Clostridium difficile: A Growing Threat In Your Facility

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Disclosure: Clorox

Prevention of *C. difficile*

- Role of the environment in transmission
- *C. difficile*
  - Microbiology and epidemiology
  - Environmental contamination
  - Environmental disinfection
  - Hand hygiene
- Norovirus
- MRSA
- Other issues: microfiber, computers, green products

Disinfection and Sterilization

EH Spaulding believed that how an object will be disinfected depended on the object's intended use.

CRITICAL - objects which enter normally sterile tissue or the vascular system or through which blood flows should be **sterile.**

SEMICRITICAL - objects that touch mucous membranes or skin that is not intact require a disinfection process (**high-level disinfection [HLD]**) that kills all microorganisms but high numbers of bacterial spores.

NONCRITICAL -objects that touch only intact skin require **low-level disinfection**.

Role of Surfaces in Transmission

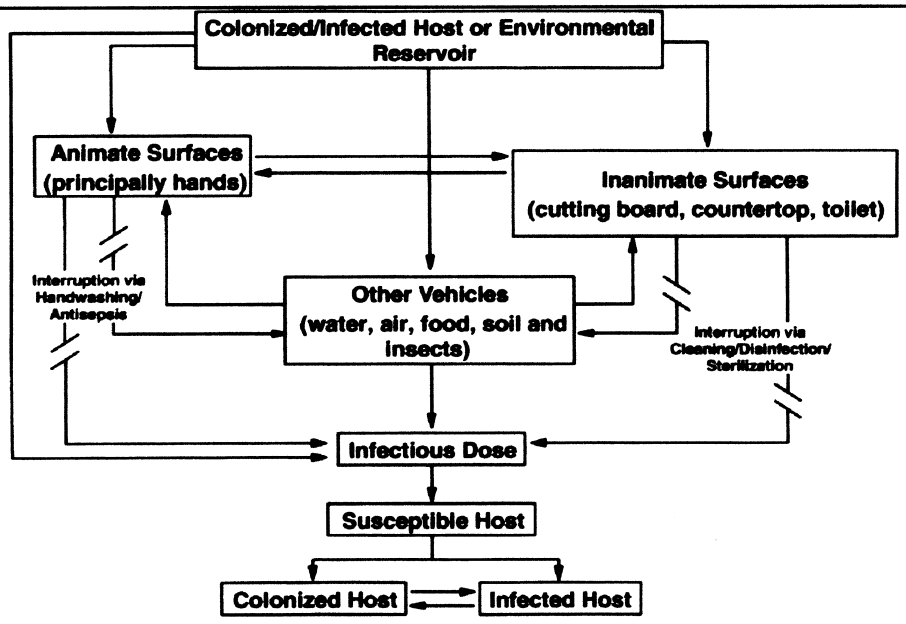
Pathogens implicated in transmission via contaminated noncritical surfaces. Patients C/I with these pathogens contaminate the environment and these pathogens survive in the environment.

- Bacteria
  - Methicillin-resistant *Staphylococcus aureus*
  - Vancomycin-resistant *Enterococcus spp.*
  - *Clostridium difficile*
  - *Acinetobacter* and *P. aeruginosa*
- Viruses
  - Rotavirus
  - Norovirus
  - SARS coronavirus

Role of the Environment In Transmission

Hota B, Clin Inf Dis 2004;39:1182

Pathogen	Survival	Environmental Data
C. difficile	Months (spores)	3+
VRE	Days to weeks	3+
MRSA	Days to weeks	2-3+
Acinetobacter	33 days	2-3+
P. aeruginosa	7 h	1+



Transmission of infectious agents via animate and inanimate surfaces

Prevention of *C. difficile*

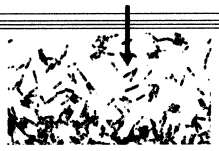
- Microbiology and epidemiology
- Role of the environment in transmission
- Prevention
  - Environmental disinfection
  - Equipment disinfection
  - Hand hygiene

Clostridium difficile: Microbiology

- Gram-positive bacillus
- Strict anaerobe
- Spore-forming
- Colonizes human GI tract

Clostridium difficile

- **Anaerobic spore-forming bacillus**
- ***Clostridium difficile* infection (CDI)**
- **Pseudomembranous colitis, toxic megacolon, sepsis, and death**
- **Infection control strategies**
  - **Prevent ingestion of the organisms/spores**
    - **Fecal-oral transmission through contaminated environment and hands of healthcare personnel**
  - **Reduce the chance of developing CDI in the event of ingestion**
    - **Minimize antimicrobial exposure – major risk factor for disease**
    - **suppression of normal flora of the colon**



