Antimicrobial Resistance:
A Silent Global Threat

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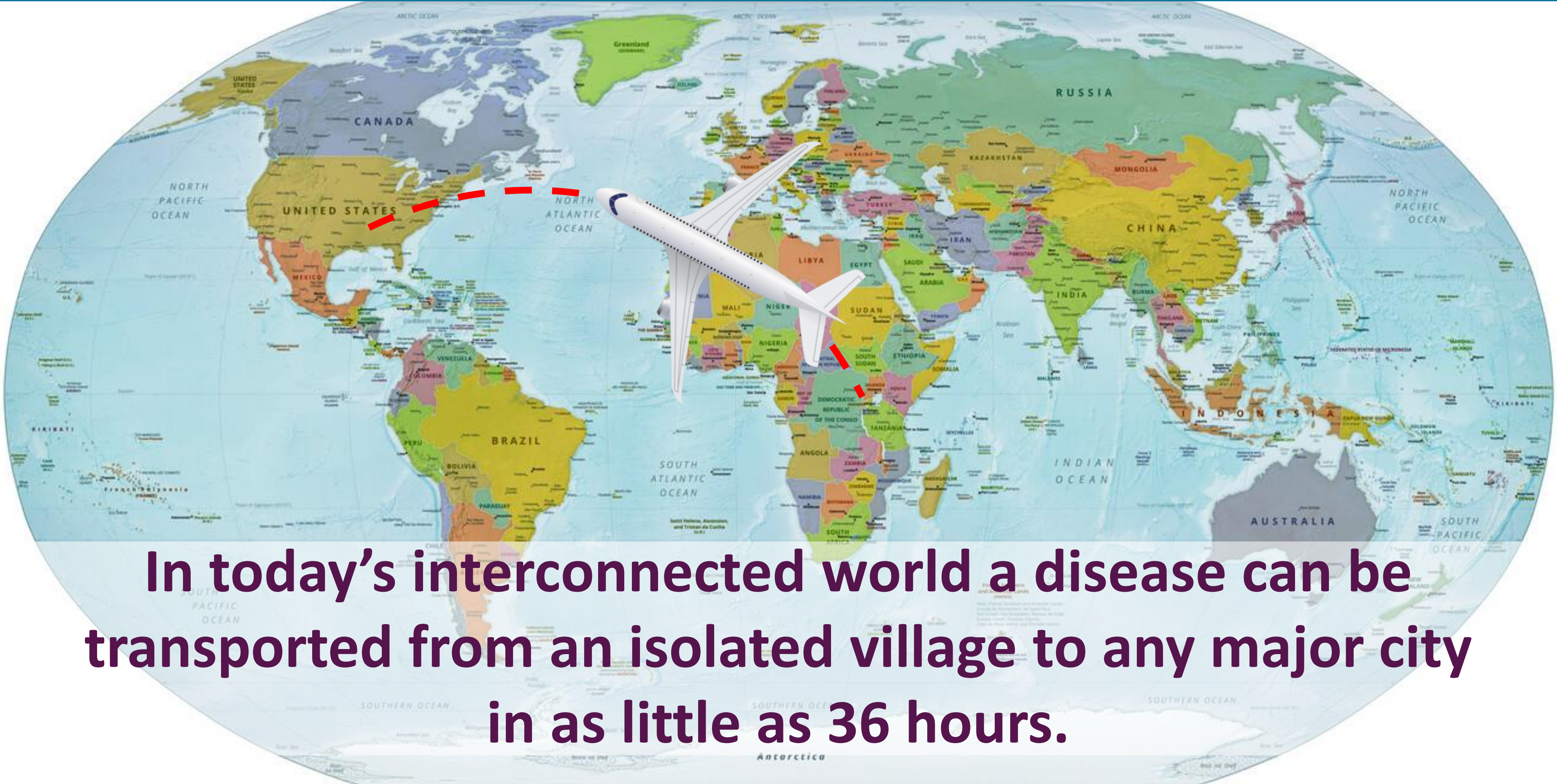
9th Annual Texas Medical Center Antimicrobial Resistance and Stewardship Conference, January 2026

No conflict of interests

Outline

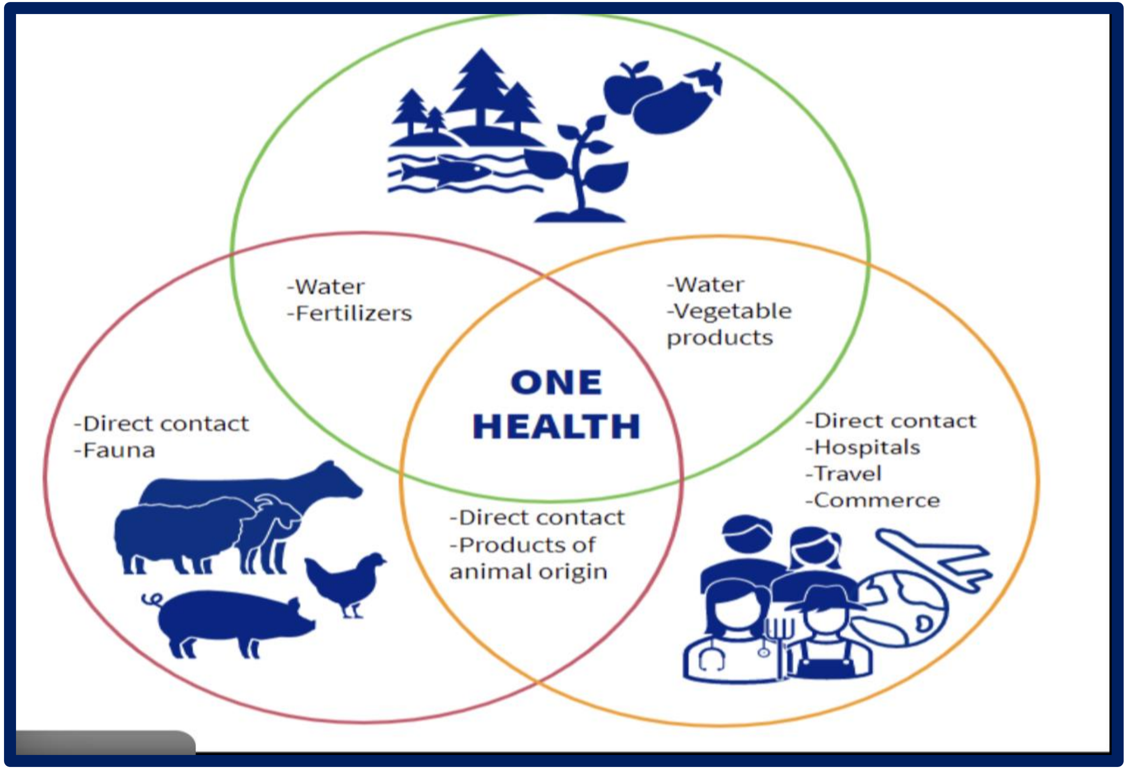
- Burden and scope of antimicrobial resistance
- AR Solutions
  - Prevention
  - Containment
  - Stewardship
- Conclusion

Antimicrobial Resistance is a global health threat



In today's interconnected world a disease can be transported from an isolated village to any major city in as little as 36 hours.

Antimicrobial Resistance is a One Health Issue



Interconnection among human health, animal health, and the environment

Antimicrobial resistance (AR) is a clear and present danger.

