

# Bleach-Based Disinfectants in Healthcare Settings

Summary of Clinical Evidence



## **Table of Contents**

### Healthcare-Associated Infection (HAI) Reduction

Study #1	<b>80% decrease in </b> <i>C. difficile</i> -associated diarrhea rates with bleach surface disinfection Infection Control and Hospital Epidemiology, 2007	4
Study #2	70% CDI rate decrease with Clorox Healthcare® Bleach Germicidal Cleaner surface disinfection The Joint Commission Journal on Quality and Patient Safety, 2013	5
Study #3	61% decrease in the rate of <i>C. difficile</i> -associated diarrhea with bleach use on surfaces Clinical Infectious Diseases, 2000	6
Study #4	<b>50% decrease in HO-CDI with daily hospital-wide bleach surface disinfection</b> Infection Control and Hospital Epidemiology, 2023	7
Study #5	<b>49% HO-CDI modeled rate reduction with daily sporicidal surface disinfection</b> Infection Control and Hospital Epidemiology, 2020	8
Study #6	<b>48% and 85% CDI rate reduction with daily and terminal bleach surface disinfection</b> Journal of Patient Safety, 2020	9
Study #7	<b>48% reduction in CDI prevalence density with terminal bleach surface disinfection</b> American Journal of Infection Control, 2010	10
Study #8	<b>45% and 85% CDI rate reduction with bleach surface disinfection and auditing</b> Infection Control and Hospital Epidemiology, 2017	11
Study #9	<b>40% reduction in CDI incidence sustained for 21 months with a ready-to-use bleach solution</b> Infection Control and Hospital Epidemiology, 2009	.12
Study #10	MDRO and HAI rate reduction in multiple facilities with bleach surface disinfection Journal of Hospital Infection, 2022	.13



## **Table of Contents**

Pathogen	Reduction, Education, Training and Compliance
Study #1	Clorox Healthcare® Fuzion® Cleaner Disinfectant reduced <i>C. difficile</i> spore contamination on surfaces American Journal of Infection Control, 2019
Study #2	<i>C. difficile</i> spores on surfaces are sensitive to bleach Clinics in Colon and Rectal Surgery, 202015
Study #3	<b>Sporicidal use on floors reduced </b> <i>C. difficile</i> <b>surface contamination</b> American Journal of Physical Medicine & Rehabilitation, 202116
Study #4	Clorox Healthcare <sup>®</sup> Bleach Germicidal Cleaner, Clorox Healthcare <sup>®</sup> Bleach Germicidal Wipes, Dispatch <sup>®</sup> Hospital Cleaner Disinfectant Towels with Bleach, and Clorox Healthcare <sup>®</sup> Hydrogen Peroxide Cleaner Disinfectants killed all 4 major clades of <i>C. auris</i> on surfaces. Infection Control and Hospital Epidemiology, 2023
Study #5	Clorox Healthcare <sup>®</sup> Bleach Germicidal Cleaner use and EVS educational intervention reduced <i>C. diff</i> and VRE surface contamination BMC Infectious Diseases, 2007
Study #6	Disinfection with Clorox Healthcare <sup>®</sup> Bleach Germicidal Wipes significantly reduced <i>C. difficile</i> surface contamination Infection Control and Hospital Epidemiology, 201319
Study #7	Clorox Healthcare® Bleach Germicidal Wipes consistently reduced <i>C. difficile</i> spore contamination on surfaces to undetectable levels Infection Control and Hospital Epidemiology, 2013
Study #8	Clorox Healthcare <sup>®</sup> Bleach Germicidal Wipes can be used for daily and discharge cleaning of patient room surfaces with little impact on patient and staff satisfaction The Journal for Healthcare Quality, 2013
Study #9	Clorox Healthcare <sup>®</sup> Bleach Germicidal Wipes significantly increased compliance, reduced cleaning time, and reduced employee costs American Journal of Infection Control, 201422
Cost Savi	ngs
Study #1	85% CDI rate decrease and up to \$216,000 excess costs avoided with Clorox Healthcare® Bleach Germicidal Wipes Infection Control and Hospital Epidemiology, 2011
Study #2	<b>\$2.6 to \$6.8 million estimated cost savings and reduced HAI rates with daily and terminal bleach disinfection</b> The Journal for Healthcare Quality, 2014



#### STUDY #1

Study Title: Use of hypochlorite solution to decrease rates of Clostridium difficile-associated diarrhea

Study Location: Barnes-Jewish Hospital, St. Louis, MO

Key Takeaway: Implementation of bleach cleaning protocols as part of a multifaceted approach was associated with an almost 80% decrease in *C. difficile*-associated diarrhea incidence rates.

**Purpose:** To evaluate the impact of environmental disinfection with hypochlorite (bleach) on units that had experienced increases in *C. difficile*-associated diarrhea (CDAD) rates.

**Methods:** Patient rooms, the nursing station, conference room, and waiting rooms in the medical ICU were cleaned with 1:10 dilution of bleach (5000 ppm). Medical equipment was cleaned with a bleach wipe (approximately 1:10 dilution). After five months, only rooms of CDAD patients were cleaned with bleach. In the surgical ICU, CDAD patient rooms and equipment bleach was used for two months.

**Results:** Implementation of the bleach cleaning protocols was associated with an almost 80% decrease in CDAD incidence rates which was sustained over a two year post-intervention period. The use of bleach may be effective at reducing CDAD in situations where the disease is endemic or hyperendemic, such as during an outbreak.



**Reference:** Mullen KM, et al. "Use of Hypochlorite Solution to Decrease Rates of *Clostridium difficile*-Associated Diarrhea." Infection Control and Hospital Epidemiology, 2007; 28(2):205–207.



#### STUDY #2

**Study Title:** <u>Reducing Clostridium difficile Incidence, Colectomies, and Mortality in the Hospital Setting: A</u> <u>Successful Multidisciplinary Approach</u>

Study Location: Rhode Island Hospital, Providence, Rhode Island

Key Takeaway: Clorox Healthcare<sup>®</sup> Bleach Germicidal Cleaner use in a 6-part intervention helped decrease *C. difficile* infection rate by 70% over the course of 6 years.

