. Dec. 1986. Bulletin 19861223. Available from: URL: http://www.osha-slc.gov/HIB19861223.html.
97. DHHS (NIOSH) Publication 97-111. Selecting, evaluating and using sharps disposal containers. Available from: URL: http://www.cdc.nisoh/sharps1.html.
98. Aerobiological Engineering. Pennsylvania State University, Graduate school of Architectural Engineering and Department of Biology. July, 1997. Available from: URL: http://www.engr.psu.edu/arc/server/wjkaerob.html.
99. Rice N, Streifel A, Veseley D. Room pressure: a critical parameter for special ventilation rooms. Proceedings of the SHEA Eighth Annual Scientific meeting; 1998; Orlando, Fla.

UAMS
UNIVERSITY OF ARKANSAS FOR MEDICAL SCIENCES

UAMS ADMINISTRATIVE GUIDE

NUMBER: 11.2.08
DATE: 05/21/02
REVISION:

SECTION: CAMPUS OPERATIONS
AREA: FACILITIES
SUBJECT: INTERIM LIFE SAFETY MEASURES (ILSM) and INFECTION CONTROL RISK ASSESSMENT (ICRA)

PURPOSE

The purpose of this policy is to provide guidance on compliance with the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) Interim Life Safety Measures (ILSM) and Infection Control Risk Assessment (ICRA) standards.

POLICY

This policy applies to buildings that support outpatient and in-patient Clinical Programs. When planning demolition, construction, renovation, cable installation or maintenance work, the responsible UAMS department will conduct a proactive risk assessment to identify hazards that could potentially compromise patient care or worker safety in occupied areas. The risk criteria will address the impact demolition, renovation, maintenance or new construction activities have on fire safety, air quality, infection control, utility requirements, noise, vibration and emergency procedures. Ongoing renovation and construction projects shall be monitored to ensure compliance with the latest JCAHO ILSM and ICRA standards. The departments of Construction and Contract Management (C&CM), Physical Plant (PP), and Occupational Health and Safety (OH&S) are responsible for enforcement where applicable. ILSM/ICRA issues will be addressed in the planning stage of all projects, and the checklists attached to this policy will be used to document compliance.

PROCEDURE

Early in the planning process, the responsible department (C&CM, PP, Telecommunications, Media Services, UAMS Police or other) will evaluate each project using the ILSM Risk Assessment (Attachment I) and the ICRA Permit/Matrix (Attachment II).

If any question on the ILSM Risk Assessment is YES, then ILSM may apply to the project. Contact Occupational Health and Safety for assistance before proceeding. If all answers are No, the signed negative assessment must be kept in the project file in the department for documentation.

If the ICRA Permit/Matrix indicates that Class I or II infection control procedures are required, the project may be signed off by the responsible department and the signed permit matrix kept in the project file in the department for documentation.

EXCEPTION: All projects affecting patients in the Highest Risk group must be approved by an ICRA Committee (See number 4 below).

If it is determined that Class II in an area of Highest Risk patients, Class III or Class IV infection control procedures are required contact the C&CM Planner or C&CM A/E Coordinator who will convene the appropriate ICRA committee members for a risk assessment meeting.

The ICRA committee must include at a minimum, Infection Control, OH&S, C&CM and patient care representatives from the affected area/areas. Other involved departments or contractors may be included as necessary to fully understand the scope of the project. An

ICRA Permit/Matrix will be completed and signed by the committee members. Required Infection Control activities for each project will be determined based on the consensus of the committee.

The C&CM planner, or C&CM A/E Coordinator will document the ILSM and ICRA measures required based on the results of the risk assessments for the project using the Construction and Contract Management Project Planning Tool.

A pre-bid conference will be scheduled by the project manager in which each applicable ILSM and or ICRA item will be reviewed for understanding & concurrence by contractors.

Upon plans completion a pre-construction conference will be scheduled by the project manager and each applicable ILSM and or ICRA item listed in project documentation will be briefed.

When a project requires Class III or Class IV Infection control precautions or ILSM applies, the Project Manager will do a daily sign-off to document that the applicable ILSM/ICRA measures are implemented using the ILSM/ICRA Daily Checklist.

Prior to project substantial completion the project manager will request that the Physical Plant foreman or designated representative conduct a fire/smoke wall inspection to verify that all specified fire/smoke separations are intact in accordance with Campus Policy 11.1.08, Maintenance of Smoke/Fire Barriers.

The ILSM and ICRA forms (Attachments I, II) and the C&CM Project planning tool and daily checklist when applicable along with minutes of the ICRA Committee risk assessment meeting, will be kept in the construction project folder and designated office files.

In addition to the ILSM and ICRA planning, all project planning will include consideration for all finishes to be used for renovation and new construction. Fire retardant or resistant materials will be selected to insure that all new product installations meet the latest NFPA Life Safety Code. Examples are products such as furnishings, draperies, interior decorations, waste containers and other materials, as indicated in Campus Operations Policy 11.4.17.

Definitions:

ICRA Committee: A multi-disciplinary group of professionals who meet and agree on what procedures will be implemented to protect the patient population from air borne infection during renovation and construction.

Patient Care Representative: The person is most directly responsible for patient care aspects on location where renovation and construction will occur.

**Click here to view ILSM and ICRA forms and description of required infection control precautions.

Attachment I

Interim Life Safety Measures Risk Assessment

These criteria are used to evaluate areas in which construction renovation or repair activities are planned or in which a Life Safety Code deficiency has been identified. Consideration should be given to the scope of operations in the area, the level of staff activity, and the acuity of patient treatment in the area.

Area: _____ Project: _____

Date Assessed: _____ PFI Unique ID# _____

Criteria	NO	YES	Findings / Comments	ILSM
The issue alters or significantly compromises exit access, exiting, or exit discharge building elements				
Significant compromise of building compartmentation including fire or smoke walls, floor / ceiling assemblies, corridor walls, use area doors, or other defend in place elements				
The issue impairs the building fire alarms or sprinkler systems for more than 4 hours in a 24-hour period.				
The activity includes significant ignition sources such as cutting, welding, or other operations using flame or producing sparks.				
The activity includes large quantities of combustible materials, flammable materials, or generation of large amounts of dust and debris.				
Other Factors:				

Findings: **[ ] ILSM are required [ ] ILSM are not necessary**

Assessed by: _____

Attachment II

Infection Control Construction Permit

Project Location:	Permit Number:
Project Manager:	Project Start Date:
Permit Requested by:	Date Requested:
Contractor:	Permit Expiration:
Contractor Supervisor:	Telephone:

UAMS MEDICAL CENTER

Complete this section based on the results of the ICRA Matrix

CONSTRUCTION ACTIVITY		RISK GROUP	
☐	**TYPE A**: Inspection and Non-Invasive Activities	☐	**GROUP I: Low Risk**
☐	**TYPE B:** Small scale, short duration activities which create minimal dust	☐	**GROUP II: Medium Risk**
☐	**TYPE C:** Activity generates moderate to high levels of dust, or requires demolition or removal of any fixed building components or assemblies.	☐	**GROUP III: Medium/High Risk**
☐	**TYPE D:** Major Demolition and construction activities.	☐	**GROUP IV: Highest Risk**

☐	**CLASS I Required**	Date:		Signature:	
☐	**CLASS II Required**	Date:		Signature:	
☐	**CLASS III Required**	Requires ICRA Committee Approval and Signatures Below			
☐	**CLASS IV Required**	Requires ICRA Committee Approval and Signatures Below			

Additional Requirements

User Contact:			
Date:			
Planning Supervisor:		Project Management Supervisor:	
Date:		Date:	
Architect/Planner:		Engineer:	
Date:		Date:	
Information Technologies (CIS)		Telecommunications:	
Date:		Date:	
Housekeeping:		Other Personnel:	
Date:		Date:	
Occupational Health & Safety:		Permit Authorized on:	
Date:			

UAMS Infection Control Risk Assessment (ICRA)

Matrix of Precautions for Construction & Renovation

	Identify specific site of all activities, e.g. bldg, floor, patient rooms, medication room, etc.

	Work hours: Can or will the work be done during non-patient care hours, or can patients be relocated for the duration of the project?

Step Three:

TYPE A	**Inspection and Non-Invasive Activities** Includes but is not limited to: • Removal of ceiling tiles for visual inspection or cable installation limited to 3 tiles at a time. • Painting (but not sanding) • Wall covering, electrical trim work, minor plumbing, installation of telephone and computer cabling and other activities which do not generate dust or require cutting of walls or access to ceilings other than as above.
TYPE B	**Small scale, short duration activities which create minimal dust** Includes, but is not limited to: • Access to chase spaces • Cutting of walls or ceiling where dust migration can be controlled. • Removal of sections of telephone or computer cabling. • **NOTE: Any Type B activity in any location when patients will not be present, and for which the area can be isolated and vacated for the minimum time as per Appendix A and cleaned to required patient standards prior to resuming patient operations can be classified as Type A.**
TYPE C	**Work that generates a moderate to high level of dust or requires demolition or removal of any fixed building components or assemblies** Includes, but is not limited to: • Sanding of walls for painting or wall covering • Removal of floor coverings, exposure of large sections of ceiling spaces and casework • Demolition of walls or new wall construction • Minor duct work or electrical work above ceilings • Major cabling activities, or removal of a complete cabling system. • Working with sinks and plumbing that could result in aerosolization of water. • Demolition, repair or construction of elevator shafts. • Repairing water damage. • Any activity which cannot be completed within a single work shift.
TYPE D	**Major Demolition and construction projects** Includes, but is not limited to: • Activities which require consecutive work shifts • Requires heavy demolition • New construction

	Considering the answers to Step 1 and 2 and using the table above *identify* the Type of Construction Project Activity (Type A-D)

Step Four:

Low Risk	Medium Risk	High Risk	Highest Risk
• Office Areas • Basement	• Cardiology • Echo cardiology • Endoscopy • Nuclear Medicine • Physical Therapy • Radiology/MRI • Respiratory Therapy • General Clinics • General Patient Room Areas • Medical Unit • Negative pressure isolation rooms • TB Unit • Laboratories (specimen)	• CCU • Emergency Room • Labor & Delivery • Newborn Nursery • Outpatient Surgery • Pharmacy • Post Anesthesia Care Unit • Surgical Units	• Any unit or clinic caring for immunocompromised patients • Bone Marrow • Burn Unit. • Cardiac Cath Lab • Central Sterile Supply • Intensive Care Units • NICU • Oncology • Operating Rooms including C-section rooms • Organ Transplant Unit

[redacted] **Using the table above, *identify* the Patient Risk Groups that will be affected for each area of concern. If more than one risk group will be affected, select the highest risk group that will be affected:**

Project Unit	Unit Below	Unit Above	Lateral	Lateral	Behind	Front
Risk Group	Risk Group	Risk Group	Risk Group	Risk Group	Risk Group	Risk Group

Step Five:

Match the highest Patient Risk Group (*Low, Medium, High, Highest*) with the planned **Construction Project Type (*A, B, C, D*)** on the following matrix, to find the...

Class of Precautions (*I, II, III, or IV*) or the level of infection control activities required.

