

C. Difficile Infection: Life Cycle, Incidence and Burden

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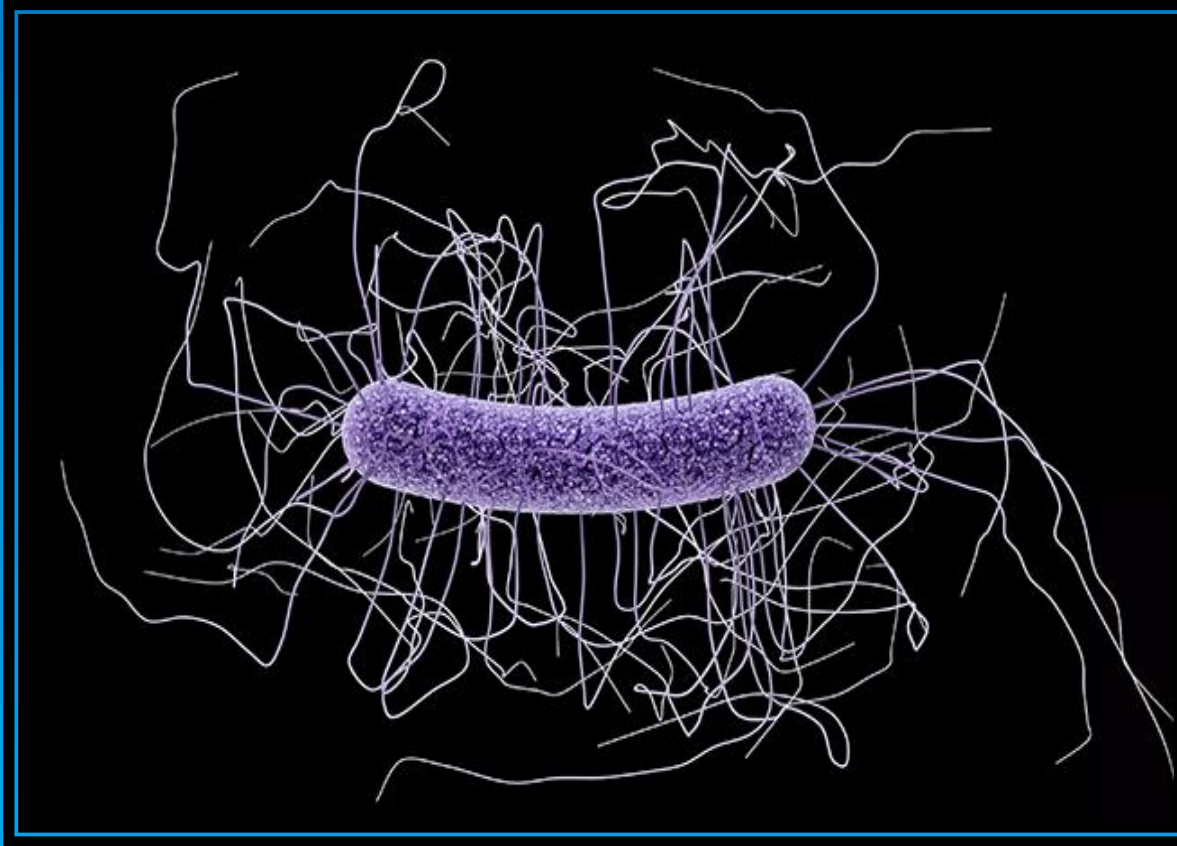
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Life Cycle

What is *Clostridium difficile*?



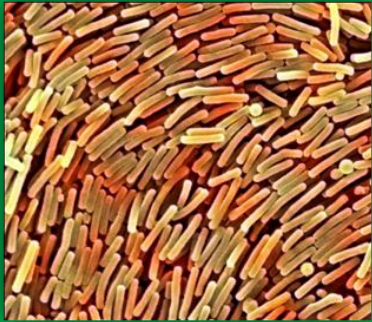
❖ Gram positive

❖ Spore forming

❖ Anaerobic

❖ Rod

Microbiology



Vegetative Form

Survives on moist surfaces for up to 6 hours¹

Susceptible to:²

- Gastric acid
- Antibacterial soaps
- Alcohol-based hand sanitizers



Spore Form^{2,3}

Survives on surfaces for months

Resistant to:

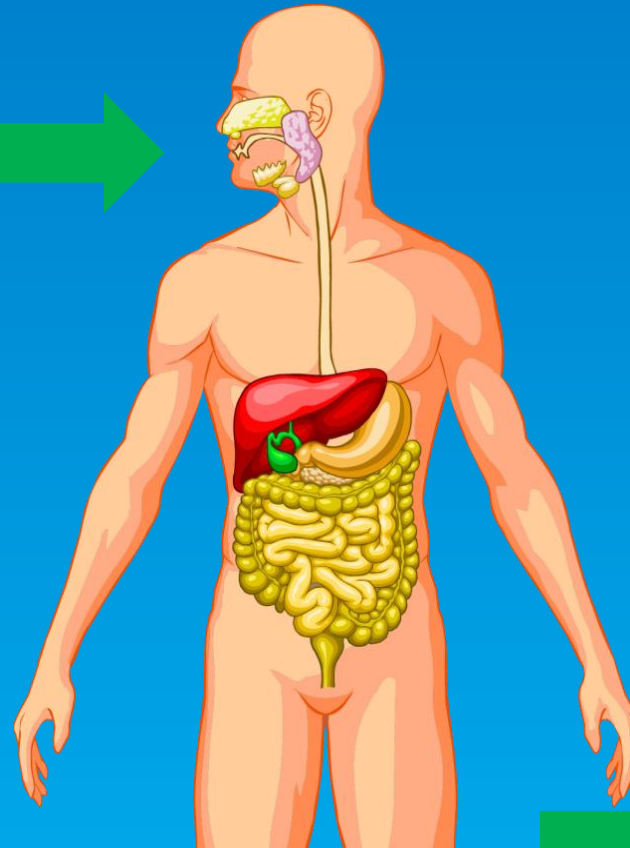
- Gastric acid
- Antibacterial soaps
- Alcohol-based hand sanitizers
- Rapidly changes to vegetative form

