Reducing *Clostridioides difficile* Infections among Inpatients

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April 03, 2019
Epidemiology of \textit{C. difficile} Infections in the United States
Epidemiology: What We Know

- *C. difficile* is an ubiquitous endemic pathogen in the US

[Image: https://www.cdc.gov/drugresistance/biggest_threats.html]
Epidemiology: What We Know

- *C. difficile* cause almost half a million infections in the United States in 2011

- ~29,000 die within 30 days of the initial diagnosis → half die as a direct result of CDI

Epidemiology: What We Know

- CDI: most commonly reported U.S. healthcare-associated infection
  - 12% of infections in 2011
  - 94% associated with accessing healthcare
  - Community associated cases have prior outpatient health care and antibiotic exposures
Epidemiology: What We Know

- ~83,000 of the patients who develop CDI will have recurrence
- Acute care cost attributable to CDI is ~$3,427 to $9,960 USD

In 2010, population-based analysis found that 94% of all CDI related to antecedent and concurrent health care exposures. Only 23% of CDI were found to be hospital-onset.

https://www.cdc.gov/mmwr/pdf/wk/mm6109.pdf
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<tr>
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National Action Plan to Prevent Healthcare-Associated Infections Progress and Targets for 2020

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Standardized Infection Ratio (SIR)

\[
SIR = \frac{\text{Observed Number of HAIs}}{\text{Predicted Number of HAIs}}
\]

- Lower SIRs are better
- The SIR will not be calculated if the number of predicted infections is less than 1.0

Cumulative Attributable Difference (CAD)

CAD = Observed HAIs – (Predicted HAIs × SIR goal)

- CAD the number of infections that must be prevented within your facility to achieve the 2020 HHS SIR goal

https://www.cdc.gov/hai/prevent/tap.html
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### Highlighted Measures

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Prevention of *C. difficile* Infections in the United States
CDI Prevention is Complex

- Ubiquitous nature
  - Inpatient and Outpatient Healthcare
  - Community exposure:
    - Animals (domestic and farm)
    - Parks
    - Restaurants
    - Homes, lawns

https://wwwnc.cdc.gov/eid/article/16/4/09-1138_article
https://www.nature.com/articles/srep41196.pdf
https://doi.org/10.1371/journal.pone.0164504
https://doi.org/10.1093/ofid/ofx018
CDI Prevention is Complex

- Diagnostic stewardship
  - Laboratory testing: Appropriate testing
  - Diagnosing the initial episode of CDI
  - Diagnosing recurrent CDI
  - Asymptomatic

https://cmr.asm.org/content/cmr/26/3/604.full.pdf
https://academic.oup.com/cid/article/66/8/1192/4589130
https://jcm.asm.org/content/jcm/55/5/1276.full.pdf
https://jamanetwork.com/journals/jamainternalmedicine/fullarticle/2434732
Critical Importance: Testing the Correct Patient with an Appropriate Laboratory Test at the Appropriate Time

- Institutionally, Clinicians and Lab staff only send samples of:
  - Patients without laxative use
  - Unexplained, new onset unformed stools
  - 3 or more stools in 24 hrs

*Approved stool EIA toxin tests vary widely in sensitivity. Laboratories should choose a toxin test with sensitivity in the upper range of sensitivity as reported in the literature [146-149, 156].

Critical Importance: Testing the Correct Patient with an Appropriate Laboratory Test at the Appropriate Time

- Diagnostic stewardship
  - Diverse stool tests available:
    - Anaerobic culture
    - Cell cytotoxicity neutralization assay (CCNA)
    - Enzyme immunoassay (EIA) [GDH; Toxin A and Toxin B]
    - Nucleic acid amplification (NAAT) [PCR, Isothermal amplification]
  - Is there an optimal testing strategy?
    - Multi-step algorithms: Two step, Three step

https://jcm.asm.org/content/55/5/1276
https://cmr.asm.org/content/26/3/604
Critical Importance: Testing the Correct Patient with an Appropriate Laboratory Test at the Appropriate Time

- Diagnostic stewardship
  - Rule out other causes of diarrhea
  - Laxatives in the past 48 hours
  - Assess when the patient was tested
    - Did the patient come with diarrhea to the ED?

Critical Importance: Testing the Correct Patient with an Appropriate Laboratory Test at the Appropriate Time

CDI is a clinical diagnosis
Reduction Strategy: Early Detection and Isolation

- Early detection
  - Ensuring appropriate staff are informed immediately about positive results

- Isolation: Patient placement
  - Pre-emptive isolation while results are pending
  - Single rooms with dedicated toilet facilities
  - Pay attention to asymptomatic carriers, if tested
Reduction Strategy: Contact Precautions

- Suspect or proven CDI should be placed on contact precautions
  - Continue until
    - Diarrhea has ceased
    - Patient is discharged
      - Presence of spores on skin surfaces

- Educate the Patient’s relatives and visitors

https://doi.org/10.1086/676023
Beyond the Norm: Environmental Cleaning and Disinfection is Required

- Only 50% hospital rooms surfaces clean at admission
- Greater room square footage increased CDI risk

https://doi.org/10.1017/ice.2015.18
https://doi.org/10.1086/591940
Beyond the Norm: Environmental Cleaning and Disinfection is Required

- Daily as well as terminal room disinfection
  - Sporicidal agent
  - No-touch terminal room disinfection methods

- Focus hygiene efforts on the most contaminated sites and sources as well as the high-touch surfaces

https://doi.org/10.1086/676023
https://doi.org/10.1016/S0140-6736(16)31588-4
CDC’s Core Elements of Antibiotic Stewardship: Hospitals, Critical Access Hospitals, Nursing Homes, Outpatient Settings

https://www.cdc.gov/getsmart/healthcare/implementation/core_elements.html
https://www.cdc.gov/longtermcare/prevention/antibiotic-stewardship.html
https://www.cdc.gov/getsmart/healthcare/implementation/core-elements-small-critical.html
Specific Classes of Antibiotics are More Likely to Cause CDI

