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To use or not to use Sporicidal agents  
everywhere?



# Disclaimer

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**Disclosures:** Employee of Clorox HealthCare <sup>TM</sup> and a volunteer with IPAC Canada <sup>TM</sup> in many roles as well as a volunteer with the C.diffFoundation<sup>TM</sup>.

**Views expressed are those of the presenter** and do not reflect the organizations I belong. The funding source for this talk was made possible by funding from Clorox Healthcare <sup>TM</sup>.



# Agenda

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- Review background of C.difficile and Interventions aimed at preventing transmission.
- Discuss the current state and challenges leading to sustained transmission of C.difficile.
- Discuss universal sporicidal use as a strategy to reduce transmission of C.difficile.
- Highlight Future considerations
- Q&A



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# BACKGROUND



# Background

1. *Clostridium difficile* (*C. difficile*) has become one of the most significant pathogens in acute-care hospital settings in North America.
2. A 2015 report released by Centers for Disease Control and Prevention (CDC), nearly 500,000 Americans suffer from *C. difficile* infections (CDI) in a single year, in which 1 in 5 patients can exhibit recurrence<sup>1</sup>.
3. The epidemiology of *C. difficile* infection has evolved within the last decade costing hospitals upwards of \$4.8 billion each year in excess health care costs<sup>1</sup>.
4. Although most cases of *C. difficile* infections (CDI) are healthcare-related, a percentage of cases (~35%) occurs in the community and appear to be unrelated to antibiotic use or prior health care exposure<sup>2</sup>.
5. Nearly 1–3% of healthy adults and 15–20% of infants are asymptomatic *C. difficile* carriers and part of their normal microbial gut community<sup>2</sup>.
6. Despite proactive infection control measures (e.g. hand hygiene, antibiotic stewardship and environmental cleaning), *C. difficile* associated disease still remains problematic.

1) Lessa FC, Mu Y, Bamberg WM, et al. Burden of *Clostridium difficile* infection in the United States. N Engl J Med. 2015;372(9):825–34.

2) Furuya-Kanamori, L., Marquess, J., Yakob, L., Riley, T. V., Paterson, D. L., Foster, N. F., ... Clements, A. C. A. (2015). Asymptomatic *Clostridium difficile* colonization: epidemiology and clinical implications. BMC Infectious Diseases, 15, 516.

<http://doi.org/10.1186/s12879-015-1258-4>

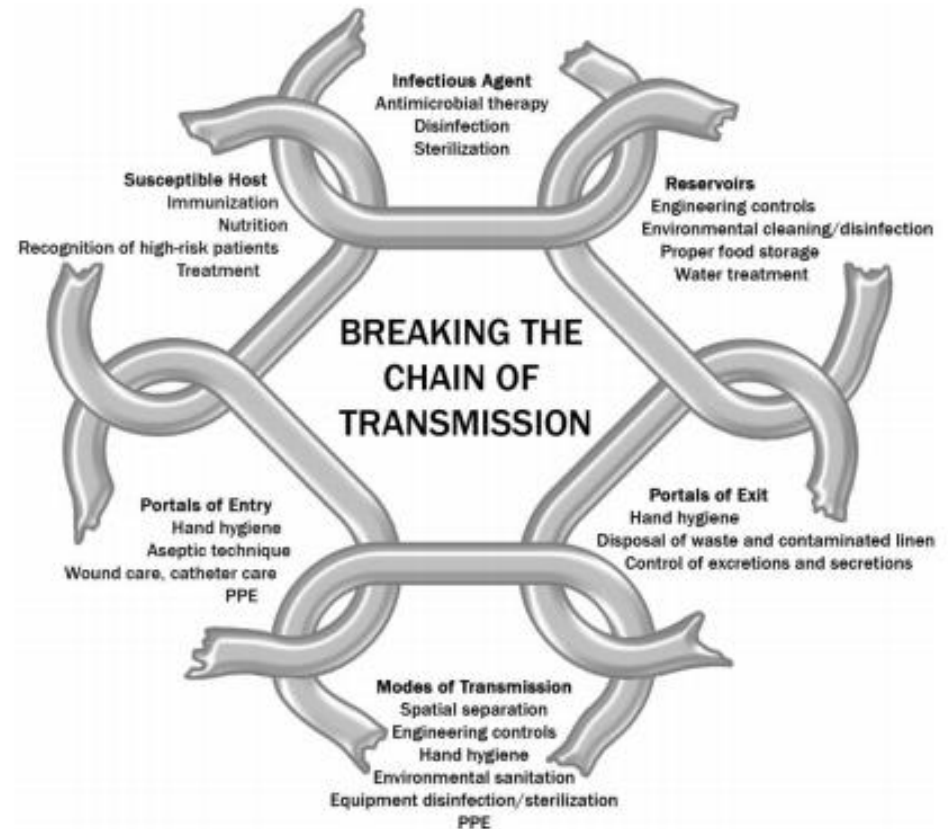
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# **INTERVENTIONS RECOMMENDED FOR REDUCTION OF HACDI**



# Process of CDI Disease Transmission: Chain of Infection

1. *Hand hygiene*
2. *Contact precautions*
3. *Identification of cases*
4. *Appropriate use of antibiotics*
5. *Environmental disinfection*



1)Ontario Agency for Health Protection and Promotion, Provincial Infectious Diseases Advisory Committee. Annex C – Testing, Surveillance and Management of Clostridium difficile. Annexed to: Routine Practices and Additional Precautions in All Health Care Settings. Toronto, ON: Queen’s Printer for Ontario; 2013. –Source of Chain of Infection Image



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# Take Away From Guidance the Documents

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1. Cases on the rise
2. CDI spread is complex
3. EPA Registered Sporicide must be used for C.difficile disinfection
4. C.difficile Management is Multifactorial and Multi Collaborative
5. State concern and concerns from studies
  - Role of community cases
  - Role asymptomatic carriage
  - Human Factors –errors
6. Perform environmental decontamination of rooms of patients with CDI using an approved sporicidal product in an outbreak or hyper endemic setting.

1) Ontario Agency for Health Protection and Promotion, Provincial Infectious Diseases Advisory Committee. Annex C – Testing, Surveillance and Management of Clostridium difficile. Annexed to: Routine Practices and Additional Precautions in All Health Care Settings. Toronto, ON: Queen's Printer for Ontario; 2013.

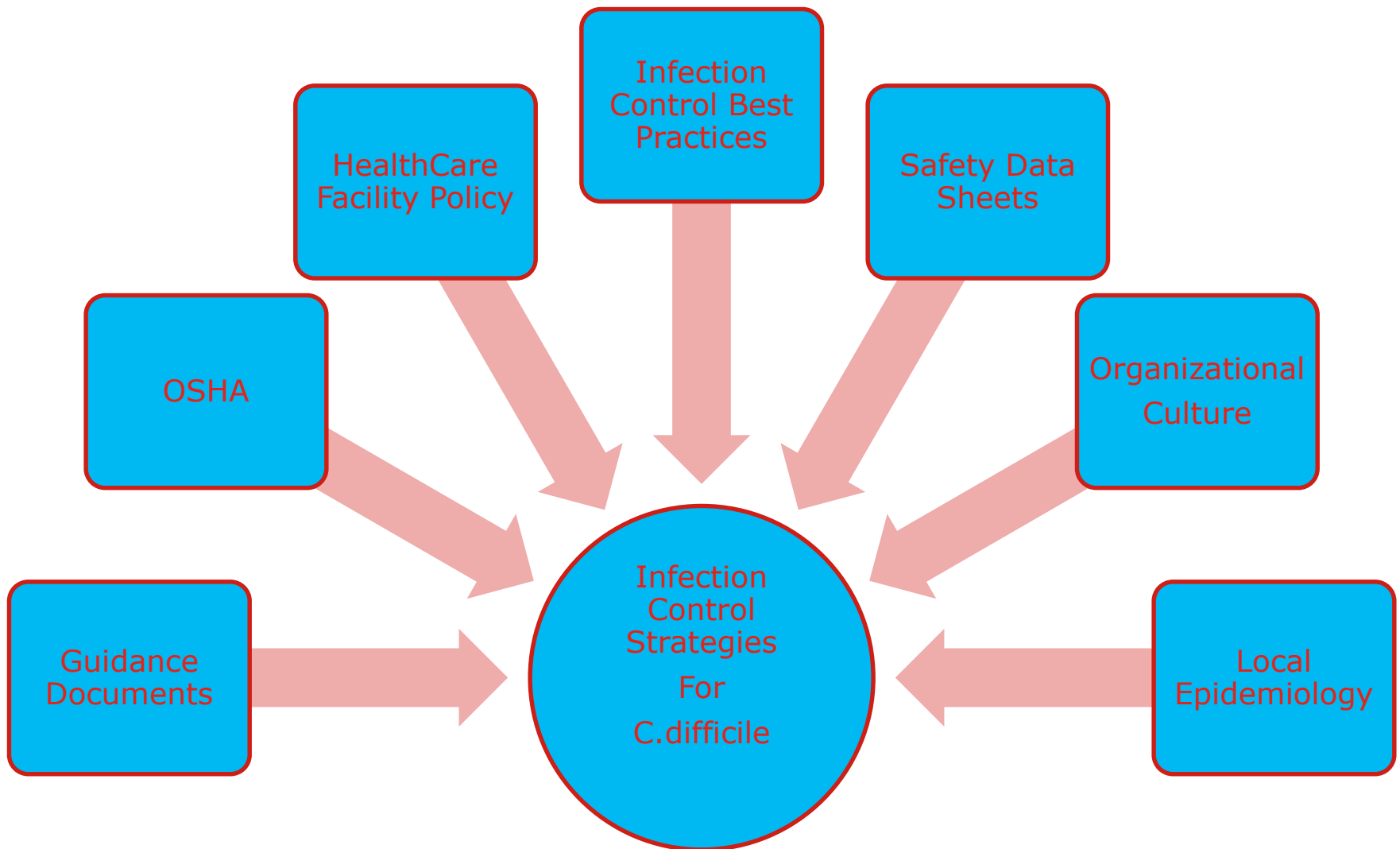
2) Lessa FC, Mu Y, Bamberg WM, et al. Burden of *Clostridium difficile* infection in the United States. N Engl J Med. 2015;372(9):825–34.