Healthy Colon

Pseudo-membranous colitis

Clostridium difficile: Epidemiology

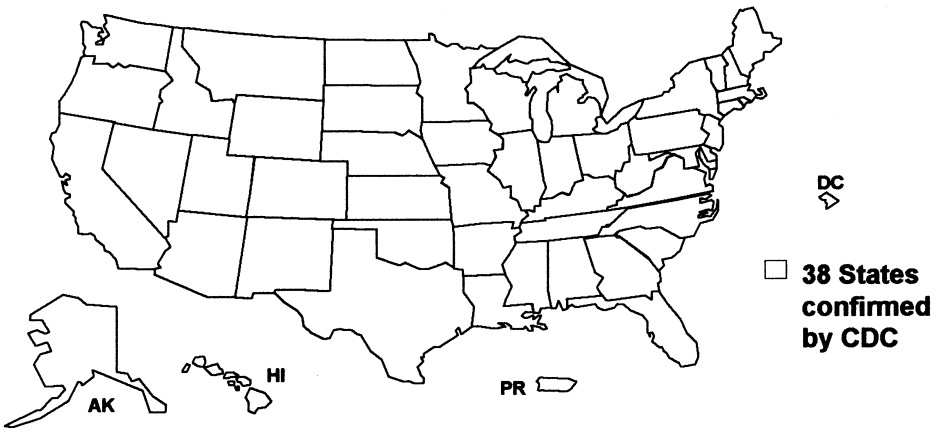
- Associated with gastrointestinal infection
- *C. difficile* toxin found in the stool of 15-25% of patients with antibiotic-associated diarrhea
- *C. difficile* toxin found in the stool of >95% of patients with pseudomembranous colitis
- Increasing incidence in U.S. (discharge diagnoses)
  - 1996: 31 per 100,000 population
  - 2003: 61 per 100,000 population
- Patients can be contaminated from environmental surfaces, shared instrumentation, hospital personnel hands and infected roommates Clin Microbiol Infect 2001;7:405; Clin Micro Rev 2004;17:863; CID 2002;34:346

Emergence of a HYPERVIRULENT Strain

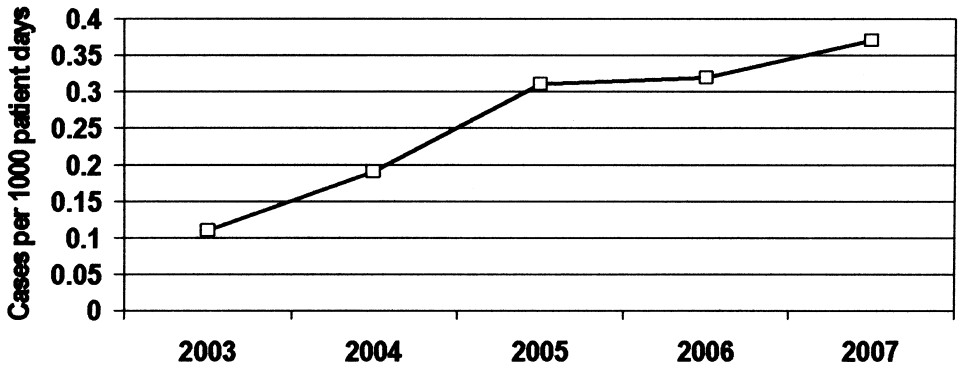
- Epidemic strain in Quebec since 2002
- Spread to United States, United Kingdom and the Netherlands
- Toxinotype III, North American PFGE type 1 (NAP1), PCR-ribotype 027, REA group B1
  - Carries binary toxin gene *cdtB* and an 18-bp deletion in *tcdC*
- Severity of disease due to hyper-production of toxins A (16-fold) and B (23-fold)
- High attributable mortality among elderly patients associated with hyper-virulent strain
- Fluoroquinolone use strongly associated as a risk factor

Pépin J, et al., *CMAJ*. 2005;173:Online1-6.; Warny M, et al. *Lancet*. 2005;366:1079-1084.; Pépin J, et al., *Clin Infect Dis. 2005;41:1254-1260.*

