

Antimicrobial Stewardship and the Role of the Infection Preventionist

Zach Willis, MD, MPH
4/28/26

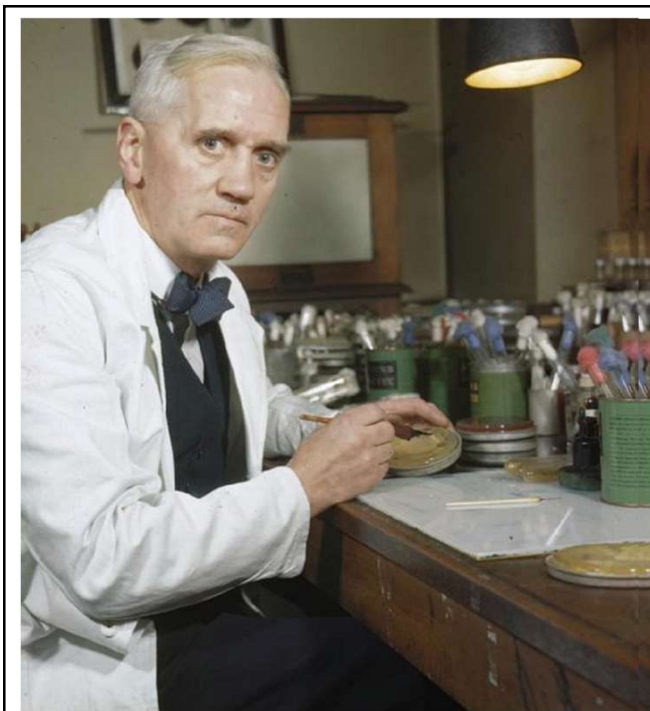


Disclosures

I have the following financial relationships with the manufacturer(s) and/or provider(s) of commercial services discussed in this activity:

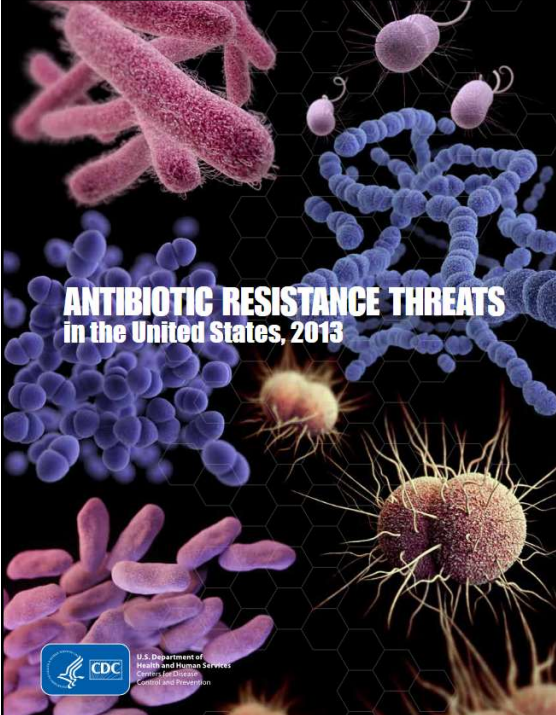
- Contracted research with:
 - Merck (monoclonal antibody for RSV prevention)
- Consultation for:
 - Scanogen, Inc. (microbiology diagnostics company)

I do not intend to discuss an unapproved/investigative use of a commercial product/device in my presentation.




The microbes are educated to resist penicillin and a host of penicillin-fast organisms is bred out.... In such cases the **thoughtless person playing with penicillin is morally responsible for the death of the man who finally succumbs to infection with the penicillin-resistant organism.**



Sir Alexander Fleming,
6/14/1945, *New York Times*



ANTIBIOTIC RESISTANCE THREATS
in the United States, 2013



 U.S. Department of Health and Human Services
Centers for Disease Control and Prevention

Estimated minimum number of illnesses and deaths caused by antibiotic resistance*:

At least  **2,049,442** illnesses,
 **23,000** deaths

**bacteria and fungus included in this report*

Estimated minimum number of illnesses and death due to *Clostridium difficile* (*C. difficile*), a unique bacterial infection that, although not significantly resistant to the drugs used to treat it, is directly related to antibiotic use and resistance:

At least  **250,000** illnesses,
 **14,000** deaths

<https://www.cdc.gov/drugresistance/pdf/ar-threats-2013-508.pdf>

**CDC's 2019 AR Threats Report:
PREVENTION WORKS.**

↓ 18% fewer deaths from antibiotic resistance overall since 2013 report	↓ 28% fewer deaths from antibiotic resistance in hospitals since 2013 report
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AND DECREASES IN INFECTIONS CAUSED BY:

↓ 41% Vancomycin-resistant <i>Enterococcus</i>	↓ 33% Carbapenem-resistant <i>Acinetobacter</i>
↓ 29% Multidrug-resistant <i>Pseudomonas aeruginosa</i>	↓ 25% Drug-resistant <i>Candida</i>
↓ 21% Methicillin-resistant <i>Staphylococcus aureus</i> (MRSA)	STABLE Carbapenem-resistant Enterobacteriaceae (CRE) & drug-resistant tuberculosis (TB disease cases)

<https://www.cdc.gov/drugresistance/pdf/threats-report/2019-ar-threats-report-508.pdf>

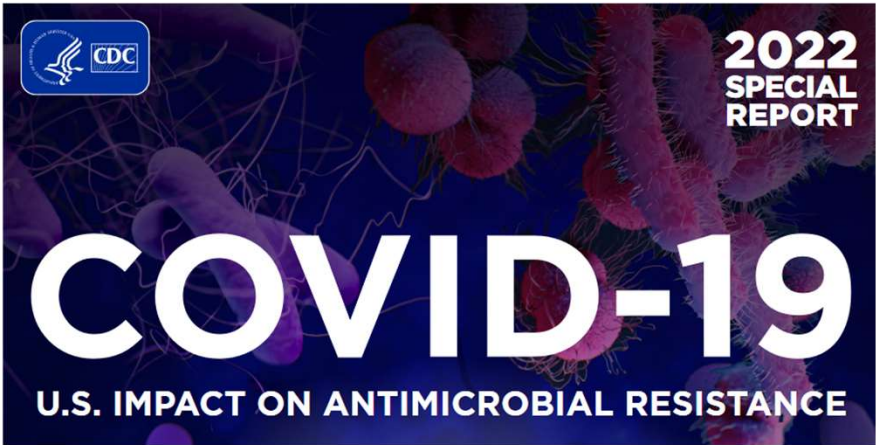
What Was Working?



