Environmental Sources of Transmission: Beyond high-touch surfaces (Floors, portable equipment, sinks)

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Objectives

- To appreciate the potential for floors, portable equipment, and clothing to contribute to transmission
- To be aware of recent developments in transmission of pathogens from healthcare facility water systems

Basic infection control practices

Chlorhexidine bathing

Hand hygiene, gloves, gowns



Infected Patient

Susceptible Patient

Environment

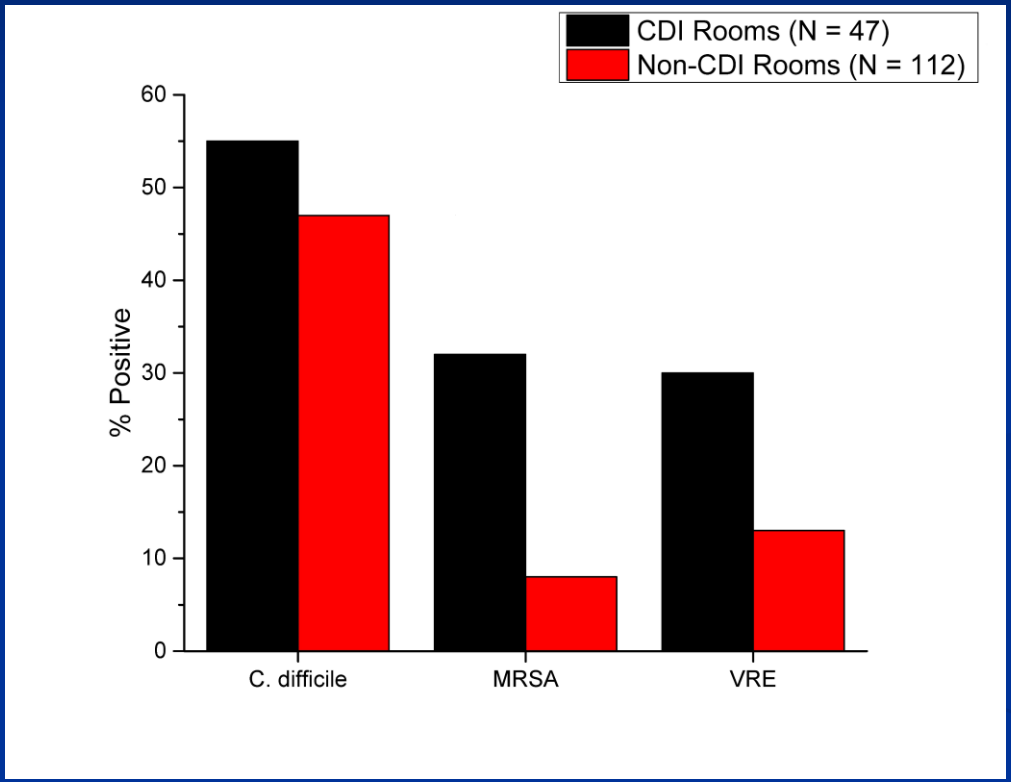
Decolonization

Environmental Cleaning

Question 1. Would you eat a mint from the floor of a cleaned C. diff room in your facility?

- A. Yes, I am confident that our cleaning and disinfection procedures eliminate *C. difficile* spores from floors
- B. Yes, if 3-second rule compliant
- C. Absolutely not

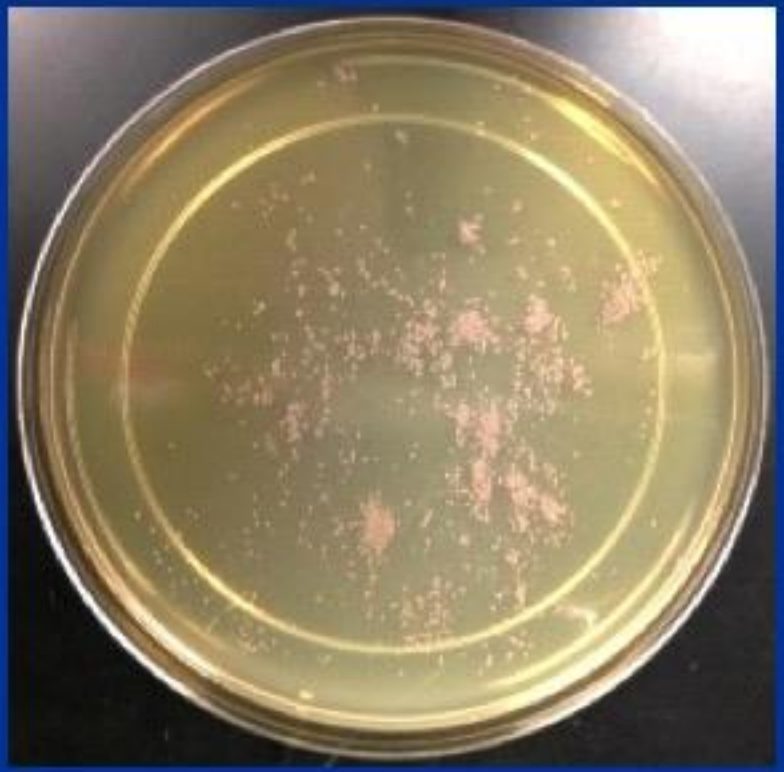
Are floors an under-appreciated source of transmission?



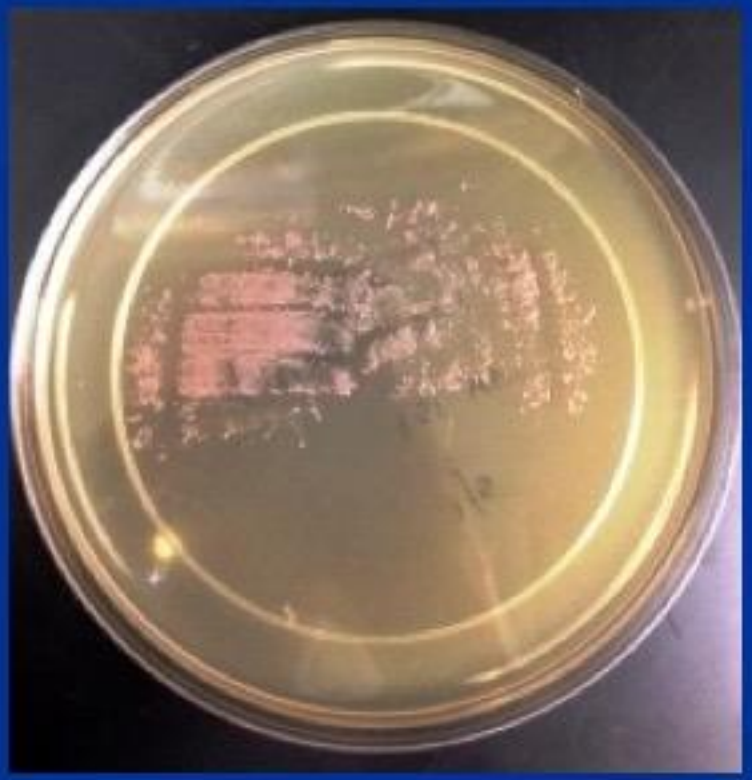
Deshpande A. Are hospital floors an underappreciated reservoir for transmission of health care-associated pathogens? Am J Infect Control 2017;45:336-8; Fekety R. Am J Med 1981;70:906-8 (floors frequently contaminated with *C. difficile* spores); Mutters R. J Hosp Infect 2009;71:43-8 (floors more heavily contaminated with *C. difficile* spores than hands of CDI patients or other environmental surfaces); Ali S. J Clin Microbiol 2015;53:2570-4 (floors in room and bathroom more heavily contaminated with *C. difficile* spores than other environmental sites); Lemmen SW. J Hosp Infect 2004;56:191-7 (floors frequently contaminated with multi-resistant gram-positive and gram-negative pathogens)

