Infection Control & Hospital Epidemiology (2018), **39**, 1467–1469
doi:10.1017/ice.2018.191

Concise Communication

A multicenter investigation to characterize the risk for pathogen transmission from healthcare facility sinks

Scott A. Gestrich MD[1], Annette L. Jencson BS, CIC[1], Jennifer L. Cadnum BS[1], Scott H. Livingston BS[1,2], Brigid M. Wilson PhD[3] and Curtis J. Donskey MD[2,3]

[1]Research Service, Louis Stokes Cleveland VA Medical Center, Cleveland, Ohio, [2]Case Western Reserve University School of Medicine, Cleveland, Ohio and [3]Geriatric Research, Education, and Clinical Center, Louis Stokes Cleveland VA Medical Center, Cleveland, Ohio

Abstract

In 4 hospitals, we demonstrated frequent dispersal of fluorescent tracer and fluoroquinolone-resistant gram-negative bacilli from sink drains to sink bowls and to surfaces outside the bowl. Fluorescent tracer dispersal correlated inversely with the depth of the sink bowl. Modifications in sink design could substantially reduce the risk for pathogen dissemination.

(Received 9 May 2018; accepted 17 July 2018)

In recent years, numerous outbreaks have been attributed to contaminated sinks.[1–3] Organisms colonizing sink drains can be dispersed from the strainer to the sink bowl and countertop by splattering of flowing water.[4,5] Outbreaks have usually involved gram-negative bacilli such as *Pseudomonas* spp and carbapenem-resistant Enterobacteriaceae.[1,2] However, sink drains may also be an underappreciated reservoir of *Candida* spp.[6,7]

Sink design may play a key role in determining the risk for dispersal of colonizing microorganisms. For example, placement of the faucet such that water flows directly onto the drain may increase the risk for organism dispersal.[2,4] However, there is limited information on the design of sinks currently used in hospitals and on their propensity to disperse pathogens. Here, we conducted a multicenter study to better characterize the risk for transmission from hospital sinks and to identify factors associated with pathogen dispersal.

Methods

Setting

The study was conducted in 4 acute-care hospitals in northeastern Ohio: a Veterans Affairs hospital, a community hospital, and 2 academic teaching hospitals. For each facility, the sink bowls and countertops in patient rooms were cleaned with a hospital-approved disinfectant after each patient discharge. The study procedures were approved by the infection prevention programs at each facility. Approval from the institutional review board was not obtained because as there was no interaction with patients or personnel.

Author for correspondence: Curtis J. Donskey, MD, Geriatric Research, Education, and Clinical Center 1110W, Louis Stokes Cleveland VA Medical Center, 10701 East Boulevard, Cleveland, Ohio 44106. E-mail: Curtis.Donskey@va.gov

Cite this article: Gestrich S. *et al.* (2018). A multicenter investigation to characterize the risk for pathogen transmission from healthcare facility sinks. *Infection Control & Hospital Epidemiology* 2018, 39, 1467–1469. doi: 10.1017/ice.2018.191

Dispersal of gram-negative bacilli from colonized sink drains

For each hospital, we cultured a convenience sample of up to 50 sinks in occupied patient rooms or personnel work areas. Before sink operation, the entire sink bowl and the adjacent countertop or other surfaces ≤15.25 cm (≤6 inches) from the bowl were sampled with separate Rayon swabs (BBL Culture Swabs, Becton Dickinson, Franklin Lakes, NJ) premoistened with sterile water. The sink bowl and adjacent surfaces were then disinfected with a commercial improved hydrogen peroxide disinfectant. Additional cultures were collected 10 minutes after disinfection and again after the hot- and cold-water faucets were run for 30 seconds; the rate of flow was adjusted to be consistent with a rate typically used for hand hygiene. After the evaluation of dispersal of gram-negative bacilli, swabs inserted through an opening of the strainer were used to sample the proximal sink drain to a depth of 2.5 cm (1 inch) below the strainer. The swabs were plated onto MacConkey agar (Hardy Diagnostics) containing ciprofloxacin 1 mg/L and incubated at 37°C for 24 hours. For a subset of 20 sinks, we filtered 50 mL of water from the faucet and cultured the filter.

