



Protecting Patients. Combatting Antimicrobial Resistance. An Update from CDC

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My Top Five Messages on Antimicrobial Resistance

- Prevention works- but the gains are fragile
- Yes, antibiotic stewardship is still important
- There's got to be a better way- Innovations to tackle AMR
- We're all in this together
- You get what you pay for- Infrastructure is critical to combating AMR

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

DECREASES IN INFECTIONS CAUSED BY:

↓ 41% Vancomycin-resistant *Enterococcus*

↓ 33% Carbapenem-resistant *Acinetobacter*

↓ 29% Multidrug-resistant *Pseudomonas aeruginosa*

↓ 25% Drug-resistant *Candida*

↓ 21% Methicillin-resistant *Staphylococcus aureus* (MRSA)

STABLE Carbapenem-resistant Enterobacteriaceae (CRE) & drug-resistant tuberculosis (TB disease cases)

Rates of Carbapenem Resistant Enterobacterales: Population Based Surveillance in Seven US States

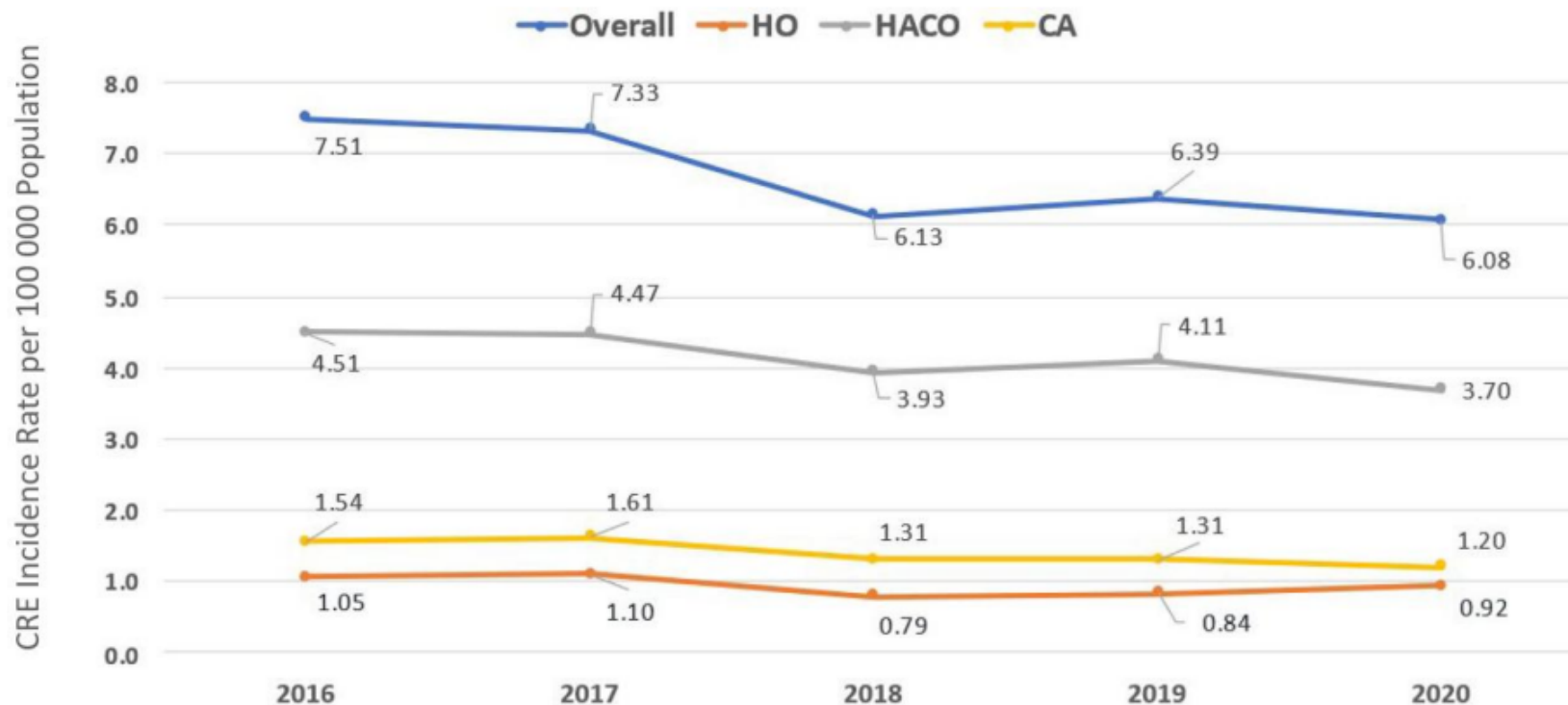


Figure 1. Crude carbapenem-resistant Enterobacterales (CRE) incidence rates, overall and by epidemiologic class, 2016–2020. Abbreviations: CA, community-associated; HACO, healthcare-associated community-onset; HO, hospital-onset.

The Threat of Antibiotic Resistance in the United States



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

New National Estimate*

Antibiotic-resistant bacteria and fungi cause at least an estimated:

 **2,868,700** infections
 **35,900** deaths



Clostridiodes difficile is related to antibiotic use and antibiotic resistance:

 **223,900** cases
 **12,800** deaths

New Threats List

Updated urgent, serious, and concerning threats—totaling 18

5 urgent threats

2 new threats

NEW:
Watch List with **3** threats



Antibiotic resistance remains a significant One Health problem, affecting humans, animals, and the environment.

www.cdc.gov/DrugResistance/Biggest-Threats

Despite these gains, CDC's 2019 AR Threats Report shows additional actions are needed to protect people.

2.8M+ antibiotic-resistant infections each year

35k+ deaths from antibiotic resistance each year

Plus: 223,900 cases and 12,800 deaths from *Clostridioides difficile*

INCREASES IN INFECTIONS CAUSED BY:

↑ **315%**

Erythromycin-resistant invasive group A strep

↑ **124%**

Drug-resistant *Neisseria gonorrhoeae*

↑ **50%**

ESBL-producing Enterobacteriaceae

Pandemic challenges unraveled U.S. progress on AR.

The data:

- ⚠ Alarming increases in resistant infections starting during hospitalization—deaths and infections increasing at least 15% each (2019 to 2020)
- ⚠ After years of steady reductions in healthcare-associated infections (HAIs), U.S. hospitals saw significantly higher rates for four out of six types of HAIs in 2020¹
- ⚠ Acute care hospitals also saw more *Candida auris* cases, including in COVID-19 units²



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

1. Weiner-Lastinger, L.M., et al. (2022). doi:10.1017/ice.2021.362

2. Prestel, C., et al. (2021). doi:10.15585/mmwr.mm7002e3

Yes, Virginia, Antibiotic Stewardship is Still Central to our Efforts to Combat Resistance

- Implications of reducing antibiotic treatment duration for antimicrobial resistance in hospital settings: A modelling study and meta-analysis
- Both the mathematical modelling and meta-analysis suggested modest reductions in resistance carriage could be achieved by reducing antibiotic treatment duration.
- The meta-analysis determined that a single additional antibiotic treatment day is associated with a 7% absolute increase in risk of resistance carriage (80% credible interval 3% to 11%).

Antibiotic Use and Resistance Reporting Are Required Starting in CY 2024

- Beginning in **CY 2024**, Antibiotic Use and Resistance (AUR Module) data are required to be reported to CDC's National Healthcare Safety Network (NHSN) under the Public Health and Clinical Data Exchange Objective of the CMS Promoting Interoperability (PI) Program
- Applies to eligible hospitals and critical access hospitals that participate in the CMS PI Program
- **Measure includes submission of both AU and AR Option data**
- For CY 2024 facilities attest to either:
 - Being in active engagement with NHSN to submit AUR data or,
 - Claim an applicable exclusion

<https://www.cms.gov/regulations-and-guidance/legislation/ehrincentiveprograms>

Comparison is the Thief of Joy And Essential for Antibiotic Stewardship

- The Antibiotic Use option was designed in collaboration with antibiotic stewards to try and address their needs.
- Their top ask: “We need comparative benchmarks”
- Would you explore carbapenem use in an ICU that dropped by 5% last year?
- Would you explore carbapenem use in an ICU that dropped by 5% last year, but that was twice as high as other ICUs?

Perspective

Application of Standardized Antimicrobial Administration Ratio as a Motivational Tool within a Multi-Hospital Healthcare System

Stephanie Shealy ^{1,2,†}, Joseph Kohn ², Emily Yongue ², Casey Troficanto ², P. Brandon Bookstaver ^{1,2}, Julie Ann Justo ^{1,2}, Hana R. Winders ^{1,2}, Sangita Dash ^{3,4} and Majdi N. Al-Hasan ^{3,4,*}

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² Department of Clinical Pharmacy, Prisma Health-Midlands, Columbia, SC 29203, USA; joseph.kohn@prismahealth.org (J.K.); Emily.Yongue@prismahealth.org (E.Y.); Casey.Troficanto@prismahealth.org (C.T.)

