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On the hands of patients with *Clostridium difficile*: A study of spore prevalence and the effect of hand hygiene on *C. difficile* removal

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Abstract

The prevalence of *Clostridium difficile* (*C. difficile*) spores was assessed in 48 observations of infected inpatients. Participants were randomized to hand hygiene with either alcohol based hand rub or soap and water. *C. difficile* was recovered in 14.6% of pre-hand hygiene observations. It was still present on five of these seven participants after hand hygiene (3/3 alcohol based hand rub; 2/4 soap and water).

Keywords

Clostridium difficile; hand hygiene; infection prevention; healthcare associated infection

Background

Clostridium difficile (*C. difficile*) accounts for 12.1% of healthcare-associated infections, resulting in nearly 500,000 cases and 15,000 deaths in the United States each year(1,2). Patient hand hygiene is underutilized in infection control campaigns, although patients themselves play a key role in the transmission of infection(3). Patients are less likely to perform proper hand hygiene in a hospital than at home, because of limited mobility and the institution's perceived cleanliness (4).

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Alcohol based hand rubs (ABHR) are ineffective against *C. difficile* spores and soap and water is a key component of hand hygiene interventions during *C. difficile* infection (CDI) outbreaks(5). However, there is little literature addressing hand contamination and the role of ABHR in the disinfection of the hands of CDI patients. We conducted a study to assess the baseline prevalence of *C. difficile* on CDI patients' hands and compare the effectiveness of ABHR versus soap and water at eliminating *C. difficile* when present.

Materials and Methods

This study was conducted from October 2015 to February 2016 at a 505 bed academic hospital where multiple CDI-targeted prevention efforts were in place. These included enhanced personal protective equipment, isolation for the duration of hospitalization, and institution-wide surveillance. The study was considered quality improvement and was exempt from IRB review.

Inpatient children and adults diagnosed with active CDI were recruited into the study by convenience sampling. CDI status was defined by a positive *C. difficile* PCR test in patients with symptomatic diarrhea. Because patients started antibiotic treatment upon CDI diagnosis and often enrolled several days after diagnosis, participants were not required to have active diarrhea at enrollment. Patients younger than eight and those in the psychiatry unit were excluded. All participants provided consent before participating, with the exception of cognitively impaired patients, for whom verbal consent was provided by a family member.

All participants were randomized to ABHR or soap and water hand hygiene by an online randomization tool(6). Two rounds of microbial testing were conducted, with hand hygiene taking place between tests. In ABHR, a 62% ethanol rub was applied to participants' hands for 30 seconds. For soap and water, mobile participants washed their hands up to the wrist in the sink for 30 seconds, using ~2 ml of chlorhexidine antimicrobial soap. Cognitively impaired and limited mobility participants were assisted by a researcher using a bedside basin and pitcher of water. All participants' hands were dried with clean paper towels. A second microbial testing procedure was conducted immediately after the participant's hands dried. To prevent cross-contamination and promote patient safety, the research assistant performed hand hygiene with ABHR and donned a gown and gloves before entering all participant rooms.

The presence of *C. difficile* spores was measured using a modified version of the glove juice protocol (7). Fifty mL of sampling solution (1× PBS, 7g/L Lecithin, 6g/L sodiumthiosulfate) was utilized. Following sample collection, one aliquot of sampling solution was incorporated in *C. difficile* brucella broth and another platted on *C. difficile* brucella agar (CDBA). Both were incubated anaerobically for 48-hours at 35°C. Broth that turned from pink to yellow was streaked for isolation on a CDBA plate. Gram stain and catalase tests were run for subsequent isolates grown on CDBA, followed by standard PCR on all presumptively positive isolates for species confirmation.

Results

Forty-four unique patients participated in the study for a total of 48 observations (Table 1). The four patients who participated twice were identified during separate hospital admissions. Pre-hand hygiene cultures recovered *C. difficile* in seven observations (14.6%). Among these participants, *C. difficile* was subsequently recovered after hand hygiene on all three performing ABHR (100%) and two washing with soap and water (50%, p = 0.182). Although not statistically significant, the five participants on which *C. difficile* was recovered were more likely than those who cleared *C. difficile* to have limited mobility (80% versus 20%) and be treated with vancomycin (80% versus 0%). There was no notable difference between these groups regarding altered mental status.

C. difficile was also recovered after hand hygiene on the hands of three participants previously negative for *C. difficile* hand flora at baseline (2 of 21 ABHR, 9.5%, 1 of 20 soap and water, 5.0%; p=0.587; Figure 1). One of the three participants had limited mobility, one had both limited mobility and altered mental status, and the third had neither.

All four participants providing two observations were randomized once to ABHR and once to soap and water (eight observations total). In seven of these observations, participants were negative for *C. difficile* spores pre- and post-hand hygiene. In the eighth, the participant was positive for *C. difficile* both before and after cleaning with soap and water.

