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Shared Hoppers: A Novel Risk Factor for the Transmission of *Clostridium difficile*

To the Editor—The environment plays a central role in transmission of *Clostridium difficile* infection (CDI) within hospitals. Surfaces and objects become contaminated with spores when in contact with feces, and these hardy spores may endure for months. Patient placement factors—such as rooming with or residing in a bed previously occupied by a CDI patient—are cited as risk factors for acquisition.[1,2] One geographic feature that may increase risk for CDI is the presence of a shared hopper room in the patient care area. A hopper is a flushable, raised basin with an extendable arm that produces a high-pressure spray when flushed. This rimless basin is used by hospital staff to dispose of waste fluids and wash out receptacles. *C. difficile* has been isolated from air samples after flushing lidless toilets, leading to contamination of proximate surfaces.[3]

Our trauma-surgical intensive care unit (TSICU) historically has had the highest burden of CDI in our facility. The 2010 rate of hospital-acquired CDI for the TSICU was 3.5 cases per 1,000 patient-days compared with other intensive care units (range, 1.5–2.4 cases per 1,000 patient-days). Despite implementation of infection prevention measures—including hand hygiene with soap and water, a nurse-driven early CDI testing strategy, empirical contact precautions while awaiting test results, environmental cleaning with hypochlorite (bleach) solution, and cleaning audits—the high rates persisted. During the spring of 2011, we observed a cluster of CDI cases in our TSICU. Two patients acquired CDI while housed in a double room adjacent to a patient in contact precautions with CDI in a private room. The 2 rooms were joined by a shared hopper room. Neighboring patients who did not share the hopper, however, did not become infected. We hypothesized that transmission occurred by healthcare worker contamination of hands, uniform, and fomites via splashing and droplet aerosol during hopper flushing and use of the sprayer. We sought to examine patient and environmental risk factors for CDI acquisition.

We conducted a case-control study at Harborview Medical Center, a 413-bed, level 1 trauma and burn center with a 24-bed TSICU. The study spanned the 12-month period from December 15, 2010, through December 14, 2011. Generally, cases were defined as those with new onset diarrhea and a positive polymerase chain reaction (PCR) test for *C. difficile* toxin B greater than 48 hours from TSICU admission. Patients with a recent acute or long-term care hospital stay were excluded to minimize misclassification of exposure. The control group had a TSICU stay of greater than 36 hours and no positive *C. difficile* PCR test for at least 30 days after discharge from the TSICU. Approximately 3 concurrent controls were randomly selected within 1 week of admission for each case.

Electronic health records were reviewed for a history of CDI within the past 3 years. Potential risk factors for acquisition were determined for the exposure period through the date of diagnosis or through TSICU stay for controls. Demographics, laboratory data, and clinical data were abstracted from the electronic health record both electronically and manually by infection control professionals. Severity of illness data were obtained from the University HealthSystem Consortium. The study protocol was approved by the institutional review board of the University of Washington, and the need for informed consent was waived.

Univariate analysis was performed, using χ^2 and Fisher exact tests on categorical variables. Multivariate analysis was performed using STATA (ver. 11.0; Stata). A 2-sided $P \leq .05$ was considered significant, and relevant confounders were retained in a backward stepwise logistic regression model.

For the study period, 28 patients with hospital-acquired CDI were identified, and 26 remained after the exclusion of 2 patients who developed CDI after readmission from other floors. Seventy-three concurrent controls met inclusion criteria. Overall, 61 (61.6%) patients were male and 78 (78.8%) of Caucasian race. For CDI patients and controls, mean age ($\pm$ standard deviation) was 43.1 $\pm$ 20.2 and 53.5 $\pm$ 20.6 years, respectively, and mean length of stay was 27.5 $\pm$ 17.9

TABLE 1. Risk Factors for Acquisition of *Clostridium difficile* Infection (CDI)

Risk factor	Cases (n = 26)	Controls (n = 73)	Unadjusted OR (95% CI)	P
Trauma patient	21 (81)	38 (52)	3.9 (1.3–11.4)	.010
>1 trip to operating room	15 (58)	15 (21)	2.9 (1.1–8.0)	.040
TSICU days at risk, mean (SD)	10.6 (5.9)	4.9 (5.9)	…	…
Admit severity of illness, extreme	16 (62)	21 (29)	4.0 (1.6–10.1)	.004
Cephalosporins				
First/second generation	23 (89)	38 (52)	7.3 (2.0–26.3)	.001
Third/fourth generation	11 (42)	8 (11)	6.0 (2.0–17.4)	.001
Current or prior room occupant with CDI	8 (31)	8 (11)	3.6 (1.2–11.0)	.018
Shared hopper with CDI patient	9 (35)	7 (10)	5.0 (1.6–15.3)	.003
H2 blocker	22 (85)	41 (56)	4.3 (1.3–13.7)	.014
Open abdomen	9 (35)	2 (3)	18.8 (3.7–95.1)	.000
Tube feeding, mean (SD), days	5.5 (5.4)	1.7 (3.9)	…	…
Ventilated patient	24 (92)	42 (58)	8.9 (1.9–40.3)	.001
Hospital length of stay, mean (SD), days	27.5 (17.9)	12.8 (11.2)	…	…
Facial fractures	6 (23)	5 (7)	4.1 (1.1–14.8)	.024

NOTE. Data are no. (%) of patients, unless otherwise indicated. CI, confidence interval; OR, odds ratio; SD, standard deviation; TSICU, trauma-surgical intensive care unit.

and 12.8 ± 11.2 days, respectively. Risk factors are presented in Table 1. When comparing CDI patients and their controls, patients were almost 4 times more likely to have had traumatic injuries, went to the operating room more often, and had a longer period of TSICU exposure. Other risk factors associated with CDI acquisition included cephalosporin use, having a prior room occupant or current roommate with CDI, and shared hopper. In subsequent multivariate modeling to control for severity of illness and other confounders, patients with an open abdomen, mechanical ventilation, longer length of stay, and shared hopper remained as significant risk factors for acquiring CDI (adjusted odds ratios not shown).