**Purpose:** To evaluate the impact of a multidisciplinary approach to reduce the risk of *C. difficile* infections.

**Methods:** The Rhode Island Hospital implemented a five-year *C. difficile* infection control plan consisting of six major interventions. The plan included infection-control education for healthcare workers and EVS staff and enhanced daily and discharge cleaning of patient rooms with bleach-based products including Clorox Healthcare<sup>®</sup> Bleach Germicidal Cleaner<sup>\*</sup>. After one year, bleach cleaning was expanded to all rooms instead of just isolation rooms. An equipment-cleaning index to assign cleaning and disinfection responsibilities was also developed.

**Results:** By 2012, the CDI rate decreased 70% from its peak of 12.2 cases per 1000 discharges to 3.6 cases per 1000 discharges in 2006. In 2011, the yearly mortality of patients with hospital-acquired *C. difficile* decreased by 64% to 19, from its peak of 52 in 2006. The results suggest that implementation of a series of multidisciplinary interventions, including enhanced environmental disinfection, can decrease *C. difficile* rates.

**Reference:** Mermel LA, Jefferson J, Blanchard K, Parenteau S, Mathis B, Chapin K, Machan JT. Reducing *Clostridium difficile* incidence, colectomies, and mortality in the hospital setting: a successful multidisciplinary approach. Jt Comm J Qual Patient Saf. 2013 Jul;39(7):298-305. doi: 10.1016/s1553-7250(13)39042-4. PMID: 23888639.



#### STUDY #3

Study Title: Environmental control to reduce transmission of Clostridium difficile

Study Location: Barnes-Jewish Hospital, St. Louis, MO

Key Takeaway: Implementation of routine bleach cleaning on surfaces as part of an infection control bundle resulted in a 61% decrease in *C. difficile*-associated diarrhea (CDAD) incidence.

**Purpose:** To evaluate whether the routine use of hypochlorite (bleach) solution on surfaces can reduce the incidence of CDAD.

**Methods:** Using a before and after design, patient rooms in the bone marrow transplantation unit, the neurosurgical intensive care unit (ICU), and a general medicine unit were routinely cleaned with a quaternary ammonium solution for nine months, followed by nine months of routine cleaning with a 1:10 dilution of bleach solution. Patients were evaluated for the presence of CDAD and disease rates were adjusted for other potential risk factors.

**Results:** In the bone marrow transplant unit, implementation of routine bleach cleaning resulted in a statistically significant 61% decrease in the CDAD rate. No decrease was observed in the other two units which had much lower baseline CDAD rates. When the original quaternary ammonium disinfectant was reinstated in the bone marrow transplantation unit, the CDAD rate increased back to the pre-intervention levels. However, implementing bleach cleaning again reduced the rate to 3.1 per 1000 patient days. Following the study, the hospital implemented routine bleach cleaning in all units with CDAD rates ≥3 per 1000 patient days.



**Reference:** Mayfield JL, Leet T, Miller J, Mundy LM. Environmental control to reduce transmission of *Clostridium difficile*. Clin Infect Dis. 2000 Oct;31(4):995-1000. doi: 10.1086/318149. Epub 2000 Oct 25. PMID: 11049782.



#### STUDY #4

**Study Title:** <u>Mitigating hospital-onset</u> *Clostridioides difficile*: The impact of an optimized environmental hygiene program in eight hospitals

**Study Location:** 8 acute-care hospitals in 6 states with stable endemic hospital-onset *C. difficile* infection standardized infection ratios (HO-CDI SIRs)

Key Takeaway: Daily hospital-wide sporicidal disinfection combined with cleaning thoroughness optimization was associated with a sustained 50% decrease in HO-CDI SIRs compared to controls.

**Purpose:** To evaluate the impact of daily hospital-wide sporicidal disinfection on hospital-onset *Clostridioides difficile* infection (HO-CDI) occurrence.

**Methods:** The study involved eight acute-care hospitals in the United States and included a control group of nine randomly selected hospitals. The intervention involved implementing a structured program for optimizing cleaning thoroughness using a sporicidal disinfectant cleaner. The primary outcome measured was the HO-CDI standardized infection ratio (SIR).

**Results:** Intervention led to a significant improvement in cleaning thoroughness, with an increase from 59% to 86% immediately following the wash-in period. Over the next 18 months, cleaning thoroughness continued to improve, reaching 93.6% for the group. The HO-CDI SIR decreased following the intervention, with a 52% reduction in quarter 1 and a sustained decrease over the next five quarters. The intervention was associated with a 0.55 reduction in HO-CDI, corresponding to a 50% relative decrease from the baseline SIR. The authors concluded that daily hospital-wide sporicidal disinfection cleaning, combined with optimization of cleaning thoroughness, was associated with a significant decrease in HO-CDI. The findings suggest that this intervention could be effective in mitigating endemic HO-CDI in hospitals. The study also highlighted the importance of implementing a comprehensive approach to environmental hygiene to prevent the transmission of healthcare-associated pathogens.

**Reference:** Carling PC, O'Hara LM, Harris AD, Olmsted R. Mitigating hospital-onset *Clostridioides difficile*: The impact of an optimized environmental hygiene program in eight hospitals. Infect Control Hosp Epidemiol. 2023 Mar;44(3):440-446. doi: 10.1017/ice.2022.84. Epub 2022 Jun 20. PMID: 35718355; PMCID: PMC10015263.



#### STUDY #5

**Study Title:** <u>Reducing C. difficile in children: An agent-based modeling approach to evaluate intervention</u> <u>effectiveness</u>

Study Location: Computer-simulated 80-bed freestanding tertiary-care pediatric hospital

Key Takeaway: Modeling predicted that a sporicidal product was the most effective single-intervention strategy to reducing hospital-onset *C. difficile* infections (HO-CDIs). Daily disinfection with a sporicidal reduced HO-CDI by 48.5% and asymptomatic *C. difficile* colonization by 73.6%.

**Purpose:** To develop an agent-based simulation model of *C. difficile* transmission in a children's hospital and evaluate the effectiveness of nine interventions and six multi-intervention bundles, including hand hygiene, sporicidal disinfection, and combinations of different interventions.