Adjusted Hazard Ratio for CDI

- Quinolones: 4
- 5th 4th Cephalosporins: 3.1
- Vancomycin: 2.6
- 1st 2nd Cephalosporins: 2.4
- β-lactamase Inhibitors: 2.3
- Clindamycin: 1.9

https://doi.org/10.1093/cid/cir301
Changing Antibiotic Prescribing Practices can Decrease the Incidence of CDI

### Table 3: Potential effects of antibiotic stewardship on *Clostridium difficile* infection prevalence densities

<table>
<thead>
<tr>
<th></th>
<th>Without intervention</th>
<th>With intervention</th>
<th>Marginal difference in <em>Clostridium difficile</em> prevalence density</th>
<th><em>Clostridium difficile</em> infection cases prevented per year (95% CI)</th>
</tr>
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<tr>
<td><strong>Hospitals</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital antibiotic stewardship (May, 2009; per 1000 occupied bed-days)</td>
<td>0.562</td>
<td>0.590</td>
<td>0.028 (0.268 to 0.757)</td>
<td>0.0077</td>
</tr>
<tr>
<td><strong>Community</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary care antibiotic stewardship (May, 2009; per 100,000 inhabitants-days)</td>
<td>0.151</td>
<td>0.182</td>
<td>0.031 (0.011 to 0.087)</td>
<td>0.0068</td>
</tr>
<tr>
<td><strong>Combined</strong> (per 100,000 inhabitants-days)</td>
<td>0.185</td>
<td>0.212</td>
<td>0.027 (0.001 to 0.054)</td>
<td>0.0090</td>
</tr>
</tbody>
</table>

*Difference between observed prevalence density and projected prevalence density under scenario of no antibiotic stewardship, assuming pre-intervention temporal trends in antibiotic consumption. Difference between *Clostridium difficile* infection prevalence density with intervention (observed) divided by difference between observed community and hospital antibiotic stewardship prevalence density, giving an explanatory variable for community or hospital. *Clostridium difficile* infection prevalence density (projected without hospital antibiotic stewardship as explanatory variable) as projected prevalence density per hospital antibiotic stewardship as explanatory variable. *Clostridium difficile* infection prevalence density (projected without hospital antibiotic stewardship as explanatory variable) as explanatory variable.*

https://doi.org/10.1016/S1473-3099(16)30397-8
Decreasing Fluoroquinolone Use is Critical in Controlling the Burden of CDI

https://doi.org/10.1016/S1473-3099(16)30514-X
# Antibiotics Remain an Important Risk Factor for Community-onset CDI

## Table 5. Multivariate Analysis: Factors Associated With Community-Associated *Clostridium difficile* Infection

<table>
<thead>
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<th>Variable</th>
<th>Adjusted Matched Odds Ratio (95% CI)</th>
<th>$P$ Value</th>
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<tr>
<td>White race</td>
<td>7.67 (2.34–25.20)</td>
<td>.0008</td>
</tr>
<tr>
<td>Cardiac disease</td>
<td>4.87 (1.20–19.80)</td>
<td>.03</td>
</tr>
<tr>
<td>Chronic kidney disease</td>
<td>12.12 (1.24–118.89)</td>
<td>.03</td>
</tr>
<tr>
<td>Inflammatory bowel disease</td>
<td>5.13 (1.27–20.79)</td>
<td>.02</td>
</tr>
<tr>
<td>Received care in emergency</td>
<td>17.37 (1.99–151.22)</td>
<td>.01</td>
</tr>
<tr>
<td>department</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cephalosporin</td>
<td>19.02 (1.13–321.39)</td>
<td>.04</td>
</tr>
<tr>
<td>Clindamycin</td>
<td>35.31 (4.01–311.14)</td>
<td>.001</td>
</tr>
<tr>
<td>Fluoroquinolone</td>
<td>30.71 (2.77–340.05)</td>
<td>.005</td>
</tr>
<tr>
<td>Beta-lactam and/or beta-lactamase</td>
<td>9.87 (2.76–340.05)</td>
<td>.0004</td>
</tr>
<tr>
<td>inhibitor combination</td>
<td></td>
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[https://doi.org/10.1093/ofid/ofx171](https://doi.org/10.1093/ofid/ofx171)
Targeted Assessment for Prevention (TAP) Strategy

**Target**
- Use National Healthcare Safety Network (NHSN) data to make TAP report
- Identify facilities/units with excess healthcare-associated infections
- Engage targeted facilities/units to participate in focused prevention efforts

**Assess**
- Assess targeted facilities and units for potential gaps in infection control
- Summarize responses and calculate scores across units, facilities, and groups

**Prevent**
- Feedback data to targeted facilities/units
- Provide Implementation Guide to access resources
- Implement proven prevention strategies in the targeted facilities and units to reduce infection rates

Tools ➔ NHSN TAP Reports ➔ TAP ‘How To’ Guide
Tools ➔ Facility Assessment Tool ➔ Facility Assessment Tool Excel Database and User Guide
Tools ➔ Feedback Report ➔ Implementation Guide - Links to Resources

[https://www.cdc.gov/hai/prevent/tap.html](https://www.cdc.gov/hai/prevent/tap.html)
How will the data be summarized?

- Data overview
- Facility SIR relative to SIR Goal
- Domain scores
- Strengths and areas for improvement
- Recommended action items
- Links to resources
“the other C. diff”

- Broad-spectrum antibiotic use
- Immune compromise
- Prolonged ICU stay
- Abdominal surgery
Risk Factors for *Candida auris* “the other *C. diff*”

- Broad-spectrum antibiotic use
- Immune compromise
- Prolonged ICU stay
- Abdominal surgery
- Central Lines
Why We Care About an Obscure *Candida* Species
Why We Care About an Obscure *Candida* Species → It is emerging & no longer obscure
How did CDC being tracking this?

It starts with an email...

February 2015

• Pakistani colleagues concerned about outbreak of *Saccharomyces cerevisiae* infections
  • 22 isolates over 2 months
  • 8 bloodstream, 3 burn wounds, 10 urine, 1 catheter tip
But it wasn’t Saccharomyces...

