Dirty Work in Clean Hospitals

Patient safety during construction and renovation – infection prevention for constructors and trades personnel in a hospital environment

The airborne route of transmission is important for a number of pathogenic microorganisms in healthcare buildings.

Maintaining good indoor air quality (IAQ) during construction and containment of particulate matter is a significant safety concern. Construction-related indoor fungal aerosol pollution can create a significant health risk to susceptible patients.

The source of such aerosols can originate from both building exterior and interior activity, which causes the disturbance of settled spores or disruption of contaminated materials within the building envelope.

Demolition, construction, renovation, including installation of services to the building structure, can result in the generation of fungal aerosol pollution, typically of the Aspergillus species. Without appropriate environmental controls these activities can result in increased incidence of invasive Aspergillosis, a condition where fungal pneumonia caused by inhalation of Aspergillus species is established, and the fungus disseminated to other organs. Because of the high morbidity and mortality rate associated with invasive Aspergillosis, it is vital to assess and manage the risk to patients.

Dirty Room Management

The standard risk evaluation and planning tool includes a six-step process to review the planned construction/renovation project.

1. Identification of risk
2. Assessment of risk
3. Classification of precautions
4. Project staff and worker training
5. Project permit issued against scope of project
6. Verification of compliance with project scope and required precautions

Before any project involving construction, renovation, maintenance, demolition or repair, an ICRA assessment should be conducted to define the scope of the activity and need for protective measures. It is important to establish collaborative policies of the Facilities Management and Engineering Departments and all outsourced contractors, including their trades personnel in a hospital environment.

American Society for Healthcare Engineering (ASHE), 5% of healthcare-associated mortalities are construction and maintenance related. The Infection Control Risk Assessment (ICRA) is the standard risk evaluation and planning tool. This includes a six-step process to review the planned construction/renovation project.

1. Identification of risk
2. Assessment of risk
3. Classification of precautions
4. Project staff and worker training
5. Project permit issued against scope of project
6. Verification of compliance with project scope and required precautions

Before any project involving construction, renovation, maintenance, demolition or repair, an ICRA assessment should be conducted to define the scope of the activity and need for protective measures. It is important to establish collaborative policies of the Facilities Management and Engineering Departments and all outsourced contractors, including their trades personnel in a hospital environment.

A key element in the protective measures is the isolation and barrier containment of the work area. This is a critical patient protection and safety measure. Typical dust containment methods rely on physical barriers, either by constructed temporary walls or with sheet film, poles and tape to secure the migration of particulate material from the worksite.

Some construction projects may require the use of specialist surface treatments or adhesives containing volatile organic compounds (VOCs), or irritating odour. Containment and treatment of the foul air can be similarly achieved by introducing temporary negative pressure air-handling controls via a portable negative air machine fitted with activated carbon filters if the discharge air is released within the healthcare environment.

Other measures include the isolation and sealing of all intake and exhaust vents in the construction zone, capping the open ends of ventilation ducts within the work zone, control of access to the work zone away from patient areas, regular and controlled removal of construction debris in sealed containers, the use of tack mats on the floor to eliminate tracking of soil on feet and damp cleaning.

The Infection Control Risk Assessment (ICRA) guidance suggests: “Before the project gets underway, perform the ICRA to define the scope of the activity and the need for barrier measures. Create and maintain negative air pressure in work zones adjacent to the patient care areas and ensure that engineering controls are maintained.”

Using HEPA filter environmental controls during construction

Portable negative air machines with HEPA filtration are used to provide temporary pressure management, dilution ventilation and filtration – the three environmental...

Dirty Work in Clean Hospitals

Patient safety during construction and renovation – infection prevention for constructors and trades personnel in a hospital environment

The standard risk evaluation and planning tool includes a six-step process to review the planned construction/renovation project.

1. Identification of risk
2. Assessment of risk
3. Classification of precautions
4. Project staff and worker training
5. Project permit issued against scope of project
6. Verification of compliance with project scope and required precautions

Before any project involving construction, renovation, maintenance, demolition or repair, an ICRA assessment should be conducted to define the scope of the activity and need for protective measures. It is important to establish collaborative policies of the Facilities Management and Engineering Departments and all outsourced contractors, including their trades personnel in a hospital environment.

American Society for Healthcare Engineering (ASHE), 5% of healthcare-associated mortalities are construction and maintenance related. The Infection Control Risk Assessment (ICRA) is the standard risk evaluation and planning tool. This includes a six-step process to review the planned construction/renovation project.