**Methods:** The study is based on a computer-simulated, 80-bed freestanding, tertiary-care pediatric hospital, including 8 identical wards with 10 single-bed patient rooms each. The model considers factors such as patient states (susceptible, colonized, or infected), interactions between agents (patients, visitors, caregivers, nurses, and physicians), and 14 potential transmission routes. The outcomes of interest were HO-CDIs per 10,000 patient days and asymptomatic *C. difficile* colonizations per 1,000 admissions.

**Results:** The simulation results indicated that daily disinfection of all hospital rooms with a sporicidal product was the most effective single-intervention strategy, reducing HO-CDIs by 48.5% and asymptomatic *C*. *difficile* colonizations by 73.6%. Screening for asymptomatic colonization at admission was the second most effective strategy. Daily environmental disinfection with sporicidal product, combined with screening for asymptomatic *C. difficile* at admission, was the most effective 2-pronged infection prevention bundle, reducing hospital-onset CDI by 62.0% and asymptomatic colonization by 88.4%. Other interventions, such as terminal environmental disinfection, healthcare worker and patient hand hygiene, and reducing room transfers, also showed considerable reductions in both outcomes. Increasing the implementation of healthcare worker hand hygiene from the typical to ideal level resulted in an additional 15.3% reduction in HO-CDIs. Four interventions showed meaningful improvements in HO-CDI prevention when implementation was increased to the ideal level. The study demonstrated the potential effectiveness of various infection prevention interventions in reducing *C. difficile* transmission in a pediatric hospital setting. The findings can inform decision-making regarding the implementation of targeted interventions to control *C. difficile* infections in pediatric hospitals.

**Reference:** Barker AK, Scaria E, Alagoz O, Sethi AK, Safdar N. Reducing *C. difficile* in children: An agent-based modeling approach to evaluate intervention effectiveness. Infect Control Hosp Epidemiol. 2020 May;41(5):522-530. doi: 10.1017/ice.2020.14. Epub 2020 Feb 13. PMID: 32052722; PMCID: PMC7461244.



#### STUDY #6

**Study Title:** Environmental Cleaning and Decontamination to Prevent *Clostridioides difficile* Infection in Health <u>Care Settings: A Systematic Review</u>

Study Location: Systematic review of studies in multiple facilities in the U.S.

Key Takeaway: Daily and terminal cleaning of CDI patient rooms with bleach solutions was associated with significant decreases in CDI rates (48% and 85%).

**Purpose:** A systematic review examining the most effective and feasible methods for environmental cleaning and decontamination to prevent *C. difficile* infection (CDI) in health care settings.

**Methods:** A search of the databases CINAHL and MEDLINE was conducted from 2008 to 2018. Twelve studies and 2 systematic reviews were selected for inclusion. Most of the studies were conducted in hospitals and used a before-after approach. The interventions examined included cleaning with bleach, hydrogen peroxide, and ultraviolet light decontamination, and the use of launderable bed covers. The interventions varied in terms of frequency, duration, and the areas targeted for cleaning and decontamination.

**Results:** Bleach use for daily and terminal cleaning of patient rooms showed positive outcomes in reducing CDI incidence. Hydrogen peroxide decontamination (HPD) and ultraviolet light decontamination (UVD) were also effective when used in addition to standard cleaning methods. It remains unclear which approach is the most effective and feasible, such as targeting CDI patient rooms, all patient rooms, or common areas. Environmental cleaning and decontamination interventions have shown promise in reducing CDI rates, but further research is needed to establish the most effective strategies and address implementation challenges. Standardized cleaning protocols, training, and monitoring of cleaning services staff can optimize manual cleaning practices.

**Reference:** Schoyer E, Hall K. Environmental Cleaning and Decontamination to Prevent *Clostridioides difficile* Infection in Health Care Settings: A Systematic Review. J Patient Saf. 2020 Sep;16(3S Suppl 1):S12-S15. doi: 10.1097/PTS.0000000000000749. PMID: 32809996; PMCID: PMC7447170.



#### STUDY #7

Study Title: Significant impact of terminal room cleaning with bleach on reducing nosocomial Clostridium difficile

Study Location: 3 facilities in the NorthShore University Health System in the Chicago, IL area

Key Takeaway: Implementation of an all-surface terminal bleach cleaning program resulted in a statistically significant 48% reduction in the prevalence density of *C. difficile* infection (CDI) cases.

**Purpose:** To reduce nosocomial (hospital acquired) rates of *C. difficile* infection in a 3-hospital system with approximately 850 beds and 40,000 annual admissions.

**Methods:** A cleaning intervention using dilute bleach was implemented to clean CDI patient rooms. The bleach mixture was applied during terminal cleaning. All surfaces, including walls, were thoroughly wiped. The effectiveness of the intervention was evaluated by measuring the rate of CDI cases per 1000 patient-days before and after the intervention.

**Results:** The results showed a significant 48% reduction in the prevalence density of CDI cases after the implementation of the bleach cleaning program (95% confidence interval: 36%-58%, p < 0.0001). No other infection control practices were altered during this period. The study findings align with previous research that supports the use of bleach to control the spread of *C. difficile*. The authors concluded that implementing a terminal bleach cleaning program can rapidly and sustainably reduce the rate of nosocomial (hospital-acquired) CDI.

**Reference:** Hacek DM, Ogle AM, Fisher A, Robicsek A, Peterson LR. Significant impact of terminal room cleaning with bleach on reducing nosocomial *Clostridium difficile*. Am J Infect Control. 2010 Jun;38(5):350-3. doi: 10.1016/j.ajic.2009.11.003. Epub 2010 Jan 31. PMID: 20123150.



#### STUDY #8

**Study Title:** <u>Clostridium difficile infection in acute care hospitals: systematic review and best practices for prevention</u>

#### Study Location: Multiple U.S. facilities

Key Takeaway: Daily and terminal patient room cleaning with bleach products reduced *C. difficile* infection (CDI) rates by 45% and 85%.

**Purpose:** Review of interventions aimed at reducing *C. difficile* infection (CDI) rates in acute care hospitals. The review evaluated studies published since 2009 and included the impact of various interventions.