1. Jump RL et al. *Antimicrob Agents Chemother.* 2007;51(8):2883–2887.

2. Fordtran JS. *Proc (Bayl Univ Med Cent).* 2006;19(1):3–12.

3. Cohen SH et al. *Infect Control Hosp Epidemiol.* 2010;31(5):431–455.

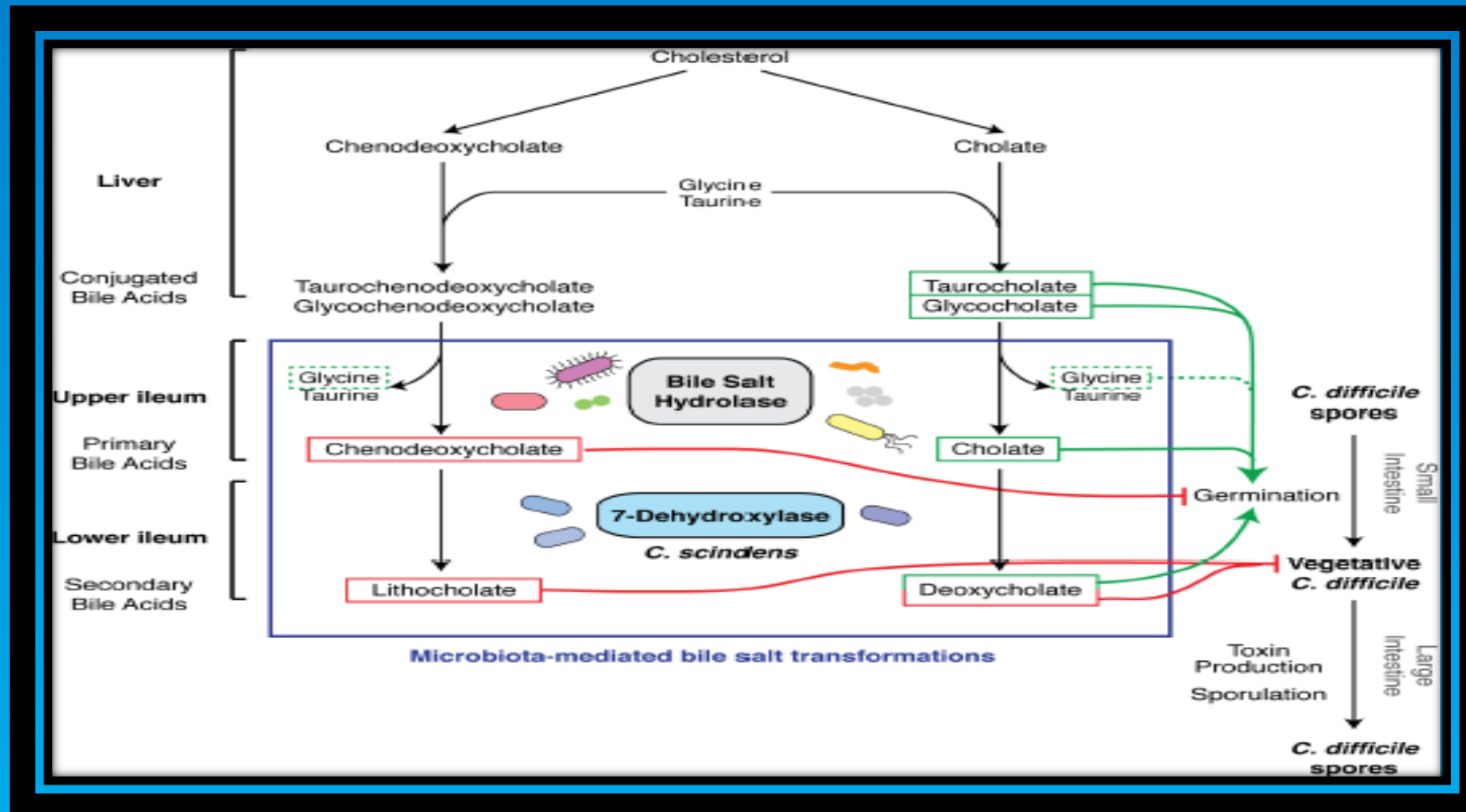
Pathogenesis and Transmission



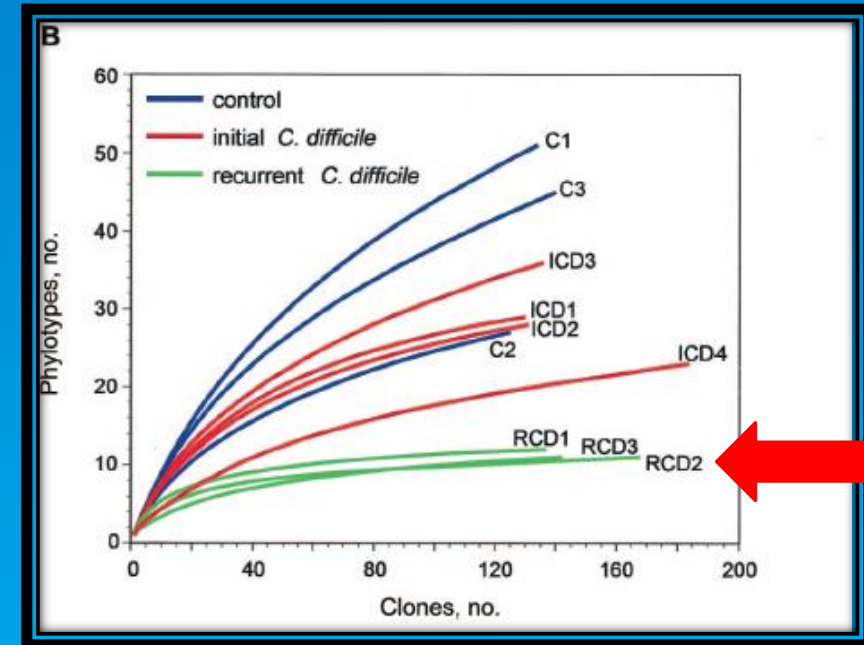
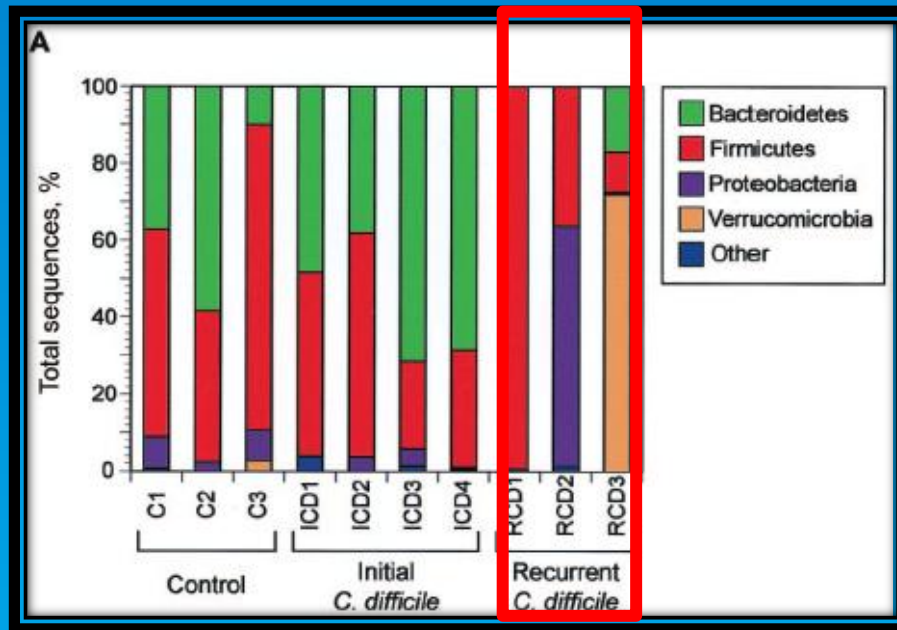
Symptoms