3) Furuya-Kanamori, L., Marquess, J., Yakob, L., Riley, T. V., Paterson, D. L., Foster, N. F., ... Clements, A. C. A. (2015). Asymptomatic Clostridium difficile colonization: epidemiology and clinical implications. BMC Infectious Diseases, 15, 516. <http://doi.org/10.1186/s12879-015-1258-4>





# Drivers For C.difficile Management Plan



# What we know so far

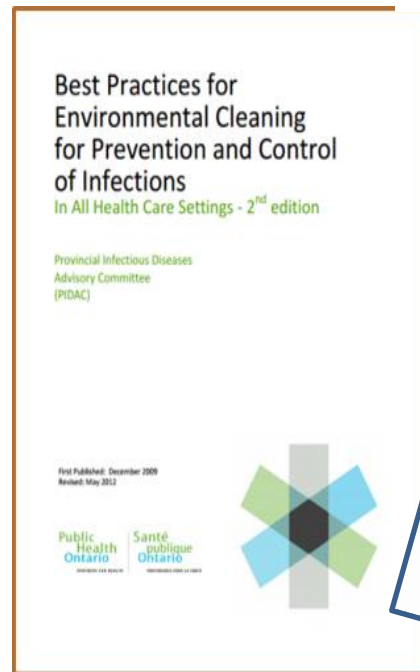
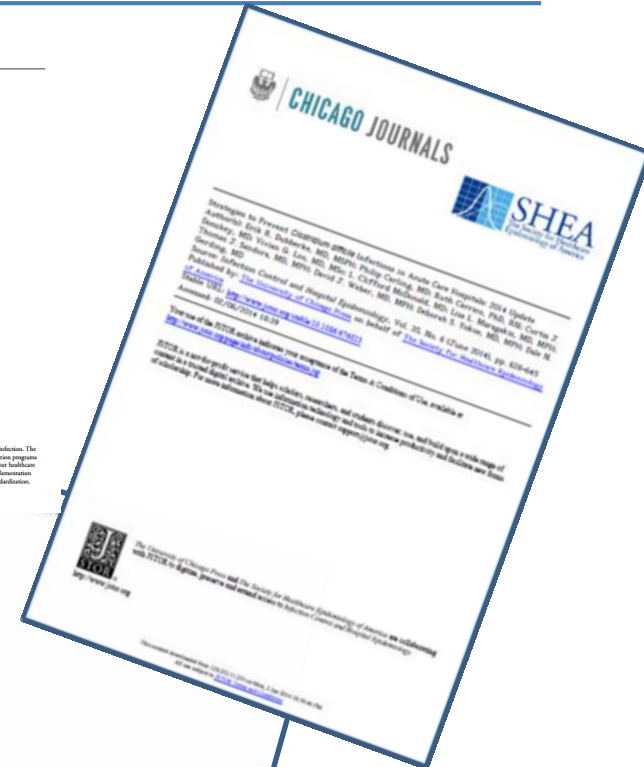
1. Lots of guidance documents
2. We know how to fight C.difficile

APIC Implementation Guide

## Guide to Preventing Clostridium difficile Infections



About APIC  
APIC's mission is to create a safer world through prevention of infection. The association's more than 14,000 members direct infection prevention programs that save lives and improve the bottom line for hospitals and other healthcare facilities. APIC advances its mission through patient safety, implementation science, cooperation and certification, advocacy, and data standardization.



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# **CURRENT STATE OF HACDI**

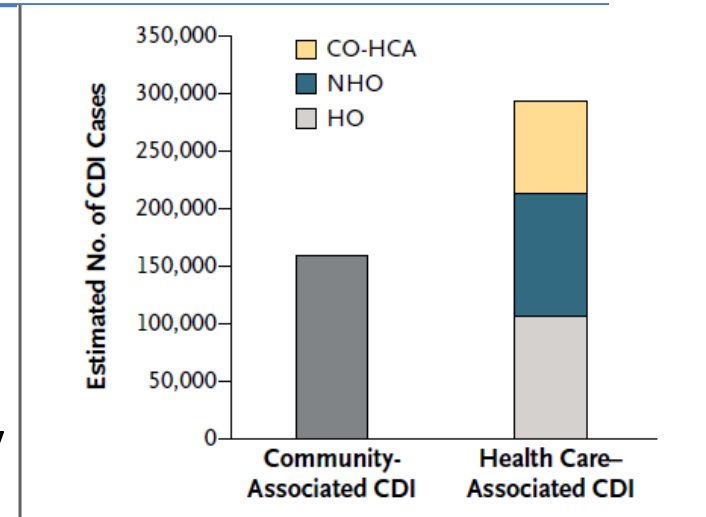


# C.difficile: Impact

## Point Prevalence:

### CDC Funded Study<sup>1</sup>

1. 450,000 annual *C. difficile* infections
2. 29,000 attributable deaths annually
3. \$1B in excess costs annually
4. 35%(159,700) attributed to community



## Trend:

### 10 year retrospective US patient discharge chart review<sup>2</sup>

1. The incidence of CDI among hospitalized adults in the United States nearly doubled from 2001-2010.
2. Little evidence of improvement in patient mortality or hospital LOS

1) Lessa et al, NEJM, 372:825-834, 2015

2) Reveles, K. R., Lee, G. C., Boyd, N. K., & Frei, C. R. (2014). The rise in Clostridium difficile infection incidence among hospitalized adults in the United States: 2001-2010. AJIC: American Journal of Infection Control, 10(42), 1028-1032

# **WHY TRANSMISSION RATES ARE NOT IMPROVING**

# Why are rates not Falling

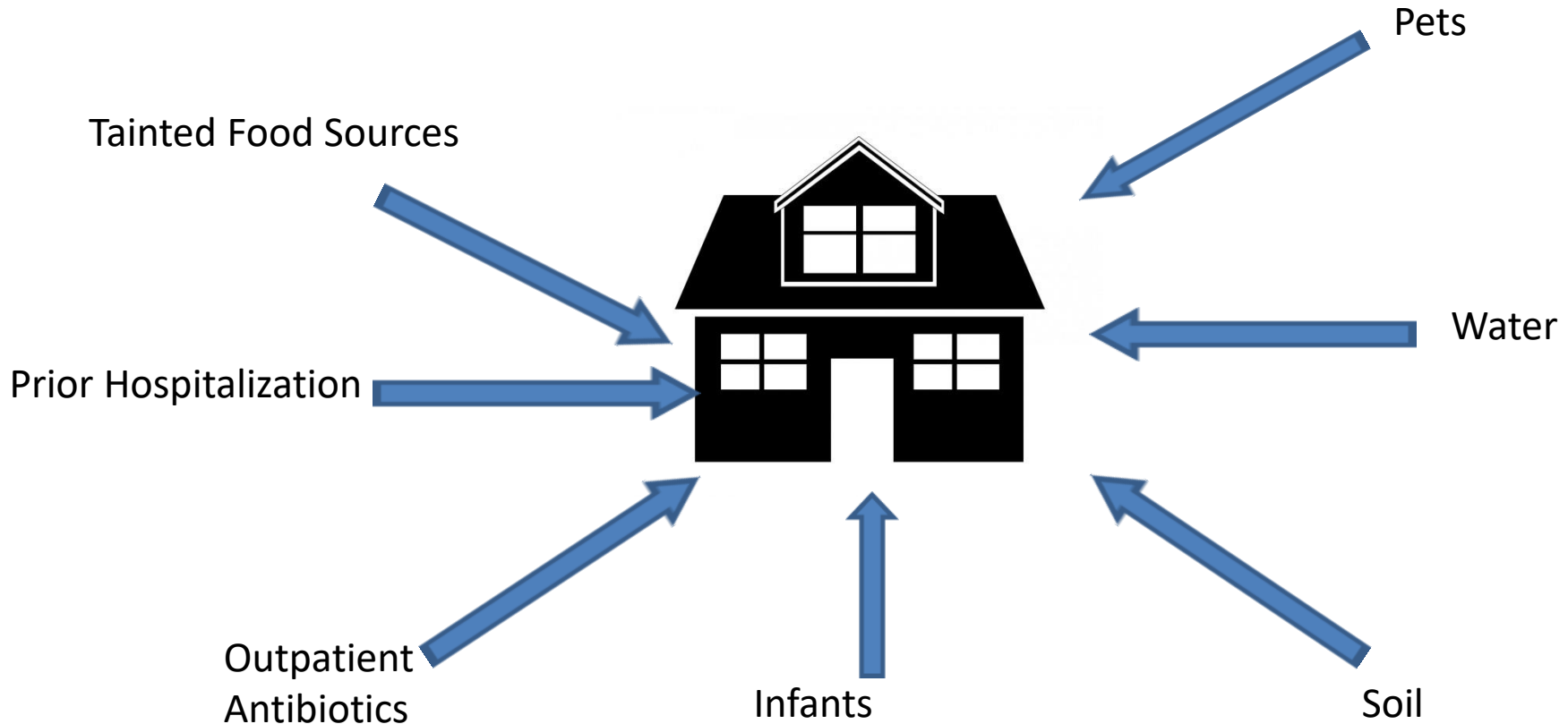
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1. Outpatient Challenges

2. Inpatient Challenges

# C.difficile Sources in the Community

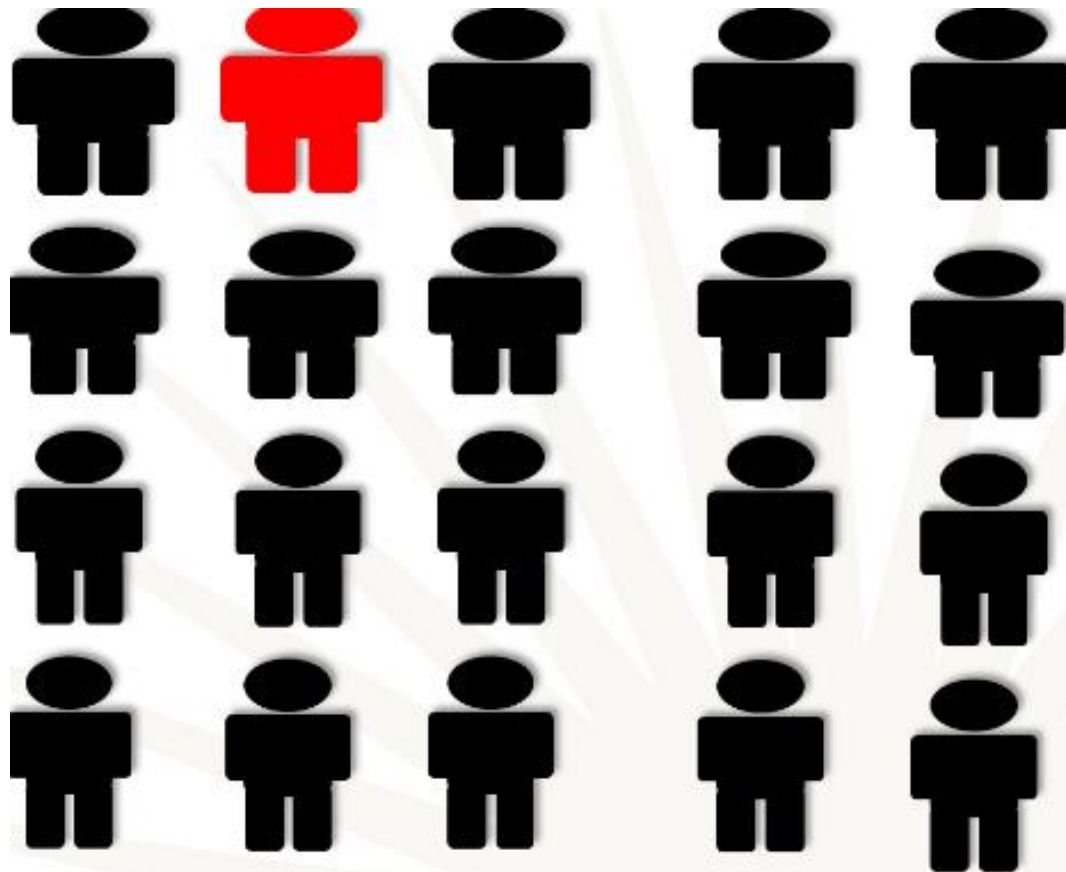
## *C.difficile* Spores are Everywhere



Clostridium difficile infection: Early history, diagnosis and molecular strain typing methods Authors C. RodriguezJ. Van Broeck B. Taminiau et al. Source Information August 2016, Volume97(Issue Complete) Page p.59To-78 - Microbial Pathogenesis

Lund, B. M., & Peck, M. W. (2015). A Possible Route for Foodborne Transmission of Clostridium difficile? Foodborne Pathogens and Disease, 12(3), 177–182. <http://doi.org/10.1089/fpd.2014.1842>

# C.difficile Epidemiology in General Public



3-5% of  
General  
Public Test  
Positive for  
C.difficile

**1 in 20**

Loo et al.  
NEJM 2011;  
365:1693-1703



# Why are rates not Falling

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1. Outpatient Challenges

2. Inpatient Challenges

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# **CURRENT CHALLENGES IN C.DIFFICILE IN-PATIENT HOSPITAL MANAGEMENT**