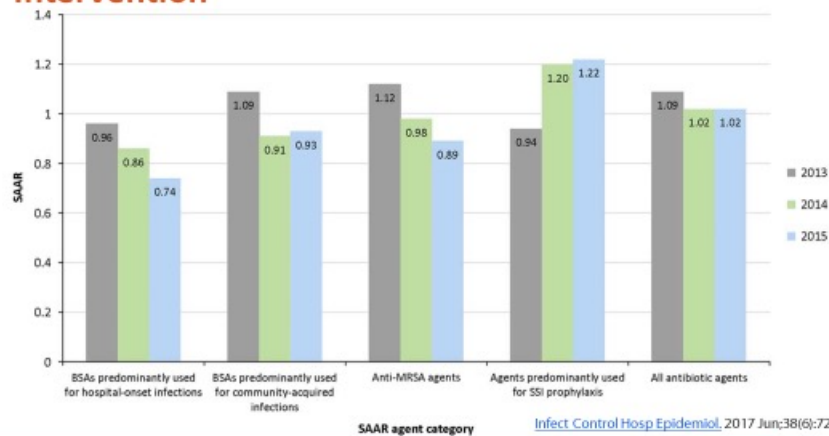
³ Department of Medicine, Division of Infectious Diseases, University of South Carolina School of Medicine, Columbia, SC 29209, USA; Sangita.Dash@uscmed.sc.edu

⁴ Department of Medicine, Division of Infectious Diseases, Prisma Health-Midlands, Columbia, SC 29203, USA

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† Stephanie Shealy is currently employed at Intermountain Healthcare in Salt Lake City, UT 84103, USA.

SAAR Values Before And After A Stewardship Intervention

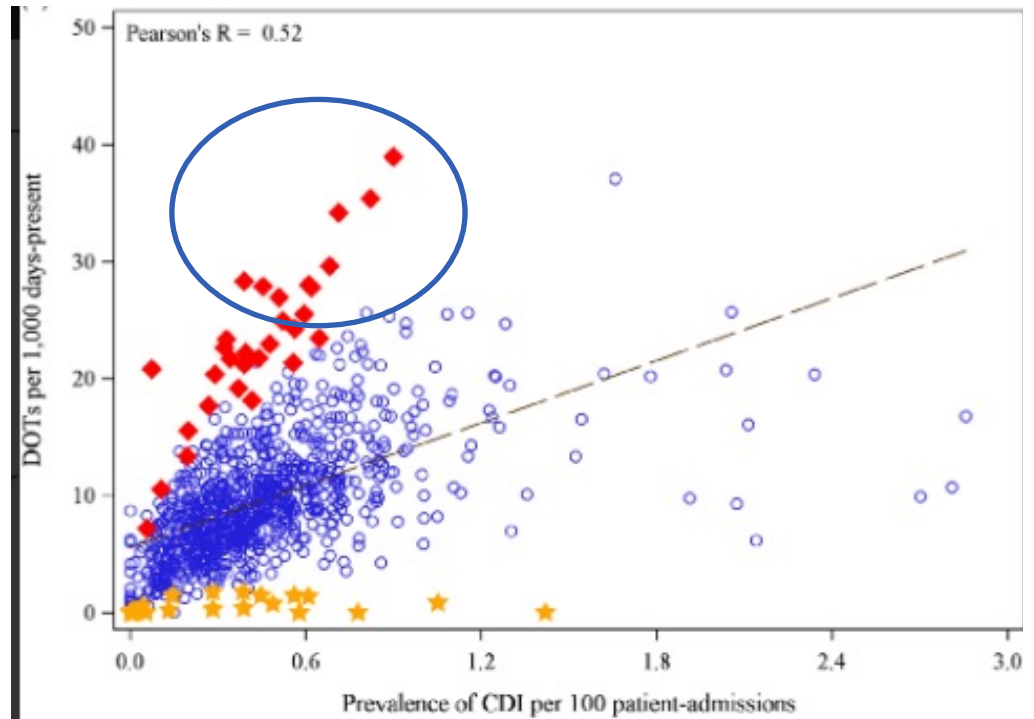


Assessing Correlation of Antibiotic Use and Resistance

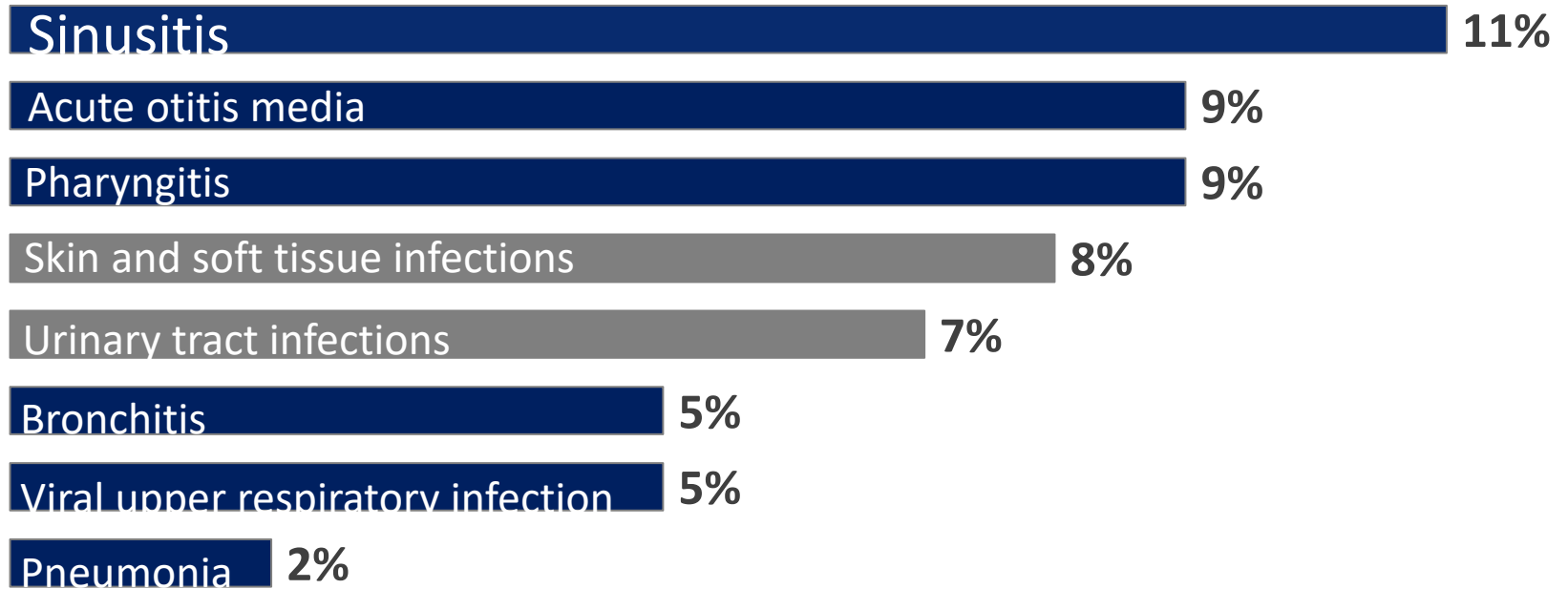
- Correlations between antibiotic use and resistance can be informative for potential opportunities to improve use.
- Are there hospitals where use of some agents is much higher than what we would expect given resistance patterns?
 - E.g. a hospital using a lot of ceftazidime-avibactam, but with very little CRE
- Are there hospitals where use of some agents is much lower than what we would expect given resistance patterns?

Association between prevalence of laboratory-identified *Clostridioides difficile* infection (CDI) and antibiotic treatment for CDI in US acute-care hospitals, 2019

Red diamonds are hospitals with more CDI treatment than predicted

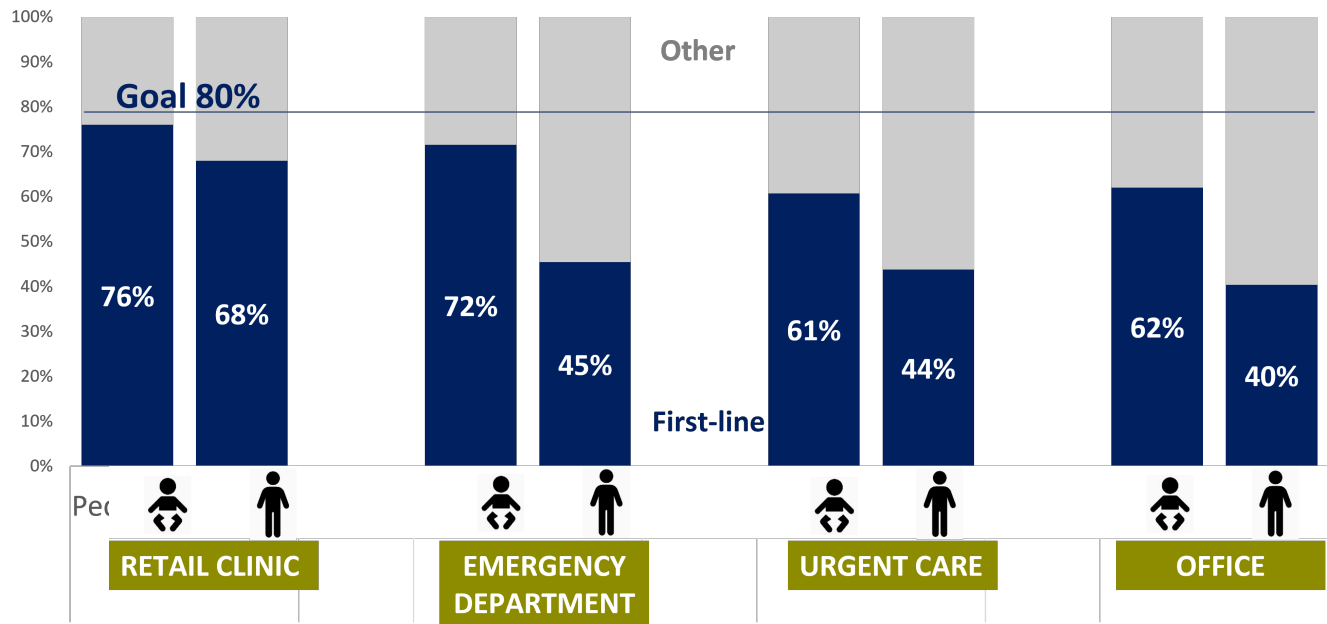


Respiratory infections are major drivers of antibiotic use in outpatient settings.



