The Microbiome of an Occupied Patient Room

November 3, 2017
By Sue Barnes, RN, CIC, FAPIC

A foundational premise of infection prevention science is that contaminated environments increase the risk of transmission of healthcare associated infections, including those caused by multidrug-resistant organisms. And that appropriate environmental cleaning and disinfection is critical to maintaining a safe environment of care for both patients and providers.

Few studies have focused on the hospital room microbiome and whether knowledge regarding the same, might adjust our approach to patient hygiene, room cleaning and/or other aspects of care. A recent study proposes that understanding how microbes interact with patients, staff, and hospital surfaces within the microbiome of a hospital environment, can contribute to a more complete knowledge of healthcare associated infections and antibiotic resistance, and how to prevent both. The study was recently published in Science Translational Medicine.1

In this study by Lax and team, bacterial cultures were collected from surfaces including floors, bed rails, countertops, faucet handles, and computer mouse devices in occupied patient hospital rooms. The investigators also swabbed the hands and noses of patients and staff, along with the shoes, shirts and cellphone of staff members.

Over the course of a patient's stay, the study found that patient's skin and room surfaces became "microbially similar." Other studies have observed the same thing concluding that our surroundings contribute to the make-up of our microbial communities.2-4, 12

An interesting, and intuitively logical observation in this study was that non-ambulatory patients had less microbial diversity in nose, hand and patient zone (e.g., bedrail) samples, and less similarity to environmental surfaces, presumably since confinement to bed reduced their exposure.

Another finding was that the longer patients stayed in their rooms, the more antibiotic-resistance genes the organisms in the environment acquired, though no association with antibiotic administration and resistance was observed except for topical antibiotics. The author suggested a reason for this in that the environment is inherently stressful for the bacteria (due to regular cleaning), so any organisms left over would have a greater likelihood of being able to acquire genes that could be relevant. Two of the most resistant environmental colonizers were Escherichia coli and Pseudomonas aeruginosa.

The hospital room microbiome has possibly the greatest potential to impact the most vulnerable patients such as in a neonatal intensive care unit (NICU). The infants in a NICU are particularly susceptible to opportunistic infection. Infected infants have high mortality rates, with the source of many NICU infections uncertain. Environmental testing in one NICU study detected mainly skin and fecal bacteria, and generally argued for the broader utility of molecular testing for identification and tracking of bacteria diversity in NICUs.5

In the Lax study several bacterial samples taken more than 71 days apart were identical, leading the investigator to conclude that either ubiquitous skin associated microbial strains had seeded the environment by sequential room occupants, staff, or that there were persistent bacteria in the environment despite cleaning (quaternary ammonium compounds daily and bleach at discharge). The risk to patients from pathogens remaining in hospital rooms from previous patients, is a finding confirmed by multiple studies.5-6

Still other researchers make observations regarding the effect of outdoor environmental and building factors on the microbiome of built environments such as hospitals, and how outdoor air and microbes contribute to indoor microbial communities.7

Over the course of this study by Lax and team, roughly 10 percent of the 252 patients who participated were found to have healthcare-associated infections. **This is consistent with CDC statistics which reflect that HAIs affect 5 percent to 10 percent of hospitalized patients in the U.S. per year**.8 However, the study did not find the causative bacteria in the room samples for any of the healthcare-associated infections. The author suggests this might mean that patients were colonized with the bacteria that caused their infections. Though, since not all surfaces were tested including patient linen, gowns and privacy curtains, it is not possible to rule out other environmental sources.

The precise amount of biological contamination on healthcare surfaces resulting in transmission or development of infection is not the same in every case. However, we do know that environmental contamination that remains after a patient is discharged from a hospital room can pose a risk of infection to the next patient. This, of course, includes multidrug-resistant organisms.

And we know that manual cleaning and disinfection of solid surfaces in the healthcare environment is often incomplete, leaving pathogens including Clostridium difficile, enterobacteriaceae, and yeast.9 Similarly, soft surfaces including patient bed linen, gowns, privacy curtains and scrubs can remain contaminated despite processing via industrial laundry facilities, and/or become re-contaminated during handling, transport or storage.10-11

The study discussed here as well as others which focus on the microbiome of the patient and the healthcare environment may be important to support more complete knowledge of patient response to clinical treatments such as chemotherapy and antibiotic administration, details of bacterial resistance development and the best approaches to patient hygiene and environmental cleaning and disinfection.

