

Significant impact of terminal room cleaning with bleach on reducing nosocomial *Clostridium difficile*

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Background: We were alerted to increased rates of *Clostridium difficile*-positive tests at all 3 hospitals in our health care system by MedMined Data Mining Surveillance Service, CareFusion (San Diego, CA). In response, an intervention of terminal room cleaning with dilute bleach was instituted to decrease the amount of *C difficile* environmental spore contamination from patients with *C difficile* infection (CDI).

Methods: The intervention consisted of replacing quaternary ammonium compound as a room cleaning agent with dilute bleach to disinfect rooms of patients with CDI upon discharge. All surfaces, floor to ceiling were wiped with dilute bleach applied with towels to thoroughly wet the surfaces. Daily room cleaning remained unchanged. Patients remained on *C difficile* contact isolation precautions until discharge. To determine the effectiveness of this program, rates of nosocomial CDI for all 3 hospitals were determined using the MedMined Virtual Surveillance Interface for 10 months prior to and 2 years after the cleaning intervention. Statistical significance was determined using Poisson regression analysis.

Results: There was a 48% reduction in the prevalence density of *C difficile* after the bleaching intervention (95% confidence interval: 36%-58%, $P < .0001$).

Conclusion: The implementation of a thorough, all-surface terminal bleach cleaning program in the rooms of patients with CDI has made a sustained, significant impact on reducing the rate of nosocomial CDI in our health care system.

Key Words: *Clostridium difficile*, bleach; terminal cleaning.

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Clostridium difficile is the leading cause of hospital-acquired infectious diarrhea.¹ Rates of *Clostridium difficile*-associated diarrhea, now called *C difficile* infection (CDI), are increasing nationwide, with drug resistant and hyper-virulent strains causing severe outbreaks and death.²⁻⁴ Hospitals and chronic care facilities are reservoirs for infection because *C difficile* spores can survive on surfaces for long periods of time.⁵ Transmission most often occurs via the hands of health care workers

who have contacted contaminated surfaces.⁶ To reduce the risk of *C difficile* transmission in health care facilities, proper cleaning to eliminate the organism from the environment is essential. In May of 2005, we were alerted to an increase in patients with positive *C difficile* stool tests at all 3 hospitals in our health care system by the MedMined Data Mining Surveillance Service, CareFusion (San Diego, CA). In response, infection control policies to prevent and control CDI were reviewed, including room-cleaning procedures. A review of the literature found favorable results with the use of dilute sodium hypochlorite (bleach) to clean rooms contaminated with *C difficile*.^{6,7} Bleach cleaning for *C difficile* outbreaks is also recommended by the Centers for Disease Control and Prevention (CDC).⁸ In light of these reports, we planned an intervention using dilute bleach to clean the rooms of patients with CDI in lieu of the compound that was currently in use.

METHODS

Setting

At the time of this intervention, the NorthShore University HealthSystem was a 3-hospital system with approximately 850 beds and 40,000 annual admissions.

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Case definition

A case of hospital-acquired CDI was defined as having a positive *C difficile* stool toxin test collected more than 48 hours after admission to the hospital. Toxin results were determined by the *C difficile* Tox A/B II test by TechLab (Blacksburg, Va.). Patients meeting the case definition were determined by running a report on the MedMined Virtual Surveillance Interface.

Intervention design

On August 1, 2005, a new cleaning program was instituted as follows: The disinfectant used for the discharge cleaning of rooms of patients with CDI at all 3 hospitals was changed from a quaternary ammonium compound to dilute bleach. The bleach mixture was made fresh daily by mixing 10 parts household bleach to 90 parts tap water. This makes a solution with an approximate concentration of 5000 ppm sodium hypochlorite. The surfaces cleaned in each room remained the same; however, washing the walls was added to the list (Table 1). To clean, the surfaces were wiped with the dilute bleach by applying with heavy cloth towels to thoroughly wet the surfaces. To determine when a terminal bleach clean should be performed, the infection control preventionists (ICP) monitored the admissions of the patients with CDI and notified environmental services at time of discharge. The ICP also reminded environmental services personnel to use the bleach procedure when performing the terminal cleaning. Periodic, unannounced cleaning observations also were carried out by the ICPs to assess compliance. During the course of their admission, any patient with CDI remained on contact isolation. Any room transfer required cleaning of the vacated room with bleach. Daily routine cleaning of the *C difficile* patient rooms was performed using the hospital standard quaternary ammonium compound; bleach was only used for terminal cleaning.

