CHAPTER 4

The Environment's Impact on Safety

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U.S. HOSPITALS ARE dangerous and stressful for patients, families, and staff members. Medical errors and hospital-acquired infections are among the leading causes of death in the United States, each killing more Americans than AIDS, breast cancer, or automobile accidents (Institute of Medicine [IOM] 2001). According to IOM's landmark *Crossing the Quality Chasm* report, "The frustration levels of both patients and clinicians have probably never been higher. Yet the problems remain. Health care today harms too frequently and routinely fails to deliver its potential benefits." Problems with U.S. healthcare not only influence patients; they affect staff as well. Registered nurses have a turnover rate averaging 20 percent (Joint Commission on Accreditation of Healthcare Organizations [JCAHO] 2002).

As with Chapter 3, in this chapter we report on some of the results of a large literature review conducted for The Center for Health Design (The Center) in 2004. A large and growing body of rigorous, scientifically defensible research shows that design of the hospital environment affects the safety of patients and staff. Design has a particular role in reducing: (1) airborne and contact-spread hospital-acquired infections, (2) patient falls, and (3) staff errors.

HOSPITAL-ACQUIRED INFECTIONS

Hospital-acquired, or nosocomial, infections pose a serious threat to the health of patients, staff, and visitors in hospitals. According to one study, up to 2 million U.S. hospital patients contract dangerous infections every year during their hospital stays (Weinstein 1998). In 1995 nosocomial infections cost $4.5 billion and contributed to more than 88,000 deaths (Weinstein 1998).

A strong body of research evidence shows that the built environment influences the incidence of infection in hospitals. Person-to-person spread of infections in the healthcare setting can occur via direct contact, droplet, airborne, fecal-oral, and bloodborne routes. The research literature shows that the design of the physical environment influences hospital-acquired infection rates by affecting both airborne and contact transmission routes. The literature suggests a clear pattern in which infection rates are lower with good air quality and single- rather than multi-bed rooms. Also, there is some evidence that providing numerous, easily accessible alcohol-based hand-rub dispensers or sinks can increase hand-washing compliance and thereby reduce contact contamination.

Reducing Airborne Transmission of Infection

Well-conducted research has linked all of the following to air quality and infection rates (Humphreys et al. 1991; Iwen et al. 1994; Loo et al. 1996; Opal et al. 1986; Oren et al. 2001):

- Type of air filter
- Direction of airflow and air pressure
- Air changes per hour in room
- Humidity
- Ventilation system cleaning and maintenance
- Dust or particulate generation during hospital construction and renovation activities

There is convincing evidence that immunocompromised and other high-acuity patient groups have lower incidence of infection when housed in an isolation room with a high-efficiency particulate air (HEPA) filtration system (Passweg et al. 1998; Sherertz and Sullivan 1985; Sherertz et al. 1987). In one study bone marrow transplant recipients assigned to beds outside a HEPA-filtered environment had a tenfold greater incidence of nosocomial Aspergillus infection compared to other immunocompromised patient populations who were in HEPA-filtered spaces (Sherertz et al. 1987).

Air contamination is lowest in laminar airflow rooms with HEPA filters, and this approach is recommended for operating room suites and areas with ultraclean room requirements such as those housing immunocompromised patient populations (Alberti et al. 2001; Arlet et al. 1989; Dharan and Pittet 2002; Friberg, Ardnor, and Lundholm 2003; Hahn et al. 2002; Sherertz et al. 1987).[1] HEPA filters are suggested for healthcare facilities by The Centers for Disease Control and the Healthcare Infection Control Practices Advisory Committee but are either required or strongly recommended in all construction and renovation areas (Sehulster and Chinn 2003).

Effective prevention or control measures during construction and renovation activities include, for example, portable HEPA filters, barriers between the patient care and construction areas, negative air pressure in the construction or renovation area relative to patient care spaces, and sealed patient windows. There is strong evidence of the impact of using HEPA filters for air intakes near construction and renovation sites (Loo et al. 1996; Mahieu et al. 2000; Opal et al. 1986; Oren et al. 2001). Humphreys et al. (1991) demonstrated that HEPA filters are not by themselves an adequate control measure and must be employed in conjunction with other measures such as enhanced cleaning, sealing of windows, and barriers.

Reducing Contact Transmission of Infection

Although infection caused by airborne transmission poses a major safety problem, most infections are now acquired in the hospital via the contact pathway (Bauer et al. 1990; IOM 2004). Many

environmental surfaces and features become contaminated near infected patients. Examples of surfaces found to be contaminated frequently via contact with patients and staff include overbed tables, bed privacy curtains, computer keyboards, infusion pump buttons, door handles, bedside rails, blood pressure cuffs, chairs and other furniture, and countertops (Aygun et al. 2002; Boyce et al. 1997; Bures et al. 2000; Devine, Cooke, and Wright 2001; Neely and Maley 2001; Noskin et al. 2000; Palmer 1999; Roberts, Findlay, and Lang 2001; Rountree et al. 1967; Sanderson and Weissler 1992; Williams, Singh, and Romberg 2003). These and other contaminated surfaces act as pathogen reservoirs that increase cross-infection risk. Boyce et al. (1997) found that in the rooms of patients infected with methicillin-resistant Staphylococcus aureus (MRSA) 27 percent of all environmental surfaces sampled were contaminated with MRSA.