Hospital Construction: Stirring Up Trouble
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July 1, 2007

Whether the project is a new facility or a retrofit — and whether the project involves ceiling tiles in an OR or simply giving a nearby room a coat of paint or new computers — risks arise for infection. The 2007 Infection Control Risk Assessment provides critical guidance for precautions to take, depending on the scope of work, to protect a hospital’s delicate procedures and especially vulnerable populations.

Click here to download the accompanying PDF, "Infection Control Risk Assessment Matrix of Precautions for Construction & Renovation."

Patients can leave the hospital sicker than they arrived if construction crews don’t use established precautions to control infection during new construction or major renovations. How can hospital-acquired infections (HAI) and the estimated 5,000 deaths associated with construction-related infections each year be prevented?

The Centers for Disease Control (CDC) recommends comprehensive preventive actions.¹ The recommendations are strongly enforced in health care construction standards published by the American Institute of Architects (AIA) to ensure construction-related infections don’t occur. The AIA’s 2006 Guideline for Design and Construction of Health Care Facilities² mandates an “infection control risk assessment” or ICRA before beginning any new construction or major renovation project. Federal enforcement (CMS) or accrediting agencies (Joint Commission) require an ICRA if the health care organization receives Medicare/Medicaid funding.

So, what is an ICRA? Who is responsible for it? How is it done? Which areas of a health care facility are more susceptible to HAI’s and need to be most vigilant during construction??

The What

An ICRA might be compared to an environmental impact statement. That is, what is the impact or risk of infectious agents released from the dust and dirt stirred up during construction activity on vulnerable patients in...
health care facilities? Can dust and dirt carry bacteria and mold into patient areas during minor or major construction and lead to serious infection?

The answer is a resounding “yes.” A large body of published peer-reviewed evidence has demonstrated over several decades that indeed, patients can, and have been infected with numerous infectious agents leading to illness and death.

The infections were the result of inadvertent exposure to fungi or mold released for example, from contaminated ceiling tiles, fireproofing insulation, contaminated HVAC systems, rotted wood cabinets, and contaminated equipment.\(^1,3\) The ICRA as described in the AIA guidelines requires that before any project begins there is planning that considers a) the degree of dust and dirt that may be generated in or near the facility; and b) the degree of susceptibility for infection in the patient population near the construction site.

That is, are they fairly healthy patients on medical units hospitalized for testing, or are they bone marrow transplant (BMT) patients in special protected units, or in operating rooms where their sterile tissue will be exposed to the air? Determining the potential risk of transmission of various infectious agents in the facility permits the facility to adopt preventive or control measures throughout all phases of construction or renovation.

**Who is responsible?**

Clearly the ICRA needs to be started at the earliest possible stage of new hospital construction or renovation. The *Guidelines* describe who is involved, elements of the ICRA that must be considered and clarifies accountability. The owners are ultimately responsible, but the ICRA process must translate into workable documentation for the owner, the architects and contractors (internal and external).

Although the ICRA must begin during the planning, design and construction/renovation stages — it continues as a process throughout the project right through commissioning and hand-off to the owner. A multidisciplinary panel of experts on infectious diseases, ventilation, engineering, facility design and construction, epidemiology, and safety performs the assessment and provides various types of documentation regarding the assessment. It is frequently part of bid documents but commonly includes a permit posted on the site stating the level of risk that was determined by the ICRA and the precautions to take during construction.

The ICRA also complements federal OSHA or state occupational health and safety requirements for worker safety. The process reduces time and the cost of rework because issues are addressed with state review agencies before the blueprint approval stage. All health care organizations — not just hospitals — have to consider issues ranging from air handling to power management to traffic flow and include the following:
• The impact of disruptions of essential services on patients and staff
• Patient placement or relocation
• Placement of effective barriers to protect patients from airborne contaminants such as *Aspergillus* species
• Air handling and ventilation needs for surgical services, airborne infection isolation (AII), and protective environment (PE), laboratories, local exhaust system for hazardous agents and other special areas
• Selection of finishes and surfaces
• Determination of additional numbers of AII (or PE if needed)
• Systems to prevent water supply contamination as a possible source of *Legionella* species and various other waterborne opportunistic pathogens
• Assessment for internal and external projects, including, for example, patient protection from demolition, ventilation and water management following planned or unplanned power outages, movement of debris, traffic flow, cleanup, and certification