Statistical analysis

To determine the effectiveness of this program, nosocomial rates of CDI were determined for all 3 hospitals from October 1, 2004, to August 31, 2007, 10 months prior to and 2 years after the cleaning intervention that began in August of 2005. Monthly patient-day figures were provided by the hospital financial database to calculate the rate. Statistical significance was determined using the Poisson regression analysis.

RESULTS

The average number of CDI patients per 1000 patient-days decreased from 0.85 in the preintervention period

Table 1. Room cleaning checklist for use at time of discharge

A. High dust
a. Ledges: shoulder and higher
b. Vents, lights
c. TV-rotate all ledges
d. TV cabinet
e. Screens and wires
B. Damp dust: Cloth rag and 1:10 dilution of bleach in bucket; damp wipe all surfaces in room
1. Room
a. Ledges (shoulder high)
b. Door handles and hinges
c. Walls to ceiling (shoulder high)
2. Bed: Top to bottom, head to foot, and left to right. Bring bed up to highest position.
a. Raise mattress and disinfect top, sides, and bottom
b. Disinfect exposed frame, springs, or bed panels
c. Headboard and footboard: disinfect top, front, and back
d. Disinfect side rails, undercarriage and lower ledges, all bed controls
3. Over-bed table
a. Disinfect surfaces and legs
b. Two-layer table top
c. Wipe out drawer
d. Wipe off mirror
4. Bedside table
a. Disinfect surface and legs
b. Wipe out drawer
5. Bathroom
a. Ledges in bathroom
b. Door handles, sinks, faucets, toilet surface
6. Shower stall and faucets
a. Wipe down walls, curtain
7. Floor
a. Wet mop-head in disinfectant
b. Mop (farthest from door) half-way room
c. Bathroom shower floor then bathroom floor
d. Flip mop head, do remainder of room

to 0.45 during bleach cleaning. This represents a 48% reduction in the prevalence density of patients with CDI for the 2 years after the bleaching intervention was implemented as compared with the prior 10 months (Fig 1). These results were statistically significant (95% confidence interval: 36%-58%, $P < .0001$).

DISCUSSION

We obtained a statistically significant decrease in the rate of patients with CDI after the implementation of the bleach cleaning program. No other infection control or nursing care practices were altered during this period of time that was directed toward *C difficile*. Hand hygiene using soap and water after caring for a *C difficile*-positive patient was already standard practice on October 1, 2004. There was no measurable improvement in hand hygiene compliance. Likewise, no antimicrobial agent formulary changes were made.