- A commercial test kit had been used for identification
- DNA sequencing revealed that the isolates were *Candida auris*
Discovery of *Candida auris*—2009

*ORIGINAL ARTICLE*

*Candida auris* sp. nov., a novel ascomycetous yeast isolated from the external ear canal of an inpatient in a Japanese hospital

Kazu Sugimoto, Koichi Makimura, Yayoi Hasumi, Yayoi Nishiyama, Katsuhisa Uchida, and Hidey Yamaguchi

1Teikyo University Institute of Medical Mycology, 359 Otsuka, Hachioji, Tokyo 192-0395, Japan

2Japan Health Sciences Foundation, 13-4 Nihonbashi-Kodenmacho, Chuo-ku, Tokyo 103-0001

3Genome Research Center, Graduate School of Medicine and Faculty of Medicine, Teikyo University, Otsuka 359, Hachioji, Tokyo 192-0395, Japan

*Auris* is Latin for
Global emergence of *Candida auris*

*Candida auris*: A rapidly emerging cause of hospital-acquired multidrug-resistant fungal infections globally

Anuradha Chowdhary, Cheshta Sharma, Jacques F. Meis
Published: May 18, 2017 • https://doi.org/10.1371/journal.ppat.1006280

Japan

South Korea

India

South Africa

Kenya

Kuwait

Pakistan

Venezuela

Israel

Germany

U.K.

Colombia

Spain
CDC formed an international collaboration
Commonly seen *Candida* species

Related to other *Candida* species known for antifungal resistance
Healthy skepticism

- Was *Candida auris* with us all along?
- Maybe newer diagnostic methods responsible for observed emergence
  - MALDI-TOF
  - DNA sequencing
- Most systems misidentify as *Candida haemulonii* or other species
Not just improved detection

• EIP Candidemia Surveillance Program
  – No Candida auris

• SENTRY & ARTEMIS (private collections from 4 continents)
  – Over 30,000 Candida isolates from 1996-2015
  – No Candida auris before 2009

• Earliest known isolate of Candida auris has been recorded in S. Korea in 1996
How did *Candida auris* emerge?

- Global spread of single epidemic strain? (e.g., through food or medical product)
- Many introductions from the environment or other sources?
- Whole-genome sequencing (WGS) provides remarkable but puzzling results
Strong phylogeographic structure – 4 clades

Simultaneous Emergence of Multidrug-Resistant *Candida auris* on 3 Continents Confirmed by Whole-Genome Sequencing and Epidemiological Analyses


Clinical Infectious Diseases

MAJOR ARTICLE

https://academic.oup.com/cid/article/64/2/134/2706620
WGS of 47 isolates from 4 world regions

- Very different across regions
  >40,000-400,000 single nucleotide polymorphisms

- Nearly identical within regions
  <70 single nucleotide polymorphisms
Was *Candida auris* in the US?

CDC identifies first US cases of drug-resistant fungal infection

- CDC issues Clinical Alert to U.S. Healthcare Facilities - June 2016
The US *Candida auris* Situation Report

- Multiple introductions into United States
- Has gained a foothold in a few cities
- Vigilance can help prevent spread to new areas; containment possible
Candida auris cases reported by state — United States, May 2013–August 2016
Candida auris cases reported by state — United States, May 2013–December 2016
*Candida auris* cases reported by state — United States, May 2013–December 2018
Candida auris cases reported by state — United States, May 2013–December 2018
Candida auris cases reported by state — United States, May 2013–December 2018
Candida auris cases reported by state — United States, May 2013–December 2018

Number of clinical cases

New York  New Jersey  Maryland  Illinois  California  Massachusetts  Oklahoma  Indiana  Florida  Texas  Virginia  NY, probable  NJ, probable  IL, probable

Candida auris cases reported by state — United States, May 2013–December 2018

January *New* *Cases*
Outbreaks Often Not Contained to Single Facility

• Spread accelerated by
  – Undetected transmission
  – Poor communication of AR pathogen status during patient transfer between facilities

KPC-CRE outbreak in Chicago, 2008
The US *Candida auris* Situation Report

- **Multiple introductions into United States**
  - Are Florida’s cases from introductions domestically or internationally?

- **Has gained a foothold in a few cities**
  - Is Miami/Dade potentially the next?

- **Vigilance can help prevent spread to new areas; containment possible**
  - Can Florida facilities squelch transmission with containment?
Transmission in Facilities

• Hands and clothes of healthcare workers
• Patient environment
• Improperly cleaned medical devices
• Transmission can be prevented through
  – Hand hygiene
  – Use of gown and gloves
  – Environmental cleaning
  – Device reprocessing
  – But only if performed consistently and correctly!
*Candida auris* has been cultured from:

- Skin surface temperature probes
- Pulse Oximeters
- Glucometers
- Blood pressure cuffs
- Ultrasound machines
- Nursing carts
Causes invasive infections

• 40-50% of clinical cases are bloodstream infections

• 40% in-hospital mortality in BSI cases
Hard to control – UK example

- Contact precautions
- Screening for colonization
- Chlorhexidine bathing
- Cleaning room with bleach 3x/day
- Terminal cleaning with higher concentration bleach
- Eventually closed unit
Key Infection Control Assessment Elements

• Educate healthcare personnel and visitors
• Adherence to hand hygiene
• Use of gown and gloves
• Environmental cleaning
• Patient placement
• Cohort patients and staff where feasible
• Interfacility notifications when transferring patients
Infection control is key for stopping transmission of *Candida auris*
A paradigm shift for *Candida* infections

- Antifungal resistance is ‘normal’
- Thrives on skin
- Contaminates patient rooms
A paradigm shift for *Candida* infections

- Antifungal resistance is ‘normal’
- Thrives on skin
- Contaminates patient rooms
- *Can spread in healthcare settings*

- What are the challenges?
Flordia’s Health Care Associated Infections

- Nychie Dotson, MPH, CIC, CPHQ  
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- Sebastian Arenas, BS  
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- CDC Medical Officer Assigned to Florida Health  
  CAPT Gregory Eckert-Raczniak, MD, PhD, MPhil, MPH, FACPM  
  Gregory.Raczniak@flhealth.gov
Extra Slides
Whole-genome sequencing of U.S. isolates
Isolates from U.S cases cluster to all four Candida auris clades

- South American clade
- African clade
- East Asian clade
- South Asian clade
CT, CA, and OK travel-related cases – South Asian clade
IN travel-related case – African clade

South Africa

Indiana (IN)
FL travel-related case* – South American clade

Venezuela

Florida (FL)
Why did *Candida auris* emerge?