1. Identification of risk
2. Assessment of risk
3. Classification of precautions
4. Project staff and worker training
5. Project permit issued against scope of project
6. Verification of compliance with project scope and required precautions

Before any project involving construction, renovation, maintenance, demolition or repair, an ICRA assessment should be conducted to define the scope of the activity and need for protective measures. It is important to establish collaborative policies of the Facilities Management and Engineering Departments and all outsourced contractors, including their trades personnel in a hospital environment.

A key element in the protective measures is the isolation and barrier containment of the work area. This is a critical patient protection and safety measure. Typical dust containment methods rely on physical barriers, either by constructed temporary walls or with sheet film, poles and tape to secure the migration of particulate material from the worksite.

Some construction projects may require the use of specialist surface treatments or adhesives containing volatile organic compounds (VOCs), or irritating odour. Containment and treatment of the foul air can be similarly achieved by introducing temporary negative pressure air-handling controls via a portable negative air machine fitted with activated carbon filters if the discharge air is released within the healthcare environment.

Other measures include the isolation and sealing of all intake and exhaust vents in the construction zone, capping the open ends of ventilation ducts within the work zone, control of access to the work zone away from patient areas, regular and controlled removal of construction debris in sealed containers, the use of tack mats on the floor to eliminate tracking of soil on feet and damp cleaning.

The Infection Control Risk Assessment (ICRA) guidance suggests: “Before the project gets underway, perform the ICRA to define the scope of the activity and the need for barrier measures. Create and maintain negative air pressure in work zones adjacent to the patient care areas and ensure that engineering controls are maintained.”

Using HEPA filter environmental controls during construction

Portable negative air machines with HEPA filtration are used to provide temporary pressure management, dilution ventilation and filtration – the three environmental...
controls required for airborne infection isolation.

5% of healthcare associated mortalities are construction and maintenance related.

In situations where large amounts of dust may be created, such as sanding or removal of ceiling tiles and ceiling mounted equipment, a higher rate of air changes per hour would be recommended. In cases of heavy particulate generation, portable filtration machines can be installed within the work area to scrub the air and provide a safer working environment for construction workers.

The controlled air flow direction provided by the portable negative air machines draws airborne particles down to floor level, and directs the contaminated air through the machine, which filters the air through a primary filter to remove large particles, followed by an optional secondary (carbon) filter to provide odour control – with final filtration through a 99.9% HEPA filter. The air can then be safely exhausted to the interior of the hospital (adjacent corridor) or alternately exhausted to the outside.

Engineering and work site related infection control measures as needed for internal construction, repairs, and renovations are as follows:

- Ensure proper operation of the air handling system in the affected area after erection of barriers, and before the room or area is set to negative pressure
- Create and maintain negative air pressure in work zones adjacent to patient care areas and ensure that required engineering controls are maintained
- Monitor negative air flow inside rigid barriers
- Monitor barriers and ensure integrity of the construction barriers; repair gaps or breaks in seal windows in work zones if practical; use window chutes for disposal of large pieces of debris as needed, but ensure that the negative pressure differential for the area is maintained
- Direct pedestrian traffic from construction zones away from patient care areas to minimise dispersion of dust
- Provide construction crews with designated entrances, corridors, and elevators wherever practical; essential services such as toilet facilities, and convenience services like vending machines, protective clothing, e.g. coveralls, footgear and headgear for travel to patient care areas; a designated space or anteroom for changing clothing and storing equipment
- Clean work zones and their entrances daily by wet-wiping tools and tool carts before their removal from the work zone; placing mats with tacky surfaces inside the entrance; covering debris and securing this covering before removing debris from the work zone
- In patient care areas, for major repairs that include removal of ceiling tiles and disruption of the space above the false ceiling, use plastic sheets or prefabricated plastic units to contain dust; use a negative pressure system within this enclosure to remove dust, and either pass air through an industrial grade, portable HEPA filter capable of filtration rates of 100–800 ft³/min, or exhaust air directly to the outside, where practical, and away from the air intake for outside sourced supply air

On completion of the project, clean and disinfect the work zone according to standard facility procedures and guidelines.

ECU (Environmental Containment Unit) systems can provide controlled access to ceiling space. The work is performed within the ECU envelope under negative pressure and controlled air flow, and filtration through the attached mobile negative air machine.
The prevention of healthcare associated infection is everyone’s responsibility, including construction workers. It is not uncommon to go through a rigorous ICRA process, establish the protective precautions and guidance, only to observe non-compliance on inspection, once the project is underway. It should be noted that Infection Control has the ‘final word’. Under the ICRA guidelines and health and safety legislations it is the responsibility of Infection Control to inspect and verify compliance on a daily basis. Should any breach in patient safety precautions be found, Infection Control has the responsibility and duty of care to stop the project until required precautions are correctly implemented.