**Methods:** A qualitative systematic search for controlled trials of interventions from January 1, 2009 to August 1, 2015 was performed using biomedical electronic databases including: Ovid, MEDLINE, EMBASE, The Cochrane Library, CINAHL, and ISI Web of Knowledge. Several intervention categories, including environmental disinfection, antimicrobial stewardship programs (ASPs), hand hygiene, chlorhexidine bathing, probiotics, and bundled approaches were identified. The quality of studies was assessed using QI-Minimum Quality Criteria Set (QI-MQCS). Interventions were grouped thematically and meta-analyses were performed where possible. Forty-six of the 3326 studies screened were included in this review.

**Results:** Bleach-based environmental disinfection and bundled interventions were found to be the most effective strategies for reducing CDI in acute care hospitals. Daily bleach disinfection of patient rooms and high-touch surfaces, in conjunction with auditing, led to a significant reduction in CDI rates. The most effective interventions, resulting in a 45% and 85% reduction in CDI, included daily to twice daily disinfection of high-touch surfaces (including bed rails) and terminal cleaning of patient rooms with chlorine-based products. Terminal bleach disinfection and UV light treatment also showed some effectiveness. Further studies are needed to identify the components of bundled interventions that reduce CDI rates. The review suggests that institutions should focus on simple, effective interventions and consider more complex approaches only if simple interventions have already been implemented.

**Reference:** Louh IK, Greendyke WG, Hermann EA, Davidson KW, Falzon L, Vawdrey DK, Shaffer JA, Calfee DP, Furuya EY, Ting HH. Infect Control Hosp Epidemiol. 2017 Apr; 38(4):476-482. doi: 10.1017/ice.2016.324. PMID: 28300019; PMCID: PMC5560033.



#### STUDY #9

**Study Title:** <u>Proposed checklist of hospital interventions to decrease the incidence of healthcare-associated</u> <u>*Clostridium difficile* infection</u>

Study Location: Brigham and Women's Hospital, Boston, MA

Key Takeaway: A 40% reduction in *C. difficile* infection (CDI) incidence was sustained for 21 months following an intervention that included a ready-to-use bleach solution and an educational campaign.

**Purpose:** To evaluate how education, prevention, and treatment bundles can decrease the incidence of CDI and the mortality associated with CDI.

**Methods:** A three-part intervention consisting of an educational campaign, a prevention bundle, and a treatment bundle was implemented to prevent the transmission of *C. difficile* among hospitalized patients. Bundle interventions were aligned with guidelines from the Society of Healthcare Epidemiologists and the Infectious Disease Society of America. The prevention bundle included cleaning the rooms of *C. difficile* patients who were on contact precautions with a bleach-based cleaning and disinfecting agent. Quarterly incidence rates and case-fatality rates for healthcare-associated CDI cases were tracked at the hospital.

**Results:** Implementation of the program led to a decrease in *C. difficile* cases from 1.1 to 0.66 cases per 1,000 patient days, a 40% reduction that was sustained for 21 months, despite the hospital recording an increase in Charlson morbidity scores. Checklists for bundle interventions were identified as a simple tool to help hospitals tackle *C. difficile*, and the authors described several ways to increase their use and value.

**Reference:** Abbett SK, Yokoe DS, Lipsitz SR, Bader AM, Berry WR, Tamplin EM, Gawande AA. Proposed checklist of hospital interventions to decrease the incidence of healthcare-associated *Clostridium difficile* infection. Infect Control Hosp Epidemiol. 2009 Nov;30(11):1062-9. doi: 10.1086/644757. PMID: 19751156.



#### STUDY #10

**Study Title:** <u>Hospital and long-term care facility environmental service workers' training, skills, activities and effectiveness in cleaning and disinfection: a systematic review</u>

Study Location: Systematic review of studies at multiple facilities in the U.S.

Key Takeaway: Bleach use on surfaces helped reduce multi-drug-resistant organism (MDRO) infections and other healthcare-associated infections (HAIs) in multiple medical facilities.

**Purpose:** To assess various aspects related to environmental service workers (ESWs) and their role in reducing multi-drug-resistant organisms (MDROs) and healthcare-associated infections (HAIs) in medical facilities. The study focused on factors such as ESW training, workload, cleaning practices, supervision, and the measurement of effectiveness in reducing MDROs and HAIs.

**Methods:** A comprehensive search of databases was conducted, and 14 cluster randomized controlled trials (RCTs) were identified. These trials investigated different interventions to reduce patient infections caused by MDROs and HAIs. Ten trials focused on reducing patient infections from MDROs/HAIs.

**Results:** Four of the trials reported significant reductions in patient infection rates using strategies such as surface disinfection with bleach, quaternary ammonium detergents, ultraviolet light, and hydrogen peroxide vapor. Of the trials, which encompassed a large numbers of hospitals (37) and patients (315,887 plus an additional 4,823,804 in two studies which reported bed-days instead of patients), only two studies reported correlations between the work of ESWs and the outcomes related to MDROs. In Long-Term Care Facilities (LTCFs), three c-RCTs combined the evaluation of both ESWs' and nurses' training and work, and one of the trials revealed a notable link between the collective efforts of ESWs and nurses and MDRO rates. Additionally, in three other c-RCTs, the focus was solely on nurses' training and work, and one of these studies identified a correlation between between nurses' work and MRSA rates.

**Reference:** Thomas RE, Thomas BC, Lorenzetti D, Conly J. Hospital and long-term care facility environmental service workers' training, skills, activities and effectiveness in cleaning and disinfection: a systematic review. J Hosp Infect. 2022 Jun;124:56-66. doi: 10.1016/j.jhin.2022.03.002. Epub 2022 Mar 18. PMID: 35307506.



#### STUDY #1

**Study Title:** Impact of routine use of a spray formulation of bleach on *Clostridium difficile* spore contamination in non-*C. difficile* infection rooms

Study Location: Louis Stokes Cleveland Veterans Affairs Medical Center, Cleveland, OH

Key Takeaway: Routine use of Clorox Healthcare<sup>®</sup> Fuzion<sup>®</sup> Cleaner Disinfectant, a hypochlorous acid bleach spray, in non-*C. difficile* infection rooms reduced *C. difficile* spore contamination in those rooms. This suggests that bleach-based disinfection for all discharges may help reduce *C. difficile* contamination facility-wide.

