Towards Eliminating *Clostridium difficile* Infections (CDI) in Illinois

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OBJECTIVES

• Summarize the impact of *Clostridium difficile* (*C. difficile*) statewide and nationally

• Discuss the importance of facility-specific interventions for meeting state and national agenda to eliminate *C. difficile* infections
• Epidemiology & Diagnosis
• Prevention
  • Hand Hygiene
  • Isolation & Gloving
  • Environmental Cleaning
  • Antibiotic Stewardship
  • Probiotics
• Treatment
  • Oral Antimicrobials; Treatment as Prevention
  • Fecal Bacteriotherapy
  • Surgical Options
• Putting It All Together: ICE CDI!
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Then</th>
<th>Now</th>
<th>Reference(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRBSIs</td>
<td>5.0/1000 catheter days</td>
<td>1.7/1000 catheter days</td>
<td>a,b</td>
</tr>
<tr>
<td>VAP</td>
<td>9.5/1000 ventilator days</td>
<td>2.0/1000 ventilator days</td>
<td>a,b</td>
</tr>
<tr>
<td>CAUTIs</td>
<td>5.4/1000 catheter days</td>
<td>3.1/1000 catheter days</td>
<td>a,b</td>
</tr>
<tr>
<td>C. difficile infection</td>
<td>5.5 cases/10,000 discharges</td>
<td>11.2 cases/10,000 discharges</td>
<td>c,d</td>
</tr>
</tbody>
</table>

Abbreviations: CRBSIs, catheter-related bloodstream infections; VAP, ventilator-associated pneumonia; CAUTIs, catheter-associated urinary tract infections.

b Am J Infect Control 2009; 37:783–805  
c Emerg Infect Dis 2009; 15:122–5  
d [http://hcupnet.ahrq.gov](http://hcupnet.ahrq.gov)

Adapted from Patterson et al, Crit Care Med 2010; 38(8):265-8.
Percentage of stool, skin (chest and abdomen), and environmental (bed rail, bedside table, call button, toilet seat) cultures positive for *Clostridium difficile* among 52 patients with *C. difficile* infection. The limit of detection for stool specimens was $\sim 2 \log_{10} \text{CFU/g}$. The numbers of patients who had samples cultured at each time point were 52 before treatment, 48 on day 3 of treatment, 43 after resolution of diarrhea, 28 at the end of treatment, 22 at 1–2 weeks after treatment, 15 at 3–4 weeks after treatment, and 8 at 5–6 weeks after treatment.


*Includes patients hospitalized with *C. difficile* infections or who acquired *C. difficile* during the hospital stay.*

*MMWR* 2011; 60(34):1171
National Impact of *C. difficile*

Deaths Caused by *C. difficile* Infections*

• Deaths related to *C. difficile* increased 400% between 2000 and 2007, partly due to a more virulent strain

• 14,000 deaths are attributed to *C. difficile* each year in the US

• > 90% of deaths related to CDI are in persons ≥ 65 years of age

*Age–adjusted rate of *C. difficile* as the primary (underlying) cause of death.

SOURCE: CDC National Center for Health Statistics, 2012

http://www.idph.state.il.us/patientsafety/ICE_C_diff_Webinar_March2012.pdf
By multivariate analysis, BI infection was statistically significant as a risk factor for reduced cure (odds ratio [OR], 0.48; 95% confidence interval [CI], .27–.85; \( P = .030 \)) and for increased recurrence (OR, 1.57; 95% CI, 1.01–2.45; \( P = .046 \)).
C. difficile Infections per 1,000 Discharges in Illinois

Percentage of *C. difficile* Infection (CDI) Cases (N = 10,342), by Inpatient or Outpatient Status at Time of Stool Collection and Type/Location of Exposures* — U.S. Emerging Infections Program, 2010

Diagnostic Accuracy of Real-time Polymerase Chain Reaction in Detection of *Clostridium difficile* in the Stool Samples of Patients With Suspected *Clostridium difficile* Infection: A Meta-Analysis

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**Background.** Current detection methods for *Clostridium difficile* infection (CDI) can be time-consuming and have variable sensitivities. Real-time polymerase chain reaction (PCR) may allow earlier and more accurate diagnosis of CDI than other currently available diagnostic tests. A meta-analysis was performed to determine the diagnostic accuracy of real-time PCR.

**Methods.** We searched MEDLINE (Pubmed/Ovid) and 4 other online electronic databases (1995–2010) to identify diagnostic accuracy studies that compared PCR with cell culture cytotoxicity neutralization assay (CCCNA) or anaerobic toxigenic culture (TC) of *C. difficile*. Screening for inclusion, data extraction, and quality assessment were carried out independently by 2 investigators and disagreements resolved. Data were combined by means of a random-effects model, and summary receiver operating characteristic curves and diagnostic odds ratios were calculated.

**Results.** Nineteen studies (7392 samples) met our inclusion criteria. The overall mean sensitivity of PCR was 90% (95% confidence interval [CI]: 88%–91%), specificity 96% (CI: 96%–97%), positive likelihood ratio 26.89 (CI: 20.81–34.74), negative likelihood ratio 0.11 (CI: 0.08–0.15), diagnostic odds ratio 278.23 (CI: 213.56–362.50), and area under the curve 0.98 (CI: 0.98–0.99). Test accuracy depended on the prevalence of *C. difficile* but not on the reference test used. At *C. difficile* prevalence of <10%, 10%–20% and >20% the positive predictive value and the negative predictive value were 71%, 79%, 93% and 99%, 98% and 96%, respectively.

**Conclusions.** Real-time PCR has a high sensitivity and specificity to confirm CDI. Overall diagnostic accuracy is variable and depends on CDI prevalence.

