**Clostridium difficile - Prevention is Better Than Cure**

Professor Mark Wilcox, University of Leeds

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**Environmental aspects of Prevention is better than cure**

Clostridium difficile infection

Professor Mark H. Wilcox

Chair, Director of Microbiology/Pathology

Units Teaching Hospitals & University of Leeds, UK

Lead on CDI

Regional Microbiology Network of Health Protection Agency

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**C. difficile in the environment**

- River (69%)
- Lake (66%)
- Swimming pool (59%)
- Mains tap water (99%)
- Sink (1%)

- Raw vegetables (2%)
- Private residences (2%)
- Dogs (10%)
- Cats (2%)

[4 hospital environments (20%)]

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**Environmental C. difficile**

Elderly Medicine ward

<table>
<thead>
<tr>
<th>Date</th>
<th>Bay floors</th>
<th>Toilet floors</th>
<th>Stair floor</th>
<th>Commodes</th>
<th>Radiators</th>
</tr>
</thead>
<tbody>
<tr>
<td>6/10</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>13/10</td>
<td>+</td>
<td>+</td>
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<tr>
<td>27/10</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
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</tr>
<tr>
<td>5/12</td>
<td>+</td>
<td>+</td>
<td></td>
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<tr>
<td>31/1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9/4</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>9/4/96</td>
<td>22/32 (69%)</td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Foner, Wilcox et al. Epidemiol Infect 2001; 120: 343-50

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**Frequency of C. difficile culture-positive environmental samples commonly associated with patients and healthcare workers in two study wards A and B**

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**Environmental C. difficile in isolation rooms**

Prevalence study results

- 203 rooms no C. difficile recovered
- 10/33 positive for 2 weeks
- 4/33 positive for 4 weeks


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**Comparison of C. difficile environmental recovery rates with four different culture methods**

- **Method**
  - Direct plating
  - CCEY + MAC
  - CCEY + thigmo + MAC
  - CCEY + thigmo + MAC + egg

- **% Recovery of C. difficile**
  - Direct plating: 30.0 ± 6.2
  - CCEY + MAC: 45.0 ± 3.9
  - CCEY + thigmo + MAC: 32.5 ± 6.2
  - CCEY + thigmo + MAC + egg: 25.0 ± 5.1

P = 0.004

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**Correlation between environmental C. difficile colonisation and clinical incidence of disease**

- **Sites**
  - Ward A
  - Ward B

- **% Environmental sites positive vs. Clinical cases**

P = 0.001

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**Environmental C. difficile**

- **% Environmental Sites Positive**
  - 0: 0/25
  - 1-25: 0/11
  - >25: 1/12 (8)
  - >50: 9/25 (36)

P < 0.01

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**CDI Transmission Pressure**

- "CDAD pressure": a modified form of colonization pressure based on symptomatic CDAD cases
- Retrospective cohort and nested case-control studies of patients admitted to US hospital during 2003-2004
- 36,775 patients included in cohort, of which 382 had CDAD

- Median CDAD pressure was higher for case patients than non-case patients (median 0.3, P<0.001)
- Only 1 patient with CDAD had a CDAD pressure of 0

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**CD Carriage & Contamination**

- **Microbiological Sampling Sites**
  - Hands, only
  - Hands + colon
  - Hands + colon + Oropharynx

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Current (CDI) cleaning controversies
- Detergent vs disinfectant (chlorine) products
- Microfibre products
- Steam cleaning
- \( \text{H}_2\text{O}_2 \) vapour
- Dichloroacetic anhydride vs. hypochlorite
- 1000 ppm vs. 5000 ppm
- Surface damage, residue removal
- Routine use, just for CDI cases, terminal clean

Current (CDI) cleaning controversies
Microfibre cleaning
- Dry cleaning
- Water based cleaning
- Reprocessing, efficacy vs. span
- Damage to fibres
- User dependency, 8-fold method
- Not all products equal efficacy


% bleach vs. ppm chlorine
- In the UK 10,000 ppm available chlorine literally corresponds to a 1:10 (10%) dilution household bleach, but the strength of individual proprietary brands of household bleach may vary
- In the US 1:10 is 500 ppm
- Study invariably refer ONLY to dilution factor (which strength was the parent bleach?!)
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In vitro effects of environmental disinfectants on spore formation

Detergent / germicide concentrations activity vs. vegetative C. difficile

Effects of environmental disinfectants & detergents on CD 001 spores

Effects of environmental disinfectants & detergents on CD 027 spores

Environmental intervention CDI studies

- Other studies

Evidence for role of chlorine-based cleaning to control CDI

- Kaatz et al. reported an outbreak of CDI ended following introduction of cleaning with hypochlorite (unbuffered hypochlorite - 500 ppm available chlorine)
- Surface contamination decreased to 21% of initial levels
- Phosphate buffer and hypochlorite (1600 ppm available chlorine) was even more effective
- Use resulted in a 98% reduction in surface contamination


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Evidence for role of chlorine-based cleaning to control CDI
- incidence of CDI in patients on a BMT was decreased significantly after substitution of methylene by hypochlorite (5000 ppm) for environmental disinfection
- after quarterly chlorhexidine solution based cleaning was reintroduced, incidence increased almost to baseline levels
- environmental C. difficile prevalence not measured
- ambient use altered during the study period
- results not reproducible for other units


Use of Hypochlorite Solution to Decrease Rates of Clostridium difficile-Associated Diarrhea
Kathleen M. Mcguigan, MPH; Jennifer Zick, BSN, CIC
Craig M. Cooperstein, MD; Martin Kollef, MD;
Erik Dubultite, MD; David K. Warren, MD, MPH

An increased role of Clostridium difficile-associated diarrhea (CDAD) was noted in 2 intensive care units of a university-affiliated tertiary care facility. The unit with enhanced environmental cleaning that included the use of a hypochlorite-based solution in place of quaternary ammonium-based solution resulted in a decrease in the rate of environmental contamination and positive cultures for iso-C. difficile.


UK CDI environmental cleaning guidance
- Environmental cleaning of rooms or bed areas of C. difficile patients should be carried out at least daily using chlorine containing cleaning agents (at least 1000 ppm).
- All commodes, toilets and bathroom areas should be disinfected after each use and with chlorine containing cleaning agents (at least 1000 ppm available chlorine).
- Terminal cleaning of either a bed space, bay or ward area after the discharge of patient with C. difficile should be performed. All areas should be cleaned using containing cleaning agents (at least 1000 ppm available chlorine) and curtains changed.

BMC Infectious Diseases
Research article
Reduction of Clostridium difficile and vancomycin-resistant Enterococcus contamination of environmental surfaces after an intervention to improve cleaning methods

Walters C, colleagues. (2010) BMC Infect Dis; (in press)

All 9 rooms of patients with CDI positive cultures prior to cleaning saw a 27% reduction (p = 0.5) after housekeeping cleaning (p = 0.2). vs. only 1/11 (9%) after bleach disinfection by research staff (p = 0.031)

After the intervention, rates of environmental contamination after housekeeping cleaning were significantly reduced.

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Risk of CDi
- Elderly patient
- Antibiotic exposure
- Gut flora inhibition
- Exposure to CD
- Antibiotic-resistant CD strain
- Virulent CD strain
- Poor host response

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