1. Infection Prevention

- Known MDRO infections:
 - Screening, isolation
 - Information sharing between facilities
 - Surveillance
- Reduction in Hospital-Acquired Infections
 - CLABSI, VAP, CAUTI

2. Antimicrobial Stewardship

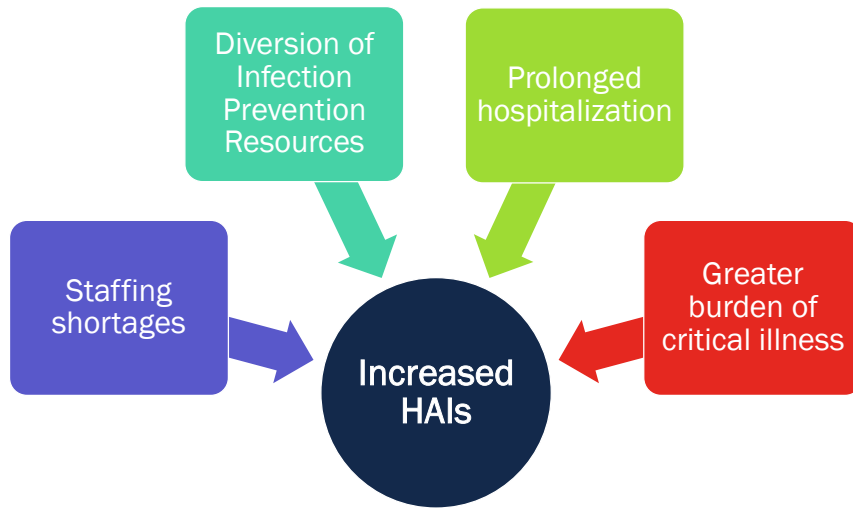


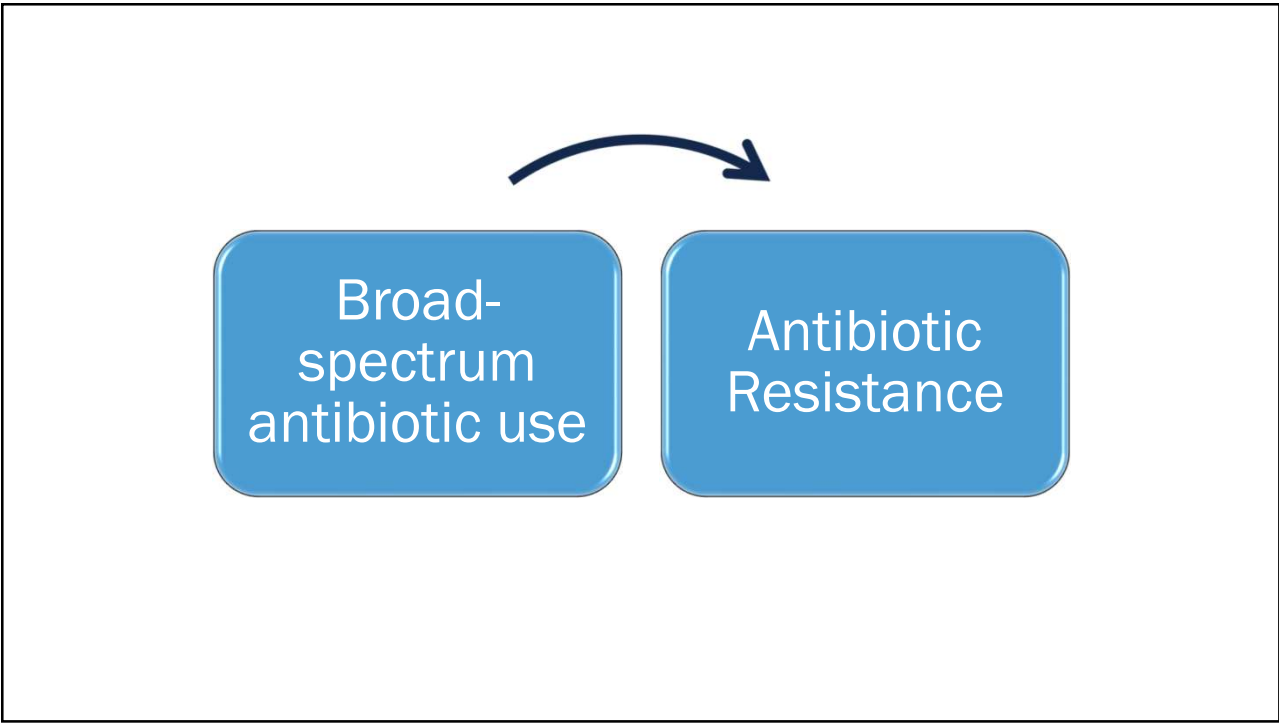
<https://www.cdc.gov/drugresistance/pdf/covid19-impact-report-508.pdf>