- Diarrhea
- Constipation
- Ileus
- Megacolon

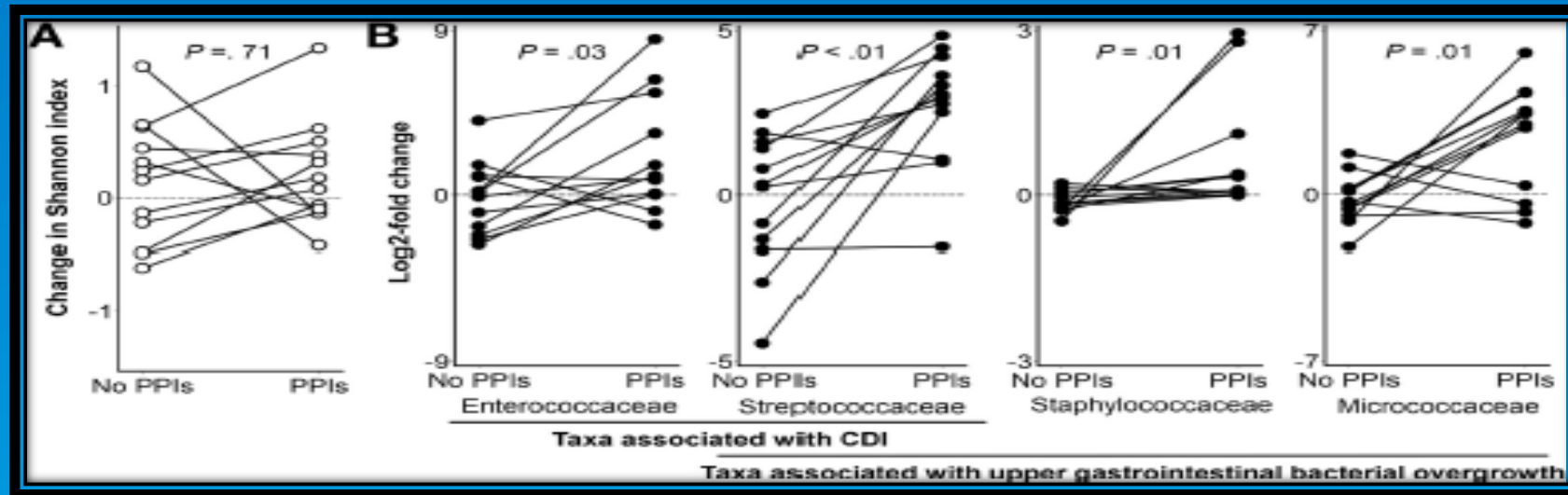
Effect of Bile Acid Metabolism on Life Cycle of *C. difficile* Infection



