Efficacy of cleaning products for *C difficile*

Environmental strategies to reduce the spread of Clostridium difficile*–associated diarrhea in geriatric rehabilitation*

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Clostridium difficile infection (CDI) is the most frequent cause of nosocomial infectious diarrhea.[1-3] The Canadian Nosocomial Infection Surveillance Program reported an incidence of 4.74 cases of *C difficile*–associated diarrhea (CDAD) per 1000 patients admitted to hospital in Canada between January 1, 2007, and April 30, 2007.[4] In the United States, the proportion of hospital discharges in which the patient record showed a discharge diagnosis code for CDI more than doubled between 2000 and 2003; the overall rate during this period was several-fold higher ($P=.001$) in persons older than 65 years of age (228/100 000) than in the 45- to 64-year-old age group (40/100 000).[5] Incidence of CDI has also increased in Canada and Europe. While these increases have been seen in both pediatric and adult populations, elderly individuals have been disproportionately affected.[5]

Clostridium difficile–associated diarrhea is associated with increased lengths of hospital stay, costs, morbidity, and mortality among adult patients.[5,6] Patients experiencing CDAD while in hospital were almost twice as likely to be discharged to long-term care facilities.[2,7] Isolation precautions, implemented to control the spread of CDAD, can result in prolonged bed rest. Negative effects of prolonged bed rest specific to the elderly can include disorientation, delirium, psychosocial dysfunction, disruption in social support, functional decline, and physical deconditioning.[8] The loss of muscle strength during bed rest has been estimated to be as high as 5% daily, with lower limbs most affected.[9] Preventing occurrence and recurrence of CDAD is an essential aspect of geriatric practice in an institutional setting and is linked to several core values of excellence in clinical care determined by the Task Force on the Future of Geriatric Medicine (**Box 1**).[10] The challenge of managing CDAD in the elderly has been described in a recent review article.[11]

Multidisciplinary team strategies are necessary to help prevent this devastating problem.

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Cet article a fait l'objet d'une révision par des pairs.
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Abstract

OBJECTIVE To review the evidence for the efficacy of products used for environmental or hand cleaning on the rates of *Clostridium difficile*–associated diarrhea (CDAD).

QUALITY OF EVIDENCE MEDLINE, EMBASE, and the Cochrane Database of Systematic Reviews were searched for articles pertinent to the efficacy of cleaning products against *C difficile* or studies with outcomes related to rates of CDAD. Evidence was level II.

MAIN MESSAGE Minimizing the incidence of CDAD in geriatric rehabilitation units is essential to achieving the goals of increasing patient function and independence for discharge into the community. Attention to environmental control of *C difficile* and its spores by health care workers and patient visitors is an important secondary prevention strategy.

CONCLUSION Chlorine-releasing agents are more effective than detergents for killing spores produced by *C difficile*. No level I evidence is available to determine if the use of chlorine-releasing agents has an effect on rates of CDAD. Hand-washing is currently the recommended strategy for reducing transmission of *C difficile*. Alcohol gels do not inactivate *C difficile* spores; however, increased use of alcohol hand gel has not been associated with higher rates of CDAD.

Résumé

OBJECTIF Examiner les preuves indiquant que les produits utilisés pour nettoyer l'environnement et les mains sont efficaces pour réduire le taux de diarrhée due au *Clostridium difficile* (DDCD).

QUALITÉ DES PREUVES On a consulté MEDLINE, EMBASE et la Cochrane Database of Systematic Reviews en retenant les articles portant sur l'efficacité des agents de nettoyage contre le *C difficile* ou les études traitant de questions liées aux taux de DDCD. Les preuves étaient de niveau II.

PRINCIPAL MESSAGE La réduction de l'incidence de la DDCD dans les unités de réadaptation gériatrique est une condition essentielle pour accroître l'état fonctionnel et l'indépendance des patients qui retournent dans la communauté. Pour les intervenants et pour les visiteurs des patients, le contrôle du *C difficile* et de ses spores dans l'environnement est primordial comme stratégie de prévention secondaire.

CONCLUSION Les agents qui libèrent du chlore sont plus efficaces que les détergents pour tuer les spores du *C difficile*. Il n'existe pas de preuves de niveau I indiquant que l'utilisation d'agents libérant du chlore influence les taux de DDCD. Le lavage des mains est la stratégie présentement recommandée pour réduire la transmission du *C difficile*. Les gels d'alcool n'inactivent pas les spores du *C difficile*; toutefois, une utilisation accrue de gels d'alcool n'a pas entraîné d'augmentation du taux de DDCD.