States with the Epidemic Strain of *C. difficile* Confirmed by CDC (N=38), Updated 9 Nov. 2007



CDAD Rates At UNC Hospitals



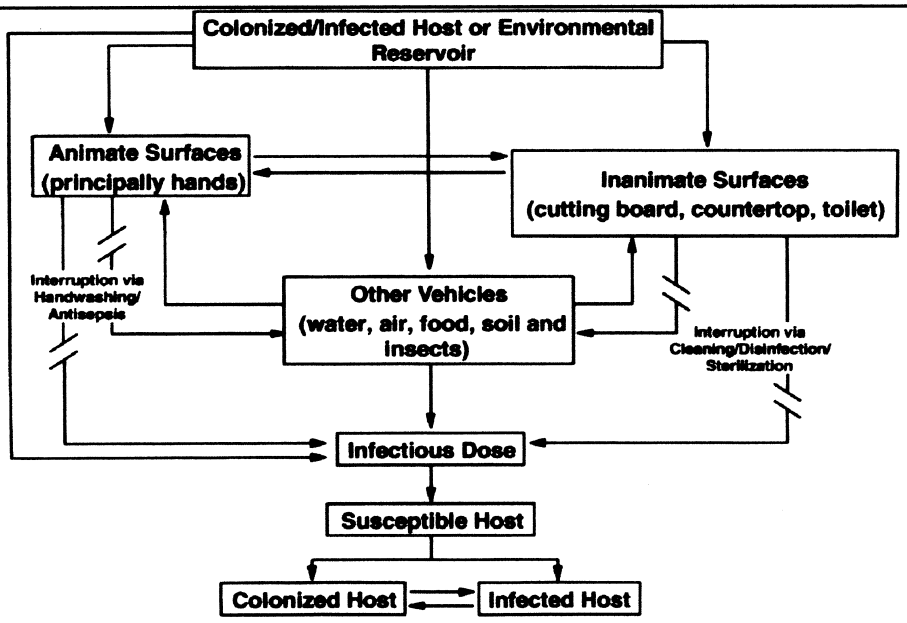
Slide courtesy of Ms. Emily Sickbert-Bennett

Pathogenesis of CDAD

- Colonization of gut by *C. difficile* required for disease
- Disruption of normal flora also required for disease
  - Antibiotic usual culprit
  - Rarely, chemotherapeutic agents can precipitate CDAD
- Virulence factors: toxins A and B
  - Responsible for inflammation, fluid and mucous secretion, and mucosal damage leading to diarrhea or colitis

C. difficile: Current Problems

- Increasing prevalence and incidence
- New epidemic strain that hyperproduces toxins A and B
- Introduction of CDAD from the community
- Lack of a completely sensitive and rapid diagnostic test for CDAD
- Absence of a treatment that will prevent recurrence of CDAD
- Inability to effectively treat fulminant CDI
- Inability to prevent CDAD



Transmission of infectious agents via animate and inanimate surfaces

C. difficile Environmental Contamination

Gerding et al Clin Inf Dis 2008;46:S43

- Because *C. difficile* shed in feces, any surface or device that becomes contaminated with feces can serve as a reservoir for *C. difficile* spores.
- Heaviest contamination
  - Floors and bedrails
- Other sites frequently found contaminated
  - Windowsills, commodes, toilets, bedsheets, call buttons, scales, blood pressure cuffs, electronic thermometers, flow-control devices for IV catheter, feeding tube equipment

Environmental Contamination
C. difficile

- 9.3% (85/910) of environmental cultures positive (floors, toilets, toilet seats) for *C. difficile*. 2.6% (13/497) cultures positive in areas with no know carriers. Kim et al. J Inf Dis 1981;143:42.
- 10% (110/1086) environmental samples were positive for *C. difficile* in case-associated areas and 2.5% (14/489) in areas with no known cases. Fekety et al. Am J Med 1981;70:907.
- 31.4% of environmental cultures positive for *C. difficile*. Kaatz et al. Am J Epid 1988;127:1289.

Environmental Contamination
C. difficile

- 29% (62/216) environmental samples were positive for *C. difficile*. 29% (11/38) positive cultures in rooms occupied by asymptomatic patients and 49% (44/90) in rooms with patients who had CDAD. McFarland et al. NEJM 1989;320:204
- 25% (117/466) of cultures positive (<10 CFU) for *C. difficile*. >90% of sites positive with incontinent patients. Samore et al. Am J Med 1996;100:32.
- 27% (13/48) of samples were positive for *C. difficile*. The NAP1 epidemic strain was found in 5 of 6 facilities. Dubberke et al. AJIC 2007;35:315.

