Transmission of resistant organisms from hospital drains

Tara Palmore, M.D.
Hospital Epidemiologist
NIH Clinical Center
National Institutes of Health
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National Institutes of Health
Turning Discovery Into Health

Disclosures

Objectives

1. Understand how drain and wastewater-related organisms can threaten patient safety in the healthcare environment.

2. Learn about strategies and tools to identify and mitigate drain and wastewater-related infection risks in your facility.

A real case

A 23-year-old man hospitalized for complications of a stem cell transplant had a newly positive perirectal surveillance culture.

- Surveillance perirectal swab grew KPC+ *Leclercia adecarboxylata* (an unusual *Enterobacteriaceae*)
- Negative surveillance swabs over the previous 18 months
- Negative blood and urine cultures

The back story

3 months earlier

Environmental Services closet A

Drain swab grows KPC+ *Leclercia*

1 month earlier

Environmental Services closets B,C,D,E

Drain swabs grow KPC+ *Leclercia*

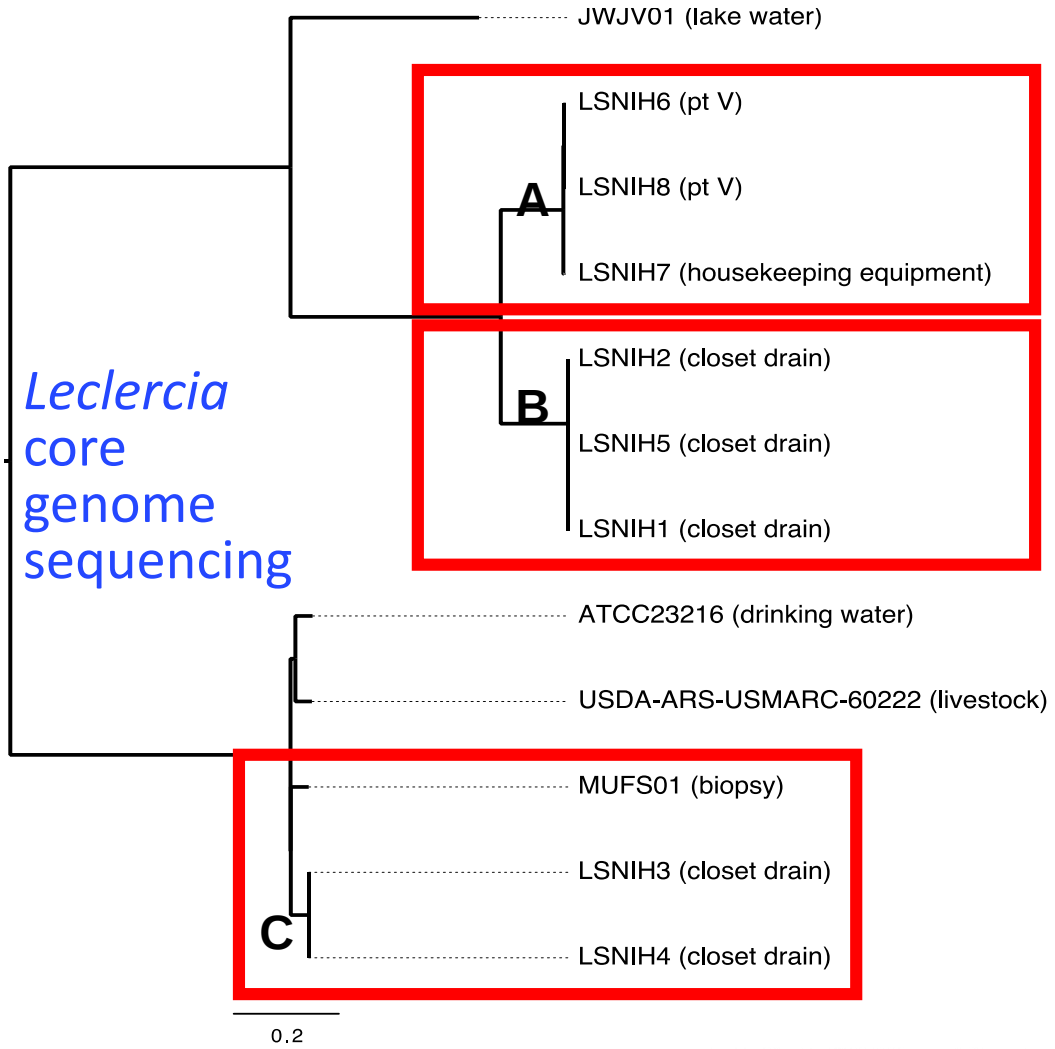
then….

