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Major Article

Can improving patient hand hygiene impact *Clostridium difficile* infection events at an academic medical center?

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Background: Hand hygiene plays an important role in the prevention of *Clostridium difficile* (CD) infection (CDI). Patient hand hygiene (PHH) may be a potentially underused preventative measure for CDI. Patient mobility and acuity along with a lack of education present obstacles to PHH for the hospitalized patient. Surveys of patients at our institution showed a need for increased PHH opportunities. The objective of this study was to increase PHH and to examine if PHH affected CDI at our hospital.

Methods: A biphasic, quasi-experimental study was performed to increase PHH through education for staff and to provide education, assistance, and opportunities to the patient for hand cleaning. PHH practice was assessed by patient surveys and analyzed by χ^2 test. PHH effect on CDI was determined by following health care facility–onset CD laboratory–identified events data analyzed by National Healthcare Safety Network standardized infection ratios (SIRs).

Results: PHH opportunities improved significantly ($P < .0001$) after staff and patient education. CD SIRs deceased significantly for 6 months ($P \leq .05$) after the PHH intervention.

Conclusions: PHH opportunities can be increased by providing education and opportunities for patients to clean their hands. PHH should be considered a relevant preventative measure for CDI in hospitalized patients.

Hand hygiene (HH) is the an effective tool for infection prevention and a cornerstone of patient care in health care facilities and the community setting.[1-3] Its importance is highlighted in the Centers for Disease Control and Prevention Healthcare Infection Control Practices Advisory Committee Guidelines on HH in health care facilities and the World Health Organization guidelines on HH as the one of the best practices to protect patients from infection.[1,4] The HH practice of the hospitalized patient has become a recent focus of study in infection prevention.[5,6] Various factors, however, affect the patient's ability to perform HH, and often patient hand hygiene (PHH) practice in the hospital is less frequent than what is practiced at home.[7] Despite evidence to suggest that HH is important in preventing infection, hospitalized patients are often not provided the opportunity to clean their hands.[8] Obstacles such as mobility, dexterity, and cognition prevent adequate attention to frequent and effective hand cleaning. A recent study has shown that education of staff members on the importance of PHH in infection prevention can improve PHH performance when the patients are provided with education, reminders, and assistance for HH.[9] Inadequate HH may present risks to the patient for acquisition of hospital-associated pathogens. Our hospital set out to assess HH practice in our patients, to improve the opportunities for PHH though staff education and patient assistance, and finally, to ask the question if improving PHH opportunities in the hospital could affect the occurrence of *Clostridium difficile* (CD) infection (CDI) in our institution.

METHODS

This is a biphasic, quasi-experimental, single-center study performed at a 495-bed university-affiliated medical center in a large

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Survey Questions:

1.) How important on a scale of 1 to 5 do you think hand hygiene / hand washing is in the prevention of infection? Circle: 1 2 3 4 5

2.) Did your nurse talk to you about or provide you with information on the importance of your hand hygiene during your hospital stay? Circle: Yes/No

3.) Were you offered an opportunity to clean your hands today by your healthcare provider? Yes/No

4.) Were you offered or encouraged to perform hand hygiene at specific times?

- prior to eating a meal Yes/No
- after using the toilet or bedpan Yes/No
- before or after meeting your visitors Yes/No
- before touching your dressings or your incision Yes/No
- after returning to your room from testing or procedures in other areas Yes/No

5.) How many times can you recall having washed /sanitized your hands today? _____

6.) Can you think of any way that we can increase your opportunity to clean your hands?

Fig 1. Patient hand hygiene survey administered by nurse surveyor.

health care system that took place between November 2013 and December 2015. The study was designed by infection preventionists (IPs) and nursing leadership in response to increasing hospital CDI events and assessments of PHH on patient units indicating that patients were not being offered opportunities to clean their hands.

In phase 1, baseline surveys were conducted to assess PHH on 4 medical-surgical nursing units with an average daily census of approximately 35 patients. Survey questions (Fig 1) were modeled after a published observational PHH study.[9] A targeted number of 30 patients to be interviewed by a nurse surveyor were requested from each of the units to establish a baseline of PHH practice. The designated nurse surveyor visited patients and orally administered the survey questions. Alert patients agreeable to answering a survey on HH were included if they were coherent, agreeable to answer questions about HH, and could recall their recent HH experience in the hospital. Patients were asked how many times they had washed their hands that day. Direct observation of the patient performing HH was not included.