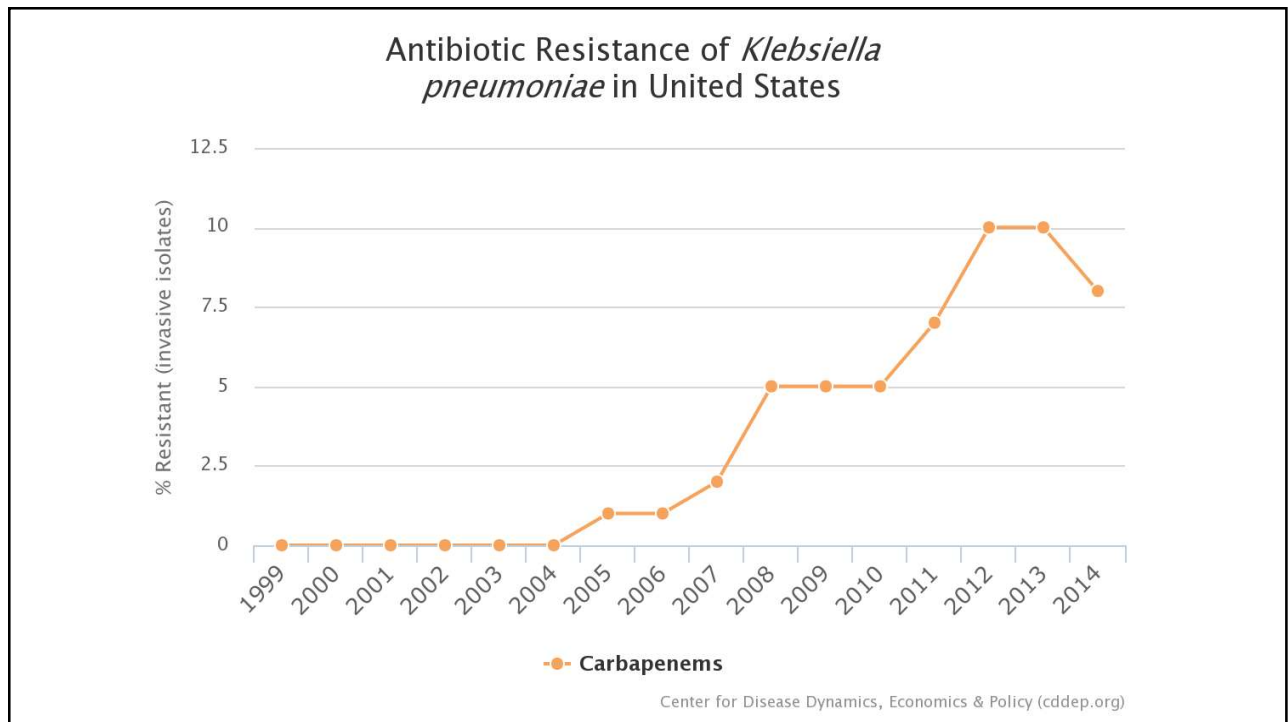
⚠ Available data show an alarming increase in resistant infections starting during hospitalization, growing at least 15% from 2019 to 2020.

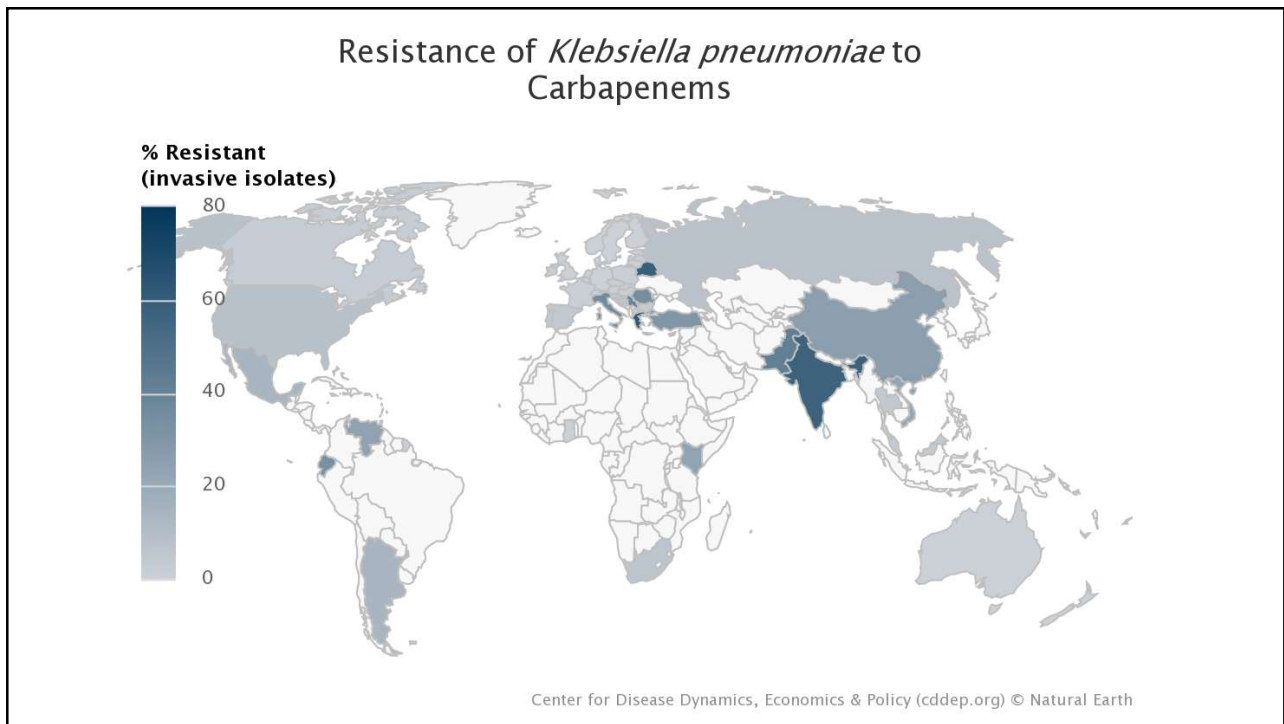
- Carbapenem-resistant *Acinetobacter* (+78%)
- Antifungal-resistant *Candida auris* (+60%)*
- Carbapenem-resistant Enterobacterales (+35%)
- Antifungal-resistant *Candida* (+26%)
- ESBL-producing Enterobacterales (+32%)
- Vancomycin-resistant Enterococcus (+14%)
- Multidrug-resistant *P. aeruginosa* (+32%)
- Methicillin-resistant *Staphylococcus aureus* (+13%)

Why Did Antimicrobial Resistance Get Worse in the Pandemic?