Routine patient surveillance

Perirectal swab grows KPC+ *Leclercia*

How did organisms get from floor drains to a patient?

- 46 environmental cultures collected from surfaces in the patient's ward, housekeeping closets and equipment.
- 1 of 7 Environmental Services mop buckets grew KPC+ *Leclercia adecarboxylata*



Sean Conlan, Ph.D. and Julie Segre, Ph.D.

Environmental sampling, 2012-17

Environmental services closets – 128 samples

- Floor drains
- Housekeeping equipment
- Surfaces

12.5% of samples grew CPO:

- *bla*$_{KPC}$+ *Aeromonas* spp.
- *bla*$_{KPC}$+ *C. freundii* complex
- *bla*$_{KPC}$+ *E. cloacae* complex
- *bla*$_{KPC}$+ *Escherichia* sp.
- *bla*$_{KPC}$+ *Pantoea* spp.
- *bla*$_{KPC}$+ *K. pneumoniae*
- *bla*$_{NDM-1}$+ *Acinetobacter* spp.
- ***bla*$_{KPC}$+ *Leclercia* spp.**

Weingarten et al, mBio 2018

Environmental sampling, 2012-17

Sinks – 340

- Faucets
- Aerators
- Traps
- Drains
- Water

3.2% of samples (11/340) grew CPO:

- bla_{KPC}+ *K. pneumoniae*
- bla_{KPC}+ *K. oxytoca*
- bla_{KPC}+ *E. cloacae* complex
- bla_{KPC}+ *C. freundii* complex

Weingarten et al, mBio 2018

Environmental sampling, 2012-17

Wastewater – 19

- Hospital sewage pipes
- Manhole
- Sludge

79% of samples (15/19) grew CPO:

- *bla*$_{KPC}$+ *Acinetobacter* spp.
- *bla*$_{KPC}$+ *Aeromonas* spp.
- *bla*$_{KPC}$+ *C. freundii* complex
- *bla*$_{KPC}$+ *Citrobacter* sp.
- *bla*$_{KPC}$+ Enterobacteriaceae
- *bla*$_{KPC}$+ *E. cloacae* complex
- *bla*$_{KPC}$+ *E. coli*
- *bla*$_{KPC}$+ *K. pneumoniae*
- *bla*$_{KPC}$+ *K. oxytoca*
- *bla*$_{KPC}$+ *Pseudomonas*
- *bla*$_{KPC}$+ *Serratia* spp

Weingarten et al, mBio 2018

Infection Control & Hospital Epidemiology (2018), **39**, 972–979
doi:10.1017/ice.2018.138

Review

Wastewater drains: epidemiology and interventions in 23 carbapenem-resistant organism outbreaks

Philip C. Carling MD, FSHEA[1,2]
[1]Infectious Diseases Section, Steward Carney Hospital, Boston, Massachusetts and [2]Boston University School of Medicine, Boston, Massachusetts

- All outbreak reports involved carbapenem-R organisms that matched isolates from sink, shower, tub drains
- Interventions:
  - Pouring disinfectants down drains
  - Scrubbing sinks and plumbing
  - Replacing sinks and plumbing
- Outcomes not well documented
- 344 patients