From floor to socks and shoes

MRSA sock print



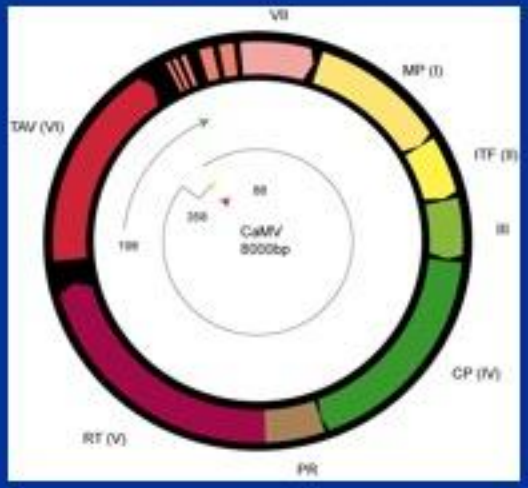
MRSA shoe print



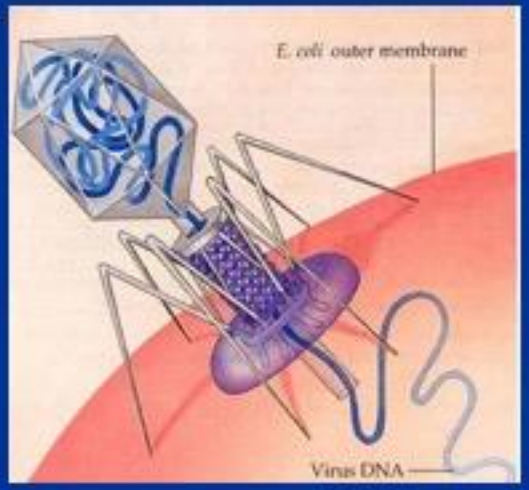
Galvin J, et al. Patient shoe covers: transferring bacteria from the floor onto surgical bedsheets. Am J Infect Control 2016;44:1430-2; Mahida N, Boswell T. Non-slip socks: a potential reservoir for transmitting multidrug resistant organisms in hospitals? J Hosp Infect 2016;94:273-5 (VRE recovered from 85% of socks and MRSA from 9%)

Use of benign surrogate markers to study pathogen transmission

Viral DNA
(Cauliflower Mosaic Virus)



Live virus
(Bacteriophage MS2)





Alhmidi H, et al. Evaluation of Viral Surrogate Markers for Study of Pathogen Dissemination During Simulations of Patient Care. Open Forum Infect Dis 2017;4:ofx128; Sassi HP, et al. Control of the spread of viruses in a LTCF using hygiene protocols. AJIC 2015;43:702-6; Alhmidi H, et al. Dissemination of a Nonpathogenic Viral DNA Surrogate Marker from High-Touch Surfaces in Rooms of LTCF Residents. AJIC pii: S0196-6553(17)30299-7.

From floor to patient



Koganti S, et al. Evaluation of hospital floors as a potential source of pathogen dissemination using a nonpathogenic virus as a surrogate marker. ICHE 2016;37:1374-7 (bacteriophage MS2 disseminated from the floor to the hands of patients and to high-touch surfaces including the nursing station and shared portable equipment)

High-touch surfaces are often in contact with the floor





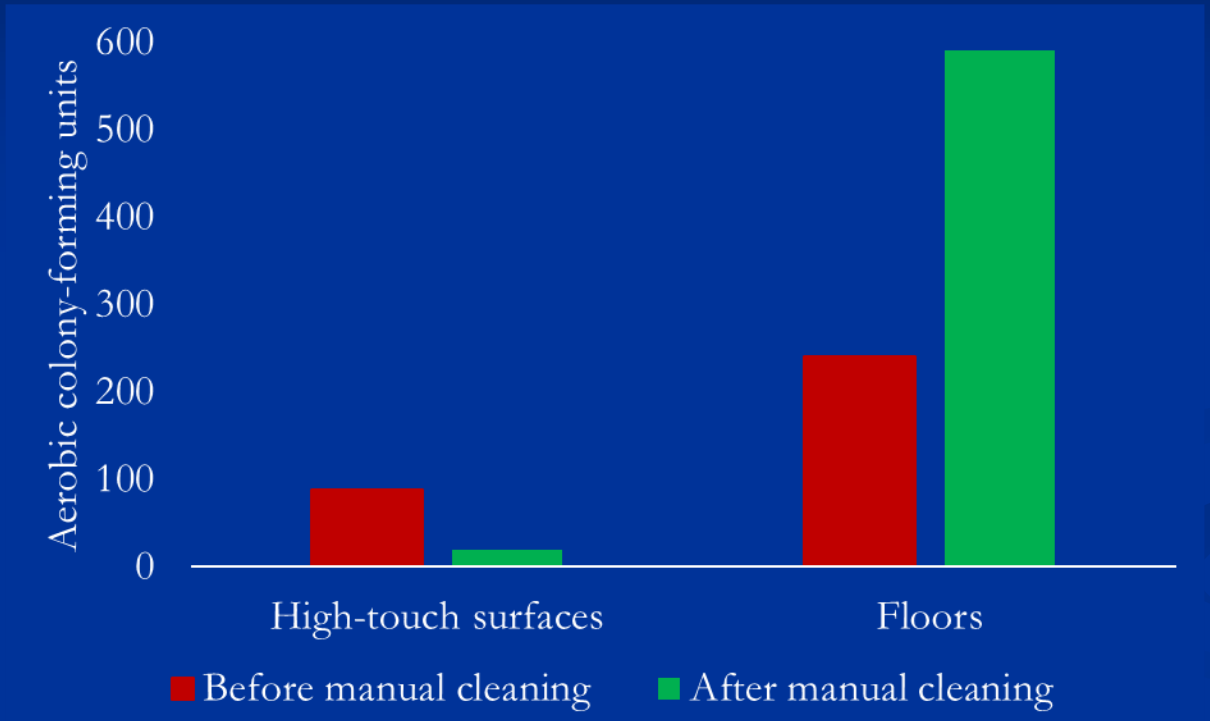






Deshpande A, et al. Are hospital floors an underappreciated reservoir for transmission of health care-associated pathogens? Am J Infect Control 2017;45:336-8 (41% of rooms surveyed had 1 or more high-touch objects in contact with the floor; contact with objects on the floor resulted in hand contamination)

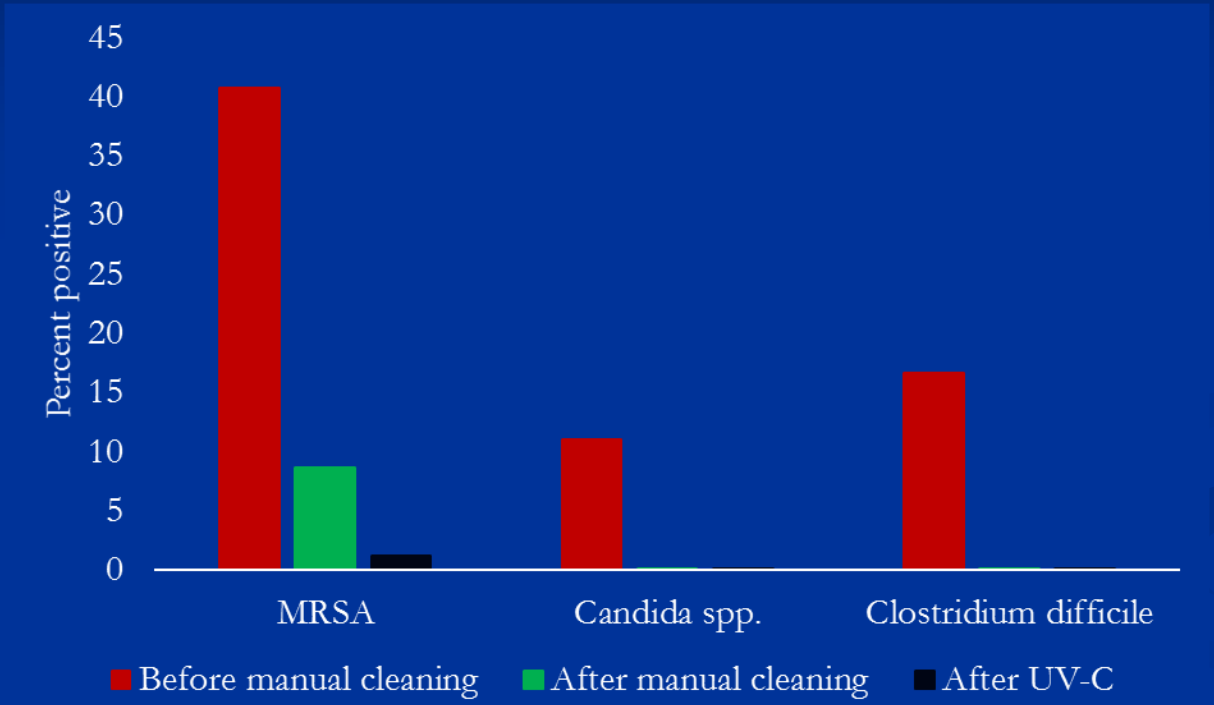
Current floor cleaning methods may be ineffective



Floor cleaning: a neutral detergent was used and the solution and mop head was changed after every 3rd room

Wong T, et al. Am J Infect Control 2016; 44:416-20

Cleaning and disinfection of floors can be more effective



Floor cleaning: a cleaner/disinfectant was used with multiple disposable mop heads used per room

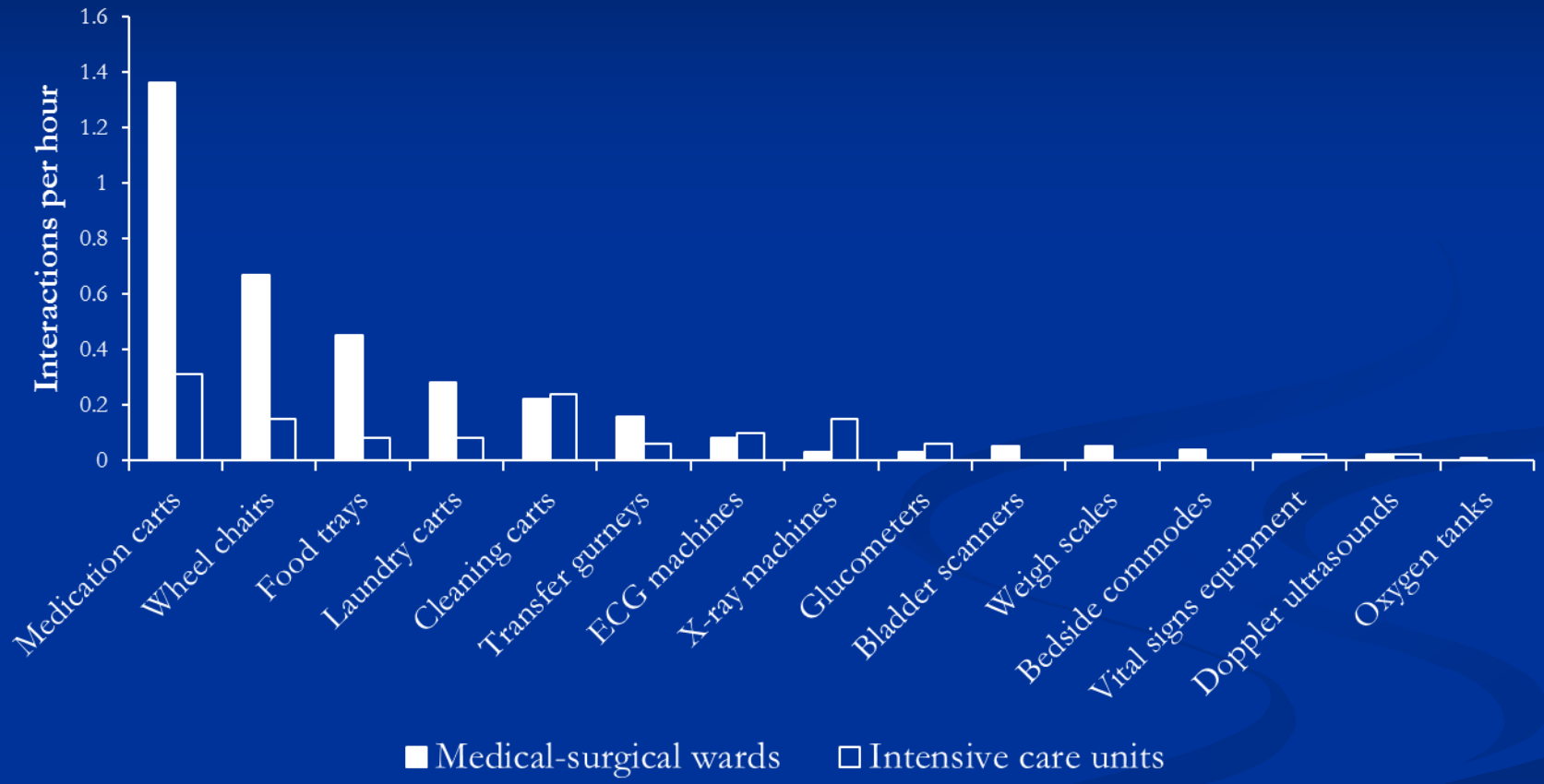
Mustapha A, et al. Am J Infect Control Am J Infect Control 2018;46:584-586

Question 2. What goes from room to room contacting patients directly or indirectly, but is rarely cleaned?

- A. Hands
- B. Physicians' white coats
- C. Stethoscopes
- D. Portable equipment

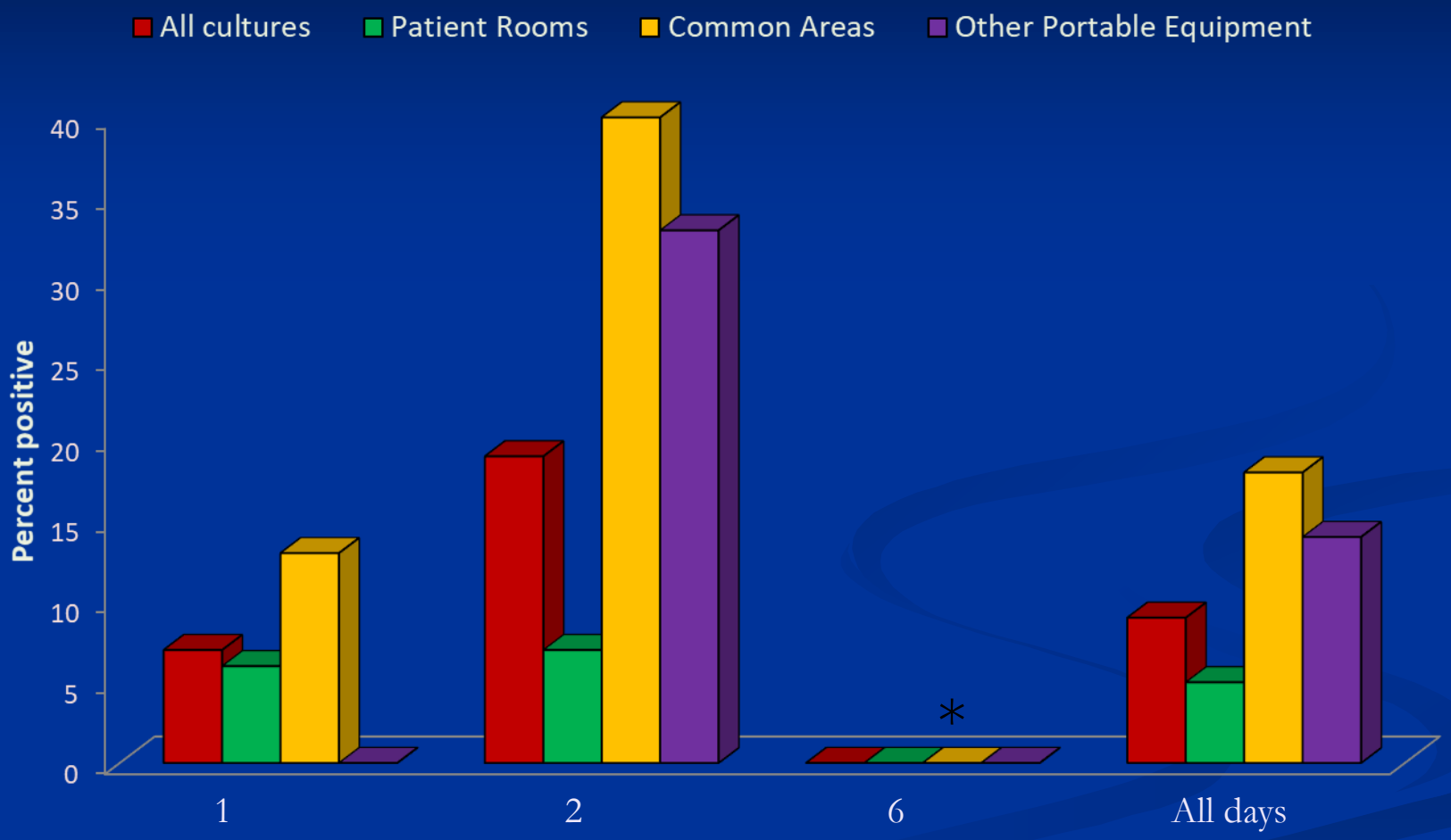
1. Suwantarat N. Quantitative assessment of interactions between hospitalized patients and portable medical equipment and other fomites. AJIC 2017; 2. Havill N. Cleanliness of portable equipment disinfected by nursing staff. Am J Infect Control 2011; 3. Kanamori H. The role of patient care items as a fomite in healthcare-associated outbreaks and infection prevention. Clin Infect Dis 2017; 4. Vajravelu RK. Evaluation of stethoscopes as vectors of *C. difficile* and methicillin-resistant S. aureus. ICHE 2012;33:96-8

Interactions between hospitalized patients and portable equipment



Suwantarat N. Quantitative assessment of interactions between hospitalized patients and portable medical equipment and other fomites. Am J Infect Control 2017;45:1276-1278; Havill NL. Cleanliness of portable medical equipment disinfected by nursing staff. Am J Infect Control 2011;39:602-604; Kanamori H. The role of patient care items as a fomite in healthcare-associated outbreaks and infection prevention. Clin Infect Dis 2017

MICU: ECG machines

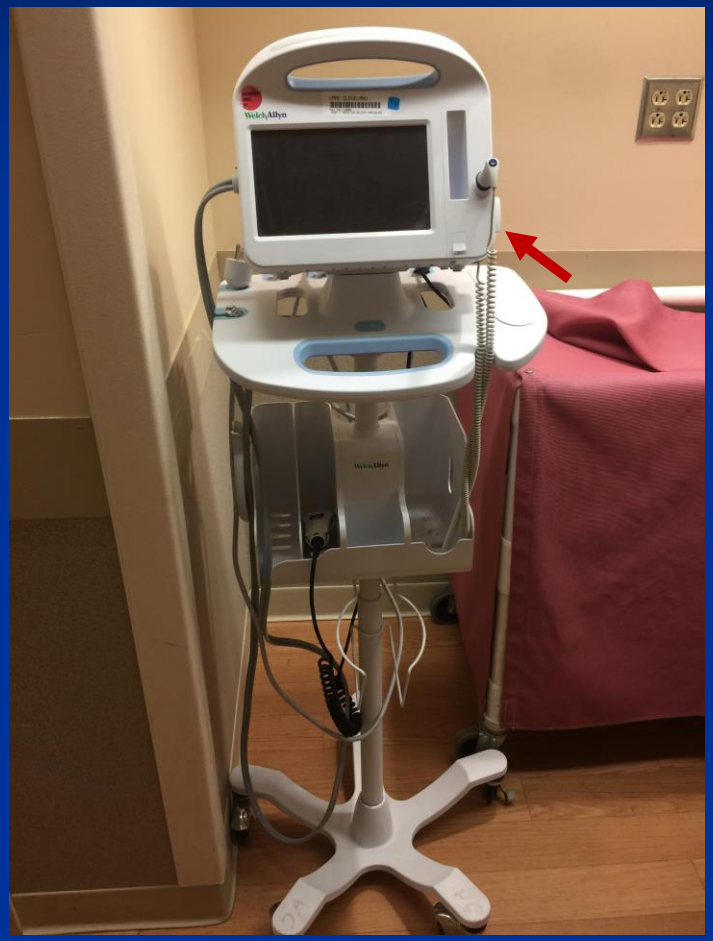


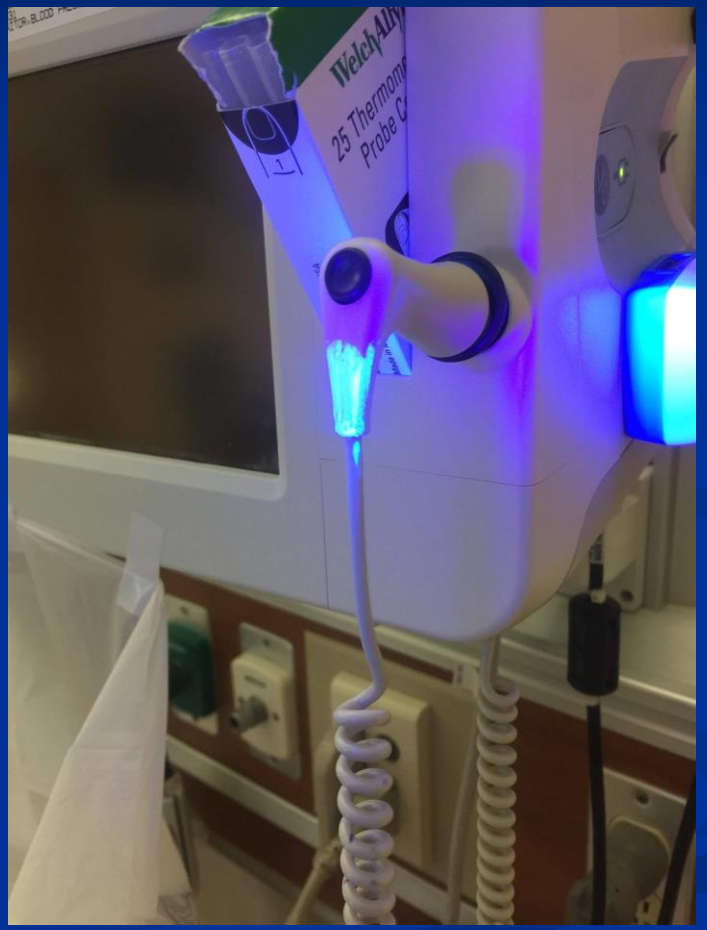
John AR, et al. Infect Control Hosp Epidemiol 2018;38:1247-1249