Domestic burden*	
3.1 million	Annual antimicrobial-resistant infections in the U.S.
48,700	Annual deaths due to AR in the U.S.
Global burden	
1.14 million	Estimated global deaths due to bacterial AR in 2021
1.91 million	Estimated global deaths due to bacterial AR in 2050
92 million	Total deaths that could be averted in the next 25 years through better care of severe infections and improved access to antibiotics**

Antimicrobial resistance isn't just a possibility. It is a problem right now in the U.S. and around the world – and it is only getting worse.

https://www.cdc.gov/antimicrobial-resistance/data-research/threats/index.html
https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(24)01867-1/fulltext

*Includes infections deaths from antimicrobial-resistant bacteria and fungi, as well as infections and deaths due to *Clostridioides difficile,* often associated with antibiotic use.

**2025 through 2050

Burden of Antimicrobial Resistance in the United States

- Each year in the United States, more than **3 million people** get an antimicrobial-resistant infection or *Clostridioides difficile* (*C. diff*) infection (often associated with taking antibiotics) and almost **50,000** people die as a result.[1]
- CDC and partners at the University of Utah estimate that treating six of the threats identified in CDC's 2019 AR Threats Report contributes **more than $4.6 billion in healthcare costs annually**.
- A Threat to Modern Medicina:
  - Loss of the ability to treat patients with sepsis, cancer, organ transplants, and of burns and trauma
  - Loss of effective antibiotic treatment could make routine infections deadly

[1] 2019 Antibiotic Resistance Threats Report | CDC
[2] Global mortality associated with 33 bacterial pathogens in 2019: a systematic analysis for the Global Burden of Disease Study 2019 - The Lancet
[3] Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis - The Lancet
[4] National Estimates of Healthcare Costs Associated With Multidrug-Resistant Bacterial Infections Among Hospitalized Patients in the United States | Clinical Infectious Diseases | Oxford Academic (oup.com)

CDC's list of antimicrobial-resistant pathogens that pose a significant risk to morbidity or mortality.

THREAT LEVEL **URGENT**

Urgent Threats

- Carbapenem-resistant *Acinetobacter*
- *Candida auris*
- *Clostridioides difficile*
- Carbapenem-resistant *Enterobacteriaceae*
- Drug-resistant *Neisseria gonorrhoeae (N. gonorrhoeae)*

THREAT LEVEL **SERIOUS**

Serious Threats

- Drug-resistant *Campylobacter*
- Drug-resistant *Candida*
- ESBL-producing Enterobacteriaceae
- Vancomycin-resistant *Enterococci*
- Multidrug-resistant *Pseudomonas aeruginosa*
- Drug-resistant nontyphoidal *Salmonella*
- Drug-resistant *Salmonella* serotype Typhi
- Drug-resistant *Shigella*
- Methicillin-resistant *Staphylococcus aureus*
- Drug-resistant *Streptococcus pneumoniae*
- Drug-resistant tuberculosis

THREAT LEVEL **CONCERNING**

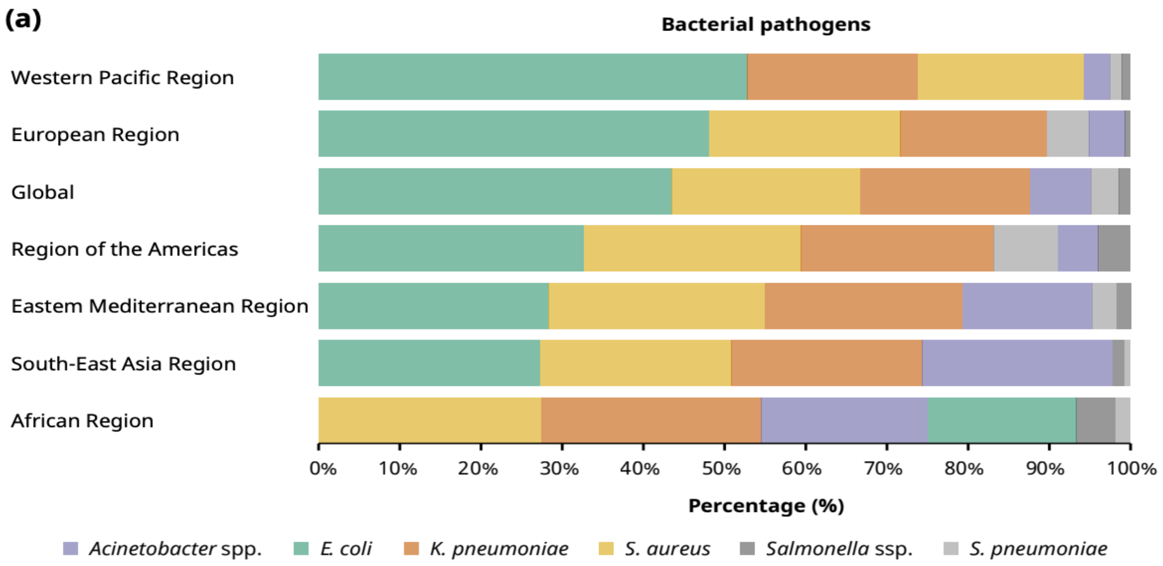
Concerning Threats

- Erythromycin-resistant Group A *Streptococcus*
- Clindamycin-resistant Group B *Streptococcus*

Watch List

- Azole-resistant *Aspergillus fumigatus*
- Drug-resistant *Mycoplasma genitalium*
- Drug-resistant *Bordetella pertussis*

Figure 3.5. Percentage distribution of bacterial pathogens (a) and the 10 most common antibiotic-resistant bacterial pathogens (b) in bloodstream infections, by WHO region, 2023



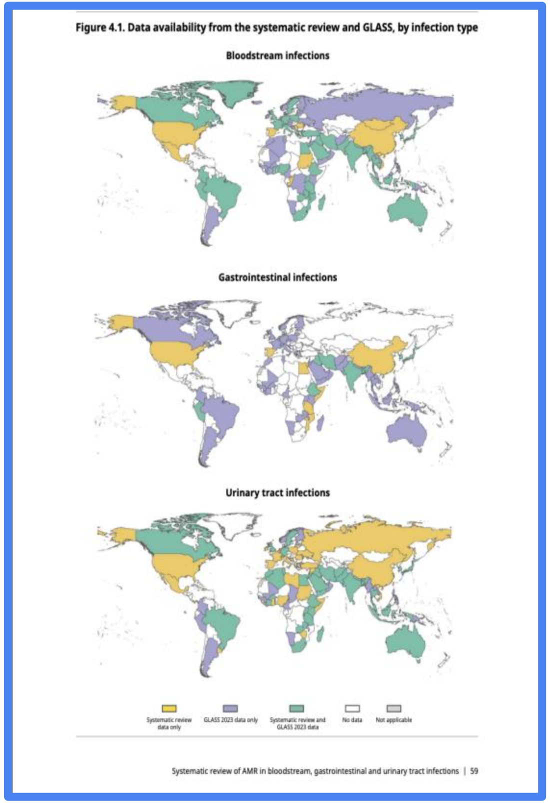


Table 3.1. Global trends in percentage AMR by infection type: median annual change (2018–2023) and 2023 percentage resistance estimates