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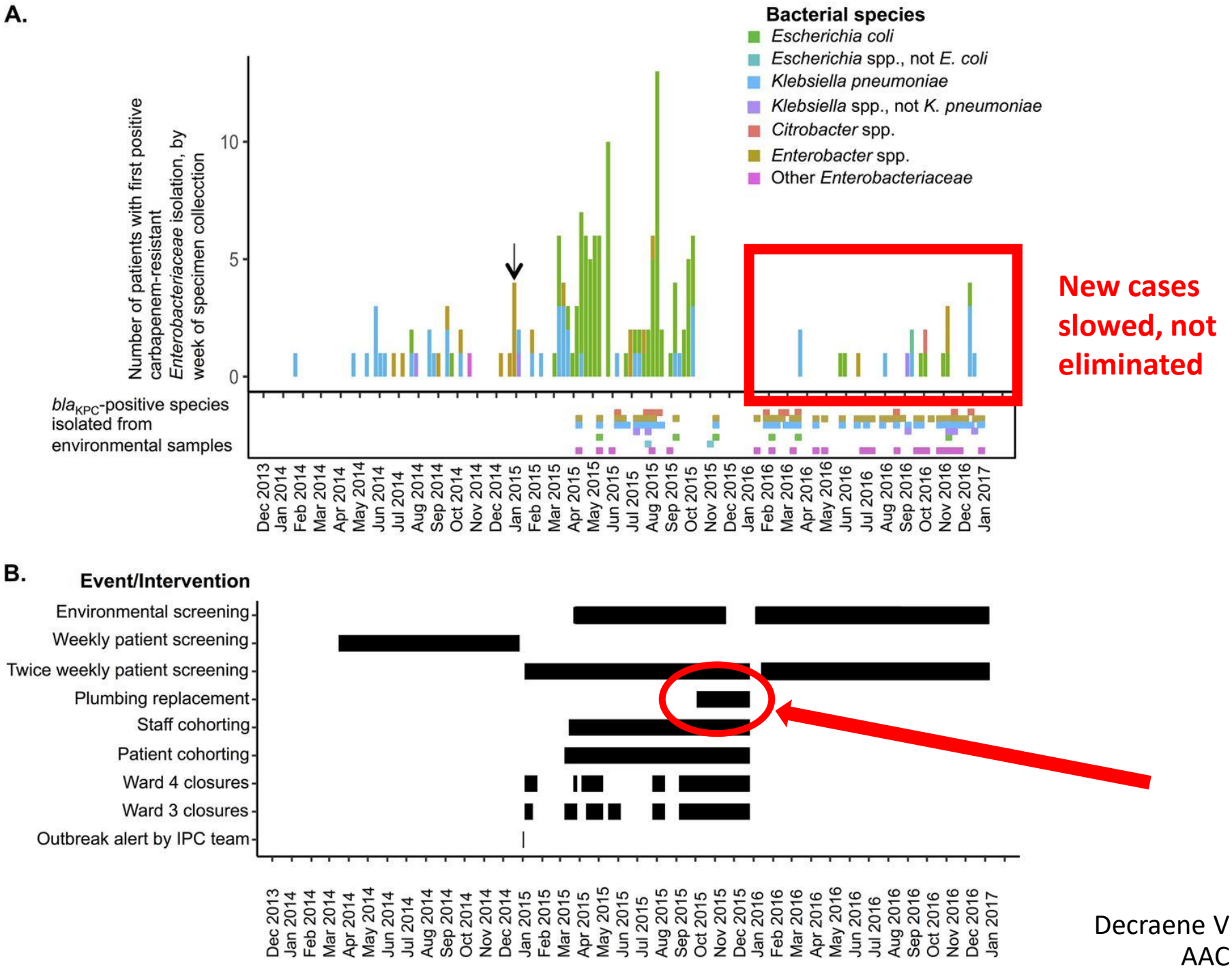
A Large, Refractory Nosocomial Outbreak of *Klebsiella pneumoniae* Carbapenemase-Producing *Escherichia coli* Demonstrates Carbapenemase Gene Outbreaks Involving Sink Sites Require Novel Approaches to Infection Control