Bleach on TV screen



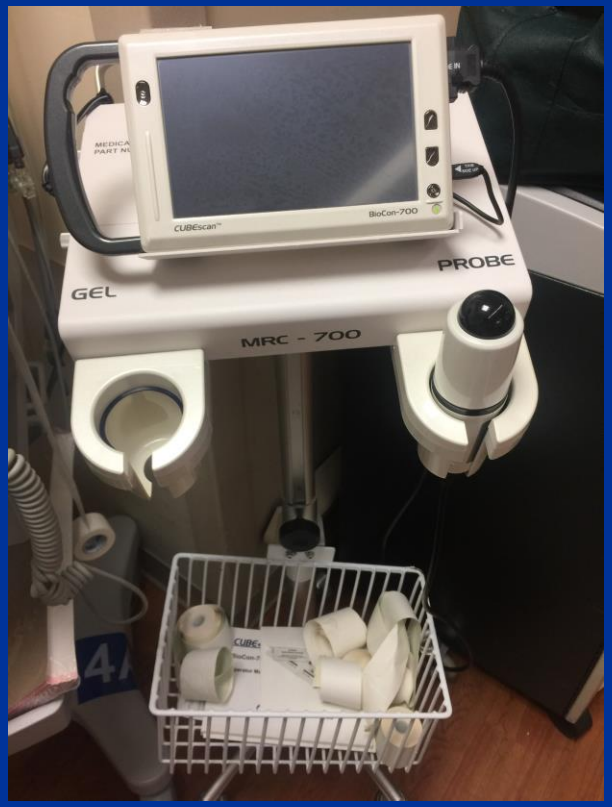
Thermometers





John AR. Evaluation of the potential for electronic thermometers to contribute to spread of healthcare-associated pathogens. Am J Infect Control 2018 Jan 22. pii: S0196-6553(17)31306-8

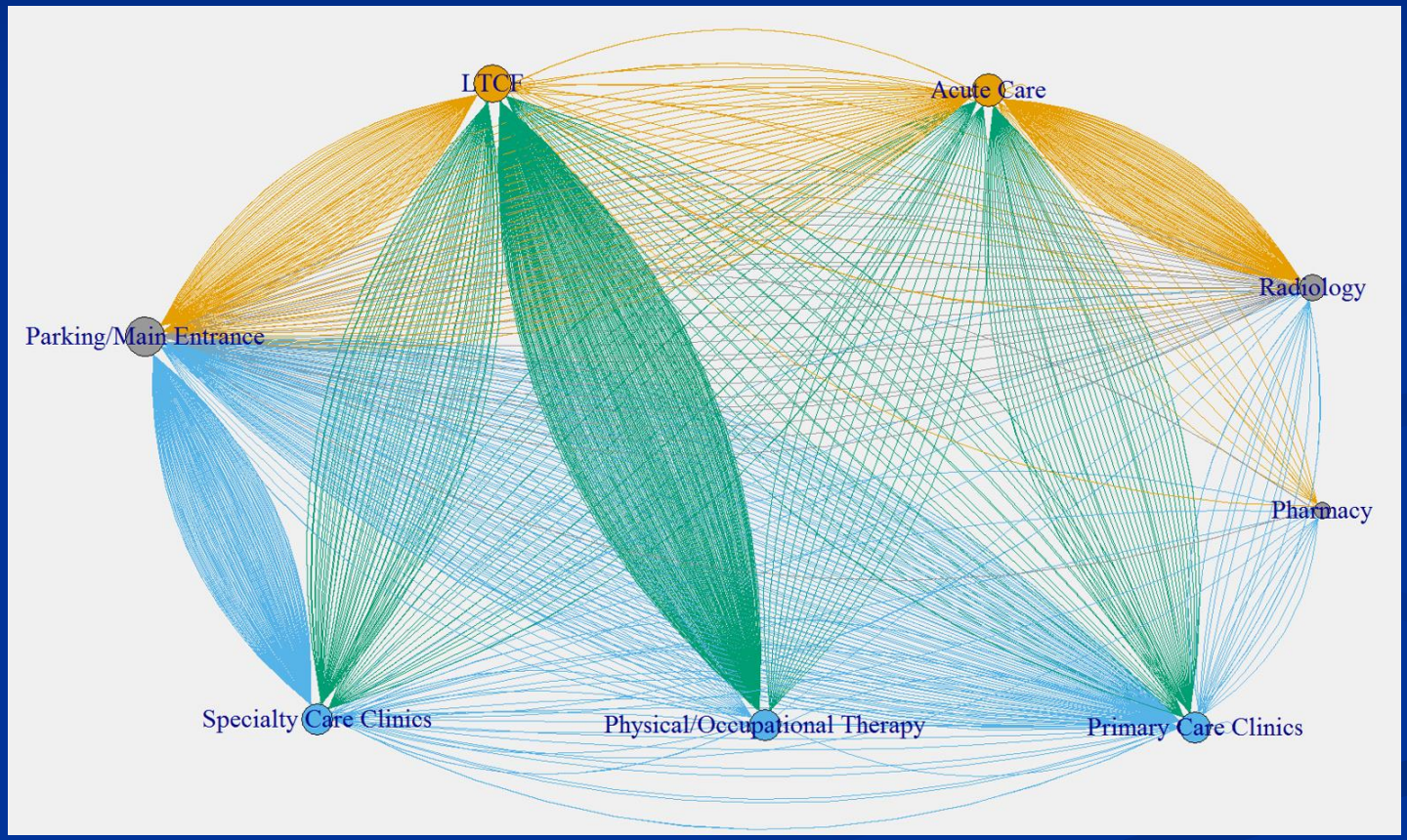
Portable equipment as a vector for ward to ward transmission





Alhmidi H. SHEA 2018

Spores on wheels: Movement of wheelchairs within a hospital and LTCF



Jencson AL. SHEA 2018

Question 3. You have an outbreak of multidrug-resistant *Pseudomonas* in your ICU. Which would you consider as a potential source?

- A. Dirty laundry
- B. Contaminated stool softener
- C. Physician's ties
- D. Contaminated sinks

Question 3. You have an outbreak of multidrug-resistant Pseudomonas in your ICU. Which would you consider as a potential source?

- A. Dirty laundry (Zygomycosis)
- B. Contaminated stool softener (*B. cepacia*)
- C. Physicians' ties
- D. Contaminated sinks