IC Matrix-Class of Precautions: Construction Project by Patient Risk

Construction Project Type

PATIENT RISK GROUP	TYPE A	TYPE B	TYPE C	TYPE D
LOW Risk Group	[redacted]	[redacted]	II	[redacted]
MEDIUM Risk Group	[redacted]	II	[redacted]	III/IV
HIGH Risk Group	[redacted]	II	[redacted]	III/IV
HIGHEST Risk Group	II	[redacted]	[redacted]	IV

[redacted] ***Match* the Patient Risk Group and Construction Project Type, to *identify* the Class of infection control Precaution required.**

Note: When the Construction Activity and Risk Level indicate that [redacted] or Class IV control procedures are necessary, an ILSM/ICRA Risk Assessment Committee must be convened for final approval.

Specific Class I-IV Color-Coded Precautions are delineated in the table on the following page.

Description of Required Infection Control Precautions by Class

	During Construction Project	Upon Completion of Project
	1. Execute work by methods to minimize raising dust from construction operations. 2. EPA disinfectant mist tiles and work surfaces to control dust before disturbing. 3. Immediately replace a ceiling tile displaced for visual inspection. HEPA-vac obvious dust collection.	1.Wet mop and/or vacuum with HEPA filtered vacuum before leaving work area.
Class II	1. Provide active means to prevent airborne dust from dispersing into atmosphere. 2. EPA disinfectant 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.	1. Wipe work surfaces with 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. Remove isolation of HVAC system in areas where work is being performed.
	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, or 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 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 disinfectant. 5. Remove isolation of HVAC system in areas where work is being performed.
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, or 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 appropriately. 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 the 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. 7. Do not remove barriers from work area until completed project is inspected by the owner's Safety Department and Infection Control Department and thoroughly cleaned by the owner's Environmental Services Department.	1. Remove barrier material carefully to minimize spreading of dirt and debris associated with construction. 2. Contain construction waste before transport in tightly covered containers 3. Cover transport receptacles or carts. Tape covering unless solid lid. 4. Vacuum work area with HEPA filtered vacuums. 5. Wet mop area with disinfectant. 6. Remove isolation of HVAC system in areas where work is being performed. 7. Clean or replace HVAC filters and verify appropriate ventilation parameters for the area have been re-established. 8. Flush the mains water system to clear dust contaminated lines if affected. 9. Commission the space as indicated.

Identify issues related to: ventilation, plumbing, electrical in terms of the occurrence of probable outages.

IMPLEMENT ELEMENT	METHOD
☐ Water Isolation:	
☐ Noise Impact:	
☐ Vibration Impact:	
☐ Generator Failure:	
☐ Fuel Shortage/Restriction:	
☐ Transportation Failure:	
☐ Natural Gas Failure:	
☐ Water Failure:	
☐ Sewer Failure:	
☐ Steam Failure:	
☐ Nurse Call Failure:	
☐ Telephone Failure:	
☐ Telemetry Failure:	
☐ Public Address Failure:	
☐ O_2 Failure:	
☐ Medical Air Failure:	
☐ Nitrogen Failure:	
☐ N_2O Failure:	
☐ CO_2 Failure:	
☐ Medical Vacuum Failure:	
☐ HVAC Failure:	
☐ Control Air Failure:	
☐ Hazmat Exposure:	
☐ Asbestos Exposure:	
☐ Structural Damage:	
☐ Natural Gas Failure:	

Identify containment measures, using prior assessment. What type of barriers? (e.g. solid wall barriers); Will a HEPA filtration be required?

(Note: Renovation/Construction Area shall be isolated from the occupied areas during construction and shall be negative with respect to surrounding areas)

Consider potential risk of water damage. Is there a risk due to compromising structural integrity? (e.g. wall, ceiling, roof)

Work hours: Can or will the work be done during non-patient care hours?

Do plans allow for adequate number of isolation/negative airflow rooms?

[redacted]	

[redacted]	**Do plans allow for the required number and type of hand washing sinks?**

[redacted]	**Does the infection control staff agree with the minimum number of sinks for this project? (Verify against AIA Guidelines for types and area)**

[redacted]	**Does the infection control staff agree with the plans relative to clean and soiled utility rooms?**

[redacted]	**Plan to discuss the following containment issues with the project team. (e.g., traffic flow, housekeeping, and debris removal (how and when)).**

Appendix A – Required Time for Removal of Airborne Contaminants

Air Changes per Hour (ACH) and Time In Minutes Required for Removal Efficiencies of 90%, 99%, and 99.9% of Airborne Contaminants[4]

	Minutes Required for a Removal Efficiency Of:		
Air Changes/Hour (ACH)	90%	99%	99.90%
1	138	276	414
2	69	138	207
3	46	92	138
4	35	69	104
5	28	55	83
6	23	46	69
7	20	39	59
8	17	35	52
9	15	31	46
10	14	28	41
11	13	25	38
12	12	23	35
13	11	21	32
14	10	20	30
15	9	18	28
16	9	17	26
17	8	16	24
18	8	15	23
19	7	15	22
20	7	14	21
25	6	11	17
30	5	9	14
35	4	9	12
40	3	7	10
45	3	6	9
50	3	6	8

This table has been adapted from the formula for the rate of purging airborne contaminants .[1312]
Values have been derived from the formula $t_1 = [\ln (C_2 / C_1) / (Q / V)] \times 60$, with $T_1 = 0$ and C_2 / C_1 - (removal efficiency / 100), and where:

t_1 = initial timepoint — C_1 = initial concentration of contaminant
C_2 final concentration of contaminant — Q = air flow rate (cubic feet/hour CFH)
V room volume (cubic feet) — Q/V=ACH

The times given assume perfect mixing of the air within the space (i.e., mixing factor = 1). However, perfect mixing usually does not occur, and the mixing factor could be as high as 10 if air distribution is very poor.[209] The required time is derived by multiplying the appropriate time from the table by the mixing factor that has been determined for the booth or room. The factor and required time should be included in the operating instruction is provided by the manufacturer of the booth or enclosure, and these instructions should be followed.

Prevention

Education Disease Exposures Infectious Diseases Patient & Visitor

Construction/Renovation

Download Complete Policy

Also see the lecture on Construction/Renovation: Health Effects

Introduction: Minimize Risks When You Renovate

Construction can disrupt microorganisms in the environment so that they pose a risk to patients. Fungal spores (i.e. Aspergillus) are frequent contaminates of ceiling tiles and w board. During construction they are disrupted, and dispersed into the air. These spores c pose a threat to immunocompromised patients.

At risk patients may include:

those receiving immunosuppressive therapy:
___ bone marrow and solid organ transplantation

those who are neutropemic due to:
___ leukemia lymphoma
___ aplastic anemia myeloplastic disease

those with a neutrophil count <500

those with congenital or acquired immunedeficiency syndrome

those immunocompromised due to
___ severe disese ___ extreme prematurity

those who receive steroids

those who have open wounds

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At Risk Construction Activities

- Demolition of existing ceilings or walls
- Exposure of ceiling spaces by removal of all or part of ceiling
- Breeching of walls, ceilings, or floors, i.e. drilling, removing ceilings
- Removal of uncovered or partially covered debris from construction areas

- Construction of new facilities on the JHMI campus
- Major disturbance of soil where dust or dirt becomes airborne
- Dusting leaks
- Major excavations or implosions (demolition of structures by collapse explosion) ir the surrounding community.

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At Risk Areas and Locations

Definition of Infection Control Risk Areas/Locations			
GROUP 1 LOWEST	**GROUP 2 MEDIUM**	**GROUP 3 MEDIUM HIGH**	**GROUP 4 HIGHEST**
• Office areas • Non-patient/ low risk areas not listed elsewhere	• Patient care & other areas not covered under group 3 or 4 • Laundry • Cafeteria • Dietary • Materials Management • PT/OT/Speech • Admission/Discharge • MRI • Nuclear Medicine • Echocardiography • Laboratories not specified as Group 3 • Public Corridors (through which patients, supplies, and linen pass)	• Emergency Rooms • Radiology • Post-anesthesia Care units (except Weinberg) • Labor and Delivery (Nelson 2) • Newborn Nurseries • Newborn Intensive Care unit • Pediatrics (except those listed in group 4) • All Intensive Care Units (except those listed in group 4) • Microbiology lab • Virology lab • Long term/sub-acute units • Pharmacy • Dialysis • Endoscopy • Bronchoscopy areas (including Blalock & Meyerhoff Unit)	• Weinberg building: IPOP HIPOP 4&5 A,B,C,D 3A WICU Radiation therapy (basement) 2, Chemo infusion 1, clinical are • Moore Clinic • Osler 8 • Nelson 6&7 • CMSC 8 E& • Pharmacy Admixture • Operating Rooms GOR Weinburg OI PACU Wilmer OR JHOPC OR Greenspring • C Section Rooms • Sterile Processing • CVDL (CMS 5) • Cardiac Catheterizati • Outpatient invasive procedures rooms • Oncology Units

		• Nelson 4 • Park 3	• Anesthesia and Pump areas

Construction in Patient Areas With Specific Clinic Hours should be scheduled during non-patient times to minimize risk.

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References

Center for Disease Control and Prevention (1994). Recommendations for Prevention of Nosocomial Pneumonia. AJIC, 22: 247-92.

Opal, S.M., Asp, A.A., Cannady, P.B., Morse, P.L., Burton, L.J., & Hammer, P.G. (1986). Efficacy of infection control measures during a nosocomial outbreak of disseminated aspergillosis-associated with hospital construction. J Infect Dis, 153: 634-637.

Purcell, R.J. (1989). Controlling Aspergillus contamination in heating ventilation and air conditioning systems. Plant Technology and Safety Management Services: Infection Control Issues in PTSM (pp.23-26). Chicago: Joint Commission of Accreditation of Healthcare Organizations.

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Responsibilities

Facilities Department (FD)

Notify the Hospital Epidemiology and Infection Control Department of planned work to obtain approval prior to start of work (for all new construction or for construction or renovation activities for departments listed in Risk Groups 3 and 4).

Telecomunication Services (TS)
Computer Information Services (CIS)
Network and Telecommunication Services (NTS)

Notify HEIC of planned work and obtain approval prior to the start of work in Risk Groups or 4.

Follow the approved procedures set up by the FD to minimize the generation of dust.

Notify Nursing Manager/Clinic/Department Manager of any proposed work and precautionary measures that will be taken.

Oversee projects by inspecting barriers, etc., on a routine basis.

Call Environmental Services to organize any clean-up.

Legal Department (LD)

Include the following language in all construction maintenance, and or renovation contracts: **"HEIC shall approve projects involving manipulation of ceiling tiles, performance of dust generating activities, manipulation of HVAC (Heating, Ventilation, and Air Conditioning) systems, plumbing, and/or other maintenance repairs prior to the initiation of the project."**

Environmental Services

Work with FD to identify areas that need to be damp mopped and clean these areas as scheduled.

Thoroughly clean new and renovated areas before admitting or readmitting patients.

Coordinated inspection of final cleaning with HEIC prior to opening/re-opening the area.

Nursing Departments and Other Departments that See Paients

Help identify high risk patients.

Relocate high risk patients to unaffected areas before construction/renovation work is initiated.