Infection type	Antibiotic	Trend	Annual % change[a]	Resistance in 2023 (%)[b]	No. of countries[c]
Bloodstream					
Acinetobacter spp.	Imipenem	Increasing	5.3 (2.7, 8.3)	54.3 (49.3, 59.2)	64
E. coli	Cefotaxime	Stable	1.4 (−0.1, 2.9)	39.0 (33.5, 44.8)	64
	3rd-gen. cephalosporins	Stable	1.3 (−0.1, 2.8)	44.8 (39.3, 50.4)	83
	Imipenem	Increasing	12.5 (9.4, 15.8)	2.4 (1.8, 3.3)	74
K. pneumoniae	Cefotaxime	Stable	−0.3 (−2.5, 1.9)	55.2 (48.5, 61.7)	60
	Imipenem	Increasing	15.3 (12.7, 18.1)	16.7 (13.9, 19.9)	73
Salmonella spp.	Ciprofloxacin	Increasing	9.4 (3.9, 15.3)	18.0 (13.9, 22.9)	65
S. aureus	Methicillin resistance	Stable	−2.5 (−4.5, −0.5)	27.1 (23.5, 31.0)	84
S. pneumoniae	Penicillin G	Stable	−11.0 (−26.8, 7.1)	5.2 (3.6, 7.6)	44
Gastrointestinal					
Salmonella spp.	Ciprofloxacin	Increasing	14.0 (6.5, 22.1)	16.3 (13.8, 19.1)	46
Shigella spp.	Ciprofloxacin	Stable	27.2 (−2.1, 66.1)	29.7 (22.9, 37.5)	19
Urinary tract					
E. coli	Cefotaxime	Stable	−0.3 (−1.5, 1.0)	39.8 (33.9, 46.0)	53
	Imipenem	Increasing	8.5 (6.1, 11.0)	2.6 (2.0, 3.5)	55
K. pneumoniae	Cefotaxime	Stable	−0.4 (−2.3, 1.4)	45.5 (38.6, 52.5)	45
	Imipenem	Increasing	12.9 (10.6, 15.1)	10.9 (8.7, 13.6)	51
Urogenital					
N. gonorrhoeae	Ceftriaxone	Stable	−3.2 (−33.9, 39.2)	0.3 (0.1, 0.6)	38

The table reports modelled estimates.

[a] Population-weighted median annual percentage change in AMR between 2018 and 2023, with 95% CrI. A trend was consid statistically meaningful if ≥ 5 countries reported ≥ 10 infections with AST in ≥ 3 years between 2018 and 2023, and if the 95% for the annual percentage change did not overlap with zero, with the lower bound ≥ 1% or the upper bound ≤ −1%.

[b] Estimated percentage AMR in 2023, derived from Bayesian regression models

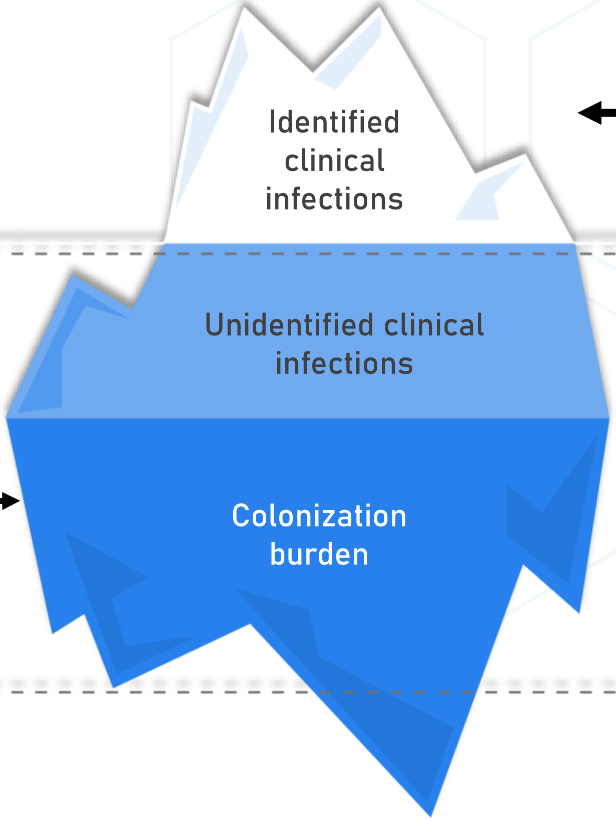
[c] Number of countries included in the analysis (including three territories and areas).

There are limitations to current global antimicrobial resistance surveillance, modeling, and colonization data.

Captured in models of global AR burden

Limited data available through CDC programs:

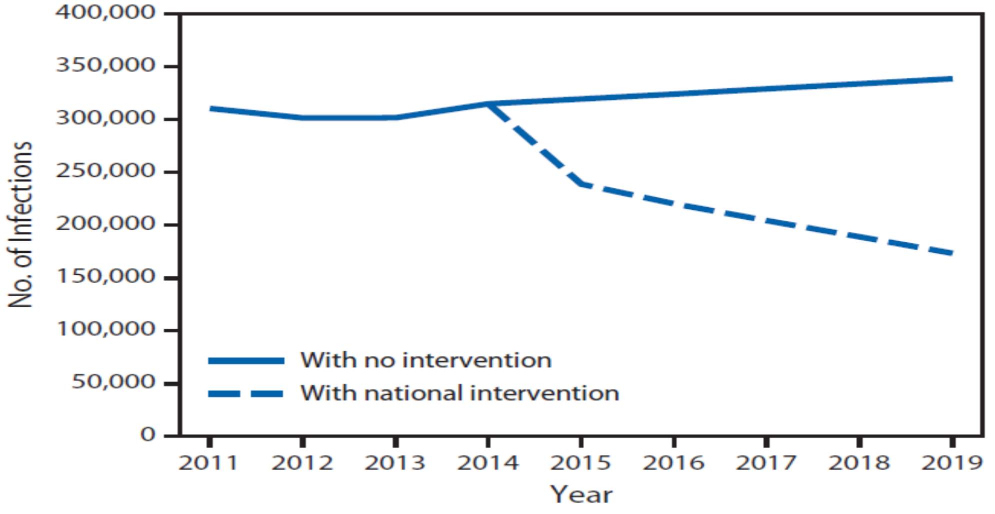
- Antibiotic Resistance in Communities & Hospitals (ARCH)
- Global Action in Healthcare Network (GAIHN)
- AR Lab Network



Current AR surveillance systems (limited globally)

Data missing in most AR surveillance systems

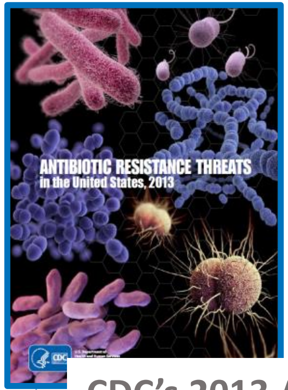
Comparison between the projected number of annual resistant infections with no intervention and with an aggressive national intervention — United States, 2014-2019



* Methicillin-resistant *Staphlococcus aureus*, carbapenem-resistant *Enterobacteriaceae*, and multidrug-resistant *Pseudomonas aeruginosa*.

† Additional information available at http://www.cdc.gov/drugresistance/resources/publications.html.