Diversity of Microbiome in Initial and Recurrent CDI

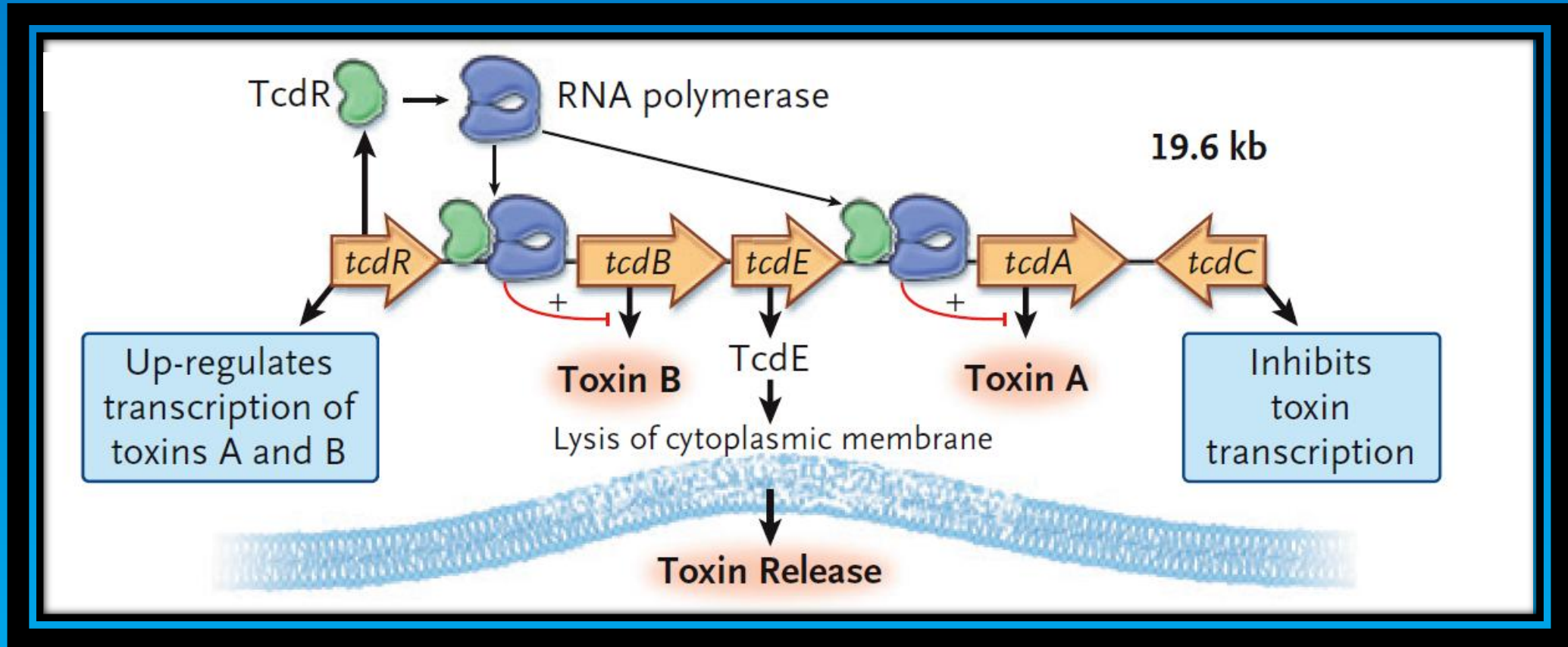


Proton Pump Inhibitor and *C. difficile* Infection: Microbiome Change?

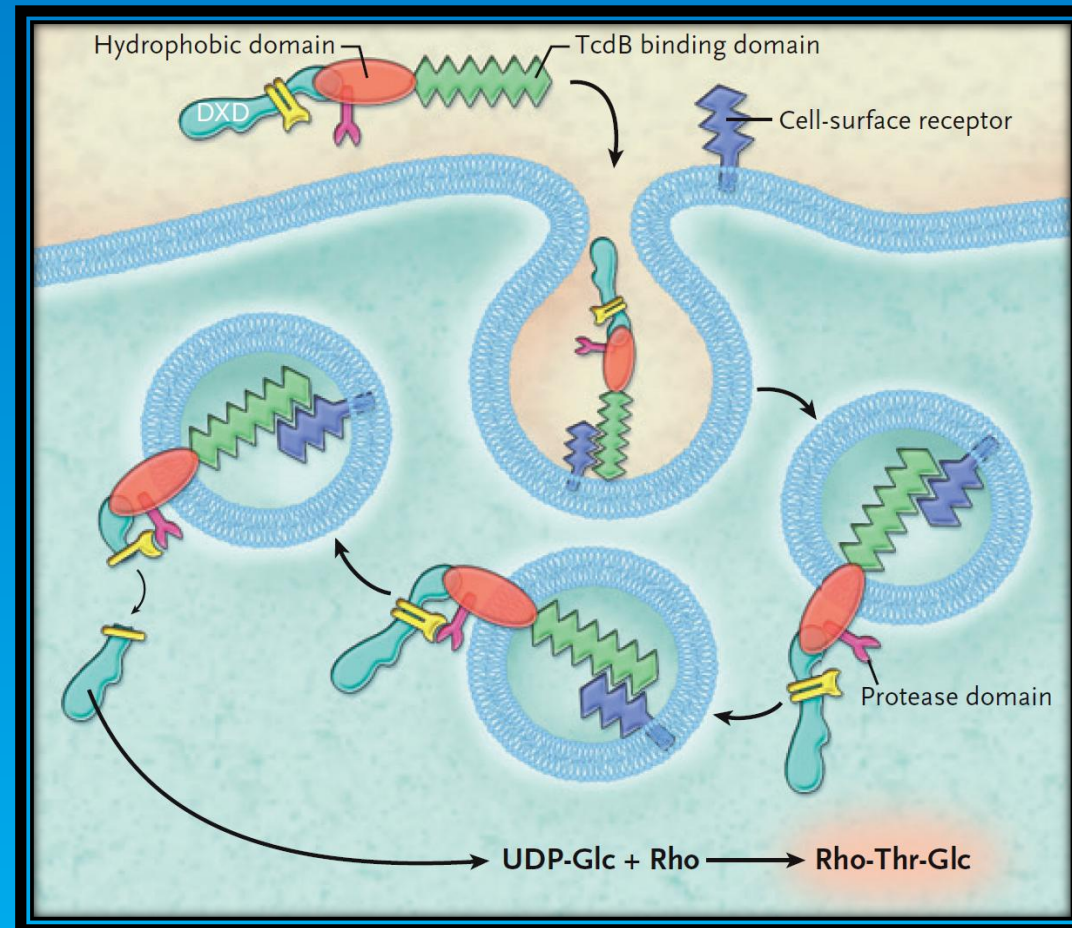


- ◇ No significant “within-individual” differences in microbiome diversity prior to or during PPI use
- ◇ Significant changes during PPI use:
 - ◇ Taxa associated with CDI
 - ◇ Increased Enterococcaceae and Streptococcaceae, Decreased Clostridiales
 - ◇ Taxa associated with gastrointestinal bacterial overgrowth
 - ◇ Increased Micrococcaceae and Staphylococcaceae
- ◇ No change in bile acids on PPI's