Optimally, avoid non-emergent admission/testing/treatment of immunocompromised patients during such periods of construction/renovation.

Hospital Epidemiology and Infection Control (HEIC)

Review procedures that are developed by FD to comply with this policy and submit to the HEIC Committee for approval.

Educate Managers, Medical Staff, Environmental Services personnel, and other staff as needed about risks to immuno-suppressed patients exposed to construction dust.

Determine whether construction poses sufficient increased risk to require/recommend th patients be moved to an area of the hospital/facility where construction is not occurring.

Review indications for performing environmental cultures with the appropriate departmer (Health, Safety and Environment; Microbiology Laboratory).

Inspect areas where construction has occurred after final cleaning and approve opening re-opening of the areas.

Conduct careful environmental investigation, including culture confirmation (as possible).

when a cluster of patients with infections potentially related to construction/renovation (aspergillosis, legionellosis, etc.) is identified.

Health and Safety and Environmental

Review air sampling strategy with HEIC

Sample appropriate areas at predetermined time intervals during times of construction/renovation.

Send all HEIC requested air amples for culture to the microbiology laboratory for fungal identification (*Aspergillus*) and speciation.

Samples should include:

- selected patient care areas
- patient rooms
- treatment areas
- predetermined control areas

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Healthcare Epidemiolo
Infection Con

PATIENT CARE OBJECTIVES

The intent of this policy is to minimize nosocomial (hospital-acquired) infections in patients that may arise as a result of exposure to organisms released into the environment during construction and renovation activities. Controlling dispersal of air- and/or water-borne infectious agents concealed within building components is critical in all of the Johns Hopkins facilities. To this end, all construction and renovation activities shall be defined and managed in such a way that occupants' exposure to dust, moisture and their accompanying hazards is limited. Controlling construction dust and dirt will further serve to protect staff and visitors, as well as sensitive procedures and equipment, from possible ill effects.

RESPONSIBILITIES

Facilities Department (FD) -

Notify the Hospital Epidemiology and Infection Control Department of planned work to obtain approval prior to start of work (for all new construction or for construction or renovation activities for departments listed in Risk Groups 3 and 4).

Telecommunication Service (TS),
Computer Information Services (JHMCIS),
Network & Telecommunication Services (NTS) -

- Notify HEIC of planned work and obtain approval prior to the start of work in Risk Groups 3 or 4.
- Follow the approved procedures set up by the FD to minimize the generation of dust.
- Notify appropriate Nursing/Clinic/Department manager of any proposed work and precautionary measures, which will be taken.
- Oversee projects by inspecting barriers, etc. on a routine basis.
- Call Environmental Services to organize any clean up.

Legal Department (LD) -

Include the following language in all construction maintenance, and or renovation contracts: **"HEIC shall approve projects involving manipulation of ceiling tiles, performance of dust generating activities, manipulation of HVAC (Heating, Ventilation, and Air Conditioning) systems, plumbing, and/or other maintenance repairs prior to the initiation of the project."**

Environmental Services (EVS) –

- Work with FD to identify areas that need to be damp mopped and clean these areas as scheduled.
- Thoroughly clean new and renovated areas before admitting or readmitting patients.
- Coordinate inspection of final cleaning with HEIC prior to opening/re-opening the area.

Nursing Departments (and other departments that see patients) –

- Help identify high-risk patients.
- Relocate high-risk patients to unaffected areas before construction/renovation work is initiated.
- Optimally, avoid non-emergent admission/testing/treatment of immunocompromised patients during periods of construction/renovation.

Hospital Infection Control and Epidemiology (HEIC) –

- Review procedures that are developed by FD to comply with this policy and submit to HEIC Committee for approval.

- Educate Managers, Medical Staff, Environmental Services personnel, and other staff as needed about risks to immuno-suppressed patients exposed to construction dust.
- Determine whether construction poses sufficient increased risk to require/recommend that patients be moved to an area of the hospital/facility where construction is not occurring.
- Review indications for performing environmental cultures with the appropriate departments (Health, Safety and Environment; Microbiology Laboratory).
- Inspect areas where construction has occurred after final cleaning and approve opening or re-opening of the areas.
- Conduct careful environmental investigation, including culture confirmation (as possible), when a cluster of patients with infections potentially related to construction/renovation (aspergillosis, legionellosis, etc.) is identified.

Health, Safety and Environment-

- Review air-sampling strategy with HEIC.
- Sample appropriate areas at predetermined time intervals during times of construction/renovation.
- Send all HEIC requested air-samples for culture to the microbiology laboratory for fungal identification (Aspergillus) and speciation.

  Samples should include selected patient care areas, patient rooms, treatment areas, and predetermined control areas.

PROCEDURES

Construction Guidelines:

Facilities Department personnel at Johns Hopkins, who are responsible for managing each construction or renovation project, will:

- Determine the infection control project classification using the matrices* (located below). HEIC and the Health, Safety and Environment department may modify, add, or delete guidelines on individual projects in collaboration with the Facilities Department project leader.
- Coordinate the relocation of affected patients and pedestrian traffic routes to areas where there is less potential for exposure to airborne contaminants with the responsible departments.
- Coordinate the preparation of the project area, including the removal of medical supplies, waste, and equipment, prior to the commencement of project activities with the responsible departments.

Project Classification:

STEP ONE

Select Construction Activity Type from the table below.

(Construction Activity Type is defined by the amount of dust that is generated, the duration of the activity, and the involvement with HVAC systems.) Contact the HEIC Department if any activity is questionable under these guidelines.

DEFINITIONS OF CONSTRUCTION ACTIVITY
Type A: **Inspections and General Upkeep Activities**. Includes but is not limited to: removal of ceiling tiles for visual inspection (limited to 1 tile per 50 square feet); painting (but not sanding); installation of wall covering; electrical trim work; minor plumbing; and activities, which do not generate dust or require cutting into 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, installation of telephone and computer cabling, access to chase spaces, cutting into walls or ceiling where dust migration can be controlled.
Type C: Any work that generates a moderate to high level of dust. Includes, but is not limited to, demolition or removal of built-in building components or assemblies, sanding of wall for painting or wall covering, removal of floor covering/wallpaper, ceiling tiles and casework, new wall construction, minor ductwork or electrical work above ceilings, major cabling activities.
Type D: **Major demolition and construction projects.** Includes, but is not limited to, heavy demolition, removal of a complete ceiling system, and new construction.

STEP TWO

Select Infection Control Risk Group from the table below.

(Infection Control Risk Groups defined are based on project location and occupancy.) Contact HEIC Department if any location is questionable under these guidelines. When possible, as in outpatient areas, day-treatment only areas, etc., work should be done after hours since these areas have limited times when patients are seen.

DEFINITION OF INFECTION CONTROL RISK AREA/LOCATION			
GROUP 1 LOWEST	**GROUP 2 MEDIUM**	**GROUP 3 MEDIUM HIGH**	**GROUP 4 HIGHEST**
• Office areas • Non-patient/ low risk areas not listed elsewhere	• Patient care & other areas not covered under group 3 or 4 • Laundry • Cafeteria • Dietary • Materials Management • PT/OT/Speech • Admission/Discharge • MRI • Nuclear Medicine • Echocardiography • Laboratories not specified as Group 3 • Public Corridors (through which patients, supplies, and linen pass)	• Emergency Rooms • Radiology • Post-anesthesia Care units **(except Weinberg)** • Labor and Delivery (Nelson 2) • Newborn Nurseries • Newborn Intensive Care unit • Pediatrics **(except those listed in group 4)** • All Intensive Care Units **(except those listed in group 4)** • Microbiology lab • Virology lab • Long term/sub-acute units • Pharmacy • Dialysis • Endoscopy • Bronchoscopy areas (including Blalock & Meyerhoff Unit) • Nelson 4 • Park 3	• Weinberg building: IPOP HIPOP 4&5 A,B,C,D 3A WICU Radiation therapy (basement) 2, Chemo infusion 1, clinical area • Moore Clinic • Osler 8 • Nelson 6&7 • CMSC 8 E&W • Pharmacy Admixture • Operating Rooms GOR Weinburg OR & PACU Wilmer OR JHOPC OR Greenspring • C Section Rooms • Sterile Processing • CVDL (CMSC 5) • Cardiac Catheterization • Outpatient invasive procedures rooms • Oncology Units • Anesthesia and Pump areas

STEP THREE

Using the Construction Activity Type and the Infection Control Risk Group selected from the tables above, use the matrix below to determine Construction Classification (Class). [Construction Classification (Class) determines the procedures to be followed during construction and renovation projects.] Contact HEIC Department for "special case" questions.

Construction Activity Matrix				
CONSTRUCTION ACTIVITY→ **RISK LEVEL ↓**	**TYPE "A"**	**TYPE "B"**	**TYPE "C"**	**TYPE "D"**
Group I	**Class I**	**Class II**	**Class II**	**Class III/IV**
Group 2	**Class I**	**Class II**	**Class III**	**Class IV**
Group 3	**Class I**	**Class III**	**Class III/IV**	**Class IV**
Group 4	**Class III**	**Class III/IV**	**Class III/IV**	**Class IV**

STEP FOUR

Implement the appropriate Infection Control Construction Guideline based on the project classification selected from the Construction Activity matrix (listed above) in STEP THREE. (Infection Control Construction Guidelines are procedures to control release(s) of airborne contaminants resulting from construction, demolition, or renovation activities.)

INFECTION CONTROL CONSTRUCTION GUIDELINES	
CLASS I	• Execute work by methods to minimize raising dust from construction operations. • Replace any ceiling tile displaced for visual inspection as soon as possible.
CLASS II	• Provide active means to prevent air-borne dust from dispersing into atmosphere • Seal unused doors with duct tape. • Contain construction waste before transport in tightly covered containers. • Wet mop and/or vacuum with HEPA filtered vacuum before leaving work area daily. • Place dust-mat at entrance and exit of work area and replace or clean when no longer effective. • Isolate HVAC system in areas where work is being performed. • Wipe casework and horizontal surfaces at completion of project.
CLASS III	• Isolate HVAC system in area where work is being done to prevent contamination of the duct system. • Complete all construction barriers before construction begins. • Maintain negative air pressure within work site utilizing HEPA filtered ventilation units or other methods to maintain negative pressure. Public Safety will monitor air pressure. • Do not remove barriers from work area until complete project is thoroughly cleaned. • Wet mop or vacuum twice per 8-hour period of construction activity or as required in order to minimize tracking. • Remove barrier materials carefully to minimize spreading of dirt and debris associated with construction. Barrier material should be wet wiped, HEPA vacuumed or water misted prior to removal. • Contain construction waste before transport in tightly covered containers. • Place dust-mat at entrance and exit of work area and replace or clean when no longer effective. • Wipe casework and horizontal surfaces at completion of project.

