Infection Prevention for Construction and Renovation in the Operating Room

Article *in* Perioperative Nursing Clinics · June 2008

DOI: 10.1016/j.cpen.2008.01.004

2 authors, including:

Janet P Haas
Lenox Hill Hospital
71 PUBLICATIONS **2,676** CITATIONS

SEE PROFILE

ELSEVIER
SAUNDERS

Perioperative Nursing Clinics 3 (2008) 137–142

PERIOPERATIVE
NURSING
CLINICS

Infection Prevention for Construction and Renovation in the Operating Room

Sandra Hardy, RN, MA*, Janet P. Haas, RN, DNSc

Infection Prevention and Control Department, New York University Medical Center, New York, NY, USA

Surgical procedures, a necessary part of medical treatment, are intended to improve function and quality of life for patients. However, surgery places patients at risk for complications, including infections. Risk factors for infection include the environment, in addition to the procedure itself and the health care workers in the room. Several reports of infections following surgery have implicated construction in or near the operating room (OR) suite [1–4]. The most frequently reported infections involve cardiac, ophthalmology, and dental surgeries.

The organisms that most frequently cause construction-related infections are *Aspergillus fumigatus* and *Aspergillus flavus* [5,6]. *Aspergillus* is a species of fungus that is ubiquitous in soil, decaying vegetation, household dust, and building material. *Aspergillus* is transmitted by small spores that become suspended in the air and can survive for prolonged periods. Transmission during surgery is by contact of aspergillus spores with the moist tissues of the surgical site. The epidemiology of aspergillus infections related to the OR differs from the usual presentation, in which inhalation of spores leads to invasive infections of both the upper and lower respiratory tracts in a susceptible (usually immune-compromised) host. Invasive aspergillus disease causes high morbidity and even mortality. Ensuring that construction sites in and near ORs are controlled is the best prevention for this devastating complication of surgery.

During construction, as floors, walls, and ceilings are penetrated, or soil is disturbed, spores are liberated and travel in dust or dirt particles. Chances of inhalation or environmental contamination increase. Tabbara and Jabarti [3] reported an outbreak of aspergillus endophthalmitis after cataract extraction during hospital construction. Five patients developed postoperative eye infections. In all five cases, cultures of aqueous or vitreous grew *A fumigatus*. All fives cases occurred in a 3-week period coinciding with hospital construction. Overberger and colleagues [7] showed the effectiveness of preventive measures in decreasing the risk of aspergillus infections during construction. In this study, the construction zone was placed under negative pressure and separated by erection of temporary barriers. Once all measures were in place, air samples from various locations both inside and outside the construction zone before, during, and after a 30-week construction project were taken. In the construction zone, total particulate concentrations and spore counts were elevated, while outside the barriers they did not change significantly from baseline levels.

The American Institute of Architects (AIA) publishes guidelines for hospital design and construction. These have become the basis by which compliance is measured [8,9]. Regulators, such as the Joint Commission, the federal government, and some states, require hospitals and other health care facilities to design, construct, and renovate according to AIA guidelines. Construction projects can be divided into the preconstruction, construction, and postconstruction periods. Each has specific tasks that must be completed to ensure safety of patients in the area.

* Corresponding author.
E-mail address: sandra.hardy@nyumc.org (S. Hardy).

1556-7931/08/$ - see front matter
doi:10.1016/j.cpen.2008.01.004

Preconstruction

The first part of the preconstruction phase is the design phase. AIA guidelines state: ''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 risks to susceptible patients and disruption of essential patient services [10]. The involvement of the infection control professional (IPC) helps ensure that space and equipment essential to infection prevention is not overlooked in the design. Some of these items include ample storage space for clean supplies, soiled utility rooms, and hand washing facilities. The IPC should be versed in the AIA requirements for the OR or procedure rooms because there are specific requirements for air flow, temperature, and humidity in these areas. The IPC doesn't act alone, but rather becomes a part of a multidisciplinary team that includes architectural and engineering designers, the OR nursing director and nurse manager, surgeons, the facilities department, safety or environmental services, and the hospital or health care administrator [10–12]. Others can be added to the team as appropriate for the organization and the project in question. Each member of this team brings expertise in a particular area. Together the group can best decide how the OR space will function as a whole.