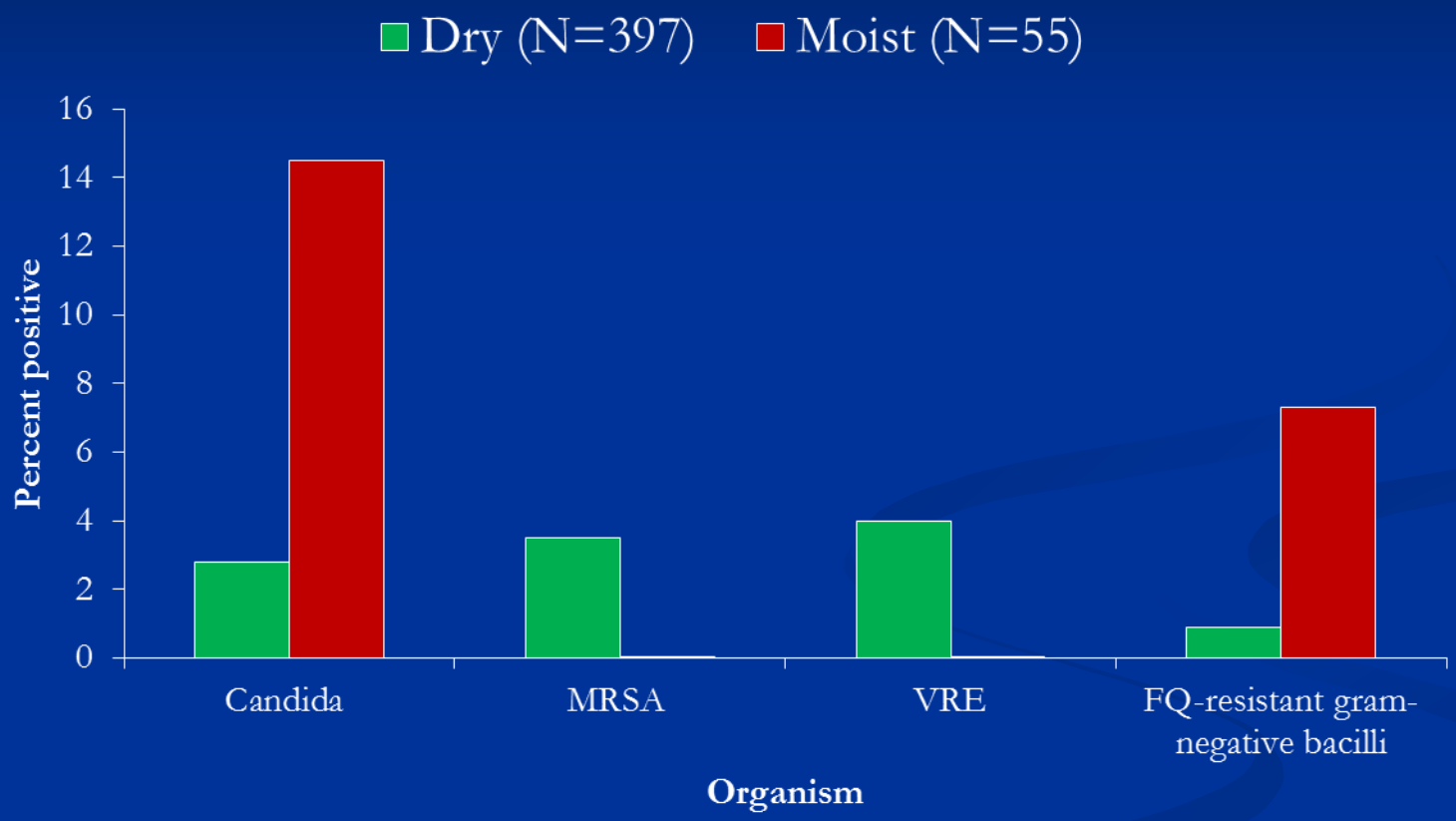
Marquez L, et al An outbreak of *Burkholderia cepacia* complex infections associated with contaminated liquid docusate. ICHE 2017;1-7; Cheng VCC, et al. Hospital outbreak of pulmonary and cutaneous zygomycosis due to contaminated linen items from substandard laundry. Clin Infect Dis 2016;62:714-20 (Hong Kong); Duffy J, et al. Mucormycosis outbreak associated with hospital linens. Pediatr Infect Dis J 2014;33:472-6 (Louisiana); ID Week 2016. Zygomycosis associated with contaminated laundry (*Rhizopus* spp. and Lichtheimia (Absidia) corymbifera)

Organisms linked to sinks

- *Pseudomonas aeruginosa*
- *Klebsiella pneumoniae* and *K. oxytoca*
- *Enterobacter cloacae*
- *Elizabethkingia meninogoseptica*
- *Acinetobacter baumanii*
- *Stenotrophomonas maltophilia*

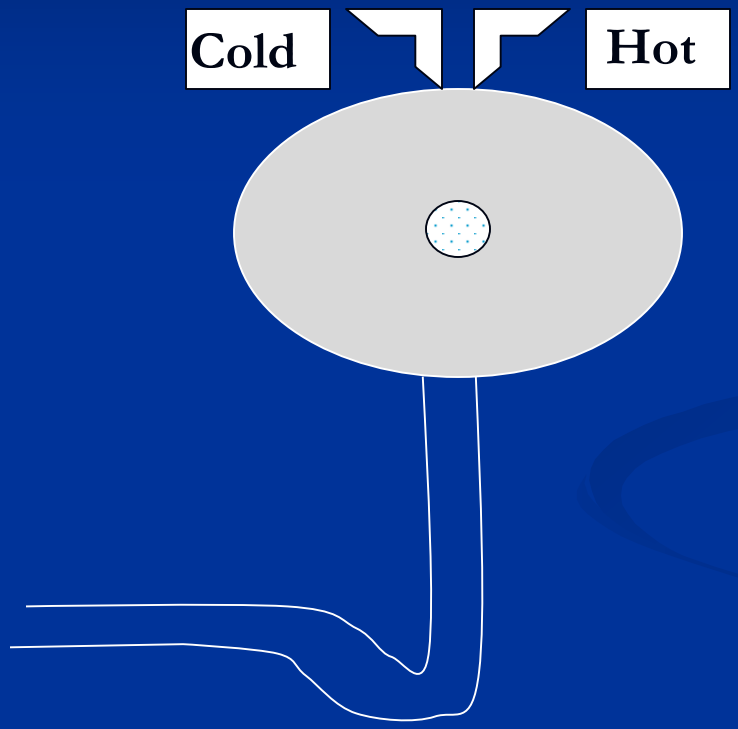
Kanamori H, et al. Clin Infect Dis 2016;62:1423-35 (review on waterborne transmission in healthcare facilities); Hota S, et al. ICHE 2009;30:25-33; Ambrogi V, et al. J Hosp Infect 2016;92:27-9; Wolf I, et al. J Hosp Infect 2014;87:126-30; Roux D, et al. J Hosp Infect 2013;85:106-11; Zhou Z, et al. J Infect Chemother 2016; Aspelund AS, et al. J Hosp Infect 2016;94:13-20; Leitner E, et al. Antimicrob Agents Chemother 2015;59:714-16; Chapuis A, et al. Frontiers Microbiol 2016;7:1-9; Amoureux L, et al. Emerg Infect Dis 2017;23:304-7; Clarivet B, et al. Euro Surveill 2016;21; Knoester M, et al. Clin Microbiol Infect 2014;20:0207-0215; Vergara-Lopez S, et al. Clin Microbiol Infect 2013;19:E490-8; Fusch C, et al. Acta Paediatrica 2015;104:e344-e349; Lowe C, et al. Emerg Infect Dis 2012;18:1242-7;