National Momentum on AR Since First *AR Threats Report*



CDC's 2013 AR Threats Report

2013

2014

- Executive Order 13676
- *National Strategy on CARB*
- President's Council of Advisors on Science & Technology Report

2015

- *National Action Plan for CARB*
- White House Antibiotic Stewardship Forum
- Presidential Advisory Committee established

2016

- Congress appropriates funding to implement CARB activities
- U.S. engagement on UN General Assembly High Level Meeting on AMR

2017

- Executive Order reestablishes Presidential Advisory Committee
- Presidential Message on Antibiotic Awareness Week

2018

- **AMR Challenge launched at UN General Assembly side event**

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SEVENTY-NINTH SESSION,
18TH MEETING (AM)

GA/12642
7 October 2024

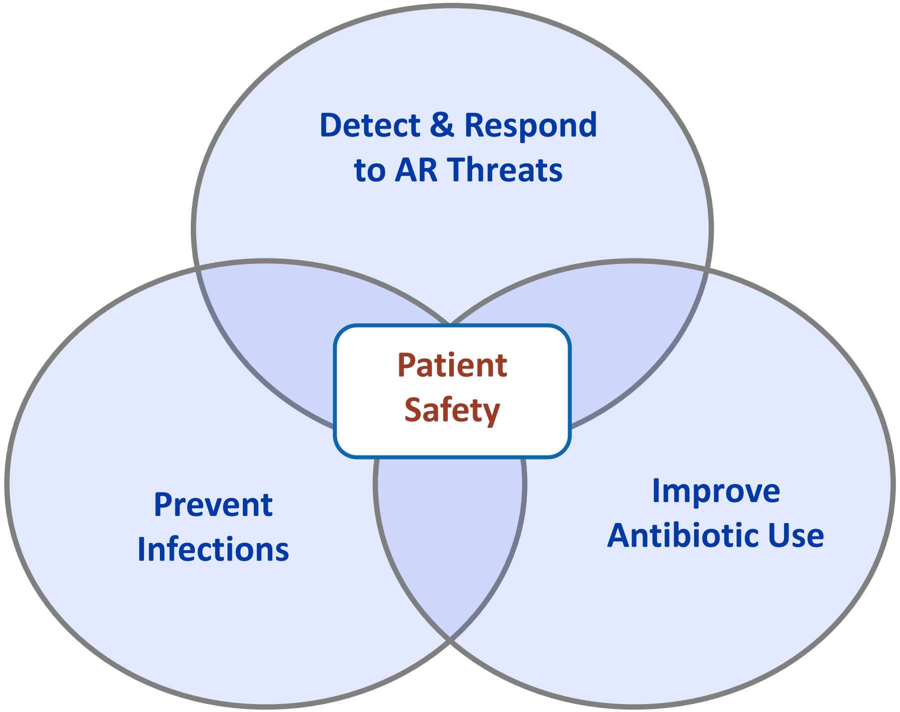
General Assembly Adopts Political Declaration on Antimicrobial Resistance, Demanding Immediate Action for Safeguarding Ability to Treat Disease, Enhance Food Security

Delegates Also Voice Hopes, Concerns over Pact for Future

The General Assembly today adopted the Political Declaration of last month's high-level meeting on antimicrobial resistance, recognizing it is one of the most urgent global health threats, and demanding immediate action to safeguard the ability to treat diseases, enhance food security and advance the Goals of the 2030 Agenda for Sustainable Development.

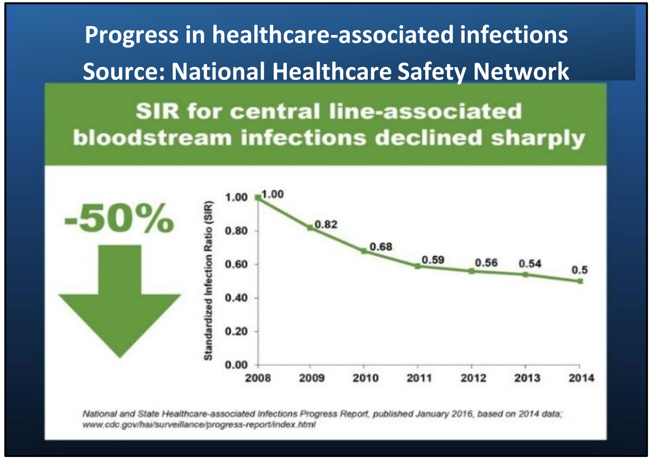
The Assembly also held a joint debate during which delegates expressed their views, hopes, disappointments and reservations on the Pact

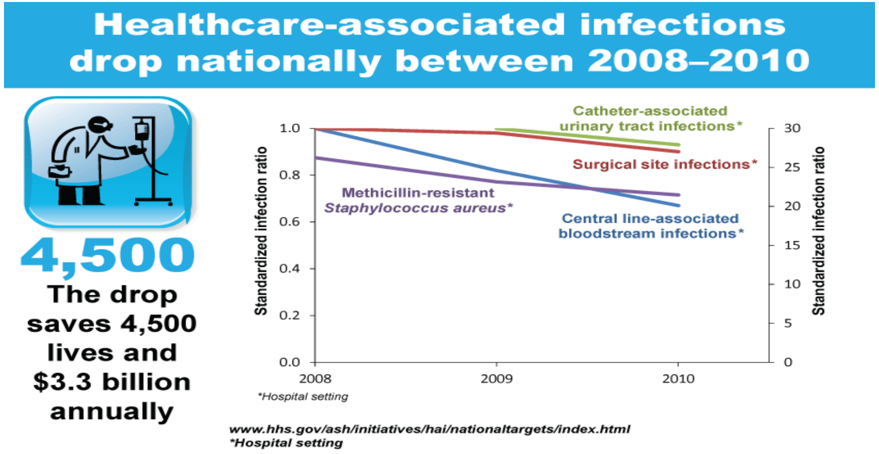
AR Solutions Initiative Focus on Patients



Building on Success: Healthcare-Associated Infections

- Many HAIs are caused by the most urgent and serious antibiotic-resistant bacteria and may lead to sepsis or death.
- CDC uses data for action to prevent infections, improve antibiotic use, protect patients.
- Combination of CDC data, guidelines, state support, and collaborations with CMS & AHRQ provide a unique opportunity to make major gains in reducing healthcare-associated infections and drug resistant infections to meet national goals.





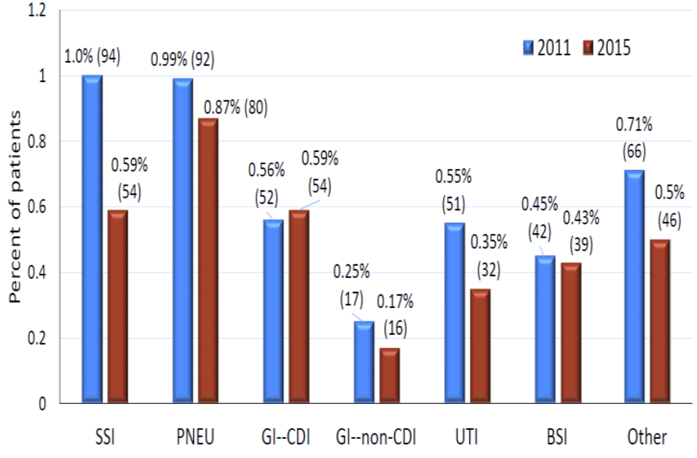
Commitment to Prevent and Control Infections Based on Data

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Changes in Prevalence of Health Care–Associated Infections in U.S. Hospitals

S.S. Magill, E. O'Leary, S.J. Janelle, D.L. Thompson, G. Dumyati, J. Nadle, L.E. Wilson,



Patients were 16% less likely to have an HAI in 2015 than they were in 2011

P-427. Prevalence of Healthcare-Associated Infections: 2023 Point Prevalence Survey in 218 U.S. Acute Care Hospitals