Toxin Production

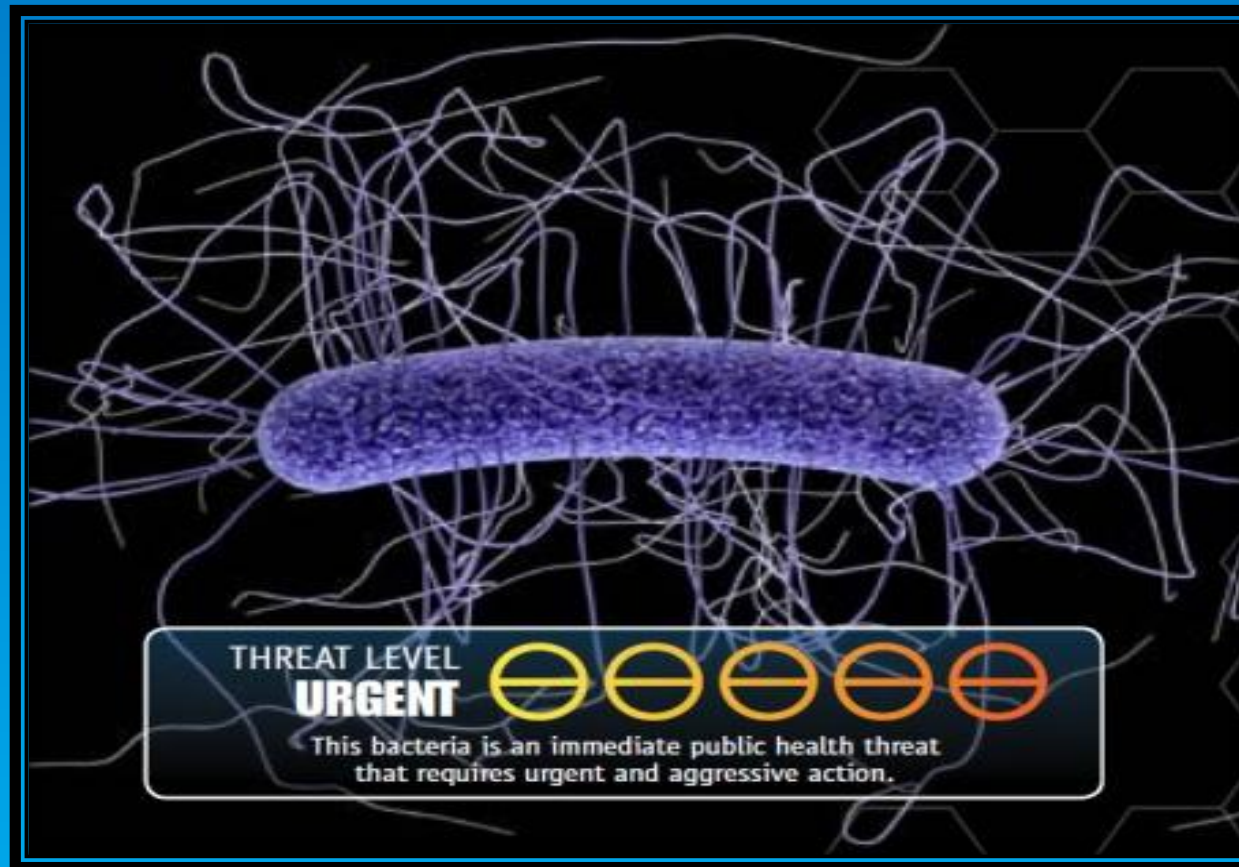


Mechanism of Pathogenicity of Toxin B



Epidemiology

The *C. difficile* Epidemic

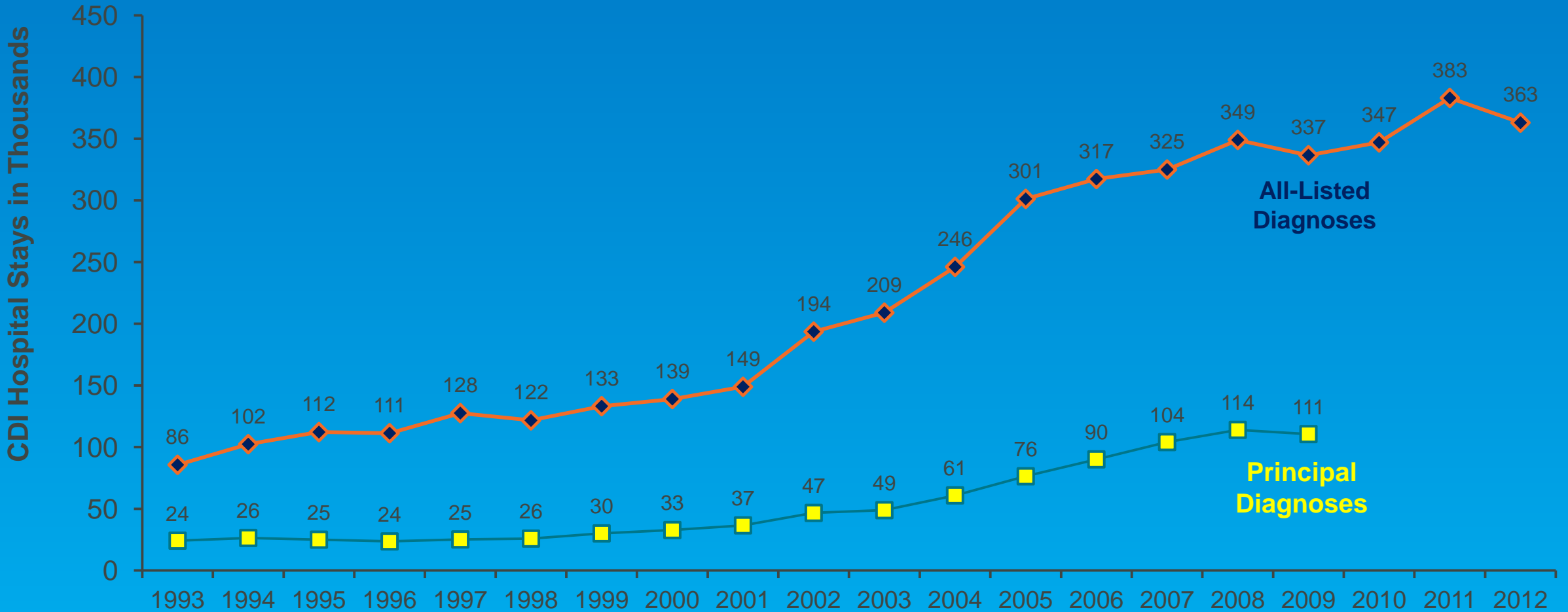


Shoes and CDI

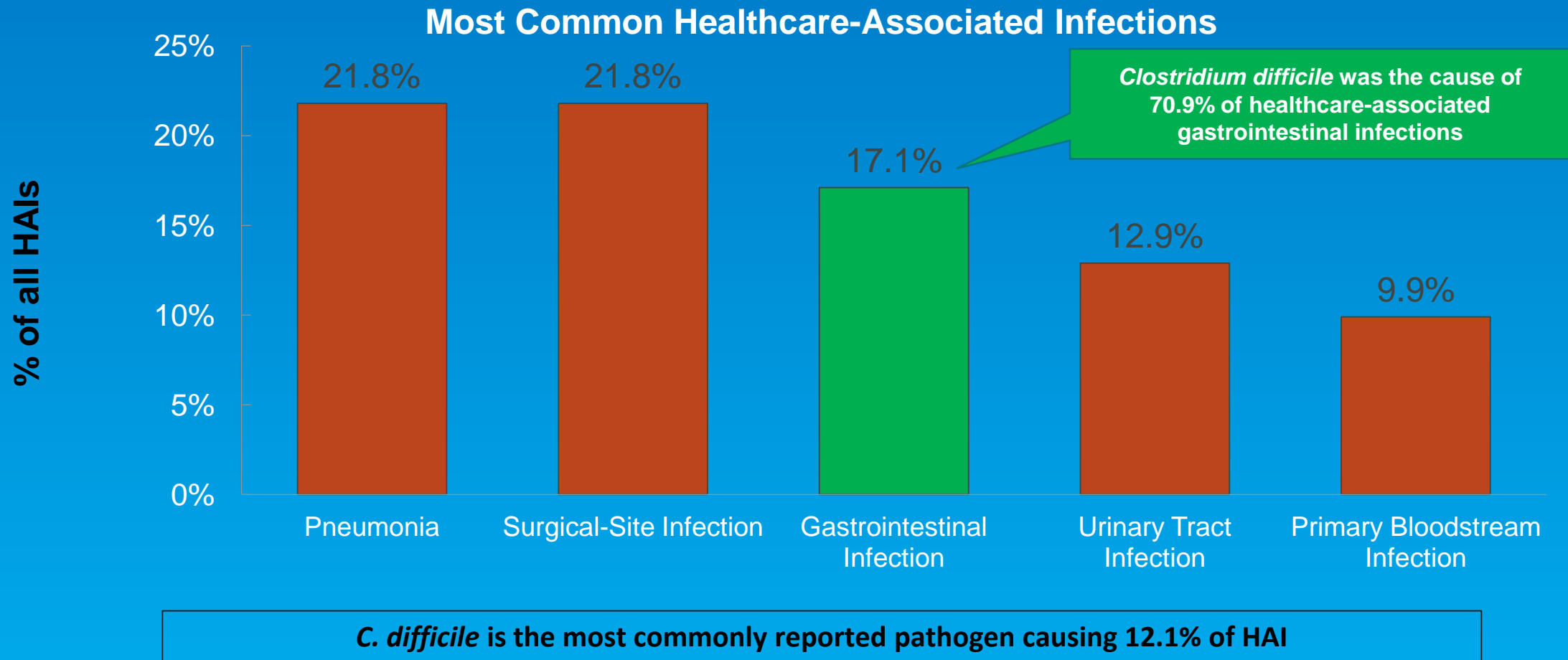


39.7% of shoe bottoms in an urban community were positive for toxigenic *C. difficile* infection