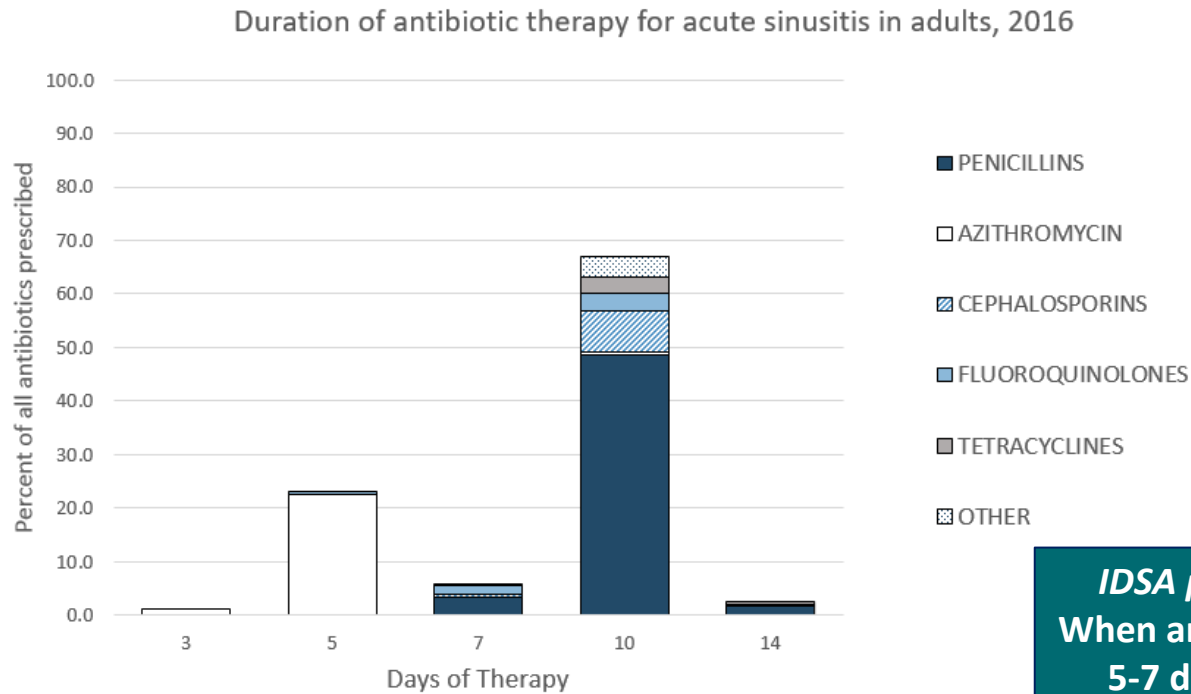
Top diagnoses leading to antibiotic prescriptions in US doctors' offices and emergency departments, 2010-2011

Antibiotic selection can be improved.



First-line antibiotic selection for **pharyngitis, sinusitis, and pediatric acute otitis media** for patients <65 years, MarketScan, 2014

Antibiotics are often prescribed for longer duration than recommended.



IDSA practice guidelines:
When antibiotics are needed,
5-7 days for adults with
uncomplicated acute sinusitis

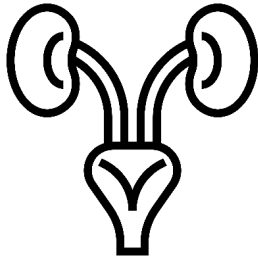
King et al. *JAMA Intern Med*. Published online March 26, 2018.

IDSA clinical practice guideline for acute bacterial rhinosinusitis in children and adults: Chow et al. *Clin Infect Dis*. 2012.

In Long Term Care Facilities Urinary and *Respiratory Infections* were the most common indications.

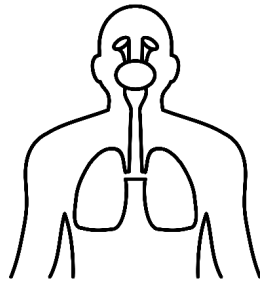
Urinary Infections

31%



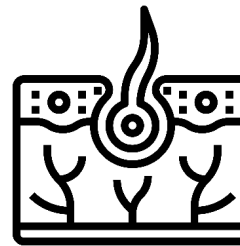
Respiratory Infections

15%



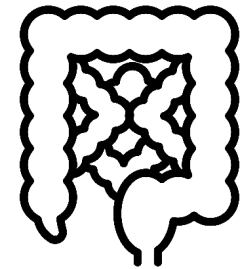
Skin Infections

12%



Gastrointestinal Infections

5%



Median Duration
(days)

8

6

8

10

Top 3 Agents

Nitrofurantoin
Ciprofloxacin
TMP-SMX

Levofloxacin
Azithromycin
Amoxicillin-
Clavulanate

Cephalexin
Doxycycline
TMP-SMX

Vancomycin (oral)
Metronidazole
Rifaximin

Prescriber Feedback in Long-Term Care Facilities

Clinical Infectious Diseases
MAJOR ARTICLE



Population-Wide Peer Comparison Audit and Feedback to Reduce Antibiotic Initiation and Duration in Long-Term Care Facilities with Embedded Randomized Controlled Trial

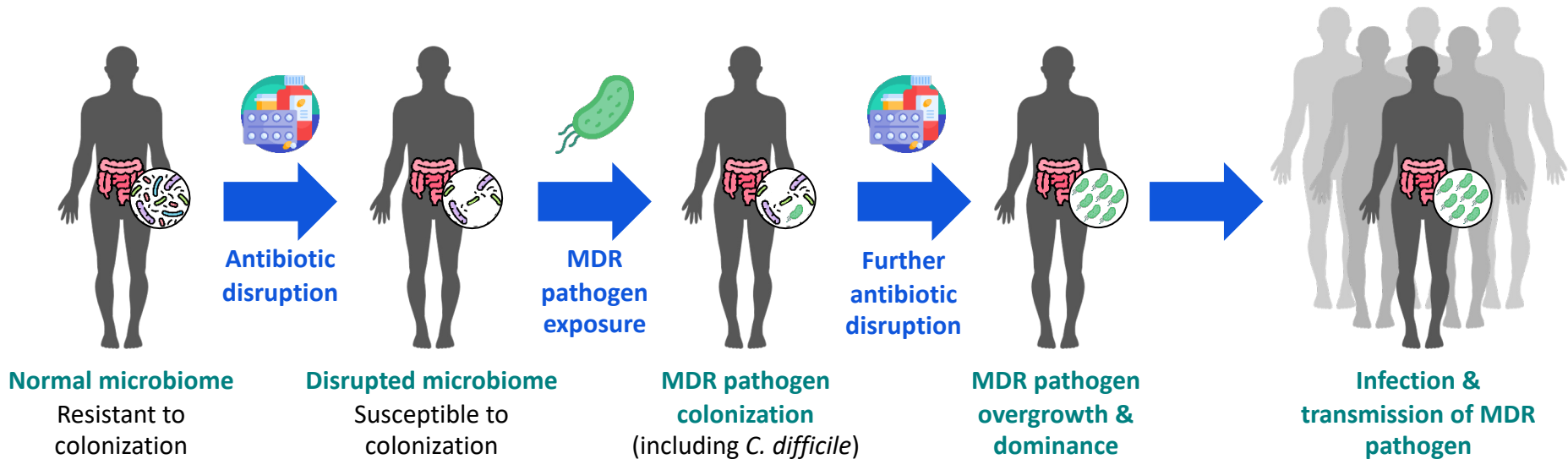
Nick Daneman,^{1,2,3,4,5} Samantha M. Lee,² Haming Bai,⁶ Chaim M. Bell,^{3,4,5,7} Susan E. Bronskill,^{1,2,4,5,8} Michael A. Campitelli,³ Gail Dobell,⁶ Longdi Fu,³ Gary Garber,^{2,9} Noah Ivers,^{3,5,8} Jonathan M.C. Lam,⁸ Bradley J. Langford,² Celia Laur,⁶ Andrew Morris,^{5,7} Cara Mulhall,⁶ Ruxandra Pinto,⁷ Farah E. Saxena,³ Kevin L. Schwartz,^{2,3} and Kevin A. Brown^{2,3}

- Randomized controlled trial in Ontario in 2019 among providers in long-term care facilities
 - 1,238 physicians caring for 96,185 residents included
 - 28% of physicians received audit and feedback, 72% of physicians received no feedback
- Audit and feedback was associated with a significantly greater decline in prolonged antibiotics (adjusted difference -2.65%)
 - Resulted in 335,912 fewer days of treatment, no significant difference in antibiotic initiation
- Peer comparison audit and feedback interventions can generate reductions in antibiotics for prolonged durations, resulting in large reductions in antibiotic days of treatment across populations.