CLASS IV	• Isolate HVAC system in area where work is being done to prevent contamination of duct system. • Complete all construction barriers before construction begins. • Maintain negative air pressure within work site utilizing HEPA filtered ventilation units or other methods to maintain negative pressure. Public Safety will monitor air pressure. • Seal holes, pipes, conduits, and punctures to prevent dust migration. • Construct anteroom and require all personnel to pass through this room. Wet mop or HEPA vacuum the anteroom daily. • During demolition, dust producing work or work in the ceiling, disposable shoes and coveralls are to be worn and removed in the anteroom when leaving work area. • Do not remove barriers from work area until completed project is thoroughly cleaned. • Remove barrier materials carefully to minimize spreading of dirt and debris associated with construction. • Barrier material should be wet wiped, HEPA vacuumed or water misted prior to removal. • Contain construction waste before transport in tightly covered containers. • Place dust-mat at entrance and exit of work area and replace or clean when no longer effective. • Keep work area broom clean and remove debris daily. • Wet mop hard surface areas with disinfectant at completion of project. HEPA vacuum carpeted surfaces at completion of project • Wipe casework and horizontal surfaces at completion of project.

Submittals

Unless previously specified in the construction documents:

- Contractors, or the responsible Johns Hopkins department, will submit report of Infection Control procedures, including locations and details of barriers, means of creating negative pressure, etc., prior to the start of project for review by Health, Safety and Environment, HEIC and Facilities departments responsible for managing the project.

- Contractor will submit product data for review as requested.

Execution

Products and Materials

Barrier products which are approved:

- Sheet Plastic: Fire retardant polyethylene, 6-mil thickness. Dry wall with metal studs.

- Solid core, wooden doors in metal frames - painted.
- Portable dust containment system, such as "ZipWall" as manufactured by Zip Wall LLC, Cambridge, Mass., or equivalent

HEPA-filtered ventilation units such as those manufactured by "HPA Aire" Model PAS 2000 HC or Model PAS 2000 HC or Model PAS 1000HC equipped air filtration units or equivalent. Provide HEPA filter, primary and secondary filters.

Exhaust Hoses: Heavy duty flexible steel reinforced; Ventilator Blower Hose, WPC such as that manufactured by Federal Hose Mtg. Co. Painsville, OH 44077 or equivalent.

Adhesive Walk-Off Mats: Provide minimum size mats of 24 inches X 36 inches such as those manufactured by 3 M, St. Paul, MN 55144 or equal.

Disinfectants: Johns Hopkins Hospital approved disinfectant.

Filters: Return and exhaust air ducts shall be covered with 2" thick pleated air filters. Filters to be model #FME-40 as manufactured by Purolator or approved equivalent. Minimum efficiency 25/35% with minimum of 10 pleats per foot.

Procedures

Isolation

- Construction activities causing disturbances of existing dust, or creating new dust, will be conducted in tight enclosures that cut off flow of particles into adjacent areas.
- Where containment is possible, utilizing building walls and doors (all doors *except construction access doors)* should be closed and sealed with duct tape to prevent dust and debris from escaping.
- Construction, demolition, or reconstruction not capable of containment utilizing, existing building walls and doors, will use one of the following methods of isolation:

  Airtight plastic barriers extending from floor to ceiling decking, or ceiling tiles if not removed. Plastic barrier seams will be sealed with duct tape to prevent dust and debris from escaping.

  Portable dust containment units with polyethylene pulled tight against floor and ceiling.

  Drywall barriers. Seams or joints will be covered or sealed to prevent dust and debris from escaping.

Additional isolation requirements

- Seal all penetrations at existing perimeter walls.
- Place isolation barriers at penetration of ceiling envelopes, chases and ceiling spaces to stop movement of air and debris.
- Erect dust barriers at elevator shafts or stairways with the field of construction, allowing for emergency egress.
- Provide anteroom or double entrance openings that allow workers to remove protective clothing or vacuum off existing clothing. Construct anteroom to maintain airflow from clean area through anteroom and into work area.
- Create overlapping flap (minimum of 2 feet wide) at plastic enclosures for personnel access.
- When openings are made into existing ceilings, a portable dust containment or plastic enclosure will be used, sealing off openings, and fitted tightly from ceiling to floor. Any ceiling access panels opened for investigation beyond the sealed areas will be replaced immediately when unattended.
- Direct pedestrian traffic from construction areas away from patient-care areas to limit opening and closing of doors (or other barriers) that may cause dust dispersion, entry of contaminated air, or tracking of dust to patient areas.

- Prevent birds and insects from gaining access to the hospital and hospital air-intact ducts. Exterior openings will remain closed when not in use.

Ventilation

- Negative air pressure will be maintained within the construction area.
- The central HVAC system will be used where possible to help maintain negative air pressure. Contractors will be responsible for blocking off supply ducts and covering return air ducts with 2" pleated air filters.
- Where central HVAC systems are not capable of maintaining negative air pressure in the work area, the contractor will provide exhaust fans or HEPA filtered ventilation units to maintain the negative air- pressure within the construction area. Exhaust fans or HEPA filtered ventilation units will run continuously. Contractors are responsible for maintaining equipment and replacement of HEPA and other filters in accordance with the manufacturer's recommendations.
- Construct an anteroom to maintain airflow from clean area through the anteroom and into the work area.

Housekeeping

- Walk-off mats will be used at exits and entrances to the work area. Adhesive walk-off mats should be placed at all doors *exiting* the construction area and carpeted walk-off mats should be placed at all doors *entering* into a construction area.
- Carpeted walk-off dust mats will be vacuumed at least twice per 8-hour shift and at the end of the workday. Any dust tracked outside of the construction area shall be vacuumed or damp-mopped immediately. Vacuum cleaners shall be outfitted with HEPA filters.
- Adhesive walk-off mats should be changed daily, or more frequently as needed, to maintain adhesive surfaces.
- When construction is in an occupied area, the construction area will be vacuumed or damp-mopped at least at the end of each shift. Vacuum cleaners will be outfitted with HEPA filters.

Protective Clothing

- Disposable shoe covers and coveralls are to be worn during demolition.
- Protective clothing will be removed any time the worker leaves the immediate work area.
- Used coveralls and shoe covers will be placed in a sealed plastic bag, prior to removal from the work area, for disposal by the contractor.

Storage of Building Supplies

- Construction materials such as drywall will be stored in clean, dry areas to prevent the growth of bacteria and fungi.
- Ductwork materials will be stored in a clean, dry area to prevent the accumulation of dust in the ductwork prior to installation.

Post Construction

- The contractor will vacuum and clean all surfaces in the completed construction area, rendering them free of dust prior to the removal of isolation barriers.
- Barrier materials should be removed carefully to minimize spreading of dirt and debris associated with construction. (Barriers should be discarded as construction debris.) Barrier materials should be wet wiped, HEPA vacuumed or water misted prior to removal.
- The contractor will remove all blockages from the air systems.
- The contractor will balance the ventilation system to design specifications (as described in the project manual/agreement.
- Johns Hopkins' Facilities department will examine the HVAC equipment and filters for blockage and/or leakage.
- Johns Hopkins' Environmental Services will perform the final cleaning of newly constructed/renovated areas before allowing patients to enter the areas.

Special Precautions for Water Handling (Plumbing alterations)

- Exercise caution when handling fluids (i.e. removing plumbing pipes and fixtures) to prevent wetting of building materials and/or contamination of work areas.
- Cap unused domestic water pipe branches at no more than 12 inches from the main line.
- Before an area is turned over for patient occupancy/use, Johns Hopkins' Facilities will test the domestic water for temperature and potability.
- **Aerators will not be used on water faucets in patient care/testing/treatment areas.**

SUPPORTIVE INFORMATION

References:

Center for Disease Control and Prevention (1994). Recommendations for Prevention of Nosocomial Pneumonia. AJIC, 22: 247-92.

Opal, S.M., Asp, A.A., Cannady, P.B., Morse, P.L., Burton, L.J., & Hammer, P.G. (1986). Efficacy of infection control measures during a nosocomial outbreak of disseminated aspergillosis-associated with hospital construction. J Infect Dis, 153: 634-637.

Purcell, R.J. (1989). Controlling Aspergillus contamination in heating ventilation and air-conditioning systems. Plant Technology and Safety Management Services: Infection Control Issues in PTSM (pp.23-26). Chicago: Joint Commission of Accreditation of Healthcare Organizations.

DEVELOPERS

Department of Hospital Epidemiology and Infection Control Committee
Facilities Design and Construction Department

SPONSOR

Medical Care Evaluation Committee

COMMUICATION & EDUCATION

Initial

- This policy will be distributed to all Interdisciplinary Clinical Practice Manual (ICPM) holders and will be available on the intranet in the ICPM. It will also be located on the HEIC internet site (www.Hopkins-HEIC.org)
- An article regarding the new policy will be submitted by HEIC for publication in "Hopkins Hot Line"

Ongoing

- HEIC will maintain the ongoing consultative relationship with Facilities, Environmental Services, and Health, Safety and Environment as needed to provide guidance and education.
- Facilities project managers will educate construction managers (including those of contractors) who will be overseeing construction/renovations. HEIC is available to assist with this education or for consultation as needed.

KEY WORDS

Construction; Renovation; Building; Repairs

REVIEW CYCLE	• Three (3) years	MEDICAL BOARD	Approval Date: 10/25/01 Effective Date: 10/25/01
VICE PRESIDENT FOR MEDICAL AFFAIRS _____ Date:			

Section 6 - Miscellaneous Policies And Procedures

6.11 Construction Administration Prevention of Nosocomial Infection During Construction

1. REFERENCE.

2. DEFINITION. The purpose of this policy is to prevent the airborne spread of fungal spores and bacteria (such as Aspergillus and Legionella) which may cause disease in susceptible individuals during hospital demolition, renovation or construction projects.

a. Patients most at risk include:

(1) patients with congenital or acquired immunodeficiency syndromes
(2) premature neonates
(3) patients receiving immunosuppressive therapy (i.e. oncology or transplants)

b. Others at risk include:

(1) all other patients
(2) hospital employees
(3) construction workers
(4) all other people in the affected areas

3. RESPONSIBILITY. The overall responsibility for controlling and preventing the spread of disease rests with all people involved in project development and execution. A person from the Department of Infection Control shall serve as a single point of contact to each relevant protect to ensure that IC procedures are incorporated in each project from inception through completion and will work closely with project managers at each stage of execution. In addition, there is a responsibility on the part of FMB, DPW and DOC to ensure that procedures are carried out through the development and contracting process.

4. PROCEDURES. Work areas are divided into three risk groups and construction activities are divided into two classes for the sake of work classification.

a. Risk groups are as follow:

GROUP 2	GROUP 3	
(LOWEST RISK)	(MEDIUM RISK)	(HIGH RISK)
General office areas	Emergency Room	Transplant Clinic
	Wards 41, 55, 58, 68 & 75	Wards 46, 51, 65 & 71
	PACU	All ICUs
	Radiology/CT/MRI	Radiation Oncology
	SSU/APC (Wards 66 & 67)	Operating Rooms
	PM & R areas	Cardiac Cath Unit
	PAD	Dialysis Unit
	Outpatient Clinic Areas	Oncology Clinics
	DPALS	Endoscopy areas
	Nutrition Care	Pharmacy Admixture area
		Infectious Disease Clinic
		Nuclear Medicine

b. Construction category classifications are as follow:

(1) CLASS I - Construction activities that **do not** increase the risk for Nosocomial Infection. This category includes, but is not limited to, minor plumbing, electrical, carpentry and duct work, aesthetic improvements, installation of phone, computer and TV lines in existing conduit. Specific examples of Class I construction include opening ceiling panels for visual inspection only (no disturbance of dust), working in utility/electrical closets, simple drilling in plaster board, installation of construction barriers and installation of new electrical or data/telecommunications outlets.