Nora Chea [1], Taniece R Eure [2], Rebecca Alkis Ramirez [3], Joelle Nadle [4], Jane E Lee [5], Monica Lehmann [6], Lyndzie Sardenga [7], Christopher A Czaja [8], Helen Johnston [9], Melissa Kellogg [10], Catherine E Emanuel [11], Alana Cilwick [12],

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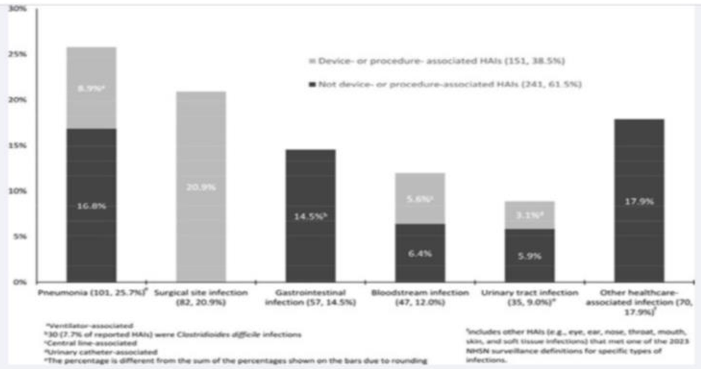


Open in new tab Download slide

Results

Of 13,654 patients in 218 hospitals, 357 (2.6%) had 392 HAIs. Compared to patients without an HAI, patients with HAIs were more frequently located in large hospitals, in critical care units, hospitalized ≥7 days on the survey date, and were more likely to have a central line, urinary catheter, or be on a ventilator on the survey date (Table). Among the 392 HAIs, 101 (25.8%) were pneumonia, 82 (20.9%)

Infection Prevention in Healthcare is Possible:

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

AND 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)

Antimicrobial-resistant infection rates in health care remain above pre-pandemic levels for many pathogens.

	Threat	Change in Rates or Number of Infections***			
		2020 vs. 2019	2021 vs. 2020	2022 vs. 2021	2022 vs. 2019
URGENT*	Hospital-onset CRE	Increase	Increase	Stable	Increase
URGENT*	Hospital-onset Carbapenem-resistant *Acinetobacter*	Stable	Stable	Stable	Increase**
URGENT*	Clinical Cases of *C. auris*	Increase	Increase	Increase	Increase
SERIOUS*	Hospital-onset MRSA	Increase	Stable	Decrease	Stable
SERIOUS*	Hospital-onset VRE	Increase	Increase	Stable	Increase
SERIOUS*	Hospital-onset ESBL-producing Enterobacterales	Increase	Stable	Stable	Increase
SERIOUS*	Hospital-onset MDR *Pseudomonas aeruginosa*	Increase	Increase	Stable	Increase

* Threat level for each pathogen, as categorized in CDC's *Antibiotic Resistance Threats in the United States, 2019.*

** There was no statistically significant difference in rate of hospital-onset carbapenem-resistant *Acinetobacter* in 2020, 2021, and 2022 when compared to the previous year. However, there was a statistically significant increase in rate of hospital-onset carbapenem-resistant *Acinetobacter* in 2022 when compared to 2019.

*** Hospital-onset rates were described using multivariable models for all threats except *C. auris*. Please note that in above table, stable indicates there was no statistically significant increase or decrease, decrease indicates a statistically significant decrease where $p<0.05$, and increase indicates a statistically significant increase where $p<0.05$, for all threats except for *C. auris*. Increases or decreases in *C. auris* were indicated by changes in the number of clinical cases reported nationally without hypothesis testing.

www.cdc.gov/antimicrobial-resistance/data-research/threats/update-2022.html

Everything is Connected: Healthcare Facilities

- Pathogens can **move with patients** when they are transferred from one healthcare facility to another, or go home.
- Pathogens can cause **infections in the community** when healthcare settings do not stop their spread.
- **Pluming and Human waste** can carry traces of previously consumed antibiotics and antibiotic-resistant bacteria. Waste goes to treatment plants and is released as treated waste water.

Facilities work together to protect patients.

Common Approach *(Not enough)*

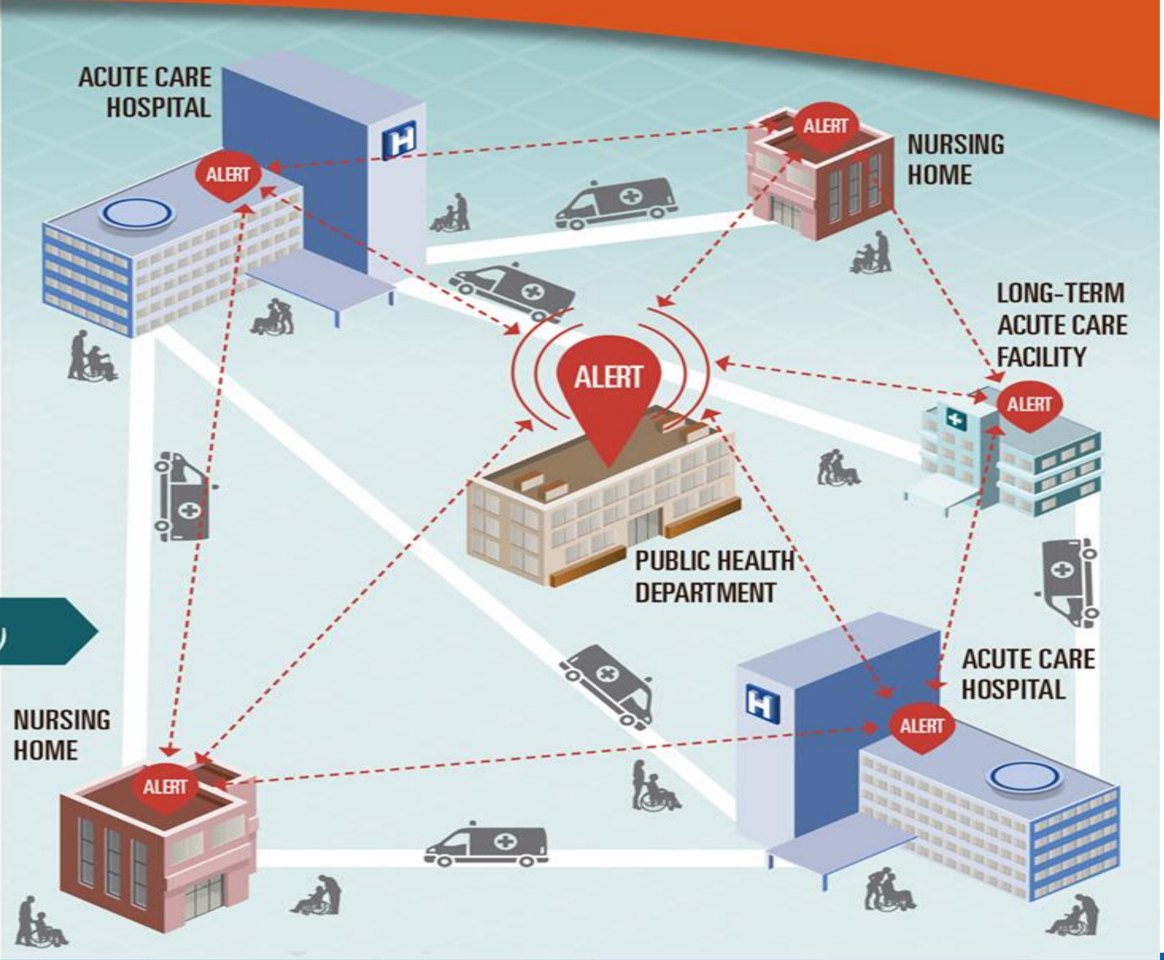
- Patients can be transferred back and forth from facilities for treatment without all the communication and necessary infection control actions in place.