- A known unknown
  - Always part of human flora?
  - Zoonotic?
  - Environmental? (soil, plant, aquatic)
  - Changing microbiome?
  - Antifungal pressures?

- No reports of isolation from the natural environment
Preliminary Epidemiologic Characteristics of US *Candida auris* Cases

- Median age: 70
- Extensive healthcare exposure
- ~30% 30-day mortality
- Similar risk factors as for other Candida spp.
- Some patients on antifungal treatment when *C. auris* isolated
- Clustering in some hospitals
Affects the sickest of the sick

- Older age
- Multiple healthcare stays (acute and long term)
- Tracheostomy
- Ventilator
- PEG
- Central catheters
- On antibiotics and antifungals
- Colonization with another MDRO
Challenge 1: Misidentification
C. auris can be misidentified as:

- **Candida haemulonii**
- Candida famata
- Candida sake
- Candida catenulata
- Candida guilliermondii
- Candida lusitaniae

- Candida parapsilosis
- Rhodotorula glutinis
- Candida spp. after a validated method of Candida identification attempted
Continuing challenges with identification

• *Candida* species from non-sterile isolates often not identified
  – Half of clinical cases in the U.S. non-bloodstream isolates
  – Consider speciation if:
    • Clinically indicated
    • History of *Candida auris* in facility
    • History of overseas healthcare
Challenge 2: Limited Treatment Options

• Pan-resistant strains
• Echinocandin resistance developed on treatment
• New antifungals in the pipeline promising but not yet available
Major Antifungal Resistance Seen

- >90% Azoles
- 7% Echinocandins
- 35% Polyenes

• Multidrug resistance is seen ~41%
• Resistance to all three classes ~4%
By Comparison: *Candida glabrata*

11% Azoles

Up to 12% Echinocandins

<1% Polyenes
Treatment recommendations for adults and children >2 months

- Consultation with ID specialist highly recommended
- Echinocandin as initial therapy
- Consider switch to liposomal amphotericin B (5 mg/kg daily) if patient is clinically unresponsive or persistent fungemia for >5 days
- Monitor for clinical improvement and conduct follow-up cultures and repeat susceptibility testing
Treatment recommendations for adults and children >2 months

• No treatment for *Candida auris* cultured from non-invasive sites without evidence of infection

• Infection control precautions should be implemented, regardless of specimen site
  – Single room, contact precautions, hand hygiene, environmental cleaning, interfacility transfer communication, screening contacts
Challenge 3: Screening
Culturing is difficult

- Enrichment broth
  - High salt/temp
  - ~25% more sensitive than direct plating
  - Up to 2-week turnaround time; recently shorten

*CHROMagar™*

*C. auris* appears pink

*Cloudy (left) = positive*
Sites of *Candida auris* colonizations

- Most sensitive (>90%) and cost-effective swab: axillae and groin

- Can also find colonization in nose, ears, mouth, rectum, vagina
Challenge 4: Persistent Colonization

Emily Lutterloh, NYS
Colonization (Asymptomatic Carriage)

- Colonization: individuals carry without symptoms
  - Most individuals with a resistant organism
- Only a fraction detected by clinical cultures
- Asymptomatically colonized individuals can
  - Transmit to others
  - Develop infections themselves
  - Be detected by screening tests
- Body sites colonized depend on organism
  - Skin, nares, digestive tract
Decolonization/source control

• Role for chlorhexidine or other topical antiseptic?

• Antifungals (e.g., terbinafine)?

• Remove pressure of antibiotics and antifungals?

• Candida vaccine?
Some *in vitro* data on chlorhexidine promising.

**Chlorhexidine activity**

- *C. auris* was effectively inhibited by chlorhexidine (Hibiscrub, Ecolab, UK) *in vitro* at concentrations below 2 and 4% for skin decolonization.
- Iodinated povidone (Videne, UK) demonstrated an even greater activity much below the average 10% concentration used as antiseptic.

**Skin antiseptic chlorhexidine wash cloth**

All UK outbreak chlorhexidine wipes (Sage, Geneva, Switzerland) and wash cloth (Clinell, Gama healthcare, Watford, UK) after 18-48 hours incubation at 30 ± 2°C.
Others not as much

![Germicidal Activity Chart](image)

Rutala et al, IDWeek, 2017
Jury still out

• *In vivo* studies on reduction in burden of colonization have not been done

• No less colonization in facilities with *C. auris* outbreaks when using chlorhexidine bathing
Challenge 5: Environmental Persistence

- In lab, persists for >4 weeks on plastic surfaces
- Quaternary ammonium compounds inadequate for disinfection
Environmental Disinfection

Cadnum et al. 2017
Environmental Disinfection

• Bleach clearly works but has drawbacks

• CDC currently recommends disinfectant effective against C. difficile spores

• More data needed
“Containment” – A New Strategy to Prevent Spread of Emerging Resistance
Containment Summary

• New approach
  – Responding before problem becomes big
  – Identifying and controlling transmission
• Protects patients/residents across continuum of care
• Keys to control
  – Detection – clinical cases and asymptomatically colonized individuals
  – Good infection control practices
  – Hand hygiene, gowns and gloves, environmental cleaning
The Containment Strategy

• Goal: identify new resistance and control transmission
• Rapid detection and response
  – Single case of emerging resistance
• Infection control assessments
  – Led by public health using standardized tools
• Colonization screenings
  – Available through public health laboratories
• Coordination between healthcare facilities
• Continued vigilance until spread is controlled
Without Early Intervention Antibiotic Resistance Spreads Like Wildfire

States with *Klebsiella pneumoniae* carbapenemase (KPC)-producing Carbapenem-resistant Enterobacteriaceae (CRE) confirmed by CDC