**Purpose:** 1) To measure *C. difficile* spore contamination in non-*C. difficile* infection (CDI) patient rooms when a quaternary ammonium chloride (quat) disinfectant was used to clean. 2) To test the hypothesis that routine use of Clorox Healthcare<sup>®</sup> Fuzion<sup>®</sup> Cleaner Disinfectant would reduce surface contamination.

**Methods:** The study took place at the Louis Stokes Cleveland Veterans Affairs Medical Center, a 215-bed acute care facility. Before May 1, 2018, bleach wipes were used for daily and discharge cleaning for *C. diff* rooms, while a quaternary ammonium disinfectant was used for non-*C. diff* rooms. After May 1, 2018, non-CDI rooms were cleaned with Clorox Healthcare<sup>®</sup> Fuzion<sup>®</sup> Cleaner Disinfectant and *C. difficile* spore and MRSA contamination were measured. Non-*C. diff* rooms were tested for 3 weeks before the switch to the bleach-spray disinfectant and then, after the swap, tested again after cleaning the room but before admission of a new patient. The efficacy of Fuzion against *C. difficile* spores was measured along with Clorox Healthcare<sup>®</sup> Bleach Germicidal

Wipes (0.65% sodium hypochlorite), and Diversey Avert Sporicidal Disinfectant Cleaner (1.31% sodium hypochlorite) using the AOAC International Germicidal Spray Products as Disinfectants test (AOAC 961.02). Ten EVS personnel were also surveyed regarding their opinion of odor and residue on surfaces of products.

**Results:** Fuzion use resulted in a statistically significant reduction in the proportion of rooms contaminated with C. difficile from 24% (12/51 with guat) to 5% (2/39 with Fuzion). For MRSA contamination, when the guat disinfectant was used, 10% (5/51 rooms and/or bathrooms) were contaminated. When Fuzion was used, there was a non-significant trend towards a reduction in contamination (0%, 0/39 rooms, p=0.07). All three disinfectants killed  $\ge 6 \log_{10} C$ . difficile spores in the in vitro test. All ten EVS personnel noted that Fuzion left less residue than the other bleach products, and that this was an advantage. Four of the ten noted that Fuzion had a more tolerable odor than the other products. The use of sporicidal disinfectants on surfaces for all post discharge room disinfection might be helpful in reducing the risk for C. difficile transmission from contaminated surfaces.



**Reference:** Ng Wong YK, Alhmidi H, Mana TSC, Cadnum JL, Jencson AL, Donskey CJ. Impact of routine use of a spray formulation of bleach on *Clostridium difficile* spore contamination in non-*C. difficile* infection rooms. Am J Infect Control. 2019 Jul;47(7):843-845. doi: 10.1016/j.ajic.2018.12.023. Epub 2019 Jan 31. PMID: 30711351.



#### STUDY #2

Study Title: Clostridioides difficile Spores: Bile Acid Sensors and Trojan Horses of Transmission

Study Location: Review of multiple C. difficile environmental contamination studies at multiple facilities

Key Takeaway: *C. difficile* spores on surfaces are sensitive to bleach but resist other commonly used disinfectants.

**Purpose:** This review highlights the significance of *C. difficile* spores in disease transmission, their resistance properties, and the role of infected individuals and environmental reservoirs in the spread of *C. difficile* infections. Strategies for eradicating spores and reducing transmission in healthcare environments are also discussed.

**Methods:** This article focuses on the spore form of *C. difficile* and its importance in disease transmission. It describes the infection cycle of *C. difficile*, where spores germinate in response to specific signals in the gut, particularly bile acids.

**Results:** *C. difficile* spores can persist in the environment for long periods of time due to their metabolic dormancy and resistance to various disinfectants. Ethanol-based sanitizers, chlorhexidine-based sanitizers, and isothiazolinone-based disinfecting detergents are ineffective against *C. difficile* spores. However, oxidizing disinfectants like bleach and hydrogen peroxide can effectively kill *C. difficile* spores. The widespread presence of *C. difficile* spores in the environment suggests frequent exposure, but only a small fraction of individuals are susceptible to infection. The resistance properties of spores makes them difficult to eradicate and promotes their spread. *C. difficile* spores contaminate various environments, ranging from soil to hospital surfaces, serving as vectors for transmission. Infected individuals, including patients and healthcare workers, play a significant role in the spread of *C. difficile* infections.

**Reference:** Shen A. *Clostridioides difficile* Spores: Bile Acid Sensors and Trojan Horses of Transmission. Clin Colon Rectal Surg. 2020 Mar;33(2):58-66. doi: 10.1055/s-0040-1701230. Epub 2020 Feb 25. PMID: 32104157; PMCID: PMC7042012.



#### STUDY #3

Study Title: Clostridioides difficile Infection Reservoirs Within an Acute Rehabilitation Environment

Study Location: University of Pittsburgh Medical Center, Pittsburgh, PA

Key Takeaway: Sporicidal disinfection on hospital floors effectively reduced *C. difficile* spore contamination on surfaces in an acute rehabilitation facility.

**Purpose:** To assess the presence of *C. difficile* spores in an acute rehabilitation environment and evaluate the effectiveness of disinfection methods.

**Methods:** Cultures were performed on 28 rehabilitation rooms, 28 rehabilitation floor surfaces, and 80 shared devices and equipment. Two disinfection interventions were implemented, and post-intervention environmental cultures were conducted to assess the effectiveness of the disinfection methods.

**Results:** Positive cultures for *C. difficile* spores were found in a small percentage of rehabilitation rooms, rehabilitation floors, and wheelchairs. After implementing new sporicidal disinfection methods, repeat cultures yielded negative results. The study concluded that non-sporicidal disinfectants were ineffective on hospital floors, emphasizing the importance of sporicidal disinfection when *C. difficile* infection rates are high. Cleaning wheelchairs was challenging, but the introduction of an ultraviolet device for wheelchair cleaning led to a reduction in spores on subsequent cultures.

