

Identifying Features of Healthcare Facility Design as a Means to Contain the Spread of Epidemic Infectious Diseases

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ABSTRACT

Hospital acquired infection or Nosocomial infection is a common mode of infection spreading in healthcare facilities. From an infection control perspective, the primary objective of hospital or healthcare design is to place the patient at no risk for infection while hospitalized. Apart from direct intervention with the human body, we can also take refuge to Engineering and Environment control to minimize, and sometimes control the endemic spread of Nosocomial diseases. We describe and propose a list of measures that we can pick up before designing healthcare facilities in order to prevent acquisition and spread of infections within the facility.

1. INTRODUCTION

When the underlying causes and mechanism of infectious disease problems are studied carefully, human behavior is often involved. It is not likely that we will ever conquer the microbial world; we must look instead to control the human factors that contribute to emergence (Halstead, 1996).

Worldwide, particularly in developing countries, urbanization has been rapid in the past two decades, and such rapid urbanization is expected to continue in the coming years. While urbanization has provided opportunities for employment, education and socio-economic development, it has also brought about a number of adverse health problems. These urban health problems are caused by different factors called health determinants. These are related, to a certain extent, to the adequacy of medical and health services, but perhaps more so to the physical, social and economic environments of the urban areas, as well as people's lifestyles and behaviours. Solutions to urban health problems require the effective involvement of non-health sectors (e.g. industry, transport, labour, education, commerce/trade, municipal utilities and services, urban planning, etc.) (WHO, 2000).

The purpose of this paper is to review recent literature on nosocomial infection. It will not discuss hospital-acquired infection control from the perspective of microbial or therapeutic mechanisms, but will try to point out the features of architectural planning and design that can contribute to the control of nosocomial infection.

2. WHAT IS NOSOCOMIAL INFECTION?

Nosocomial infections – known also as hospital-acquired infections, hospital-associated infections, and hospital infections - are potentially devastating infections that occur as unintended by-products of needed care. It can be defined as:

“An infection acquired in hospital by a patient who was admitted for a reason other than that infection. An infection occurring in a patient in a hospital or other healthcare facility in whom the infection was not present or incubating at the time of admission. This includes infections acquired in the hospital but appearing after discharge, and also occupational infections among staff of the facility” (WHO, 2002).

Broadly there are two forms of Nosocomial infections:

1. Endogenous infection, self-infection, or auto-infection. The causative agent of the infection is present in the patient at the time of admission to hospital without any symptom, but develops during the stay in the hospital.
2. Cross-contamination followed by cross-infection. During the stay in hospital the patient comes into contact with new infective agents, becomes contaminated, and subsequently develops an infection (WHO, 1999).

The most common sites of nosocomial infection in healthcare settings are urinary tract, gastrointestinal tract, respiratory tract, and, skin and soft-tissue (Nicolle, 2001). Two basic modes of vector can be deduced from the types of infections that occur. One is device specific, e.g., urinary tract and bloodstream infections, and the other through environmental dissemination, e.g., air-borne, water-borne and contact-borne infections like respiratory and skin-mucous infections.

3. WHY BE CONCERNED?

Despite progress in public health and hospital care, infections continue to develop in hospitalized patients; and may also affect hospital or healthcare workers (HCW's).

Healthy individuals have a normal general resistance to infection. Patients with underlying diseases, newborn babies, and the elderly have less resistance and will probably develop an infection after contamination. At the global level, number of people aged 60 years or over will rise from 606 million in 2000 to 1.9 billion in 2050. In more developed regions (viz., Australia/New Zealand, Europe, Northern America and Japan) the same population will account for 32 per cent of the population (UNPD, 2003). This data warrants that this is a worldwide concern, not only restricted to less privileged regions of the world, for professionals involved in healthcare

industry. Table 1 shows an example from one the most advanced healthcare infrastructure in the world at the moment.

Table 1. Nosocomial infections, United States, 1998

Year	Admissions (x10⁶)	Patient days^a (x10⁶)	Length of stay (days)	Nosocomial infection (x10⁶)	Nosocomial infections (/1000patient days)
1975	38	299	7.9	2.1	7.2
1995	36	190	5.3	1.9	9.8
^a Patient days = total inpatient days					

Nosocomial Infection affect 5-10% of all patients—2 million per year—who are admitted to acute care facilities in the US. Hospital-acquired infections are implicated in over 88,000 deaths in the US each year at a cost of over \$4.5 billion (Weinstein, 1998).

4. WHAT IS BEING DONE?

Authoritative preventive guidelines such as the one developed by the Center for Disease Control and Prevention (CDC) have been published, but the expense for implementing them can be prohibitive (Hong, 2001). Each country needs to develop its own protocol to prevent nosocomial transmission of diseases.

