Learning Objectives

*Clostridium difficile* infection (CDI)

- Cell - spore - cell life cycle
- Review pathogenesis and mode of transmission of CDI
- Review morbidity and mortality estimates and sources of onset of CDI
- Strategies to prevent and respond to cases and outbreaks of CDI
Spores are dormant and metabolically inert.

They can remain dormant for years and can germinate and transform into bacterial cells under the right conditions.

Spores are significantly more resistant than bacterial cells to:
- Heat
- UV
- Disinfection
- Alcohol
- Irradiation

The bacterial spore is an intermediate form in the lifecycle of some Gram positive bacteria, most notably *Bacillus* and *Clostridium* spp.
Cell – Spore – Cell Life Cycle

Descending Order of Resistance to Disinfectants

- **Bacterial Spores** *(Bacillus, Clostridium – including *C. difficile*)
- **Mycobacteria** *(M. tuberculosis, M. terrae, M. chelonae)*
- **Small, non-enveloped viruses** *(Poliovirus, Parvovirus, Papilloma virus, Norovirus)*
- **Fungi** *(Aspergillus, Penicillium)*
- **Gram-negative bacteria** *(Pseudomonas, Legionella, Escherichia, Klebsiella – including -KPC and other CRE, Acinetobacter)*
- **Large, non-enveloped viruses** *(Adenoviruses, Rotaviruses)*
- **Gram-positive bacteria** *(Staphylococcus – including MRSA, Streptococcus, Enterococcus – including VRE)*
- **Enveloped viruses** *(Human immunodeficiency virus, Hepatitis B virus, Hepatitis C virus, Influenza A virus)*
A Brief History of *Clostridium difficile*

- **1935**: Discovered and named *Bacillus difficile*
- **1978**: Recognized as a major cause of antibiotic-associated diarrhea
  - Possibly triggered by widespread use of clindamycin
- **1980+**: Over-use of penicillins and cephalosporins fanned the flames of CDI
- **2000+**: Fluoroquinolone antibiotics linked to a new and more virulent strain *C. difficile*
  - This strain is more resistant to fluoroquinolones
  - Strain appears more virulent possibly due to its increased production of toxins A and B and other factors
  - Today, *C. difficile* infection (CDI) accounts for 15-25% of all episodes of antibiotic-associated diarrhea

Sources: Harvard Medical School, U.S. CDC
Clostridium difficile Infection (CDI)

- *C. difficile* causes inflammation of the colon (colitis) leading to CDI

- People undergoing prolonged use of antibiotics, and the elderly, are at greater risk of acquiring CDI

- Symptoms include
  - Watery diarrhea
  - Fever
  - Loss of appetite
  - Nausea
  - Belly pain and tenderness

- Patients can be colonized and test positive for bacterium, yet show no symptoms, yet excrete
**Clostridium difficile Facts**

- Healthy people usually not susceptible to CDI
- Causes diarrhea and more serious intestinal conditions such as colitis in susceptible people
- Close to 500,000 CDI cases annually and > 29,000 deaths in the U.S. annually
  - Three deaths every hour, every day of the year
  - Death occurs in ~ 9% of hospitalized patients with CDI
- More than 80% of CDI deaths occur in people 65 or older
- For people over 65, one in 11 died of a healthcare associated CDI within a month of receiving CDI diagnosis
- Infection returns in ~ 20% of CDI patients treated with antibiotics

http://www.apic.org/AM/Template.cfm?Section=National_C_Diff_PrevalanceStudy&Template/CM/HTMLDisplay.cfm&ContentID=11333

**Burden of C. difficile Infections (CDI) in the U.S. * **

- 453,000 Estimated number of CDIs in the U.S. each year
- 29,300 Estimated number of deaths annually in the U.S.
- > 3 Estimated number of deaths each hour attributed to CDI

* NEJM 2015 372: 825-834
Estimate Burden of *C. difficile* Exposure by Setting*

* NEJM, 2015 372: 825-834
** Reported visiting a doctor’s or dentist’s office in the previous 12 week period

How is *C. difficile* Transmitted to Others?

* *C. difficile* is shed in feces and fecal-oral is route of transmission

* Spores transferred to patients mainly from hands of healthcare personnel who have touched a contaminated surface or item

* Residual *C. difficile* from environmental surfaces
  - Any surface, device, or material
  - Hospital rooms – bed rails
  - Bathroom surfaces
  - Medical equipment


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Range of *C. difficile* Contamination of Surfaces in 7 Studies

![Bar graph showing the percentage of contaminated surfaces.](image)

**Toilets in CDI Patient Rooms**

- *C. difficile* was recovered from the air at heights of 25 cm above the toilet seat.
- Surface contamination around the toilet continued for 90 minutes after flushing.