# In Patient Challenges

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1. Complex Transmission
2. Tenacity of C.difficile
3. Microbiologic Testing
4. Environmental Contributions
5. Infection Control Laspes
6. Role of asymptomatic or C.difficile Carriers

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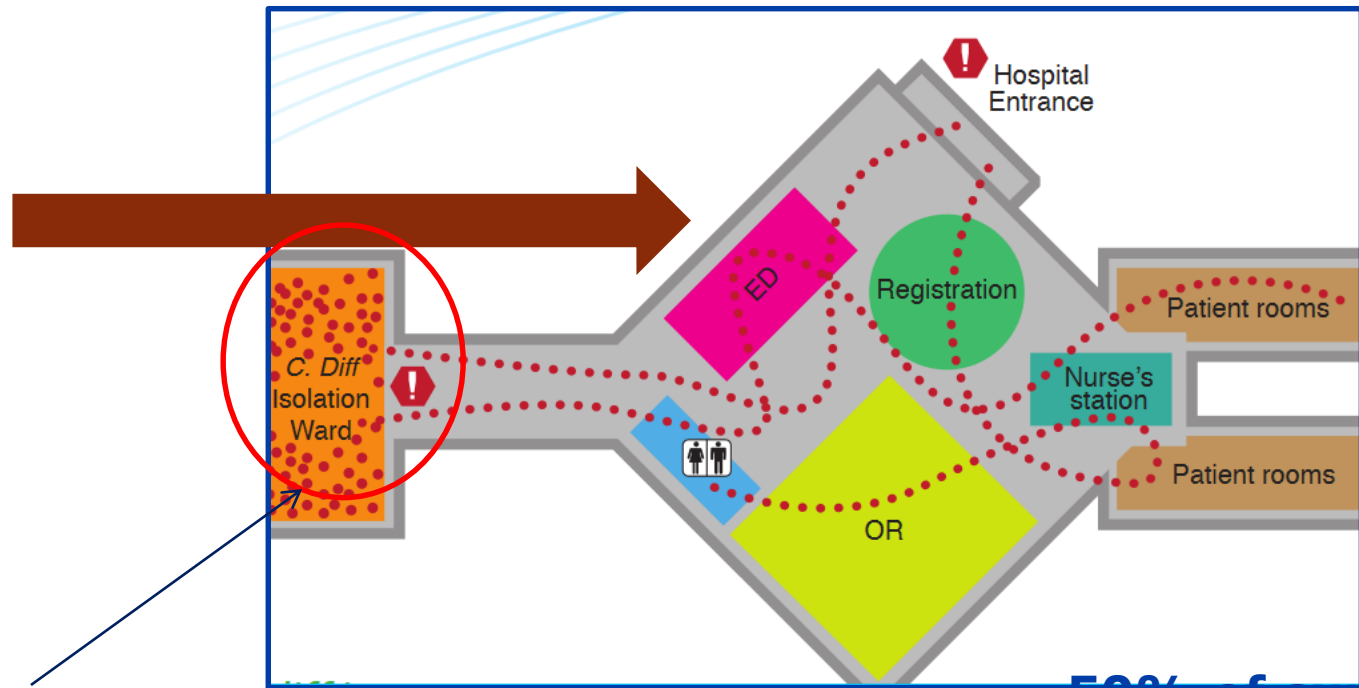
# TRANSMISSION COMPLEXITIES



# Mode of Transmission Hospitals

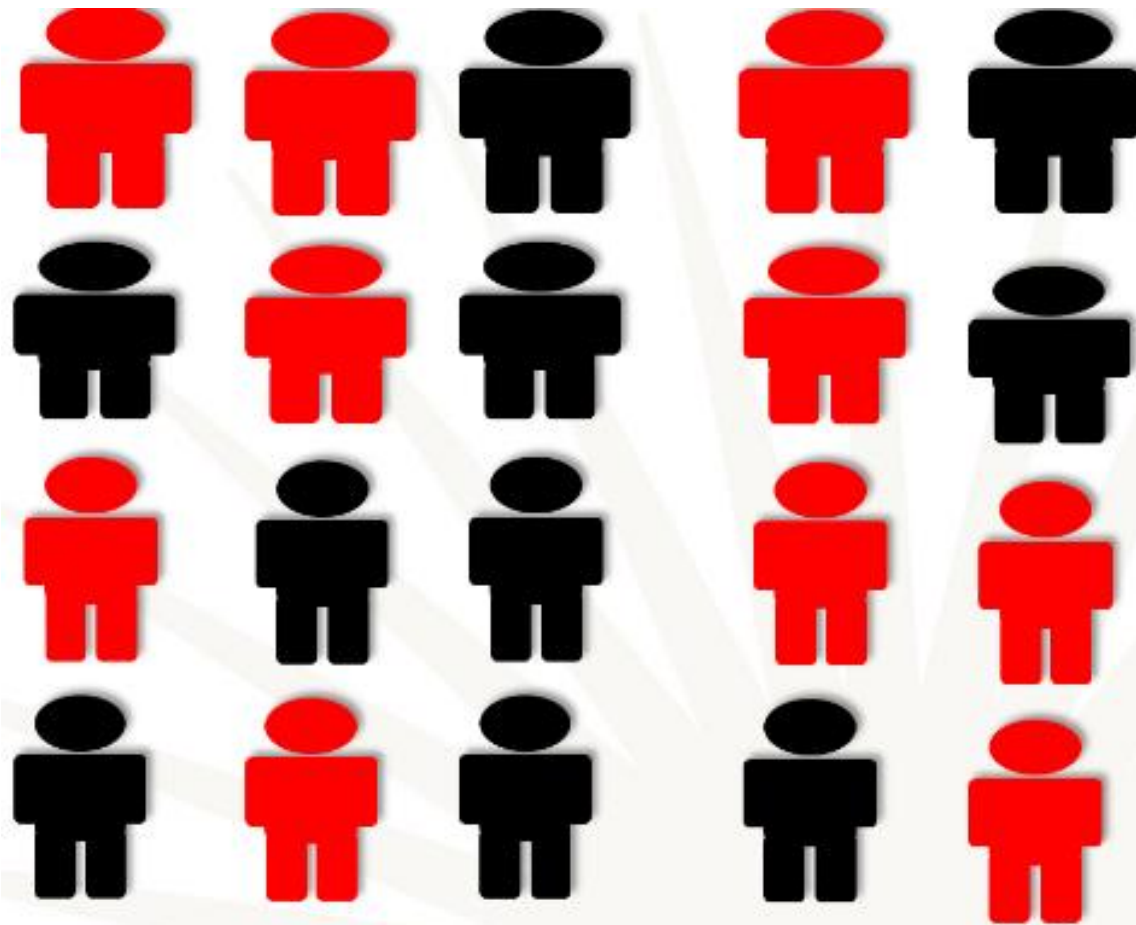
**Up to 50% of people admitted to hospital could be C.difficile Positive(1)**

**Delayed Isolation and detection of C.difficile Patients**



**50% of surfaces in a C.difficile patients room where positive after cleaning(1)**

# C.difficile Epidemiology in Acute Care



50% of Adult  
Inpatients  
tested positive  
for C.difficile

**10 in 20 on a  
Hospital  
Inpatient Unit**

Riggs et al  
Clin Infect  
Dis. 2007  
15;45(8)

# Tenacity Of C.difficile

## Bacterial spores:

- *Clostridium difficile*
- *Bacillus atrophaeus*

## Mycobacteria:

- *Mycobacterium tuberculosis*

## Nonlipid or small viruses:

- Rhinovirus
- Influenza Virus

## Fungi:

- *Aspergillum spp.*
- *Candida spp.*

## Vegetative bacteria:

- *Staphylococci spp.*
- *Streptococci spp.*
- *Escherichia coli*

## Lipid or medium-sized viruses:

- Hepatitis B Virus (HBV)
- Hepatitis C Virus (HCV)
- Human Immunodeficiency Virus (HIV)
- Herpes Simplex Virus Types 1 (HSV 1)
- Herpes Simplex Virus Types 2 (HSV 2)

Table 1: Persistence of clinically relevant bacteria on dry inanimate surfaces.

Type of bacterium	Duration of persistence (range)
<i>Acinetobacter spp.</i>	3 days to 5 months
<i>Bordetella pertussis</i>	3 – 5 days
<i>Campylobacter jejuni</i>	up to 6 days
<i>Clostridium difficile</i> (spores)	5 months
<i>Chlamydia pneumoniae, C. trachomatis</i>	≤ 30 hours
<i>Chlamydia psittaci</i>	15 days
<i>Corynebacterium diphtheriae</i>	7 days – 6 months
<i>Corynebacterium pseudotuberculosis</i>	1–8 days
<i>Escherichia coli</i>	1.5 hours – 16 months
<i>Enterococcus spp.</i> including VRE and VSE	5 days – 4 months
<i>Haemophilus influenzae</i>	12 days
<i>Helicobacter pylori</i>	≤ 90 minutes
<i>Klebsiella spp.</i>	2 hours to > 30 months
<i>Listeria spp.</i>	1 day – months
<i>Mycobacterium bovis</i>	> 2 months
<i>Mycobacterium tuberculosis</i>	1 day – 4 months
<i>Neisseria gonorrhoeae</i>	1 – 3 days
<i>Proteus vulgaris</i>	1 – 2 days
<i>Pseudomonas aeruginosa</i>	6 hours – 16 months; on dry floor: 5 weeks
<i>Salmonella typhi</i>	6 hours – 4 weeks
<i>Salmonella typhimurium</i>	10 days – 4.2 years
<i>Salmonella spp.</i>	1 day
<i>Serratia marcescens</i>	3 days – 2 months; on dry floor: 5 weeks
<i>Shigella spp.</i>	2 days – 5 months
<i>Staphylococcus aureus</i> , including MRSA	7 days – 7 months
<i>Streptococcus pneumoniae</i>	1 – 20 days
<i>Streptococcus pyogenes</i>	3 days – 6.5 months
<i>Vibrio cholerae</i>	1 – 7 days

Increase in Resistance

# Prior Room Occupancy



1. A meta-analysis of the combined data from included studies overwhelmingly indicated an increased risk of acquisition when put in a room that previously housed a patient with C.difficile<sup>1</sup>.
2. Current environmental cleaning practices fail to reduce the risk of acquisition as spores can be airborne up to 48hrs after discharge of C.difficile Patient<sup>1</sup>.
3. Receipt of antibiotics by prior bed occupants was associated with increased risk for CDI in subsequent patients. Antibiotics can directly affect risk for CDI in patients who do not themselves receive antibiotics<sup>2</sup>.

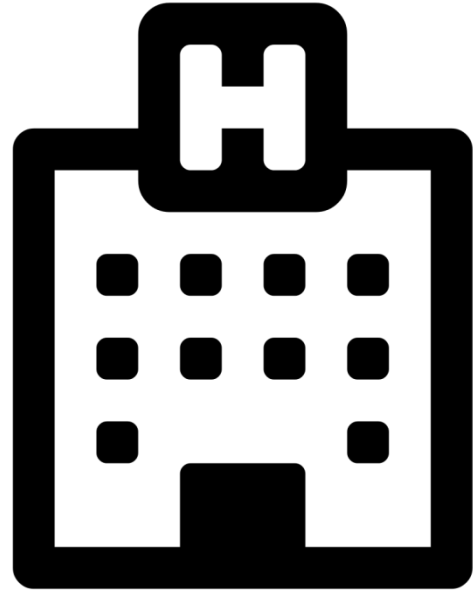
1. Mitchell BG, Dancer SJ, Anderson A, Dehn E. Risk of organism acquisition from prior room occupants: a systematic review and meta-analysis. J Hosp Infect 2015;91:211–217.