Incidence of Both Principal and Secondary CDI Diagnoses Continues to Increase



C. difficile Infection is a Common Cause of Healthcare Associated Infection (HAI)



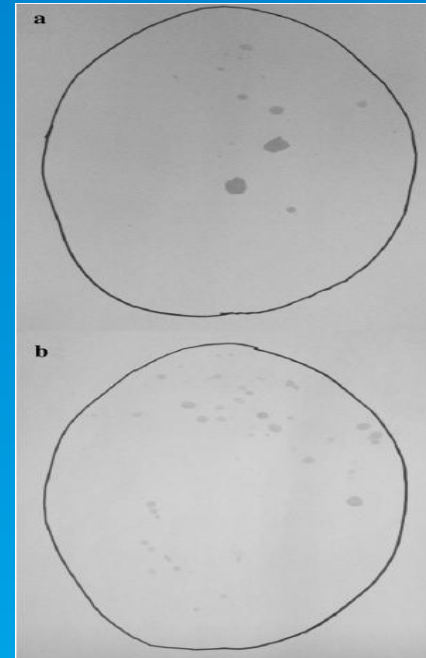
Flushing Toilet and Spread of CDI



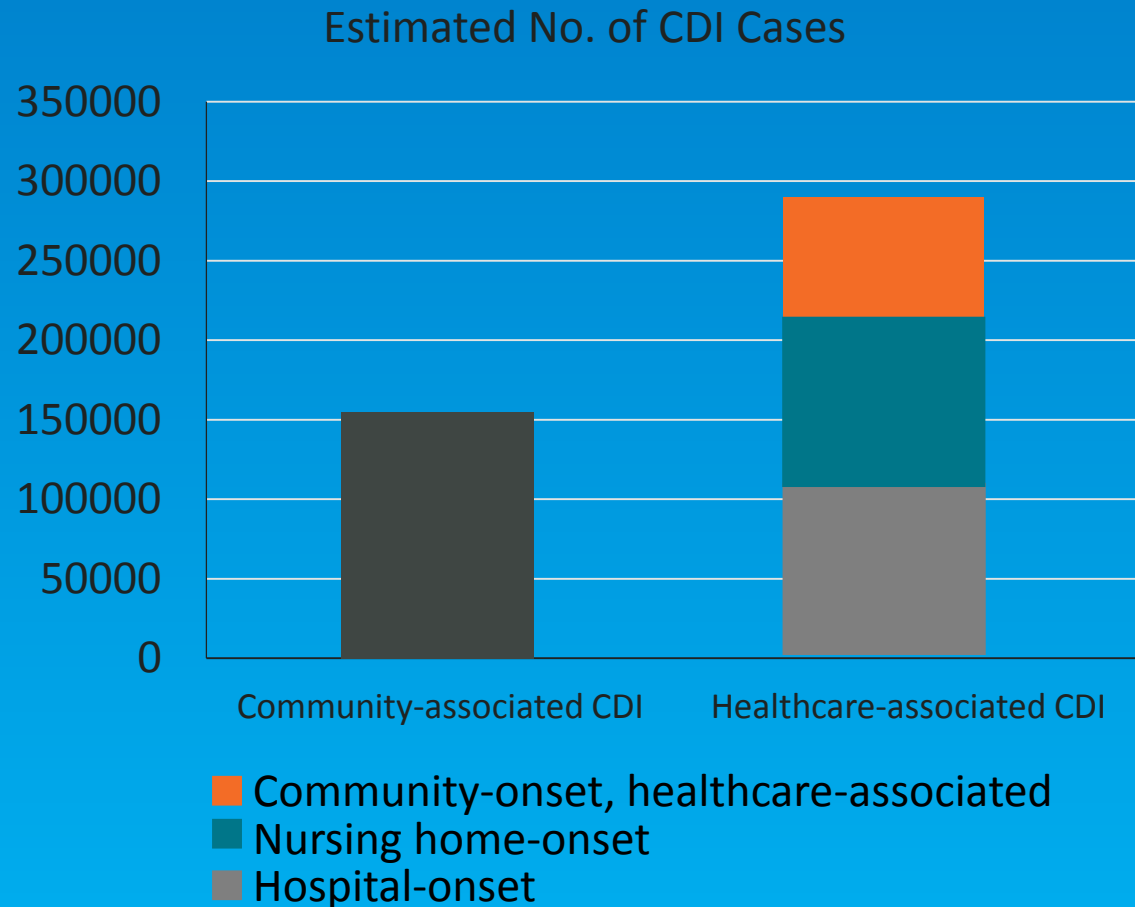
Comparison of recovery of *Clostridium difficile* from the air with the toilet seat open and closed (N=2)