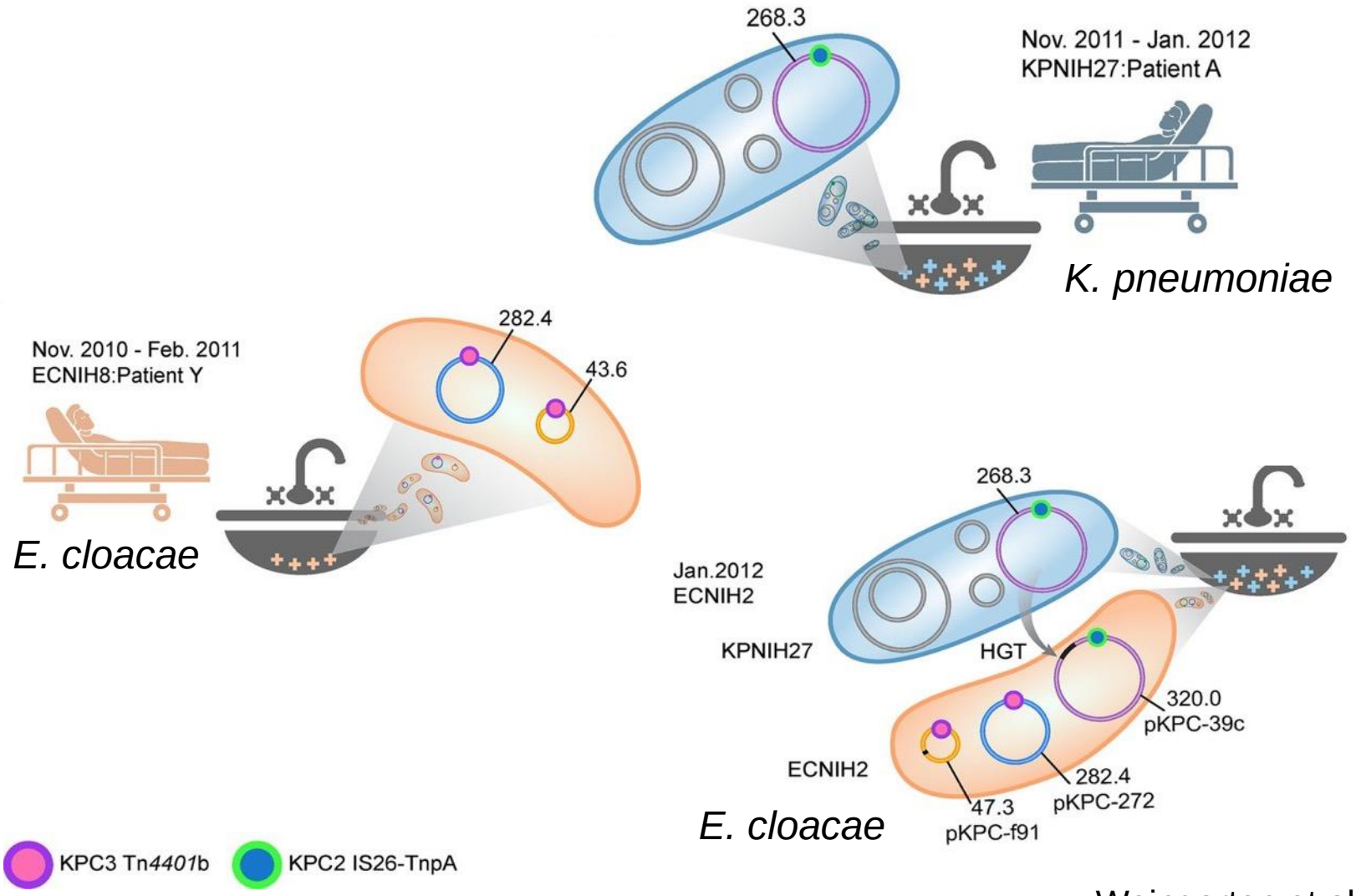
V. Decraene,[a] H. T. T. Phan,[b,c] R. George,[d] D. H. Wyllie,[b,c] O. Akinremi,[c,e] Z. Aiken,[d] P. Cleary,[a] A. Dodgson,[b,f] L. Pankhurst,[b,c] D. W. Crook,[b,c,e] C. Lenney,[d] A. S. Walker,[b,c] N. Woodford,[c,e] R. Sebra,[g] F. Fath-Ordoubadi,[d] A. J. Mathers,[h,i] A. C. Seale,[j,k] M. Guiver,[f] A. McEwan,[d] V. Watts,[a] W. Welfare,[l,m] N. Stoesser,[b,c] J. Cawthorne,[d] the TRACE Investigators' Group

- 514 patient acquisitions of carbapenem-resistant *E. coli* (largely bla_{KPC}) over 6 years
- Sink drains, shower drains colonized on the most heavily affected wards