(a) STANDARD PROCEDURES for Class I construction: Generally, despite the minimal risk factors involved, the project COR shall work closely with the IC POC to coordinate all activities. In addition, the following specific procedures shall be employed:

(1) Water misting of work surfaces as necessary to control dust while cutting.

(2) Duct tape (and polyvinyl barrier as needed) shall be applied around doors/door jambs and at bottom of doors to prevent passage of dust into non-project locations.

(3) Masks shall be worn by construction personnel for certain cutting procedures as outlined by OSHA. Masks will be furnished by the contractor.

(4) Penetrations to walls, ceilings floors and/or doors must not be left unprotected and must be covered and

clearly identified at the end of each work day.

6.11-2

(b) SITE CLEAN UP PROCEDURES for class I construction:

(1) Construction debris must be placed in containers before being transported through hospital areas. (Sealed plastic containment bags and/or cover are appropriate but must not be confused with hospital waste containers.)

(2) Vacuum and wet mop all horizontal areas at the end of each work day.

(3) Place dust mats at entrances/exits of work area and clean daily. (Furnished by contractor.)

(4) Seal off air vents near construction area as required after coordination with FMB to insure non-interference with HVAC and negative-pressure systems.

2) CLASS II - Construction areas that increase the risk of Nosocomial infection. These projects require tight barrier protection and precautions. They include, but are not limited to, construction of new walls, major utility changes, major equipment installation, demolition of drywall, plaster or ceramic tile, acoustical ceiling tiles or floor tiles and removal of windows and/or casework. Specific examples of Class II construction include activities that disturb the environment where settled dust is found and may cause spores to become airborne, demolition or renovation of existing walls or ceilings, exposure of ceiling space (crawling or other movement in ceiling areas) and removal of uncovered or partially covered debris from construction areas.

(a) STANDARD PROCEDURES for Class II construction: Generally, because of the critical nature of this type of construction it is essential that the COR work very closely with the IC POC, and the contractor to closely coordinate all aspects of the project. In addition, the following specific procedures shall be employed:

(1) The DOC shall hold a pre-construction meeting at which the IC POC shall have the opportunity to thoroughly brief the COR and contractor on these procedures and answer any questions that may arise.

(2) The COR shall conduct regular meetings with the

IC POC and contractor representative to ensure that all procedures are being followed completely.

6.11-3

(3) The COR, contractor POC and IC POC shall regularly monitor the project site for compliance. The COR is solely permitted to give instructions to the contractor.

(4) Dust partitions shall be installed to seal off construction areas from patient care areas prior to start of construction. The location and extent of these barriers shall be shown in plans and specifications. These barriers shall be inspected by the COR continually during project accomplishment to ensure complete separation between work site and patient care areas.

(5) Ceiling access panels without barriers must be closed when unattended.

(6) Openings where ceiling tiles are removed must be provided with barriers.

(7) Debris, when transported through hospital areas, must be completely covered to contain dust during transport. There will be no transportation of debris through patient care areas. If possible, debris shall be removed in evenings or non-duty times.

(8) Dust will be kept at a minimum by frequent wet mopping and placing adhesive floor mats at entrances and exits to and from the work area.

(9) In renovation areas the existing supply and exhaust return shall be isolated during construction. Dust from construction procedures must be prevented from entering the HVAC system with filters installed at return air duct openings to maintain negative pressure. Based on the decision of the design agent, with input from the IC POC, it may be necessary to totally isolate all HVAC ducts during project accomplishment.

(10) Standing water must not be allowed to exist at the construction site.

(11) Notice to Staff members: Any perceived discrepancies in actual site conditions must be reported to FMB **only**. It is not allowed to talk directly with contractor personnel except in an emergency.

(12) Patients may be relocated based on local conditions based on discussions between the COR and the IC POC.

6.11-4

(13) Every effort shall be made to separate hospital operations and construction activities. Exceptions shall be discussed thoroughly prior to the start of construction.

(14) When it is known that loud noise will result from construction activities prior coordination will be done between the COR, the contractor's rep and the IC POC.

(15) Meetings between the COR and the IC POC shall be scheduled based on their mutual agreement. COR site visits shall be recorded in a log for IC POC reference.

(16) Contractor personnel shall wear clothing which minimizes contamination of non-project areas when they pass through these areas. It may be required that they wear special covering to contain dust while they pass through non-construction areas. Masks must also be supplied by the contractor. (Masks will be evaluated by Industrial Hygiene)

(17) The sealing of all surface penetrations will be defined in the project design, IAW NFPA 101, Life Safety Code.

(18) The COR shall be responsible for completing the attached **Infection Control/Interim Life Safety Check List** as requested by the IC POC.

(b) STANDARD BARRIERS for Class II construction: Generally, the following paragraphs should be included in the project specification prior to contract award.

(1) A closed door with duct tape applied over the frames and door is acceptable for projects that can be contained within a single room and when existing walls extend completely between floor and upper structure.

(2) Construction not capable of containment within a single room must have the following barriers:

(a) Fire resistant, airtight plastic barrier that extends from floor to upper structure or a drywall barriers to separate the construction area from non-construction area.

(b) An anteroom or double entrance opening should be available during demolition phase, when appropriate. This allows workers to remove protective clothing or to vacuum off existing clothing in a non-construction area and offers additional dust containment.

6.11-5

(c) Each entrance/exit must be constructed so that it complies with dust control requirements and integrity of exits maintained.

(c) SITE CLEAN UP PROCEDURES for Class II construction:

(1) Barriers shall not be removed from the project site until all work is complete and the entire project area has been cleaned and sanitized. Barriers shall be removed in a manner that will minimize dust and site contamination. All plastic barriers shall be transported in a covered container.

(2) All existing plumbing pipes shall be flushed and sanitized prior to reuse.

(3) Hospital work areas must be HEPA vacuumed wherever possible.

(4) Hospital housekeeping shall wet mop all horizontal areas with a hospital-approved disinfectant.

(5) All blockage of vents, ducts and/or pipes shall be removed.

(6) Cleanliness of project site shall be approved jointly by the COR and the IC POC.

3. Upon completion of the project, housekeeping will be afforded four days to complete cleaning and sanitation of the construction site after **ALL** construction has been completed.

KEY:

DOC is the Directorate of Contracting (Bldg T-20).

COR is the Contracting Officer's Representative and has the legal authority to act in behalf of the Contracting Officer. The project COR shall be identified at the pre-construction meeting.

FMB is the Facilities Management Branch. They may be reached at 782-7932/7935.

WRAMC Fire Department may be reached at 782-3496.

Developing a Management Plan for Waterborne Pathogens

The new EC.1.7 standard requires health care organizations to develop a utilities management plan that provides processes for "managing pathogenic biological agents in cooling towers, domestic hot water, and other aerosolizing water systems...."

One of the more troublesome such agents is *Legionella*. Following is a suggested strategy for conducting a risk assessment of potential sources of *Legionella* and developing a management plan for maintenance and operation of water systems.

Begin the process with a risk assessment to determine conditions that may be conducive to growth of *Legionella* and other waterborne pathogens. Assess two major areas of concern—the domestic water system and the cooling towers. Once that is done, focus on other at-risk patient populations and their interaction with humidifiers, whirlpool therapy baths, and other aerosolizing devices. After the risk assessment is completed, you will know what areas and equipment to manage for patient safety.

A sample management plan

The following is an example of a management plan outline:

Overview

This is important for coordination among facility operators, infection control practitioners, and medical staff members. Paint a clear picture of the overall strategy.

Preventive measures

Domestic water system: steps to take based on the risk assessment; establishing and checking water temperatures (if this is your control mechanism), regular maintenance, policies for construction, normal operation, and special situations.

Cooling towers: physical cleaning, biocidal regimen, maintenance, conditions to avoid, inspection checklist, drift control, siting.

HVAC equipment: humidifiers, ductwork, air handling units, filters.

Other equipment: decorative fountains, dental water lines, whirlpool baths, misters, and so on.

Environmental sampling

Environmental sampling for *Legionella* is *not* required but may be useful.[1] If the organization chooses not to sample routinely, it would be prudent to prepare to sample in case facility-acquired Legionnaires' Disease is identified. Outline the following: use of the data (for example, negative results are not an excuse for relaxing preventive measures); equipment to sample; number of samples per screening; supplies needed; frequency of screenings; integration of a rapid test; instructions for each screening; interpretation of results; documentation. Finding a qualified laboratory is especially important because *Legionella* culture methodology is highly specialized.

Handling Legionella problems

Define the *Legionella* "problem" and determine how the organization will respond. Outline steps for epidemiologic as well as environmental aspects of an investigation, and for emergency disinfection of cooling towers and the domestic water system.

More resources

No single document covers everything an organization needs for developing its management plan. ASHRAE Guideline 12-2000, OSHA's technical manual, and the CDC Guidelines (once published) are only starting points (see the Nov/Dec 2000 *Environment of Care® News*).

Also, bear in mind that you will want to write your plan to include measures for waterborne pathogens other than *Legionella*.

Further information is also availabl through the American Society for Healthcare Engineering (ASHE) Web site, at *www.ashe.org/media/water.html*

[1] *It may indicate specific maintenance for cooling towers or hot water tanks. Test results may also provide direction for patient surveillance. Finding strains other than* Legionella pneumophila *serogroup 1 indicates that sputum cultures should be ordered in addition to urinary antigen (UA) tests for appropriate patients per CDC guidelines, because UA tests detect only serogroup 1.*

—*Matt Freije is president of HC Information Resources Inc, Fallbrook, California.*

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Legionnaires' Disease

Part I. Issues on Prevention of Nosocmial Pneumonia, 1994

Legionnaires' disease is a multisystem illness, with pneumonia, caused by *Legionella* spp. In contrast, Pontiac fever is a self-limited influenza-like illness, without pneumonia, that is associated with *Legionella* spp.(382)

I. Epidemiology

Since identification of the etiologic agent, numerous outbreaks of nosocomial Legionnaires' disease have been reported and have provided the opportunity to study the epidemiology of epidemic legionellosis. In contrast, the epidemiology of sporadic (i.e., nonoutbreak-related) nosocomial Legionnaires' disease has not been well elucidated. However, data suggest that when one case is recognized, the presence of additional cases should be suspected. Of 196 cases of nosocomial Legionnaires' disease reported in England and Wales during 1980 to 1992, 69% occurred during 22 nosocomial outbreaks (defined as two or more cases occurring at an institution during a 6-month period).(383) Nine per cent of cases occurred >6 months before or after a hospital outbreak. Another 13% were in hospitals where other sporadic cases (but no outbreaks) were identified. Only 9% occurred at institutions where no outbreaks or additional sporadic cases were identified.