Guidelines for infection prevention and control in hospitals are well documented (**Box 2**).[5] Recent literature supports the importance of antimicrobial stewardship.[5]

While *C difficile* shares many transmission risk factors with other organisms in terms of infection prevention, its ability to form spores has unique implications for hand hygiene and environmental disinfection strategies. The *C difficile* spores are resistant to the bactericidal effects of alcohol and most hospital disinfectants.[5] The importance of addressing the incidence of spores in the environment is essential to controlling the spread of CDAD, as colonization of *C difficile* from an exogenous source is an essential prerequisite for CDAD (**Box 3**).[6,12-16]

The aim of this article is to describe the available evidence for the role of cleaning products in preventing the spread of CDAD in hospitals and its relevance in the elderly population receiving inpatient rehabilitation care. Additionally, evidence on the controversial issue of increased use of alcohol-based hand rubs is explored. Within the inpatient geriatric rehabilitation setting, care is provided primarily by family physicians. As such, they play an important role in providing leadership related to hospital-specific infection control guideline development and on-unit compliance with environmental infection control measures.

Box 1. Selected attributes and competencies for excellence in geriatric care

- Patient-centred care that respects patient and family preferences and balances the burden of therapies with potential benefits
- Comprehensive care that addresses mental health and social issues as well as medical conditions
- Coordinated care that includes communication among providers
- Interdisciplinary team care with shared responsibility for patient care processes and outcomes
- Commitment to quality and its continuous improvement
- Focus on function and quality of life as outcomes
- Prevention (primary, secondary, and tertiary) and rehabilitation as strategies to preserve, maintain, and restore function and prevent disability and dependency
- Emphasis on patient safety and avoiding iatrogenesis

Adapted from Besdine et al.[10]

Box 2. General strategies to prevent *Clostridium difficile* infection

To reduce the risk of *Clostridium difficile*–associated diarrhea (CDAD) in colonized patients ...
- follow antimicrobial usage restriction and stewardship guidelines.

To prevent patient colonization ...
- avoid the use of electronic thermometers; the handles become contaminated with *C difficile*.
- use dedicated patient care items and equipment; if items must be shared, clean and disinfect the equipment between patients.
- use full barrier precautions (gowns and gloves) for contact with patients with CDAD and for contact with their body substances and environment (contact precautions).
- place patients with CDAD in private rooms and lavatories, if available; give isolation preference to patients with fecal incontinence if room availability is limited.
- perform meticulous hand hygiene; perform hand hygiene with soap and water preferentially, ensuring that proper hand-washing techniques are used.
- perform environmental decontamination of rooms housing patients with CDAD.
- educate health care personnel and hospital administration about the clinical features, transmission, and epidemiology of CDAD.

Adapted from Dubberke et al.[5]

Box 3. Prerequisites and risk factors for *Clostridium difficile*–associated diarrhea

Prerequisites
- Colonization with *C difficile* from an exogenous source
- Disruption in the normal gastrointestinal flora

Risk factors for occurrence
- Antibiotic exposure
- Being 65 years of age or older
- An immunocompromised state
- Critical illness
- Long length of stay in hospital (greater than 7 days)
- Being bedridden
- Being unable to perform activities of daily living

Risk factors for recurrence (occurs in 15% to 55% of cases)
- Being 65 years of age or older
- Greater severity of initial infection or symptoms
- Renal insufficiency
- Recent gastrointestinal surgery
- Re-exposure to antibiotics

Data from Pépin et al,[6] Tonna and Welsby,[12] Barbut and Petit,[13] Manian et al,[14] Gianasca and Warny,[15] and Starr.[16]

Quality of evidence

We searched MEDLINE (January 1996 to November 2008), EMBASE (1998 to 2009), and the Cochrane Database of Systematic Reviews using the key words Clostridium difficile, *CDAD,* Clostridium *infection, cleaning agents, detergents,* and *disinfectants* to find English-language reports on cleaning products effective against *C difficile* spores. A manual search of references in articles found was also completed. Ten reports describing efficacy of cleaning

Levels of evidence

Level I: At least one properly conducted randomized controlled trial, systematic review, or meta-analysis
Level II: Other comparison trials, non-randomized, cohort, case-control, or epidemiologic studies, and preferably more than one study
Level III: Expert opinion or consensus statements

agents on *C difficile* spores and 5 studies describing the use of hand cleaning agents were found in total. Evidence was level II.

