Hospital Facility Management in Preparation for Emerging Infectious Disease Events

a report by
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Andrew J Streifel is an Environmentalist with the Department of Environmental Health and Safety at the University of Minnesota Hospital. He has 30 years of direct experience in the hospital environment. His experience in the hospital include evaluation of indoor air quality for patients and staff and conducting environmental surveys for exposure to hazardous materials such as infectious agents, anaesthetic gases, disinfectants, laboratory chemicals and the multitude of hospital agents used in a complex university facility. This extensive experience in the hospital environment also involves water quality and food sanitation evaluations. Problem-solving concerns in the hospital environment have translated to assisting many hospitals and commercial establishments in resolving environmental issues that range from the above to pest control and waste management. Sampling methods and interpretation of that information are also a part of his investigation skills.

In preparation for infectious disease events the US Department of Health and Human Services has initiated the Bioterrorism Hospital Preparedness Program (BHPP) as part of the Health Resources and Services Administration (HRSA) roles and responsibilities. Preparation for hospitals means involving hospital facility managers in the preparation for such events. One benchmark goal for participating hospitals is to provide one airborne infection isolation room (AIIR) per hospital and the capability to handle 10 paediatric or adult cases for certain regional or metropolitan hospitals. These programmes must manage special ventilation requirements. This could mean extensive capital investment or improvised rapid response.

Governments are attempting to prepare by stockpiling personal protective equipment (PPE), developing better communication systems, have caches of pharmaceuticals and the capability to handle large surges of infected or infectious patients. Hospitals need to consider what measures are necessary to address the potential of airborne-spread infectious agents. The majority of hospitals may never see an infectious disease surge but they must still consider their response to an infectious disease with an airborne-spread modality.

The reality of these planning efforts may never be fulfilled, but, if unprepared, the system will be overwhelmed when some infectious disease develops. Global infectious disease concerns are focused on the pandemic threat of avian flu becoming transmitted human to human. This potential has a hint of reality in reports from Asia indicating in-family susceptibility and disease spread. As healthcare facilities prepare for emerging infectious disease (EID) the preparation will require the need for rapid isolation/quarantine capability for uncertain numbers of patients.

The BHPP is administered through the US government by region and state. Each state planning group should undertake similar preparation for logistical needs and must plan for unique urban versus rural issues. The diversity of urban and rural response becomes less distinct with the potential for out-migration of populations from the cities to rural communities who then must also be prepared. The distance from the city of concern might be a tank of petrol. What the rural hospitals can do to prepare must now become more standardised and in step with urban planning.

In the US, state health departments have been conducting surveys with specific scrutiny for hospital preparedness. Certain states have revealed that hospitals have inadequate ventilation provision for airborne infection isolation. The parameters in the US are different to those found in other countries and after a survey of over 800 AIIR it is understood that most rooms do not meet the American Institute of Architects (AIA) or the Center for Disease Control and Prevention (CDC) ventilation guidelines for pressure, air exchanges and filtration. From such revelations comes a need to train and provide guidance for the appropriate response, which involves tremendous capital outlay. Efforts to develop infection control training are important for healthcare workers and citizens in order to interrupt the transmission of microbes and prevent infections/influenza. The reality of previous pandemics and the yearly infectious seasons should provide an insight into how to prepare for tomorrow's infectious disease emergency.

Infectious diseases are spread via contact, ingestion and airborne modalities. It is thought that the majority of infectious diseases are spread via contact and ingestion modes. The uncertainty of airborne-spread disease creates a societal paranoia for such a pandemic spread. Historical experience has demonstrated that previous pandemic diseases have been managed with infection control means and methods. Today, society thinks we cannot deal with tomorrow's diseases except with pharmaceuticals. We must not forget our past experience and the knowledge that we have gained since the last pandemic. Infectious disease response measures have varied in the handling of pandemics. A relatively recent pandemic, the Great Influenza of 1918, is well described. During the pandemic a