Sample time Mean cfu *C. difficile* detected in air samples
0-90 min after each flush

Sample time	Control tests (water only added)	Toilet lid closed		Toilet lid open		
		10 cm above height	Seat above height	25 cm above height	10 cm above height	Seat above height
0-30 min	0	4	3	7	6	35
30-60 min	0	1	7	4	0	3
60-90 min	0	0	0	1	0	0

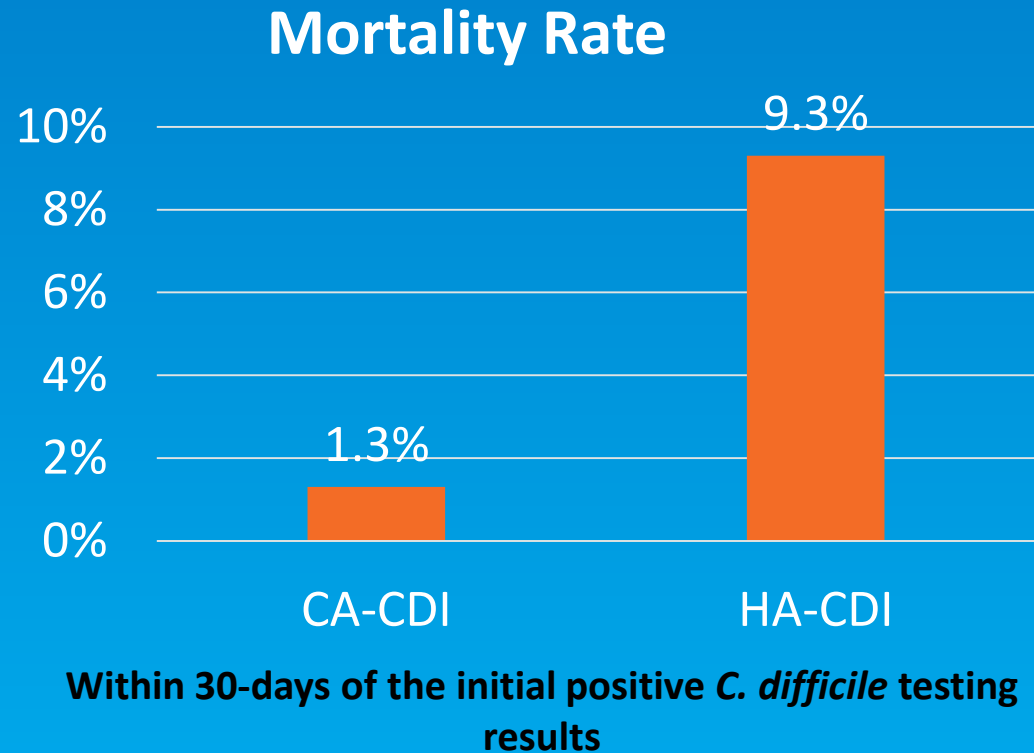
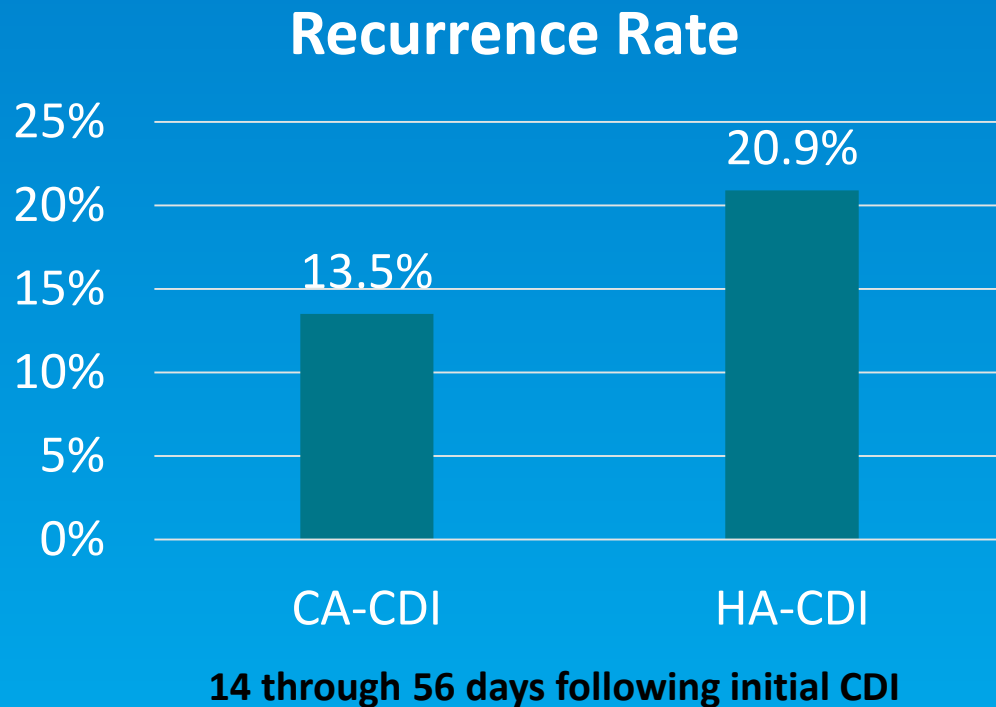


