Strategies to prevent the spread of antimicrobial resistance in Colorado

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Objectives

- Identify the prevalence of antimicrobial resistance threats in Colorado.
- Implement infection control strategies to prevent spread of antimicrobial resistance in long-term care settings.
- Implement antimicrobial stewardship strategies in long-term care settings.

Antimicrobial resistance

Antimicrobial resistance threats

Candida auris

Carbapenem-resistant *Enterobacterales* (CRE) - *E. cloacae*, *K. pneumoniae*, *E. coli*

ESBL-producing *Enterobacterales* (ESBL) - *E. coli*, *K. pneumoniae*

Clostridioides difficile

https://www.cdc.gov/drugresistance/biggest-threats.html

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National epidemiology

	C. auris	**CRE**	**ESBL**	***C. difficile***
Emergence	First identified in the U.S. in 2016	First identified in the U.S. in 2001	Emerged in the 1980's	Epidemic strain, ribotype 027, emerged in the 2000s
Antimicrobial resistance	Antifungals CRE colonization (>50%)	Carbapenems Carbapenemases (30%)	Penicillins, cephalosporins, and monobactams	Fluoroquinolones
Incidence	Increase in number and spread in the U.S. since 2018 Outbreaks in healthcare settings (LTACH, vSNF)	Decrease 7.5 to 6.1 per 100k from 2016-2020 35% increase in hospital-onset CRE in 2020	200 per 100k in 2017	144 per 100k in 2017 36% decrease in healthcare-associated infections
Community-associated	-	21%	47%	50%

Duffy OFID 2023; Guh NEJM 2020; Guh OFID 2023; Lyman Annals Internal Med 2023; Woodworth. MMWR 2018.

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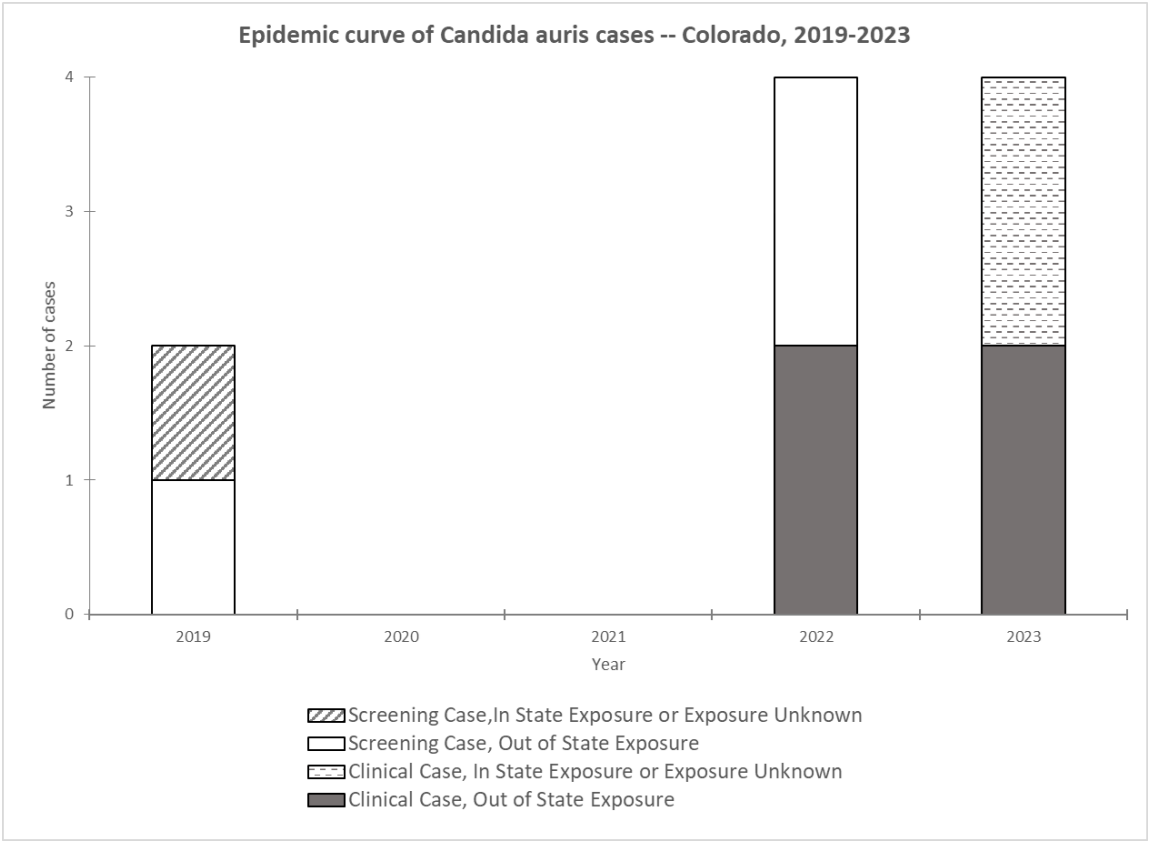
C. auris in Colorado