2. Freedberg DE, Salmasian H, Cohen B, Abrams JA, Larson EL. Receipt of Antibiotics in Hospitalized Patients and Risk for Clostridium difficile Infection in Subsequent Patients Who Occupy the Same Bed. JAMA Intern Med. Published online October 10, 2016. doi:10.1001/jamainternmed.2016.6193

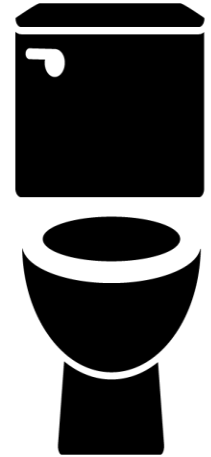


# Stool Management

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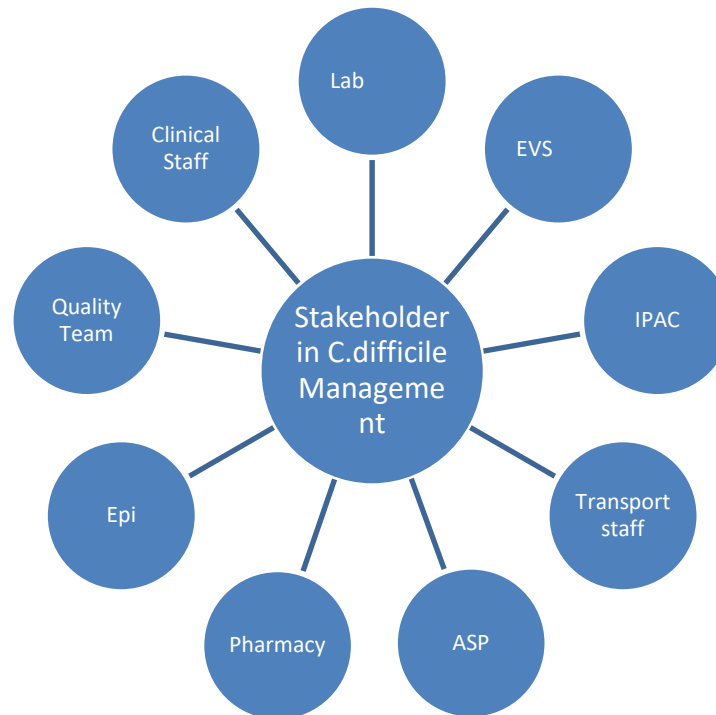
1. *C. difficile* was recoverable from air sampled at heights up to 25 cm above the toilet seat
2. Contamination could permit transmission of *C. difficile* from asymptomatic carriers, and thus explain some CDI cases where no apparent linked CDI cases are found.
3. Lidless conventional toilets increase the risk of *C. difficile* environmental contamination, and we suggest that their use is discouraged, particularly in settings where CDI is common



Best EL, Fawley WN, Parnell P, Wilcox MH. The potential for airborne dispersal of *Clostridium difficile* from symptomatic patients. Clin Infect Dis 2010;50:1450-7.

# Multiple Players

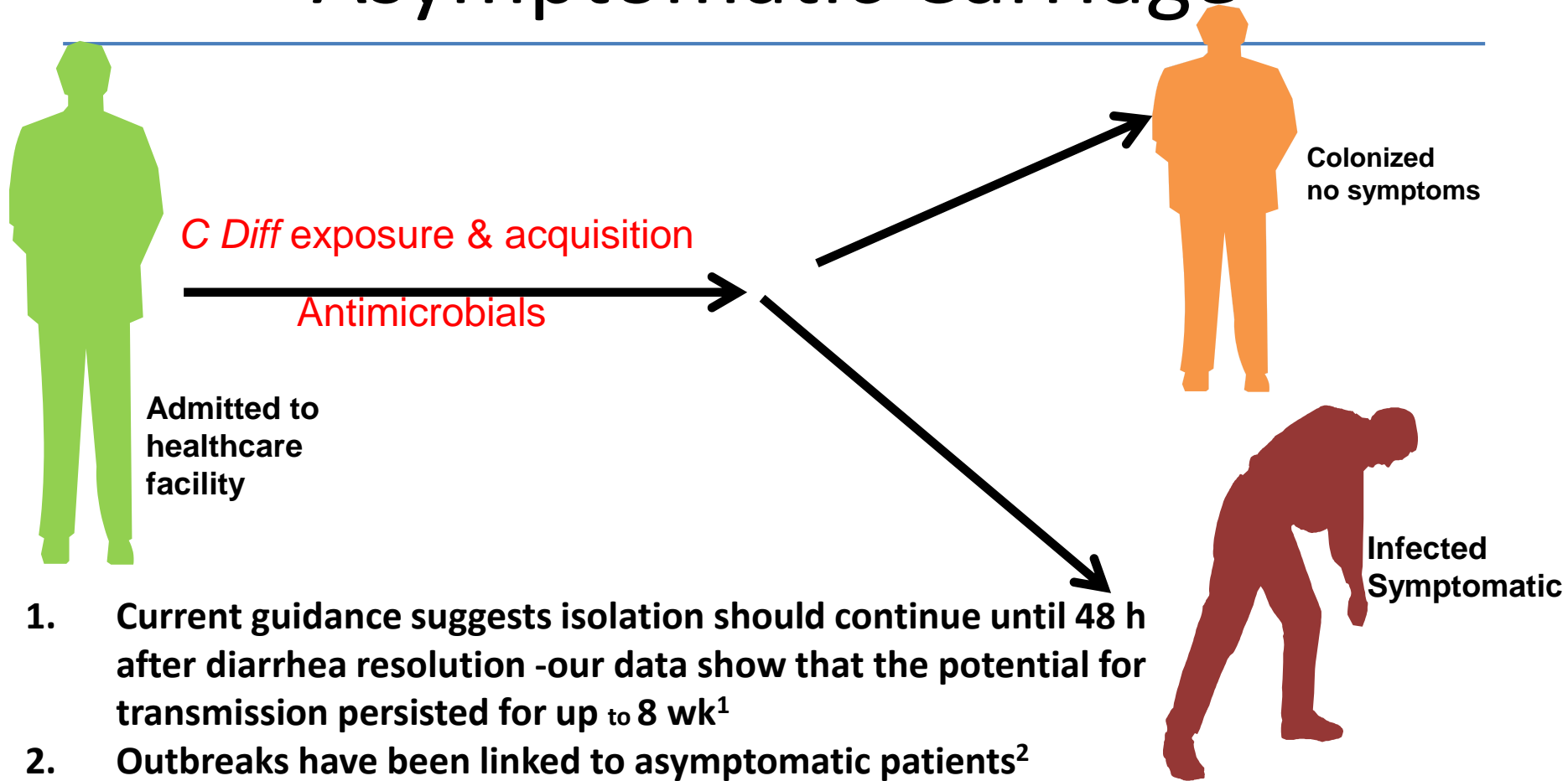
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1. In cases when you have to use sporicidal disinfectants, is there ever a delay initiating switch to sporicidal products from non sporicidal?—**30%--YES<sup>1</sup>**
2. Are there ever gaps that lead to failure to use a sporicidal agent for Cdiff patients —**40%--Yes/Sometimes<sup>1</sup>**

1) Becker's Webinar Registration Survey Results

# Asymptomatic Carriage



1. Current guidance suggests isolation should continue until 48 h after diarrhea resolution -our data show that the potential for transmission persisted for up to 8 wk<sup>1</sup>
2. Outbreaks have been linked to asymptomatic patients<sup>2</sup>
3. 1/3 of *C.difficile* transmissions arise from asymptomatic carriers and there is an severe underestimation of their role <sup>3</sup>
4. 45% of *C.difficile* cases are genetically unrelated<sup>3</sup>










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1) Guerrero, D.M., et al., Asymptomatic carriage of toxigenic *Clostridium difficile* by hospitalized patients. *J Hosp Infect*, 2013. 85(2): p. 155-8  
2) Walker AS, Eyre DW, Wyllie DH, Dingle KE, Harding RM, O'Connor L, et al. (2012) Characterisation of *Clostridium difficile* Hospital Ward-Based Transmission Using Extensive Epidemiological Data and Molecular Typing. *PLoS Med* 9(2): e1001172. doi:10.1371/journal.pmed.1001172  
3) Eyre, D.W., et al., Diverse sources of *C. difficile* infection identified on whole-genome sequencing. *N Engl J Med*, 2013. 369(13): p. 1195-205

# Diagnosis Challenges



IS IT  
REAL?

BRISTOL STOOL CHART		
	Type 1	Separate hard lumps Very constipated
	Type 2	Lumpy and sausage like Slightly constipated
	Type 3	A sausage shape with cracks in the surface Normal
	Type 4	Like a smooth, soft sausage or snake Normal
	Type 5	Soft blobs with clear-cut edges Lacking fibre
	Type 6	Mushy consistency with ragged edges Inflammation
	Type 7	Liquid consistency with no solid pieces Inflammation



# C. Difficile Lab Diagnosis Challenges

Diagnostic Test	Description	Advantages/Disadvantages
Cell cytotoxin assay	<ul style="list-style-type: none"><li>• Fecal samples are plated on human fibroblasts</li><li>• If toxin B is present, this results in cell death</li></ul>	<ul style="list-style-type: none"><li>• Time consuming, laborious, and expensive</li><li>• Lacks sensitivity</li><li>• No longer considered gold standard</li></ul>
Enzyme immunoassay	<ul style="list-style-type: none"><li>• Immunoassay directed towards both toxins A and B</li></ul>	<ul style="list-style-type: none"><li>• Widely used</li><li>• Rapid and easy to perform</li><li>• Lacks sensitivity</li></ul>
Glutamate dehydrogenase test (GDH)	<ul style="list-style-type: none"><li>• Relies on the presence of GDH antigen, which is produced by all isolates of <i>C. difficile</i></li></ul>	<ul style="list-style-type: none"><li>• Excellent negative predictive value</li><li>• Positive test necessitates second confirmatory test to assess whether toxin is present</li></ul>
Nucleic acid amplification of toxin A or B gene	<ul style="list-style-type: none"><li>• Real-time polymerase chain reaction of toxin A or B gene</li></ul>	<ul style="list-style-type: none"><li>• Highly sensitive and specific</li><li>• Expensive, limited availability</li></ul>