Cleaning products for environmental control

Clostridium difficile bacteria are not part of the normal gastrointestinal flora. One of the prerequisites for CDAD is colonization with *C difficile* from an exogenous source. Surfaces that become contaminated with feces can serve as reservoirs for *C difficile*. Although the vegetative form of *C difficile* is fragile, it is capable of sporulating when environmental conditions do not support growth. Spores produced by *C difficile* can persist in the environment for extended periods of time.[3] *Clostridium difficile* spores have been isolated from numerous surfaces in patient rooms including commodes, bed railings, nursing call devices, and clothing.[17] Additionally, *C difficile* spores have been shown to persist as a skin contaminant on patients even after their diarrhea resolves, which can serve as a reservoir for health care provider transmission to other patients.[18]

Reducing environmental sources of *C difficile* spores is likely to reduce *C difficile* colonization in hospitalized patients, which might in turn reduce rates of CDAD. To reduce the number of spores in the environment, the Centers for Disease Control and Prevention recommend using chlorine-releasing products after meticulous cleaning to remove organic material.[3] Health Canada guidelines simply state that during an outbreak thorough environmental cleaning with a disinfectant of demonstrated effectiveness might be required.[19]

Evidence to support decision making about the use of environmental cleaners is weak. Of concern is the limited data linking choice of cleaning agent to rates of CDAD. Furthermore, there is no level I evidence to support the efficacy of any one chemical germicide for reducing the presence of spores in the environment. Our search yielded 9 studies and 1 research letter describing research into the efficacy of cleaning products against *C difficile* spores. Four studies compared cleaning agents in the laboratory setting to determine efficacy against *C difficile* spores (**Table 1**),[20-23] the research letter reported the effects of different cleaning agents on the rate of sporulation in the laboratory setting,[24] and 2 studies reported the effects of cleaning agents on *C difficile* spore levels in the hospital environment.[25,26] Only 3 studies described the effects of cleaning agents on rates of CDAD in the hospital setting (**Table 2**).[27-29]

Effects of cleaning agent choice on sporulation rates in the laboratory setting. All studies tested commercially available products. Of the agents tested, those containing high levels of chlorine (5000 mg/L free chlorine) showed consistent efficacy against *C difficile* spores.[21] Lower dilutions of chlorine (1000 and 3000 mg/L free chlorine) showed inconsistent capacity to eradicate spores; 1 author reported efficacy[20] and 2 reported benefit only with extended exposure.[21,22] Hydrogen peroxide had mixed results, with 1 report describing no benefit[20]; however, no concentration was provided. Hydrogen peroxide at a concentration of 7% showed efficacy similar to high levels of chlorine.[21] Peracetic acid also showed mixed results,[22,23] with benefit shown only when a spore suspension was exposed to a peracetic acid solution at a ratio of 1:4,[23] which is not reflective of hospital cleaning practices. Detergent alone or 70% isopropyl alcohol showed no benefit.[20,23]

Of interest is the effect of subinhibitory levels of cleaning agents on the sporulation capacity of *C difficile*. One study showed that exposure to low levels of cleaning agents resulted in higher sporulation capacity compared with no exposure to cleaning agents, suggesting that sporulation capacity might increase in response to environmental stresses such as cleaning.[24]

Effects of cleaning agent choice on sporulation rates in the hospital environment. A recent study explored the adequacy of cleaning procedures and disinfection practices on sporulation rates in a hospital environment.[25] During the 6-week study, commonly touched surfaces in rooms of patients with CDAD were cultured before and after housekeeping cleaned and again after researchers performed a second cleaning. Housekeeping cleaning protocols included using a clean cloth or mop soaked in 10% bleach, and researchers applied a 10% bleach solution using a spray bottle. All of the 9 rooms tested had cultures positive for *C difficile* before cleaning, 7 (78%) had cultures positive for *C difficile* after being cleaned by housekeeping, and 1 (11%) had cultures positive for *C difficile* after being cleaned by research staff. The authors reported that after the study was complete, cleaning staff were given additional time for cleaning (30 minutes per room), were trained to disinfect frequently touched surfaces (eg, bed rails, bedside tables, call buttons, telephones), and were trained to complete their cleaning with a 10% bleach solution spray.[25]

A second study assessed the level of environmental *C difficile* in a variety of clinical areas, including geriatric care wards, after dry-mist hydrogen peroxide decontamination.[26] The clinical areas included were selected to

Table 1. Summary of studies comparing the effects of cleaning agents on *Clostridium difficile* spores