We report on an investigation of elevated rate of CDI in a TSICU with a structural design of shared hoppers between rooms. Our findings suggest that sharing a hopper with a CDI patient increases the risk for acquisition in a vulnerable TSICU population. Our study was limited by not matching on length of stay and comorbidities. CDI patients had longer environmental contact in the TSICU and greater severity of illness, requiring more surgical intervention. These patients, therefore, received more antibiotic exposure than controls, further enhancing their risk. We attempted to account for these confounders in the analysis, but the effect of length of stay was formidable. Nonetheless, this evidence implies that the contribution of hopper dispersion of *C. difficile* spores bears further investigation. Modification of hospital construction guidelines would ideally consist of private rooms with a dedicated toilet basin and lid to minimize healthcare worker and environmental contamination.

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Survey on Influenza Vaccination Noncompliance among Nursing Students

To the Editor—While annual influenza vaccination is strongly recommended for healthcare personnel (HCP),[1] no specific evidence advocates nursing students to do the same. In a recent British study examining influenza vaccination among nursing students, the students lacked strong intention to receive vaccination.[2] In Canada, many healthcare degree programs encourage seasonal influenza vaccination, but only 21% of programs require it.[3] According to a 2008–2009 survey of deans representing 563 US schools of medicine and nursing regarding adherence to the Advisory Committee on Immunization Practices recommendations for HCP, only 19.2% of 439 schools of nursing required influenza vaccination, and nursing schools were less likely to provide students free influenza vaccination compared with medical schools (31% vs 78%).[4] Given the lack of study on nursing student influenza vaccination, we examined our nursing students' noncompliance with HCP influenza vaccination recommendations.

Among 544 nursing students who participated the 2013–2014 University of Pittsburgh Medical Center (UPMC) influenza vaccination data collection survey (September 20, 2013–December 6, 2013), 161 students (29.6%) who reported not obtaining the vaccination without a medical contradiction were selected as study subjects. To protect students' personal information, a group e-mail alias (2014flusurvey@list.pitt.edu) was created to contact subjects. To incentivize participation, a $5 Starbucks gift card was offered to every thirtieth respondent. Using the Qualtrics survey system, the questionnaire was designed with 14 questions: 1 queried vaccination compliance, 1 elicited an alias name for anonymous incentive distribution, 4 collected demographic information, and 8 generated reasons for noncompliance. After approval by the University of Pittsburgh institutional review board, the survey link was sent using the group alias e-mail. The survey was conducted over 2 weeks (April 15–28, 2014), with 2 reminder e-mails.

Of the 161 students, 58 students (36%) responded (i.e., 53 completed the survey, and 5 sent "I got the vaccination" e-mail replies). Most respondents (79%) reported receiving influenza vaccination; only 12 students (21%) were noncompliant. These students were all female and aged 20–55 years (median, 21). All were engaged in a clinical practicum. Nine were undergraduates, 2 were MSN students, and 1 was a PhD student. Students chose many reasons as applicable for not getting the vaccine: healthy enough (ie, never get the flu; 58%), possible side effects (eg, soreness; 25%), inconvenience (25%), sick after the previous vaccination (17%), no time (17%), and "don't like needles" (17%). Among the students who reported not getting the vaccine, 67% acknowledged knowing a free influenza vaccination was available through the student health service.

Most noncompliant students (91%) agreed that unvaccinated HCP (including nursing students) could be at risk of contracting influenza or transmitting the virus during patient care. Although 75% of noncompliant students disagreed that the influenza vaccine causes illness and 58% believed the influenza vaccination is effective in preventing influenza, 59% disagreed nonetheless that nursing students should receive the annual vaccination, and 67% disagreed with mandatory influenza vaccination as a condition of employment. To promote improved compliance, these students suggested that more convenient times and locations should be made available (Table 1).

Although our survey generated only a 36% response rate, and only 21% of the respondents provided information about their noncompliance, we believe our study presented useful information about the annual influenza vaccination compliance among nursing students. In the 2013–2014 flu season, at least 78.9% of our students reported receiving the vaccination (418 students total; 372 from the UPMC influenza

TABLE 1. Selected Responses to the Survey Question "I Would Get Vaccinated for Influenza This Coming Year If ..."

Response
There was a way to protect against all strains of the flu.
I was absolutely forced to .... Students living in dorms should get the vaccine because of crowded living conditions, but otherwise we should be allowed personal choice on the flu vaccine.
It was free and more convenient.
It was offered at a convenient time either in the nursing building or at clinical/the hospital.
I was told that ... you had to make an appointment at the student center, which was hard to do with a schedule that is Monday–Friday, with clinical and classes lasting until 7 p.m. at night most nights and starting at 5 a.m. I think the School of Nursing should have a fair that vaccinates all students, similar to how hospitals get all of their employees vaccinated.

NOTE. This question was adopted from the 2005 University of Pittsburgh Medical Center "How do you feel about the influenza vaccine?" survey.

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