After collection of the baseline surveys, staff on each of 4 participating patient units were provided with an educational presentation prepared by nurse educators on the role of HH in preventing infection. The educational presentation provided the following: (1) results of the recent baseline patient surveys, (2) reference to the hospital's patient manual concerning the importance of HH for the patient, (3) the relationship of HH to infection prevention in health care,[4] and (4) specified times that staff should encourage and assist patients with HH (ie, prior to meals, after using the toilet or bedpan, prior to touching dressings and incisions, after returning from testing or a procedure, before and after having visitors). Staff members were then instructed to provide verbal PHH education to all newly admitted patients using the information from the educational presentation and information in the patient manual as a reference. Staff was also instructed to provide reminders, assistance, and encouragement for PHH. Laminated signs were posted in each patient room with reminders for staff to assist patients in washing their hands throughout the day. Prepackaged alcohol wipes (69.5%) were made available at the patient's bedside during room setup for those patients unable to get to the sink. Soap and water handwashing was encouraged along with use of the bedside alcohol hand wipes. All staff members were asked to assist patients with HH, especially those with mobility issues. Staff received regular reminders for encouraging PHH using screensavers on computer monitors and posted signage in staff areas.

After education of staff on the participating patient units, nurse surveyors were asked to interview 90 patients on each of the 4 participating medical-surgical units. A ratio of 1:3 before and after patient surveys was anticipated for statistical purposes. Reponses from the baseline and postimplementation surveys were entered into a database and analyzed by χ^2 test. The analysis was presented to nursing administration for consideration of whole-hospital implementation of the PHH initiative.

On approval, phase 2 (whole-hospital implementation) was planned by collaboration of the IPs and the hospital's Nursing Professional Practice Council. Phase 2 planning began in December 2014, and the initiative was implemented whole-hospital in March 2015. Baseline surveys were obtained in phase 2 from all hospital inpatient units, including medical, surgical, intensive care, labor and delivery, and rehabilitation units. Education of staff and placement of reminder signs on the patient units began in March and was fully in place by April 2015. Follow-up surveys for phase 2 were completed 1 year later in March 2016 by members of the Nursing Quality and Education Council.

For studying the effect of PHH on CDI events, the hospital's current bundle practices for CDI prevention were reviewed by IPs. CDI prevention methods at our institution included early stool testing for CD by nucleic acid amplification methodology, institution of contact precautions on stool testing, environmental cleaning with a hydrogen peroxide–peracetic acid sporicidal agent first introduced in August 2013, ultraviolet light disinfection of isolation rooms at discharge on request of the patient unit since 2013, HH for all staff with soap and water when taking care of a patient with CDI, and an active antibiotic stewardship program. No changes to this bundle were made prior to or during the phase 2 implementation of the PHH initiative.

CDI events were defined as all in-patient positive CD stool tests reported to the National Healthcare Safety Network (NHSN) per the "Multidrug resistant organism and *Clostridium difficile* infection (MDRO/CDI) laboratory-identified event module"[10] requirement first introduced in 2013 (updated yearly) and meeting the NHSN requirement for CD hospital-onset (HO) laboratory-identified (LabID) events. LabID events categorized as HO are those specimens collected >3 days after admission to a facility and testing positive for CD by NHSN-accepted methodology (ie, nucleic acid amplification testing). CD LabID event data analyses were obtained from summary reports available for participating institutions on the NHSN Web site (https://www.cdc.gov/nhsn). Data are stratified by time (eg, month, quarter), categorized as HO or community-onset, and aggregated across the entire reporting facility. LabID events were reported

directly to the NHSN by the hospital's microbiology laboratory and were not subject to review by IPs. Standardized infection ratios (SIRs) for HO CD LabID events were obtained using the online applications available on the NHSN Web site for requested time periods.

RESULTS

PHH education and opportunities increased significantly ($P < .0001$) in phase 1 of the study. Table 1 summarizes the results of patient responses on PHH before and after the initiative. Baseline surveys obtained from the 4 patient study units (97 of 120 anticipated surveys; 81%) showed HH education had been provided to 34% of patients, and opportunities for PHH were provided to 60% of patients. Education on HH and opportunities for HH were increased to 64% and 86%, respectively (271 of 360 anticipated surveys; 81%). The largest percentage change occurred in providing education to the patient (88.2%), in HH opportunity provided by staff (43.3%), and in specified times such as before touching dressings-incisions (131.2%), in performing HH before and after having visitors (74.2%), and after returning from testing or a procedure (73.7%). Additionally, the average frequency of PHH reported by patients surveyed also increased from 2.7 to 3.75 times. Ninety-nine percent of patients rated HH as a 4 or 5 on the 1-5 scale regarding importance to infection prevention.