STUDY	AGENTS INCLUDED	METHODS	OUTCOMES
Fawley et al,[20] 2007	Anionic surfactant and NaDCC (1000 mg/L free chlorine)* Detergent and hypochlorite* NaDCC alone (1000 mg/L free chlorine)* Nonionic surfactant and phosphate Hydrogen peroxide (concentration not provided)	Solution of mature spores were exposed to cleaning agents for 0, 10, 20, and 30 min, cleaned then incubated anaerobically for 48 h; results interpreted in comparison to nonexposed control preparations	All 3 chlorine-containing agents inactivated vegetative cells and spores within 10 min of exposure; exposure to detergent (nonionic surfactant and phosphate) or hydrogen peroxide resulted in no difference in the number of viable spores compared with controls at 30 min
Perez et al,[21] 2005	Chlorine dioxide equal to 600 mg/L free chlorine* Acidified bleach equal to 5000 mg/L free chlorine* Domestic bleach in 3 dilutions (5000 mg/L free chlorine, 3000 mg/L free chlorine, and 1000 mg/L free chlorine)* 7% hydrogen peroxide	Spores were grown anaerobically and heated to kill vegetative cells; stainless steel disks were contaminated with spore suspension and exposed to cleaning agents for 10, 15, or 30 min; after neutralizing the cleaning agent, agar plates were inoculated with the contents of each disk and incubated for 2 and 5 d	Acidified bleach, regular bleach (5000 mg/L free chlorine), and 7% hydrogen peroxide inactivated spores within 10 min of exposure; chlorine dioxide and domestic bleach at 3000 mg/L and 1000 mg/L free chlorine were all able to inactivate spores; however, exposure times were longer (up to 30 min)
Block,[22] 2004	0.26% peracetic acid—a biocide with manufacturer claims of sporicidal activity NaDCC tablets (1000 mg/L free chlorine)*	Spores were grown anaerobically on blood agar plates and harvested by suspending the cultures in methanol; equal aliquots of spore suspensions were dried on stainless steel disks and PVC floor covering material; each material was exposed to the test solutions for 3, 5, or 10 min, after which time remaining viable spores were counted	Neither agent was effective in eradicating the spores, although both agents reduced spore counts; on stainless steel, at 10 min, peracetic acid exposure resulted in a 6 $\log_{10}$ reduction in viable spores compared with a 0.7 $\log_{10}$ reduction in viable spores with NaDCC (P=.011); on PVC, the $\log_{10}$ reduction in viable spores for peracetic acid (2.7) and NaDCC (0.9) were not statistically different
Wullt et al,[23] 2003	70% isopropanol 2% glutaraldehyde 0.26% peracetic acid Acidified nitrite	*C difficile* bacteria and spores were grown anaerobically on blood agar for 48 h; vegetative cells were killed using ethanol, and spores were suspended in water to which disinfecting agents were added for 5, 15, and 30 min before being inactivated	Glutaraldehyde, peracetic acid, and acidified nitrite reduced spore counts by 99% after 15-min exposure; glutaraldehyde has been associated with dermatitis and symptoms of asthma secondary to exposure; isopropanol showed no effect on spore viability even after 30-min exposure

NaDCC—sodium dichloroisocyanurate, PVC—polyvinyl chloride.
*Chlorine-releasing product.

represent high-, moderate-, and low-risk areas, based on the existing *C difficile* infection rates at the facilities enrolled in the study. Three geriatric wards (10 rooms) represented high-risk areas; 2 isolation rooms on a hematology unit represented moderate-risk areas; and 2 isolation rooms (1 in an obstetric ward and 1 in an elective orthopedic ward) represented low-risk areas. After cleaning but before decontamination, 100% of geriatric care rooms had at least 1 culture positive for *C difficile*. After decontamination, 5 rooms had 1 or more positive cultures for *C difficile* (P=.033). Of 203 cultures taken in the 10 rooms, 48 (24%) were positive for *C difficile* before decontamination and 7 (3%) were positive for *C difficile* after decontamination (P<.0001). Although these benefits were not achieved in the moderate- and low-risk rooms,[26] this suggests that additional cleaning strategies in high-risk areas might provide protection from exposure to *C difficile* spores.