Simulation of Transmissions Per Day Following Importation of Antibiotic Resistant Bacteria
Potential Impact of Containment

Intervention effectiveness
- No intervention
- 50%
- 20%
- 5%

Transmissions per day vs Days since importation

Courtesy of Prabasaj Paul and Rachel Slayton
Containment Responses

• Guidance applies to all healthcare facilities (post-acute care, acute care)

• Containment responses occur in facilities
  – Where patient / resident with targeted resistance is currently present
  – Where patient or resident with targeted resistance is not currently present but had stay within prior ~30 days
  – That frequently shares patients or residents with a healthcare facility that has ongoing transmission of targeted resistance

• Where response occurs is not necessarily where resistant organism was acquired
Use of Hand Hygiene, Gown and Gloves

- Need to make compliance easy!
  - Supplies necessary for hand hygiene should be readily accessible
    - In every patient/resident room
    - Ideally, ABHR within arms reach of care activities

- Setting-specific recommendations for gowns and gloves
  - Contact Precautions for targeted antibiotic resistance used in most acute care hospitals
  - For colonized long-term care facility residents
    - Gown and gloves for high risk activities recommended
    - No restriction from group activities
Environmental Cleaning and Disinfection

• The environment can serve as a source for transmission

• Many challenges observed during responses
  – Insufficient staff time to perform cleaning and disinfection
  – Lack of respect for EVS staff as part of healthcare team
  – Inadequate communication of cleaning responsibilities
    • EVS and nursing
  – Insufficient cleaning and disinfection of mobile equipment

• Objective measures of cleaning processes critical for assessing quality
Colonization Screening and Best Practices

• Multiple point prevalence surveys if transmission identified
• Patients/residents asked for verbal consent
  – Consent scripts and FAQ available
• Collection performed by trained healthcare worker
  – Generally facility nursing staff
• Surveyors informed of containment response activities
• Results shared with patient/family
• Results used to inform infection control
  – In consultation with public health
What Containment Looks Like in a Healthcare Facility

• Containment responses might result in
  – More use of gowns and gloves
  – More specific signage about PPE on patient/resident rooms
  – Moving patients/residents in order to cohort
  – Colonization screening

• Containment responses should not result in
  – Colonized residents restricted to room indefinitely
  – Exclusion from group activities in post-acute care facilities
Most Common Healthcare-Associated Bloodstream Infection in This Study?
Most Common Healthcare-Associated Bloodstream Infection Reported to the National Healthcare Safety Network (NHSN) between 2011-2014?
## Most Common Healthcare-Associated Bloodstream Infection in This Study?

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>All Health Care–Associated Infections (N = 504)</th>
<th>Pneumonia (N = 110)</th>
<th>Surgical-Site Infections (N = 110)</th>
<th>GI Infections (N = 86)</th>
<th>UTIs (N = 65)</th>
<th>Bloodstream Infections (N = 50)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. (%)</td>
<td>Rank</td>
<td>No. (%)</td>
<td>Rank</td>
<td>No. (%)</td>
<td>Rank</td>
</tr>
<tr>
<td><strong>Clostridium difficile</strong></td>
<td>61 (12.1)</td>
<td>1</td>
<td>0</td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Staphylococcus aureus</strong></td>
<td>54 (10.7)</td>
<td>2</td>
<td>18 (16.4)</td>
<td>2</td>
<td>17 (15.5)</td>
<td>2</td>
</tr>
<tr>
<td><strong>Klebsiella pneumoniae or K. oxytoca</strong></td>
<td>50 (9.9)</td>
<td>3</td>
<td>13 (11.8)</td>
<td>3</td>
<td>15 (13.6)</td>
<td>3</td>
</tr>
<tr>
<td><strong>Escherichia coli</strong></td>
<td>47 (9.3)</td>
<td>4</td>
<td>3 (2.7)</td>
<td>4</td>
<td>14 (12.7)</td>
<td>4</td>
</tr>
<tr>
<td><strong>Enterococcus species</strong></td>
<td>44 (8.7)</td>
<td>5</td>
<td>2 (1.8)</td>
<td>5</td>
<td>16 (14.5)</td>
<td>5</td>
</tr>
<tr>
<td><strong>Pseudomonas aeruginosa</strong></td>
<td>36 (7.1)</td>
<td>6</td>
<td>14 (12.7)</td>
<td>6</td>
<td>7 (6.4)</td>
<td>6</td>
</tr>
<tr>
<td><strong>Candida species</strong></td>
<td>32 (6.3)</td>
<td>7</td>
<td>4 (3.6)</td>
<td>7</td>
<td>3 (2.7)</td>
<td>7</td>
</tr>
<tr>
<td><strong>Streptococcus species</strong></td>
<td>25 (5.0)</td>
<td>8</td>
<td>7 (6.4)</td>
<td>8</td>
<td>8 (7.3)</td>
<td>8</td>
</tr>
<tr>
<td><strong>Coagulase-negative staphylococcus species</strong></td>
<td>24 (4.8)</td>
<td>9</td>
<td>0</td>
<td>9</td>
<td>7 (6.4)</td>
<td>9</td>
</tr>
<tr>
<td><strong>Enterobacter species</strong></td>
<td>16 (3.2)</td>
<td>10</td>
<td>3 (2.7)</td>
<td>10</td>
<td>5 (4.5)</td>
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</table>

*Note: The number in parentheses indicates the percentage.*
### Most Common Healthcare-Associated Bloodstream Infection Reported to NHSN 2011-14

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<td>Enterococcus faecalis</td>
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<tr>
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<td>Proteus spp.</td>
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<td>Yeast NOS</td>
<td>763</td>
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## Global Emergence of Invasive Infections Caused by the Multidrug-Resistant Yeast *Candida auris*

### Summary:
The Centers for Disease Control and Prevention (CDC) has received reports from international healthcare facilities that *Candida auris*, an emerging multidrug-resistant (MDR) yeast, is causing invasive healthcare-associated infections with high mortality. Some strains of *C. auris* have elevated minimum inhibitory concentrations (MICs) to the three major classes of antifungals, severely limiting treatment options. *C. auris* requires specialized methods for identification and could be misidentified as another yeast when relying on traditional biochemical methods. CDC is aware of one isolate of *C. auris* that was detected in the United States in 2013 as part of ongoing surveillance. Experience outside the United States suggests that *C. auris* has high potential to cause outbreaks in healthcare facilities. Given the occurrence of *C. auris* in nine countries on four continents since 2009, CDC is alerting U.S. healthcare facilities to be on the lookout for *C. auris* in patients.