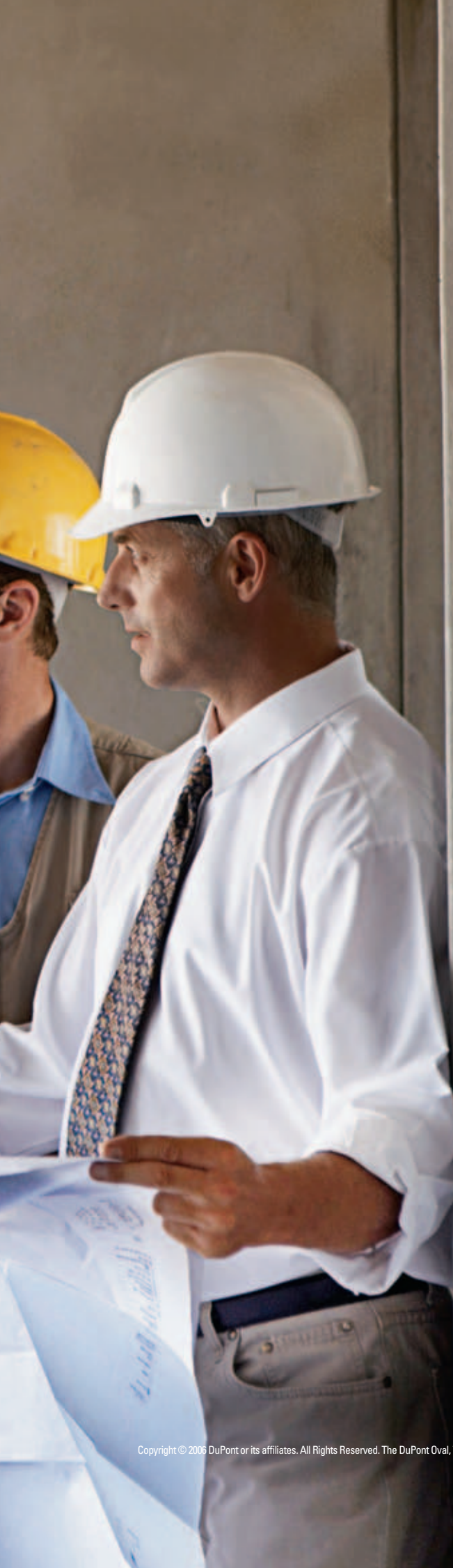

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Table 1: AIA – Guidelines for Design and Construction of Hospitals and Health Care Facilities – Criteria for AIIRs

- Differential pressure shall be a minimum of 0.01 inch water gauge (2.5 pascals).
- Provide ventilation to ensure >12 room air exchanges per hour.
- The controls for switching rooms for the purpose of changing from airborne infection isolation to protective environment ventilation are unacceptable.
- AIIRs shall have self-closing devices on all exit doors.
- AIIR perimeter wall, ceilings and floors including penetrations shall be sealed tightly so that air does not infiltrate the environment from outside or other spaces.
- Rooms shall have a permanently installed visual mechanism for constantly monitoring the pressure status of the room when occupied with an infectious patient.

non-pharmaceutical response was utilised. The implementation of infection control measures that include social distancing, school closing and public meeting revocation are planned if such a disease process develops.

Such efforts will help diminish but not reduce incoming infectious patients to hospitals. The initial exposures, from the first infected patients who present at a hospital, require symptom triage and examination and need to be moved directly to holding areas set up to protect workers while treating potentially infected patients. These areas can be created through personal protective measures and engineering controls. There is a need for validation of such infection control measures, through objective analysis and situation practice, in order to prepare for a potential outbreak.

For the evaluation and design of AIIR, Rybock has advocated isolation room standardisation for ventilation design in the AIIRs. In an effort to validate selected hospitals' AIIRs for ventilation parameters using criteria from design books (AIA, CDC, American Society of Heating, Refrigerating and Air-Conditioning Engineers – see *Table 1*) over 100 hospitals were visited. A need for quality improvement was found when evaluated according to the AIA criteria. Priorities for upgrading the ventilation in over 500 surveyed rooms were established in order to achieve respective control parameters (pressure differential, air exchanges and filtration). It was apparent that training for developing airborne infection isolation and surge patient care capability was not available for hospital facility managers for EID. While AIIRs are located in specific areas, surge areas must be improvised with certain planning. Such surge areas must be manipulated to provide patient care under circumstances requiring PPE along with ventilation management and less control for individual rooms. The areas can best be managed in suites of rooms within smoke or fire control zones.