Table 2 shows similar baseline patient survey responses during phase 2 compared with phase 1. Phase 1 surveys indicated 46% of patients receiving PHH education versus 48% in phase 2 (n = 80). The occurrence of providing assistance or having HH opportunity offered in phase 1 was 68% versus 60% in phase 2. Follow-up surveys (n = 189) from phase 2 showed an increase of 10% in PHH education provided (53% vs 48% prior). PHH opportunities for cleaning hands prior to meals, after toileting, before touching dressings and incisions, after coming back from testing, and after having visitors had also increased between 6% and 52%. The overall opportunities for PHH offered did not change during phase 2. The average frequency of PHH reported by the patients did not change (average 2.4 before vs 2.6 times after the initiative).

CD SIRs for the study period showed a decrease in the number of observed HO LabID events in the first 2 quarters (Qs) after the implementation of PHH in March 2015, and a corresponding decrease in the HO SIRs from 0.834 to 0.572 and 0.497, respectively (Table 3). SIR *P* values for Q2 and Q3 (0.0157 and 0.0103, respectively) were significantly lower than expected ($P \leq .05$). The Q4 SIR, however, showed an increase to 0.3844 over the 2 preceding quarters.

DISCUSSION

CDI continues to increase with an estimated 453,000 cases occurring in U.S. health care facilities, and hospitalizations for this infection have doubled from 2000 to 2010.[11] Bundle strategies have been published to address prevention of CDI. Bundles strategies have included early and expanded contact isolation, rapid testing of stool specimens, handwashing for health care workers with soap and water, and cleaning surfaces with sporicidal disinfectants.[12] The role of the patients' hands in the transmission of CDI has been previously suggested as a possible route of transmission.[13,14] It can be hypothesized that patients ingest material on their hands to facilitate fecal-oral transmission of CD spores in the hospital.

Table 1
Phase 1 patient survey responses: percent change in PHH education and opportunities provided to patients

PHH survey questions	Pre-education and assistance (n = 97)	Posteducation and assistance (n = 291)	% change	χ^2 *P* value
Verbal or written education provided by staff	33/96 (34)	188/291 (64)	88.2	<.0001
Opportunity for HH provided by staff	55/92 (60)	251/291 (86)	43.3	<.0001
Opportunity for HH was provided				
Prior to meals	51/92 (55)	201/277 (72.5)	31.8	.002
After toileting	66/94 (70)	236/287 (82)	17.1	.013
Before or after having visitors	21/87 (24)	106/253 (41.8)	74.2	.003
Before touching dressings or incisions	15/73 (20.5)	92/194 (47.4)	131.2	<.0001
After returning from testing or procedure areas	18/76 (23.6)	88/214 (41)	73.7	.007
Average no. of times HH performed that day	2.7	3.75	—	—

NOTE. Values are n/N (%) or as otherwise indicated.
HH, hand hygiene; *PHH*, patient hand hygiene.

Table 2
Phase 2 patient survey responses: percent change in PHH education and opportunities provided to patients

Survey dates	Surveys completed	Average frequency of PHH	PHH education provided, %	Opportunity for PHH offered, %	Before meals, %	After toileting, %	After visitors, %	Before touching dressings-incisions, %	Returning from testing, %
March 2015	80	2.4	48	68	58	66	27	37	28
March 2016	189	2.6	53	68	62	70	41	44	35
Percentage change			10.4	0.0	6.9	6.1	51.9	18.9	25.0

PHH, patient hand hygiene.

Table 3
SIRs 6 months prior to and 6 months after PHH initiative

Summary Q Y		HO-CDI events	Patient days	Expected HO-CDI	SIR	SIR *P* value*	SIR 95% confidence intervals
Q4 2014		19	21,185	22.34283444	0.85	.4928	0.527-1.303
Q1 2015		22	26,135	26.36644796	0.834	.4021	0.536-1.243
Q2 2015	PHH implemented	16	25,743	27.98729968	0.572	.0157*	0.338-0.909
Q3 2015		11	25,253	22.14398362	0.497	.0103*	0.261-0.863
Q4 2015		18	23,613	22.15018585	0.813	.3844	0.497-1.259

HO-CDI, hospital-onset *Clostridium difficile* infection; *PHH*, patient hand hygiene; *Q*, quartile; *SIR*, standardized infection ratio; *Y*, year.
*Significant *P* value ($P = .05$).