Sink design features associated with dispersal of fluorescent gel from sink drains

For a subset of sinks, we examined dispersal of a fluorescent gel from the sink drain to identify sink characteristics associated with dispersal. For this assessment, 1 mL of a commercial fluorescent gel (Glitterbug Potion, Brevis Corporation, Salt Lake City, UT) was inoculated on the outer surfaces of the drain pipes just below the sink strainer with a pipette tip. The water was run for 30 seconds, and a black light was used to assess dispersal to any surfaces outside the bowl. Prior to the assessment, the sink bowl and countertop were cleaned and the black light was used to identify and remove any artifact that might yield false-positive fluorescence readings.

The characteristics of the sinks were recorded, including depth of the sink bowl (ie, vertical distance from the strainer to the sink edge), circumference of the bowl, location of the faucet relative to the strainer (ie, directly over the strainer versus offset), automatic versus manual operation, and type of faucet (goose neck versus other). A multivariable logistic model was used to identify factors associated with dispersal of the fluorescent gel. The χ^2 test was used to compare categorical variables and the Mann-Whitney U test was used for continuous variables. To assess for collinearity among our model variables, we examined the variance inflation factor. For a subset of 3 sinks that dispersed the fluorescent gel, we examined the impact of different rates of water flow on dispersal.

Results

Overall, 194 sets of sink cultures were obtained from the 4 study hospitals (range, 45–50): 138 in patient rooms and 56 in personnel work areas. Figure 1 shows the percentages of cultures positive for fluoroquinolone-resistant gram-negative bacilli overall and for each hospital for the sink bowl and the adjacent countertop or other surfaces ≤15.25 cm (≤6 inches) from the bowl before disinfection (A) and after disinfection followed by running the water for 30 seconds (B). Cultures of the sink bowl and adjacent areas after disinfection but before running the water were consistently negative, as were cultures of water from faucets. All swabs obtained from the drain of sinks that dispersed fluoroquinolone-resistant gram-negative bacilli were positive for fluoroquinolone-resistant gram-negative bacilli.

A subset of 171 consecutive sinks were included in the evaluation of dispersal of fluorescent gel. Of the 171 sinks, 137 (80%) were manually operated, 34 (20%) were automated, 117 (68%) had faucets offset from the strainer, 54 (32%) had faucets that delivered water directly onto the strainer, and 150 (88%) had goose-neck–style faucets. The median bowl depth was 19 cm (range, 12–31 cm).

Of the 171 sinks tested, 67 (39%) dispersed fluorescent tracer outside the sink bowl. In the multivariable logistic model, the only factor significantly associated with dispersal of fluorescent gel outside the sink bowl was the sink bowl depth ($P = .02$) (Table 1). Dispersal occurred frequently when the bowl depth was ≤ 19 cm and rarely when the depth was >19 cm (64 of 133 [48%] vs 3 of 38 [8%]; $P < .001$). Dispersal occurred as frequently in sinks in which the faucet was offset from the drain as in those positioned such that water flowed directly onto the strainer (44 of 118 [37%] vs 24 of 54 [44%]; $P > .05$). The variance inflation factor was < 1.5 for all variables.

For each of the 3 sinks used to assess the effect of water flow rate on dispersal, we found that increased flow rate increased the frequency of dispersal. At a flow rate of <200 mL/s, no dispersal occurred from any of the sinks. However, when the flow rate was 260 mL/s or higher, dispersal was consistently demonstrated.

Discussion

Many recent studies have demonstrated the potential for colonized sinks to disperse pathogens.[1–4] For example, Hota et al[3] controlled an outbreak of multidrug-resistant *P. aeruginosa* linked to sinks by implementing changes to reduce dispersal including reducing the water flow pressure and installing barriers between sinks and adjacent preparatory areas. However, limited information is available on the design of sinks currently used in hospitals and on design features associated with pathogen dispersal. In 4 hospitals, we demonstrated that running water resulted in frequent dispersal of fluorescent gel and colonizing fluoroquinolone-resistant gram-negative bacilli from sink drains to sink bowls and surfaces outside the bowl. The one design feature that was significantly associated with dispersal of fluorescent gel was the sink bowl depth: shallow bowls were more likely to disperse the fluorescent gel.