Forest Plot Estimates of Pooled Sensitivity

Forest Plot Estimates of Pooled Specificity

Theoretical Values of PPV and NPV for Increasing CDI Prevalence Calculated Using Pooled Sensitivity (90%) and Specificity (96%)

TOPICS

- Epidemiology & Diagnosis
- Prevention
  - Hand Hygiene
  - Isolation & Gloving
  - Environmental Cleaning
  - Antibiotic Stewardship
  - Probiotics
- Treatment
  - Oral Antimicrobials; Treatment as Prevention
  - Fecal Bacteriotherapy
  - Surgical Options
- Putting It All Together: ICE CDI!
Device-focused Prevention Guidelines for:

- **CLABSI**
- **VAP**
- **cUTI**
- **SSI**
- **MRSA**
- **C. difficile**
Evaluation of the national Cleanyourhands campaign
to reduce *Staphylococcus aureus* bacteraemia and
*Clostridium difficile* infection in hospitals in England and
Wales by improved hand hygiene: four year,
prospective, ecological, interrupted time series study

Sheldon Paul Stone senior lecturer, stroke physician, and general physician for older people¹, Christopher Fuller project manager and nursing research fellow², Joan Savage research associate², Barry Cookson director³, Andrew Hayward senior lecturer², Ben Cooper mathematical modeller⁵¹⁰, Georgia Duckworth director⁴, Susan Michie professor of health psychology⁶, Miranda Murray consultant scientist⁴, Annette Jeanes consultant nurse in infection control⁷, J Roberts emeritus professor of economics of infectious disease⁸, Louise Teare consultant microbiologist and infection control doctor⁹, Andre Charlett head of department¹⁰

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Estimated Use of Hand Hygiene Consumables, by Quarter

Estimated Quarterly Rate of *C. difficile* Infection (per 10,000 bed days)

HH – Unintended Consequence Caveat?

Efficacy of Selected Hand Hygiene Agents Used to Remove *Bacillus atrophaeus* (a Surrogate of *Bacillus anthracis*) From Contaminated Hands

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**Antibiotic-resistant Bacillus anthracis** is caused by *Bacillus anthracis*, a large gram-positive, aerobic, spore-forming bacillus. Bacillus anthracis has nearly a worldwide distribution, exists in the soil in the form of extremely stable spores, and causes infection in farm and wild animals who have grazed on contaminated land or ingested contaminated feed. Human infection is most commonly acquired by contact with infected animals or with contaminated animal products such as wool, hide, hair, or bone; inhalation of spores; or by ingestion of contaminated meat. Clinical infection depends on the route of transmission and includes cutaneous anthrax, inhalation or pulmonary anthrax, and gastrointestinal anthrax.

*Bacillus anthracis* has been recognized as a likely agent for bioterrorism because the spores are highly stable in the environment, virtually all persons are susceptible, infection can occur as a result of inhalation of spores, and considerable morbidity and mortality result from infection. During October and November 2001, 22 people

**Context** The intentional use of *Bacillus anthracis* transmitted via the US mail in October-November 2001 resulted in 22 people developing inhalation or cutaneous anthrax. Glove use with handwashing prior to and after contact with potential contaminated environmental surfaces and cutaneous lesions has been recommended. However, only limited data are available on the susceptibility of *B. anthracis* to antiseptics.

**Objective** To evaluate the efficacy of several hand antiseptics (interventions) and soap and water (control) against *Bacillus atrophaeus*, a surrogate of *B. anthracis*.

**Design, Setting, and Participants** Challenge study conducted among healthy adult volunteers, using the Standard Test Method for Evaluation of the Effectiveness of Healthcare Professional Handwash Formulations (American Society for Testing and Materials E 1174-94) to determine the efficacy of various hand hygiene products at wash times of 10, 30, and 60 seconds. Volunteers were excluded if they had eczema, psoriasis, or other chronic skin conditions; nonintact skin; or allergies to any study agent. Study agents were a waterless rub containing 61% ethyl alcohol, a 2% chlorhexidine gluconate preparation, and an antibacterial microfiber towel that releases hypochlorite. A nonantimicrobial soap was used as a control.

**Main Outcome Measure** Reduction of *B. atrophaeus* spores (log_{10} CFU/mL) on contaminated hands.

**Results** Washes of 10, 30, and 60 seconds with either soap and water or 2% chlorhexidine gluconate eliminated 1.5 to 2.0 log_{10} CFUs/mL of *B. atrophaeus* spores at wash 3. Mean reductions (95% confidence intervals) with 10-, 30-, and 60-second washes with soap and water were 2.4 (2.2-2.5), 2.3 (2.2-2.4), and 2.1 (1.9-2.4) log_{10} CFUs/mL, respectively; and with 2% chlorhexidine gluconate, 2.1 (2.0-2.3), 1.8 (1.5-2.0), and 1.7 (1.5-1.9) log_{10} CFUs/mL, respectively. Handwashing with chlorhexidine-containing towels was increasingly effective as the wipe time increased; reductions at 10, 30, and 60 seconds were 1.3 (1.1-1.5), 1.6 (1.2-2.0), and 2.2 (2.1-2.2) log_{10} CFUs/mL, respectively. A waterless rub containing 61% ethyl alcohol was ineffective in eliminating *B. atrophaeus* spores at all times tested (0 [-0.1 to 0.1], -0.2 [-0.3 to -0.1], and 0 [-0.2 to 0.2] log_{10} CFUs/mL).

**Conclusions** In this evaluation of hand hygiene agents, handwashing with soap and water, 2% chlorhexidine gluconate, or chlorhexidine-containing towels reduced the amount of *B. atrophaeus* spore contamination, whereas use of a waterless rub containing ethyl alcohol was not effective in removing spores.

*JAMA. 2003;289:1274-7*.

Prospective, Controlled Study of Vinyl Glove Use to Interrupt Clostridium difficile Nosocomial Transmission

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PURPOSE: Despite recognition that Clostridium difficile diarrhea/colitis is a nosocomial infection, the manner in which this organism is transmitted is still not clear. Hands of health care workers have been shown to be contaminated with C. difficile and suggested as a vehicle of transmission. Therefore, we conducted a controlled trial of the use of disposable vinyl gloves by hospital personnel for all body substance contact (prior to the institution of universal body substance precautions) to study its effect on the incidence of C. difficile disease.

PATIENTS AND METHODS: The incidence of nosocomial C. difficile diarrhea was monitored by active surveillance for six months before and after an intensive education program regarding glove use on two hospital wards. The interventions included initial and periodic in-services, posters, and placement of boxes of gloves at every patient’s bedside. Two comparable wards where no special intervention was instituted served as controls.