**Reference:** Weppner J, Gabet J, Linsenmeyer M, Yassin M, Galang G. *Clostridium difficile* Infection Reservoirs Within an Acute Rehabilitation Environment. Am J Phys Med Rehabil. 2021 Jan 1;100(1):44-47. doi: 10.1097/PHM.000000000001579. PMID: 32889863.



#### STUDY #4

Study Title: Efficacy of 23 commonly used liquid disinfectants against Candida auris isolates from the 4 major clades

Study Location: Louis Stokes Cleveland Veterans Affairs Medical Center, Cleveland, OH

Key Takeaway: Clorox Healthcare bleach and hydrogen peroxide products killed *Candida auris* (*C. auris*) on surfaces (>5 log<sub>10</sub> reduction).

**Purpose:** To assess the efficiency of 23 disinfectants commonly utilized in healthcare settings against isolates from the four primary clades of *Candida auris*.

**Methods:** This study was conducted in a laboratory setting. The test strains of *C. auris* were derived from four distinct phylogenetic clades, while *Candida albicans* ATCC strain 10231 was also included for comparison. The selection of disinfectants was informed by a 2019 survey of 57 healthcare facilities across 30 states. All brands used in these facilities were tested. In rooms of patients with *Clostridioides difficile* infection (CDI), chlorine-based and peracetic-acid-based disinfectants were commonly used. For non-CDI patients' rooms, quaternary ammonium, improved hydrogen peroxide, chlorine-based, and phenolic disinfectants were employed. To assess the efficacy of the disinfectants against *C. auris*, the study followed the EPA MLB SOP MB-35-03 protocol. Contact times were based on manufacturer recommendations and log10 reductions were calculated by comparing treated and untreated carriers. Disinfectants were considered effective if they achieved a >5 log<sub>10</sub> reduction in *C. auris* following the recommended contact time.

**Results:** Chlorine-based and peracetic acid-based disinfectants consistently achieved reductions of over 5 log<sub>10</sub> for all *C. auris* strains and *C. albicans*, while the effectiveness of hydrogen peroxide-based and quaternary ammonium alcohol-based disinfectants varied for different strains. Specifically, Clorox Healthcare® Bleach Germicidal Cleaner, Clorox Healthcare® Bleach Germicidal Wipes, Dispatch® Hospital Cleaner Disinfectant Towels with Bleach, and Clorox Healthcare® Hydrogen Peroxide Cleaner Disinfectant all demonstrated >5 log<sub>10</sub> reduction against *Candida albicans* and all four major clades of *C. auris*. Quaternary ammonium-based and phenolic acid-based disinfectants generally showed limited efficacy across the strains tested.

**Reference:** Haq MF, Pearlmutter BS, Cadnum JL, Donskey CJ. Efficacy of 23 commonly used liquid disinfectants against Candida auris isolates from the 4 major clades. Infect Control Hosp Epidemiol. 2023 Aug 2:1-5. doi: 10.1017/ice.2023.157. Epub ahead of print. PMID: 37528766.



#### STUDY #5

**Study Title:** <u>Reduction of *Clostridium difficile* and vancomycin-resistant Enterococcus contamination of environmental surfaces after an intervention to improve cleaning methods</u>

Study Location: Louis Stokes Cleveland Veterans Affairs Medical Center, Cleveland, OH

Key Takeaway: Simple educational interventions for EVS staff on the importance of environmental cleaning, assessing cleaning, and providing feedback can result in improved decontamination of environmental surfaces.

**Purpose:** To assess the adequacy of cleaning practices in rooms of patients with *C. difficile*-associated diarrhea (CDAD) or vancomycin-resistant Enterococcus (VRE) colonization or infection before and after implementation of two cleaning methods.

**Methods:** Cultures were taken from commonly touched surfaces (i.e., bedrails, telephones, call buttons, door knobs, toilet seats and bedside tables) in rooms of patients with CDAD or VRE colonization or infection at three timepoints: (1) before EVS cleaning; (2) after EVS cleaning with 10% bleach in CDAD rooms and quaternary ammonium solutions in VRE rooms; (3) after research staff cleaned with ready-to-use Clorox Healthcare® Bleach Germicidal Cleaner\* in both CDI and VRE rooms. EVS staff then received education on environmental cleaning and feedback, and during a 10 week follow-up period, additional cultures were collected before and after cleaning.

**Results:** Rooms with VRE and CDAD patients were still heavily contaminated after cleaning by EVS staff. Contamination was further reduced to zero (VRE rooms) or 11% (CDAD rooms) after cleaning by research staff. Both bleach disinfectants used in the study were shown to kill *C. difficile* in a laboratory setting. After the educational intervention was administered to EVS staff, the low rates of environmental contamination observed after cleaning by research staff were maintained when rooms were cleaned by EVS.



**Reference:** Eckstein BC, Adams DA, Eckstein EC, Rao A, Sethi AK, Yadavalli GK, Donskey CJ. Reduction of *Clostridium difficile* and vancomycin-resistant Enterococcus contamination of environmental surfaces after an intervention to improve cleaning methods. BMC Infect Dis. 2007 Jun 21;7:61. doi: 10.1186/1471-2334-7-61. PMID: 17584935; PMCID: PMC1906786.



#### STUDY #6

**Study Title:** An environmental disinfection odyssey: evaluation of sequential interventions to improve disinfection of *Clostridium difficile* isolation rooms

Study Location: Louis Stokes Cleveland Veterans Affairs Medical Center, Cleveland, OH

Key Takeaway: Enhanced and supervised cleaning of CDI rooms with Clorox Healthcare® Bleach Germicidal Wipes as part of a series of interventions significantly reduced C. difficile surface contamination.

**Purpose:** To evaluate the impact of sequential cleaning and disinfection interventions implemented in a hospital.

Methods: Three sequential tiered interventions were implemented during a 21-month period, including: (1) fluorescent markers to assess thoroughness of cleaning; (2) the addition of an ultraviolet disinfection device for CDI rooms; (3) the addition of enhanced daily cleaning and supervised terminal cleaning of CDI rooms using Clorox Healthcare® Bleach Germicidal Wipes. Cultures were sampled from CDI rooms after cleaning and disinfection.