### Background:
*Candida auris* is an emerging multidrug-resistant (MDR) yeast that can cause invasive infections and is associated with high mortality. It was first described in 2009 after being isolated from external ear discharge of a patient in Japan. Since the 2009 report, *C. auris* infections, specifically fungemia, have been reported from South Korea, India, South Africa, and Kuwait. Although published reports are not available, *C. auris* has also been identified in Colombia, Venezuela, Pakistan, and the United Kingdom.

It is unknown why *C. auris* has recently emerged in so many different locations. Molecular typing of strains performed by CDC suggests isolates are highly similar, possibly suggesting a single point of emergence. The continuing emergence of *C. auris* presents a serious international public health threat.
CDC’s Strategies to Prevent *Clostridioides difficile* Infection in Acute Care Facilities

- Isolate and initiate contact precautions
- Confirm CDI in patients
- Perform environmental cleaning to prevent CDI
- Develop infrastructure to support CDI prevention
- Develop a facility-specific antibiotic stewardship program
- Supplementary measures

https://www.cdc.gov/cdiff/clinicians/cdi-prevention-strategies.html
CDC’s Strategies to Prevent *Clostridioides difficile* Infection in Acute Care Facilities

- Supplementary measures (outbreaks or not reducing CDI to goals)
  - Consider participating in regional CDI prevention activities
  - Co-hort patients should be managed by dedicated staff (i.e., without responsibility for care of non-CDI patients)
  - Consider evaluating and testing patients at high risk for CDI to detect asymptomatic carriage
    - Isolate patients that test positive, but do not treat in the absence of symptoms ➔ Avoid using high-risk antibiotics
  - Consider limiting the use of medications hypothesized to increase risk for CDI (e.g., proton pump inhibitors, H2-receptor blockers)

https://www.cdc.gov/cdiff/clinicians/cdi-prevention-strategies.html
CDI Infection Control Bundles and Human Factors Engineering

- Bundles
  - Successful
  - Limitations:
    - Complex and difficult to institute
    - Adherence

Veterans Affairs, 87-bed facility focus groups: Healthcare personnel
  - Systems Engineering Initiative for Patient Safety (SEIPS)

https://doi.org/10.1016/j.ajic.2017.08.027
## CDI Infection Control Bundles and Human Factors Engineering

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<th>SEIPS Component</th>
<th>Testing and Diagnosis</th>
<th>Hand Hygiene</th>
<th>CIP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Person</strong></td>
<td>Unaware of laboratory guidelines for stool and atypical presentations</td>
<td>Lack of clarity around where handwashing should occur</td>
<td>Lack of clarity around many aspects of CIP</td>
</tr>
<tr>
<td></td>
<td>Identify and appreciate nurses' role in testing</td>
<td>Concern about patients' reactions to staff handwahsing location (e.g., patient bathroom)</td>
<td>Observation of lack of gowning by family, food service, and also by HCWs during brief patient contacts</td>
</tr>
<tr>
<td><strong>Task</strong></td>
<td>Many positive aspects of newer PCR test (expedient, efficient, available, and highly sensitive)</td>
<td>Sinks (water too hot)</td>
<td>Nurses are proactive in initiating CIP before testing results back</td>
</tr>
<tr>
<td><strong>Tools</strong></td>
<td>Barriers to testing related to laboratory policy</td>
<td>Soap supplies adequate</td>
<td>ES is effective with CIP</td>
</tr>
<tr>
<td></td>
<td>Facilitators to testing (increased frequency, almost universal testing of new admissions, assumption of CD with diarrhea until testing proves otherwise)</td>
<td>ICU gown bags without clear labels as to dirty or clean status</td>
<td>Adherence is time-consuming</td>
</tr>
<tr>
<td><strong>Organization</strong></td>
<td>Patient placed in CIP once CD test ordered</td>
<td>ER and outpatient clinics do not institute CIP</td>
<td>Less time spent with patients under CIP</td>
</tr>
<tr>
<td><strong>Environment</strong></td>
<td>Sinks cluttered</td>
<td>Hospital does not share bundle compliance data</td>
<td>Supplies usually adequate</td>
</tr>
<tr>
<td></td>
<td>Potential contamination from room after handwashing</td>
<td>Desire data on impact of bundle to increase motivation for bundle adherence</td>
<td>ICU gown bags without clear labels as to dirty or clean status</td>
</tr>
</tbody>
</table>

https://doi.org/10.1016/j.ajic.2017.08.027
### Identify Barriers and Facilitate Bundle Implementation