The overall proportion of nosocomial pneumonias due to *Legionella* spp. in the North America has not been determined, although individual hospitals have reported ranges of 0%-14%.(384-386) Because diagnostic tests for *Legionella* spp. infection are not routinely performed on all patients with hospital-acquired pneumonia in most U.S. hospitals, these ranges probably underestimate the incidence of Legionnaires' disease.

Legionella spp. are commonly found in a variety of natural and man-made aquatic environments (387,388) and may enter hospital water systems in low or undetectable numbers.(389,390) Cooling towers, evaporative condensers, heated potable-water-distribution systems within hospitals, and locally produced distilled water can provide a suitable environment for legionellae to multiply. Factors known to enhance colonization and amplification of legionellae in man-made water environments include temperatures of 25-42°C,(392-396) stagnation,(397) scale and sediment,(393) and the presence of certain free-living aquatic amoebae that are capable of supporting intracellular growth of legionellae. (398,399)

A person's risk of acquiring legionellosis following exposure to contaminated water depends on a number of factors, including the type and intensity of exposure and the exposed person's health status. (400-402) Persons with severe immunosuppression or chronic underlying illnesses, such as hematologic malignancy or end-stage renal disease, are at markedly increased risk for legionellosis.(402-405) Persons in the later stages of acquired immunodeficiency syndrome are also probably at increased risk of legionellosis, but data are limited because of infrequent testing of patients.(402) Persons with diabetes

mellitus, chronic lung disease, or non-hematologic malignancy, those who smoke cigarettes, and the elderly are at moderately increased risk.(382) Nosocomial Legionnaires' disease has also been reported among patients at children's hospitals.(406,407)

Underlying disease and advanced age are not only risk factors for acquiring Legionnaires' disease but also for dying from the illness. In a multivariate analysis of 3,524 cases reported to CDC from 1980 through 1989, immunosuppression, advanced age, end-stage renal disease, cancer, and nosocomial acquisition of disease were each independently associated with a fatal outcome.(402) The mortality rate among 803 persons with nosocomially acquired cases was 40% compared with 20% among 2,721 persons with community-acquired cases,(402) probably reflecting increased severity of underlying disease in hospitalized patients.

II. Diagnosis

The clinical spectrum of disease due to *Legionella* spp. is broad and ranges from asymptomatic infection to rapidly progressive pneumonia. Legionnaires' disease cannot be distinguished clinically or radiographically from pneumonia caused by other agents,(408,409) and evidence of infection with other respiratory pathogens does not rule out the possibility of concomitant *Legionella* spp. infection.(410-412)

The diagnosis of legionellosis may be confirmed by any one of the following: culture isolation of *Legionella* from respiratory secretions or tissues, or microscopic visualization of the bacterium in respiratory secretions or tissue by immunofluorescent microscopy; and, for legionellosis due to L. *pneumophila serogroup 1, detection of L. pneumophila serogroup-1 antigens in urine by radioimmunoassay, or observation of a four-fold rise in L. pneumophila serogroup-1 antibody titer to >= 1:128 in paired acute and convalescent serum specimens by use of an indirect immunofluorescent antibody test (IFA).(413,419) A single elevated antibody titer does not confirm a case of Legionnaires' disease because IFA titers >= 1:256 are found in 1-16% of healthy adults.(411,414-417)*

Because the above tests complement each other, performing each test when Legionnaires' disease is suspected increases the probability of confirming the diagnosis.(418) However, because none of the laboratory tests is 100% sensitive, the diagnosis of legionellosis is not ruled out even if one or more of the tests are negative.(418,419) Of the available tests, the most specific is culture isolation of Legionella spp. from any respiratory tract specimen.(420,421)

III. Modes of Transmission

Inhalation of aerosols of water contaminated with Legionella spp. is believed to be the primary mechanism of entry of these organisms into a patient's respiratory tract.(382) In several hospital outbreaks, patients were considered to be infected through exposure to contaminated aerosols generated by cooling towers, showers, faucets, respiratory therapy equipment, and room-air humidifiers. (11,241,258,422-428) In other studies, aspiration of contaminated potable water or pharyngeal colonizers has been proposed as the mode of transmission to certain patients.(426,429-431) Person-to-person transmission, however, has not been observed.

IV. Definition of Nosocomial Legionnaires' Disease

The incubation period for Legionnaires' disease is generally 2-10 days;(432) thus, for epidemiologic purposes, in this document and in the accompanying recommendations by the HICPAC, laboratory-confirmed legionellosis that occurs in a patient who has spent > or = 10 days continuously in the

hospital prior to onset of illness is considered ***definite*** *nosocomial Legionnaires' disease, and laboratory-confirmed infection that occurs 2-9 days after hospitalization is* ***possible*** *nosocomial infection.*

V. Prevention and Control Measures

A. Prevention of Legionnaires' Disease in Hospitals with No Identified Cases (Primary Prevention)

Prevention strategies in healthcare facilities with no cases of nosocomial legionellosis have varied by institution, depending on the immunologic status of the patients, the design and construction of the facility, resources available for implementation of prevention strategies, and state and local regulations.

There are at least two schools of thought regarding the most appropriate and cost-effective approach to prevent nosocomial legionellosis, especially in hospitals where no cases or only sporadic cases of the illness are detected. However, a study comparing the cost-benefit ratios of these strategies has not been done.

The first approach is based on periodic, routine culturing of water samples from the hospital's potable water system, for Legionella spp.(433,434) When ≥30% of the samples obtained are culture-positive for Legionella spp., the hospital's potable water system is decontaminated(434) and diagnostic laboratory tests for legionellosis are made available to clinicians in the hospital's microbiology department so that active surveillance for cases can be instituted.(434,435) This approach is based on the premise that no cases of nosocomial legionellosis can occur in the absence of Legionella spp. from the potable water system, and, conversely, once Legionella spp. are cultured from the water, cases of nosocomial legionellosis may occur.(429,436) Proponents of this strategy indicate that when physicians are informed that the potable water system of the hospital is culture-positive for Legionella spp., they are more inclined to conduct the necessary tests for legionellosis.(435) A potential advantage of this approach is the lower cost of culturing a limited number of water samples, if the testing is done infrequently, compared with the cost of routine laboratory diagnostic testing for legionellosis in all patients with nosocomial pneumonia in hospitals that have had no cases of nosocomial legionellosis.

The main argument against this approach is that in the absence of cases, the relationship between the results of water cultures and the risk of legionellosis remains undefined. The bacterium has been frequently present in hospital water systems,(437) often without being associated with known cases of disease.(271,385,438,439) In a study of 84 hospitals in Quebec, 68% were found to be colonized with Legionella spp., and 26% were colonized at >30% of sites sampled; however, cases of Legionnaires' disease were rarely reported from these hospitals.(271) Similarly, at one hospital where active surveillance for legionellosis and environmental culturing for Legionella spp. were done, no cases of legionellosis occurred in a urology ward during a 3.5-month period when 70% of water samples from the ward were culture-positive for L. pneumophila serogroup 1.(385) Interpretation of the results of routine culturing of water may be confounded by variable culture results among sites sampled within a single water system and by fluctuations in the concentration of Legionella spp. in the same site. (440,441) In addition, the risk of illness following exposure to a given source may be influenced by a number of factors other than the presence or concentration of organisms; these include the degree to which contaminated water is aerosolized into respirable droplets, the proximity of the infectious aerosol to potential host, the susceptibility of the host, and the virulence properties of the contaminating strain. (442-444) Thus, data are insufficient to assign a level of risk of disease even on the basis of the number of colony-forming units detected in samples from the hospital environment. By routinely culturing water samples, many hospitals will have to be committed to water-decontamination programs to eradicate Legionella spp. Because of this problem, routine monitoring of water from the hospital's potable water system and from aerosol-producing devices is not widely recommended.(445)

The second approach to prevent and control nosocomial legionellosis is by a) maintaining a high index of suspicion for legionellosis and appropriately using diagnostic tests for legionellosis in patients with nosocomial pneumonia who are at high risk of developing the disease and dying from the infection, (385,446) b) initiating an investigation for a hospital source of Legionella spp. upon identification of one case of definite or two cases of possible nosocomial Legionnaires' disease, and c) routinely maintaining cooling towers and using only sterile water for filling and terminal rinsing of nebulization devices.

Measures aimed at creating an environment that is not conducive to survival or multiplication of Legionella spp. have been advocated and utilized in hospitals where cases of nosocomial legionellosis have been identified; these include routine maintenance of potable water at > or = 50°C or <20°C at the tap or chlorination of heated water to achieve 1-2 mg/L free residual chlorine at the tap, especially in areas where immunosuppressed and other high-risk patients are located.(385,429,440,447-450) However, the cost-benefit ratio of such measures in hospitals with no identified cases of legionellosis needs further study.

B. Prevention of Legionnaires' Disease in Hospitals with Identified Cases (Secondary Prevention)

The indications for a full-scale environmental investigation to search for and subsequently decontaminate identified sources of Legionella spp. in hospital environments remain to be elucidated, and probably vary from hospital to hospital. In institutions where as few as 1-3 nosocomial cases are identified over a period of up to several months, intensified surveillance for Legionnaires' disease has frequently detected numerous additional cases.(404,423,426,448) This suggests the need for a low threshold for initiating an investigation following the identification of nosocomial, laboratory-confirmed cases of legionellosis. However, when developing a strategy to respond to such an identification, infection-control personnel should consider the level of risk of nosocomial acquisition of, and mortality from, Legionella spp. infection at their particular hospital.

An epidemiologic investigation of the source of Legionella spp. involves several important steps, including retrospective review of microbiologic and medical records; active surveillance to identify all recent or ongoing cases of legionellosis; identification of potential risk factors (including environmental exposures for infection, such as showering or use of respiratory-therapy equipment) by line listing of cases, analysis by time, place, and person, and comparison with appropriate controls; collection of water samples from environmental sources implicated by the epidemiologic investigation and from other potential sources of aerosolized water; and subtype-matching between legionellae isolated from patients and environmental samples.(428,452-454) The latter step can be crucial in supporting epidemiologic evidence of a link between human illness and a specific source.(455)

In hospitals where the heated-water system has been identified as the source of the organism, the system has been decontaminated by pulse (one-time) thermal disinfection or superheating (i.e., flushing for at least 5 minutes each distal outlet of the hot-water system with water at 65°C) and hyperchlorination (flushing all outlets of the hot-water system with water containing >= 10 mg/L free residual chlorine). (150,546-458) Following either of these procedures, most hospitals maintain heated water at >= 50°C or <20°C at the tap or chlorinate heated water to achieve 1-2 mg/L free residual chlorine at the tap. (385,429,440,447-450) Additional measures, such as physical cleaning or replacement of hot-water storage tanks, water-heaters, faucets, and showerheads, may be required because scale and sediment that provide organisms protection from the biocidal effects of heat and chlorine, may accumulate in them.(393,450) Alternative methods for control and eradication of legionellae in water systems, such as treatment of water with ozone, ultraviolet light, or heavy metal ions, have limited the growth of legionellae under laboratory and/or operating conditions.(391,459-463) However, further data are needed regarding the efficacy of these methods before they can be considered standard. In hospitals

where the cooling towers are contaminated, measures for decontamination have been previously published.(464)

For highly immunocompromised patients, other preventive measures have been used. At one hospital, immunosuppressed patients were restricted from taking showers, and, for these patients, only sterile water was used for drinking or flushing nasogastric tubes.(430) In another hospital, a combined approach, consisting of continuous heating, particulate filtration, ultraviolet treatment, and monthly pulse hyperchlorination of the water supply of the bone-marrow transplant unit, was used to decrease the incidence of Legionnaires' disease.(459)

In view of the high cost of an environmental investigation and of instituting control measures to eradicate Legionella spp. from sources in the hospital(465,466) and the differential risk, based on host factors, for acquiring nosocomial legionellosis and of having severe and fatal infection with the microorganism, the decision to search for and the choice of procedures to eradicate hospital environmental sources of Legionella spp. should take into account the type of patient population served by the hospital.