**Results:** The fluorescent marker intervention improved the thoroughness of cleaning of high-touch surfaces (from 47% to 81% marker removal), relative to the baseline period. During the baseline period, 67% of CDI rooms had positive cultures after disinfection. After interventions 1, 2 and 3, the percentages of CDI rooms decreased by 57%, 35% and 7%, respectively. This represents reductions in the prevalence of positive cultures from CDI rooms of 14%, 48% and 89% for interventions 1, 2 and 3, respectively. An intervention that included formation of a dedicated daily disinfection team and implementation of a standardized process for clearing CDI rooms that included bleach cleaning achieved consistent CDI room disinfection. Culturing provides a valuable tool to drive improvements in environmental disinfection.



Reference: Sitzlar B, Deshpande A, Fertelli D, Kundrapu S, Sethi AK, Donskey CJ. An environmental disinfection odyssey: evaluation of sequential interventions to improve disinfection of *Clostridium difficile* isolation rooms. Infect Control Hosp Epidemiol. 2013 May;34(5):459-65. doi: 10.1086/670217. PMID: 23571361.



#### STUDY #7

**Study Title:** Transfer of *Clostridium difficile* spores by nonsporicidal wipes and improperly used hypochlorite wipes: practice + product = perfection

Study Location: Louis Stokes Cleveland Veterans Affairs Medical Center, Cleveland, OH

Key Takeaway: Clorox Healthcare<sup>®</sup> Bleach Germicidal Wipes consistently reduced *C. difficile* spore contamination on surfaces to undetectable levels with no *C. difficile* spore transfer to clean surfaces in a laboratory setting.

**Purpose:** To investigate the potential for cross-contamination of *C. difficile* spores onto clean surfaces by improper use of disinfectant wipes during regular cleaning process.

**Methods:** Clorox Healthcare<sup>®</sup> Bleach Germicidal wipes (0.55% sodium hypochlorite) and Virex<sup>®</sup> II 256 quaternary ammonium chloride disinfectant saturated onto Kimtech wipes (Kimberly Clark<sup>®</sup>) were tested against laboratory *C. difficile* strain VA-17 under varying conditions (i.e., fresh or used Clorox Healthcare<sup>®</sup> Bleach Germicidal Wipe; Kimtech wipe saturated with disinfectant or water). A bench top pre-inoculated with 5 log<sub>10</sub> *C. difficile* was manually wiped with each of the wipes for 10 seconds. The same wipe was then used to wipe a clean bench top. Each bench-top (inoculated and clean) was allowed 5 minutes of contact time before sampling with a sterile cotton swab.

**Results:** Use of fresh (i.e., pre-moistened) Clorox Healthcare<sup>®</sup> Bleach Germicidal Wipes on surfaces consistently reduced *C. difficile* spores to undetectable levels on an inoculated bench-top after 5 minutes of contact time, with no transfer to clean bench tops. A used hypochlorite wipe left only 0.4 log<sub>10</sub> *C. difficile* spores on the fourth bench top. In contrast, large numbers of spores were transferred to all four sequential clean sites by wipes moistened with Virex<sup>®</sup> II 256 disinfectant quat ammonium wipe, with 3 log<sub>10</sub> measured on the fourth surface. Use of a sporicidal disinfectant such as bleach on surfaces is preferred in *C. difficile* infection rooms but correct practices are essential to ensure proper decontamination.

**Reference:** Cadnum JL, Hurless KN, Kundrapu S, Donskey CJ. Transfer of *Clostridium difficile* spores by nonsporicidal wipes and improperly used hypochlorite wipes: practice + product = perfection. Infection Control and Hospital Epidemiology, 2013; 34(4):441-2.



#### STUDY #8

**Study Title:** <u>Patient and environmental service employee satisfaction of using germicidal bleach wipes for</u> <u>patient room cleaning</u>

#### Study Location: Mayo Clinic, Rochester, NY

Key Takeaway: Clorox Healthcare<sup>®</sup> Bleach Germicidal Wipes can be used for daily and discharge cleaning of patient rooms with little impact on patient and staff satisfaction.

**Purpose:** To assess the satisfaction of patients and environmental service (EVS) staff with bleach wipes used to clean CDI patient rooms as part of a "Wipe Out" *C. difficile* project on medical and hematology/oncology units.

**Methods:** EVS staff were trained in the use of bleach wipes containing 0.55% sodium hypochlorite (5,500 ppm) for daily and terminal patient room cleaning of high-touch surfaces in all rooms in five patient care units. Training included education, competency and verification, disinfecting process design, and surface hygiene testing. Patients and EVS staff were surveyed before and after the implementation of the intervention to assess satisfaction and tolerance of the bleach wipe product used during room cleaning.

**Results:** Amongst patients, 91% were very satisfied with how well their rooms were cleaned every day. Bleach wipes were well-tolerated by 100% of patients surveyed on the medical units and less well-tolerated by patients (22%) on the hematology-oncology units. EVS staff (N=6) reported less satisfaction and more respiratory irritation from using the bleach wipes; however, after using them over time their satisfaction improved. Bleach wipes can be used for both daily and discharge cleaning of patient rooms with little impact on patient or staff satisfaction.

**Reference:** Aronhalt KC, McManus J, Orenstein R, Faller R, Link M. Patient and environmental service employee satisfaction of using germicidal bleach wipes for patient room cleaning. J Healthc Qual. 2013 Nov-Dec;35(6):30-6. doi: 10.1111/j.1945-1474.2011.00202.x. Epub 2012 Apr 24. PMID: 22530592.



#### STUDY #9

Study Title: The value of ready-to-use disinfectant wipes: compliance, employee time, and costs

Study Location: University of Louisville School of Medicine, Louisville, KY

Key Takeaway: Clorox Healthcare<sup>®</sup> Bleach Germicidal Wipes significantly increased compliance, reduced the time to clean, and kept surfaces wet for the contact time. Using RTU wipes, employee costs were reduced by \$38.58 per employee per day.

**Purpose:** To evaluate timeliness, costs, and compliance with cleaning protocols when using ready-to-use (RTU) wipes or the bucket method to clean and disinfect patient rooms.