There's Got to be a Better Way...

- Our historic approach to combating antimicrobial resistance has been to treat infections that occur and to try to prevent transmission from the infected person to others.
- There is more and more work on efforts to go “upstream” to prevent the infections with the resistant organisms in the 1st place.
- Fueled by our growing understanding of the microbiome.

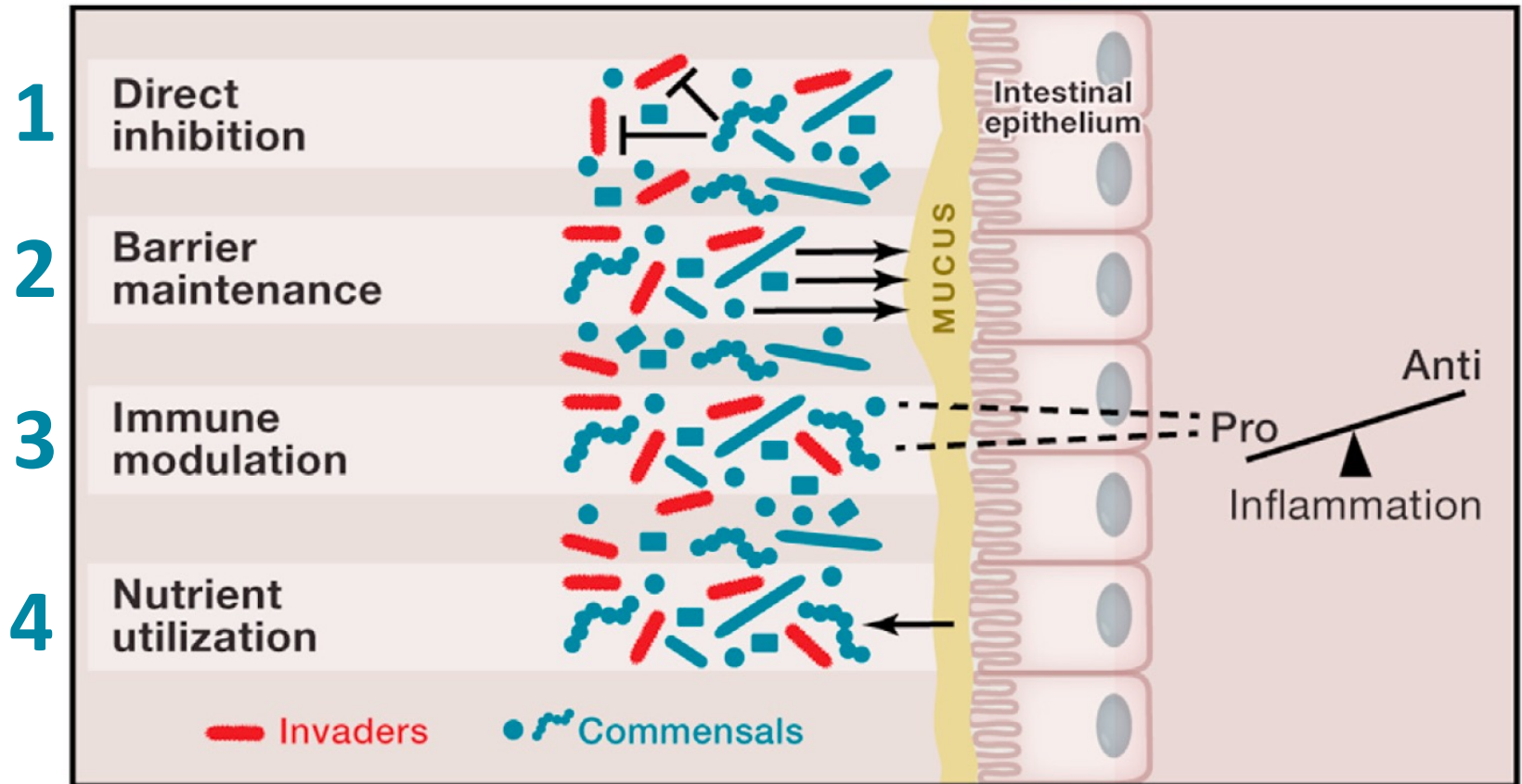
The cascade from antibiotic-mediated microbiome disruption to infection and transmission



MDRO, multidrug-resistant organism.

Conceptual model co-developed by Dr. Alison Laufer-Halpin.

The human microbiome has a central role in colonization resistance through four actions



McKenney PT, Pamer EG. *Cell*. 2015;163:1326-32.

Pathogen abundance and dominance increases the risk of subsequent infection¹⁻⁵

Longitudinal study of 94 patients undergoing allo-HSCT: association of intestinal domination with bacteremia¹

Dominating taxon ^b	VRE bacteremia ^a		Gram-negative bacteremia ^b	
	HR (95% CI)	P value	HR (95% CI)	P value
<i>Enterococcus</i>	9.35 (2.43–45.44)	0.001	1.35 (0.25–5.08)	0.690
Proteobacteria (i.e. Gram-negative bacteria)	0.75 (0.01–6.14)	0.837	5.46 (1.03–19.91)	0.047

^a Bacteremia for each organism was defined as at least one positive blood culture within the study period.

^b Intestinal domination was analyzed as a time-varying predictor.

Allo-HSCT, allogeneic hematopoietic stem cell transplantation; CI, confidence interval; HR, hazard ratio; VRE, vancomycin-resistant enterococci. Table modified from Table 3 in Taur Y, et al. *Clin Infect Dis*. 2012;55(7):905-914.

1. Taur Y, et al. *Clin Infect Dis*. 2012;55(7):905-914. 2. Shimasaki T, et al. *Clin Infect Dis*. 2019;68(12):2053-2059. 3. Perez-Nadales E, et al. *Microbiol Spectr*. 2022;10(4):e0272821. 4. Sun Y, et al. *mSphere*. 2021;6(3):e0050021. 5. Rao K, et al. *mSphere*. 2020;5(4):e00450-20.

Gut colonization with multidrug resistant (MDR) pathogens carries a substantial risk of subsequent MDR infection

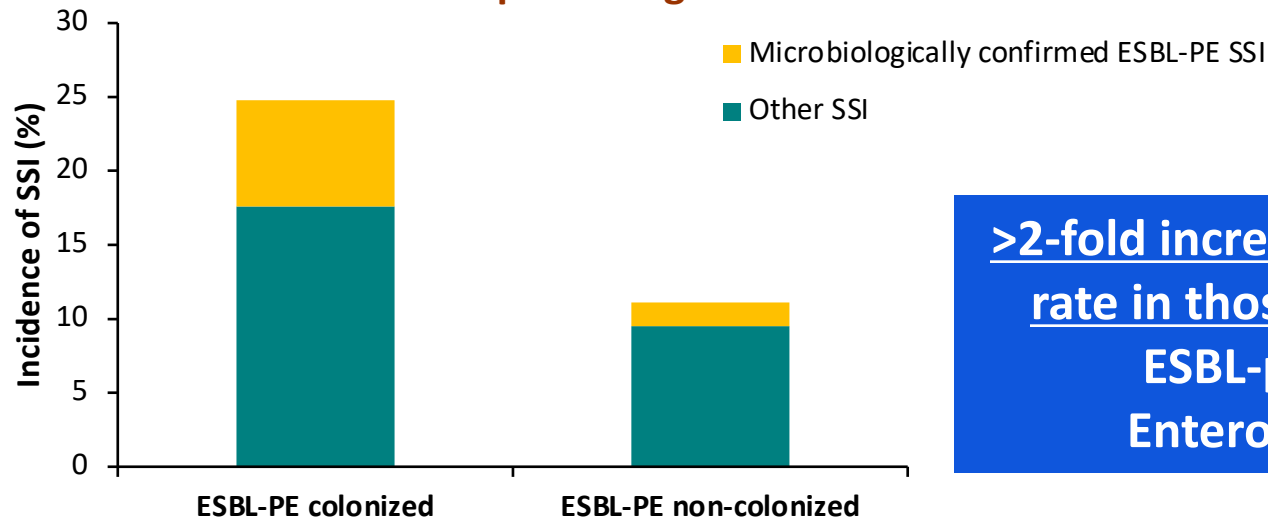
Meta-analysis to estimate risk from colonization on the cumulative incidence of infection

Colonizing pathogen	# of studies	N*	Cumulative incidence	Median follow-up time
MDR-GNB	32	9034	14%	30 days
CRE or CPE	19	4547	19%	30 days
ESBL-E or 3GCR-E	14	4461	8%	30 days
<i>E. coli</i>	7	3098	8%	30 days
<i>K. pneumoniae</i>	4	741	9%	77 days
VRE	16	4747	8%	30 days

3GCR-E, third-generation cephalosporin-resistant Enterobacterales; CPE, carbapenemase-producing Enterobacterales; CRE, carbapenem-resistant Enterobacterales; ESBL-E, extended-spectrum β -lactamase-producing Enterobacterales; MDR-GNB, multidrug-resistant Gram-negative bacteria; VRE, vancomycin-resistant enterococci; N*, number of colonized patients at risk. Willems RPJ, et al. *Lancet Infect Dis.* 2023;23(6):719-731.

