

Prevention by Design

Construction and Renovation of Health Care Facilities for Patient Safety and Infection Prevention



Russell N. Olmsted, MPH, CIC

KEYWORDS

- Construction • Health care facilities • Risk assessment
- Waterborne and airborne pathogen • Health care design • Ventilation • Water quality
- Operating room design

KEY POINTS

- Outbreaks of disease are associated with construction and renovation when planning and risk mitigation are ignored or not effective.
- The infection control risk assessment (ICRA) and mitigation recommendations are essential components of infection prevention and patient safety programs.
- Infection preventionists/health care epidemiologists should be aware of and have access to the guidelines for design and construction of health care facilities developed by the Facility Guidelines Institute as well as other applicable requirements enforced by the authority having jurisdiction that applies to their local affiliates.
- Infection preventionists/health care epidemiologists can inform and proactively assist multidisciplinary teams involved in construction and renovation but this needs to be part of the project as early as possible in its inception to ensure the protection of patients, personnel, and visitors.
- Policies and procedures that address ICRA, safe work practices, training, monitoring, contingencies, and authority should be established and made operational.

In Jules Verne's¹ 1879 novel, "The Begum's Millions" ("Les Cinq Cents Millions de la Bégum" in French), one of the main characters, Dr Sarrasin, inherits a large fortune and sets out to create a utopian model city. He desires that this new city address unsanitary conditions evident in his native country, France. Of note, his designs include a preference that health care is delivered in the home. Recognizing that an acute care hospital would still be needed, he specified that this be limited to 20 to 30 beds per

Clinical Intelligence, Unified Clinical Organization, Trinity Health, Mailstop W3B, 20555 Victor Parkway, Livonia, MI 48152, USA

E-mail address: olmstedr@trinity-health.org

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ward but that each room be a single-patient room with attached bathroom. In addition, the structure was to be disposable (meaning made of pinewood) with no carpet or wallpaper and incinerated at the end of the year of use. This article shows that Verne was prescient in that many of these design elements, except for the disposable nature of the built environment, have been incorporated into contemporary guidelines.

INTRODUCTION

The built environment encompasses a broad range of physical design elements, including spaces for care of patients, support services, electronics, and major technical equipment; building systems that provide air and water; and surfaces and finishes. This spectrum of spaces and surfaces collectively is referred as the environment of care (EOC). In general, these are less frequently a source of microorganisms causing health care–associated infection (HAI) compared with other sources, such as the patient’s endogenous microflora, especially when an invasive device is present, or a surgical procedure.² Carriage of microbes on hands of health care personnel (HCP) also is a more likely mechanism of exposure to potential pathogens. Even so, the proportional contribution of the EOC as a reservoir of pathogens is estimated at 20%.³ Over the past several years there have been several studies showing that the EOC is a significant source of multidrug-resistant organisms (MDROs), *Clostridium difficile*, and norovirus.⁴ In addition, investigation of the role of the EOC has found that admission to a patient room previously occupied by a patient with an MDRO or *C difficile* is a risk factor for their acquisition by the next occupant.⁵

Specific pathogens can suggest an environmental source; for example, from demolition of drywall or gaps in maintenance of key mechanical systems, which include *Aspergillus* spp, *Fusarium* spp, *Rhizopus* spp, *Bacillus cereus*, *Legionella* spp, a wide range of gram-negative bacteria, and nontuberculous mycobacteria.² When HAIs are caused by opportunistic pathogens it is important to apply key principles such as chain of transmission and the following criteria to determine whether reservoirs are present in the environment and to help guide implementation of mitigation strategies, if applicable.

CRITERIA FOR EVALUATING THE STRENGTH OF EVIDENCE FOR ENVIRONMENTAL SOURCES OF INFECTION

1. The organism can survive after inoculation onto the fomite.²
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 1 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.

Annual spend on construction or renovation of health care facilities is approximately \$40 billion.⁶ Because cost of construction per square meter ranges from \$4300 to \$12,920, there has been some modulation in the build of larger inpatient rooms.⁷ A large proportion of current construction projects therefore involve a shift toward

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