Project staff training at all levels is important to ensure that the purpose of the precautions is clearly understood and their individual responsibility to patient safety recognised. Temporary barriers constructed with film and adhesive tape do not provide a robust protective environment for extended projects and cannot withstand the rigours of worker entry/exit, delivery of materials or removal of waste. A constructed barrier should be fit for purpose and incorporate negative pressure air controls with ≥12 air changes per hour.

The ICRA process should be implemented at the earliest stage of project planning and be incorporated within the construction specifications, and clearly documented within the terms and conditions of the contract when project work is outsourced. Prior to commencement of the project, all work staff should receive a formal briefing on the risk assessment and clearly understand their role and responsibilities in compliance with the ICRA requirements.

A comparative study
What follows is a comparative study of environmental infection prevention quality improvement programmes. He is a regular speaker at international Infection Prevention conferences. Michael is also a patron for University Hospitals in the UK and Middle East.

De Nobili, Director of Infection Prevention at the Osaka University Hospital in Japan.

A recent presentation at the Japanese Society for Environmental Infection evaluated three methods of construction containment during renovations at the Osaka University Hospital. During construction at Osaka University Hospital the infection control department monitored environmental contamination in three work sites, including a paediatric surgical ward, and a renovation of rooms housing on to a corridor adjacent to a Transplantation Ward (Class 100 clean room). Each site perimeter was contained by a sealed bath dry-wall barrier. The access to each of the three work sites used three different methods for air handling controls and they were compared for their respective performance by microbiological measure:

- Site 1 used an exhaust fan to the building exterior.
- Site 2 installed negative air HEPA filtration system directly to the partition wall.
- Site 3 installed mobile exhaust system – ECU with negative air HEPA filtration, exhaust of filtered air to interior corridor.

Methods
Periodic air sampling was conducted during construction, and at the end of the work period on exit of workers from the site. Samples were also taken at times of known high levels of dust generation. Three air samples sites were monitored: within the work site; in the corridor immediately outside of the access point to the worksite; and at several remote points in adjacent corridors.

Microbiological cultures were enumerated for Aspergillus and filamentous fungi.

Results
High levels of Aspergillus and filamentous fungi were detected within the work zone. Negative air pressure applied to the work zone reduced contamination levels substantially. Viable spores were not, however, totally controlled by exhaust to the exterior on Site 1, or through a wall mounted HEPA filter on Site 2. Aspergillus spores were detected immediately outside the work zone and also in remote areas adjacent corridors.

Conclusion
Construction/renovation projects should take isolation precautions to comply with the Infection Control Risk Assessment (ICRA) CDC HICPAC (Healthcare Infection Control Practices Advisory Committee) Guidelines.

Environmental containment and air controls provided by a mobile ECU + HEPA system has proven to be useful in reducing the risk of exposure to Aspergillus and filamentous fungi contamination of the healthcare environment.

The ECU used in this study was a mobile system made up of a collapsible steel frame with a transparent polycarbonate envelope attached to the NAM (Negative Air Machine) with 99.97% efficiency / 0.1μm HEPA system. The ECU was a self contained unit which provided access via all sides and ceiling panel.

This system also allows for the controlled and safe entry and exit to the worksite. When the doors or ceiling panel are open for access, the negative air pressure within the ECU creates a secure, controlled air flow of airborne particulate and filtration via the NAM/HEPA and prevents dispersion to the protected patient area.

The system can be used to isolate a single door entry or deployed in combination with a corridor flange, to isolate a full corridor or corridor section.

The deployment of an ECU system provides a robust method for particle containment and protects environment during construction. Negative air pressure and controlled air flow through the negative air machine and HEPA filter provides required air changes per hour, reducing particles across within the works area and preventing dispersal to the exterior patient environment. ICRA validation is provided for by visual real time monitoring of the HEPA filtration controls and pressure gauge monitor and alarms.

This ECU/NAM temporary isolation system has been validated for clinical use and complies with the CDC specifications for conversion of standard single rooms to Airborne Infectious Isolation Rooms (AIR) and isolation of larger areas to provide cohort isolation in response to surge demand and pandemic preparedness.

This system is currently deployed in Saudi Arabia to support the requirements for isolation during the current MERS-CoV cluster outbreak, and isolation of patients in Mecca and Medina during the Haj pilgrimage.

1. CDC Guidelines for environmental infection control in healthcare facilities: MMWR 2003; 52 (No RR-10): 1-48
2. ICRA Educational Series – Construction & Maintenance; Risk Mitigation and Management: Environmental Containment Unit (ECU System) Minic Technologies USA, www.Minic.com