Effects of cleaning agent choice on rates of CDAD. Our search yielded 3 studies describing the effects of cleaners on rates of CDAD.[27-29] Changes in the rates of CDAD in geriatric medicine units cleaned with hypochlorite disinfectant were inconsistent.[28] In medical and surgical intensive care unit settings, rates of CDAD were reduced following a change in cleaning protocols

Table 2. Summary of studies comparing cleaning agents on rates of CDAD

STUDY	AGENTS INCLUDED	METHODS	OUTCOMES
Mayfield et al,[27] 2000	Unbuffered 1:10 hypochlorite solution* Quaternary ammonium solution	9-month before-and-after design comparing cleaning with hypochlorite or detergent on rates of CDAD; 3 units were included (bone marrow transplant, neurosurgical ICU, and general medicine)	Before use of hypochlorite, rates of CDAD were 8.6, 3.0, and 1.3 cases per 1000 patient-days for bone marrow transplant, neurosurgical ICU, and general medicine, respectively; after implementing the hypochlorite cleaning protocol, CDAD rates fell to 3.3 (HR 0.37, 95% CI 0.19-0.74) for bone marrow transplant, but did not change significantly on the other units; on return to the original disinfectant protocol in the bone marrow transplant unit, rates of CDAD returned to prestudy levels of 8.1 cases per 1000 patient-days
Wilcox et al,[28] 2003	Hypochlorite disinfectant* Neutral detergent	2-year ward-based crossover study comparing effects of environmental cleaning with either hypochlorite or detergent on CDI	One ward experienced a drop in CDI incidence from 8.9 to 5.3 cases per 100 admissions ($P<.05$); the other ward showed an increase in CDI incidence to 4.7 from 3.5 per 100 admissions ($P<.05$)
McMullen et al,[29] 2007	Quaternary ammonium detergent Household bleach (diluted to 5000 mg/L free chlorine) and hypochlorite containing towels to clean equipment such as computers and monitoring equipment in patient rooms*	5-month before-and-after study comparing effects of changing to a chlorine-releasing cleaning agent from a detergent cleaner in a medical ICU and surgical ICU following an outbreak of CDAD	The outbreak resulted in an increase in the monthly rates of CDAD to 16.6 and 10.4 cases per 1000 patient-days from 5.3 and 2.5 cases per 1000 patient-days, respectively; postintervention, rates in the medical ICU and surgical ICU were 3.7 and 2.2 cases per 1000 patient-days, respectively

CDAD—*Clostridium difficile*–associated diarrhea, CDI—*Clostridium difficile* infection, CI—confidence interval, HR—hazard ratio, ICU—intensive care unit.
*Chlorine-releasing product.

that included adding chlorine-releasing cleaners and chlorine-containing towels for computers and monitors.[29] Use of chlorine-containing cleaners was shown to be beneficial for reducing rates of CDAD in a bone marrow transplant unit; the CDAD rate increased to preintervention rates once the cleaning protocol was discontinued. Rates of CDAD in the neurosurgical intensive care unit and general medicine ward were lowered, but results were not statistically significant.[27]

Although chlorine-releasing agents are more effective for killing spores than detergents are in the laboratory setting, efficacy related to reducing levels of spores in the environment or rates of CDAD in the hospital has not been consistently shown. The advantages and disadvantages of chlorine cleaners are considerations for their use in hospitals and are described in **Box 4**.[19]

Hand washing versus the use of alcohol-based hand rubs

Clostridium difficile spores colonize patients mainly via the hands (fecal-oral route) of health care personnel or visitors who have touched a contaminated surface or item.[3,30] Concern over the increased use of alcohol-based hand gels (ABHGs) and rates of CDAD have been explored in 4 published reports.[31-34] One 3-year retrospective study in a 500-bed teaching hospital where ABHGs were promoted showed that hygiene compliance rose from 38% to 63% with promotion; 85% of hand hygiene was achieved with ABHGs and 15% with hand-washing. Rates of CDAD per 1000 patient-days rose from 1.74 to 2.33 in the first year, then decreased to 1.14 and 1.18 in the subsequent 2 years, respectively.

Box 4. Advantages and disadvantages of chlorine-releasing cleaners

Advantages
- Low cost
- Fast acting
- Readily available in nonhospital settings

Disadvantages
- Corrosive to metals
- Inactivated by organic material
- Irritant to skin and mucous membranes
- Unstable when diluted to usable state (1:9 parts water)
- Reduced shelf-life when diluted
- Good ventilation recommended for area where being used

Data from the Steering Committee on Infection Control Guidelines.[19]

Statistical significance for the change in CDAD rates between years was not reported.[31] Another report from a 600-bed teaching hospital showed that in the 3 months following an intensive marketing campaign to promote the use of ABHGs, there was a non-significant decrease in CDAD cases of 17.4% ($P=.2$).[34] Similar results have been reported in studies that included geriatric rehabilitation and long-term care beds.[32,33] One report described an increase in the use of ABHGs (1.3 L to 2.0 L per 100 patient-days) over 6 years in a 2200-bed hospital that included 761 rehabilitation, geriatric, and long-term care beds. There was a non-significant ($P=.82$) improvement in rates of CDAD (numbers not reported) during that period.[32] Another 287-bed facility with 120 long-term care beds reported that over 6 years the promotion of ABHGs resulted in no change in the rate of CDAD (3.24 to 3.38 cases per 10 000 patient care days, $P=.78$).[33]