HH is associated with prevention of infection; however, a recent systematic review of PHH studies has suggested that the evidence supporting its impact on health care–associated infections is limited.[5] Improving the HH of patients has been addressed by authors who have proposed that strategies should be used to empower patients to improve their HH while in the hospital[7,8] The authors indicate the reasons for not completing HH include a lack of knowledge, inability to access facilities, and an inability to wash hands without assistance. Substantial numbers of patients do not wash their hands after bedpan or commode use even though they regularly do so after toileting in their home situation. Patients should be offered the opportunity to clean their hands and receive assistance when faced with the inability to perform the task alone.

HH studies to prevent CDI have primarily focused on health care worker HH and not on the role of the patients' hands in preventing this infection. In 2005, a review article of literature pertaining to the possible relationship of contamination of patients' hands to the transmission of health care–associated infections, suggested CDI as a prime example of an infection that could be impacted by improving PHH.[14] The authors state that the relationship between PHH and infection acquisition is inferred rather than demonstrated and that further studies should be undertaken to more firmly establish PHH as a preventive tool for CD disease.

The potential role of the bacteriology of patients' hands in the transmission of infection was demonstrated by a study that found 39% of patients' hands were contaminated with at least 1 pathogenic organism and 8% were contaminated with ≥2 pathogens within 48 hours of admission to the hospital.[15] Of 100 patients cultured during this study, 14 were positive for CD. It is reasonable to hypothesize that improving PHH can potentially remove CD from patients' hands and prevent transmission of CDI by preventing fecal-oral transmission.

The hospital environment, setup of the patient room, and physical limitations of the patient present obstacles to handwashing performance. A Department of Veterans Affairs hospital study published in 2015 suggested 4 critical moments for PHH in a patient-centered model intended to improve HH.[16] The critical moments for HH included the following: before and after touching wounds, before eating, after using the restroom, and on entering or leaving their room. This patient-centered model was then applied to surveyed patients to determine their opinions on HH and to evaluate their HH practice during hospitalization. Only 59 (10%) of patients observed during the baseline period were adequately performing HH by the 4 important moments described in this study. More significantly, only 13% were found to be cleaning their hands before meals, which would be the optimal time to prevent fecal-oral transmission. PHH increased to 79% during this institution's HH intervention.

An observational study on HH performance in hospitalized oncology patients showed similar low compliance of patients with HH and demonstrated that HH can be improved with education of health care workers on PHH.[9] This educational intervention study highlighted that nurses are the primary drivers of HH education and that encouragement from the nurse was required for patients to be compliant with HH practice. In the study, it should be observed, however, that more than half of patients interviewed reported they were not offered the opportunity to clean their hands, whereas the nursing staff reported that such opportunities were offered. This highlights one of the possible disadvantages of a patient interview-survey approach to PHH research and can contribute to a potential limitation of the present study. The impact of health care providers interacting with patients to increase HH performance was additionally reported in a long-term care facility where an interdisciplinary team worked with residents to increase their HH prior to eating a meal. This study demonstrated a sustained increase in PHH among the facility's residents after provider interaction to improve HH.[17]

Our study was also intended to improve the PHH of our patients and to study the possible effect of increased PHH opportunities on CDI events. Our study was completed in 2 phases. The first phase demonstrated that education and opportunities for PHH can be improved by educating staff members on PHH and then instructing the staff to provide their patient with education, reminders, encouragement, assistance, and opportunities to clean their hands throughout the day. The second phase of the initiative was implemented after sufficient data were collected to suggest that improving PHH could be achieved with this approach. The Nursing Professional Practice Council was engaged to plan and implement the study hospital-wide, whereas IPs were interested in answering the question as to whether PHH could influence CDI events.

HH in the hospital depends on a readily accessible and feasible mechanism of hand cleaning for the patient.[18,19] Cleaning can include soap and water washing with wash cloths, wet and dry paper towels, or a bedside alcohol wipe that is brought to the patient bedside. Although alcohol is not considered to be an effective agent for killing CD spores, it can be theorized that the alcohol wipes provided mechanical cleansing of the patients' hands, which removes organic debris and, potentially, spores from the skin surface. This mechanism can be disputed because some studies have found that a medicated-alcohol hand wipe was not as effective as soap and water or an alcohol rub in removing transient microorganism from hands.[20] It may be pointed out that a retrospective study of the incidence of CDI before and after instituting an alcohol-based handrub, published in 2010, did find that introducing alcohol sanitizer did not lead to increased CDI, even though CD spores are not completely eradicated by the alcohol-based products.[21] The authors concluded that improving HH in general influences CDI incidence. Similarly, although the alcohol wipes may not kill CD spores, improved compliance of PHH may potentially assist in controlling CD events in the hospitalized patient.