RESULTS: A decrease in the incidence of C. difficile diarrhea from 7.7 cases/1,000 patient discharges during the six months before intervention to 1.5/1,000 during the six months of intervention on the glove wards was observed (p = 0.015). No significant change in incidence was observed on the two control wards during the same period (5.7/ 1,000 patient discharges).

Clostridium difficile is an important cause of colitis and diarrhea in patients exposed to certain antibiotics [1,2]. In addition to the risk of antibiotic exposure, there is a growing consensus that C. difficile is acquired nosocomially. The prevalence of asymptomatic C. difficile carriage is high in hospitalized populations [2,3] and low in the general adult population [4,5], and numerous hospital outbreaks and case clusters have been reported [3,6–10]. The mode of C. difficile transmission, however, is not clear. C. difficile has been recovered from the environment and from potential fomites, but most studies show high recovery rates only in the immediate environment of clinical cases or from likely contaminated items such as toilet seats or bedpans [11,12]. The relative importance of fomite or environmental acquisition in the hospital transmission of C. difficile remains unknown.

C. difficile has also been recovered from the hands of hospital personnel [13–16]. Transmission of C. difficile from patient to patient via the hands of hospital personnel may be an important mode of transmission that could be interrupted by the use of gloves by personnel when handling body substances, particularly feces. To test this hypothesis, we studied the effect of intensive vinyl glove use for all body substance contact as a means to reduce the incidence of C. difficile-associated diarrhea and asymptomatic carriage on two hospital wards.
You wouldn’t step in it.

Why do you put your hands in it?

Wear Gloves!!

## C. difficile Diarrhea/1,000 Patients

<table>
<thead>
<tr>
<th></th>
<th>6 mo pre</th>
<th>6 mo during</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Glove ward</strong></td>
<td>7.7</td>
<td>1.5</td>
<td>0.02</td>
</tr>
<tr>
<td><strong>Control ward</strong></td>
<td>5.7</td>
<td>4.5</td>
<td>NS</td>
</tr>
<tr>
<td><strong>Whole hospital</strong></td>
<td>3.2</td>
<td>3.2</td>
<td>NS</td>
</tr>
</tbody>
</table>

## Practices for Discontinuing *C. difficile* Infection Precautions in Canadian Health Care Facilities, by Facility Type (n = 662)

<table>
<thead>
<tr>
<th>Precautions discontinued</th>
<th>Acute care (n=132), n(%)</th>
<th>Long-term care (n=530), n(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>After patient has been asymptomatic for:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>48 hours</td>
<td>37 (28)</td>
<td>145 (27)</td>
</tr>
<tr>
<td>72 hours</td>
<td>49 (37)</td>
<td>172 (33)</td>
</tr>
<tr>
<td>Other</td>
<td>0 (0)</td>
<td>1 (0.2)</td>
</tr>
<tr>
<td>After treatment has been initiated</td>
<td>0 (0)</td>
<td>6 (1)</td>
</tr>
<tr>
<td>After treatment has ended and no relapse has been documented within 48 hours</td>
<td>23 (17)</td>
<td>132 (25)</td>
</tr>
<tr>
<td>Precautions are continued until discharge</td>
<td>1 (1)</td>
<td>16 (3)</td>
</tr>
<tr>
<td>Other policy for discontinuing</td>
<td>22 (17)</td>
<td>58 (11)</td>
</tr>
</tbody>
</table>

The Environment — A Better Product?

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

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Evanston, Illinois

**Background:** We were alerted to increased rates of *Clostridium difficile*-positive tests at all 5 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.

*Copyright © 2010 by the Association for Professionals in Infection Control and Epidemiology, Inc. Published by Elsevier Inc. All rights reserved. (Am J Infect Control 2010;38:350-3.)*
Rates decreased from 0.85 CDI cases/1000 patient-days in the preintervention period to 0.45 (P < .0001). Vertical line = Onset of bleach intervention.

Impact of Hydrogen Peroxide Vapor Room Decontamination on *Clostridium difficile* Environmental Contamination and Transmission in a Healthcare Setting

OBJECTIVE. To determine whether hydrogen peroxide vapor (HPV) decontamination can reduce environmental contamination with and nosocomial transmission of *Clostridium difficile*.

DESIGN. A prospective before-after intervention study.

SETTING. A hospital affected by an epidemic strain of *C. difficile*.

INTERVENTION. Intensive HPV decontamination of 5 high-incidence wards followed by hospital-wide decontamination of rooms vacated by patients with *C. difficile*-associated disease (CDAD). The preintervention period was June 2004 through March 2005, and the intervention period was June 2005 through March 2006.

RESULTS. Eleven (25.6%) of 43 cultures of samples collected by sponge from surfaces before HPV decontamination yielded *C. difficile*, compared with 0 of 37 cultures of samples obtained after HPV decontamination (*P* < .001). On 5 high-incidence wards, the incidence of nosocomial CDAD was significantly lower during the intervention period than during the preintervention period (1.28 vs 2.28 cases per 1,000 patient-days; *P* = .047). The hospital-wide CDAD incidence was lower during the intervention period than during the preintervention period (0.84 vs 1.36 cases per 1,000 patient-days; *P* = .26). In an analysis limited to months in which the epidemic strain was present during both the preintervention and the intervention periods, CDAD incidence was significantly lower during the intervention period than during the preintervention period (0.88 vs 1.89 cases per 1,000 patient-days; *P* = .047).

CONCLUSIONS. HPV decontamination was efficacious in eradicating *C. difficile* from contaminated surfaces. Further studies of the impact of HPV decontamination on nosocomial transmission of *C. difficile* are warranted.
Incidence of nosocomial *Clostridium difficile*–associated disease on 5 wards (A–E) that underwent intensive hydrogen peroxide vapor decontamination, during the preintervention period (gray bars; June 2004 through March 2005) and the intervention period (black bars; June 2005 through March 2006).

Comparison of the Microbiological Efficacy of Hydrogen Peroxide Vapor and Ultraviolet Light Processes for Room Decontamination

Nancy L. Havill, MT;1 Brent A. Moore, PhD;2 John M. Boyce, MD1,2

OBJECTIVE. To compare the microbiological efficacy of hydrogen peroxide vapor (HPV) and ultraviolet radiation (UVC) for room decontamination.

DESIGN. Prospective observational study.

SETTING. 500-bed teaching hospital.