At the 2009 Society for Healthcare Epidemiology of America 19th Annual Scientific Meeting, results of the efficacy of hand-wash products on spore removal were reported.[35] Subjects whose palms were inoculated with *C difficile* spores performed a 15-second wash followed by a 15-second rinse with 3 products: a 4% chlorhexidine gluconate antimicrobial hand wash, a 0.3% triclosan antimicrobial hand wash, and a non-antimicrobial body wash. Tap water and a heavy-duty hand cleaner (used for extreme soiling in manufacturing environments) were used as controls. A $\log_{10}$ reduction in spore count from baseline was determined for each product. All products were statistically equivalent in their ability to reduce spore count and were comparable to tap water (achieving a reduction of approximately 1 $\log_{10}$), except for the heavy-duty hand cleaner (which achieved a significantly greater $\log_{10}$ reduction of 1.21 in spore count; no *P* values were provided).[35]

Conclusion

Choice of hospital decontamination products specified in CDAD cleaning protocols can influence the prevalence and environmental distribution of *C difficile* contamination and resulting patient colonization. Use of chlorine-releasing, hypochlorite-based cleaners or hydrogen peroxide in rooms exposed to *C difficile* spores can reduce the number of spores within the environment with some evidence to suggest it also can reduce the risk of recurrence and spread of CDAD. Evidence is strongest for products with higher concentrations of disinfecting agents (eg, 5000 mg/L free chlorine or 7% hydrogen peroxide). The benefits of chlorine use might be greater in units where rates of CDAD are high (eg, geriatric rehabilitation or assessment units) or in response to outbreaks of CDAD. Additionally, effectiveness of cleaning agents used in the hospital environment on levels of spores and, more important, rates of CDAD, might be related to training and time-constraints of cleaning staff.

EDITOR'S KEY POINTS

- Preventing occurrence and recurrence of *Clostridium difficile*–associated diarrhea (CDAD) is an essential aspect of geriatric practice in an institutional setting.
- This article describes the available evidence for the role of cleaning products in preventing the spread of CDAD in hospitals and its relevance to the elderly population receiving inpatient rehabilitation care.
- Of the commercially available products tested, those that contained high levels of chlorine (5000 mg/L free chlorine) showed consistent efficacy against *C difficile* spores. Lower dilutions of chlorine (1000 and 3000 mg/L free chlorine) showed inconsistent capacity to eradicate spores (1 study reported efficacy and 2 reported benefit only with extended exposure). Detergent alone or 70% isopropyl alcohol showed no benefit.
- Although wearing gloves and washing hands thoroughly are currently considered optimal strategies to reduce the hand distribution of *C difficile* spores among health care workers and hospital visitors, use of alcohol-based hand rubs is unlikely to positively or negatively influence the rate of CDAD.

POINTS DE REPÈRE DU RÉDACTEUR

- La prévention de l'éclosion et de la récurrence de la diarrhée due au *Clostridium difficile* (DDCD) est un aspect essentiel de la pratique gériatrique chez les patients institutionnalisés.
- Cet article résume les données probantes concernant le rôle des produits de nettoyage pour prévenir la propagation de la DDCD à l'hôpital et son importance pour la population âgée recevant des soins hospitaliers de réadaptation.
- Parmi les différents produits commerciaux testés, ceux contenant des niveaux élevés de chlore (5000 mg/L de chlore libre) se sont montrés régulièrement efficaces contre les spores du *C difficile*. Les dilutions plus faibles (1000 et 3000 mg/L de chlore libre) avaient une capacité inégale pour éradiquer les spores (une étude les trouvait efficaces et 2 autres, seulement avec une exposition prolongée). L'alcool isopropylique à 70 % ou un détergent seul n'étaient pas utiles.
- Quoique le port de gants et le lavage minutieux des mains soient toujours considérés comme la meilleure façon de réduire la dissémination des spores du *C difficile* chez les intervenants de la santé et les visiteurs de l'hôpital, il est peu probable que le fait de se frotter les mains avec de l'alcool ait une quelconque influence sur le taux de DDCD.

Although wearing gloves and washing hands thoroughly are currently considered optimal strategies to reduce the hand carriage of *C difficile* spores among

health care workers and hospital visitors, the use of alcohol-based hand rubs is unlikely to positively or negatively influence the rate of CDAD in any given environment.