IP and AS Goal

Prevent antimicrobial resistant infections and C-diff

[Antibiotic Resistance Threats in the United States, 2019 \(cdc.gov\)](#)

Slide courtesy of Emily Sickbert-Bennett, PhD

CDC strategies that work in healthcare:

-  Preventing device- and procedure-related infections, such as from urinary catheters or central lines
-  Stopping the spread of resistant germs within and between healthcare facilities
-  Containing emerging threats through early detection and aggressive response
-  Tracking and improving appropriate antibiotic use
-  Infection prevention and control in non-hospital settings, such as long-term care facilities

AS: Core Elements



Core Elements of Hospital Antibiotic Stewardship Programs



Hospital Leadership Commitment
Dedicate necessary human, financial, and information technology resources.



Accountability
Appoint a leader or co-leaders, such as a physician and pharmacist, responsible for program management and outcomes.



Pharmacy Expertise (previously "Drug Expertise"):
Appoint a pharmacist, ideally as the co-leader of the stewardship program, to help lead implementation efforts to improve antibiotic use.



Action
Implement interventions, such as prospective audit and feedback or preauthorization, to improve antibiotic use.



Tracking
Monitor antibiotic prescribing, impact of interventions, and other important outcomes, like *C. difficile* infections and resistance patterns.



Reporting
Regularly report information on antibiotic use and resistance to prescribers, pharmacists, nurses, and hospital leadership.



Education
Educate prescribers, pharmacists, nurses, and patients about adverse reactions from antibiotics, antibiotic resistance, and optimal prescribing.

4 of 7 have
direct link to IP

<https://www.cdc.gov/antibiotic-use/healthcare/pdfs/hospital-core-elements-H.pdf>

Slide courtesy of Emily Sickbert-Bennett, PhD

AS/IP Strategy Alignment



- MDRO epidemiology
- *C. difficile* prevention
- Diagnostic stewardship
 - CLABSI
 - HAP and VAP
 - CAUTI
 - *C. difficile*

Stewardship: A Multidisciplinary Endeavor



Essential,
"Core-Team"
Personnel

- Physician (usually ID)
- Lead Pharmacist (usually ID)
- Clinical Microbiologist
- Infection Preventionist
- Information Technologist

Core AS Strategies



Restriction (“prior authorization”)

Requires expert approval before drug is dispensed (or to continue past 48-72 hours)



Prospective audit and feedback

Monitoring positive cultures, targeted antibiotics



Guideline Development

Implement evidence-based practices in diagnosis and management of infections



Quality Improvement

Continuous improvement to reduce variance and unnecessary care



Provider Education

Additional ASP Tactics

- 48-hour antibiotic time-outs
- Handshake stewardship
 - ASP rounds
- Patient education
- Antimicrobial formulary management
- Medication use evaluations (MUE) and targeted education



ASP: Tracking Data



- Antibiotic use in days of therapy/1000 patient-days (DOT/1000)
 - Can look at individual antibiotics, groups of antibiotics
 - Hospital-wide, specific units, groups of units...
- NHSN Antimicrobial Use (AU data)
 - Adds: reasonable(ish) antibiotic groupings
 - Benchmarks with similar(ish) units at other hospitals
 - SAAR \approx SIR
- Major limitation:
 - Don't know if the patient *should* be on antibiotics
 - Don't know if the antibiotic choices were optimal

IP vs AS



	Infection Prevention	Antimicrobial Stewardship
#1 audience	Bedside staff esp. nursing	Ordering providers and pharmacists

Case



A surgical ICU has noticed an increase in the incidence of HA-CDI over the past six months, from 5 cases in the prior 4 quarters to 7 in the past 2 quarters. They have had no significant changes in staffing or patient population. What should they look at first?

- Adherence to isolation precautions
- Post-operative antibiotic prophylaxis
- Post-discharge deep cleaning
- Empiric antibiotic selection
- Handwashing practices

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CDI Prevention

C-diff Prevention



IP	Both	ASP
<ul style="list-style-type: none">• Handwashing• Surveillance• Isolation• Unit layout• Deep cleaning	<ul style="list-style-type: none">• Diagnostic Stewardship!	<ul style="list-style-type: none">• Avoid highest-risk CDI antibiotics• Minimize antibiotic durations• Prevent unnecessary antibiotic initiation

C-diff: Don't blame me!

nature medicine



Article

<https://doi.org/10.1038/s41591-023-02549-4>

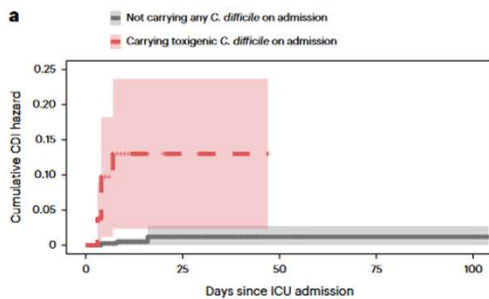
Longitudinal genomic surveillance of carriage and transmission of *Clostridioides difficile* in an intensive care unit

Received: 2 August 2022

Arianna Miles-Jay¹, Evan S. Sritikin^{1,2}, Michael Y. Lin², Teppet Shimasaki¹, Michael Schoeny¹, Christine Fukuda², Thelma Dangana², Nicholas Moore¹, Sarah E. Sansom¹, Rachel D. Yelin¹, Pamela Bell¹, Krishna Rao², Micah Keidan², Alexandra Standke², Christine Bassis², Mary K. Hayden² & Vincent B. Young^{1,2}

Accepted: 17 August 2023

Published online: 18 September 2023



- Cultured almost 4,000 stools and rectal swabs from 1,289 ICU admissions
- Only 1% of eligible patients had acquisition of toxigenic *C. difficile* via cross-transmission
- Colonized with toxigenic *C. difficile* on admission: **24x** greater risk of CDI