Colonization with MDR pathogens increases the all-cause risk of infection

Incidence of surgical site infection (SSI) in after colorectal surgery in patients colonized vs not colonized with ESBL-producing Enterobacterales



>2-fold increase in overall SSI rate in those colonized by ESBL-producing Enterobacterales

ESBL, extended-spectrum β -lactamase; ESBL-PE, ESBL-producing Enterobacterales; MDR, multidrug resistant; SSI, surgical site infection. Dubinsky-Pertsov B, et al. *Clin Infect Dis*. 2019;68(10):1699-1704.

Decolonization Prevents Infection- And Is Commonly Used, Usually Before Procedures

— US and International

- Pre-operative application of nasal mupirocin to prevent *S. aureus* infections following cardiac and orthopedic surgery^{1,2,3}
 - ACS/SIS SSI Guidelines, 2016 Update: Decision about whether to implement screening and decolonization protocols should depend on baseline SSI and MRSA rates.³
 - CDC Surgical Site Infection Guideline (2017) did not address issue⁴
- Pre-operative administration of non-absorbable antimicrobials, along with mechanical bowel preparation, to prevent surgical infection and anastomotic leaks following bowel surgery^{1,2,3,5}
- Prevention of secondary cases of meningococcal disease (oral rifampicin or other agents)⁶

— Netherlands

- From onset of ICU care, selective digestive decontamination (SDD) and selective oral decontamination (SOD) to prevent infections and reduce mortality⁷

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Targeted versus Universal Decolonization to Prevent ICU Infection

Susan S. Huang, M.D., M.P.H., Edward Septimus, M.D., Ken Kleinman, Sc.D., Julia Moody, M.S.,

ORIGINAL ARTICLE

Decolonization to Reduce Postdischarge Infection Risk among MRSA Carriers

Chlorhexidine versus routine bathing to prevent multidrug-resistant organisms and all-cause bloodstream infections in general medical and surgical units (ABATE Infection trial): a cluster-randomised trial

Susan S Huang, Edward Septimus, Ken Kleinman, Julia Moody, Jason Hickok, Lauren Heim, Adrijana Gombosov, Taliser R Avery,

Decolonization in Nursing Homes to Prevent Infection and Hospitalization

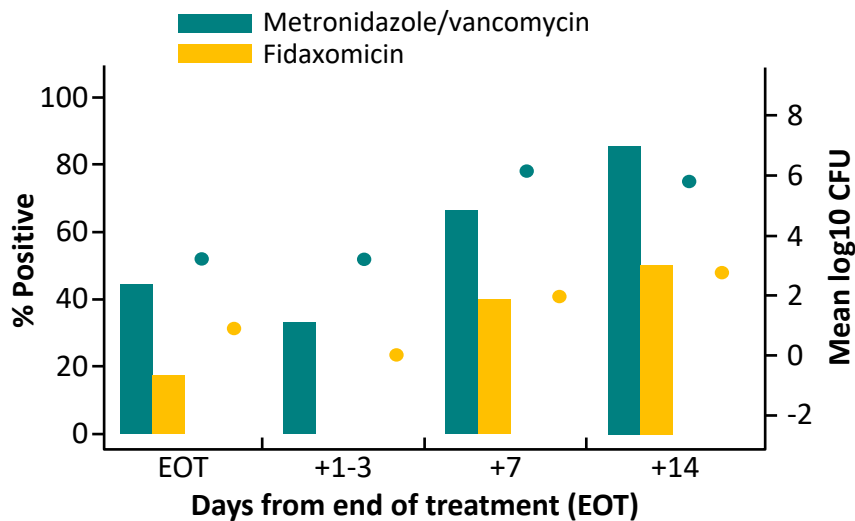
- 16.6% reduction in transfers to hospital due to an infection.
- 14.6% reduction in transfer to a hospital for any reason
- “The number needed to treat was 9.7 to prevent one infection-related hospitalization and 8.9 to prevent one hospitalization for any reason.”
- N Engl J Med 2023;389:1766-77, DOI: [10.1056/NEJMoa2215254](https://doi.org/10.1056/NEJMoa2215254)

What's Next?

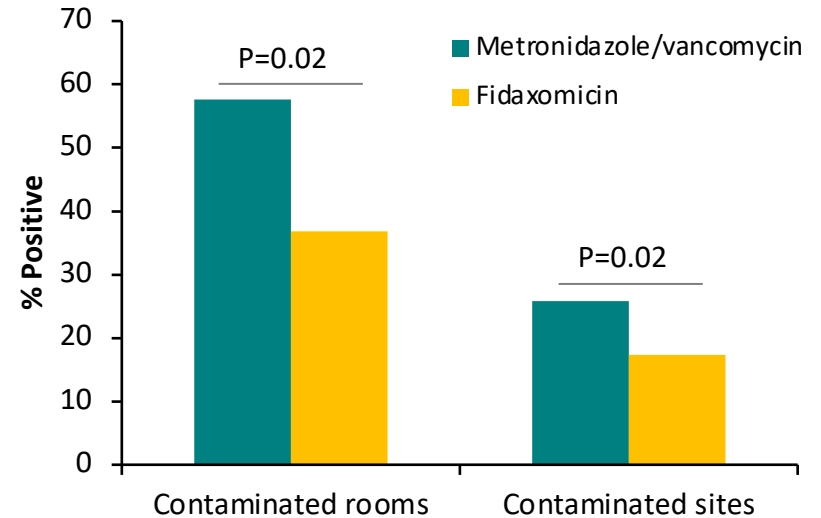
- These studies show the potential promise of decolonizing therapies.
- But they all use antiseptics and/or antibiotics that have unintended consequences- disruption of microbiome and potential emergence of resistance.
- Can we develop more targeted agents to decolonize harmful pathogens while sparing the rest of the microbiome?

Microbiome-sparing treatment for *C. difficile* reduces pathogen load and environmental contamination^{1,2}

Fecal sample positivity rate and colony counts within positive samples after EOT with metronidazole/vancomycin vs. fidaxomicin¹



Environmental contamination rates for patients treated with metronidazole/vancomycin vs. fidaxomicin²



CFU, colony forming units; EOT, end of treatment.

Left figure modified from Figure 5B in Davies K, et al. *Open Forum Infect Dis.* 2020;7(11):ofaa362. Right figure modified from Figure 1 in Biswas JS, et al. *J Hosp Infect.* 2015;90(3):267-70.

1. Davies K, et al. *Open Forum Infect Dis.* 2020;7(11):ofaa362; 2. Biswas JS, et al. *J Hosp Infect.* 2015;90(3):267-70.

Patients treated with fecal microbiota transplantation (FMT) for recurrent *C. difficile* infection may have better outcomes vs. those treated with antibiotics

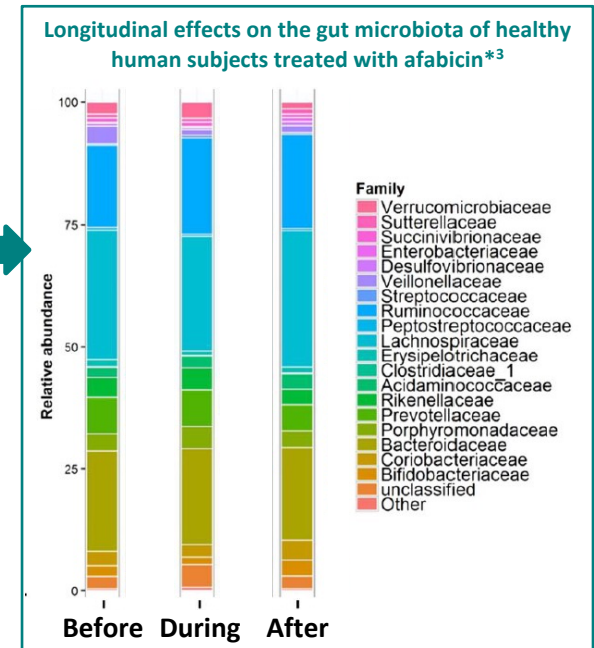
	After propensity score matching		
	Treated with FMT (N=57)	Treated with antibiotics (N=57)	Difference, % (95% CI)
Primary outcomes			
Bloodstream infection, n (%)	2 (4)	15 (26)	23 (10-35)
Secondary outcomes			
Length of hospitalization	–	–	14 (9-20)
Mean (SD), days	13.4 (13.7)	27.8 (17.6)	–
Overall survival at 90 days	–	–	32 (16-47)
Alive after 90 days, n (%)	51 (89)	33 (58)	–

CI, confidence interval; FMT, fecal microbiota transplantation; SD, standard deviation.
Table modified from Table 2 in Ianiro G, et al. *Ann Intern Med*. 2019;171(10):695-702.