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)*

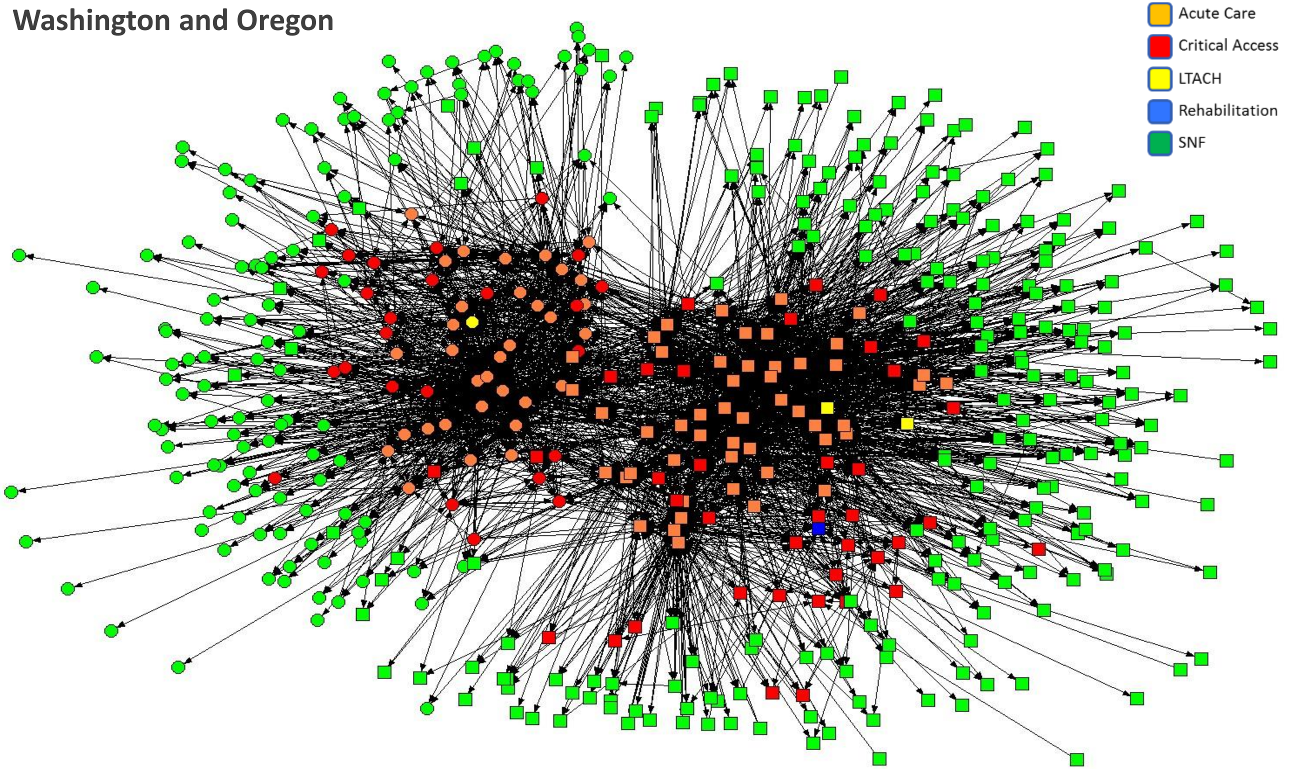
- Public health departments track and **alert** health care facilities to antibiotic-resistant or *C. difficile* germs coming from other facilities and outbreaks in the area.
- Facilities and public health authorities share information and implement shared infection control actions to stop spread of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



Healthcare is Complex

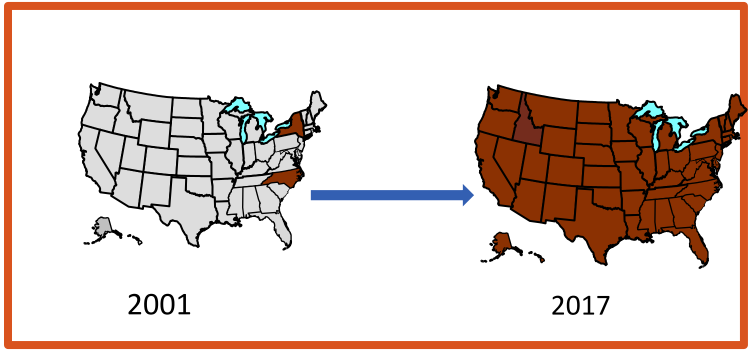
C. difficile: Connectedness of Facilities

Washington and Oregon



Rachel Slayton

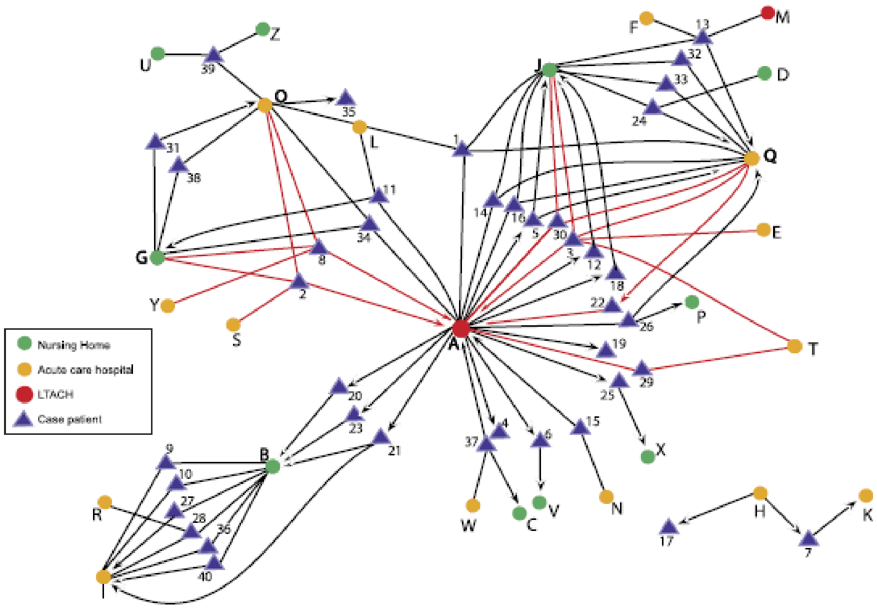
Spread of CRE and Emerging Resistant Threats



- Emerging resistant infection identified outside of large metropolitan areas
  - Imported from healthcare facilities in higher prevalence areas
- Resistant microorganisms do not respect borders
- Some patients with new resistant infection mechanism had international travel in year prior

CRE- Carbepenem resistant *Enterobacteriacea*

Think Outside the Hospital and the Role of Colonized Patients Control of Drug-Resistant Infections



Source of Outbreak:

- CRE infected patient in an LTAC
- Colonized patients Transferred

Long length of stay
High-acuity patients
Less resources dedicated to infection control
Staffing challenges

Won S, Munoz-Price S, Lolans K, Hota B, Weinstein R, Hayden M. for the Centers for Disease Control Prevention Epicenter Program. Rapid and Regional Spread of Klebsiella pneumoniae Carbapenemased CID 2011:53