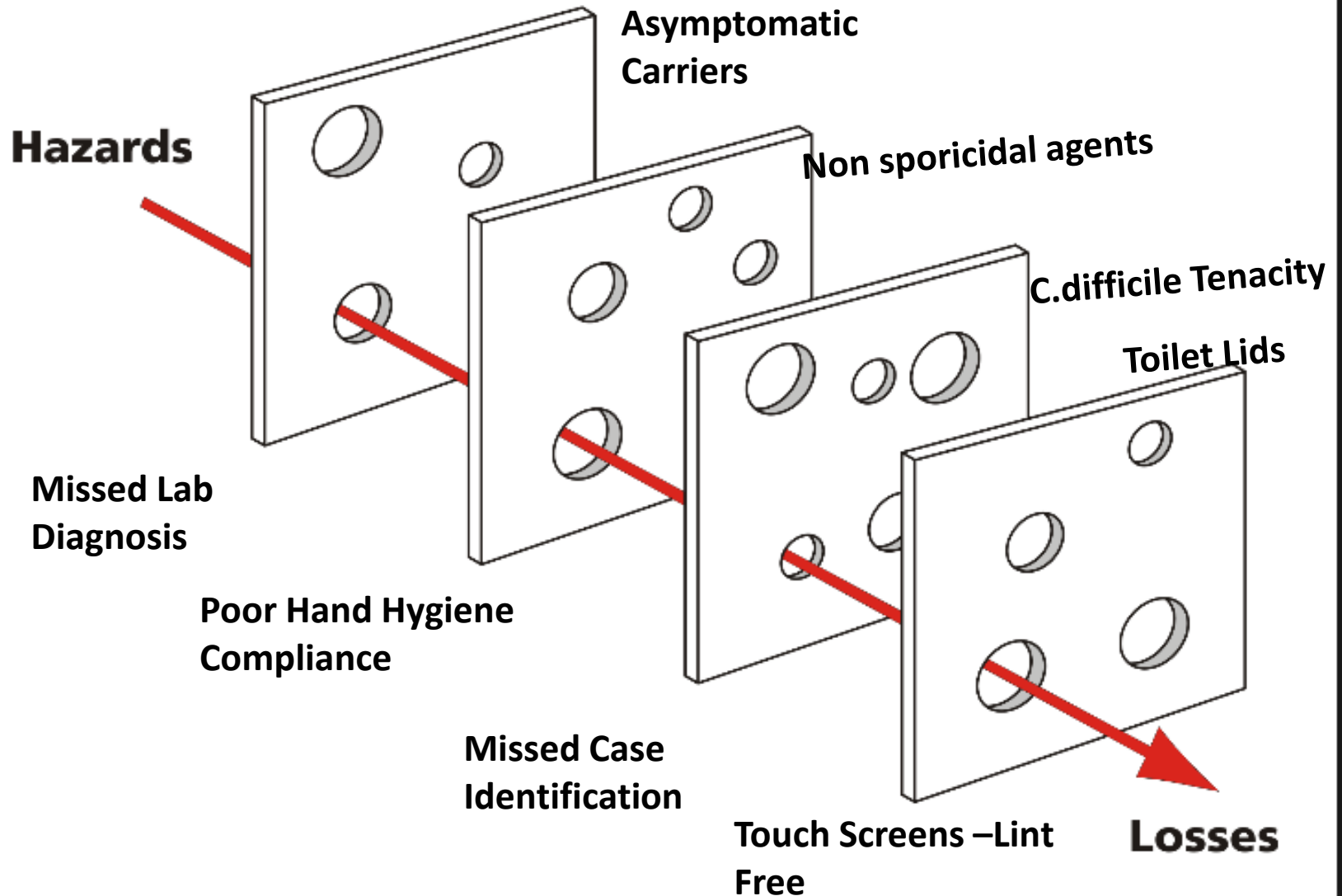
1. No single commercial test can be used as a stand-alone test for diagnosing CDI.
2. Therefore, the use of a two-step algorithm is recommended.

# Cleaning Opportunities

1. *C. difficile* was recovered on 49% of sites in rooms occupied by patients with CDI and on 29% of sites in rooms occupied by asymptomatic carriers.<sup>1,2</sup>
2. Computer touch screens can be potential reservoirs of opportunistic pathogens in hospitals cleaning instructions such as Mild Soap , Lint free cloth and water current increase risk of infection transmission<sup>4</sup>
3. Non Sporicidal agents have been shown to promote sporulation of hyper virulent strains like NAP1<sup>2</sup>
4. Published literature has shown that as levels of environmental contamination increase, so does the prevalence of *C. difficile* hand carriage among health care workers<sup>3</sup>

1. Guerreiro, Isabelle et al Using expert process to ombat *Clostridium difficile* infections American Journal of Infection Control , Volume 0 , Issue 0
2. Wilcox MH, Fawley WN. Hospital disinfectants and spore formation by *Clostridium difficile*. Lancet 2000;356:1324
3. Underwood S, Stephenson K, Fawley WN, et al. Program and abstracts of the 45th Annual Interscience Conference on Antimicrobials and Chemotherapy (Washington, DC). 2005. Effects of hospital cleaning agents on spore formation by North American and UK outbreak *Clostridium difficile* (CD) strains [abstract LB-28-2005].
4. Hirsch, Elizabeth B., et al. "Surface microbiology of the iPad tablet computer and the potential to serve as a fomite in both inpatient practice settings as well as outside of the hospital environment." *PloS one* 9.10 (2014): e111250.

# Recap of Challenges in Inpatient

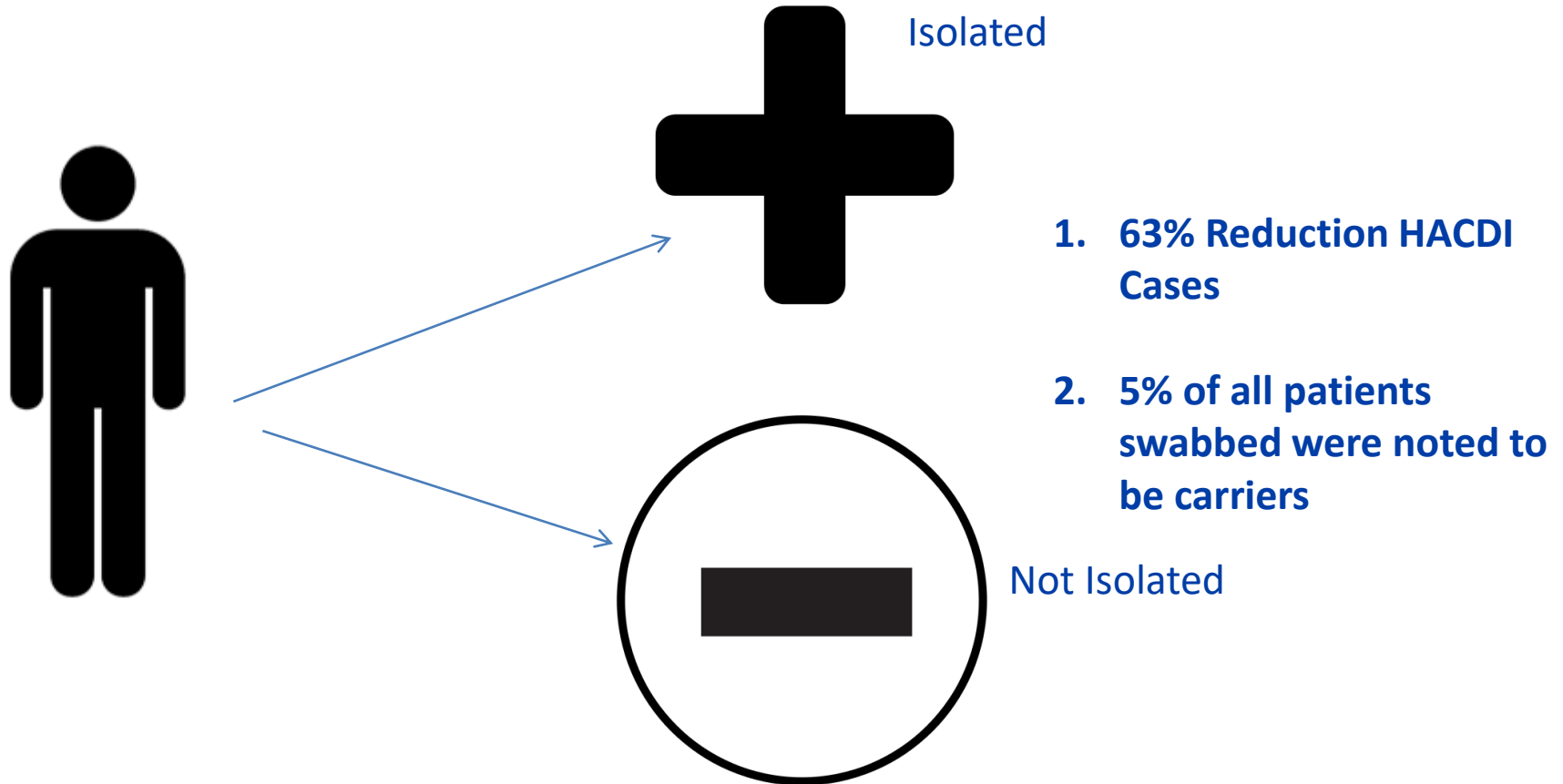


# Should We Screen Everyone



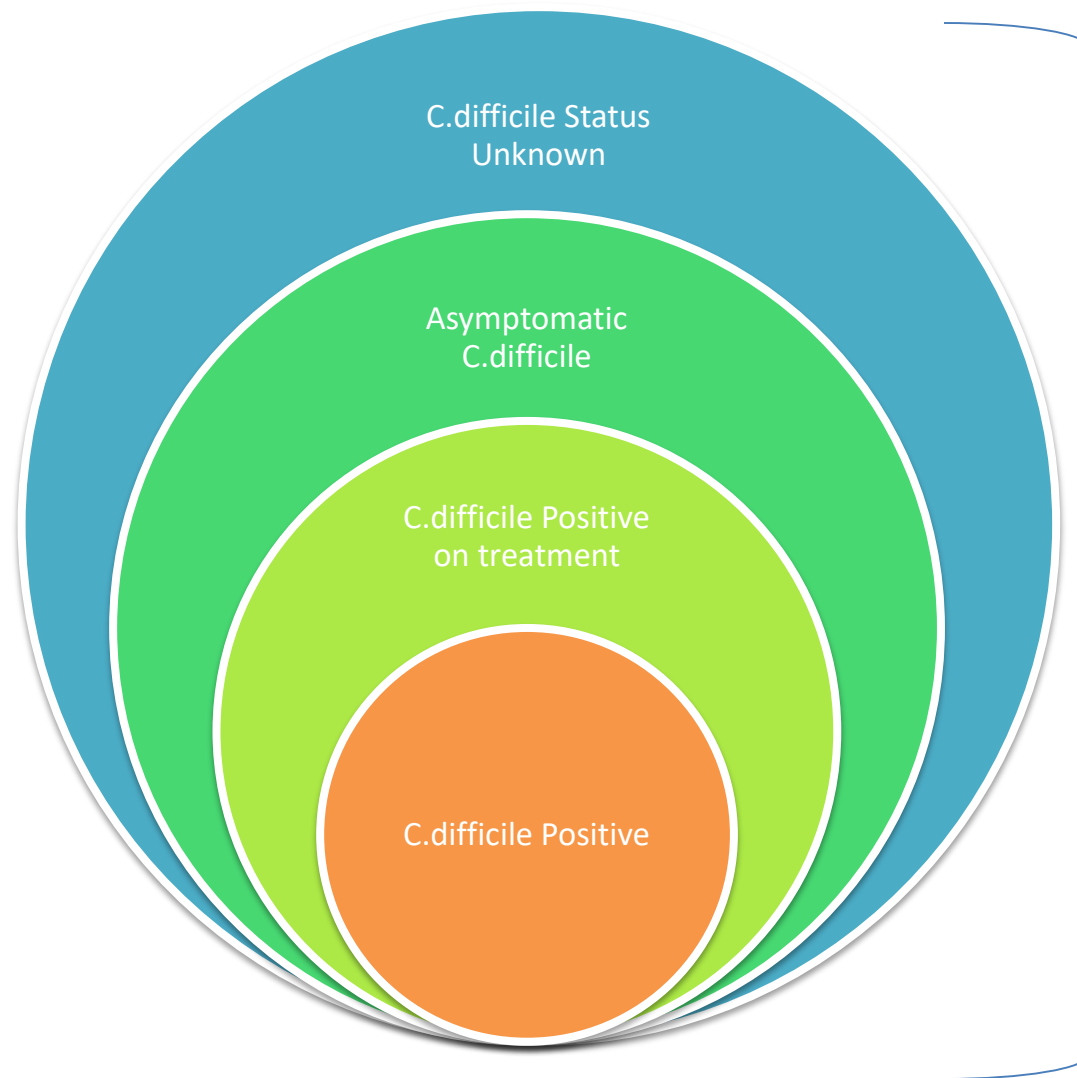


## Where is the Break- Down... C.difficile Screening on Admission



Longtin Y, Paquet-Bolduc B, Gilca R, et al. Effect of Detecting and Isolating Clostridium difficile Carriers at Hospital Admission on the Incidence of C difficile Infections: A Quasi-Experimental Controlled Study. *JAMA Intern Med.* 2016;176(6):796-804. doi:10.1001/jamainternmed.2016.0177