Impact of AS programs on *C.difficile*

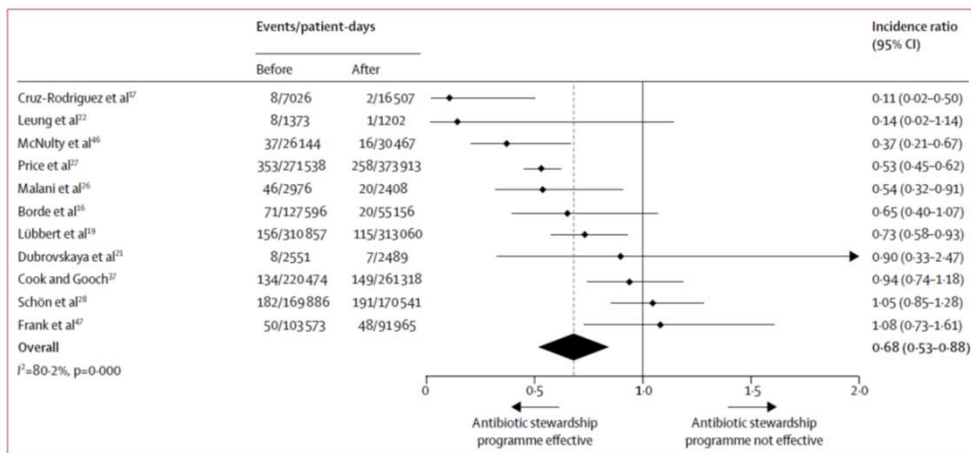


Figure 4: Forest plot of the incidence ratios for studies of the effect of antibiotic stewardship on the incidence of *Clostridium difficile* infections

Baur, Gladstone, Burkert, et al. *Lancet Infectious Diseases*; 17:9:990-1001, 2017

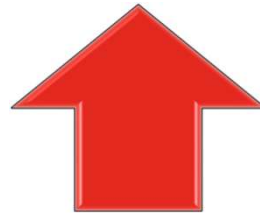
J Antimicrob Chemother 2021; 76: 1676–1688
doi:10.1093/jac/dkab091 Advance Access publication 31 March 2021

Journal of
Antimicrobial
Chemotherapy

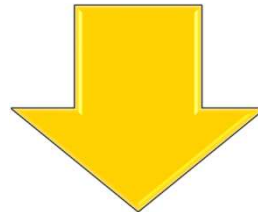
**Antibiotics and healthcare facility-associated *Clostridioides difficile*
infection: systematic review and meta-analysis 2020 update**

Claudia Slimings^{1*} and Thomas V. Riley^{2,3}

Which
antibiotics are
most likely to
cause CDI?



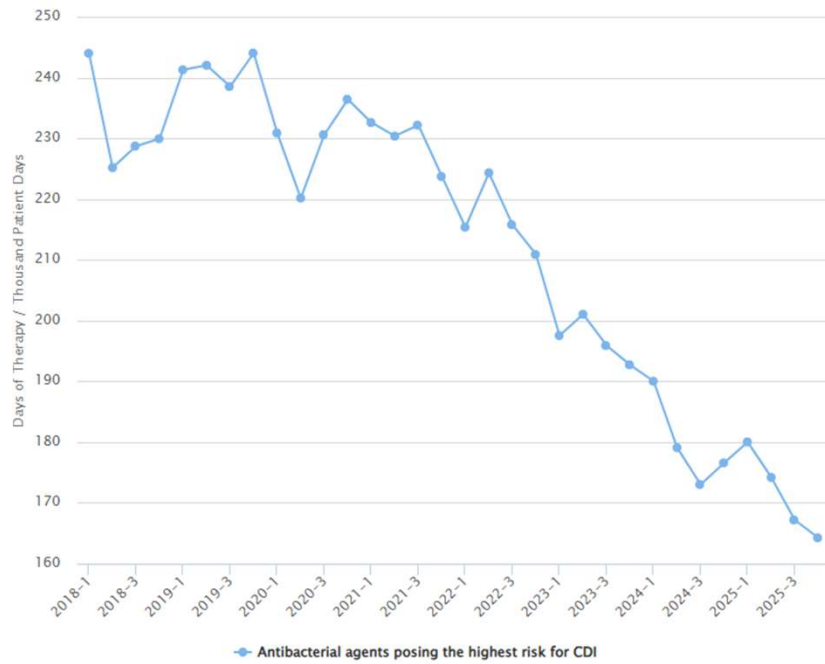
Carbapenems
3rd- and 4th-gen cephalosporins
Vancomycin
Fluoroquinolones
Clindamycin
Piperacillin-tazobactam



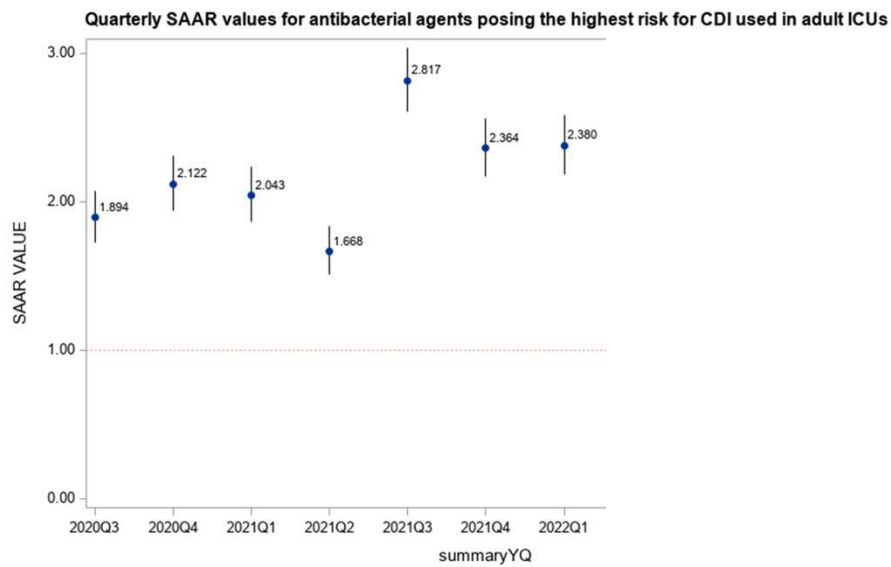
Narrow penicillins
1st-gen cephalosporins
TMP-SMX
Tetracyclines

Antibiotics with High Risk of CDI

UNC Medical Center



Antibiotics with high risk for CDI in SICU



Diagnostic Stewardship: Why?