Recovery of potential pathogens from hospital surfaces

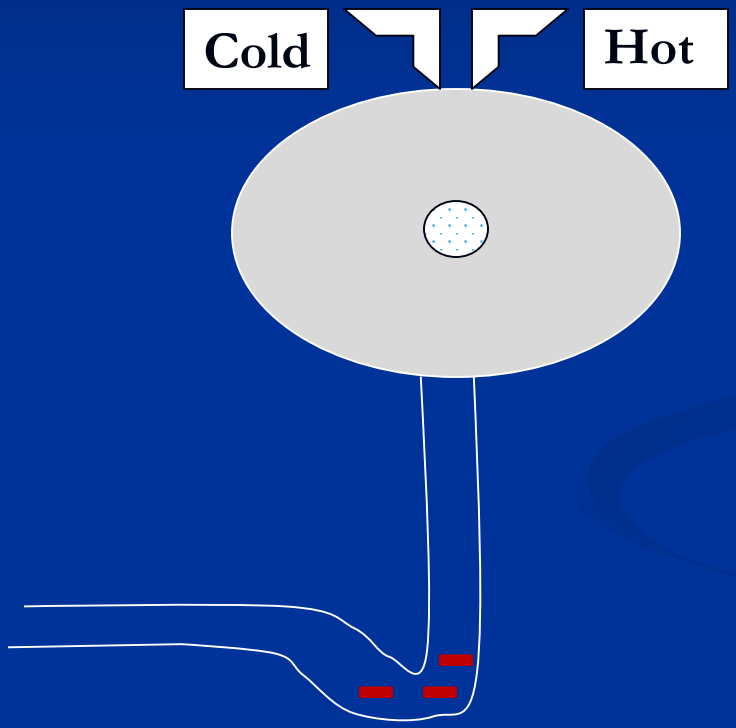


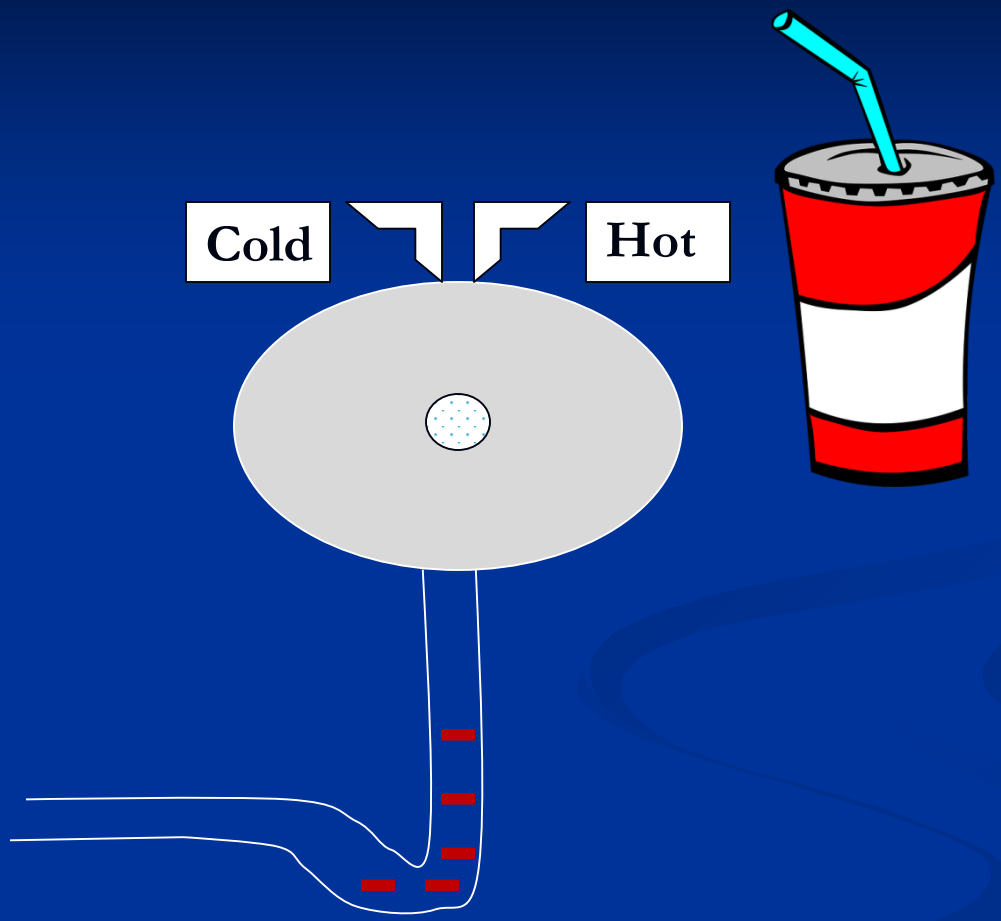
Piedrahita C, et al. Environmental Surfaces in Healthcare Facilities are a Potential Source for Transmission of *Candida auris* and other *Candida* species. ICHE 2017;38:1107-9; Jencson AL, et al. Hospital sinks are a potential nosocomial source of *Candida* infections. Clin Infect Dis 2017.

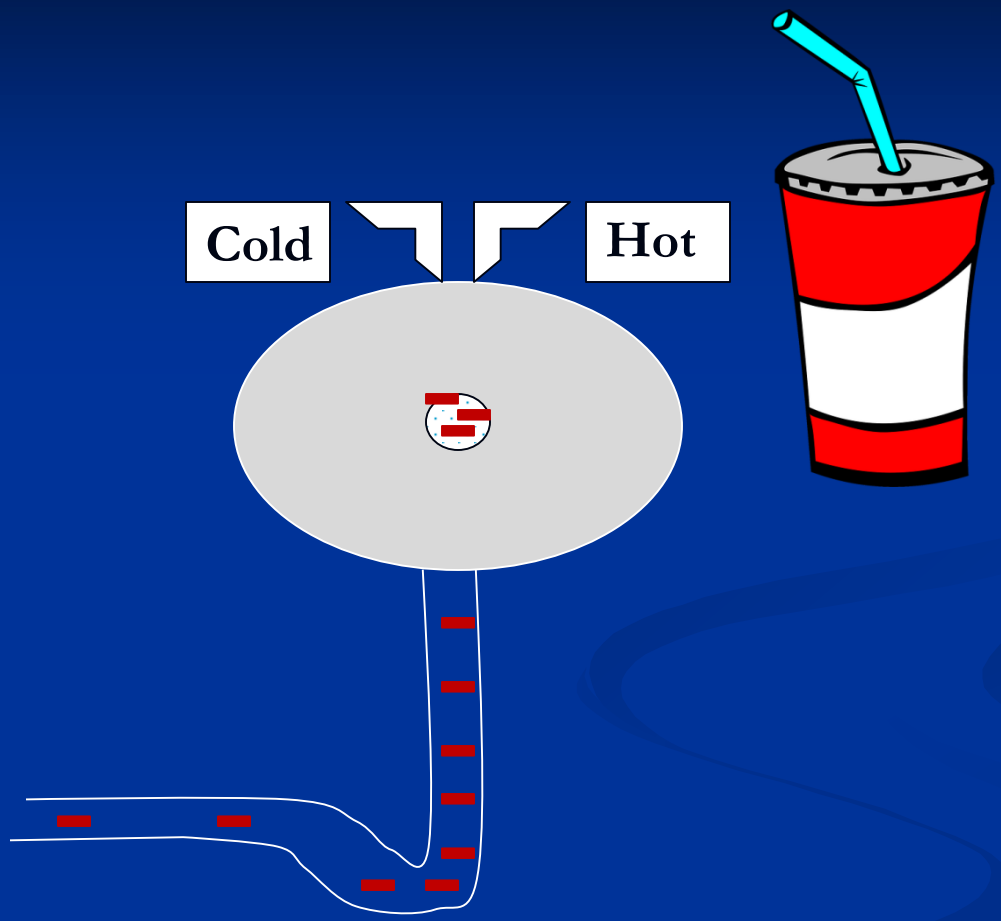
From sink to patient

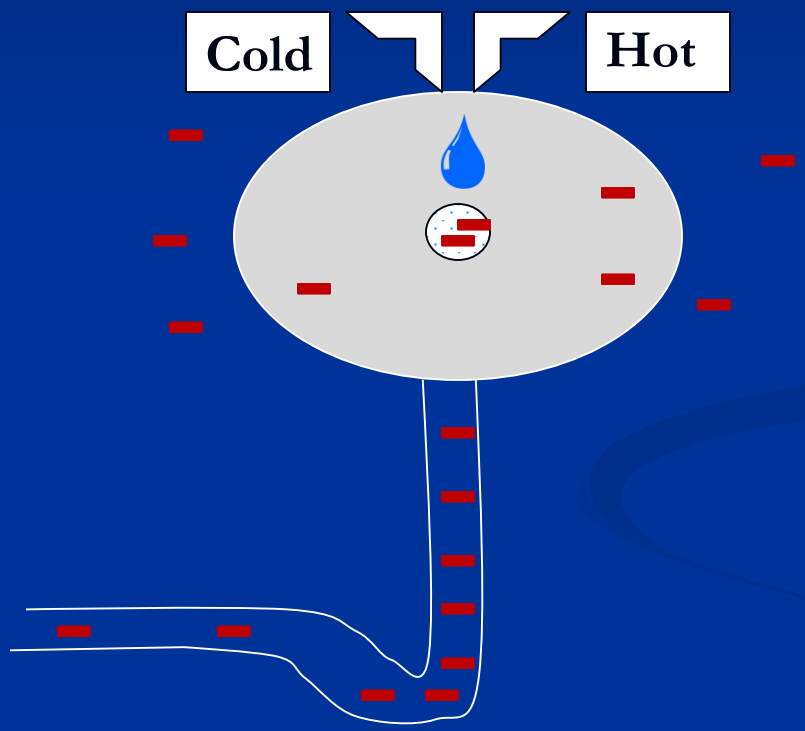


Kotay S, et al. Spread from the sink to the patient: in situ study using GFP expressing *E. coli* to model bacterial dispersion from sink trap reservoirs. Appl Env Microbiol Feb. 2017