The Containment Strategy

- Systematic approach to slow spread of novel or rare multidrug-resistant organisms or mechanisms through aggressive response to ≥1 case of targeted organisms
  - Carbapenemase-producing organisms, *mcr-1*
  - Pan-resistant organisms
  - *Candida auris*
- Assessment of infection control practices
- Social Network analyses
- Public health engagement

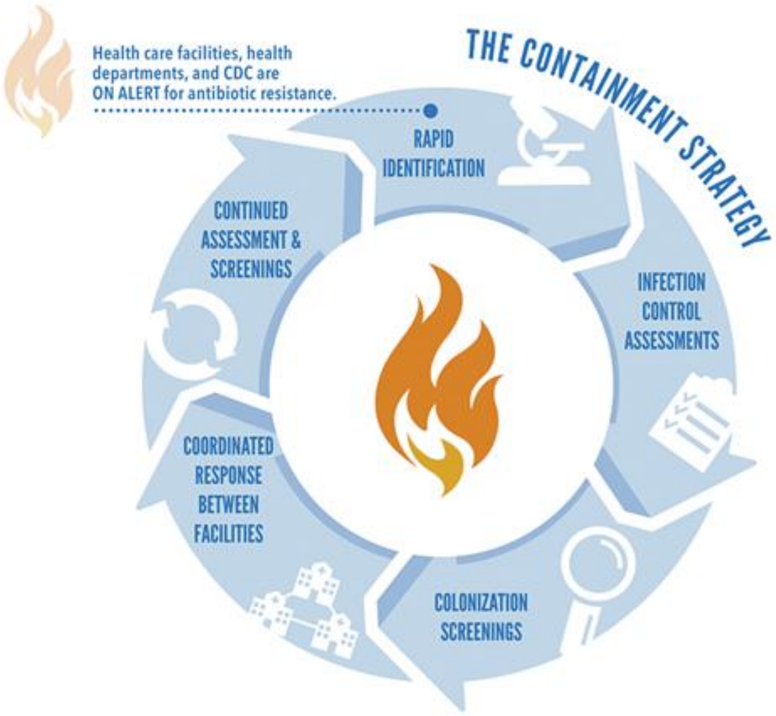
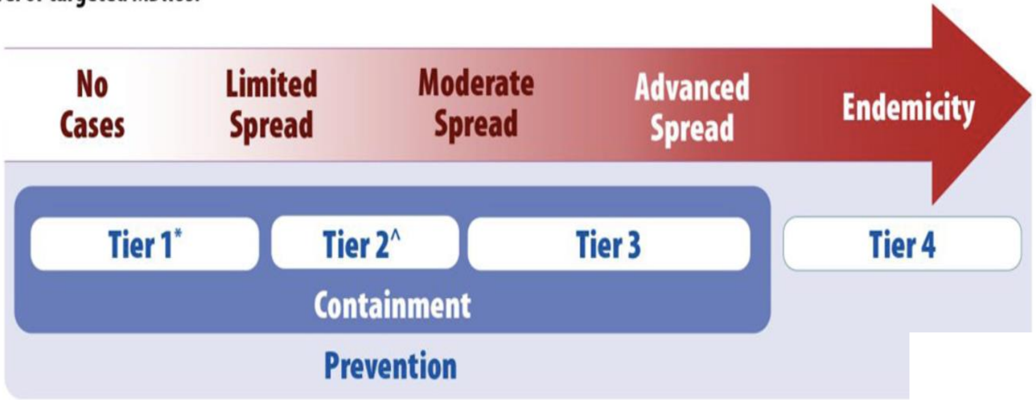


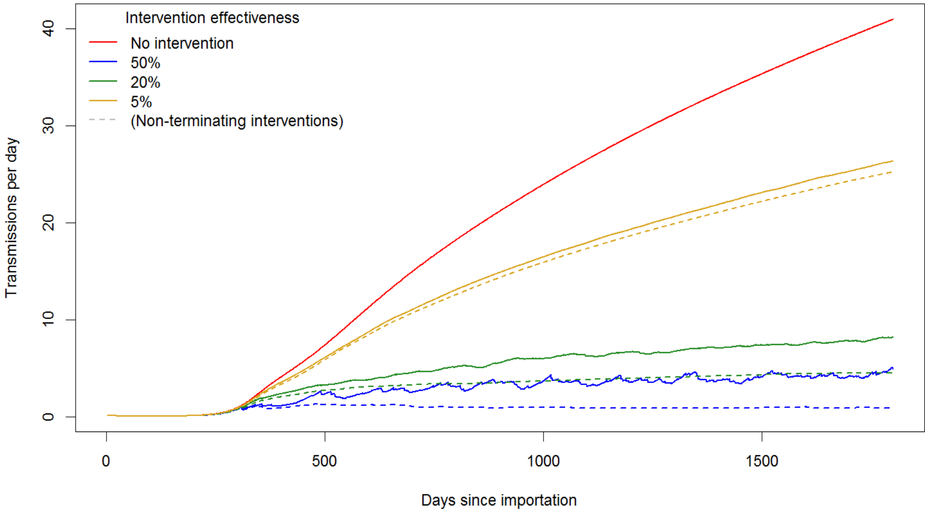
Figure 1. Relationship between epidemic stages, response tiers, containment response, and prevention activities for novel or targeted MDROs.



Organism or resistant mechanism that have

*Never (or very rarely) been identified **in the United States** and for which experience is extremely limited are Tier 1

^Never (or very rarely) been identified **in a public health jurisdisction but are more common in other parts of th**



Texas | A.R. & Patient Safety Portal (cdc.gov)

Antibiotic Use Across Settings

Environment

- Sometimes applied as pesticides to manage crop disease
- Effect on human health not well understood
- Human and animal waste, and pharmaceutical manufacturing waste, can introduce antibiotics and antibiotic resistance into the environment

People

- Saved millions of lives and transformed medicine
- CDC estimates that U.S. doctors' offices and emergency departments prescribe about 47 million antibiotic courses each year for infections that don't need antibiotics--that's about 30% of all antibiotics prescribed in these settings[2]

Animals

- Used to treat infections in pets and food animals
- Since 2017, veterinary oversight has been required for the use of medically important antibiotics in the feed and drinking water of food animals for treatment, control, or prevention of infection [3,4]

GEOGRAPHIC LOCATIONS

Antibiotics are prescribed differently across the United States. Reasons for regional variation may include different prescribing behaviors, diagnostic patterns, disease burden, and levels of antimicrobial resistance among certain pathogens.

OUTPATIENT PRESCRIPTION RATE OF ALL CLASSES DISPENSED IN U.S. PHARMACIES BY STATE MAP

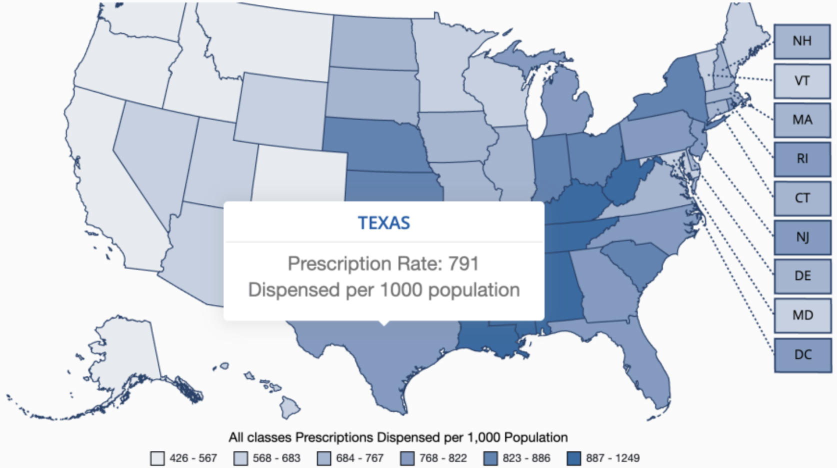
YEAR
2024

ANTIBIOTIC CLASS
All Classes

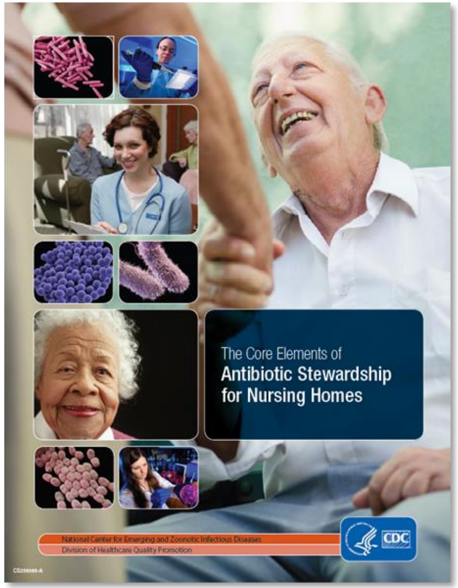
This map displays prescription rates all classes per 1,000 population dispensed in outpatient pharmacies across U.S. states in 2024.

OUTPATIENT PRESCRIPTION RATE OF ALL CLASSES BY STATE IN 2024

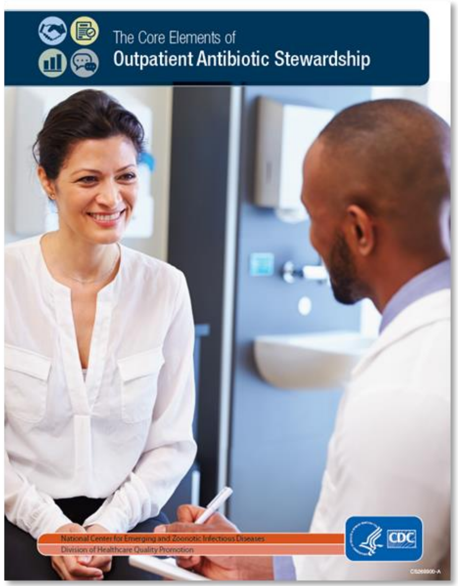
VIEW DATA SAVE IMAGE SHARE



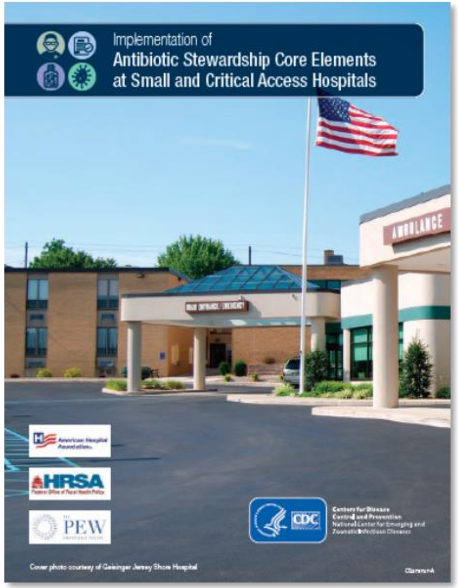
CDC provides resources to support antibiotic stewardship programs across healthcare settings.



Nursing homes



Outpatient



Small and Critical Access Hospitals

Resource-limited Settings

https://www.cdc.gov/antibiotic-use/core-elements/index.html

Antibiotic Stewardship and Sepsis: A Balancing Act

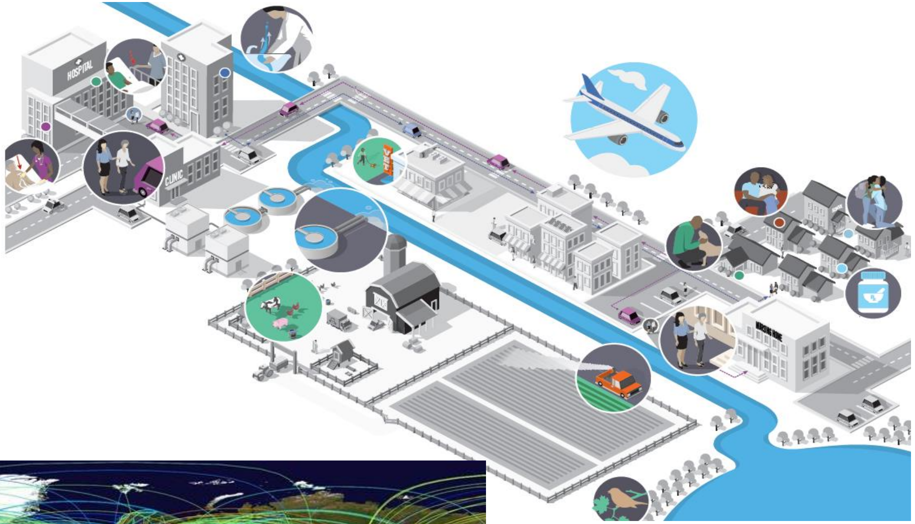
- Antibiotic stewardship implementation can help avoid delays in diagnosis and initiation of treatment of suspected infections and optimize treatment of patients with sepsis.
- Antibiotic stewardship can help prevent infections with *C. difficile* and antimicrobial-resistant bacteria.[1]

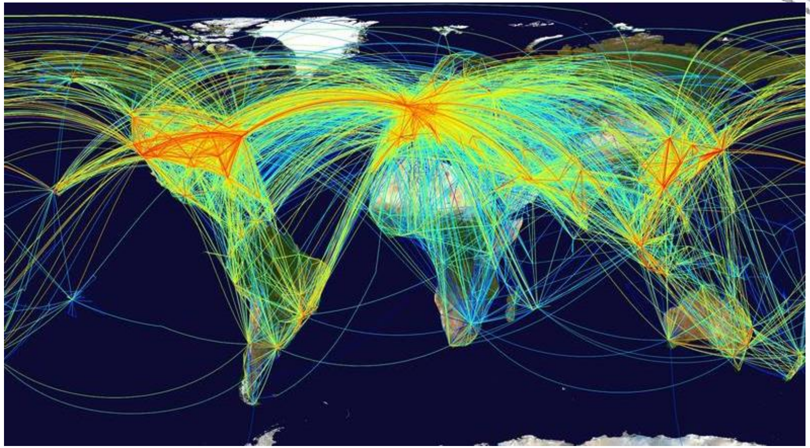
1. Baur et al, Lancet Infect Dis. 2017 Sep;17(9):990-1001.

Innovation Gaps to Fight Antibiotic Resistance

- New antibiotics, vaccines, and therapeutics to prevent or treat antibiotic resistant infections
- Reliable diagnostics, including at point of care, to support early detection and improved antibiotic use and enhance healthcare provider and veterinarian decision-making
- Better understanding of the microbiome and how it can be leveraged to prevent and treat infection
- Better strategies for preventing spread in healthcare and community settings
- Better strategies to improve antibiotic stewardship wherever antibiotics are used
- Better understanding of antibiotic resistance in the environment and its impact on human and animal health
- Predictive analytics to help identify actions needed to prevent the spread of resistance across human and animal healthcare facilities, food, the community, and the environment

A Complex Web: Everything Is Connected





Cultural Change in Expectations

Impact in each and every live

today and always