Increased rates of CDAD, as recently published in the literature, translate to higher morbidity and mortality for patients, especially seniors, and create a greater burden on the health care system as a whole. Strategies aiming to reduce recurrence and spread of CDAD are needed. This is particularly true in geriatric rehabilitation units, where numerous providers are intimately involved in each patient's care on a daily basis.

Family physicians can play an important role in providing leadership to ensure geriatric rehabilitation facility policies and protocols incorporate cleaning strategies into the bundle of infection control and prevention strategies employed. Awareness and knowledge of the evidence regarding CDAD risks and effective interventions are necessary to providing that leadership.

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Contributors
Both authors contributed to the literature search and preparation of the article.

Competing interests
None declared

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References

1. Gravel D, Miller M. *Ongoing surveillance for* Clostridium difficile *associated diarrhea (CDAD) within acute-care institutions.* Ottawa, ON: Canadian Nosocomial Infection Surveillance Program, Public Health Agency of Canada; 2007.
2. Miller MA, Hyland M, Ofner-Agostini M, Gourdeau M, Ishak M; Canadian Hospital Epidemiology Committee. Canadian Nosocomial Infection Surveillance Program. Morbidity, mortality and healthcare burden of nosocomial *Clostridium difficile*-associated diarrhea in Canadian hospitals. *Infect Control Hosp Epidemiol* 2002;23(3):137-40.
3. Schulster LM, Chinn RY, Arduino MJ, Carpenter J, Donlan R, Ashford D, et al. *Guidelines for environmental infection control in health-care facilities. Recommendations from CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC).* Chicago IL: American Society for Healthcare Engineering, American Hospital Association; 2004.
4. Health Canada. *Surveillance for* Clostridium difficile *associated diarrhea: preliminary results from January 1 to April 30, 2007.* Ottawa, ON: Health Canada; 2007.
5. Dubberke ER, Gerding DN, Classen D, Arias KM, Podgorny K, Anderson DJ, et al. Strategies to prevent *Clostridium difficile* infections in acute care hospitals. *Infect Control Hosp Epidemiol* 2008;29(Suppl 1):S81-92.
6. Pépin J, Valiquette L, Cossette B. Mortality attributable to nosocomial *Clostridium difficile*-associated disease during an epidemic caused by a hypervirulent strain in Quebec. *CMAJ* 2005;173(9):1037-42.
7. Dubberke ER, Butler AM, Reske KA, Agniel D, Olsen MA, D'Angelo D, et al. Attributable outcomes of *Clostridium difficile*-associated disease in non-surgical patients. *Emerg Infect Dis* 2008;14(7):1031-8.
8. De Morton NA, Keating JL, Jeffs K. Exercise for acutely hospitalized older medical patients. *Cochrane Database Syst Rev* 2007;(1):CD005955.
9. Tsilmingras D, Rose AK, Berlowitz DR. Patient safety in geriatrics: a call for action. *J Gerontol A Biol Sci Med Sci* 2003;58(9):M813-9.
10. Besdine R, Boult C, Coleman EA. Caring for older Americans: the future of geriatric medicine. *J Am Geriatr Soc* 2005;53(6 Suppl):S245-56.
11. Kelly CP. A 76-year-old man with recurrent *Clostridium difficile*-associated diarrhea: review of *C difficile* infection. *JAMA* 2009;301(9):954-62. Epub 2009 Feb 3.
12. Tonna I, Welsby PD. Pathogenesis and treatment of *Clostridium difficile* infection. *Postgrad Med J* 2005;81(956):367-9.
13. Barbut F, Petit JC. Epidemiology of *Clostridium difficile*-associated infections. *Clin Microbiol Infect* 2001;7(8):405-10.
14. Manian FA, Aradhyula S, Greisnauer S, Senkel D, Setzer J, Wiechens M, et al. Is it *Clostridium difficile* infection or something else? A case-control study of 352 hospitalized patients with new-onset diarrhea. *South Med J* 2007;100(8):782-6.
15. Gianasca PJ, Warny M. Active and passive immunization against *Clostridium difficile* diarrhea and colitis. *Vaccine* 2004;22(7):848-56.
16. Starr J. *Clostridium difficile* associated diarrhea: diagnosis and treatment. *BMJ* 2005;331(7515):498-501.
17. Government of Manitoba. Clostridium difficile*-associated diseases (CDAD) infection control guidelines.* Winnipeg, MB: Government of Manitoba; 2006.