Continue to: Recommendations for Prevention and Control of Legionnaires' Disease

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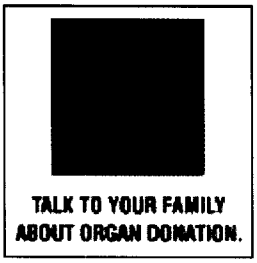

Articles

CONSIDERATIONS TO PREVENT GROWTH AND SPREAD OF LEGIONELLA IN HVAC SYSTEMS

If we have learned one thing about Legionnaire's Disease since its discovery in 1976, it's that the bacteria that causes it thrive under certain conditions that exist within heating, ventilating and air conditioning (HVAC) systems. But, with proper system design and maintenance, adverse health risks can be avoided.

Affecting up to 100,000 people a year in the United States, Legionnaire's Disease is a pneumonia-like and sometimes-fatal illness that took its name from the American Legion Convention it "crashed" at the Bellevue-Stratford Hotel in Philadelphia. It is caused by the bacterium *Legionella Pneumophila* which thrives in wet areas where conditions are favorable to growth. Carried in water vapor aerosols as small as 1 to 5 microns, the bacteria may be inhaled. Entering the deepest part of the lungs, the bacteria can attack any individual -- particularly someone with a weakened immune system.

Once an individual has been exposed to *Legionella Pneumophila* pneumonia-like symptoms appear within 2 to 10 days of the exposure. The symptoms exhibited can include fever, chills, muscle aches, diarrhea, headache and a dry cough. Mortality rates of approximately 15 percent are frequently quoted for the disease, however treatment with antibiotics is usually effective.

The Ideal Bacteria Incubator

Within the context of HVAC systems, a number of potential breeding grounds for the bacteria exist. The most common location for the proliferation and amplification of *Legionella Pneumophila* within the HVAC system is the cooling tower. However, the bacteria thrive in humidifiers, drain pans and other sources where standing water may accumulate.

In the normal operation of a cooling tower, a number of conditions exist that are conducive to the survival and transport of the bacteria:

- A standing pool of water.
- Water temperature that is satisfactory to support bacteria growth -- the bacteria typically proliferate between 68 degrees Fahrenheit and 113 degrees Fahrenheit with significant growth occurring between 95 degrees Fahrenheit and 110 degrees Fahrenheit.
- Dirt and other particulate matter easily enter the open water system. These can provide nutrients for the *Legionella Pneumophila*
- Water mist is generated, allowing the bacteria to become airborne.

In fact, *Legionella Pneumophila* is present in the water samples of nearly all cooling towers. However, the levels of bacteria found in most cases are below those that would typically cause human health effects. So, while the mere presence of the bacteria is not cause for alarm, control of its levels is critical in minimizing the potential for detrimental health effects. Such control can be accomplished through the diligent design of the HVAC system, and the administration of an appropriate maintenance program including proper water treatment.

Minimizing Risk by Design

At the design and installation stage of an HVAC system, a number of considerations should be made to limit the potential for the growth of this bacterium and to minimize the potential for inhalation should it become airborne. These include:

- Locate the cooling towers far enough away from outdoor air intakes and other ventilation inlets (such as windows) to eliminate entrainment of water mist in the intake air. Prevailing winds should be considered in selecting a site for the cooling tower and outdoor air intakes.
- Locate cooling tower discharge away from outdoor air intakes, occupied areas, pedestrian walkways and other areas where people may frequently be present.
- Design enclosures for cooling towers to minimize or eliminate the potential for drift from the cooling tower.
- Locate kitchen and bathroom exhausts so that the exhausted air is not brought back into the building through the outdoor air intakes.
- Specify air-handling units with sloped, corrosion-resistant drain pans.
- Locate outdoor air intakes to minimize or eliminate the entry of rainwater.

Maintaining a "Clean" System
Once a system has been properly installed, a number of operation and maintenance tasks can be performed to minimize the potential for elevated levels of the *Legionella Pneumophila* bacteria. These include:

- Chemically clean and flush the cooling tower before putting it into initial service and before annual start-up if located in milder climates where seasonal operation is required.
- Ensure easy access to facilitate frequent, routine cleaning and maintenance.
- Maintain a proper water treatment program, including biocide treatment, to minimize the potential for bacteria growth.
- Perform regularly scheduled quantitative analysis of the cooling tower water for *Legionella Pneumophila* Remember that the mere presence of the bacteria should not be cause for alarm.
- Remove standing water from air handling unit drain pans and rectify problems to allow for proper drainage.
- Correct conditions contributing to the collection of standing water near outdoor air intakes.

When designing and installing an HVAC system, numerous factors must be considered from mechanical, aesthetic, functional and indoor air quality perspectives. However, minimizing the potential for the amplification of the *Legionella Pneumophila*bacteria in HVAC systems need not be expensive or difficult. The proper design of the HVAC system is an important first step. Once the system is designed and installed, appropriate operation and maintenance is critical in achieving this goal. Operating and maintenance schedules must be developed early, and diligently followed to control this bacterium below the levels that may cause health effects.

Jeff Coleman is senior product manager for service marketing in Carrier's Commercial Systems and Services Division, Syracuse, N.Y. For other insights regarding air quality, contact your Carrier representative for a copy of Carrier's Indoor Air Quality, A Guide for Management.

Relationship between Infection Control and Facilities Management

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Navy Facility Manager Conference

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Topics to Cover

- Construction Project Coordination and Controls in Hospitals
- Airborne Pathogens
- Waterborne Pathogens
- Bioterrorism

2

Planning for Healthcare Construction and Renovation

- Requirements to ensure design facilitation of desired infection control practices:
  - Early consultation among
    - Engineers
    - Architects
    - Infection Control Professionals
    - Epidemiologists
  - Infection Control Risk Assessment (ICRA)

3

Infection Control Hazards, Implications, & Interventions

- Compromise of air quality during construction can →
  - Potential for continued environmental contamination from
    - Fungi *Aspergillus* spp.
    - Water-associated microorganisms i.e. *Legionella* spp.
- Patients with active TB or chickenpox
  - Potential reservoirs of airborne agents
  - May transmit disease to other susceptible patients/staff if AIIRs improperly designed/ poorly maintained

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Complexities of Construction / Renovation Activities

- Critical to improving broader aspects of safety and risk reduction related to
  - Chemicals
  - Dust
  - Allergens
  - Infectious agents to susceptible hosts

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Construction Activity As Independent Risk Factor for Infectious Disease

- Requires infection control input on a continuing basis
  - Erection of appropriate barriers to protect patients' movement around construction areas

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Strategic Planning

- 2001 Guidelines for Design and Construction of Hospital and Healthcare Facilities
  - ICRA Planning process →
    - Increased opportunity for long-range/ongoing interaction among facilities management and infection control

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ICRA

- Essential component of facility functional or master programming, given significant differences in populations
  - Organizational committee
  - Multidisciplinary panel
  - Expertise in infectious disease, facility design and construction, ventilation, and epidemiology

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Design Elements Needing Infection Control Involvement

- Air and water quality (e.g., HVAC systems, including filtration issues)
- Fixtures: sink numbers, placement, type; related handwashing dispensers, paper towels, lotion, clinical sinks, etc.)
- Sharps disposal unit placement, type, and quantity
- Surfaces: ceiling tiles, walls, counters, floors, and furnishings
- Utility rooms: soiled, clean, instrument processing, holding, or workrooms
- Storage areas

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Project Team Oversight for Maintenance and Operational Phase

- Area preparation and review
- Demolition, construction, cleanup, return to service preparation, & final project review
- Checklists for IC Practices pre full service

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Codes, Standards, & Regulations

- CMMS
  - Medicare & Medicaid
  - HRSA
  - AIA/AAH in conjunction with DHHS
- OSHA
- CDC guidelines
  - NIOSH
- EPA

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Specific Area Detail Infection Prevention / Control

- Air must flow from clean to dirty areas
- Infection isolation room design
  - Negative pressure, vented to outside, away from air intakes
    - May be used for general care, but must include ability to monitor directional airflow QD to ensure proper AII
  - May require positive pressure
    - Protected environment for severely immuno-suppressed patients
    - Anterooms required

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Numbers

- Sufficient negative-pressure AIIRs required in newly designed or renovated facilities after providing *at least one* in acute care facilities
- Program assessment must consider patient population
  - Tuberculosis
  - Pediatric patients
- Some specialties require at least one AIIR
  - Critical Care
  - Neonatal/newborn nurseries
  - Peds/Adolescent care areas

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Design

- Anterooms for AIIR not required, but if present air should flow corridor→anteroom
- Isolation room properly sealed with ventilation rates 12 ACH
  - Exhausted directly outside or recirculated only after HEPA filtration
- Supplemental devices
  - Older vent'n Sx may require retrofitting of rooms to ensure proper pressure relationships + minimum ACHs
    - Assess with great care

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Separate toilet, bathtub (or shower), and handwashing facilities required for each AIIR

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Protective Environment

- Many facilities do not need such units for severely compromised patients as following bone marrow transplantation

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Miscellaneous Issues

- Rooms should not have switched positive / negative airflow capability. If AIIR required:
  - Self-closing devices on corridor doors assist in maintenance proper airflow
  - Tightly sealed so air not infiltrate the environment from outside or other spaces
- Air pressurization relationships should be governed by appropriate P/Ps describing routine pressure monitoring and by whom
- Maintenance must be included in IC policies
- Each room needs area for handwashing, gowning, storage of clean/soiled materials directly outside or inside entry door of room

ICRA Requirement for Specialty Areas

- ICRA considers specific patient populations
- Determine need/feasibility of ≥1 rooms that could function as AIIRs for patients suspected of airborne contagious infections
- Waiting rooms in
  - ED
  - Clinic areas
  - Psychiatry
  - PACU

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Traffic As Contributor to Air Contamination

- Infection risks/hazards
  - Patients & visitors may be source of infectious agents
  - Waste and contaminated linen, supplies, & equipment may → environmental hazards and odor
- Prevention / control measures
  - Patients in AIIR need transport via defined hospital policy
  - Transport clean supplies shouldn't allow contact/storage near contaminated materials

Traffic As Contributor to Air Contamination (2)

- Laundry/trash chutes contaminated & bags can rupture
  - Must be closely analyzed/usage monitored for potential transmission infectious agents
- Waste transport should be designed for maximum containment, esp'ly during construction/renovation, to reduce risk of contributing contamination to environment