Efforts are underway to provide training to ensure that preparation for isolation of patients individually, or in a larger capacity, is ready for presentation. US government funding was provided for such a programme at the University of Minnesota for the development of a training website–(www.meret.umn.edu). This training programme provides six modules for basic infection control for the Minnesota Emergency Readiness Education and Training (MERET) programme. The intent is to provide training to facilities management and hospital professionals if the need for ventilation control is required. Two modules are intended for management of ventilation: "Design and Maintenance of Airborne Isolation Rooms" and "Development of Temporary Negative Pressure Isolation" (TNPI). These public domain educational modules are intended for training facility management personnel and construction workers to enable them to utilise methods common to hospital construction standards for infectious disease isolation. These methods rely on validation efforts using tools that give objective information for interpretation.

Today society thinks we cannot deal with tomorrow's diseases except with pharmaceuticals.

This dual approach for construction and EID preparation raises interesting questions concerning a growing group of patients in a number of hospitals worldwide – immunocompromised patients. Such

Flowers Hospital, Dothan, AL photo: Michael Parker

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patients in certain categories are prone to opportunistic infections from common airborne spore-forming fungi. Opportunistic infectious diseases are often devastating to the patient's recovery and can cause death. Efforts have been recommended to prevent aspergillosis in occupied hospitals.

The association of construction as potential source of aspergillosis and other infections has required adopting best practice construction methods for containment and control. Ventilation methods are prescribed to utilise exhaust ventilation. Portable high-efficiency particulate air (HEPA) filters and barriers are effective in isolating construction projects in occupied hospitals. These methods are effective for protecting immunocompromised patients from common airborne fungi while construction happens in and around hospitals by isolating the construction project. These same construction methods can be used for isolating infectious patients in zones similar to construction zones but with no demolition or building process. Infectious patients can be in isolated infectious disease zones (IDZ) or AIIR rooms where there is a need and the capacity for isolation. The two concerns overlap and the concept should be merged to create IDZ for preventing the airborne spread of infectious disease regardless of whether the construction project or patient is infectious.

Integral to such management is the development of best practice for construction in healthcare. Hospitals can provide knowledge on the development of the construction zone but that should be prioritised as to the patient risk. Most hospitals cannot afford the hardware to permanently provide isolation capability for large numbers of patients, but these hospitals can provide improvised methods for preventing infectious aerosols from escaping.

The Minnesota Department of Health and the University of Minnesota have developed training programmes for basic infection control and providing proper design for isolation capability through the MERET programme. The intention is to provide guidance to develop the concepts of isolation of emerging airborne-spread infectious disease regardless of whether patients or construction are the source. The MERET module provides instruction and validation methods for TNPI using portable negative pressure HEPA filter machines.

These methods incorporate plastic and duct tape along with carpentry skills to establish a temporary barrier to protect workers from exposure when caring for patients in the IDZ. With modification, these methods can be used for training during construction projects. Such training allows for preparedness while providing practice in TNPI construction in the healthcare facility. Using objective data to demonstrate ventilation control is essential for ensuring a safe environment of care for workers and patients.

Construction raises the risk of infection for those susceptible to aspergillosis and other opportunistic fungi that are potentially growing in healthcare facilities. Hospitals need to contain the release, growth or accumulation of such fungal spore. Infectious disease ventilation practice should provide the same control and prevention of aspergillosis during construction as when infectious patients are housed in a safe area in the hospital. Individual infectious patients can be housed in an AIIR or as a group in an IDZ. These methods are described in basic documents provided by CDC for environmental infection control concerning respective direction of airflow.

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Summary

Developing construction infection control risk mitigation is promoted for patient safety. The large capital expense involved may be justified in large designated hospitals in metro areas, but most hospitals will not be able to upgrade. Training using common construction best practice can be useful for short-term disease management similar to construction management. It is important that the validation process is part of ensuring appropriate control. Training is essential for ensuring a safe environment of care during construction and infectious disease events in order to prevent the airborne spread of potential pathogens. ■