An essential part of the preconstruction phase is developing the Infection Control Risk Assessment (ICRA). The ICRA takes into consideration the type of construction or renovation being done, the amount of time the project will take, and the area of the facility in which the project will be done. The Association for Professionals in Infection Control and Epidemiology has developed a guide to the types of infection control precautions needed based on these factors [12–14]. Appendix 1 shows the version of the construction guideline matrix at the authors' hospital. The focus of infection control during construction is on containing dust and moisture. It is important to document what types of barriers will be needed, what protection is required for elevators that will be used, and what type of cleanup is required. In addition, the ICRA should delineate the routes that construction workers will take getting to and from the project site, the protective clothing or actions required (such as requirements that workers vacuum themselves with a high-efficiency particulate air [HEPA] filter vacuum system to remove dust), and the routes for materials and debris. Depending upon the project, the ICRA may be completed during a preconstruction walk-through before the project begins. However, for larger projects, the AIA now requires preconstruction drawings to include barrier locations and descriptions of how they are to be built [10,11]. It may not be possible to actually walk through the spaces in these cases, so the ICRA is then based on drawings of the project. It is important to have all infection-prevention and environmental-safety measures documented before the project is sent out for bid because these measures will add costs that should be estimated by contractors. Clearly documenting the requirements also gives all parties something to refer to as the project progresses.

A construction and renovation policy (CRP) ensures that management understands the ICRA and specifies essential participants [10]. Following the CRP ensures a safe environment for patients, visitors, and employees during construction projects or repairs of the facility; and provides guidance for project managers, engineers, environmental service workers, and department heads. It determines who has the authority to stop the project and for what reasons, as well as who has authority to restart the project. It includes expectations for contractor accountability in the event of breaches in infection control practices and related agreements [10].

Before construction or renovation in the OR, all construction personnel should be educated about the potential risks to patients and the rationale and strategies for infection prevention during the project. The education includes information regarding the pathogen *Aspergillus* and its transmission, the type of barriers used to contain the dust, and airflow considerations for maintaining negative pressure in the construction area, even though the OR is under positive pressure [9,10,14].

In addition, construction workers must be informed of the routes they should use to enter and exit the construction area, and how to get needed tools and material to the site. To promote understanding, educational material should be provided in the language of the workers if at all possible. To ensure that time is set aside for this important education, the construction contact should require subcontractors and workers to attend [10–12]. OR staff must also be educated about the importance of infection prevention during construction, and told to contact the appropriate OR manager, or even the construction

project manager, if barriers are not intact or if work practices are unsafe.

Construction

Infections have been transmitted through the dissemination of microorganisms from disruption of environmental reservoirs (eg, drywall, ceiling tiles, flooring casework) [5]. Before beginning construction, patient supplies and equipment should be removed from the construction site. Any equipment that cannot be moved should be sealed tightly in plastic. Barriers must be erected around virtually all construction or renovation sites in the OR. The specific type of physical barrier required depends on the project's scope, duration, degree of activity (generation of high or low levels of dust), and local fire codes. The OR is considered one of the highest risk areas because of the invasive nature of surgical procedures and the underlying health issues of the population served [9,10]. For short-term projects, such as installation of new cables in the semirestricted area, a portable plastic enclosure from ceiling height to floor with flaps that overlap by at least 2 ft for entry access may be sufficient. For larger and longer term projects, the barrier may include a plastic dust abatement curtain before construction of the rigid barrier; sealing and taping all joint edges, including the top and bottom; extending the barrier from floor to ceiling; and fitting or sealing any temporary doors connecting the construction zone to the adjacent area. An entry vestibule for changing clothes and storing tools is needed for larger jobs. Many facilities are now posting the ICRA at the entrance to the construction site. This communicates compliance with the ICRA requirement, and displays the requirements for barriers and other infection prevention measures openly for all to follow.

Special ventilation is required during construction. Under normal conditions, ORs are maintained under positive pressure with air introduced at the ceiling and exhausted near the floor [15]. This means that air flows from the operating room toward the corridors and adjacent areas. During construction, the air within the construction area must be contained [9,10,14]. Fans should be turned off before opening ductwork. Adjacent areas should be evaluated to ensure there are no hidden wall or ceiling penetrations [9,10]. One of the first steps in preparing for construction is to isolate the ventilation system in the area. Air exhaust from the construction site should be directed outside via a window with no recirculation into the building. If the exhaust must tie into a recirculation air system, a prefilter and HEPA filter unit are used before exhaust to prevent contamination of the ducts. In addition, the construction site must be under negative pressure with respect to surrounding areas. The construction personnel or the facilities department must maintain and monitor the negative pressure. This can be done with a smoke test similar to that used for tuberculosis isolation rooms, or with mechanical monitors. The results should be documented, and some facilities choose to post the results of monitoring at the entrance to the construction site as well as keeping them on file.

During construction and renovation, specific traffic patterns should be established and maintained. Designated entry and exit procedures should have been defined in the preconstruction phase [9,10,12]. While construction is occurring, operating room personnel must be able to move from place to place without contaminating their surgical scrubs. Clean or sterile supplies and equipment must be transported to storage areas by a route that minimizes the potential for contamination from any source [10,14]. During construction, this includes construction materials and debris along with the usual OR soiled or contaminated trash and linen. Hallways, elevators, entrances, and exits for construction workers must be designated and clearly marked [10,12]. Patients may not be transported on the same elevator with construction material and debris.