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Issues with Carpeting

- Carpets not generally associated with nosocomial infection
- Contamination of carpeting following saturation with water or during demolition has been implicated in transmission of *Aspergillus* spp
  - Other fungi may contaminate carpets
  - Potential as reservoir if carpet-cleaning agents interfere with antimicrobial compound incorporated into carpets
- Require regular vacuuming, shampooing, or extraction
  - Use of HEPA filter vacuum machines recommended during construction activity

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Carpeting Prevention/Control Interventions

- Aesthetics re stains/odor support avoidance carpet in areas frequent spillage, heavy soilage
  - OR, OB, ICU, kitchen, labs, chemotherapy units, toilet or utility rooms
  - If subject to frequent wet-cleaning methods, shouldn't be physically affected by germicides
  - If subject to traffic when wet, should have non-slip surface & perimeters should be tightly sealed
- Clean per manufacturer's directions

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Carpeting Prevention/Control Interventions (2)

- Outbreak investigations of clustered fungal infection should include examination of potential for contaminated carpeting after events i.e., fires or building demolition activity
- Following major flood, assess for carpet removal
  - If exposed to sewage, discarded and area disinfected with diluted bleach
  - If wet from steam, potable water leaks, and wet for less that 24-38 hours, check with manufacturer re use of diluted bleach

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Internal Construction or Renovation Activity

- Infection control hazards, implications, & risks
  - Dust and debris may carry microorganisms e.g., *Aspergillus* spp.
  - Ventilation Sxs may malfunction from accumulation of dist/debris on filters, resulting in decreased airflow/filtration
  - Contamination of patient rooms, supplies, equip't, and areas in which pts may be treated e.g., radiology

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Prevention/Control in Internal Construction / Renovation

- Ensure IC membership on project team to consider all risks previously listed
- Minimize pt movement around major construction activity
  - Immunocompromised patient
    - Education re preferred access to facility
    - Located in remote site from construction
- Barriers: Isolate areas from occupied areas using sealed, airtight barriers

See Checklist

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Barrier Checklist

- Signage directing pedestrian traffic from site
- Isolated using airtight fire-rated barriers
- Determine if area used fresh/outside or recirculated air; add filters or cover return vents prn with filter material/plastic
- Balance vent'n to ensure exhaust maintains negative airflow in construction site
- Recognize potential vibration/disturbances to dislodge dust collected above suspended/false ceilings + vibration/contamination plumbing
- Verify adj areas have sealed penetrations & intact ceilings

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Barrier Checklist (2)

- Verify that facility Sx can continuously provide provide proper ACH & pressure rel'ps from construction area into other pt care areas
- Accountability for, & frequency of, testing air pressure throughout project
- Specification of temperature and humidity limits that could lead to limiting use of work area (e.g., OR)

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Debris Removal

- Use chute with HEPA filtered negative air machines if possible
  - Preferable over elevator use
  - Close chute whenever not in use
  - Remove debris at least daily
    - Via carts with tightly fitted covers
    - Transport during lowest activity prd

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Critically Review Indications for Environmental Cultures

- Unlikely to provide useful information for prevention of possible construction-related infections
- ID indicators for visible monitoring
- Educate patient care staff to look for:
  - Visible dust
  - Footprints
  - Opened doors
  - Flies
  - Wet ceiling tiles
  - Other risks

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After Completion Construction

- Ensure ventilation Sxs balanced to design specifications
- Flush water lines thoroughly pre-occupation: risk loosened internal corrosion during vibration pipes, increased potential of water contamination
- Ensure contractors removed partitions & cleaned, disinfected to specific agreements
- Ensure staff routine cleaning prior to re-service

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Demolition and Construction Planning

- Isolate project activity as much as possible
  - Temporary relocation of patients
  - Continuous environmental monitoring
    - Avoid contamination air and water
  - Small area should be:
    - Walled/sealed off
  - Construction crew may need to wear special clothing or covers while in site

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Interruptions of Normal Water Service

- Infection risks/hazards
  - Lack potable water for drinking, food prep'n
  - Lack handwashing water
  - Lack water for flushing toilets, clinical sinks, decontamination, sterilization
- Prevention/control interventions
  - Schedule interuptions low-activity times
  - Plan/arrange volume potable water
  - Use disposable towelettes &/or alcohol-based hand hygiene agents for pts/personnel

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Infection Control Risks to Water Damage

- May lead to damage requiring special cleaning & remediation
  - Fungal contamination risks greatly increased
    - All types surfaces
      - ✓ Walls, ceilings, flooring, furnishings, etc
    - Invisible moisture can continue to support bacterial and fungal growth
      - ✓ Requires rapid remedial action

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Prevention/Control Interventions

- Degree of decontamination required depends on location & risks affecting ventilation Sxs
  - Additional resources may be consulted
  - Systematic, general approach to remediation after water damage from floods, sewage backup, steam leaks, & groundwater infiltration

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Prevention/Control Interventions (2)

- Remove materials within 24-48 hrs damage
- Decontaminate via spray chlorine-based mist or diluted bleach and drying
- Balance vent'n to reduce supply air volume to effect negative air pressure area & seal off with tape
- ID wall areas for removal and opened for drying
- Decontaminate opened wall area with 1:9 dilution copper-8-quinolinolate compound, using pressurized spray pump

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Prevention/Control Interventions (3)

- Clean up surface soil removal using detergent (1:200 dilution trisodium phosphate) and disposable cleaning materials followed by final cleaning with 1:10 dilution bleach
- Vacuum ceilings with HEPA-filtered vacuum

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Prevention/Control Interventions (4)

- Wall damage: specific recommendations if water leaks affect drywall laths, plaster, or sheet rock within 24 hours:
  - Wall vinyl should be stripped
  - Portions of drywall may need to be removed to examine & determine the extent of damage with wet meter
  - If needed, removal and replacement; only minimal cleaning may be required

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Prevention/Control Interventions (5)

- Major flooding occurrence with material not removed within 24-48 hours, increased probability → microbial growth already
  - Removal sub controlled conditions (sealed off, negative air pressure)
  - Water-soaked areas removed ≥12" above watermark and discarded, while allowing opened areas to dry
  - Hard surfaces may be cleaned with diluted bleach without rinsing off the bleach
  - Area should be sprayed top-bottom with antimicrobial or dilution of copper-8-quinolinolate cpd
  - After install new wall piece, seal/finish as usual

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Prevention/Control Interventions (6)

- Upholstered furniture cleaning following contamination requires considerations similar to carpet, including disposal in event of major soaking due to floods, leaks, or sewage.
  - If affected only by steam moisture, it can be dried
  - Hardwood with intact laminate can be cleaned and disinfected with dilute bleach

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Review Preparation Pre-Occupancy

- General checks
  - Check airflow, pressures, filters, location of air intakes and vents
  - Check that drains to sanitary sewer system are connected and functioning

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2 Weeks before Occupying New Facility

- Check steam, gas sterilizers by processing packs
- Check water temps, verify correct temperature
- Complete written schedules & procedures for routine maintenance of equip't, cooling towers, suction machines (central & portable); establish documentation
- Determine transportation systems
- Walk through facility with local health department representative & facility management personnel to ensure compliance with local and state codes

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1 Week before Occupying New Facility

- Evaluate air in OR
- Assess methods for determining effectiveness of particulate matter removal
- Evaluate laminar air hoods for effective operation; ensure functioning according to manufacturer specifications; ensure maintenance contract arranged & testing accomplished
- Open all faucets simultaneously to test drain effectiveness
- Check that aerators are not on faucets
- Check floor drains, ensure traps have water seals to prevent sewer gases out of rooms

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Cont'd 1 Week before Open Facility

- Ensure contractors have completed their cleaning/disinfecting; ensure housekeeping dep't completed facility followup cleaning
- Ensure fresh handwashing products in dispensers
- Ensure registered pest control management is functioning
- Be prepared to intensify surveillance for nosocomial infection and monitoring of infection control practice

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Some Airborne Pathogens of Concern in Healthcare Facility Construction

- *Aspergillus*
  - BMT & Cancer - tiles, humidified cell incubators, air filters; NICU - false ceiling; ICU renovation -elevators
- *Legionella*
  - Cooling towers, soil, water
- *M. tuberculosis*

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3 Waterborne Pathogens of Concern in Healthcare Facility Construction

- *Pseudomonas*
  - ICU potable water –f ill flush water bottles
- Group A *Streptococcus*
  - Maternity - shower head
- *Mycobacterium xenopi*
  - Endoscopy - scopes

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Potential Sites Waterborne Pathogens

- Sinks and Countertops
  - Pathogens survive around outside of handwashing sinks
    - Rim of basin
    - China set-on sinks
    - Set-on backsplash
    - Laminate = compressed paper
      - ✓ Dense, but porous
      - ✓ Absorbent

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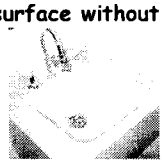
Seamless Sink

- Solid surface
  - No pores, seams, or voids
    - As in laminate, tile, wood and granite
  - Impermeable, hygienic joints
  - Sink integral with countertop →
    - One continuous surface without
      - ✓ Rims
      - ✓ Caulk
      - ✓ Seams



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NICU Handwashing

- Handwashing must be scrupulously practiced by all personnel and visitors in critical care areas
  - Three minute duration of scrub upon arrival in NICU with antimicrobial soap and running water
    - Previous to patient contact
  - 10-15 second handwashing
    - Between patient contacts
      - ✓ Using soap, friction, and running water

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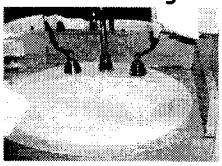
Example of Risks of Waterborne Pathogens Surrounding Handwashing Activities

- One infection due to a waterborne pathogen put Infection Control, Facilities, Nursing, Peds, & Housekeeping on alert to potential NICU problem
  - Inappropriate adherence to handwashing procedures
  - Configuration of sinks
    - Laminated materials
      - ✓ Crack
      - ✓ Absorb moisture
      - ✓ Can breed pathogens



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Successful Outcome

- Facilities, Infection Control, Pediatrics, Nursing Services, and Housekeeping collaborated for the following:
  - Scrupulous and consistent adherence to appropriate handwashing
  - Housekeeping practices scrupulously reviewed/practiced
  - Installation of solid handwashing sinks
- Zero outbreaks of *Pseudomonas* or any other waterborne pathogens in the NICU

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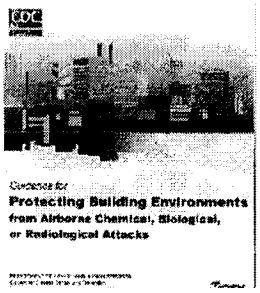
Bioterrorism Readiness



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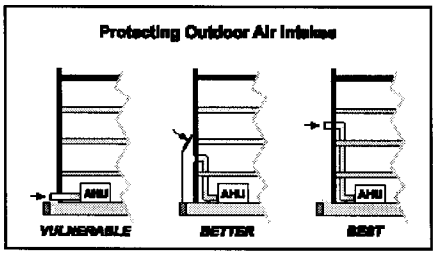
Protecting Building Environments from Airborne Chemical, Biological, or Radiological Attacks



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