METHODS. HPV and UVC processes were performed in 15 patient rooms. Five high-touch sites were sampled before and after the processes and aerobic colony counts (ACCs) were determined. Carrier disks with ~10⁶ Clostridium difficile (CD) spores and biological indicators (BIs) with 10⁴ and 10⁶ Geobacillus stearothermophilus spores were placed in 5 sites before decontamination. After decontamination, CD log reductions were determined and BIs were recorded as growth or no growth.

RESULTS. 93% of ACC samples that had growth before HPV did not have growth after HPV, whereas 52% of sites that had growth before UVC did not have growth after UVC (P<.0001). The mean CD log reduction was >6 for HPV and ~2 for UVC. After HPV 100% of the 10⁴ BIs did not grow, and 22% did not grow after UVC, with a range of 7%-53% for the 5 sites. For the 10⁶ BIs, 99% did not grow after HPV and 0% did not grow after UVC. Sites out of direct line of sight were significantly more likely to show growth after UVC than after HPV. Mean cycle time was 153 (range, 140–177) min for HPV and 73 (range, 39–100) min for UVC (P<.0001).

CONCLUSION. Both HPV and UVC reduce bacterial contamination, including spores, in patient rooms, but HPV is significantly more effective. UVC is significantly less effective for sites that are out of direct line of sight.

Infect Control Hosp Epidemiol 2012;33(5):507-512

ANTIBIOTIC STEWARDSHIP

Monthly Count Data for New Cases of CDI and Number of OBDs Before and After Introduction of Revised Antibiotic Guidelines

OBD = occupied bed days.

Probiotics for the Prevention and Treatment of Antibiotic-Associated Diarrhea
A Systematic Review and Meta-analysis

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Breanne Johnsen, BS
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The use of antibiotics that disturb the gastrointestinal flora is associated with clinical symptoms such as diarrhea, which occurs in as many as 30% of patients. Symptoms range from mild and self-limiting to severe, particularly in Clostridium difficile infections, and antibiotic-associated diarrhea (AAD) is an important reason for nonadherence with antibiotic treatment. Probiotics are microorganisms intended to have a health benefit when consumed. Synbiotics refer to preparations in which probiotic organisms and prebiotics (nondigestible food ingredients that may benefit the host by selectively stimulating bacteria in the colon) are combined.

Context Probiotics are live microorganisms intended to confer a health benefit when consumed. One condition for which probiotics have been advocated is the diarrhea that is a common adverse effect of antibiotic use.

Objective To evaluate the evidence for probiotic use in the prevention and treatment of antibiotic-associated diarrhea (AAD).

Data Sources Twelve electronic databases were searched (DARE, Cochrane Library of Systematic Reviews, CENTRAL, PubMed, EMBASE, CINAHL, AMED, MANTIS, TOXLINE, ToxFILE, NTIS, and AGRICOLA) and references of included studies and reviews were screened from database inception to February 2012, without language restriction.

Study Selection Two independent reviewers identified parallel randomized controlled trials (RCTs) of probiotics (Lactobacillus, Bifidobacterium, Saccharomyces, Streptococcus, Enterococcus, and/or Bacillus) for the prevention or treatment of AAD.

Data Extraction Two independent reviewers extracted the data and assessed trial quality.

Results A total of 82 RCTs met inclusion criteria. The majority used Lactobacillus-based interventions alone or in combination with other genera; strains were poorly documented. The pooled relative risk in a DerSimonian-Laird random-effects meta-analysis of 63 RCTs, which included 11,811 participants, indicated a statistically significant association of probiotic administration with reduction in AAD (relative risk, 0.58; 95% CI, 0.50 to 0.68; P < .001; P = 54%; [risk difference, −0.07; 95% CI, −0.10 to −0.05]; [number needed to treat, 13; 95% CI, 10.3 to 19.1]) in trials reporting on the number of patients with AAD. This result was relatively insensitive to numerous subgroup analyses. However, there exists significant heterogeneity in pooled results and the evidence is insufficient to determine whether this association varies systematically by population, antibiotic characteristic, or probiotic preparation.

Conclusions The pooled evidence suggests that probiotics are associated with a reduction in AAD. More research is needed to determine which probiotics are associated with the greatest efficacy and for which patients receiving which specific antibiotics.