Healthcare settings and its delivery systems are varied worldwide. It is directly related to resources afforded by each country. WHO communicable diseases program relies on the massive support of CDC of the United States. CDC plays an important role, along with other sister concerns of WHO regional offices in combating infectious or communicable diseases. The qualities of healthcare delivery services do vary globally but the fundamental principle of disease spreading is the same. Nosocomial surveillance data is not always accessible in every part of the world. But CDC, National Nosocomial Infections Surveillance (NNIS), and, Study of the Efficacy of Nosocomial Infection Control (SENIC) are being too generous to share the data that they had been procuring over the last 30yrs in the United States. Such research data and methodologies are also used as guidance in rest of the world. For instance, over the past 25 years, CDC's National Nosocomial Infections Surveillance (NNIS) system has received monthly reports of nosocomial infections from a nonrandom sample of United States hospitals; more than 270 institutions report.

5. HOW CAN WE CONTROL NOSOCOMIAL INFECTION?

Infection control personnel play a critical role in preventing infections and medical errors. In an ideal situation, they conduct infection surveillance

in acute-care facilities, apply standard definitions and surveillance protocols, calculate infection rates, report these data to essential personnel, implement prevention interventions, and evaluate their impact (Jarvis, 2001).

Surveillance is defined as “the ongoing systematic collection, analysis, and interpretation of health data essential to the planning, implementation, and evaluation of public health practice, closely integrated with the timely dissemination of these data to those who need to know”(Gaynes, 2001). Surveillance data thus is the first and foremost key component in fighting infectious diseases. This data should be collected as post-occupancy evaluation (POE) data and derived into processed data for use by the design professionals.

To minimize the risk for infection in hospitalized patients, infection control professionals should participate in facility design from a building’s inception (AIA, 2001). This allows for identifying and implementing potential infection control issues early and provides an opportunity to design solutions prospectively. Infection control professionals also play an important role in educating architects, engineers, and construction workers about potential infection control risks and appropriate methods for reducing them.

As part of the planning process for constructing a new facility, an infection control risk assessment should be conducted to determine the potential risk for transmission of microorganisms within the hospital. In general, the risks can be classified as infections transmitted by air, water or environment (Noskin, 2001).

6. DESIGN FEATURES AS A RISK TO INFECTION

Infection control can be very cost-effective. Approximately one third of nosocomial infections are preventable (Noskin, 2001). To meet and exceed this level of prevention, we need to pursue several strategies simultaneously.

6.1 Interior Cautions

Interior finishes and fixtures should be chosen with advice from the infection control personnel. The best finishes are durable and easy to clean. Surfaces that are porous or textured may be difficult to clean and might therefore harbor potentially pathogenic microbes (Carter, 1997).

Carpeting should be avoided in high risk areas because the cleaning process may aerosolize fungal spores. Regardless of the flooring chosen, it should be easily cleanable and water resistant (AIA, 2001).

Wall coverings should be fluid resistant and easily cleaned, especially in areas where contact with blood or body fluids may occur (e.g., laboratories, operating rooms). Finishing around plumbing fixtures should be smooth and water resistant (AIA, 2001).

False ceilings and acoustical tiles should be avoided in high-risk areas, since they may support microbial growth when wet or harbor dusts and pests that may contaminate the environment if disturbed (Noskin, 2001).

Handwashing is the single most important method to prevent hospital infection. Every patient room, examination room, and procedure room needs at least one sink (AIA, 2001).

Placement of effective barriers to protect susceptible patients from airborne contaminants.

Consideration of the domestic water system to limit waterborne opportunistic pathogens. (AIA, 2001)

The features briefed above are interior details that should be taken care of. But from the planning point of view, a possible study can be undertaken to analyze the efficiency of a healthcare design.

6.2 Analyzing Planning and Design

The design of health-care facilities has undergone substantial changes, in the more developed world, in large part because patients with impaired host defenses now represent an increasing proportion of hospitalization (Noskin, 2001).

Study is yet to be executed whether the zoning and planning of a healthcare facility has anything to do with infection spreading or not, apart from simple techniques of demarcation or segregation, air-control through locating departments far apart. But, we believe that a representative study can be undertaken by taking several types, in terms of planning and zoning e.g., linear type, cluster type, tier type, etc., and find out which kind of design is less prone to nosocomial infections. And from the results we can go further deep to find out the factors that make one kind of planning or zoning different from the others. The results can, as we believe, open up new information that can strengthen the knowledge base of infection control personnel and health care designers.

7. CONCLUSION

With the resurgence of emerging infectious diseases and increasing aged population and/or more immunocompromised severely ill patients to be hospitalized in the future, exploring all facets of possibilities in overcoming possible endemic or epidemic out breaks of infectious diseases is direly imminent. Analyzing the already designed hospital plans in terms of nosocomial counts can provide us with new insights to improve the safety of the health care settings, not only in developed countries, but also in resource poor regions of the world. As UNPD (2002) suggests, with an average influx of 2 million migrants to the more developed regions from the poorer regions for the next 50 years, healthcare will soon become a global issue to be tackled.

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