- Most infectious diseases diagnostics have imperfect specificity and positive predictive value
 - Patients can have C-diff colonization, urinary tract colonization, ET tube or trach colonization, Group A Strep colonization, CVC colonization...
- False-positives:
 - Mask the patient's true problem
 - Cause unnecessary antibiotic exposure
 - Overcount HAIs
- Very difficult for clinicians to ignore a positive culture
- Not the goal: missing HAIs, saving money

Diagnostic Stewardship Principles



- Perform infectious diseases diagnostic testing *appropriately*
 - Examples:
 - Adequate blood culture volumes sent from fresh peripheral sticks
 - Reject formed stools sent for C-diff testing
- Only send testing when infection reasonably suspected
 - Avoid false-positives
 - Especially nonsterile sites (respiratory tract, urinary tract, wounds)

Diagnostic Stewardship Partnership between IP and AS

Complementary skill sets:

- IP: expertise in bedside/nursing care and QI
- AS: experience working with/educating ordering providers

Shared goals:

- Overdiagnosis of HAI
→ overuse of antibiotics

Diagnostic Stewardship Stakeholders



Frontline staff

Obtain most samples for testing
Often suggest testing to providers



Microbiology lab

Assess sample adequacy
(e.g., rejecting formed stools)
Reporting algorithms



Ordering providers and
pharmacists

Order diagnostic tests and make
treatment decisions

***C. difficile* Diagnostic Stewardship**



Problem

- *C. difficile* colonization is common
 - Nontoxigenic strains
 - Toxigenic strains not causing symptoms
- Diarrhea is common in the hospital
 - Laxatives, enteral feeds, withdrawal symptoms, most drugs, etc...

Strategies

- Use high-specificity test algorithms
 - Avoid PCR-only CDI testing
- Avoid *C. difficile* testing if:
 - Not true diarrhea (<3 episodes/24 hours, formed stool)
 - Recent laxative exposure
 - Recent negative test

QUALITY IMPROVEMENT
C. difficile test ordering:
“hard stop”

⚠ You cannot sign these orders because information is missing or requires your attention:

C. Diff testing is not currently indicated for this patient. If after review of the C Diff ordering guidelines, you still need to place the order, contact your designated approval point person and document the name and the date of contact in the C Diff order

Slide courtesy of
 Emily Sickbert-Bennett, PhD

ASP Role in CDI Diagnostic Stewardship



- Hard stop design
- Provider education
- Clinical review of C-diff tests that violated hard stop
 - Physicians and pharmacists on staff already doing clinical reviews daily
 - Approvals when clinically indicated



**Lower Respiratory
Cultures**

HAP/VAP Diagnostic Stewardship



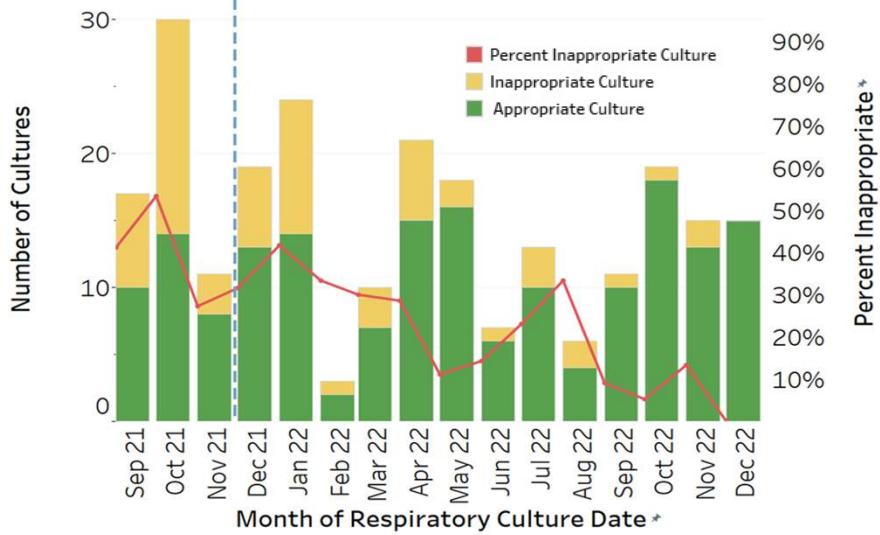
- Surveillance definition \neq Clinical definition
- Respiratory cultures from airway devices have very poor specificity and PPV
- False-positive cultures \rightarrow treatment courses
 - Often repetitively in one patient
 - Usually broad-spectrum

Diagnostic Stewardship Project



- Education provided to PICU before launch
- Audited every respiratory culture sent from patients in PICU
 - 9/1/21-12/31/22 (15 months)
 - 3 months pre- and 12 months post-intervention.
 - Cultures assessed as guideline-concordant or -discordant
 - Systemic signs of illness (fever, leukocytosis, etc) PLUS respiratory symptoms (persistently increased PEEP/FiO2, CXR changes, purulent ETT output)
- Periodic feedback to PICU providers