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Boyce JM, Role of Environmental Contamination in Transmission of Healthcare-Associated Pathogens

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Proactive Preventive Approach

- *C. difficile* infections can be prevented through infection control recommendations and a/b stewardship
- By the time you know you have a patient with CDI, the spores are already in the environment
- Proactive preventive approach
- Focus on hand hygiene
- Sporicidal disinfectant for daily cleaning
- Objectively measure and analyze thoroughness of your cleaning procedures

**Correlation Between Environmental Contamination and Hand Contamination**

- HCWs who have **no** direct contact with an affected patient, but touch bedding or objects in room may contaminate hands
- HCWs can contaminate their clothing with *C. difficile*
  - 11/57 (19%) of nursing uniforms were contaminated with *C. difficile* after caring for affected patients in one study
  - The role of contaminated uniforms in transmission of *C. difficile* has not been determined

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Perry C et al. J Hospital Infect 2001; 48:238
Proportion of Objects Cleaned as Part of Terminal Room Cleaning in 20 Acute Care Hospitals

Many high touch objects are not well cleaned

Focus on Hand Hygiene

Soap and Water

- Wet hand with warm water (at least 110°F / 43.3°C)
- Apply soap to hands
- Rub hands together vigorously for 15 - 20 seconds, covering all surfaces of hands and fingers
- Rinse hands with warm water
- Thoroughly dry hands with disposable towel
- Use towel to turn off faucet
Rationale for Soap and Water: Lack of efficacy of alcohol-based handrub against *C. difficile*

<table>
<thead>
<tr>
<th>Interventions compared</th>
<th>Mean log reduction (95% CI), log_{10} CFU/mL</th>
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<tbody>
<tr>
<td>Warm water and plain soap</td>
<td>No hand hygiene</td>
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<tr>
<td>Warm water and plain soap</td>
<td>Alcohol-based handrub</td>
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<tr>
<td>Cold water and plain soap</td>
<td>No hand hygiene</td>
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Cleaning and Disinfection

- Remember spores are nature’s ultimate survivalist
- Use EPA-registered hard surface hospital-use disinfectant products with *C. difficile* sporicidal claims
- Carefully follow label directions for use, including requirements for pre-cleaning, where indicated
- Implement a quality measurement system to assess effectiveness of cleaning
Environmental Cleaning

- Ensure that environmental cleaning is adequate and high-touch surfaces are not being overlooked
- Objectively measure and analyze thoroughness of your cleaning procedures
  - One study using a fluorescent environmental marker to assess cleaning showed:
    - Only 47% of high-touch surfaces in 3 hospitals were cleaned
    - Sustained improvement in cleaning of all objects, especially in previously poorly cleaned objects, following educational interventions with the environmental services staff

Responding to an Outbreak

- Use Contact Precautions for patients with known or suspected CDI and continue until diarrhea ceases
- Place CDI patients in private rooms, wherever possible
- Use gloves when entering patients’ rooms and during patient care.
- Perform Hand Hygiene after removing gloves
- Use gowns when entering patients’ rooms and during patient care
- Dedicate or perform cleaning of any shared equipment
- Elevate your environmental C&D strategy
Environmental Cleaning

Ensure that environmental cleaning is adequate and high-touch surfaces are not being overlooked

Objectively measure and analyze thoroughness of your cleaning procedures

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Laundry and Linens

- *Clostridium difficile* spores survive the laundering process and may be transferred to clean linen
- *Clostridium difficile* spores may cross-contaminate cleaning cloths in the wash cycle
- Some disinfectant chemistries significantly reduce, but do not eliminate the spores
- There are no EPA-registered laundry sporicidal products at this time (no approved test method)

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CDC does not have any specific guidance on warewash for *C. difficile* spores

- If patients or residents have CDI, use disposable plates, cups, etc, whenever possible
- Automated dishwashing equipment used in hospitals is typically sufficient*
  - There is more than an adequate amount of soap and water in those systems to reduce the spore counts*

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* source: U.S. CDC
A Quick Recap

*Clostridium difficile* infection (CDI)

- Cell - spore - cell life cycle
- Review pathogenesis and mode of transmission of CDI
- Review morbidity and mortality estimates of CDI
- Strategies to prevent and respond to outbreaks of CDI

Thank you

Ecolab is everywhere it matters. Because what we do - and how we do it - matters everywhere.

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