### Efficacy Results of Probiotic Use by Study

<table>
<thead>
<tr>
<th>Study</th>
<th>Genus, Strain</th>
<th>Intervention</th>
<th>Control</th>
<th>No. With Antibiotic-Associated Diarrhea, In Group (%)</th>
<th>RR (95% CI)</th>
<th>Favorable Probiotic</th>
<th>Favorable Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jiraphyt, 2002</td>
<td><em>B. bifidum</em></td>
<td>15 (3)</td>
<td>12 (3)</td>
<td>0.75 (0.1-4.2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shin, 2002</td>
<td><em>B. bifidum</em></td>
<td>20 (2)</td>
<td>10 (0)</td>
<td>0.05 (0.001-0.4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sunan, 2002</td>
<td><em>B. bifidum</em></td>
<td>20 (1)</td>
<td>10 (0)</td>
<td>0.05 (0.001-0.4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lightle, 2004</td>
<td><em>B. bifidum</em></td>
<td>15 (0)</td>
<td>10 (0)</td>
<td>0.05 (0.001-0.4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Durante, 2006</td>
<td><em>B. infantis</em></td>
<td>20 (2)</td>
<td>10 (0)</td>
<td>0.05 (0.001-0.4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sambono, 2004</td>
<td><em>B. infantis</em></td>
<td>15 (2)</td>
<td>10 (0)</td>
<td>0.05 (0.001-0.4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coma, 2005</td>
<td><em>B. infantis</em></td>
<td>15 (1)</td>
<td>10 (0)</td>
<td>0.05 (0.001-0.4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mylonas, 2005</td>
<td><em>B. infantis</em></td>
<td>15 (2)</td>
<td>10 (0)</td>
<td>0.05 (0.001-0.4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Convey, 2007</td>
<td><em>B. infantis</em></td>
<td>15 (2)</td>
<td>10 (0)</td>
<td>0.05 (0.001-0.4)</td>
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<tr>
<td>Conti, 2007</td>
<td><em>B. infantis</em></td>
<td>15 (2)</td>
<td>10 (0)</td>
<td>0.05 (0.001-0.4)</td>
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<tr>
<td>Shiao, 2007</td>
<td><em>B. infantis</em></td>
<td>15 (2)</td>
<td>10 (0)</td>
<td>0.05 (0.001-0.4)</td>
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<tr>
<td>Kim, 2008</td>
<td><em>B. infantis</em></td>
<td>15 (2)</td>
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<td>0.05 (0.001-0.4)</td>
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<tr>
<td>Koning, 2009</td>
<td><em>B. infantis</em></td>
<td>15 (2)</td>
<td>10 (0)</td>
<td>0.05 (0.001-0.4)</td>
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<tr>
<td>Schreiber, 2010</td>
<td><em>B. infantis</em></td>
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<td>0.05 (0.001-0.4)</td>
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<tr>
<td>Venius, 2008</td>
<td><em>B. infantis</em></td>
<td>15 (2)</td>
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<td>0.05 (0.001-0.4)</td>
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<td>Farkas, 2009</td>
<td><em>B. infantis</em></td>
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<tr>
<td>Nicken, 2009</td>
<td><em>B. infantis</em></td>
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<td>0.05 (0.001-0.4)</td>
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<td>Meret, 2009</td>
<td><em>B. infantis</em></td>
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<td>Koning, 2010</td>
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<tr>
<td>Chen, 2011</td>
<td><em>B. infantis</em></td>
<td>15 (2)</td>
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<td>0.05 (0.001-0.4)</td>
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<tr>
<td>Sanguin, 2011</td>
<td><em>B. infantis</em></td>
<td>15 (2)</td>
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<tr>
<td>Yoon, 2011</td>
<td><em>B. infantis</em></td>
<td>15 (2)</td>
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<td>0.05 (0.001-0.4)</td>
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<tr>
<td>Bhalla, 2011</td>
<td><em>B. infantis</em></td>
<td>15 (2)</td>
<td>10 (0)</td>
<td>0.05 (0.001-0.4)</td>
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</tbody>
</table>

**Overall random effects model:**

- $P_{overall} = 0.0001$ (Chi-square test)
- $I^2 = 94.4\%$ (Heterogeneity index)
- $R^2 = 0.954$ (Coefficient of determination)

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TOPICS

• Epidemiology & Diagnosis
• Prevention
  • Hand Hygiene
  • Isolation & Gloving
  • Environmental Cleaning
  • Antibiotic Stewardship
  • Probiotics
• Treatment
  • Oral Antimicrobials; Treatment as Prevention
  • Fecal Bacteriotherapy
  • Surgical Options
• Putting It All Together: ICE CDI!
A Comparison of Vancomycin and Metronidazole for the Treatment of Clostridium difficile–Associated Diarrhea, Stratified by Disease Severity

Fred A. Zar,1 Srinivasa R. Bakkanagari,2 K. M. L. S. T. Moorthi,2 and Melinda B. Davis1

1University of Illinois at Chicago, Chicago, and 2Saint Francis Hospital, Evanston, Illinois

Background. The incidence and severity of Clostridium difficile–associated diarrhea (CDAD) has been increasing, and there have been recent reports of metronidazole treatment failure. Metronidazole is still commonly used as first-line treatment for CDAD but has never been compared with vancomycin in a prospective, randomized, double-blind, placebo-controlled trial. We conducted such a trial, stratifying patients according to disease severity, to investigate whether one agent was superior for treating either mild or severe disease.

Methods. From October 1994 through June 2002, patients with CDAD were stratified according to whether they had mild or severe disease based on clinical criteria and were randomly assigned to receive oral metronidazole (250 mg 4 times per day) or oral vancomycin (125 mg 4 times per day) for 10 days. Both groups received an oral placebo in addition to the study drug. Patients were followed up for 21 days to assess cure, treatment failure, relapse, or intolerance.

Results. One hundred seventy-two patients were enrolled, and 150 of these patients successfully completed the trial. Among the patients with mild CDAD, treatment with metronidazole or vancomycin resulted in clinical cure in 90% and 98% of the patients, respectively (P = .36). Among the patients with severe CDAD, treatment with metronidazole or vancomycin resulted in clinical cure in 76% and 97% of the patients, respectively (P = .02). Clinical symptoms recurred in 15% of the patients treated with metronidazole and 14% of those treated with vancomycin.

Conclusions. Our findings suggest that metronidazole and vancomycin are equally effective for the treatment of mild CDAD, but vancomycin is superior for treating patients with severe CDAD.
TREATMENT AS PREVENTION?

Rates of Relapse of *C. difficile*-associated Diarrhea, by Disease Severity and Treatment

<table>
<thead>
<tr>
<th>Disease severity</th>
<th>No. of patients who experienced relapse/no. of patients who were cured (%)</th>
<th>Mtz group</th>
<th>Vm group</th>
<th>Total</th>
<th>$P^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td></td>
<td>3/37 (8)</td>
<td>2/39 (5)</td>
<td>5/76 (7)</td>
<td>.67</td>
</tr>
<tr>
<td>Severe</td>
<td></td>
<td>6/29 (21)</td>
<td>3/30 (10)</td>
<td>9/59 (15)</td>
<td>.30</td>
</tr>
<tr>
<td>All</td>
<td></td>
<td>9/66 (14)</td>
<td>5/69 (7)</td>
<td>14/135 (10)</td>
<td>.27</td>
</tr>
</tbody>
</table>

**NOTE.**  Mtz, metronidazole; Vm, vancomycin.

$^a$  $P$ values were calculated using Fisher’s exact test.

Fidaxomicin versus Vancomycin for Clostridium difficile Infection

Thomas J. Louie, M.D., Mark A. Miller, M.D., Kathleen M. Mullaney, D.O., Karl Weiss, M.D., Arnold Lentnek, M.D., Yoav Golan, M.D., Sherwood Gorbach, M.D., Pamela Sears, Ph.D., and Youe-Kong Shue, Ph.D., for the OPT-80-003 Clinical Study Group®

ABSTRACT

BACKGROUND

Clostridium difficile infection is a serious diarrheal illness associated with substantial morbidity and mortality. Patients generally have a response to oral vancomycin or metronidazole; however, the rate of recurrence is high. This phase 3 clinical trial compared the efficacy and safety of fidaxomicin with those of vancomycin in treating C. difficile infection.