Proportion of Respiratory Cultures that were Guideline-Concordant

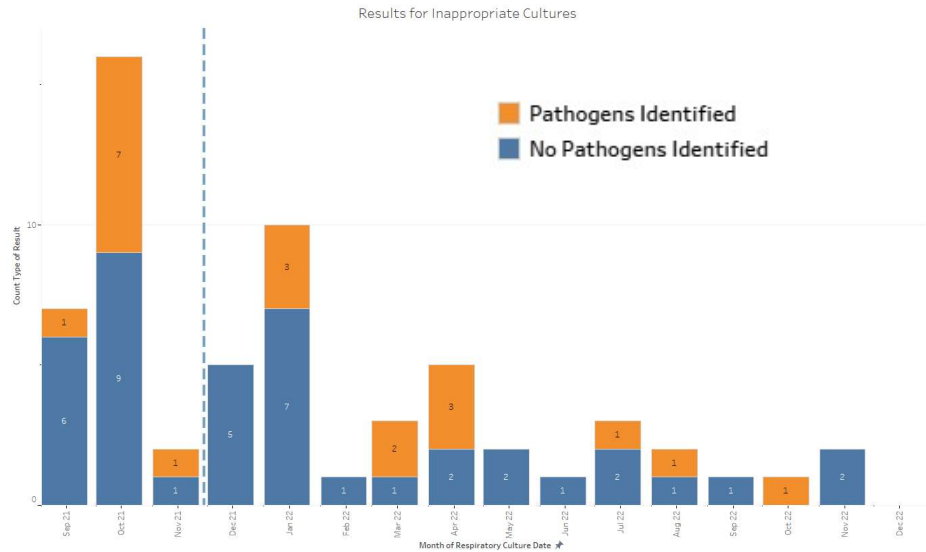


Results of Guideline-Discordant Cultures



Orange:
cultures
that grew
pathogens

Blue:
cultures
that did not
grow

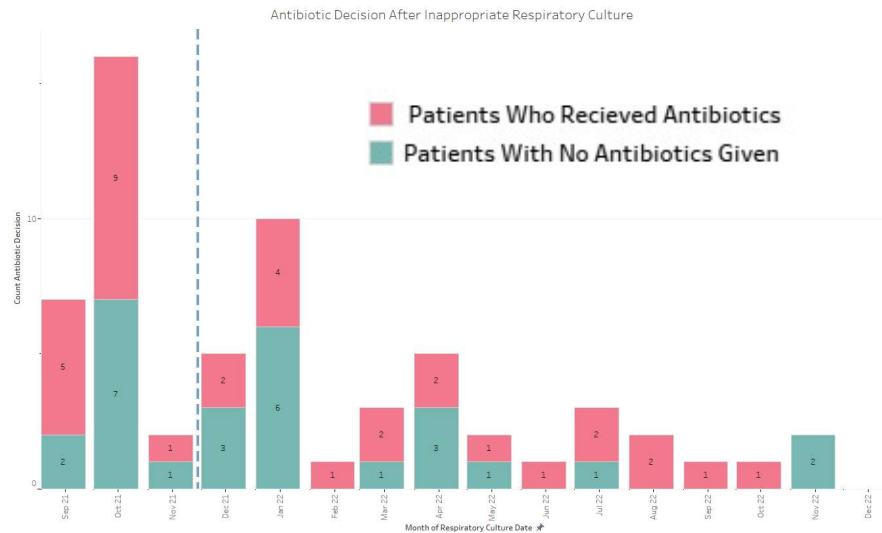


The plot of count of Combined Type of Reso Culture Result (copy 2) for Respiratory Culture Date Month. Color shows details about Combined Inappropriate Type of Reso Culture Result (copy). The marks are labeled by count of Combined Type of Reso Culture Result (copy 2). The data is Filtered on Location, which keeps PICU and PICU. The view is Filtered on Combined Inappropriate Type of Reso Culture Result (copy), which excludes Null.

Guideline-Discordant Cultures Treated with Antibiotics



Salmon: Number of guideline-discordant cultures treated with antibiotics



The plot of count of Were Antibiotics Given For Patients With Inappropriate Cultures? for Respiratory Culture Date Month. Color shows details about Were Antibiotics Given For Patients With Inappropriate Cultures?. The marks are labeled by count of Were Antibiotics Given For Patients With Inappropriate Cultures?. The data is filtered on Location, which keeps PCICU and PICU. The view is filtered on Were Antibiotics Given For Patients With Inappropriate Cultures?, which excludes Null.



**UTI Diagnostic
Stewardship**

UTI Diagnostic Stewardship



- Asymptomatic bacteriuria is common
 - Older adults
 - Patients with indwelling catheters
- Overdiagnosis leads to:
 - Missed diagnoses
 - Antibiotic exposure (often repeatedly)
 - False-positive CAUTIs

CAUTI Diagnosis Pitfalls



- Pyuria and asymptomatic bacteriuria are very common with long-dwelling urinary catheters
 - You can have ASB with or without pyuria, and pyuria may be sterile
 - You can NOT have a UTI without pyuria
 - Exception: neutropenia
- UTIs are symptomatic, but ICU patients often unable to report symptoms
- Always get a UA BEFORE or at least with the urine culture
 - Use fresh catheter for culture whenever possible
- “Pan-culture” for febrile patients with an ETT and a Foley is likely to turn up a positive culture
 - Avoid this approach

Protocolized Urine Sampling is Associated with Reduced Catheter-associated Urinary Tract Infections: A Pre- and Postintervention Study

Jennifer A. Frontera,^{1,6} Erwin Wang,² Michael Phillips,² Martha Radford,² Stephanie Sterling,² Karen Delorenzo,³ Archana Saxena,² Shadi Yaghi,¹ Ting Zhou,¹ D. Ethan Kahn,¹ Aaron S. Lord,¹ and Joseph Weisstuch²

- Intervention:
 - Catheter removal required before sending urinary testing
 - Urine culture sent only after UA
- Urinary catheter days reduced by 37%
- 63% reduction in CAUTI
 - 5.9 → 2.2 CAUTI/1000 catheter days

Clinical Infectious Diseases, 2020



Blood Culture Diagnostic Stewardship

Blood Culture Diagnostic Stewardship



JAMA Pediatrics | [Original Investigation](#)

Association of Diagnostic Stewardship for Blood Cultures in Critically Ill Children With Culture Rates, Antibiotic Use, and Patient Outcomes Results of the Bright STAR Collaborative

Charlotte Z. Woods-Hill, MD, MSHP; Elizabeth A. Colantuoni, PhD; Danielle W. Koontz, MA, MS;
Annie Voskertchian, MPH; Anping Xie, PhD; Cary Thurm, PhD; Marlene R. Miller, MD, MSc; James C. Fackler, MD;
Aaron M. Milstone, MD, MHS; and the Bright STAR Authorship Group

- Can we steward *blood cultures*? Should we?
- Logic: Fever → blood cultures → empiric antibiotics
- Would *CLABSIs go down??* Would septic shock go up?

