noted. The authors (Toner & Adalja, 2012) identified 22 seroepidemiological studies; the majority of these studies found no or little evidence of subclinical H5N1 infections. Four studies had to be excluded for methodological reasons. Of the remaining 18 studies, in 11,477 persons only 144 were found to be seropositive (1.25%). The authors note that many of the 18 studies suffer from inadequate design and methods and conclude that it is impossible to draw a final conclusion on what the prevalence of asymptomatic seroconverters means in terms of fatality rate. For instance, an irrelevant seroconversion could have happened after an exposure to contaminated water. Toner and Adalja (2012) confirm that people who are infected become seriously ill and a large proportion die. In response to this article, Zelicoff (2012) writes in a letter to the editor that “morbidity from novel influenza strains does not equate with an impending pandemic, let alone one with high mortality.” Zelicoff (2012) suggests that “it would appear likely that a systematic, prospective cohort study is in order to adequately capture the frequency of asymptomatic infection.”


Laboratory-acquired Brucellosis in Turkey

Sayin-Kutlu et al. (2012) report about a multicenter survey conducted in 38 hospitals in 17 of the 81 provinces in Turkey. Thirty-eight of the 667 interviewed laboratory workers had experienced a lab-acquired brucellosis (LAB, 5.8%). Statistical analysis revealed the three most important factors that reduce the likelihood of an LAB are using a biosafety cabinet class II (odds ratio 0.13, P value 0.009), full adherence to glove use (odds ratio 0.27, P value 0.004), and longer experience as a lab worker (odds ratio 0.86, P value <0.001). Performing bacterial isolation, being a staff member, and being male increased the odds of an LAB significantly (5.12, 3.21, and 2.14, respectively). Brucellosis is still endemic in Mediterranean and Middle Eastern countries, including Turkey. In many of these countries, laboratory facilities and equipment are not appropriate. In the Turkish study (Sayin-Kutlu et al., 2012), the interviewees diagnosed with LAB named inadequate facilities such as lack of biosafety cabinets and tools (79%), lack of knowledge about the mode of transmission (52%), and ignoring the risk of infection (64%) as the cause of LAB.


Beyond Traditional Biosafety

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Biosafety professionals have ever-expanding roles at their institutions. In this Beyond Traditional Biosafety column, we focus on topics that may fall outside the scope of the traditional biosafety role, but where the expertise of the biosafety professional may be called upon to provide a valuable contribution to his or her institution. Please e-mail any comments or suggestions to Ted Myatt, tedmyatt@gmail.com, Co-Editor Barbara Johnson at barbara_johnson@verizon.net, or Co-Editor Karen B. Byers at karen_byers@dfci.harvard.edu.

Construction in Healthcare Facilities—Risks from Opportunistic Fungi and Control Solutions

Construction, demolition, and renovation activities are common occurrences in a healthcare facility. Hospitals are constantly seeking to better utilize current space, as well as to expand to accommodate growing needs. Potentially, construction work in hospitals can place patients, staff, workers, and visitors at risk for serious health issues. These include risks from inhalation exposure to opportunistic fungi, the focus of this article.

Airborne dust and other debris generated during construction work can contain opportunistic fungi that are generally harmless to the average person, but can cause serious infections in severely immunocompromised patient populations. The primary infection control concern during hospital construction is exposure to fungal elements that can cause a group of invasive fungal respiratory diseases. One such disease, aspergillosis (caused by Aspergillus spp., most commonly A. fumigatus, A. flavus, and A. terreus), can affect compromised patients such as those undergoing high-dose chemotherapy for hematological malignancies with or without stem cell or bone marrow transplants, and those with auto-immune disease, solid organ transplants, and immunosuppressive diseases such as AIDS (Kauffman, 2010; Maschmeyer, 2007; Muller, 2002; Yeghen, 2000). Aspergillosis can take several forms. These include nonin-
vascive forms such as in the formation of a fungus ball in aspergillosis, hypersensitivity disease in conditions such as acute bronchopulmonary aspergillosis, and invasive disease such as that involving the lungs (invasive pulmonary aspergillosis), skin (invasive cutaneous aspergillosis), or multiple organ systems (disseminated aspergillosis).

Invasive pulmonary aspergillosis (IPA) is the form most often associated with construction activities. The mortality rate for IPA ranges from 58% to nearly 90% in bone marrow transplant recipients undergoing high-dose chemotherapy treatment (Lin, 2001). In addition to aspergillosis, airborne contaminants created during construction activities can create acute irritation in healthy patients, staff, workers, and visitors.

To control airborne dust and debris from travelling outside the construction site, the worksite should be isolated from the surrounding occupied areas. Members of the construction team, as well as Infection Control and Project Management personnel, should work together to ensure that construction work is segregated from hospital populations. Guidance for managing risks from construction in hospitals is provided by two groups—The Facility Guidelines Institute (FGI) and The Joint Commission (TJC) (FGI, 2010; TJC, 2009). The FGI has published several recommendations that hospitals should implement before and during construction activities to ensure that high-risk patients are protected. These include physically isolating the worksite from surrounding areas, isolating the mechanical systems, and maintaining the worksite at a negative pressure relative to surrounding occupied areas. TJC subsequently adopted the FGI guidelines for controlling the potential impacts from construction, as described in Standard EC.02.06.05 (TJC, 2009). This standard outlines the hospital’s need to manage risk associated with construction through design and complete a pre-construction risk assessment (PCRA). An important element of the PCRA is the Infection Control Risk Assessment (ICRA), which focuses on the impact construction can have on the health of the patients, staff, and visitors. The PCRA should consider air quality, infection control, noise, vibration, and utility interruptions that may occur during construction work.

