Infection Control of \textit{C. difficile}: Why are we failing and which special approaches could help us succeed?

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Objectives

- To discuss real-world challenges to effective control of *C. difficile* transmission
- To discuss special approaches to consider if basic control measures are failing
Transmission of *C. difficile*

- Infected Patient
- Environment
- Susceptible Patient
Contamination of hands with *C. difficile*

Contaminated environmental surfaces are an important source of hand contamination

- Skin contact: 50% of hand cultures positive
- Environment contact: 50% of hand cultures positive

Abdomen

Bed rail

Basic infection control practices

Hand washing, gloves, gowns

Susceptible Patient

Environment

Infected Patient

Why do basic practices often fail to control *C. difficile*?

Contamination of a patient call button with VRE after housekeeping cleaning

VRE = vancomycin-resistant *Enterococcus*  
Regular monitoring and feedback are essential

1). Direct observation
2). ATP bioluminescence
3). Fluorescent markers

Methods

Improvement in cleaning based on fluorescent marker removal
No decrease in incidence of *C. difficile* infections
Automated UV Radiation Device

- Mobile, automated, easy to use
- Kills *C. difficile* spores (2-3 log reduction)
- ~1 hour for *C. difficile* rooms
- ~15 minutes for non-spore forming organisms

Log reduction in *C. difficile* spores with UV device versus bleach

<table>
<thead>
<tr>
<th></th>
<th>Direct UV exposure</th>
<th>Indirect UV exposure</th>
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<tbody>
<tr>
<td>UV device</td>
<td>2 - 4 log</td>
<td>1 - 2.4 log</td>
</tr>
<tr>
<td>Bleach</td>
<td>6 log</td>
<td>6 log</td>
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</table>

Spore contamination in *C. difficile* isolation rooms after cleaning

![Graph showing percent positive CDI rooms after various cleaning methods.]

- Direct Plating
- Broth Enrichment

**Cleaning Methods:**
- Baseline
- Fluorescent Marker
- UV Device
- Enhanced Daily + Terminal Cleaning
Gap: practical and effective methods to monitor room disinfection

- **Low-tech**
  - Aerobic culture using *C. difficile* selective broth supplemented with thioglycolate as a reducing agent

- **High-tech**
  - Terbium fluorescence – heated spores release dipicolonic acid (DPA) which reacts with terbium to produce a unique fluorescence spectrum

What if basic practices are implemented and we are still failing to control *C. difficile*?

Consider Special Approaches

- Preemptive isolation
- Prolong duration of isolation
- Daily disinfection of high-touch surfaces
- Screen for and isolate asymptomatic carriers

Potential benefits of special approaches

Transmission reduction \sim \begin{align*}
\text{Patient days} \times \text{Transmission risk (spore shedding)} \end{align*}

\text{Effort required for interventions}
Hypothesis: Transmission risk varies

Super shedders

Minimal shedding
Sethi AJ, et al. Persistence of skin contamination and environmental shedding of *C. difficile* during and after treatment of *C. difficile* infection. ICHE 2010;31:21-7

Shedding of spores before, during, and after treatment
1). Expedite identification and isolation of infected patients
   - Preemptive isolation while test results are pending

Shedding of spores at the time of the order for *C. difficile* testing

Time from order placement to test result availability (days)

- Results in >3 Days (N=32; 16%)
- Results in 2-3 Days (N=35; 17%)
- Results in 1-2 Days (N=91; 45%)
- Results in <1 Day (N=33; 16%)
- Sample Rejected (N=12; 6%)

Number of Patients vs. Time from order placement to test result availability (days)
12% of all *C. difficile* tests rejected due to leaking of sample or labeling error

Leaking stool

Mis-labeled samples
2). Source control

Daily disinfection of high-touch surfaces during CDI treatment

Improve bathing to reduce the burden of spores on skin

Daily disinfection of high-touch surfaces

A. *C. difficile*

- \( P \) (Baseline) = 0.74
- \( P \) (Days1-5) < 0.001

Positive Hand Cultures, %

Days of Intervention

- Daily Disinfection
- Standard Cleaning
Patient hand washing for removal of *C. difficile* spores

Before

After
3). Prolong the duration of isolation
Comparison of CDI patients at diagnosis and 1-4 weeks after completion of treatment

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<thead>
<tr>
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<th>At time of diagnosis</th>
<th>1-4 weeks after treatment</th>
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<tbody>
<tr>
<td><strong>C. difficile stool density</strong></td>
<td>5.3 logs</td>
<td>3.3 logs</td>
</tr>
<tr>
<td><strong>Positive skin culture</strong></td>
<td>88%</td>
<td>40%</td>
</tr>
<tr>
<td><strong>Positive environmental cultures, mean (N = 4)</strong></td>
<td>1.7</td>
<td>0.86</td>
</tr>
<tr>
<td><strong>Acquisition on hands after skin contact</strong></td>
<td>76%</td>
<td>48%</td>
</tr>
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</table>

How many additional days of isolation would be required if precautions were extended until discharge or 1 month after treatment?

C. difficile infection

4). Screen for and isolate asymptomatic carriers

Exposure

Asymptomatic carrier

1/3

2/3
Asymptomatic carriage of *C. difficile* in a long-term care facility (LTCF) and hospital

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<tr>
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<th>LTCF 2007</th>
<th>LTCF 2012</th>
<th>Hospital 2009</th>
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<tr>
<td><strong>Prevalence</strong></td>
<td>51%</td>
<td>28%</td>
<td>11%</td>
</tr>
<tr>
<td><strong>Positive chest &amp; abdomen culture</strong></td>
<td>59%</td>
<td>18%</td>
<td>13%</td>
</tr>
<tr>
<td><strong>Environmental contamination</strong></td>
<td>50%</td>
<td>11%</td>
<td>5%</td>
</tr>
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Extreme Makeover: VA Edition

Old LTCF

New LTCF
Summary

- Major challenges for infection control:
  - Poor implementation of basic practices
  - Inadequate methods to monitor effectiveness

- Special approaches that are promising:
  - Early identification and isolation of infected patients
  - Source control (e.g., daily disinfection of surfaces)
  - Environmental cultures to monitor disinfection
Why do basic practices often fail to control *C. difficile*?

Only modest reduction in contamination of CDI rooms after cleaning despite interventions