If traffic patterns are not easily altered to meet these requirements, then construction personnel may need to work during off-hours or weekends. If infection control requirements still cannot be met, the area may need to be relocated or closed temporarily [10]. Any decision to relocate or temporarily close should be made by the multidisciplinary planning team. The ICRA incorporates a list of guidelines for movement of supplies, equipment, and debris.

Construction workers entering the semirestricted and restricted area should be provided with disposable jump suits, head and shoe covers. Protective clothing should be removed before exiting the work area. Tools and equipment should be damp-wiped before being transported from the work area. In unrestricted areas, protective apparel is not always worn. In cases where workers don't wear protective clothing, an HEPA-filtered vacuum should be used to remove dust from clothing before leaving the construction site [8,9,12]. The construction area should be maintained in a clean manner by contractors and swept

Appendix 1

Construction matrix used at New York University medical center

Construction Matrix used at NYU Medical Center
CONSTRUCTION PRECAUTIONS NEEDED TO PREVENT INFECTIONS IN PATIENTS

INSTRUCTIONS: Locate the type of work that is planned (Type A, B, C, or D) along the top row of the grid, then find the area of planned construction in left column (Group 1, 2, 3, or 4). The intersecting area in the grid tells the class of work (CLASS I, II, III or IV) and the precautions that are needed.

<table>
<tr><th>Construction activity CLASS grid
(By area and type of work)</th><th>Type A Inspection and noninvasive activities. Includes, but is not limited to, removal of ceiling tiles for visual inspection limited to 1 tile per 50 square feet, painting (but no sanding), wall-covering, electrical trim work, minor plumbing and activities which do not generate dust of require cutting of walls or access to ceilings other than for visual inspection.</th><th>Type B Small scale, short duration activities which create minimal dust. Includes, but is not limited to, installation of phone and computer cabling, access to chase spaces, cutting of walls or ceilings where dust migration can be controlled.</th><th>Type C Any work which 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, ceiling tiles or casework, new wall construction, minor duct work or electrical work above ceilings, major cabling activities and any work that can not be completed in one shift.</th><th>Type D Major demolition and construction projects. Includes, but is not limited to, activities which require consecutive shifts, heavy demolition or removal of a complete cabling system and new construction.</th></tr>
<tr><td><u>Group 1</u>
Office areas
Non patient care areas not otherwise specified.(NOS)

<u>Group 2</u>
Cardiology/Echocardiology
Endoscopy/Nuclear Medicine/MRI
Radiology/PhysicalTherapy/
Respiratory Therapy</td><td>CLASS I
1.Execute work by methods to minimize raising dust.
2.Immediately replace any ceiling tiles displaced for visual inspection.</td><td colspan="2">CLASS II (All of precautions for CLASS I, plus)
1. Isolate area with barriers or provide active means to prevent airborne dust from dispersing into atmosphere.
2. Seal unused doors with masking tape.
3. Block off and seal air vents
4. Wipe surfaces with disinfectant.
5. Provide adhesive walk off mats at entrance and exit of work area.</td><td>CLASS III
(See instructions for Class III)

CLASS IV(All of precautions for CLASS I, II & III, plus)
1. Seal holes, pipes, conduits and punctures appropriately.</td></tr>
<tr><td><u>Group 3</u>
CCU/ Emergency Department/Labor and Delivery/Laboratories/Newborn Nursery/ Outpatient surgery/Pediatrics/Pharmacy/PACU Surgical Units</td><td></td><td></td><td>CLASS III</td><td>2. Create an anteroom if necessary.

3. DO NOT remove barriers from work area until completed project thoroughly cleaned by the Building Services Dept and is inspected by Environmental Services and Infection Surveillance Departments.</td></tr>
<tr><td><u>Group 4</u>
Cardiac Cath lab (?)
Central Sterile Supply/IntensiveCare Units/Medical Units/OncologyUnit/ Operating Rooms (including C-section rooms in L &D)</td><td>CLASS II
(See instructions for class II)</td><td colspan="2">CLASS III (All of precautions for CLASS I & II, plus)
1. Project mgr. to notify Infection Surveillance and Environmental Services Depts before construction begins.
2. Isolate HVAC system where work is being done to prevent contamination of duct system.
3. Complete all barriers before construction begins, or use Control Cube Method.
4. Post signs as necessary.
5. Use plastic barriers above ceiling tiles.
6. Maintain negative air pressure within the work site or use HEPA filtration units, when necessary.
7. Wear paper coveralls and shoe coverings for wall demolition or other activities creating excessive dust. Remove each time workers leave the work site.
8. Use most direct route to the outside for waste removal and contain construction waste in tightly covered containers before transport.
9. Cover transport carts and tape covering.
10. Remove barriers carefully to minimize spread of dirt and construction debris.
11. Wet mop and/or Vacuum with HEPA filtered vacuum before leaving work area.</td><td></td></tr>
</table>

or HEPA-vacuumed daily or more frequently as needed. Walk-off mats help minimize tracking of heavy dirt and dust from the construction area [9,10]. The construction site must be frequently monitored to ensure compliance with the ICRA [10,12] and maintenance of appropriate air-pressure relationships [9,10]. The use of a checklist provides a way to ensure that all aspects of the site are monitored daily. The project manager or designee is usually responsible for day-to-day monitoring of the construction site, with the ICP also checking the area often. Some facilities have a designated person who monitors construction sites and oversees the infection control and safety aspects of construction projects.