An effective method to isolate the construction site is to maintain a worksite that is at negative pressure to surrounding occupied spaces for the duration of the project. To do this, negative-air machines are typically used to draw in air from the construction zone which is then filtered through high efficiency particulate air (HEPA) filters in the machine and exhausted to the outdoors. To ensure that pressure is kept negative, regular pressure measurements are collected. On critical projects occurring near immunocompromised patient populations, continuous pressure monitors may be installed at the project entrance. Also, potential impacts to adjacent spaces need to be evaluated prior to using negative-air machines. For example, an isolation room or other area with critical airflow patterns and pressure relationship that is adjacent to the construction site requires that the air flow patterns be evaluated to ensure that the existing pressure relationship is never compromised.

In addition to adjusting the pressure in the work space, several other control methods need to be implemented to prevent the potential transfer of opportunistic fungi to surrounding areas. These include the following:

- Construct barriers that physically separate the construction work zone from surrounding areas to prevent the transfer of dust and other airborne contaminants. The barrier materials should be fire retardant and sealed tightly.
- Isolate or shutdown existing heating, ventilating, and air-conditioning (HVAC) systems serving the work area for the duration of the project.
- Fully cover all containers used for the transport of tools, materials, or debris and ensure that they are visibly free from dust accumulation (including the wheels).
- Use designated transport routes and elevators (if necessary) to remove materials from the worksite, and clean these routes daily.
- Clean the worksite regularly (at a minimum at the end of the work shift) using damp-wiping and wet-sweeping methods to control dust.
- Install sticky mats at each entrance/exit of the containment area and change these mats at the end of each work day, or more frequently if necessary.
- Sequence material delivery and debris removal to occur at times when outpatient traffic is low and/or when patients are not expected to be within the corridor.
- After completion of the construction work, and prior to containment disassembly, thoroughly clean all dust and debris from the work zone by vacuuming with a HEPA-filtered vacuum and wiping with a damp cloth.

A critical component of the overall risk management plan to maintain the construction site is to have a process to verify controls that are in place. This includes regular verification of the air pressure, cleaning effectiveness, and containment setup. Additionally, biological air monitoring may also need to be considered. Although no standards for fungi concentrations in air exist, airborne particle counts and cultivatable fungi from air sampling are often used to evaluate the effectiveness of isolation measures, as well as to qualify a space following construction. Studies have shown that nosocomial infections appear when *Aspergillus* spp. levels range from 0.9 - 2.2 colony forming units per cubic meter of air (cfu/m$^3$) (Sehulster & Chinn, 2003). Many experts use <1.0 cfu/m$^3$ as an acceptable criterion for areas of the hospital where there are immunocompromised patients (Sehulster & Chinn, 2003).

Isolating construction work from surrounding areas has been shown to decrease the incidence of infectious diseases. One study found that implementation of an infection control strategy during construction significantly reduced the incident density (ID) of nosocomial aspergillosis from 9.88 per 1,000 days at risk to 2.91 per 1,000 days at risk, comparable to the preconstriction baseline (3.18 per 1,000 days at risk) (Loo, 1996).

Many large teaching hospitals have already undergone
construction risk assessments to help in identification and reduction of any risk due to infection of immunocompromised patient populations. Important lessons learned when working to prevent the potential transfer of opportunistic fungi to surrounding areas include:

• Involve the Infection Control Team early and often within the PCRA and ICRA processes.
• Ensure that the hospital team possesses the correct skill sets and competencies to evaluate and mitigate risks due to construction, including industrial hygiene, engineering and building systems, site isolation and pressurization, and epidemiology.
• Train contractors to properly isolate construction areas from sensitive patient populations; hold contractors accountable for proper and safe work practices.
• Establish an effective epidemiological surveillance program for at-risk patient populations, monitor for invasive fungal infections as well as other nosocomial infections, and follow-up on any infection trends potentially associated with periods during construction.
• If air sampling (i.e., relative pressure, airborne dust, and mold) is conducted to evaluate the effectiveness of mitigation measures, ensure that the criteria for when to sample, what to sample, and the metric for acceptance are established prior to conducting the air sampling.
• Verify that the newly constructed area meets acceptable criteria before patients are moved into high-risk areas; this includes criteria for work practices, cleaning procedures, and mechanical and building systems.

Biosafety professionals who are employed at institutions with a hospital or are affiliated with a hospital should be aware of the potential biohazard risks associated with construction in healthcare facilities. Those professionals who understand the importance of site isolation and how to implement and verify containment will be better prepared to assist Infection Control professionals and other healthcare team members to protect the health of patients, staff, workers, and visitors.

References


The Joint Commission on Accreditation Health (TJC). (2009). Standard EC 02.06.05. Accreditation process guide for hospitals (p. 64). Oak Brook, IL: Joint Commission Resources.