Discussion

In our study of 48 CDI observations, 14.6% had *C. difficile* spores on the hand prior to hand hygiene. This result is half the prevalence reported in a prior study assessing hand hygiene effectiveness in *C. difficile* patients (8). This previous study found that 32.1% of CDI patients and 37.5% of asymptomatic carriers had *C. difficile* on the hand at baseline. Possible reasons for these disparate results include variation in the degree and severity of CDI. Time on effective CDI treatment and type of treatment may also impact shedding of CDI (9,10). Future studies are necessary to evaluate the reasons for variation in recovery of CDI from the hands of CDI patients.

Given the unanticipated low rate of *C. difficile* recovery at baseline, our assessment of the comparative efficacy of soap and water and ABHR is limited by small sample size. It is important to note that subjects' typical hand hygiene, even with soap and water, did not always remove *C. difficile*. With numerous known impediments to proper patient hand washing in the hospital setting, including invasive medical devices, immobility, and limited access to sinks, portable hand hygiene products that are effective against spore-forming organisms like *C. difficile* are urgently needed.

Conclusions

This study highlights the need for future work to rigorously assess effective hand hygiene methods for *C. difficile*.

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Highlights

- *C. difficile* may remain on a high proportion of patient hands after soap and water.
- New *C. difficile* contamination can occur immediately after patient hand hygiene.
- Prevalence of *C. difficile* on patient hands may be lower than previously predicted.

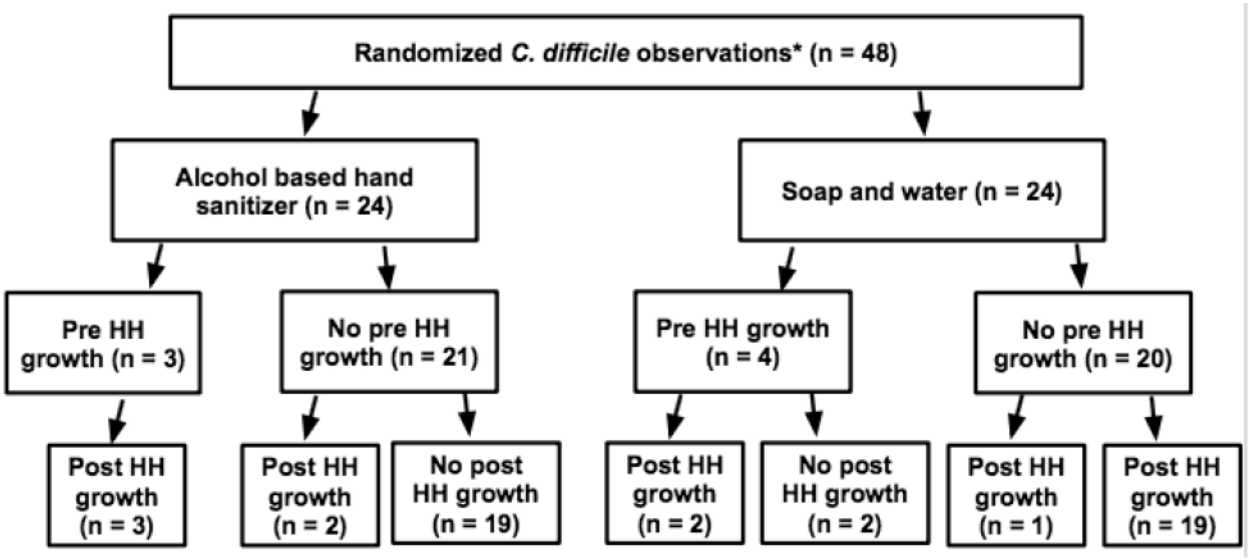

Figure 1.

C. difficile growth based on the hand hygiene method. *Four participants were tested on two distinct admissions, totaling eight observations; HH: hand hygiene

Table 1

Baseline characteristics of observations (n=48).

Characteristic	All observations (n = 48)	ABHR (n = 24)	Soap and Water (n = 24)	p-value
Sex, female	16 (33.3)	7 (29.2)	9 (37.5)	0.76
Mean age, years (IQR)	56.7 (49.5, 68.0)	58.4 (53.5, 68.3)	54.9 (48.0, 66.5)	0.45
Mean BMI (IQR)	26.9 (21.1, 29.6)	26.4 (20.3, 28.5)	27.4 (22.6, 34.0)	0.69
Altered Mental Status *	17 (36.2)	10 (41.7)	7 (30.4)	0.62
Limited Mobility *	25 (53.2)	15 (62.5)	10 (43.5)	0.31
Primary *C. difficile* antibiotic treatment at time of enrollment				0.69
Vancomycin	39 (84.8)	21 (87.5)	18 (81.8)	
Metronidazole	7 (15.2)	3 (12.5)	4 (18.1)	
Mean time between laboratory confirmed *C. difficile* infection and study enrollment, days (IQR)	5.5 (2.0, 7.0)	6.1 (2.0, 7.5)	4.8 (2.0, 7.0)	0.41

Note: Data are number (%) of observations, unless otherwise indicated. Four participants were tested on two distinct admissions, totaling eight observations. *C. difficile, Clostridium difficile;* IQR, interquartile range

* Ascertained from patient chart review