**How is it done?**

The AIA guidelines do not describe or mandate how it is to be carried out, but merely require documentation that it was done to protect and prevent infectious risks to patients. Enforcement agencies also do not prescribe the process. One method, known as the ICRA Matrix, has been almost universally adopted because of its systematic approach to the process. It facilitates communication among clinicians, engineers, and architects. The process defines the type of project, the type of patient risk groups, and the type of infection control procedures needed to minimize risk (Figure 1).

**Applying the Matrix**

The matrix will be explained as examples in areas of common construction, renovation or repair such as an OR, and related services. A small ICRA panel of experts (e.g., infection control and a facility manager) may be able to communicate rapidly for simple projects. A new hospital construction project or even major renovation will require a full panel and weeks of planning beforehand.

Class I renovation of a lobby: hospital or freestanding surgical center. The admitting area may just need a coat of paint. It’s a simple, in-and-out job, and that’s why it’s considered a Type A construction project, that is, just inspection or minimal dust producing activity. Patients and families may be coming in, but it is a general administrative, office type area where patients are not receiving direct care. Therefore, everyone is considered to be part of the low-risk patient group. Although the lobby needs to be well ventilated, there are few other precautions needed. Signage and good communication will keep patients and families from worrying that this work will compromise their health. Class I precautions are simple: Ensure the work is executed by methods that
minimize dust and dirt related to the work, and upon completion a simple clean-up is sufficient.

Class II renovation: installing computers near procedure rooms or an OR. Even small-scale, short-duration activities like installing computer cabling require special precautions. Patients in hospitals or outpatient ORs are considered high-risk because skin will be broken and sterile tissues exposed for varying lengths of time. Although it may appear that putting in the computer cables is likely only to cause minimal dust, and considered Type B construction, this needs to be very carefully considered for dust production and may possibly be a Type C. However, presuming the area can be sealed off tightly with soft (plastic) barrier for a relatively fast project, Class II precautions may be appropriate. This means, for example:

- Minimal dust will be generated if no drilling is required. However, even if only minor drilling is needed and a dustless drill is used to minimize dispersal, the area must be separated from the clean, sterile corridors.
- Pre-framed plastic barriers sealed into place can separate the work area from the clean area.
- Air vents can be blocked off and sealed, and dust mats placed at the entrance and exit of the work area.
- Upon completion work surfaces need to be cleaned/disinfected, and construction waste contained before transport using tightly covered containers. The area should be cleaned with a HEPA-filtered vacuum and wet mopped. A final cleaning is done after the barriers are removed.

Class III renovation: adding a ceiling mounted monitor in a procedure room. Any time the ceiling is opened or work performed on the HVAC ductwork, there is risk of stirring up and recirculating of dust throughout the area. Ceiling-mounted monitors, booms, major cabling activities, and minor duct or electrical work are among the construction activities falling into this category (Type C).

Because endoscopy rooms or suites are used for procedures and not invasive surgery (air exchange requirements are less stringent, and procedure rooms don’t have to be on a sterile corridor, for example), patients are classified as medium-risk. Pain practice patients would also fall into this category. The combination of medium-risk patients and Type C construction calls for Class III infection control precautions. The essential requirement for Types C and D is isolation of the HVAC, ensuring that the construction/renovation area is negatively pressurized with respect to adjacent areas. Here are Class III precautions during construction:

- Isolate the HVAC system in the area where the work is being performed.
- Before construction begins, complete all critical barriers (sheetrock, plywood or plastic) to seal the area from non-construction areas, or establish an anteroom connecting to the work site using a HEPA vacuum for vacuuming workers’ clothing before exiting.
• Maintain negative air pressure within the work site, utilizing HEPA-equipped air filtration units (negative air machines or NAMs).
• Cover/contain construction waste before transport.

After construction is complete, incorporate the following guidelines.

