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Concurrent Detection of Bacterial Pathogens in Hospital Roommates

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Abstract

Background: Some nurse-driven interventions have successfully reduced rates of healthcare-associated infections (HAI), though incidence remains unacceptably high. Bacterial contamination in patient rooms may be a source of exposure for patients and, thus, a target for future interventions; however, few studies have investigated the role of the patient room on organism acquisition.

Objectives: The purpose of this study was to determine the incidence of concurrent detection of bacterial pathogens among patients sharing a hospital room.

Methods: We performed a retrospective network analysis using electronic administrative and clinical data collected from all patients admitted in 2006 through 2012 to four New York City hospitals totaling 2,065 beds within 183 inpatient units. A computerized algorithm identified concurrent organism detection among roommates, defined as two patients who shared a room on at least one day and had a first positive culture for the same organism within three days following cohabitation.

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Results: In total, 741,271 patient admissions were included. The algorithm identified 373 concurrent detection events: 158 (42%) in which the patients' first positive cultures were drawn after they were no longer sharing a room but within three days of cohabitation; 144 (39%) in which the patients' first positive cultures were drawn while they were still sharing a room but on different days; and 71 (19%) in which the patients' first positive cultures were drawn while they were sharing a room on the same day.

Discussion: Methods to improve environmental decontamination should be included as part of a comprehensive approach to infection prevention in hospitals. Nurses have an important role to play in the planning and implementation of interventions to reduce bioburden in the patient environment.

Keywords

environmental contamination; healthcare-associated infection; hospital cleaning; infection prevention; patient safety

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Curtailing the spread of pathogens and preventing healthcare-associated infections (HAI) are ongoing patient safety challenges. HAI rates are frequently included among the metrics used to measure quality of nursing care (Montalvo, 2007). Nurse-driven interventions including protocols for prudent use and expeditious removal of urinary catheters and standardized care bundles for central lines have shown measurable success in reducing HAI (Furuya, Dick, Herzig, Pogorzelska-Maziarz, Larson, & Stone, 2016; Parry, Grant, & Sestovic, 2013). Still, HAI incidence in U.S. acute care hospitals remains unacceptably high, with estimates in excess of 700,000 per year (Magill et al., 2014).

One reason that may account for persistently high infection rates despite improvements in nursing care is that many infection prevention initiatives have focused on patient-level interventions—specifically for high-risk populations, such as those who have indwelling catheters and devices. While effective for breaking the chain of transmission for specific types of infections, these strategies fail to address the patient environment as a potential reservoir for organisms that cause HAIs. Given the demonstrated ability of bacterial pathogens to survive for prolonged periods on hospital surfaces and equipment even after cleaning has occurred (Boyce, Potter-Bynoe, Chenevert, & King, 1997; Dancer, 2009), patient rooms are likely sources of exposure to potentially harmful organisms. There has been limited research characterizing the frequency with which hospital roommates acquire the same organism, which is an important measure for understanding how contamination in patient rooms contributes to HAI incidence. Only a single study has examined the association between infection or colonization and the number of roommates patients encounter while hospitalized, finding that the number of roommates increases the incidence of colonization and infection with methicillin-resistant *Staphylococcus aureus* and vancomycin-resistant enterococci (Hamel, Zoutman, & O'Callaghan, 2010). Examining the role of patient rooms as sources of pathogen exposure is an essential step towards identifying and implementing nursing interventions to break the chain of transmission for all patients. Hence, the purpose of this study was to determine the incidence of concurrent detection of bacterial pathogens among patients sharing a hospital room.

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Methods

This study was conducted using a preexisting database containing information from four inpatient facilities in a New York City network from 2006 through 2012: A 221-bed community hospital, a 283-bed pediatric acute care hospital, a 647-bed adult tertiary/quaternary care hospital, and a 914-bed pediatric and adult tertiary/quaternary care hospital with a total of 183 inpatient units. To ensure that rooms and units were representative of inpatient medical/surgical acute care, units with < 5 rooms ($n = 101$) and units with rooms containing ≥ 10 beds ($n = 13$) were excluded. All patients were included if they were assigned to a room in one of the included units for at least one day. This study was reviewed and approved by the study facilities' institutional review boards, and a waiver of informed consent was granted.

The database was constructed using retrospectively collected data from electronic sources archived by the study institutions. A list of all positive cultures taken during the study period, including date and time of culture collection, was obtained from the institutions' clinical microbiology laboratories. Patient room assignments on each day of hospitalization were collected from the institutions' admission-discharge-transfer systems. Age at time of admission was extracted from hospital administrative records. These data sources were linked using patient unique medical record numbers and admission dates. Though some units implemented universal surveillance cultures for brief periods in response to outbreaks, most did not have widespread screening; thus, the majority of cultures were taken based on clinical suspicion of infection.

A daily data table was created with a single record for each day of admission for every patient, including a unique identifier for the patient admission, admission date, current date of stay, day of stay (i.e., the difference between admission date and current date plus one), location including unit, room and bed number, and whether a positive blood, wound, urine or respiratory culture with a newly acquired organism (first culture positive for that organism in any body site) was drawn on that day. Six organisms commonly associated with HAIs at the study institutions were included in the analysis: *Acinetobacter baumannii*, *Enterococcus faecalis*/*E. faecium*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Streptococcus pneumoniae*. A computerized algorithm identified concurrent organism detection, defined as two patients who shared a room on at least one day and had a first positive culture for the same organism within three days following cohabitation. For each patient admission, the program retrieved all colonization events from a table containing the dates of any first positive cultures with the six organisms. The program then retrieved all roommates that the patient shared a room with for three days prior and three days after the culture date. For each roommate, the program then queried the colonization table to see if that patient also had a first positive culture for the same organism during that time period.