Our findings suggest that modifications in sink design could substantially reduce the risk for dissemination of colonizing pathogens. In the study hospitals, 78% of sinks had relatively shallow bowl depths (ie, ≤ 19 cm) that were associated with dispersal of fluorescent gel. Modified designs with deeper sink bowls could reduce dispersal. It is plausible that having the faucet offset from the sink strainer might reduce dispersal. However, we did not find that sinks with offset faucets had significantly lower dispersal of fluorescent gel, suggesting that this modification alone is not sufficient to prevent pathogen dispersal. Finally,

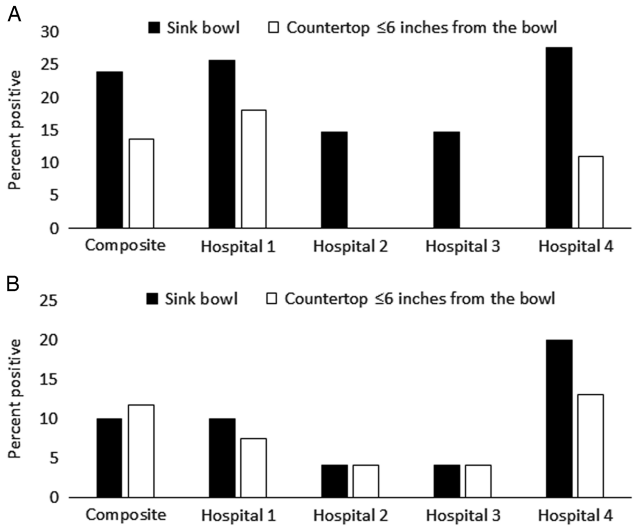

Fig. 1. Frequency of recovery of fluoroquinolone-resistant gram-negative bacilli from sink bowls and countertops at baseline (*A*) and after running the hot- and cold-water faucets for 30 seconds (*B*). The sink bowl and countertop were disinfected after the baseline cultures but before running the water.

Table 1. Odds Ratios for Sink Design Features Associated with Dispersal of Fluorescent Gel from the Sink Drain by Running Water

Characteristic	Odds Ratio	95% Confidence Interval	*P* Value
Bowl depth (cm)[a]	0.69	0.59–0.79	.00
Faucet flow indirect versus direct relative to strainer	1.28	0.58–2.88	.54
Faucet goose neck versus other design	0.78	0.29–2.10	.62
Automatic versus manual sink	0.73	0.30–1.74	.48
Bowl circumference (cm)	1.01	0.99–1.04	.33

[a]Vertical distance from the strainer to the sink edge.

https://doi.org/10.1017/ice.2018.191 Published online by Cambridge University Press

avoiding high water flow rates by reducing water pressure might be beneficial.

Acknowledgments. We would like to thank the Infection Control personnel at the participating hospitals for assistance in obtaining the assessments of sinks in their facilities.

Financial support. This work was supported by a Merit Review grant (no. 1 I01 BX002944-01A1) from the Department of Veterans Affairs to C.J.D.

Conflicts of interest. C.J.D has received research grants from GOJO, Pfizer, Clorox, EcoLab, and Avery Dennison. All other authors report no conflicts of interest relevant to this article.

References

1. Kanamori H, Weber DJ, Rutala WA. Healthcare outbreaks associated with a water reservoir and infection prevention strategies. *Clin Infect Dis* 2016;62:1423–1435.
2. Kizny Gordon AE, Mathers AJ, Cheong EYL, *et al*. The hospital water environment as a reservoir for carbapenem-resistant organisms causing hospital-acquired infections—a systematic review of the literature. *Clin Infect Dis* 2017 May 15;64:1435–1444.
3. Decker BK, Palmore TN. Hospital water and opportunities for infection prevention. *Curr Infect Dis Rep* 2014;16:432.
4. Hota S, Hirji Z, Stockton K, Lemieux C, Dedier H, Wolfaardt G, Gardam MA. Outbreak of multidrug-resistant *Pseudomonas aeruginosa* colonization and infection secondary to imperfect intensive care unit room design. *Infect Control Hosp Epidemiol* 2009;30:25–33.
5. Kotay S, Chai W, Guilford W, Barry K, Mathers AJ. Spread from the sink to the patient: in situ study using green fluorescent protein (GFP) expressing-*Escherichia coli* to model bacterial dispersion from hand washing sink trap reservoirs. *Appl Environ Microbiol* 2017;83(8):pii: e03327–16.
6. Piedrahita C, Cadnum JL, Jencson AL, Shaikh AA, Ghannoum M, Donskey CJ. Environmental surfaces in healthcare facilities are a potential source for transmission of *Candida auris* and other *Candida* species. *Infect Control Hosp Epidemiol* 2017;38:1107–1109.
7. Jencson AL, Cadnum JL, Piedrahita C, Donskey CJ. hospital sinks are a potential nosocomial source of *Candida* infections. *Clin Infect Dis* 2017;65:1954–1955.

https://doi.org/10.1017/ice.2018.191 Published online by Cambridge University Press