Throughout the construction or renovation project, the facilities or maintenance department should monitor and evaluate the air-pressure differentials and humidity within the construction zone (negative pressure) and the adjacent OR (positive pressure) to ensure that the ventilation system is functioning properly. Any concerns identified should be brought to the attention of the ICP and project manager or, if required, to the multidisciplinary team.

Postconstruction

Before the construction area can be returned to full service or patient occupancy, the multidisciplinary team should walk through and inspect the area. A tool that has been used by contractors is a ''punch list,'' which ensures missed details have been addressed (eg, hand washing sinks, installation of soap) [10].

A cleanup agreement is established in the early planning phase. This agreement delineates who is responsible for the various aspects of cleanup and final cleaning after removal of barriers. The facilities department restores appropriate air condition and heating equipment, and cleans or replaces filters [9,10]. Before the OR suite can be occupied, an environmental air sampling is conducted to evaluate for potential sources of airborne fungal spores that can be detrimental to a patient undergoing surgery [5,9–11]. States and localities may require inspection before the OR can be open for use. Check your state or city regulations.

Summary

Construction and renovation projects in the operating room can increase the risk of invasive aspergillus infections among patients having surgery during these activities. A proactive approach minimizes the risk of infections. A multidisciplinary team is required to plan and implement preventive measures throughout the construction project. The OR staff and leadership play an important role in the planning of new or renovated facilities and especially in monitoring the construction site within their work area. Appropriate preventive measures during OR construction help to promote patient safety.

References

[1] Pasqualotto AC, Denning DW. Post-operative aspergillosis. Clin Microbiol Infect 2006;12:1060–76.
[2] Diaz-Guerra TM, Mellado E, Cuenca-Estrella M, et al. Genetic similarity among one aspergillus flavus strain isolated from a patient who underwent heart surgery and two environmental strains obtained from the operating room. J Clin Microbiol 2000; 38:2419–22.
[3] Tabbara KF, Jabarti AA. Hospital construction–associated outbreak of ocular aspergillosis after cataract surgery. Ophthalmology 1998;105:522–6.
[4] Sanchez RO, Hernandez JM. Infection control during construction and renovation in the operating room. Semin Perioper Nurs 1999;8(4):208–14.
[5] Cooper EE, O'Reilly MA, Guestand DI, et al. Influence of building construction work on Aspergillus infection in a hospital setting. Infect Control Hosp Epidemiol 2003;24:472–6.
[6] Vonberg R-P, Gatmeier P. Noscomial aspergillosis in outbreak settings. J Hosp Infect 2006;63:246–54.
[7] Overberger PA, Wadowsky RM, Schaper MM. Evaluation of airborne particulates and fungi during hospital renovation. Am Ind Hyg Assoc J 1995;56: 706–12.
[8] The American Institute of Architects and Facilities Guidelines Institute. Guidelines for design and construction of hospitals and health care facilities. Washington (DC): American Institute of Architects Press 2001. 5.1 A; p. 15.
[9] Centers for Disease Control and Prevention. Guidelines for environmental infection control in health care facilities. MMWR 2003;53(RR10):1–42.
[10] Bartley JM, the 1997, 1998 and 1999 APIC Guidelines Committee. APIC state-of-art report: the role of infection control during construction in healthcare facilities. Am J Infect Control 2000;28:156–69.
[11] Hansen W. Infection control during construction. Manual; policies, procedures, and strategies for compliance. 2nd. Marblehead (MA): HCPro, Inc. 2004. p. 24–41, 185, 214–19.
[12] Health Canada. Construction-related nosocominal infection in patients in health care facilities: decreasing the risk of aspergillus, legionella and other infections. Can Commun Dis Rep 2001;27(Suppl 2):1–46.

[13] Streifel AJ, Hendrickson C. Assessment of health risks related to construction. HPAC Heating/Piping/AirConditioning Engineering 2002;27–32.
[14] Association of Operating Room Nurse. Standards, recommended practices guidelines. Denver (CO): Association of Operating Room Nurses 2006.
[15] Streifel AJ. Health-care IAQ guidance for infection control. HPAC Heating/Piping/AirConditioning Engineering 2000;28–36.