Cold
Hot


Cold
Hot


Cold
Hot

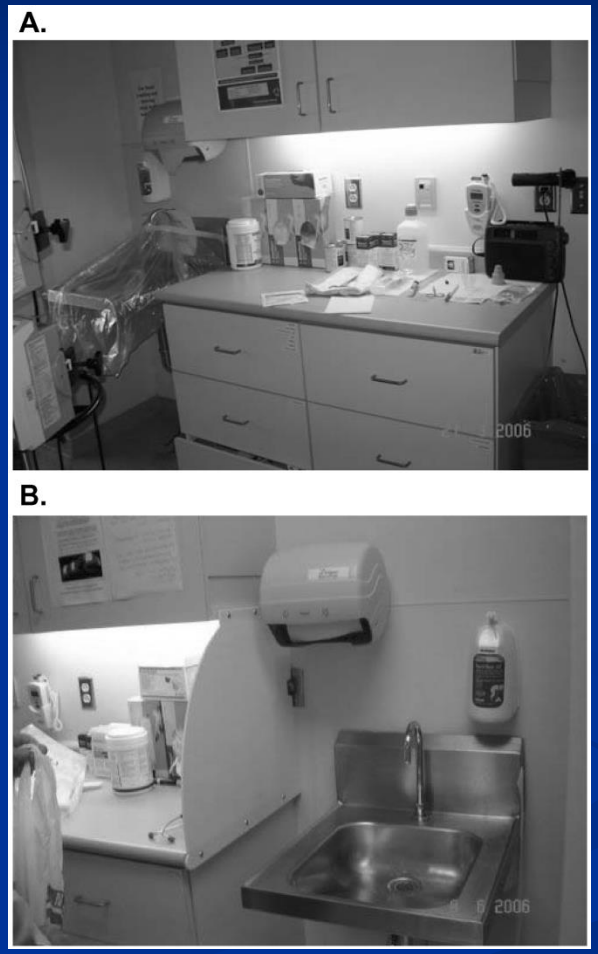

Cold
Hot



Improving room design to reduce risk for transmission from sinks

Before renovation

After renovation



Hota S, et al. Outbreak of multidrug-resistant *P. aeruginosa* colonization and infection secondary to imperfect intensive care unit room design. ICHE 2009;30:25-33.

Sink drain disinfection

Sink disinfection methods

- Disinfectants poured down sink – bleach, hydrogen peroxide, acetic acid
- Vibration and heat
- Ozonated water
- Valve in sink to enhance disinfectant contact time

Swab from just below strainer



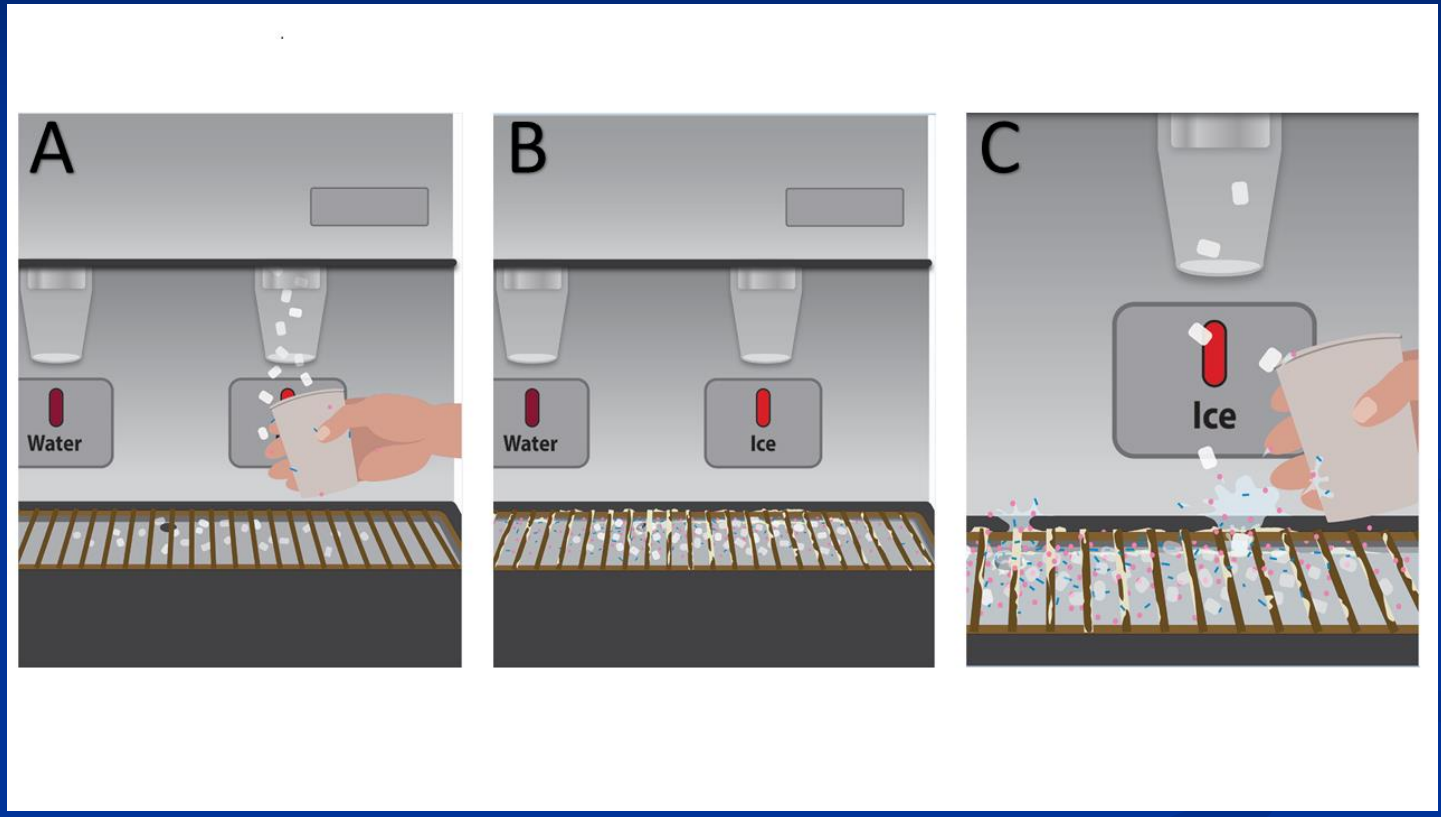
Kizny Gordon AE. The Hospital Water Environment as a Reservoir for Carbapenem-Resistant Organisms Causing Hospital-Acquired Infections-A Systematic Review. Clin Infect Dis 2017;64:1435-1444; Livingston S. Eradicating *Pseudomonas* and *Candida auris* from a sink drainage system using a novel sink that generates ozonated water. SHEA 2018; Cadnum JL. Evaluation of a novel approach for disinfection of sinks in healthcare facilities. SHEA 2018.

Cover up: A sink drain cap prevents dispersal from sinks



Livingston S, et al. Society for Healthcare Epidemiology of America Annual Meeting, 2018

Contaminated ice machines as a source of pathogen transmission



Kanwar A. A cold hard menace: A contaminated ice machine as a potential source for transmission of carbapenem-resistant *Acinetobacter baumannii*. AJIC 2017; Kanwar A. Hiding in plain sight: Contaminated ice machines as a potential source for dissemination of pathogens. Manuscript in revision.

Summary