METHODS

Adults with acute symptoms of C. difficile infection and a positive result on a stool toxin test were eligible for study entry. We randomly assigned patients to receive fidaxomicin (200 mg twice daily) or vancomycin (125 mg four times daily) orally for 10 days. The primary end point was clinical cure (resolution of symptoms and no need for further therapy for C. difficile infection as of the second day after the end of the course of therapy). The secondary end points were recurrence of C. difficile infection (diarrhea and a positive result on a stool toxin test within 4 weeks after treatment) and global cure (i.e., cure with no recurrence).

RESULTS

A total of 629 patients were enrolled, of whom 548 (87.1%) could be evaluated for the per-protocol analysis. The rates of clinical cure with fidaxomicin were noninferior to those with vancomycin in both the modified intention-to-treat analysis (88.2% with fidaxomicin and 85.8% with vancomycin) and the per-protocol analysis (92.1% and 89.8%, respectively). Significantly fewer patients in the fidaxomicin group than in the vancomycin group had a recurrence of the infection, in both the modified intention-to-treat analysis (15.4% vs. 25.3%, P=0.005) and the per-protocol analysis (13.3% vs. 24.0%, P=0.004). The lower rate of recurrence was seen in patients with non–North American Pulsed Field type 1 strains. The adverse-event profile was similar for the two therapies.

CONCLUSIONS

The rates of clinical cure after treatment with fidaxomicin were noninferior to those after treatment with vancomycin. Fidaxomicin was associated with a significantly lower rate of recurrence of C. difficile infection associated with non–North American Pulsed Field type 1 strains. (Fund by Optimir Pharmaceuticals; ClinicalTrials.gov number, NCT00314951.)

Comparative Effectiveness of *C. difficile* Treatments as Prevention

<table>
<thead>
<tr>
<th>Context</th>
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<tbody>
<tr>
<td>Several antibiotics are available for treatment of <em>Clostridium difficile</em> infections.</td>
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<table>
<thead>
<tr>
<th>Contribution</th>
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<tbody>
<tr>
<td>This comparative effectiveness review of 11 randomized trials involving adults with <em>C. difficile</em> found that initial cure rates did not statistically significantly differ for fidaxomicin, vancomycin, and metronidazole. Recurrent disease was common with all agents but was less frequent with fidaxomicin (15%) than with vancomycin (25%).</td>
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</table>

<table>
<thead>
<tr>
<th>Caution</th>
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<tbody>
<tr>
<td>There were few studies, and most had small sample sizes. Studies used heterogeneous definitions for cure. Potential harms were inconsistently reported.</td>
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</table>

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<thead>
<tr>
<th>Implication</th>
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<tr>
<td>Any of several agents could be used for initial treatment of <em>C. difficile</em> infection. Fidaxomicin may be a superior agent for recurrent infection.</td>
</tr>
</tbody>
</table>

— The Editors

More Manipulating the Human Microbiome

Systematic Review of Intestinal Microbiota Transplantation (Fecal Bacteriotherapy) for Recurrent *Clostridium difficile* Infection

Ethan Gough,¹ Henna Shaikh,² and Amee R. Manges¹,³

Departments of ¹Epidemiology Biostatistics and Occupational Health, and ²Biology, McGill University, and ³Research Institute of the McGill University Health Centre, Montreal, Quebec, Canada

*Clostridium difficile* infection (CDI) is a gastrointestinal disease believed to be causally related to perturbations to the intestinal microbiota. When standard treatment has failed, intestinal microbiota transplantation (IMT) is an alternative therapy for patients with CDI. IMT involves infusing intestinal microorganisms (in a suspension of healthy donor stool) into the intestine of a sick patient to restore the microbiota. However, protocols and reported efficacy for IMT vary. We conducted a systematic literature review of IMT treatment for recurrent CDI and pseudomembranous colitis. In 317 patients treated across 27 case series and reports, IMT was highly effective, showing disease resolution in 92% of cases. Effectiveness varied by route of instillation, relationship to stool donor, volume of IMT given, and treatment before infusion. Death and adverse events were uncommon. These findings can guide physicians interested in implementing the procedure until better designed studies are conducted to confirm best practices.

In 317 patients treated across 27 case series and reports, IMT was highly effective, showing disease resolution in 92% of cases.

Surgical Options

Diverting Loop Ileostomy and Colonic Lavage
An Alternative to Total Abdominal Colectomy for the Treatment of Severe, Complicated Clostridium difficile Associated Disease

Matthew D. Neal, MD,* John C. Alverdy, MD,† Daniel E. Hall, MD,*‡ Richard L. Simmons, MD,* and Brian S. Zuckerbraun, MD*‡

Objective: To determine whether a minimally invasive, colon-preserving approach could serve as an alternative to total colectomy in the treatment of severe, complicated Clostridium difficile–associated disease (CDAD).

Background: C. difficile is a significant cause of morbidity and mortality worldwide. Most cases will respond to antibiotic therapy, but 3% to 10% of patients progress to a severe, complicated, or “fulminant” state of life-threatening systemic toxicity. Although the advocated surgical treatment of total abdominal colectomy with end ileostomy improves survival in severe, complicated CDAD, outcomes remain poor with associated mortality rates ranging from 35% to 80%.

Methods: All patients who were diagnosed with severe, complicated (“fulminant”) CDAD and were treated at the University of Pittsburgh Medical Center or VA Pittsburgh Healthcare System between June 2009 and January 2011 were treated with this novel approach. The surgical approach involved creation of a loop ileostomy, intraoperative colonic lavage with warmed polyethylene glycol 3350/electrolyte solution via the ileostomy and postoperative antegrade instillation of vancomycin flushes via the ileostomy. The primary end point for the study was resolution of CDAD. The matching number of patients treated with colectomy for CDAD preceding the initiation of this current treatment strategy was analyzed for historical comparison.

Results: Forty-two patients were treated during this time period. There was no significant difference in age, sex, pharmacologic immunosuppression, and Acute Physiology and Chronic Health Evaluation-II scores between our current cohort and historical controls. The operation was accomplished laparoscopically in 35 patients (83%). This treatment strategy resulted in reduced mortality compared to our historical population (19% vs 50%; odds ratio, 0.24; P = 0.006). Preservation of the colon was achieved in 39 of 42 patients (93%).