Results

A total of 741,271 admissions representing 460,051 unique patients were included. Over the study period, 9,454 patients had at least one positive culture for *E. faecalis* or *E. faecium*, 8,908 had at least one for *S. aureus*, 7,910 had at least one for *K. pneumoniae*, 6,007 had at

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least one for *P. aeruginosa*, 1,491 had at least one for *A. baumannii*, and 766 had at least one for *S. pneumoniae*. The algorithm identified 379 concurrent detection events among roommate pairs. Six of these pairs were excluded from the analysis because one roommate had been previously hospitalized with the same organism.

The greatest proportion of concurrent detection events involved *S. aureus* (46%, *n* = 173), followed by *P. aeruginosa* (22%, *n* = 82), *Enterococcus* spp. (14%, *n* = 51), *K. pneumoniae* (13%, *n* = 48), *A. baumannii* (5%, *n* = 18), and *S. pneumoniae* (< 1%, *n* = 1). The rate of concurrent detection events per 10,000 colonized patients was 194 for *S. aureus*, 136 for *P. aeruginosa*, 120 for *A. baumannii*, 60 for *K. pneumoniae*, 53 for *E. faecalis* or *E. faecium*, and 13 for *S. pneumoniae*. The rate of concurrent detection events per 10,000 admissions was 1.6 at the community hospital, 3.1 at the adult tertiary/quaternary care hospital, 5.8 at the pediatric and adult tertiary/quaternary care hospital, and 6.9 at the pediatric acute care hospital. Roommate pairs with concurrent detection were similar to the overall patient population with respect to age; mean (standard deviation) age were 48 (30.8) and 44 (28.1), respectively. Total length of stay was greater for roommate pairs with concurrent detection than the overall patient population; mean (standard deviation) length of stay was 41 (43.3) days and 7 (10.2) days, respectively.

Of the 373 roommate pairs who had concurrent detection, 158 (42%) were pairs in which the patients' first positive cultures were drawn after they were no longer sharing a room but within three days of cohabitation. In 144 pairs (39%), the patients' first positive cultures were drawn while they were still sharing a room but on different days. In the remaining 71 pairs (19%), the patients' first positive cultures were drawn while they were sharing a room on the same day.

Discussion

Tracing infections to specific exposures can be challenging for nursing and infection prevention staff due to the large number of environments and personnel that patients encounter while hospitalized (Archibald & Jarvis, 2011). In this study, by focusing on concurrent detection among roommates, we identified a subset of infected or colonized patients whose exposure source was likely their assigned room. Notably, 42% of concurrent detection events were recognized after patients were no longer sharing a room, suggesting that patients with unrecognized infection or colonization may have been placed with new roommates without appropriate transmission-based precautions and without the knowledge of nurses on the unit (Siegel, Rhinehart, Jackson, & Chiarello, 2007). This finding underscores the importance of mindful adherence to standard precautions for all patients.

There are multiple scenarios by which patients sharing a room could test positive for a newly acquired organism during or shortly after cohabitation: (a) both roommates could have been exposed to preexisting contamination in the room; (b) a previously infected or colonized roommate could have contaminated the shared environment and exposed the other; (c) nurses or other members of the healthcare team caring for both roommates could have served as vectors; or (d) the roommates could have acquired the same organism from unrelated sources (Duckro, Blom, Lyle, Weinstein, & Hayden, 2005; Hardy, Oppenheim,

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Gossain, Gao, & Hawkey, 2006;). While it would be difficult in most cases to determine which scenario occurred, all of the possible circumstances underscore the importance of adequate disinfection procedures, both in occupied rooms and during terminal cleaning after patient discharge.

Although this retrospective study is limited by a lack of molecular typing, which prohibited us from determining whether roommates shared a genetically identical organism strain, the findings add a novel component to the growing body of evidence that patient rooms are an important source of exposure to pathogenic bacteria. In conjunction with other HAI reduction strategies (Research Committee of the Society of Healthcare Epidemiology of America, 2010), methods to improve environmental decontamination should be considered as part of a comprehensive approach to infection prevention in hospitals. For ambulatory patients and visitors, education and reinforcement of hygienic measures including hand hygiene and the avoidance of high-bioburden surfaces may also help to reduce infection rates.

As the licensed professional workforce responsible for ensuring patient safety on the unit, nurses may be a valuable resource for informing the development of improved environmental cleaning policies and procedures. Hospital administrators and those responsible for overseeing environmental service workers should leverage nurses' knowledge by inviting the feedback of frontline nursing staff who have a unique understanding the patient care workflow and can identify commonly missed opportunities for decontaminating surfaces and equipment. In many hospitals, the responsibility for cleaning point-of-care equipment often falls to busy nursing staff who must prioritize patient-care responsibilities, and who may not have received adequate training in effective cleaning techniques (Aiken, et al., 2001; Anderson, Young, Stewart, Robertson, & Dancer, 2011). As other authors have noted, this system should be reevaluated in order to utilize nurses' time more effectively (Mitchell, et al., 2017).

Conclusion

The results of this study support a growing consensus that furniture, equipment, and surfaces in hospital rooms sometimes serve as reservoirs for pathogens that cause HAI. Nurses may be able to help improve environmental decontamination within their institutions by identifying frequently missed surfaces or moments of care that require targeted attention from environmental services teams.

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