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<tr>
<td><strong>Person</strong></td>
<td>• RNs identify CDI risk factors, symptoms, and mimics, which allow them to initiate earlier testing</td>
<td>• RNs review patient history and symptoms and order CIP independently</td>
<td>• RNs identify CDI risk factors, symptoms, and mimics, which allow them to initiate earlier testing</td>
</tr>
<tr>
<td></td>
<td>• HTs collaborate with RNs for identification of CDI</td>
<td>• Resource of infection control nurse facilitates initiating and discontinuing CIP</td>
<td>• HTs collaborate with RNs for identification of CDI</td>
</tr>
<tr>
<td></td>
<td>• RNs order CD testing despite external resistance</td>
<td>• Variable family adherence to CIP despite RN education</td>
<td>• RNs order CD testing despite external resistance</td>
</tr>
<tr>
<td></td>
<td>• Delay in obtaining stool sample delays diagnosis</td>
<td>• ES is knowledgeable and willing to educate others on CIP room cleaning</td>
<td>• Delay in obtaining stool sample delays diagnosis</td>
</tr>
<tr>
<td></td>
<td>• RNs believe that risk-benefit ratio supports more frequent testing</td>
<td>• Adherence to CIP by food service and visitors has improved</td>
<td>• RNs believe that risk-benefit ratio supports more frequent testing</td>
</tr>
<tr>
<td></td>
<td>• Many RNs unaware of bundle</td>
<td>• Increased RN and HT time and workload</td>
<td>• Many RNs unaware of bundle</td>
</tr>
<tr>
<td><strong>Task</strong></td>
<td>• Handwashing time-consuming</td>
<td>• RNs aware CIP room cleaning is time-consuming (approximately 1 h)</td>
<td>• RNs aware CIP room cleaning is time-consuming (approximately 1 h)</td>
</tr>
<tr>
<td></td>
<td>• Desire for faster methods</td>
<td>• Inadvertent noncompliance with CIP when nurses very busy</td>
<td>• Inadvertent noncompliance with CIP when nurses very busy</td>
</tr>
<tr>
<td><strong>Tools</strong></td>
<td>• Concern for CDI transmission drives initiation of early testing</td>
<td>• Adequate gown supplies</td>
<td>• Adequate gown supplies</td>
</tr>
<tr>
<td></td>
<td>• Rapid PCR testing facilitates CDI diagnosis and reduces unnecessary room changes</td>
<td>• Gowns fall off easily</td>
<td>• Gowns fall off easily</td>
</tr>
<tr>
<td></td>
<td>• Soap dispenser problems (empty or broken)</td>
<td>• Equipment and supply problems</td>
<td>• Equipment and supply problems</td>
</tr>
<tr>
<td></td>
<td>• Sink problems (hot water, manual faucets, or clutter on sink)</td>
<td>• Personal stethoscopes are inappropriately used by providers</td>
<td>• Personal stethoscopes are inappropriately used by providers</td>
</tr>
<tr>
<td></td>
<td>• Signs on hand sanitizers direct staff to wash hands</td>
<td>• Isolation stethoscopes meant for patient rooms are taken outside</td>
<td>• Isolation stethoscopes meant for patient rooms are taken outside</td>
</tr>
<tr>
<td></td>
<td>• Addition of sink in hallway</td>
<td>• No automatic EMR ordering of CIP when ordering CDI testing</td>
<td>• No automatic EMR ordering of CIP when ordering CDI testing</td>
</tr>
<tr>
<td></td>
<td>• Broken soap dispensers fixed quickly</td>
<td>• Unclear policies on always wearing gowns in CIP rooms and disposal of CIP patient feces</td>
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</tr>
<tr>
<td><strong>Organization</strong></td>
<td>• RNs usually have organizational support for independently ordering test</td>
<td>• Most staff adherent to CIP; RNs usually comfortable pointing out lapses in CIP, although harder to do with MDs</td>
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</tr>
<tr>
<td></td>
<td>• Variable RN-provider communication when ordering CDI testing</td>
<td>• Culture of institutional support for CIP</td>
<td>• Culture of institutional support for CIP</td>
</tr>
<tr>
<td></td>
<td>• Laboratory guidelines only allow for testing loose stools</td>
<td>• RNs have organizational support for independent testing and decision-making</td>
<td>• RNs have organizational support for independent testing and decision-making</td>
</tr>
<tr>
<td></td>
<td>• Problems with ED (pressure and missed diagnosis)</td>
<td>• RNs appreciate role and workload of ES in preventing CDI transmission</td>
<td>• RNs appreciate role and workload of ES in preventing CDI transmission</td>
</tr>
<tr>
<td><strong>Environment</strong></td>
<td>• Problems with sinks (too few or poor location)</td>
<td>• RNs think an EMR prompt screening for CDI symptoms would expedite early testing</td>
<td>• RNs think an EMR prompt screening for CDI symptoms would expedite early testing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Ordering CD testing prompts nurses to start IP</td>
<td>• Ordering CD testing prompts nurses to start IP</td>
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<tr>
<td></td>
<td></td>
<td>• Accessibility of CIP supplies (eg, gowns, gloves, stethoscopes)</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>• CIP signs are clear</td>
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[https://doi.org/10.1016/j.ajic.2017.08.027](https://doi.org/10.1016/j.ajic.2017.08.027)
The loss of diversity of the human microbiome leads to the overgrowth of opportunistic pathogens.

Toxin Negative, Toxigenic Culture Positive Patients Have Outcomes Similar to Negative/Negative Patients

<table>
<thead>
<tr>
<th></th>
<th>Group 1 (CTA positive)</th>
<th>Group 2 (CC positive, CTA negative)</th>
<th>Group 3 (all negative)</th>
<th>Group 1 vs Group 2 p-values</th>
<th>Group 1 vs Group 3 p-values</th>
<th>Group 2 vs Group 3 p-values</th>
</tr>
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<tbody>
<tr>
<td>n</td>
<td>235</td>
<td>292</td>
<td>5580</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female (%)</td>
<td>243 (56%)</td>
<td>118 (45%)</td>
<td>3154 (54%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean age, (years, SD)</td>
<td>69 (20)</td>
<td>65 (21)</td>
<td>64 (21)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean white cell count (×10³/µL, SD)</td>
<td>12.4 (8.9)</td>
<td>10.1 (5.8)</td>
<td>9.9 (10.7)</td>
<td>0.0004</td>
<td>&lt;0.0001</td>
<td>0.6970</td>
</tr>
<tr>
<td>Mean rise in creatinine (%; SD)</td>
<td>37% (63)</td>
<td>52% (147)</td>
<td>33% (65)</td>
<td>0.1238</td>
<td>0.2270</td>
<td>0.0028</td>
</tr>
<tr>
<td>&gt;100% rise in creatinine (%)</td>
<td>40.7% (16%)</td>
<td>21.1% (12%)</td>
<td>44.7% (79%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean albumin (g/L, SD)</td>
<td>31 (7)</td>
<td>32 (8)</td>
<td>34 (8)</td>
<td>0.5226</td>
<td>&lt;0.0001</td>
<td>0.0017</td>
</tr>
<tr>
<td>Albmin &gt;20 g/L (%)</td>
<td>13.3% (4%)</td>
<td>11.16% (7%)</td>
<td>241% (85%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Died (%)</td>
<td>7.2% (45%)</td>
<td>20% (97%)</td>
<td>50% (580)</td>
<td>0.022</td>
<td>&lt;0.0001</td>
<td>0.530</td>
</tr>
<tr>
<td>Mean length of stay before sample (days, SD)</td>
<td>180 (29)</td>
<td>14.1 (24)</td>
<td>10.7 (21)</td>
<td>0.1584</td>
<td>&lt;0.0001</td>
<td>0.0157</td>
</tr>
<tr>
<td>Mean length of stay after sample (days, SD)</td>
<td>19.4 (25)</td>
<td>186 (27)</td>
<td>14.2 (22)</td>
<td>0.9498</td>
<td>&lt;0.0001</td>
<td>0.0022</td>
</tr>
<tr>
<td>Death rate per 1000 inpatient days</td>
<td>9.03</td>
<td>5.53</td>
<td>6.26</td>
<td>0.0195</td>
<td>0.0033</td>
<td>0.4224</td>
</tr>
</tbody>
</table>