• Do not remove barriers from work area until the completed project is inspected by the safety and infection control departments, and thoroughly cleaned by environmental services.
• Remove barrier materials carefully to minimize spreading of dirt and debris.
• Vacuum the work area with HEPA-filtered vacuums and wet mop work area surfaces with disinfectant.
• Return the ventilation to the areas where the work has been performed.

Class IV renovation: repairing a leak or ceiling tiles in an OR. Leaks from condensation or flooding affecting ceiling tiles are not uncommon. Monitoring for stains or signs of leaks is important since moisture supports growth of mold or fungus and serious problems may be prevented if caught in time. A small stain seen from below may actually reveal a large garden of fungal blooms above the ceiling. The very act of pushing the tile up is likely to disturb the mold. A burst of fungal spores can quickly contaminate a sterile area and disperse into the ventilation system, causing major contamination of the general area. It’s too late to control it at that point.

So even though this activity is considered Type A, the location in this example is the key. Despite the minor nature of the activity and because an OR is considered a high-risk area, stringent Class IV precautions are required. Inpatient care areas a special containment cube could be used; it is pushed upward and sealed tight to the ceiling. With a negative air machine connected to the cube, one can create the necessary barrier and negative pressure needed to contain the contamination as the worker examines and works in the space above the ceiling.

However in an OR, because the contamination may be more extensive and the source of the leak may require extensive repairs, a soft barrier should be installed to seal the contaminated room away from the other ORs while a solid barrier is constructed to tightly seal the room from the clean areas. Attention must be placed on sealing returns and determining how the air can be cleaned and safely removed. The workers should be wearing protective clothing; all the precautions outlined for Class III apply, and once again require the following:

• Maintaining negative air pressure within the work site utilizing NAM.
• Constructing an anteroom, requiring all personnel to pass through this room so they can be vacuumed using a HEPA vacuum cleaner if they are not wearing cloth or paper coveralls.
• Sealing holes, pipes, conduits, and punctures appropriately.
• Barriers are only removed from work area after completed project is inspected by the owner’s safety department and infection control department and thoroughly cleaned by the owner’s environmental services department. The tiles removed should be carefully bagged and the area cleaned.
• Once the inspection is complete, the same Class III cleanup steps apply.

Class III and IV examples demonstrate that the matrix is just a starting point of how to assess the risk for patients — not everything fits the matrix perfectly. The key is to think of how the dust and debris can be contained, and to not expose patients or clean areas to the debris and risk of infectious agents that may be released when construction and renovation begin.

**Facing the challenge**

Clearly, starting new construction of a hospital — or additions to an existing structure — means extensive planning to protect from excavation problems that may affect adjacent hospitals. Installation of new air handlers into existing structure is a particular challenge in terms of protecting functional ORs and very high-risk patients such as BMT patients who are very susceptible to fungal infections. The same principles apply but require increased attention to sealed, tight barriers in order to maintain negative pressure in the construction zone.

Infection control is one of the most daunting challenges facing health care. Understanding the ICRA and hospitals expectations for infection prevention from the environment should help HVAC engineers in planning installation activities and at least give them a head start in meeting these expectations. *ES*

**Sidebar: Required ICRA Elements**

**Design planning**

ICRAs must consider the following:

• Airborne infection isolation rooms and protective environment rooms (e.g., number of rooms, locations)
• Ventilation and filtration in areas such as emergency department waiting rooms
• Air handling and ventilation in areas such as airborne infection isolation rooms, protective environment rooms, surgical areas, and laboratories
• Systems to prevent water contamination from *Legionella sp.* and other pathogens
• Finishes and surfaces

**Construction**

During construction the ICRA must also focus on the impact to areas or individuals within the building while construction is taking place such as:
• Effects of interrupting patient or employee services
• Protection of building occupants during planned or unplanned outages
• Identification of hazards and plans for protection from these hazards
• Placement of patients at high risk of infection

Mitigation
Infection control risk mitigation recommendations should include the following:

• Safe areas for location or relocation of patients
• Standards for barriers to protect individuals near construction areas from airborne contaminants
• Plans for temporary disruptions to HVAC and water supply systems
• Demolition protection
• Infection control education and training for staff, construction workers, and visitors

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References

Links
Premier Inc.