18. Bobulsky GS, Al-Nassir WN, Riggs MM, Sethia AK, Donskey CJ. *Clostridium difficile* skin contamination in patients with *C difficile*-associated disease. *Clin Infect Dis* 2008;46(3):447-50.
19. Laboratory Centre for Disease Control, Bureau of Infectious Diseases, Health Canada. Hand washing, cleaning, disinfection and sterilization in health care. *Can Commun Dis Rep* 1998;24(Suppl 8):1-57.
20. Fawley WN, Underwood S, Freeman J, Baines SD, Saxton K, Stephenson K, et al. Efficacy of hospital cleaning agents and germicides against epidemic *Clostridium difficile* strains. *Infect Control Hosp Epidemiol* 2007;28(8):920-5. Epub 2007 Jun 15.
21. Perez J, Springthorpe VS, Sattar SA. Activity of selected oxidizing microbicides against the spores of *Clostridium difficile*: relevance to environmental control. *Am J Infect Control* 2005;33(6):320-5.
22. Block C. The effect of perasafe and sodium dichloroisocyanurate (NaDCC) against spores of *Clostridium difficile* and *Bacillus atrophaeus* on stainless steel and polyvinyl chloride surfaces. *J Hosp Infect* 2004;57(2):144-8.
23. Wullt M, Odenholt I, Walder M. Activity of three disinfectants and acidified nitrite against *Clostridium difficile* spores. *Infect Control Hosp Epidemiol* 2003;24(10):765-8.
24. Wilcox MH, Fawley WN. Hospital disinfectants and spore formation by *Clostridium difficile. Lancet* 2000;356(9238):1324.
25. Eckstein BC, Adams DA, Eckstein EC, Rao A, Sethis AK, Yadavalli GK, et al. Reduction of *Clostridium difficile* and vancomycin-resistant *Enterococcus* contamination of environmental surfaces after an intervention to improve cleaning methods. *BMC Infect Dis* 2007;7:61.
26. Shapey S, Machin K, Levi K, Boswell TC. Activity of a dry mist hydrogen peroxide system against environmental *Clostridium difficile* contamination in elderly care wards. *J Hosp Infect* 2008;70(2):136-41. Epub 2008 Aug 9.
27. Mayfield JL, Leet T, Miller J, Mundy LM. Environmental control to reduce transmission of *Clostridium difficile. Clin Infect Dis* 2000;31(4):995-1000. Epub 2000 Oct 25.
28. Wilcox MH, Fawley WN, Wigglesworth N, Parnell P, Verity P, Freeman J. Comparison of the effect of detergent versus hypochlorite cleaning on environmental contamination and incidence of *Clostridium difficile* infection. *J Hosp Infect* 2003;54(2):109-14. Erratum in: *J Hosp Infect* 2004;57(3):267.
29. McMullen KM, Zack J, Coopersmith CM, Kollef M, Dubberke E, Warren DK. Use of hypochlorite solution to decrease rates of *Clostridium difficile*-associated diarrhea. *Infect Control Hosp Epidemiol* 2007;28(2):205-7. Epub 2007 Jan 26.
30. Boyce JM, Pittet D; Healthcare Infection Control Practices Advisory Committee; HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. Guideline for hand hygiene in health-care settings: recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. Society for Healthcare Epidemiology of America/Association for Professionals in Infection Control/Infectious Diseases Society of America. *MMWR Recomm Rep* 2002;51(RR-16):1-48.
31. Boyce JM, Ligi C, Kohan C, Dumigan D, Havill NL. Lack of association between the increased incidence of *Clostridium difficile*-associated disease and the increasing use of alcohol-based hand rubs. *Infect Control Hosp Epidemiol* 2006;27(5):479-83. Epub 2006 Apr 26.
32. Vernaz N, Sax H, Pittet D, Bonnabry P, Schrenzel J, Harbarth S. Temporal effects of antibiotic use and hand rub consumption on the incidence of MRSA and *Clostridium difficile. J Antimicrob Chemother* 2008;62(3):601-7. Epub 2008 May 8.
33. Gordin FM, Schultz MI, Huber RA, Gill JA. Reduction in nosocomial transmission of drug-resistant bacteria after introduction of an alcohol-based handrub. *Infect Control Hosp Epidemiol* 2005;26(7):650-3.
34. Gopal Rao G, Jeanes A, Osman M, Aylott C, Green J. Marketing hand hygiene in hospitals—a case study. *J Hosp Infect* 2002;50(1):42-7.
35. Edmonds SE, Kasper D, Zapka C, Barnhart R, Gerber R, Macinga D, et al. *Clostridium difficile* and hand hygiene: spore removal effectiveness of hand wash products. Paper presented at: Society for Healthcare Epidemiology of America 19th Annual Scientific Meeting; March 2009; San Diego, CA.