CTA = cytotoxin assay, CC = cytotoxigenic culture. *Sex was not recorded for four patients in this group.

Table 2: Clinical characteristics of first episodes of inpatients with available clinical outcome results

Overdiagnosis of *Clostridium difficile* Infection in the Molecular Test Era

Table 1. Baseline Characteristics of the Study Population by *Clostridium difficile* Test Group

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>C difficile Positive</th>
<th>C difficile Negative</th>
<th>P Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tox+/PCR+ (n = 131)</td>
<td>Tox+/PCR- (n = 162)</td>
<td></td>
</tr>
<tr>
<td>Age, median (IQR), y</td>
<td>64 (52-71)</td>
<td>59 (47-71)</td>
<td>.12</td>
</tr>
<tr>
<td>Female sex, No. (%)</td>
<td>64 (48.9)</td>
<td>530 (47.2)</td>
<td>.61</td>
</tr>
<tr>
<td>Comorbidities, median (IQR)</td>
<td>4 (2-6)</td>
<td>3 (2-5)</td>
<td>.01</td>
</tr>
<tr>
<td>APR-DRG risk of mortality subclass 3 or 4, No. (%)</td>
<td>104 (79.4)</td>
<td>787 (70.1)</td>
<td>.008</td>
</tr>
<tr>
<td>Intensive care unit care on day 1 ± 1 d, No. (%)</td>
<td>30 (22.9)</td>
<td>435 (38.7)</td>
<td>.002</td>
</tr>
<tr>
<td>Hospital days before day 1, median (IQR)</td>
<td>10 (6-24)</td>
<td>8 (6-12)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Admitted from health care facility, No. (%)</td>
<td>40 (30.5)</td>
<td>160 (14.2)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>C difficile positive within 90 d before day 1*</td>
<td>5 (3.8)</td>
<td>10 (6.2)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Antibiotic days within 90 d before day 1, median (IQR)*</td>
<td>16 (7-32)</td>
<td>8 (4-18)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Other diarrheal or gastrointestinal inflammatory process, No. (%)</td>
<td>8 (6.1)</td>
<td>161 (14.3)</td>
<td>.02</td>
</tr>
<tr>
<td>Metronidazole or oral vancomycin within 48 h before day 1, No. (%)</td>
<td>3 (2.3)</td>
<td>184 (16.4)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>WBC count ≥15 000 cells/µl on day 1 ± 1 d, No./total No. tested (%)</td>
<td>54/129 (41.9)</td>
<td>323/1101 (29.3)</td>
<td>.01</td>
</tr>
<tr>
<td>WBC count &lt;4000 cells/µl on day 1 ± 1 d, No./total No. tested (%)</td>
<td>20/129 (15.5)</td>
<td>200/1101 (18.2)</td>
<td>.52</td>
</tr>
</tbody>
</table>

Overdiagnosis of Clostridium difficile Infection in the Molecular Test Era

Polage C et al. JAMA Intern Med. 2015 Nov;175(11):1792
Disruption of the Human Microbiome by Antibiotics can have Long Lasting Effect

- Antibiotics lead to short term and long term changes in the quantity and composition of the human microbiome.

Top 5 Ribotypes Among Healthcare Associated CDI

2012: 027, 0106, 014, 002, 020
2013: 027, 0106, 014, 002, 020
2014: 027, 0106, 014, 002, 020
2015: 027, 0106, 014, 002, 020

Courtesy: Dr. Maria Karlsson, EIP sites
Summary of Core Elements of Hospital Antibiotic Stewardship Programs

- Action:
  - Implementing recommended actions (e.g. “antibiotic time out” after 48 hours)

- Tracking:
  - Monitoring antibiotic prescribing and resistance patterns

- Reporting:
  - Regular reporting information on antibiotic use and resistance to doctors, nurses and relevant staff

- Education:
  - Educating clinicians about resistance and optimal prescribing

https://www.cdc.gov/antibiotic-use/healthcare/implementation/core-elements.html
Summary of Core Elements of Hospital Antibiotic Stewardship Programs

- **Leadership Commitment:**
  - Dedicating necessary human, financial and information technology resources

- **Accountability:**
  - Appointing a single leader responsible for program outcomes. Experience with successful programs show that a physician leader is effective

- **Drug Expertise:**
  - Appointing a single pharmacist leader responsible for working to improve antibiotic use.

[https://www.cdc.gov/antibiotic-use/healthcare/implementation/core-elements.html](https://www.cdc.gov/antibiotic-use/healthcare/implementation/core-elements.html)
- TAP Reports
- Uses NHSN data to identify facilities and locations with excess infections
- Translates a target SIR into a numeric HAI prevention goal, providing a concrete goal to drive action
TAP Facility Assessment Tools

- Capture prevention policy and practice awareness/perception among facility and healthcare personnel
- Should be administered to a variety of staff and healthcare personnel
  - Frontline providers
  - Mid-level staff
  - Facility’s senior leadership
- Collection of multiple assessments is recommended for interpreting results

https://www.cdc.gov/hai/prevent/tap.html