Conclusions: Loop ileostomy and colonic lavage are an alternative to colectomy in the treatment of severe, complicated CDAD resulting in reduced morbidity and preservation of the colon. Patients will respond to oral antibiotic therapy, but 3% to 10% of patients with CDAD progress to a severe, complicated, or “fulminant” state of life-threatening systemic toxicity.

The indications for surgical management of patients with CDAD are not clearly defined; however, most advocate surgical intervention in patients with worsening clinical examinations or peritonitis or patients in shock. Total abdominal colectomy with end ileostomy has been advocated as the operation of choice and has been demonstrated to marginally improve survival compared to nonoperative management in these critically ill patients. This operation was undertaken even before the etiology of the CDAD was known, primarily because of its superficial similarities to “toxic megacolon” as a late acute manifestation of inflammatory bowel disease.

Colectomy for severe, complicated CDAD has many disadvantages. Most notably, mortality rates in small series continue to range from 35% to 80%. In addition, laparotomy and subtotal or total abdominal colectomy can result in significant morbidity, and survivors often require permanent ileostomy. Furthermore, there are no universally accepted definitions of severity and physicians cannot predict which patients will progress to fulminant disease. Although standardized strategies of medical management for mild or moderate disease have long been established, the approaches to the treatment of severe and severe complicated (fulminant) CDAD have remained tentative and fragmented.

We now present our experience with an alternative surgical approach to the management of severe, complicated CDAD, which may prove a safer and simpler option. On the basis of the nature of the disease as a bacterial toxin-mediated mucosal inflammatory process with delayed and indirect systemic threats to life, we hypothesized that minimally invasive ileal diversion with intraoperative colonic lavage using a high-volume polyethylene glycol or electrolyte solution will clear C. difficile infection, resulting in eradication of CDAD.
Operative Treatment Strategy for Loop Ileostomy and Colonic Lavage for Severe, Complicated *C. difficile*-associated Disease

1. Creation of diverting loop ileostomy.
2. Intraoperative antegrade colonic lavage with 8 liters of warmed PEG3350/electrolyte solution via ileostomy.
3. Postoperative antegrade colonic enemas with vancomycin (500 mg in 500 mL X 10 days) via ileostomy.

Demographics and Outcomes in Patients with Severe, Complicated CDAD Treated with Ileostomy or Colonic Lavage Versus Colectomy

<table>
<thead>
<tr>
<th></th>
<th>Ileostomy/Lavage</th>
<th>Colectomy</th>
<th>P</th>
</tr>
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<tbody>
<tr>
<td>Age, y</td>
<td>65.3 ± 13</td>
<td>62.1 ± 14</td>
<td>0.28</td>
</tr>
<tr>
<td>Sex</td>
<td>45% women</td>
<td>45% women</td>
<td>1.0</td>
</tr>
<tr>
<td>APACHE-II (mean ± SD)</td>
<td>29.7 ± 5.5</td>
<td>28.5 ± 7.1</td>
<td>0.39</td>
</tr>
<tr>
<td>While blood cell count</td>
<td>25.4 ± 12.1</td>
<td>27.1 ± 13.2</td>
<td>0.54</td>
</tr>
<tr>
<td>Band count (mean ± SD)</td>
<td>21.4 ± 12.2</td>
<td>21.3 ± 12.9</td>
<td>0.97</td>
</tr>
<tr>
<td>Albumin (mean ± SD)</td>
<td>2.0 ± 0.8</td>
<td>2.2 ± 0.8</td>
<td>0.26</td>
</tr>
<tr>
<td>Intensive care unit</td>
<td>38/42 (90%)</td>
<td>38/42 (90%)</td>
<td>0.64</td>
</tr>
<tr>
<td>Intubated</td>
<td>27/42 (64%)</td>
<td>26/42 (62%)</td>
<td>0.82</td>
</tr>
<tr>
<td>Vasopressors</td>
<td>31/42 (74%)</td>
<td>32/42 (76%)</td>
<td>0.81</td>
</tr>
<tr>
<td>Immunosuppression</td>
<td>19/42 (45%)</td>
<td>17/42 (40%)</td>
<td>0.66</td>
</tr>
<tr>
<td>Postoperative death</td>
<td>8/42 (19%)</td>
<td>21/42 (50%)</td>
<td>0.006*</td>
</tr>
</tbody>
</table>

*Odds ratio = 0.24 (0.09–0.63).
TOPICS

• Epidemiology & Diagnosis
• Prevention
  • Hand Hygiene
  • Isolation & Gloving
  • Environmental Cleaning
  • Antibiotic Stewardship
  • Probiotics
• Treatment
  • Oral Antimicrobials; Treatment as Prevention
  • Fecal Bacteriotherapy
  • Surgical Options
• Putting It All Together: ICE CDI!
Proposed Checklist of Hospital Interventions to Decrease the Incidence of Healthcare-Associated *Clostridium difficile* Infection

Sarah K. Abbett, MD; Deborah S. Yokoe, MD, MPH; Stuart R. Lipsitz, ScD; Angela M. Bader, MD, MPH; William R. Berry, MD, MPA, MPH; Elise M. Tamplin, M(ASCP), MPH, CIC; Atul A. Gawande, MD, MPH

**BACKGROUND.** The incidence and severity of *Clostridium difficile* infection (CDI) are increasing, and previously described interventions for controlling the spread of CDI are not easily generalized to multiple healthcare institutions.

**OBJECTIVE.** We tested prevention and treatment bundles to decrease the incidence of CDI and the mortality associated with CDI at our hospital.

**DESIGN.** Observational before-after study of adult patients admitted to a tertiary care, university-affiliated hospital during the period from January 2004 through December 2008.

**METHODS.** In January 2006, we launched an educational campaign and introduced a prevention bundle—a series of specific processes aimed at preventing the transmission of *C. difficile* among hospitalized patients, including enhanced isolation practices, laboratory notification procedures, and steps coordinating infection control and environmental services activities. In April 2006, we implemented a treatment bundle—a set of hospital-wide treatment practices aimed at minimizing the risk of serious CDI complications. We tracked quarterly incidence rates and case-fatality rates for healthcare-associated CDI cases at our hospital. Our main outcome was the healthcare-associated CDI incidence rate, measured as the number of healthcare-associated cases of CDI per 1,000 patient-days.