The findings from this study underscore the importance of patient and environmental hygiene to reduce infection risk. It also validates what we know regarding the limitations of manual cleaning and disinfection, highlighting the ongoing presence of pathogens of concern in the hospital environment despite regular cleaning using standard protocols (e.g., daily cleaning with quaternary ammonium compound products and terminal cleaning with bleach). And it serves to underscore the importance of using and continuing to study novel technologies as adjuncts to manual cleaning such as UV light disinfection, HP vapor disinfection, antimicrobial soft and solid surfaces and silver ion based laundry treatment. It also leaves questions on the table for future studies. For example, it would be interesting to learn whether novel antimicrobial treated solid and soft surfaces would affect the microbial load on these surfaces, and more importantly, infection rates. If, for instance, antimicrobial threaded or antimicrobial treated bed linen was used, providing a physical barrier between the patient and the rest of the patient's inanimate environment, would there be the same degree of shared patient and environmental bacteria and resistance genes? And if so, would that in turn reduce healthcare-associated infection rates?

Sue Barnes, RN, CIC, FAPIC, is a national infection prevention thought leader and policy specialist.

References:
1. Lax S et al. Bacterial colonization and succession in a newly opened hospital. Science Translational Medicine. 24 May 2017.
2. Song SJ, Lauber C, Costello EK, et al. Cohabiting family members share microbiota with one another and with their dogs. eLife 2013;2:e00458.
3. Oberauner L, Zachow C, Lackner S, Högenauer C, Smolle KH, Berg G. The ignored diversity: complex bacterial communities in intensive care units revealed by 16s pyrosequencing. Sci Rep. 2013;3:1413.
4. Gaüzère C, Godon JJ, Blanquart H, Ferreira S, Moularat S, Robine E, et al. “Core species in three sources of indoor air belonging to the human micro-environment to the exclusion of outdoor air”. Sci Total Environ. 2014;485–486(0):508–17.
5. Brooks B, Firek BA, Miller CS, Sharon I, Thomas BC, Baker R, et al. Microbes in the neonatal intensive care unit resemble those found in the gut of premature infants. Microbiome. 2014;2(1):1.
6. Chemaly RF, Simmons S, Dale C, et al. The role of the healthcare environment in the spread of multidrug-resistant organisms: update on current best practices for containment. Therapeutic Advances in Infectious Disease. 2014;2(3-4):79-90.
7. Adams R, et al. Microbiota of the indoor environment – a meta analysis. Microbiome. 2015 3:49.
8. CDC. https://www.cdc.gov/washington/~cdcatWork/pdf/infections.pdf.
9. Bokulich NA, Mills DA, Underwood MA. “Surface microbes in the neonatal intensive care unit: changes with routine cleaning and over time”. J Clin Microbiol. 2013;51(8):2617–4.
10. Cheng VC, Chen JH, Wong SC, Leung SS, So SY, Lung DC, Lee WM, Trendell-Smith NJ, Chan WM, Ng D, To L, Lie AK, Yuen KY. Hospital Outbreak of Pulmonary and Cutaneous Zygomycosis due to Contaminated Linen Items From Substandard Laundry. Clin Infect Dis. 2016 Mar 15;62(6):714-21.
11. Duffy J, Harris J, Gade L, Sehulster L, Newhouse E, O'Connell H, Noble-Wang J, Rao C, Balajee SA, Chiller T. Mucormycosis outbreak associated with hospital linens. Pediatr Infect Dis J. 2014 May;33(5):472-6.
12. Karow J. Biotia Aims to Cut Hospital-Acquired Infections by Monitoring Microbiome of Hospital Environment. May 24, 2017. GenomeWeb online: https://www.genomeweb.com/infectious-disease/biotia-aims-cut-hospital-acquired-infections-monitoring-microbiome-hospital

Ref #1 above Lax study: