A. Introduction

Guidelines for Environmental Infection Control in Health-Care Facilities (2003)

AT A GLANCE

Introduction from the Guidelines for Environmental Infection Control in Health-Care Facilities (2003).

ON THIS PAGE

Introduction

The health-care environment contains a diverse population of microorganisms, but only a few are significant pathogens for susceptible humans. Microorganisms are present in great numbers in moist, organic environments, but some also can persist under dry conditions. Although pathogenic microorganisms can be detected in air and water and on fomites, assessing their role in causing infection and disease is difficult.[11] Only a few reports clearly delineate a "cause and effect" with respect to the environment and in particular, housekeeping surfaces.

Eight criteria are used to evaluate the strength of evidence for an environmental source or means of transmission of infectious agents (Box 2).[11, 12]Applying these criteria to disease investigations allows scientists to assess the contribution of the environment to disease transmission. An example of this application is the identification of a pathogen (e.g., vancomycin-resistant enterococci [VRE]) on an environmental surface during an outbreak. The presence of the pathogen does not establish its causal role; its transmission from source to host could be through indirect means (e.g., via hand transferal).[11] The surface, therefore, would be considered one of a number of potential reservoirs for the pathogen, but not the "de facto" source of exposure. An understanding of how infection occurs after exposure, based on the principles of the "chain of infection," is also important in evaluating the contribution of the environment to health-care associated disease.[13] All of the components of the "chain" must be operational for infection to occur (Box 3).

The presence of the susceptible host is one of these components that underscores the importance of the health-care environment and opportunistic pathogens on fomites and in air and water. As a result of advances in medical technology and therapies (e.g., cytotoxic chemotherapy and transplantation medicine), more patients are becoming immunocompromised in the course of treatment and are therefore at increased risk for acquiring health-care associated opportunistic infections. Trends in health-care delivery (e.g., early discharge of patients from acute care facilities) also are changing the distribution of patient populations and increasing the number of immunocompromised persons in nonacute-care hospitals. According to the American Hospital Association (AHA), in 1998, the number of hospitals in the United States totaled 6,021; these hospitals had a total of 1,013,000 beds,[14]representing a 5.5% decrease in the number of acute-care facilities and a 10.2% decrease in the number of beds over the 5-year period 1994–1998.[14] In addition, the total average daily number of patients receiving care in U.S. acute-care hospitals in 1998 was 662,000 (65.4%) – 36.5% less than the 1978 average of 1,042,000.[14] As the number of acute-care hospitals declines, the length of stay in these facilities is concurrently decreasing, particularly for immunocompetent patients. Those patients remaining in acute-care facilities are likely to be those requiring extensive medical interventions who therefore at high risk for opportunistic infection. The growing population of severely immunocompromised patients is at odds with demands on the health-care industry to remain viable in the marketplace; to incorporate modern equipment, new diagnostic procedures, and new treatments; and to construct new facilities. Increasing numbers of health-care facilities are likely to be faced with construction in the near future as hospitals consolidate to reduce costs, defer care to ambulatory centers and satellite clinics, and try to create more "home-like" acute-care settings. In 1998, approximately 75% of health-care associated construction projects focused on renovation of existing outpatient facilities or the building of such facilities;[15] the number of projects associated with outpatient health care rose by 17% from 1998 through 1999.[16] An aging population is also creating increasing demand for assisted-living facilities and skilled nursing centers. Construction of assisted-living facilities in 1998 increased 49% from the

previous year, with 138 projects completed at a cost of $703 million.[16] Overall, from 1998 to 1999, health-care associated construction costs increased by 28.5%, from $11.56 billion to $14.86 billion.[16]

Environmental disturbances associated with construction activities near health-care facilities pose airborne and waterborne disease threats risks for the substantial number of patients who are at risk for health-care associated opportunistic infections. The increasing age of hospitals and other health-care facilities is also generating ongoing need for repair and remediation work (e.g., installing wiring for new information systems, removing old sinks, and repairing elevator shafts) that can introduce or increase contamination of the air and water in patient-care environments. Aging equipment, deferred maintenance, and natural disasters provide additional mechanisms for the entry of environmental pathogens into high-risk patient-care areas.

Architects, engineers, construction contractors, environmental health scientists, and industrial hygienists historically have directed the design and function of hospitals' physical plants. Increasingly, however, because of the growth in the number of susceptible patients and the increase in construction projects, the involvement of hospital epidemiologists and infection-control professionals is required. These experts help make plans for building, maintaining, and renovating health-care facilities to ensure that the adverse impact of the environment on the incidence of health-care associated infections is minimal. The following are examples of adverse outcomes that could have been prevented had such experts been involved in the planning process:

a. transmission of infections caused by *Mycobacterium tuberculosis*, varicella-zoster virus (VZV), and measles (i.e., rubeola) facilitated by inappropriate air-handling systems in health-care facilities;[6]

b. disease outbreaks caused by *Aspergillus* spp., [17-19] *Mucoraceae*, [20] and *Penicillium* spp. associated with the absence of environmental controls during periods of health-care facility-associated construction;[21]

c. infections and/or colonizations of patients and staff with vancomycin-resistant *Enterococcus faecium* [VRE] and *Clostridium difficile* acquired indirectly from contact with organisms present on environmental surfaces in health-care facilities;[22–25] and

d. outbreaks and pseudoepidemics of legionellae,[26, 27] *Pseudomonas aeruginosa*, 28-30 and the nontuberculous mycobacteria (NTM)[31, 32] linked to water and aqueous solutions used in health-care facilities.

The purpose of this guideline is to provide useful information for both health-care professionals and engineers in efforts to provide a safe environment in which quality health care may be provided to patients. The recommendations herein provide guidance to minimize the risk for and prevent transmission of pathogens in the indoor environment.

Box 2. Eight criteria for evaluating the strength of evidence for environmental sources of infection*+

1. The organism can survive after inoculation onto the fomite.
2. The organism can be cultured from in-use fomites.
3. The organism can proliferate in or on the fomite.
4. Some measure of acquisition of infection cannot be explained by other recognized modes of transmission.
5. Retrospective case-control studies show an association between exposure to the fomite and infection.
6. Prospective case-control studies may be possible when more than one similar type of fomite is in use.
7. Prospective studies allocating exposure to the fomite to a subset of patients show an association between exposure and infection.
8. Decontamination of the fomite results in the elimination of infection transmission.

***** These criteria are listed in order of strength of evidence.

+ Adapted from references 11 and 12.

Box 3. Chain of infection components*

1. Adequate number of pathogenic organisms (dose)
2. Pathogenic organisms of sufficient virulence
3. A susceptible host
4. An appropriate mode of transmission or transferal of the organism in sufficient number from source to host
5. The correct portal of entry into the host

* Adapted from reference 13.

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