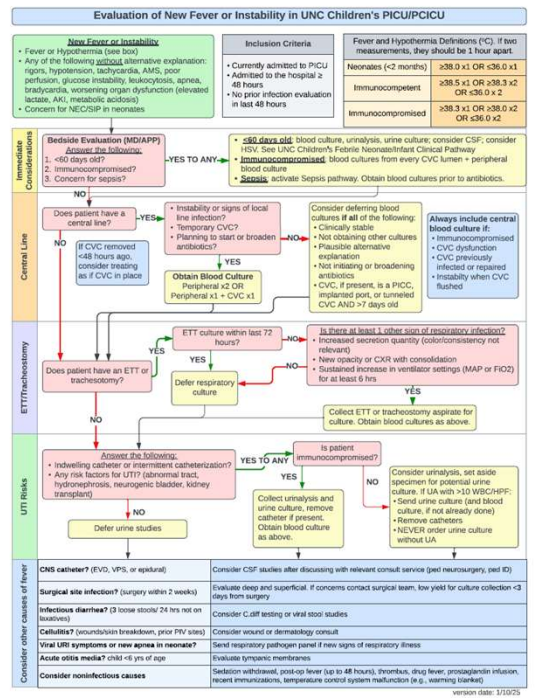
Blood Culture Diagnostic Stewardship



- 14 PICUs independently developed blood culture best practices
 - Reduce variability in blood culture decision, source, frequency of repeats
 - Studied 24 months pre- and 18 months post-implementation
- Results:
 - Blood cultures fell 33% (49 blood cultures/1000 patient-days fewer)
 - Broad-spectrum antibiotics use fell 13%
 - Unchanged: PICU mortality, LOS, readmission, sepsis, severe sepsis
 - **CLABSIs fell 36%** (1.79 → 1.14 CLABSI/1000 line-days)

Unified ICU Diagnostic Stewardship

- No more automatic “pan-culture”!
- Fever is common in the ICU and has many non-infectious causes
- Poor specificity of cultures (frequent false-positives)
- Considered approach to cultures
 - Illness severity
 - Pre-test probability



Asymptomatic bacteriuria



DO I REALLY NEED TO TREAT MY PATIENT FOR A UTI?

TREATING ASYMPTOMATIC BACTERIURIA HAS NO BENEFITS AND CAUSES HARM.

IN FACT, IT LEADS TO AN INCREASE IN...

- Healthcare costs
- Length of stay
- C. diff infections
- Antibiotic resistance
- Misclassification of CAUTI

MY PATIENT IS SICK AND I SUSPECT A UTI. SHOULD I TEST?

UA is only helpful for predicting UTI among patients with appropriate urinary symptoms.

No UA Needed	Send UA
<ul style="list-style-type: none"> Odor Color Altered mental status alone Fever or leukocytosis without urinary symptoms 	<ul style="list-style-type: none"> Frequency Burning Pain

WHAT IS THE BEST WAY TO TEST?

- Order a UA if symptomatic
- Interpret UA
- Order urine culture only if UA+
- Treat based on culture results

Learn more at <https://www.medicalevidence.com/unc-healthcare-urgency/Epidemiology/Pages/CAUTI-Prevention-Infobox.aspx>

Adult UTI Guideline Update

4 New Algorithms

- Diagnosis
- Altered Mental Status
- Treatment
- Urine Culture Interpretation

Reserve UTI diagnostic workup for those with UTI symptoms:

- Painful urination
- New or worsening urinary frequency or urgency
- Suprapubic pain
- Flank pain or tenderness

Inappropriate urine cultures pose harm to patients:

- Unnecessary antibiotics
- Misdiagnosis

Bladder Infection or Cystitis

UNC 1st line options:

- Nitrofurantoin
- Bactrim (SMX-TMP)

! Ciprofloxacin does NOT cover 1 in 3 E. coli isolates at UNCMC

Pyelonephritis

UNC 1st line empiric options:

- Ceftriaxone
- Gentamicin

Target therapy to cultures & use shortest effective duration

Case



The neonatal ICU has had three CLABSIs in the past four months with a similar pattern. The infections have occurred during the time period of days of life 3-7. The infants have all had umbilical venous catheters; all had had negative blood cultures at birth and received 48 hours of empiric antibiotics.

A NICU clinician notes that at their previous employer, it was common to continue the birth antibiotics until day of life 7, regardless of birth culture results.

AS/IP: Are we ever at odds?



- Head in the sand approaches
 - No culture → No HAI!
- Antibiotic prophylaxis example:
 - Reduced incidence of VAP in neuro ICU patients who received a single dose of ceftriaxone



Can we start today?!

Umm, we need more data, maybe additional trials, then a Cochrane review and an update to IDSA guidelines



Future Directions



- Diagnostic stewardship
 - Only scratched the surface
 - Requires IP/ASP collaboration and *many* stakeholders
- NHSN AR data
 - Now mandatory
 - But not yet useful
 - Hopefully will provide more data about AR patterns.



Questions?

References



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Slimings C, Riley TV. Antibiotics and healthcare facility-associated *Clostridioides difficile* infection: systematic review and meta-analysis 2020 update. *Journal of Antimicrobial Chemotherapy*. 2021 Jul 1;76(7):1676–1688.

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