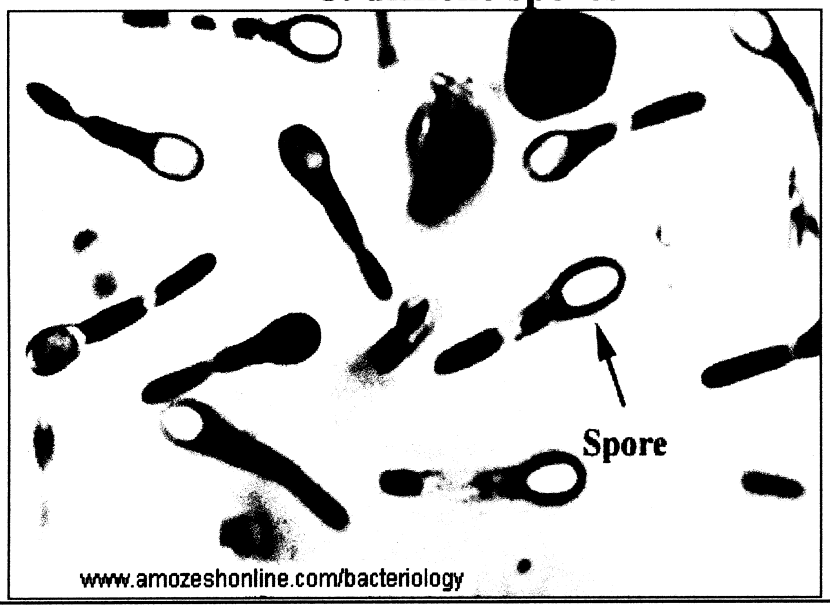
Role of the Environment
C. difficile

- **The presence of *C. difficile* on the hands correlated with the density of environmental contamination.** Samore et al. Am J Med 1996;100:32.
  - **0-25% environmental sites positive-0% hand cultures positive**
  - **26-50% environmental sites positive-8% hand cultures positive**
  - **>50% environmental sites positive-36% hand cultures positive**
- ***C. difficile* incidence data correlated significantly with the prevalence of environmental *C. difficile*.** Fawley et al. Epid Infect 2001;126:343.
- **Environmental contamination does not play a major role in nosocomial CDAD in some endemic situations.** Cohen et al. Clin Infect Dis 1997;24:889.
- **59% of 35 HCWs were *C. difficile* positive after direct contact with culture-positive patients.**
- ***C. difficile* skin contamination (≥ 1 site-groin, chest, abdomen, forearms, hands) in patients with CDI high (93%) and was easily acquired by hands. Clin Inf Dis 2008;46:447-50**

Survival
C. difficile

- Vegetative cells
  - Can survive for at least 24 h on inanimate surfaces
- Spores
  - Spores survive for up to 5 months. 10^6 CFU of *C. difficile* inoculated onto a floor; marked decline within 2 days. Kim et al. J Inf Dis 1981;143:42.
  - Hypersporulation has been shown to be a virulence-associated characteristic of outbreak strains of *C. difficile*.

C. difficile spores



Decreasing Order of Resistance of Microorganisms to Disinfectants/Sterilants

Prions

Spores

Mycobacteria

Non-Enveloped Viruses

Fungi

Bacteria

Enveloped Viruses

Environmental Disinfection

- Disinfection with a 1:10 dilution of concentrated sodium hypochlorite (i.e., bleach) has been shown to be effective in reducing environmental contamination in patient rooms and in reducing CDI rates in hospital units where the rate of CDI is high.

Disinfectants and Antiseptics

C. difficile spores at 20 min, Rutala et al, 2006

- No measurable activity (1 *C. difficile* strain, J9)
  - CHG
  - Vesphene (phenolic)
  - 70% isopropyl alcohol
  - 95% ethanol
  - 3% hydrogen peroxide
  - Clorox disinfecting spray (65% ethanol, 0.6% QUAT)
  - Lysol II disinfecting spray (79% ethanol, 0.1% QUAT)
  - TBQ (0.06% QUAT); QUAT may increase sporulation capacity- Lancet 2000;356:1324
  - Novaplus (10% povidone iodine)
  - Accel (0.5% hydrogen peroxide)