# Use Sporicidal Disinfectants on all Cases



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## **SPORICIDES**

**1) WHAT ARE THEY**

**2)DISADVANTAGES**

**3)PROOF OF CONCEPT OF UNIVERSAL SPORICIDAL USE**

# Disinfection and *C. difficile*

*C. difficile*

Spore Form

Non Spore Form

A current list of EPA-approved disinfectants with sporicidal claim is available at:

<http://www.epa.gov/pesticide-registration/list-k-epas-registered-antimicrobial-products-effective-against-clostridium>

## E.P.A Registered Sporicide

1. Sodium Hypochlorite
2. Peracetic/Hydrogen Peroxide Combination

## Non Touch

1. Ultraviolet Light Devices
2. Fogging Systems
3. Spray Systems



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# PROPERTIES OF AN IDEAL DISINFECTANT<sup>1</sup>

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Consideration	Question to Ask
Kill Claims	Does the product kill the most prevalent healthcare pathogens
Kill Times and Wet-Contact Times	How quickly does the product kill the prevalent healthcare pathogens. Ideally, contact time greater than or equal to the kill claim.
Safety	Does the product have an acceptable toxicity rating, flammability rating
Ease-of-Use	Odor acceptable, shelf-life, in convenient forms (wipes, spray), water soluble, works in organic matter, one-step (cleans/disinfects)
Other factors	Supplier offer comprehensive training/education, 24-7 customer support, overall cost acceptable (product capabilities, cost per compliant use, help standardize disinfectants in facility

1) Rutala, Weber. Infect Control Hosp Epidemiol. 2014;35:855-865

# Arguments For Sporidical Use

- Efficacy<sup>1</sup>
- Guidance Documents<sup>1</sup>
- Endemic C.difficile Rates<sup>1</sup>
- **Asymptomatic Colonization or Carriers**
- **Error Reduction/Human Factors/Swiss Cheese**
- **Hyper Virulent Strains**
- **Proactive versus Reactive Strategy**

<sup>1</sup>Ontario Agency for Health Protection and Promotion, Provincial Infectious Diseases Advisory Committee. Annex C – Testing, Surveillance and Management of Clostridium difficile. Annexed to: Routine Practices and Additional Precautions in All Health Care Settings. Toronto, ON: Queen's Printer for Ontario; 2013

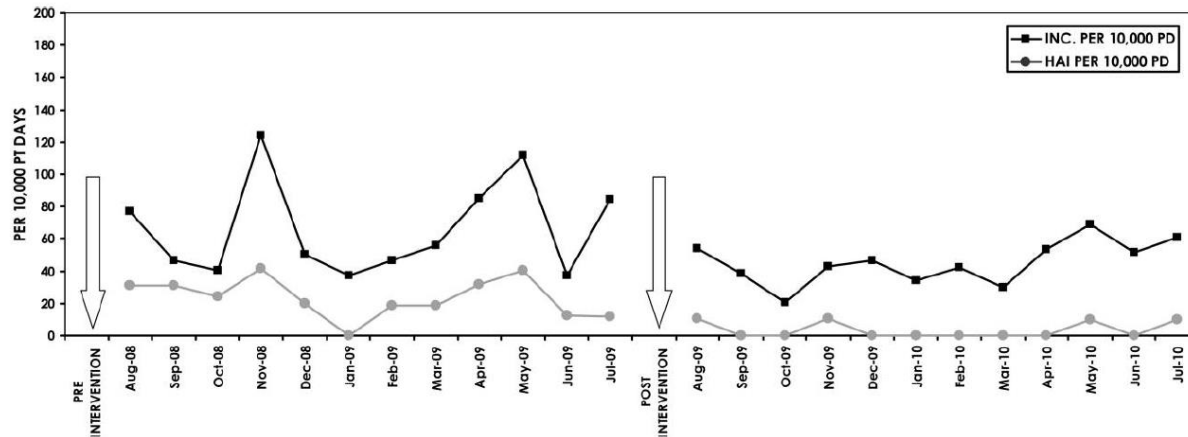
# Sporicidal Agents Get Better C.difficile Log Reduction

- Meticulous cleaning with any cleaner/disinfectant reduces the number of spores in the environment<sup>1</sup>
- However, greater reduction and inactivation of spores is achieved when a sporicidal agent is used<sup>1</sup>
- Removal of spores influenced by contact time (duration of wetness) and texture of surface being cleaned<sup>2</sup>

Technique	Reduction in Spores	Dry Time
Wiping with any disinfectant	> 2.9 log <sub>10</sub>	2-6 minutes
Spraying (no wipe) with sporicide	3.4 log <sub>10</sub>	28-40 minutes
Wiping with sporicide	3.9 log <sub>10</sub>	2-6 minutes

# Reducing CDI Using a Sporocidal Wipe for Cleaning

- Before/after study in two high-risk medical wards
- Intervention:
  - **Daily** and **terminal** cleaning of **all** rooms with ATP monitoring before/after (similar pass rate)
  - Quaternary ammonium compound before
  - Hypochlorite wipes with 10 minute contact time after
- **Results: 24.2 to 3.6 cases per 10,000 patient-days (85% decline)**





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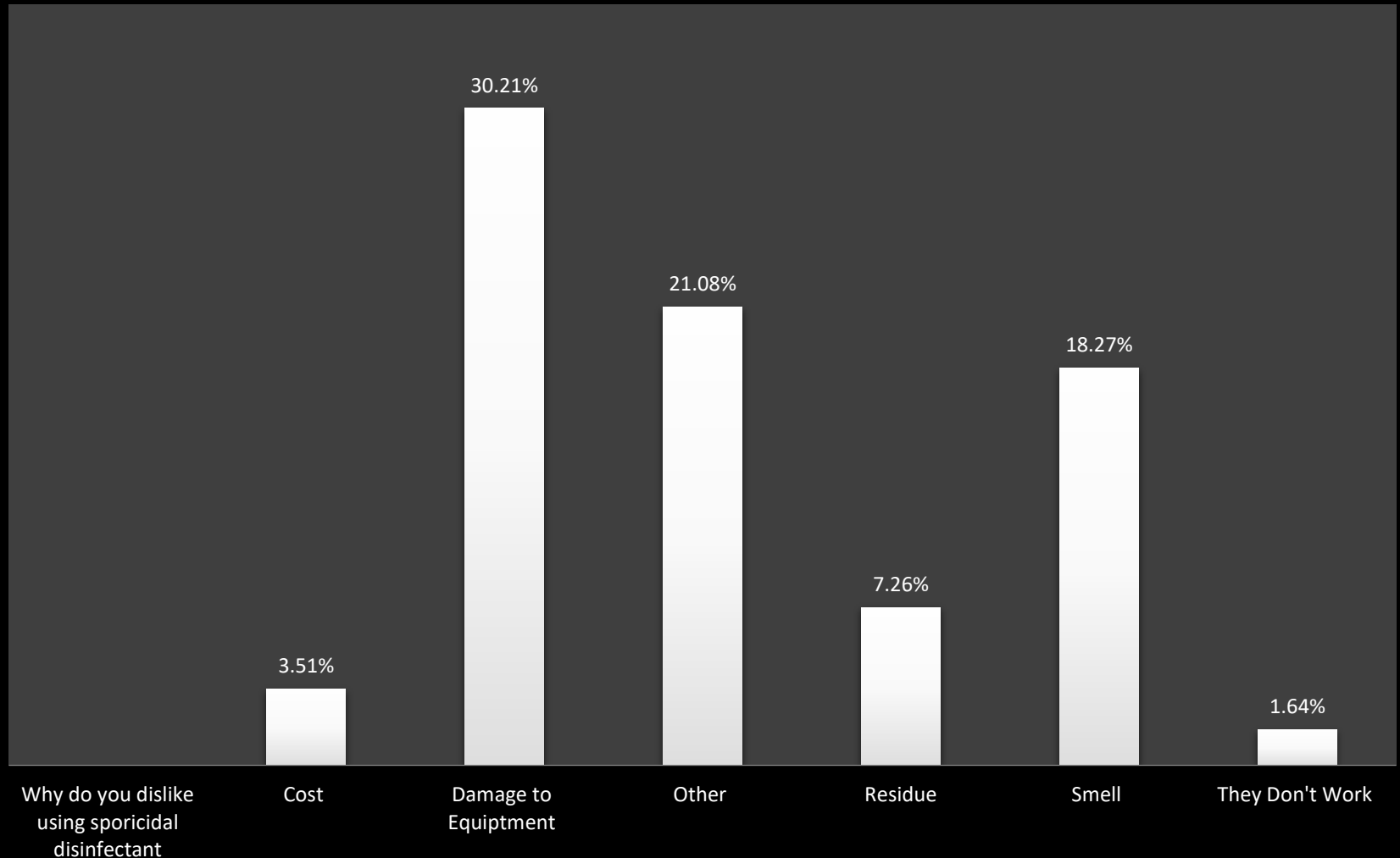
# CHALLENGES TO USING SPORICIDE

**SURFACE COMPATIBILITY(DEGRADATION TO EQUIPMENT, RESIDUE, COLOR SAFE, ),  
GUIDANCE DOCUMENTS, OCC CONCERNS, COST, ODOR, TOXICITY**

# Survey Results

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## Why do you dislike Sporocidal Agents



# Concerns against Sporidical Use

- Safety concerns from patients and staff
- Damage to equipment and the environment.
- Damage to patient equipment
- Cost
- Limited indications as per local guidance document or facility policy

# Occupational Health Concerns

American Journal of Infection Control 44 (2016) e85–e89



Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: [www.ajicjournal.org](http://www.ajicjournal.org)



Major article

## Occupational health risks associated with the use of germicides in health care



David J. Weber MD, MPH <sup>a,b,c,\*</sup>, Stephanie A. Consoli RN <sup>b</sup>, William A. Rutala PhD, MPH <sup>a,b,c</sup>

<sup>a</sup> Department of Hospital Epidemiology, University of North Carolina Health Care, Chapel Hill, NC

<sup>b</sup> Department of Occupational Health, University of North Carolina Health Care, Chapel Hill, NC

<sup>c</sup> Division of Infectious Diseases, University of North Carolina School of Medicine, Chapel Hill, NC

1. Healthcare Occupational clinical symptoms(Dermatitis, respiratory symptoms e.g. asthma) as a result of chemical exposures, including low-level disinfectants, are exceedingly rare.
2. The scientific evidence does not support that the use of low-level disinfectants by HCP is an important risk for the development of asthma or contact dermatitis

Weber, D. J., Consoli, S. A., & Rutala, W. A. (2016). Occupational health risks associated with the use of germicides in health care. *AJIC: American Journal of Infection Control*, 44(Supplement), e85-e89. doi:10.1016/j.ajic.2015.11.030

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**DESPITE THESE CHALLENGES BENEFITS  
OUTWEIGH THE DISADVANTAGES  
SHOW WINS**

# Proof of concept for Facility Wide Disinfection

30

Journal for Healthcare Quality

## Patient and Environmental Service Employee Satisfaction of Using Germicidal Bleach Wipes for Patient Room Cleaning

*Kimberly C. Aronhalt, James McManus, Robert Orenstein, Rebecca Faller, Mary Link*

1. Bleach wipes can be used for both daily and discharge cleaning of patient rooms with little impact on patient or employee satisfaction.
2. Involving patients in Process Improvement decisions assured staff-driven improvements are tolerated and accepted by patients

**85% decrease in CDI facility wide**

# Proof of concept for Facility Wide Disinfection

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Vol. 36 No. 3 May/June 2014

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## **Prevention of Hospital-Onset *Clostridium difficile* Infection in the New York Metropolitan Region Using a Collaborative Intervention Model**