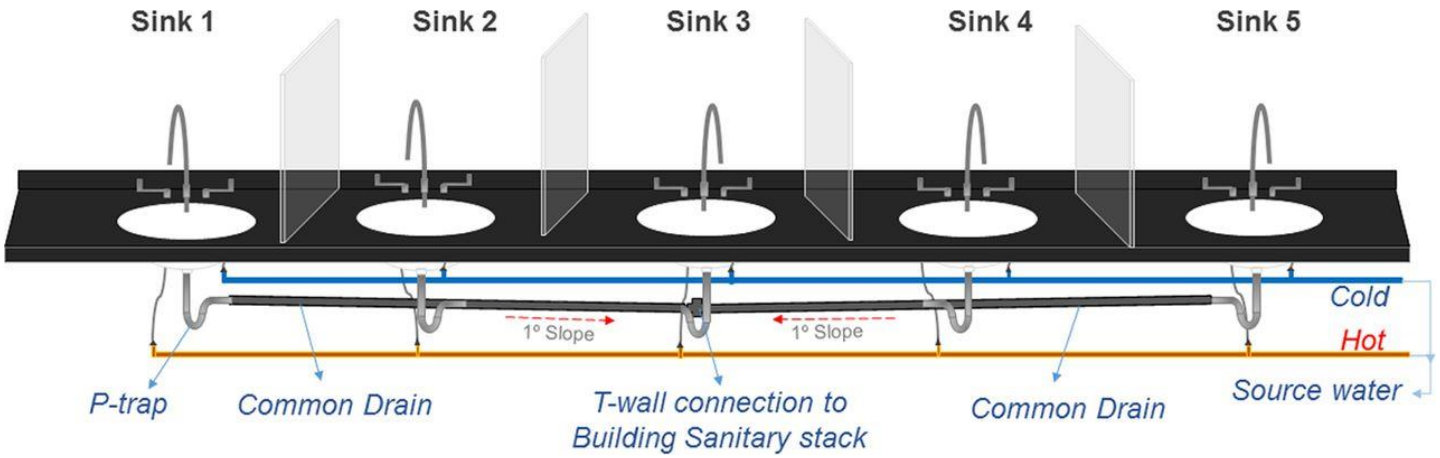
Decraene V et al, AAC 2018

How carbapenemase genes from patients can spread to the environment



Weingarten et al, mBio 2018

Sink lab research shows unrelenting upward growth of *E. coli* toward sieve



Amy Mathers, M.D.

Kotay, Appl Environ Microbiol 2017

Fluorescent dye on the sieve illustrates the extent of splatter


Remember to
"Scrub the Hub"
FOR AT LEAST 15-30 SECONDS!
Speak Up
For Safety!
You Can Help Prevent Central Line
Associated Blood Stream Infections!

Danielle Rankin, MPH, CIC
Florida Dept. of Health

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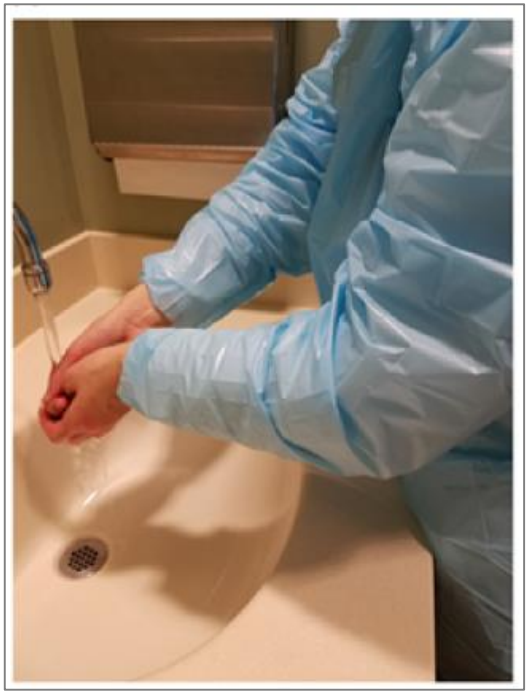
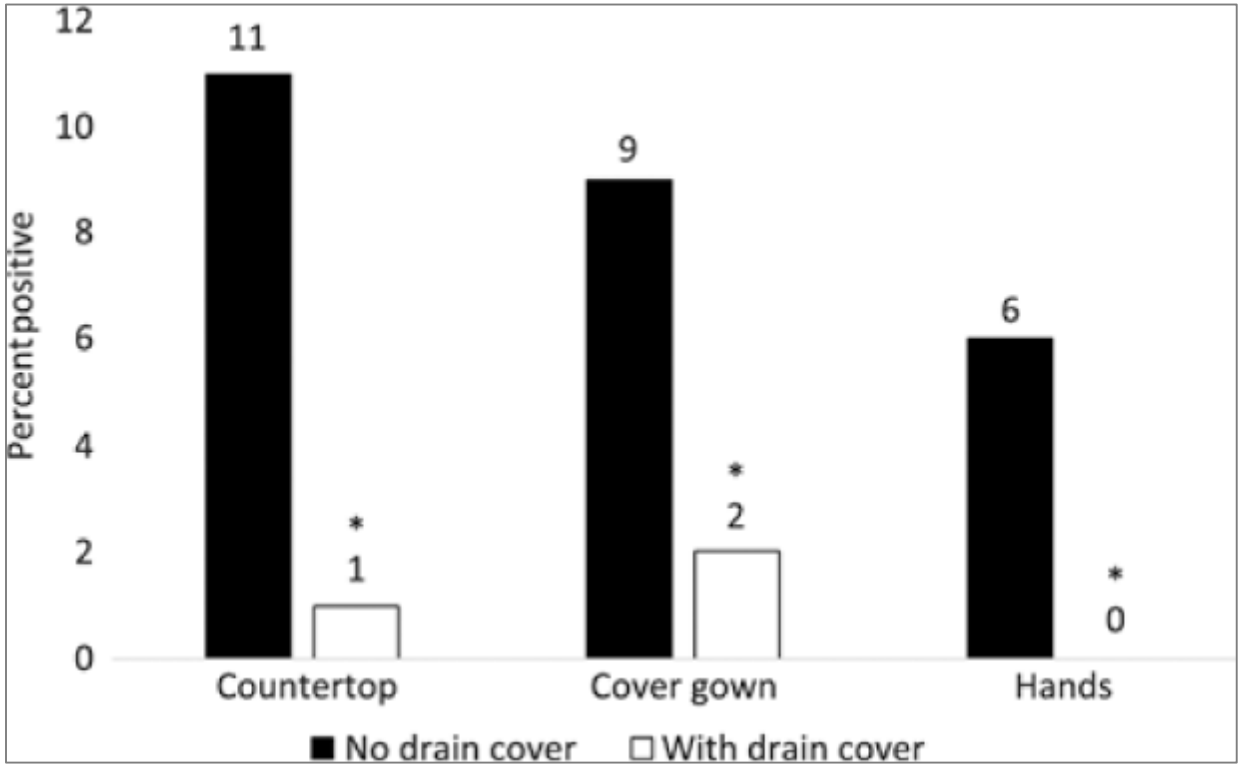
Interrupting transmission from sink drains to patients