**RESULTS.** We followed patients for a total of 1,047,849 patient-days. The healthcare-associated CDI incidence rates fell from an average of 1.10 cases per 1,000 patient-days before intervention to 0.66 cases per 1,000 patient-days after intervention. This statistically significant decrease amounts to a 40% reduction in incidence after the intervention.

**CONCLUSIONS.** Our intervention was successful in reducing the incidence of CDI at our hospital. On the basis of our experience, we propose the use of a checklist of hospital interventions to decrease the incidence of healthcare-associated CDI.

*Infect Control Hosp Epidemiol* 2009; 30:1062-1069
# C. difficile Infection Checklist at Brigham and Women’s Hospital

## Clostridium difficile Infection (CDI) Checklist

Hospital interventions to decrease the incidence and mortality of healthcare-associated C. difficile infections

### Prevention Checklist

- When an MD, PA, NP, or RN suspects a patient has CDI:
  - Physician, Physician Assistant, or Nurse Practitioner:
    - Initiate Contact Precautions Plus
    - Order stool C. difficile toxin testing
    - Discontinue non-essential antimicrobials
    - Discontinue all anti-peristaltic medications
  - Registered Nurse:
    - Obtain stool sample for C. difficile toxin test
    - Place patient in single-patient room
    - Place Contact Precautions Plus sign on patient’s door
    - Ensure that gloves and gowns are easily accessible from patient’s room
    - Place dedicated stethoscope in patient’s room
    - Remind staff to wash hands with soap and water following patient contact
  - Microbiology Laboratory Staff Person:
    - Call relevant patient floor with positive C. difficile toxin test result
    - Provide daily list of positive test results for Infection Control
  - Infection Control Practitioner:
    - Check microbiology results daily for positive C. difficile toxin results
    - Call relevant floor to confirm that patient with positive C. difficile toxin results is in a single-patient room and that the Contact Precautions Plus sign is on the patient’s door
    - Flag the patient’s C. difficile status in the hospital’s clinical information system or in the patient’s paper chart
    - Alert housekeeping that the patient is on Contact Precautions Plus
  - Environmental Services Staff Person:
    - Prior to discharge cleaning, check for Contact Precautions Plus sign on the patient’s door
    - If Contact Precautions Plus sign is on the door, clean the room with a bleach-based cleaning agent
    - Confirm for supervisor that bleach-based cleaning agent was used for discharge cleaning for every patient on Contact Precautions Plus

### Treatment Checklist

- When an MD, PA, or NP diagnoses mild CDI: All of the following criteria are present: diarrhea (>6 BM/day), no fever, WBC<15,000, no peritoneal signs, and no evidence of sepsis
  - Physician, Physician Assistant, or Nurse Practitioner:
    - Initiate oral metronidazole at dose 500mg every 8 hours
    - If no clinical improvement by 48-72 hours after diagnosis, treat patient as moderate CDI
    - Continue therapy for at least 14 days total and at least 10 days after symptoms have abated

- When an MD, PA, or NP diagnoses moderate CDI: At least one of the following criteria is present: diarrhea (5-12 BM/day), fever 37.5-38.5°C, WBC 15,000-25,000, or frankly visible stable lower gastrointestinal bleeding
  - Physician, Physician Assistant, or Nurse Practitioner:
    - Initiate oral vancomycin at dose 250mg every 6 hours
    - If no clinical improvement by 48 hours, add IV metronidazole at dose 500mg every 8 hours
    - Consider obtaining infectious disease consultation
    - Consider obtaining abdominal CT scan
    - Continue therapy for at least 14 days total and at least 10 days after symptoms have abated

- When an MD, PA, or NP diagnoses severe CDI: At least one of the following criteria is present: diarrhea (>12 BM/day), fever >38.5°C, WBC >25,000, hemodynamic instability, marked & continuous abdominal pain, ileus, absence of bowel sounds, evidence of sepsis, or intensive care unit level of care required
  - Physician, Physician Assistant, or Nurse Practitioner:
    - Obtain immediate infectious disease consultation
    - Obtain immediate general surgery consultation
    - Obtain abdominal CT scan
    - Initiate oral vancomycin at dose 250mg every 6 hours together with IV metronidazole at dose 500mg every 6 hours
    - Following consultation with general surgery regarding its use, consider rectal vancomycin
    - Ask general surgery service to assess the need for colectomy

Abbreviations: MD=medical doctor, PA=physician assistant, NP=nurse practitioner, RN=registered nurse, BM=bowel movement, WBC=white blood cell count, CT=computed tomography, IV=intravenous
Contact Precautions Plus Sign, as Developed at Brigham and Women’s Hospital for Healthcare Workers Caring for Patients with *C. difficile* Infection

Incidence Rates of Healthcare-associated *C. difficile* Infection Among Patients Hospitalized at Brigham and Women’s Hospital (excludes newborns in neonatal ICU)

**CDI Key Points from CDC**

- *Clostridium difficile* infections (CDIs) increased several fold in the past decade and became more serious, but are nonetheless preventable.

- Of all CDIs, 94% are related to health-care exposures and are potentially preventable by reducing unnecessary antibiotic use and interrupting patient-to-patient transmission of *C. difficile*.

- CDIs were reduced by 20% over approximately 21 months by 71 hospitals participating in prevention programs focused primarily on infection control strategies (e.g. early reliable detection, isolation, and enhanced environmental cleaning).

- Of all health-care–associated CDIs, 75% have their onset outside of hospitals, and 52% of the CDIs treated in hospitals are present on admission; these infections are a potential source for intrahospital transmission.

- More must be done to prevent CDIs by various stakeholders working together to expand prevention strategies, including a greater focus on antibiotic stewardship and extending prevention strategies in settings across the continuum of health-care delivery.

RAW’s Take Home Message — Basics Can Work!

- Early Diagnosis Essential
- Prompt Treatment
- Universal Gloving
- Aggressive Environmental Cleaning
- Antimicrobial Stewardship
- Next: Manipulate the Human Microbiome, e.g., Probiotics