Microbiome-sparing antibiotics: precision therapy as a tool for microbiome preservation

Examples of targeted pathogen-specific agents in development with potential microbiome-sparing profiles^{1,2}

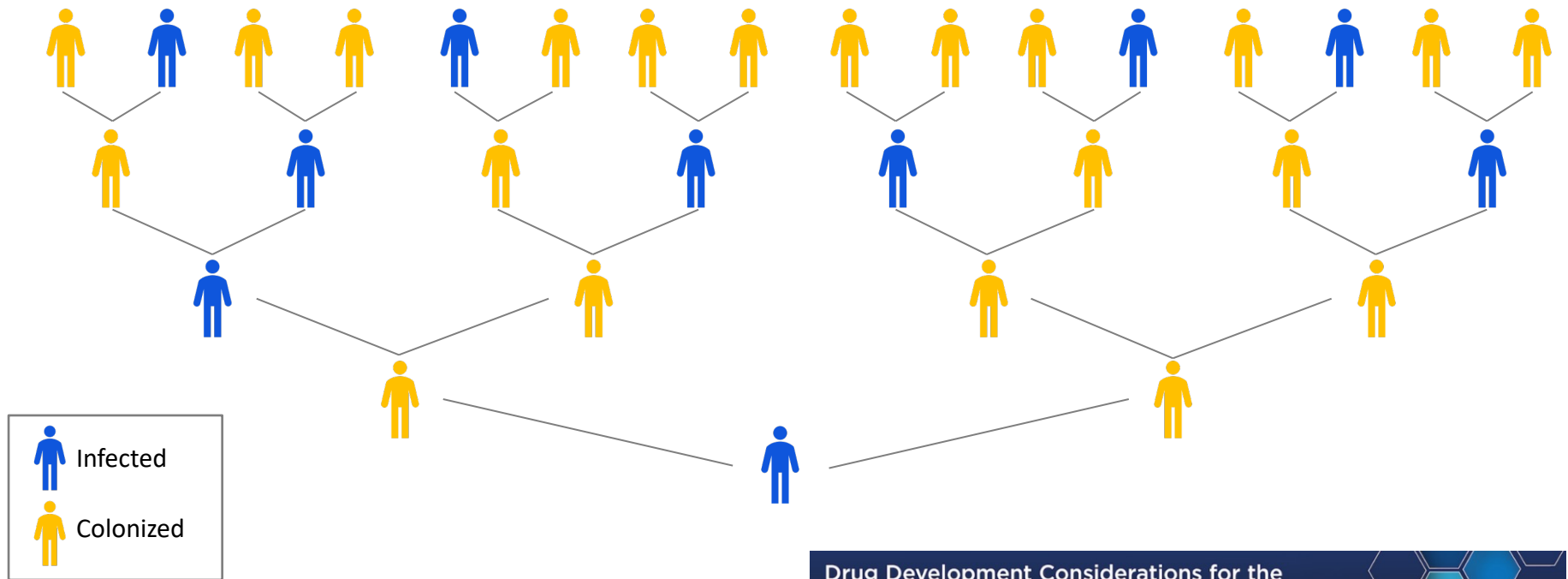
Name	Phase	Company	Target	Pathogen
Ridinilazole	III	Summit Therapeutics	Minor groove binder	<i>Clostridium difficile</i>
CRS3123	II	Crestone, Inc.	Methionyl-tRNA synthetase	<i>Clostridium difficile</i>
Afabicin	II	Debiopharm	FabI	<i>Staphylococcus</i> spp.
AR-101 (mAb)	II	Aridis Pharma	LPS serotype 011	<i>Pseudomonas aeruginosa</i>
SMT-738	Preclinical	Summit Therapeutics	LolC/E complex	<i>Enterobacteriaceae</i>
Debio 1453	Preclinical	Debiopharm	FabI	<i>Neisseria gonorrhoeae</i>
Antisense (various peptide conjugate-peptide nucleic acids)	Preclinical	Techulon Inc.	Specific inhibition of gene translation	MRSA, <i>Acinetobacter baumannii</i> , and <i>P. aeruginosa</i>



*Relative abundance percentages for major bacterial families from the human gut microbiota with 20-day treatment with afabicin (240 mg twice per day, oral).

1. Avis T, et al. *Drug Discov Today*. 2021;26(9):2198-2203. 2. Alshrari AS, et al. *Biomedicines*. 2023; 11(2):426. 3. Nowakowska J, et al. *J Antimicrob Chemother*. 2023; doi: 10.1093/jac/dkad181.

Reducing colonization and pathogen abundance protects the population



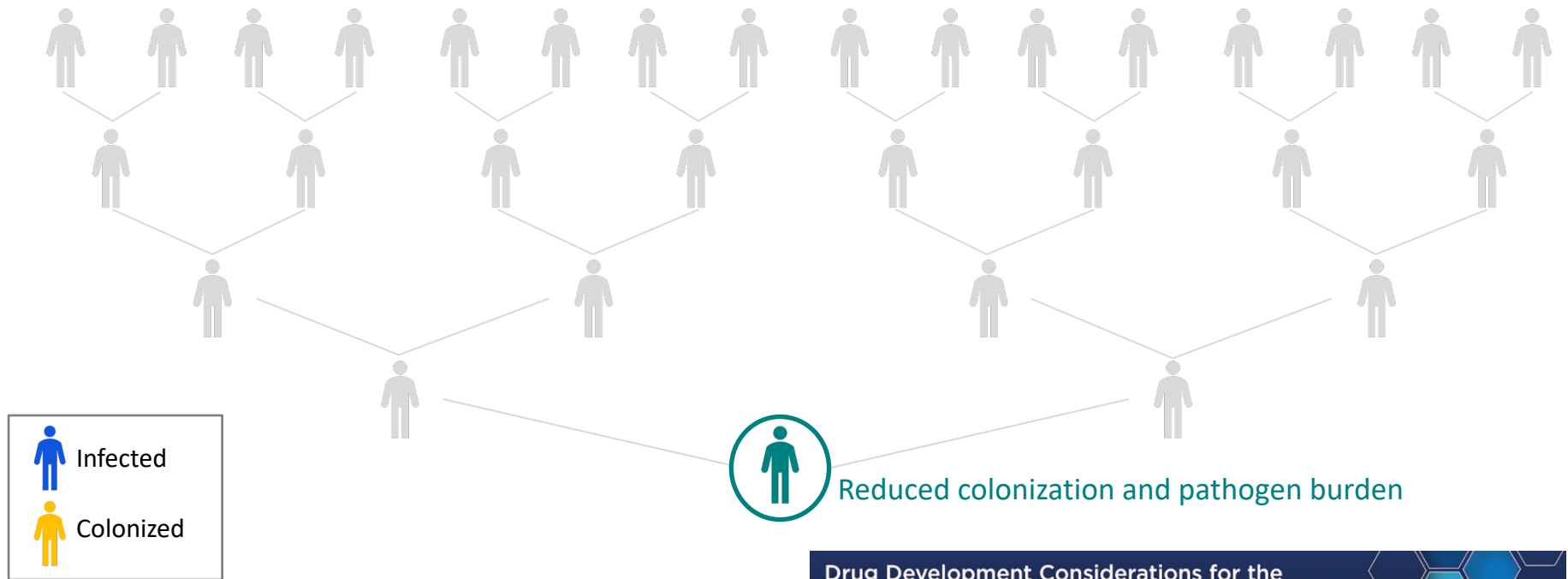
Modified from presentation by John Jernigan at the CDC/FDA Virtual Public Workshop: Drug Development Considerations for the Prevention of Health Care Associated Infections. Aug 30, 2022.

Drug Development Considerations for the Prevention of Healthcare-Associated Infections

—Virtual Public Workshop Cosponsored by CDC & FDA



Reducing colonization and pathogen abundance protects the population

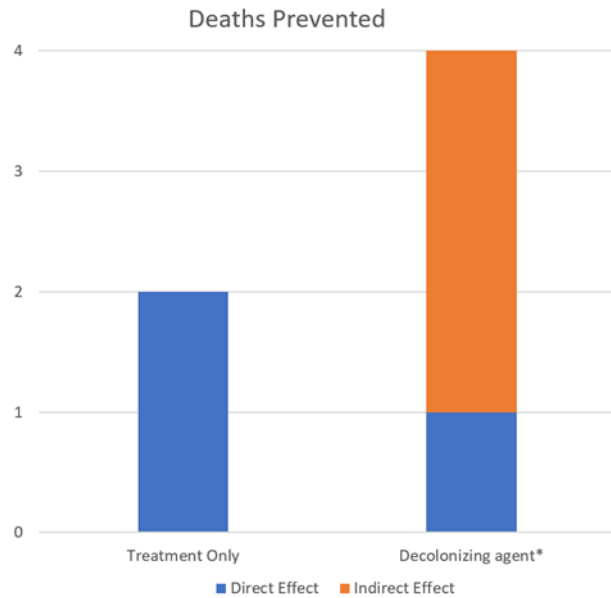


Modified from presentation by John Jernigan at the CDC/FDA Virtual Public Workshop: Drug Development Considerations for the Prevention of Health Care Associated Infections. Aug 30, 2022.