Cultured gram negative organisms from countertops, hands, and gowns after hand washing in hospital sinks with gram negative colonization of drains.



Livingston et al, ICHE 2018; Hajar et al, ICHE 2019

Interrupting transmission from sink drains to patients, cont.

- Clean and disinfect sink basin, faucet, faucet handles, and surrounding counter top at least daily.
- Avoid placing patient care items or preparing medications next to sinks.
- Select a sink design with faucet offset from the drain, and deeper bowls that minimize splashing.
- Put covers on toilets and hoppers.
- Do not discard patient waste down sinks.
- Minimize discarding liquid nutritional supplements and other beverages down sinks or toilets.

https://www.cdc.gov/hai/prevent/environment/water.html

Stool is in the air

Measured particle concentrations and sizes and bioaerosol concentrations under 3 conditions:

1. No flushing
2. Flushing empty toilet
3. Flushing toilet with stool

Mean Bioaerosol Concentrations

Toilet Conditions	Mean Bioaerosol Conc. (St. Dev.), CFU/m^3)
No Waste No Flush	210 (136)[a]
No Waste With Flush	240 (132)
Fecal Waste With Flush	278 (149)[a]

[a] Room conditions identified by pairwise Tukey test as significantly different (p-value = 0.005)

Particle concentration increased more after flush of empty toilets than toilets with waste

Knowlton et al CDC Epicenters, Antimicrob Resist Infect Control 2018

Putting a lid on carbapenemase-producing organism transmission from ICU hoppers

<u>18 months, 5 ICUs</u>

- 56 KPC acquisitions
  - 20 clinical cultures
  - 36 colonizations

Genome sequencing suggested nosocomial reservoir rather than patient-to-patient transmission

Putting a lid on carbapenemase-producing organism transmission from ICU hoppers

		
	18 months	18 months
KPC acquisition	56	30
Clinical cultures	20	9
Colonization	36	21
Acquisitions/10K pt days	22.10	11.36
Acquisitions/1000 adm	7.54	3.85
Clinical cultures/1000 adm	**9.15**	**2.69**

ODDS RATIO 0.29 p<.001

Conclusions

- Drains, toilets and other wastewater reservoirs are documented sources of direct or indirect transmission of MDROs to patients.
- Optimizing hygiene practices, environmental cleaning, and infection control measures is necessary but not sufficient.
- Innovative yet feasible, cost-effective, and scalable solutions are needed for this patient safety problem.

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