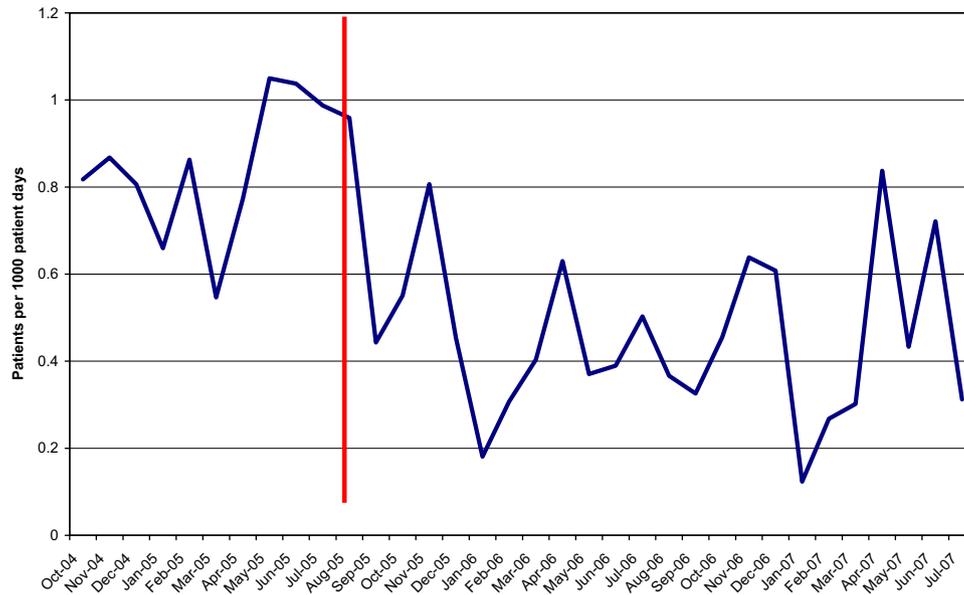


Fig 1. Rate of patients with a positive test for *C difficile* at hospital day 3 or greater before and after the implementation of a bleach cleaning intervention (indicated by the vertical line) in August 2005. Rates decreased from 0.85 CDI cases/1000 patient-days in the preintervention period to 0.45 ($P < .0001$).

Our results are similar to others who have implemented cleaning regimens with bleach to control the spread of *C difficile*. Mayfield et al performed a before-and-after intervention study on 3 patient care units replacing quaternary ammonium solution with 1:10 hypochlorite solution to clean the rooms of patients with a positive *C difficile* test.⁶ The unit with the highest incidence of CDI saw a significant decrease in the CDI rate; however, 2 other units (with rates >3.1) saw no change when bleach was used. This is different than our experience in which we saw our low rates go even lower, suggesting it is possible to decrease CDI rates even below 0.5 cases per 1000 patient-days with this cleaning method. The reason for this inconsistency is not clear; however, in the Mayfield et al report, the authors state that rooms were “cleaned routinely” with hypochlorite. Perhaps different surfaces were cleaned.

Success with bleach cleaning was also experienced by McMullen et al.⁷ In their intervention, one unit cleaned all rooms with bleach, whereas the other unit only cleaned the rooms of patients with CDI. Both units experienced a significant decrease in the amount of CDI. The second unit switched to cleaning only positive patient rooms, as was our practice, and both units maintained lowered rates of *C difficile* in a 2-year postintervention time frame. Our results and the McMullen et al⁷ experience show that bleaching only *C difficile*-positive rooms can have a positive impact. Additionally, we have shown that this cleaning is effective when performed only upon discharge. This

lower frequency bleach cleaning regimen may help to reduce concern over adverse effects of bleach on the environment and health care workers.

CDI is acquired almost exclusively in the health care setting.⁵ The health care environment is contaminated with *C difficile* spores, and they can be transferred to the patient by coming in contact with contaminated surfaces, equipment, or the hands of health care workers. *C difficile* spores survive in the environment and can remain viable on surfaces for months.⁹ The spore has a thick protein coat that renders them resistant to most chemicals including hospital cleaning agents such as quaternary ammonium compounds and alcohol hand gel.¹⁰ Thus, the right cleaning agent must be used according to manufacturers guidelines to kill *C difficile* spores. Sodium hypochlorite is one chemical that can penetrate the spore's thick protein coat and destroy the organism.¹¹

A new disinfection approach using hydrogen peroxide vapor has been studied and also shows promise.^{12,13} The benefit of a hydrogen peroxide mist system is that it can disinfect medical equipment that is difficult to clean with bleach solution and towels. The limitations of this approach are that it cannot be performed while a patient occupies a room, it needs special equipment and personnel, the cost is relatively high, and there is a longer turnaround time before the room is ready for the next patient.¹⁴

In conclusion, we demonstrated that implementation of a terminal bleach cleaning program in the

rooms of patients with CDI can have a rapid and sustainable impact on reducing the rate of nosocomial CDI. This method decreased the prevalence density of *C difficile* in our 3 hospitals, even in the setting of a low endemic rate of disease.

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