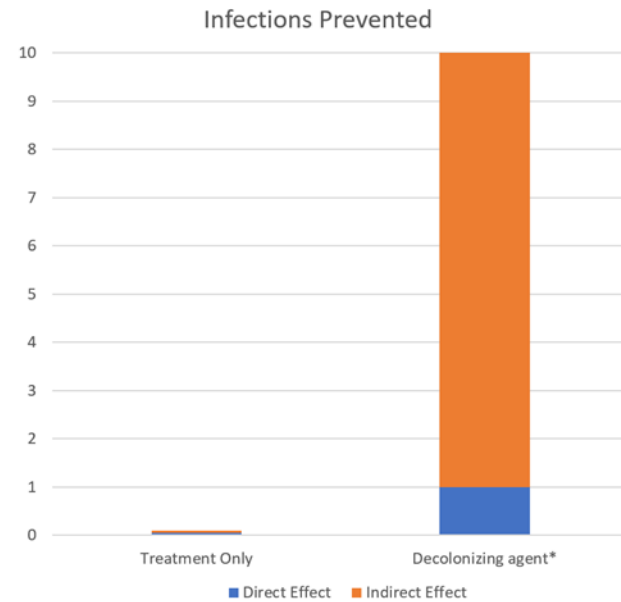
Drug Development Considerations for the Prevention of Healthcare-Associated Infections
—Virtual Public Workshop Cosponsored by CDC & FDA



Decolonization Therapy- Impacts Beyond the Individual



*All infected patients receive treatment for infection

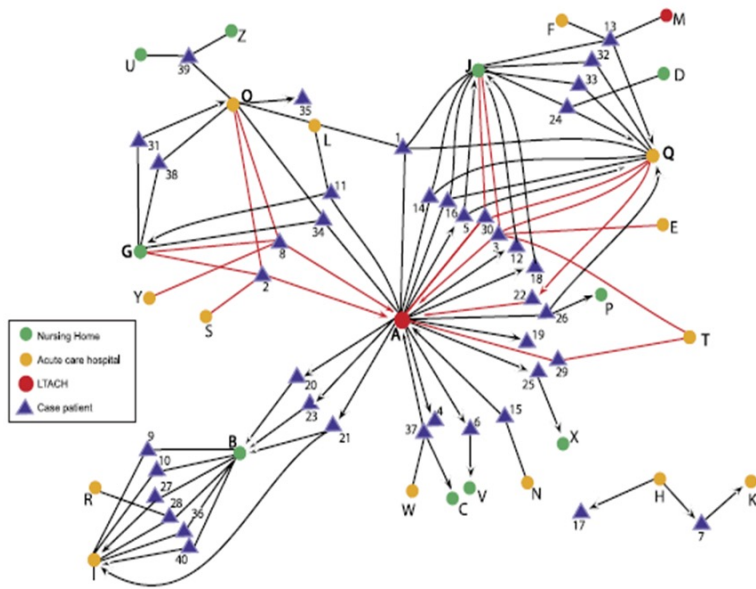


*All infected patients receive treatment for infection

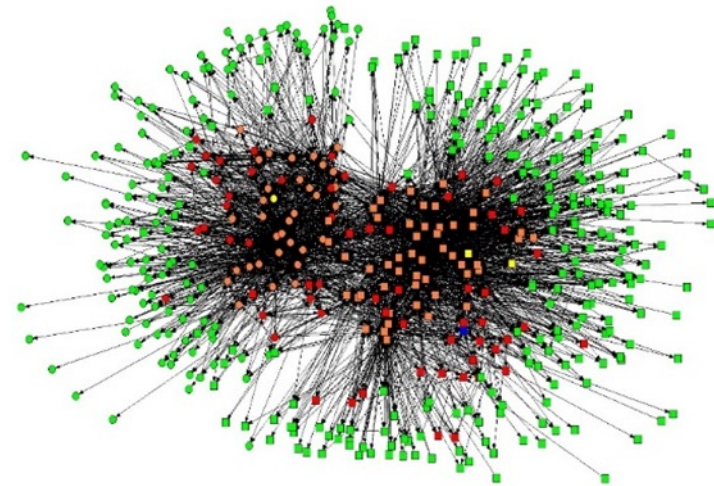
Resistance Anywhere is Resistance Everywhere

- Pathogens never have and never will, respect any boundaries.
- They spread between patients, facilities, cities, states and countries.

Containment Will Require Coordination and Communications



Network analysis of a CRE outbreak in IL
Circles are all different healthcare facilities



Network analysis of movements of patients with C. difficile between healthcare facilities in WA and OR
Circles and squares are facilities, lines are patients

Facilities work together to protect patients.

Common Approach *(Not enough)*

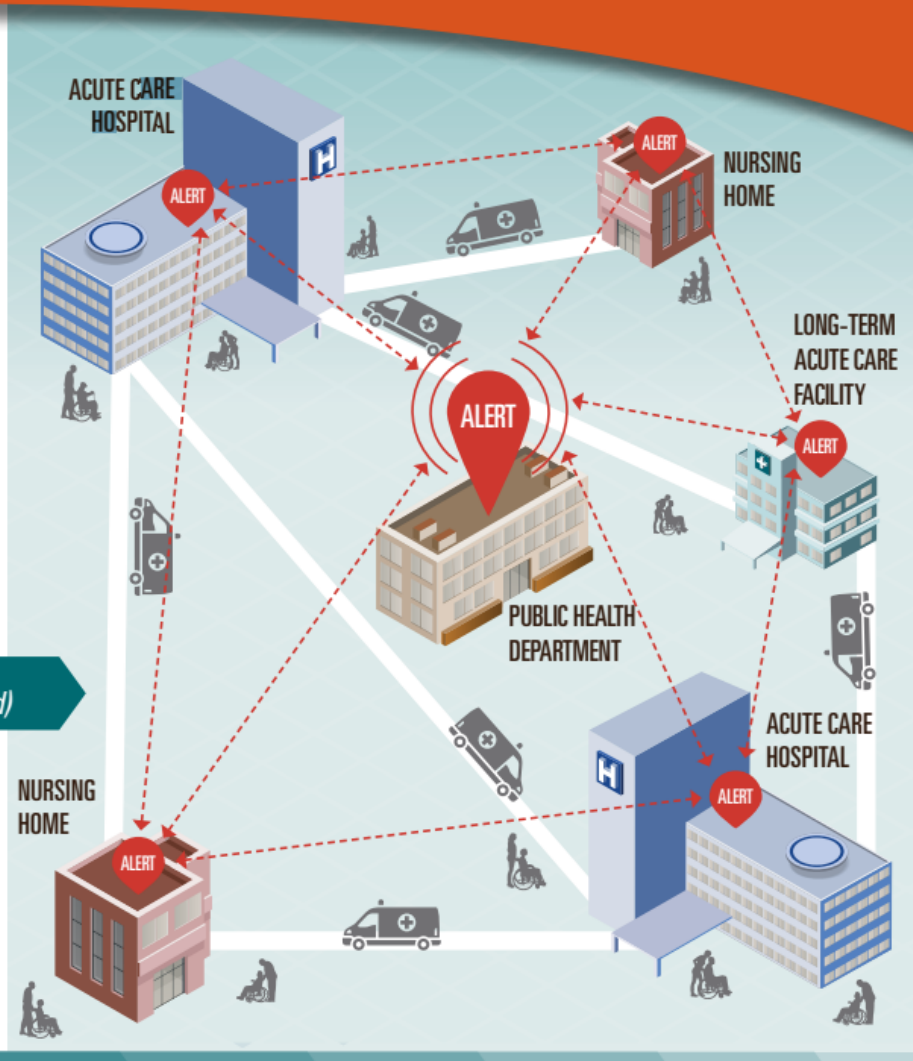
- Patients can be transferred back and forth from facilities for treatment without all the communication and necessary infection control actions in place.

Independent Efforts *(Still not enough)*

- Some facilities work independently to enhance infection control but are not often alerted to antibiotic-resistant or *C. difficile* germs coming from other facilities or outbreaks in the area.
- Lack of shared information from other facilities means that necessary infection control actions are not always taken and germs are spread to other patients.

Coordinated Approach *(Needed)*

- Public health departments track and **alert** health care facilities to antibiotic-resistant or *C. difficile* germs coming from other facilities and outbreaks in the area.
- Facilities and public health authorities share information and implement shared infection control actions to stop spread of germs from facility to facility.



Patient Safety & Quality

48-Hour Hospital Overdose Reporting

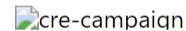
Adverse Health Care Events

Discharge Data

Healthcare-associated Infections (HAIs) & Antimicr...