**Methods:** Environmental services staff were randomized to use either ready-to-use (RTU) wipes or the bucket method with the same sodium hypochlorite cleaner/disinfectant solution in each. Participants were asked to clean and disinfect 6 sites in a number of patient rooms. Designated sites were marked with invisible fluorescent marker without the employee's knowledge to measure compliance based on removal of a residual fluorescent marker viewable under an ultraviolet light. Compliance points were awarded: 0 points for no removal, 1 point for partial removal, and 2 points for complete removal for a total of 12 points. Time to clean and the time a surface stayed wet after application of the disinfection (up to 10 mins) was measured. Time-related cost savings were calculated based on an employee cleaning 15 rooms per day, allowing 20 minutes per room, and at an employee wage of \$10 per hour.

**Results:** Clorox Healthcare<sup>®</sup> Bleach Germicidal Wipes provided measurable operational benefits over the bucket method. There was significantly higher compliance with cleaning and disinfection processes (10.6 vs 8 compliance points, respectively) and it took significantly less time to complete the process (178 seconds vs 231 seconds). Surfaces wiped with the RTU wipes remained wet for more than 10 minutes (surpassing all contact times) compared to four minutes for the bucket method. Potential time-related cost savings from using the wipes were estimated at \$38.58 per employee per day. This study demonstrates that the use of RTU wipes on surfaces significantly increases compliance with cleaning and disinfection practices, reduces the time to disinfect a patient room, ensures longer surface wetness times, and can potentially reduce costs. A more rapid disinfection process can assist the facility with prompt patient transfers and/or admissions.

**Reference:** Wiemken TL, Curran DR, Pacholski EB, Kelley RR, Abdelfattah RR, Carrico RM, Ramirez JA. The value of ready-to-use disinfectant wipes: compliance, employee time, and costs. Am J Infect Control. 2014 Mar;42(3):329-30. doi: 10.1016/j.ajic.2013.09.031. PMID: 24581022.



### **Cost Savings**

#### STUDY #1

Study Title: A Targeted Strategy to Wipe Out Clostridium difficile

Study Location: Mayo Clinic, Rochester, Minnesota

Key Takeaway: Implementation of daily and discharge cleaning with Clorox Healthcare<sup>®</sup> Bleach Germicidal Wipes on surfaces, as part of an intervention bundle, resulted in an 85% decrease in CDI rates. \$135,000 to \$216,000 of excess costs were averted.

**Purpose:** To determine whether a targeted surface cleaning strategy using bleach-based wipes could reduce rates of *Clostridium difficile* infection (CDI) incidence on two units of a 1,249-bed hospital where CDI was highly endemic.

**Methods:** A before and after intervention was performed in two units at Mayo Clinic Hospital, Saint Marys Campus in Rochester, MN. The intervention compared CDI rates between a 12 month period of daily and discharge patient room cleaning using a quat disinfectant (HB-Quat) and a 12 month period of daily and discharge cleaning with 0.55% (5500ppm) Clorox Healthcare Bleach Germicidal Wipes.

**Results:** In each unit, implementation of bleach surface cleaning protocol resulted in an 85% decrease in CDI rates, that is a decrease from around 24 cases per 10,000 patient days to just under 4 cases per 10,000 patient days. The median time between hospital-acquired CDI cases increased from 8 to 80 days. The unit with the highest rate of CDI incidence in the hospital went 318 days without a hospital acquired case. The seven-fold reduction in the rate of hospital-acquired CDI meant that 27 cases of CDI were averted in the 12-month intervention period. \$135,000 to \$216,000 of excess costs were averted (assuming an incremental cost of a hospital-acquired CDI of \$5,000 to \$8,000).



**Reference:** Orenstein R, Aronhalt KC, McManus JE Jr, Fedraw LA. A targeted strategy to wipe out *Clostridium difficile*. Infect Control Hosp Epidemiol. 2011 Nov;32(11):1137-9. doi: 10.1086/662586. Epub 2011 Oct 6. PMID:



## **Cost Savings**

#### STUDY #2

**Study Title:** <u>Prevention of hospital-onset *Clostridium difficile* infection in the New York metropolitan region using a collaborative intervention model</u>

Study Location: 35 acute care hospitals in the New York metropolitan area

Key Takeaway: \$2.6 to \$6.8 million estimated cost savings with reduced HAI rates resulting from interventions including daily and terminal disinfection with bleach.

**Purpose:** To evaluate a Collaborative multifaceted approach to prevent *C. difficile* infection (CDI) in 35 acute care hospitals in the New York metropolitan area over 22 months.

**Methods:** Each hospital joining the Collaborative established an interdisciplinary team comprised of IPs, physicians, nurses, EVS and transport support staff to drive CDI reduction. A steering committee guided the Collaborative. Each hospital implemented a two-component *C. difficile* intervention that included:

- 1. An infection prevention intervention including contact precautions for patients with diarrhea, adherence to hand hygiene protocols, and isolating or cohorting CDI (confirmed or suspected) patients
- 2. An environmental cleaning intervention including standardized daily and terminal cleaning of high-touch surfaces in patient rooms and bathrooms, with a bleach disinfectant.

CDI rates were calculated for four definitions of cases (1) hospital-onset, hospital-associated, (2) nonhospitalassociated, (3) community-onset, hospital-associated, and (4) recurrent CDI. Bundle and environmental checklist compliance data were obtained through direct observation using the checklists.

**Results:** Compliance with the protocols in each intervention was  $\geq$ 95%. A significant reduction in the mean hospital-onset CDI rate was observed during the study. Hospitals that reported the highest CDI rates at the project's start generally demonstrated the greatest reductions of up to 50%. Significant reductions in the rates of the other types of CDI cases were not observed. There were an estimated 1,084 fewer cases of hospital-onset CDI than expected. Total cost savings for the Collaborative were estimated at \$2.7 to \$6.8 million based on costs attributable to *C. difficile*.

**Reference:** Koll BS, Ruiz RE, Calfee DP, Jalon HS, Stricof RL, Adams A, Smith BA, Shin G, Gase K, Woods MK, Sirtalan I. Prevention of hospital-onset *Clostridium difficile* infection in the New York metropolitan region using a collaborative intervention model. J Healthc Qual. 2014 May-Jun;36(3):35-45. doi: 10.1111/jhq.12002. Epub 2013 Jan 7. PMID: 23294050.