Estimated U.S. Burden of *C. difficile* Infection, According to the Location of Stool Collection and Inpatient Health Care Exposure, 2011

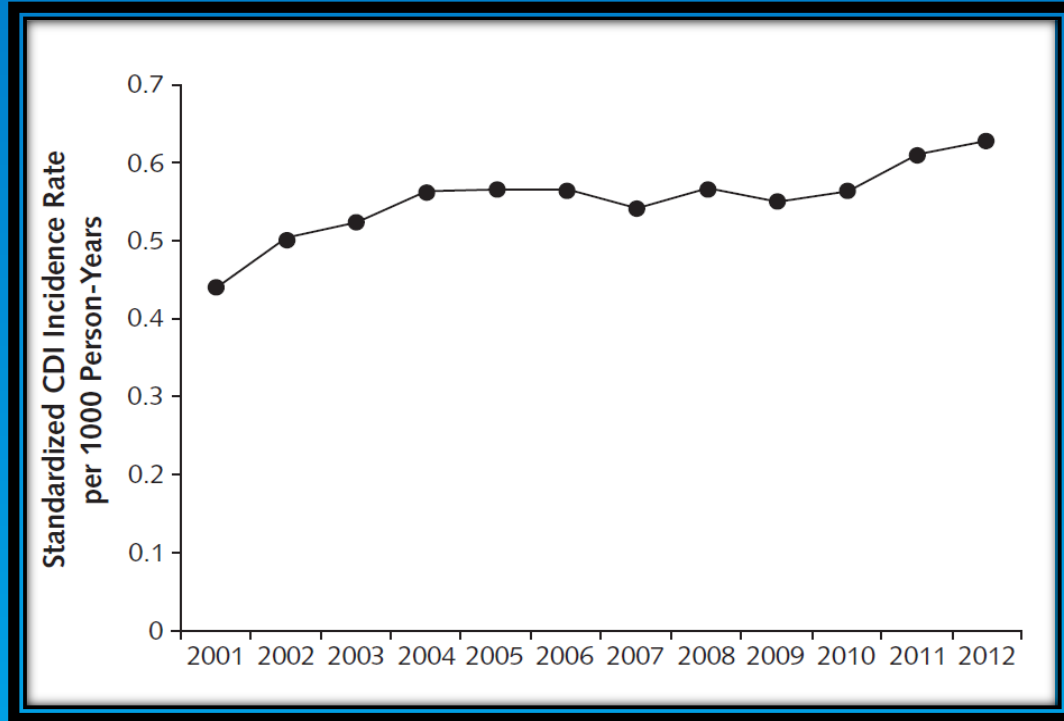


- Of community-associated CDI, 82% were estimated to be associated with outpatient healthcare exposure
- ~2/3 were healthcare-associated infection but ~1/4 were hospitalized when symptoms began

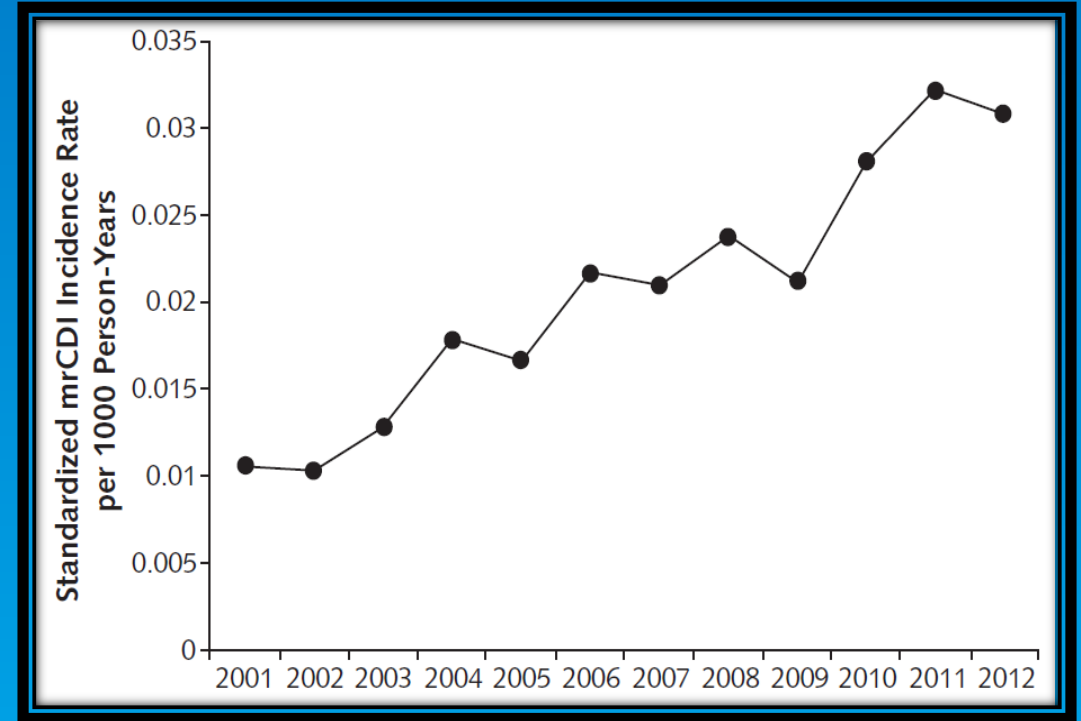
Adjusted U.S. National Estimates of Recurrences and Deaths Associated with CDI



Multiply Recurrent CDI is Increasing



Annual Incidence of CDI
increased **42.7%**



Annual Incidence of mrCDI
increased **188.8%**

Estimated Annual Death and Mortality Rate Associated with *C. difficile*, United States, July 1999-June 2007

Age Group, y	Number of Deaths			% of all Cause Gastroenteritis	Rate per 1,000,000
	Coded	Modeled (95% CI)	Total		
0-4	6	0	6	1.0	0.30
5-64	499	355 (232-478)	854	63.4	3.6
≥ 65	4934	2108 (1818-2399)	7043	75.6	195
<i>Overall</i>	5440	2463 (2050-2876)	7903	70.2	27.2

- *C. difficile* mortality increased 5-fold from 1999–2000 to 2006–2007
- *C. difficile* is the main contributor to gastroenteritis-associated deaths

C. difficile Infection 30-Day Mortality by Decade of Life