*Brian S. Koll, Rafael E. Ruiz, David P. Calfee, Hillary S. Jalon, Rachel L. Stricof, Audrey Adams, Barbara A. Smith, Gina Shin, Kathleen Gase, Maria K. Woods, Ismail Sirtalan*

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- 1. Environmental Cleaning Approach: Standardize cleaning using a hypochlorite based disinfectant for both routine and terminal cleaning areas**
- 2. Significant reduction in hospital-onset CDI rates in participating New York metropolitan regional hospitals.**

**\$2.6-6.8 Million- In Estimated Cost Savings with reduced HAI rates**

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# NON TOUCH SYSTEMS



# Non Touch Systems Work

Clinical trials using UV or HP devices for terminal room disinfection to reduce health care-associated infections

Author, year	Design	Setting	Modality tested	Pathogen(s)	Outcome (HAI)	Assessment of HH compliance	Assessment of EVS cleaning	Other HAI prevention initiatives
Boyce, 2008 <sup>56</sup>	Before-after (CDI high-incidence wards)	Community hospital	HPV (Bioquell)	CDI	2.28 to 1.28 per 1,000 Pt days ( $P = .047$ )	No	No	NA
Cooper, 2011 <sup>65</sup>	Before-after (2 cycles)	Hospitals	HPV (NS)	CDI	Decreased cases (incidence NS)	No	No	Yes
Levin, 2013 <sup>66</sup>	Before-after	Community hospital	UV-PX, Xenex	CDI	9.46 to 4.45 per 10,000 Pt days ( $P = .01$ )	No	No	Yes
Passaretti, 2013 <sup>67</sup>	Prospective cohort (comparison of MDRO acquisition; admitted to rooms with or without HPV decontamination)	Academic center	HPV (Bioquell)	MRSA VRE CDI All MDROs; MRSA, VRE, CDI	2.3 to 1.2 ( $P = .30$ ) 7.2 to 2.4 ( $P < .01$ ) 2.4 to 1.0 ( $P = .19$ ) 12.6 to 6.2 per 1,000 Pt days ( $P < .01$ )	No	No	No
Manian, 2013 <sup>68</sup>	Before-after	Community hospital	HPV (Bioquell)	CDI	0.88 to 0.55 cases per 1,000 Pt days ( $P < .0001$ )	Yes	No	No
Hass, 2014 <sup>69</sup>	Before-after	Academic center	UV-PX, Xenex	CDI MRSA VRE MDRO-GNB Total	0.79 to 0.65 per 1,000 Pt days ( $P = .02$ ) 0.45 to 0.33 per 1,000 Pt days ( $P = .007$ ) 0.90 to 0.73 per 1,000 Pt days ( $P = .002$ ) 0.52 to 0.42 per 1,000 Pt days ( $P = .04$ ) 2.67 to 2.14 per 1,000 Pt days ( $P < .001$ )	No	Yes	Yes
Mitchell, 2014 <sup>70</sup>	Before-after	Acute care hospital	Dry hydrogen vapor (Nocospray)	MRSA (colonization and infection)	9.0 to 5.3 per 10,000 Pt days ( $P < .001$ )	Yes	No	Yes
Miller, 2015 <sup>71</sup>	Before-after	Urban hospital	UV-PX, Xenex	CDI	23.3 to 8.3 per 10,000 Pt days ( $P = .02$ )	No	No	Yes
Nagaraja, 2015 <sup>72</sup>	Before-after	Academic center	UV-PX, Xenex	CDI	1.06 to 0.83 per 1,000 Pt days ( $P = .06$ )	No	No	No
Pegues, 2015 <sup>73</sup>	Before-after	Academic center	CV-C (Optimum)	CDI	30.34 to 22.85 per 10,000 Pt days (IRR = 0.49; 95% CI, 0.26-0.94; $P = .03$ )	Yes	Yes	No
Anderson, 2015 <sup>74</sup>	RCT	9 hospitals	UV-C (Tru-D)	MRSA, VRE, CDI	51.3 to 33.9 per 10,000 Pt days ( $P = .036$ )*	Yes	Yes	No

CDI, *Clostridium difficile* infection; CI, confidence interval; EVS, environmental service; GNB, gram-negative bacteria; HAI, health care-associated infections; HH, hand hygiene; HP, hydrogen peroxide; HPV, hydrogen peroxide vapor; IRR, incidence rate ratio; MDRO, multidrug-resistant organism; MRSA, methicillin-resistant *Staphylococcus aureus*; NA, not applicable; NS, not stated; Pt, patient; RCT, randomized clinical trial; UV, ultraviolet light; UV-PX, ultraviolet light, pulsed-xenon device; VRE, vancomycin-resistant enterococci.

\*Outcome includes new colonization plus HAI.

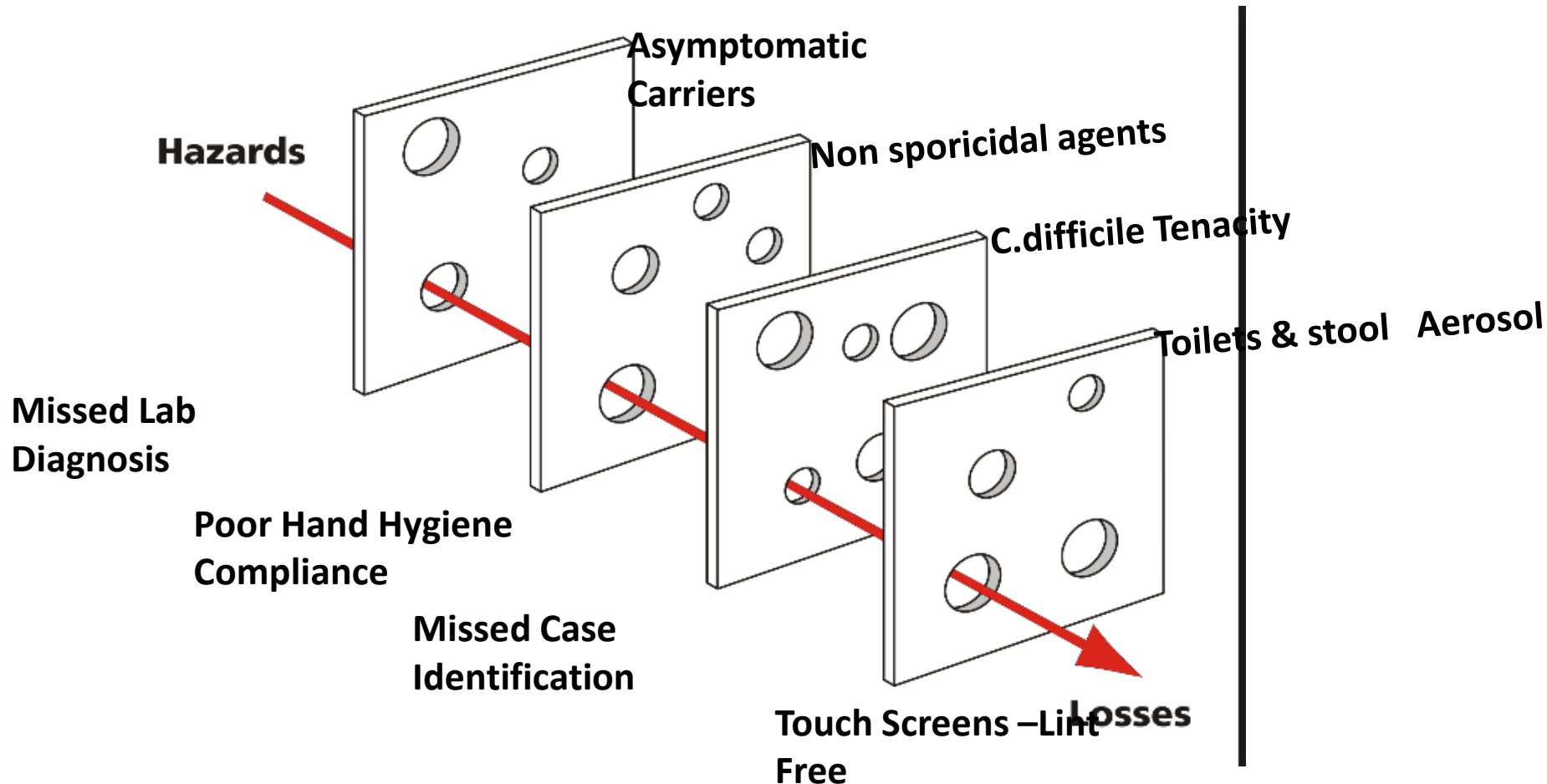
David J. Weber William A. Rutala Deverick J. Anderson Luke F. Chen Emily E. Sickbert-Bennett John M. Boyce  
Effectiveness of ultraviolet devices and hydrogen peroxide systems for terminal room decontamination: Focus on  
clinical trials Authors Source Information May 2016, Volume44(Issue Supplement) Page p.e77To-e84

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# CALL TO ACTION

**GUIDANCE DOCUMENTS TO CATCH UP-RECOMMENDATIONS, ROLE AS CARRIERS  
TOUGHER EQUIPMENT  
GENTLER DISINFECTANTS  
ENGINEERED SPORICIDIAL APPLICATIONS THAT WORK ALL THE TIME  
CONCLUSIONS**

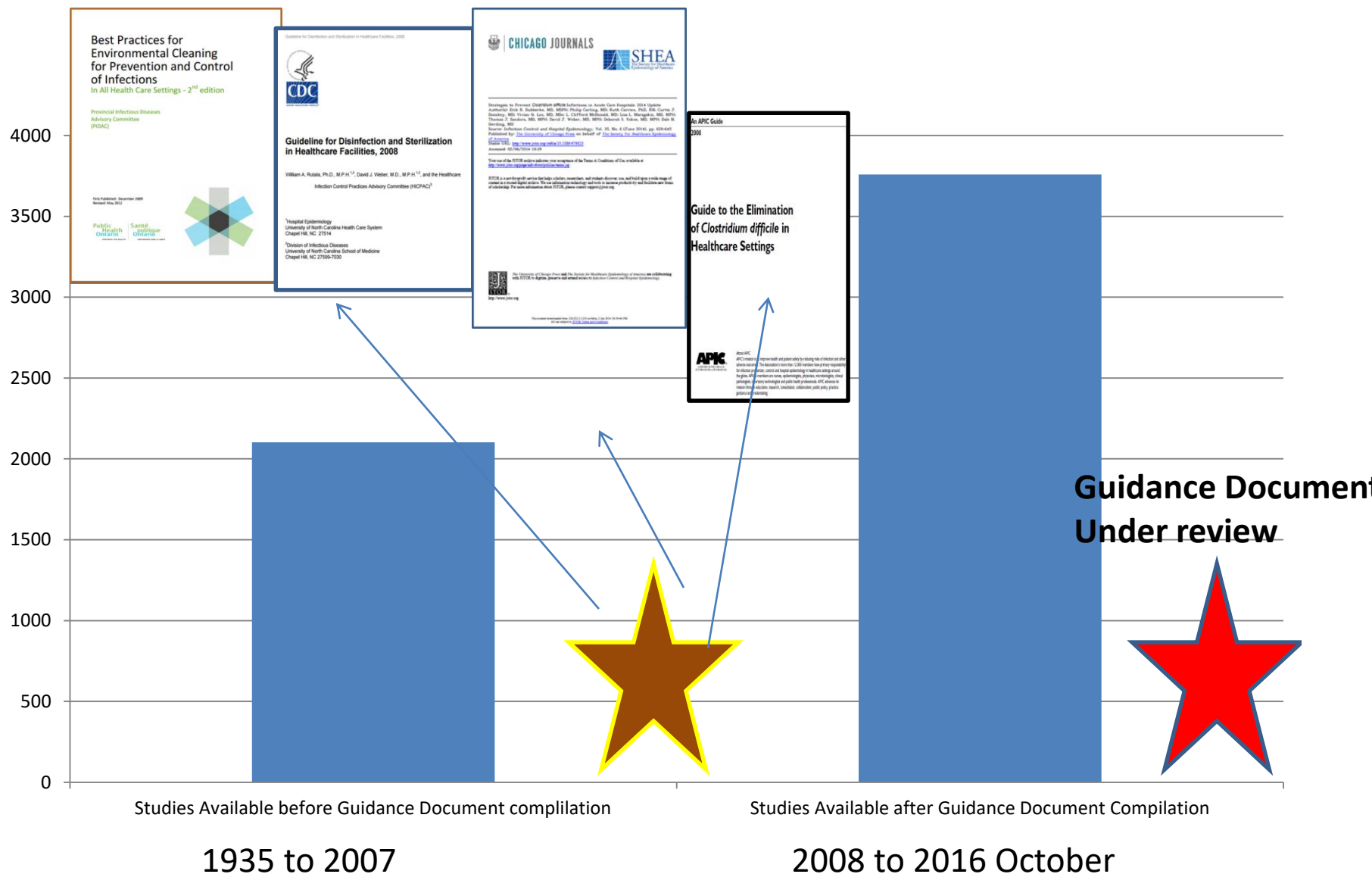
# Recap of Challenges in Inpatient



**Successful translation of evidence-based practice guidelines requires that the “work system” as well as the behavioral patterns of the providers are addressed <sup>1</sup>**