The effect of using PHH to specifically decrease CDI transmission has not been widely examined. In our study, PHH appeared to influence CDI events seen in the decrease in HO CD LabID events occurring after the PHH initiative was implemented hospital-wide. This was evident in Q2 and Q3 of 2015, which showed a statistically significant decrease in observed CD HO LabID events. A similar decrease during Q4, however, did not occur when compared with the prior quarters. The increase in CD LabID events in Q4 may attest to the importance of sustainability of an initiative and a continued need for support and education of staff to maintain a PHH initiative.

There are confounding factors and potential bias to our study. Bias could have been introduced in the selection of patients being surveyed. Only patients who were awake, alert, and available at the time of the surveys were included as participants. Patients who were unable to participate may have had a different HH experience than those who were alert and awake. Also, the patient may not have felt comfortable answering the survey questions verbally, and this could have influenced their answers. As pointed out previously, patients do not always recall events accurately in the hospital. No direct observation of patient HH was done by the surveyors. Patient responses to the number of times they had washed their hands may also vary by the time of day the survey was obtained. Patients were, however, asked if they could provide any suggestions for improvement of their HH and answers varied from having hand sanitizer at the bedside, having their nurse ask if they wanted to clean their hands, assistance to get to the sink, hand wipes with their meals, to reminders to wash throughout the day. It is recognized that some of these answers could have been suggested by the nature of the questions.

Transitioning from phase 1 to phase 2 widened the patient populations being surveyed to include all hospital units, including obstetrics, rehabilitation, clinical observation units, and intensive care units where patients may have varying HH habits depending on their acuity, mobility, mental capacities, and motivation. A much higher frequency of PHH was found initially on the labor and delivery unit (average, 4.4 times per day), for example, than on a medical-surgical floor, which reported only 1-2 HH performances per day.

Staff HH compliance had also been trending upward at our facility by approximately 5% per year because of a sustained program to improve HH compliance. Increased attention to staff HH could also have affected CD LabID events. Staff HH observations are, however, weighted heavily toward alcohol sanitizer cleansing rather than soap and water washes, which is thought to more likely impact CD LabID events.

Seasonal variations in CDI influenced by antibiotic pressure that coincide with respiratory virus season could also have exerted an effect on infection increases and decreases. CDI in our institution tends to increase during the respiratory season with increased antibiotic use. There were, however, no changes to our hospital antibiotic stewardship program during this study and no overt antibiotic influences noted by our stewardship program during or after respiratory season.

Finally, the phases of our study did take place over a 2-year time period because the nursing council committees had to collaborate with IPs to plan the initiative and hospital staff had to be trained and educated on their role as providers of PHH. Sustainability of any initiative is an issue with staff turnover and the need for constant reminders to support the effort among new staff members. Follow-up surveys in the second phase (Table 2) were performed a full year after implementation. Those survey results found that PHH had at least been sustained since implementation. Other components of our CDI prevention bundle have changed since this time, and it was not possible to continue to study the ongoing effect of PHH without additional confounding factors being added.

In future studies, it would be beneficial to perform cultures of patient hands to look specifically for CD spores and to determine what factors may influence acquisition or carriage of CD on patients' hands. It would also be beneficial to determine if patients who regularly perform HH are protected against acquisition of CDI in the hospital. A recent publication of a nonblinded, randomized trial to determine the impact of a PHH intervention in hospitalized patients using hand culture techniques, demonstrated that PHH did impact acquisition of health care–associated pathogens.[22] In patients who had negative hand cultures on admission, it was found that a PHH intervention significantly reduced the likelihood of those patients acquiring hospital-associated pathogens versus those who received standard care without emphasis on PHH. This study's intervention also included HH education, bedside access to hand sanitizer, and encouragement for patients to clean hands. Although CD recovery was not included in this research, such studies provide additional evidence that PHH can reduce the likelihood of hand acquisition of pathogens in hospitalized patients.

CONCLUSIONS

Our hospital's initiative to improve PHH through staff education and assistance to the patient was associated with decreased CDI events during the study period. PHH should be considered as a potential addition to CDI prevention measures in hospitalized patients. Sustained PHH requires participation of staff to engage the patient with opportunities, reminders, and encouragement to keep their hands clean. PHH remains a part of the CDI prevention strategies at our hospital and is considered an important part of our patient experience.

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