CRE Reporting

[RESOURCES >](#) [PUBLICATIONS >](#)



Extensively Drug-Resistant Organism (XDRO) Registry

The Illinois Department of Public Health has guided development of an infection control tool called the XDRO Registry (www.xdro.org). The purpose of the XDRO Registry is two-fold:

- 1. Improve inter-facility communication:** The XDRO Registry primarily allows for CRE information exchange. Health care facilities can query the registry to see whether a patient has

82. First 5 Years of Experience with the Illinois Extensively Drug-Resistant Organism (XDRO) Registry and Implementation of Automated Alerting

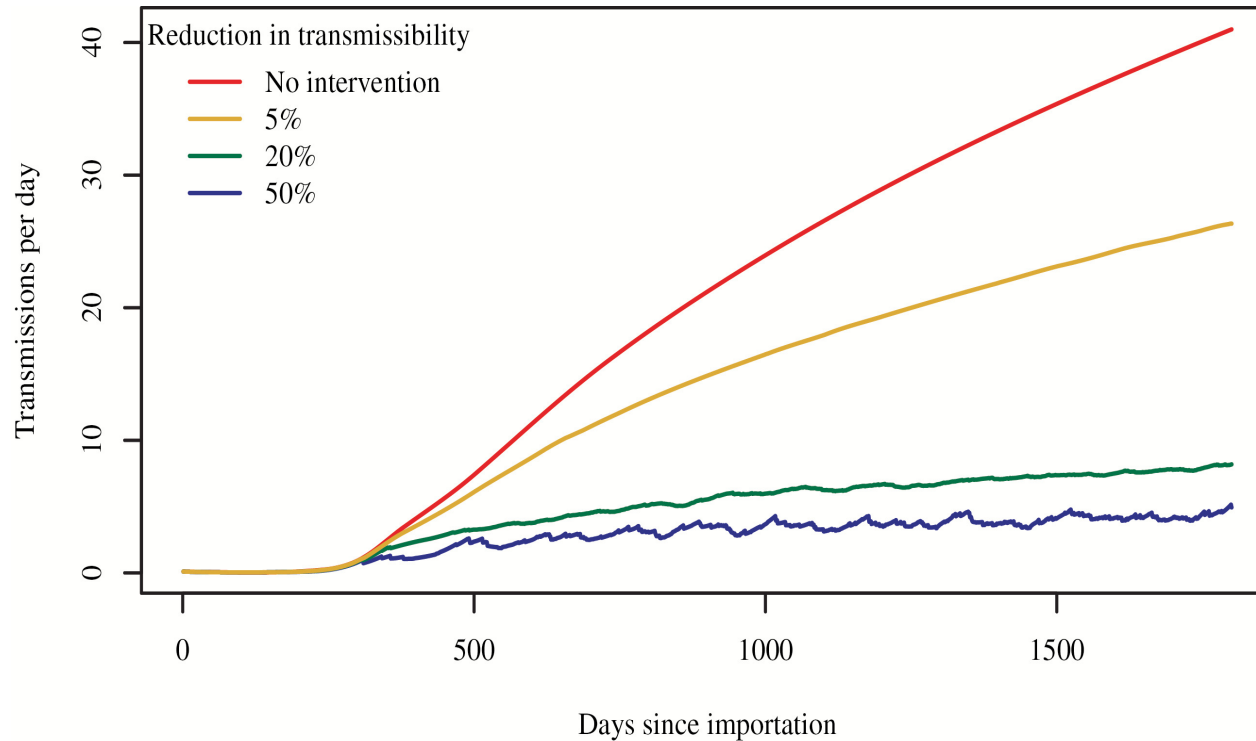
Michael Y Lin, MD, MPH, Angela Tang, MPH, Amy E Fealy, MPH, Wei Gao, BS, George Markovski, BS, Yingxu Xiang, MS, William Trick, MD

Open Forum Infectious Diseases, Volume 6, Issue Supplement_2, October 2019, Pages S3–S4, <https://doi.org/10.1093/ofid/ofz359.006>

Published: 23 October 2019

- 6,445 unique patients (11,258 total reports) from 213 facilities have been reported to the XDRO registry
- The registry has been manually queried 39,678 times by 232 facilities.
- Among 1176 first alerts/patient/facility, 49% of patients' XDRO status were previously unknown to the facility, and 33% were not in contact precautions at the time of alert.
- Seventy-five facilities have achieved automation of alerting.

Potential Impact of Containment Strategy



Prabasaj Paul, Rachel B Slayton, Alexander J Kallen, Maroya S Walters, John A Jernigan, Modeling Regional Transmission and Containment of a Healthcare-associated Multidrug-resistant Organism, *Clinical Infectious Diseases*, ciz248, <https://doi.org/10.1093/cid/ciz248>

Detect Resistance Faster and Respond: CDC's Containment Strategy

Goal: identify new resistance and control transmission

- Aggressive, systematic response to ≥ 1 case of targeted organisms:
 - Carbapenem resistance
 - *Candida auris*
 - Totally resistant organisms
- Slows but does not stop spread



<https://www.cdc.gov/hai/outbreaks/mdro/index.html>

Supplemental funding helps build key health departments capacities

CDC plans to invest \$1.25 billion of American Rescue Plan Act funds in health department HAI/AR programs from 2021-2024

Strengthening HAI/AR Program Capacity (SHARP)

- Building HAI/AR program infrastructure and workforce
- Expanding testing via the domestic AR Lab Network
- Improving antibiotic stewardship
- Enhancing use of the National Healthcare Safety Network
- Training frontline healthcare workers through Project Firstline

AR Lab Network

Transforming the national lab infrastructure with regional and local labs with gold-standard methods and technology

Workforce

Support for 900+ health department staff supporting HAI/AR programs and the AR Laboratory Network



**Infections /
Colonization**

**160,000 colonization
screenings**



**Pathogen
Identification**

**160,000 isolate
characterizations**



PCR / WGS

**320,000 whole-
genome sequences**

CDC's Global AR Lab & Response Network

- A global collaborative network to address priority emerging AR threats using a One Health approach for rapid detection and response to resistant organisms in healthcare, community, food, and the environment that impact human health
- Builds sustainable testing for detection of high impact bacterial and fungal AR threats, based on local needs and capacity, for effective and rapid response
- Enhances communication between lab and epi, and fosters knowledge sharing among partners
- Network spans nearly 50 countries and works with more than 20 partners organizations

High-impact AR pathogens included:

- HAIs – carbapenem-resistant Enterobacterales [GAIHN]
- Enterics – *Salmonella* (Typhi and non-typhi) [PNI]
- Enterics – drinking, surface, and wastewater [WASH]
- Fungi – *Candida* spp, including *C. auris*, and *Aspergillus*
- Inv. Bac and Resp – *S. pneumoniae*, *N. meningitidis*, *B. pertussis*
- STDs – *Neisseria gonorrhoeae* [EGASP]



Global
Funding
2022:

CDC invested more than **\$40 million** (\$15 million of annual appropriations and \$25 million of supplemental appropriations) in **48 countries**, with additional projects supporting regional and global efforts

Identification of the Outbreak

June-August 2022: Health department HAI/AR Programs report 3 facility clusters of VIM*-producing *P. aeruginosa* infections



Ophthalmology Clinic,
California



Long-Term Care Facility,
Utah



Long-Term Care Facility,
Connecticut

September-October 2022: Whole genome sequencing (WGS) showed that all 3 outbreaks and isolated infections in 2 additional states caused by same strain

*VIM: Verona integron metallo- β -lactamase, the most common carbapenemase identified in *P. aeruginosa* in the U.S.

Multiple Investigative Approaches Pointed to Single Artificial Tears Brand

Case-control study at long-term care facility

- Cases had 5 times greater odds of exposure to artificial tears than controls
(Crude OR: 5.0 [95% CI 1.10-22.82])
- Unable to differentiate artificial tears brands
- EzriCare Artificial Tears: largest purchasing volume

4 facility clusters

- 2 with eye infections; 2 without
- EzriCare Artificial Tears used across all facilities
- 28/37 (76%) patients used Artificial Tears
- 22/26 (59%) confirmed or probable use of EzriCare Artificial Tears

31 patients not linked to clusters

- 17/27 (63%) used artificial tears
- 11/16 (69%) with product information used EzriCare Artificial Tears
 - 8/8 (100%) with eye infections



EzriCare Artificial Tears

- Preservative-free formulation
- Dispensed in multidose vials
- Distributed nationwide
- Manufactured in India

You Get What You Pay For... Or What You Don't

- Our advances in antimicrobial detection and prevention infrastructure require on-going resources.
- Combating AMR is not a “one and done” proposition.
- We're already starting to see some erosion of funding of the critical support for state-based efforts.
- We have to ensure that funders know how important these investments are.

My Top Five Messages on Antimicrobial Resistance

- Prevention works- but the gains are fragile
- Yes, antibiotic stewardship is still important
- There's got to be a better way- Innovations to tackle AMR
- We're all in this together
- You get what you pay for- Infrastructure is critical to combating AMR