1. Hebden, J. N., & Murphy, C. (2013). Minimizing ambiguity to promote the translation of evidence-based practice guidelines to reduce health care-associated infections. *AJIC: American Journal of Infection Control*, 41(1), 75-76.  
doi:10.1016/j.ajic.2012.09.002

# Guidance Document Era



# Guidance Document Review

AGREE domain	ACG 2013	APIC 2013	ESCMID 2009	HPA/DH 2008	SHEA/IDSA 2014
Scope and purpose (%)	63.0	85.2	68.5	85.2	74.1
Stakeholder involvement (%)	38.9	27.8	40.7	44.4	50.0
Rigor of development (%)	18.1	15.3	48.6	17.4	35.4
Clarity of presentation (%)	75.9	53.7	88.9	79.6	75.9
Applicability (%)	4.2	58.3	19.4	55.6	43.1
Editorial independence (%)	77.8	47.2	63.9	30.6	66.7
Overall recommendation	NR	RWM	RWM	RWM	RWM

NOTE. ACG, American College of Gastroenterology; AGREE II, Appraisal of Guidelines for Research and Evaluation II; APIC, Association of Professionals in Infection Control and Epidemiology; DH, Department of Health; ESCMID, European Society for Clinical Microbiology and Infectious Diseases; HPA, Health Protection Agency; IDSA, Infectious Diseases Society of America; NR, Not recommended; RWM, Recommended, with modifications; SHEA, Society for Healthcare Epidemiology of America.

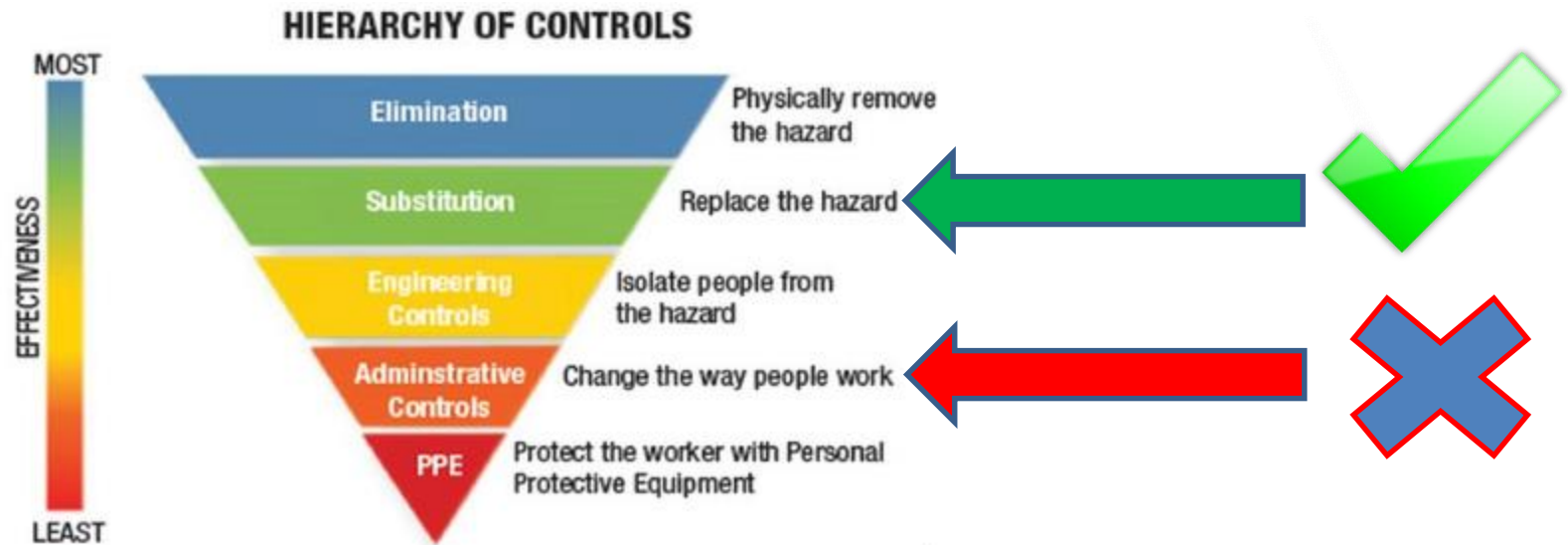
1. **There is a considerable need for high quality CPGs because they are often used for patient care.**
2. **Future guidelines of CDI prevention should be developed using validated methodological standards.**
3. **Furthermore, there is a need for higher quality primary research on this topic, to better inform recommendations.**

# C.difficile Interventions

## Recommendations

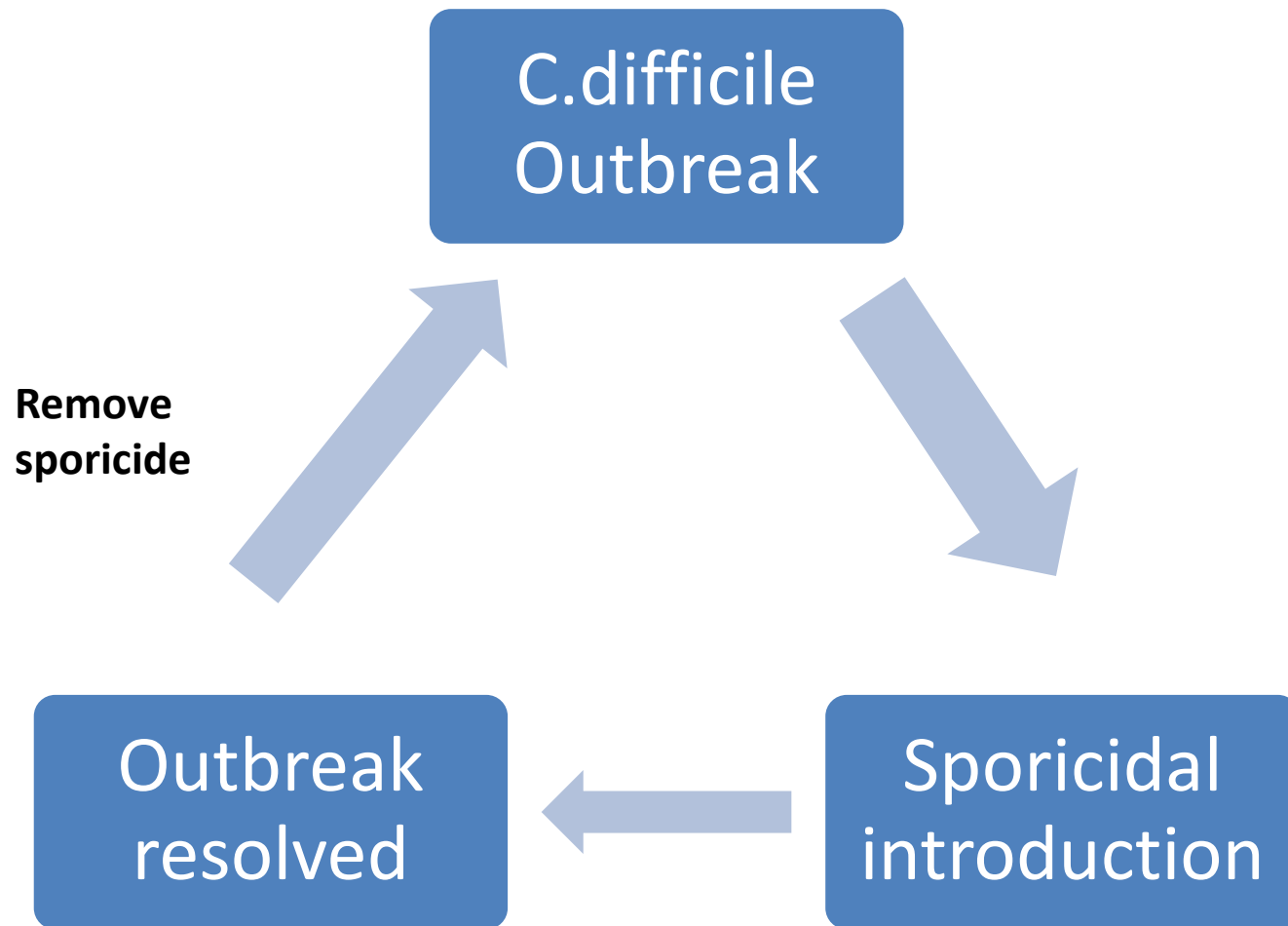
Intervention	Horizontal/Universal (All the time)	Vertical/Targeted (Sometimes)
Hand Hygiene	X	
Antimicrobial Stewardship	X	
Environmental Disinfection with Sporicide		X

# Error Reduction and Safety by Sporicide Everywhere



<https://www.cdc.gov/niosh/topics/hierarchy/>

# Hospital Cleaning Staff Member Question





# IP and EVS Wish List

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## **1. Ideal disinfectants**

Better surface compatibility, Faster Contact times, minimal Occupational Health Concerns

## **2. Updated Guidance Documents**

Reflecting current changes, Revisions with new data and Considerations of complexity of C.difficile transmission pathways

## **3. Improved Surfaces and Equipment**

Tougher surfaces, special covers, procurement of equipment that's hardy,



# Summary..

1. Multiple sources of CDI--Asymptomatic carriage is relevant
2. Human Factors is an important consideration in hospital disinfection
3. Better innovation on disinfectants needed
4. Guidance documents are up for renewal
5. Universal Sporicidal Disinfectant use is an effective C.difficile control strategy

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# Becker Pre Registration Survey

Do you use sporicidal agents in all declared Cdiff outbreaks in your facility?		
No	5.62%	
Not Applicable	25.53%	
Yes	68.85%	
In cases when you have to use sporicidal disinfectants, is there ever a delay initiating switch to sporicidal products from non sporicidal?		
All the time	1.87%	
Never	37.00%	
Not applicable'	27.87%	
Sometimes	28.10%	
Are there ever gaps that lead to failure to use a sporicidal agent for Cdiff patients		
Never	26.00%	
Not applicable	25.53%	
Sometimes	31.85%	
Yes	9.60%	
Why do you dislike using sporicidal disinfectant		
Cost	3.51%	
Damage to Equipment	30.21%	
Other	21.08%	
Residue	7.26%	
Smell	18.27%	
They Don't Work	1.64%	

Thank You