- 6 (60%) male
- Median age 53.5y (range <1-77y)
- 2 patients admitted to a ventilator-capable skilled nursing facility (vSNF)
- 2 patients without known out-of-state exposure

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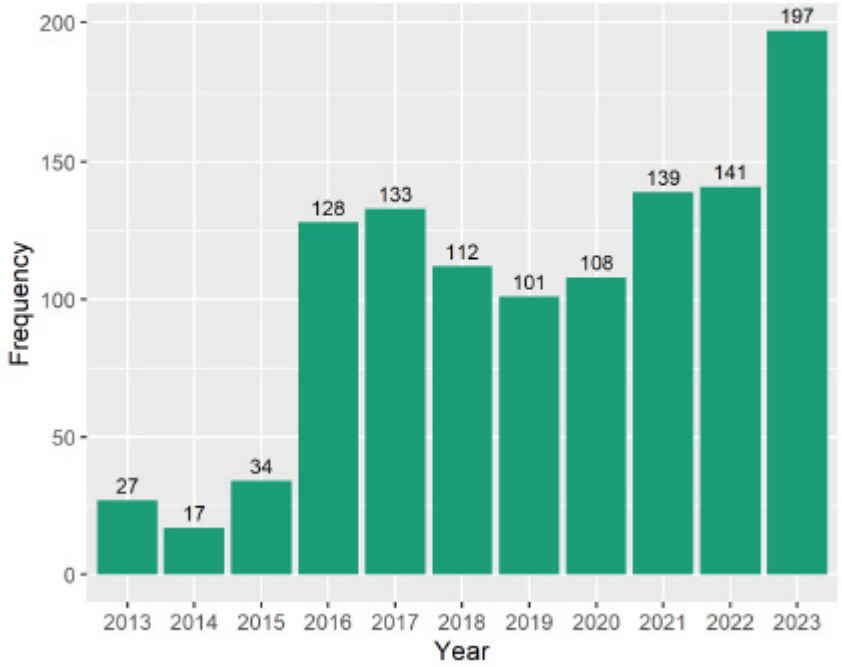
CRE in Adams, Arapahoe, Denver, Douglas, and Jefferson Counties

Incident CRE Cases by Year — Adams, Arapahoe, Denver, Douglas, and Jefferson Counties, Colorado, 2013-2023



	Overall (N=1137)
Sex	
F	660 (58.0%)
M	477 (42.0%)
Ethnicity	
Hispanic	171 (15.0%)
Not Hispanic	697 (61.3%)
Unknown	252 (22.2%)
Missing	17 (1.5%)
Race	
American Indian or Alaska Native	10 (0.9%)
Asian	28 (2.5%)
Black	96 (8.4%)
Multiple	5 (0.4%)
Native Hawaiian and Other Pacific Islander	3 (0.3%)
Unknown	246 (21.6%)
White	749 (65.9%)
Age	
Mean (SD)	63.9 (20.1)
Median [Min, Max]	68.0 [1.00, 107]

* Case definition change in 2016.

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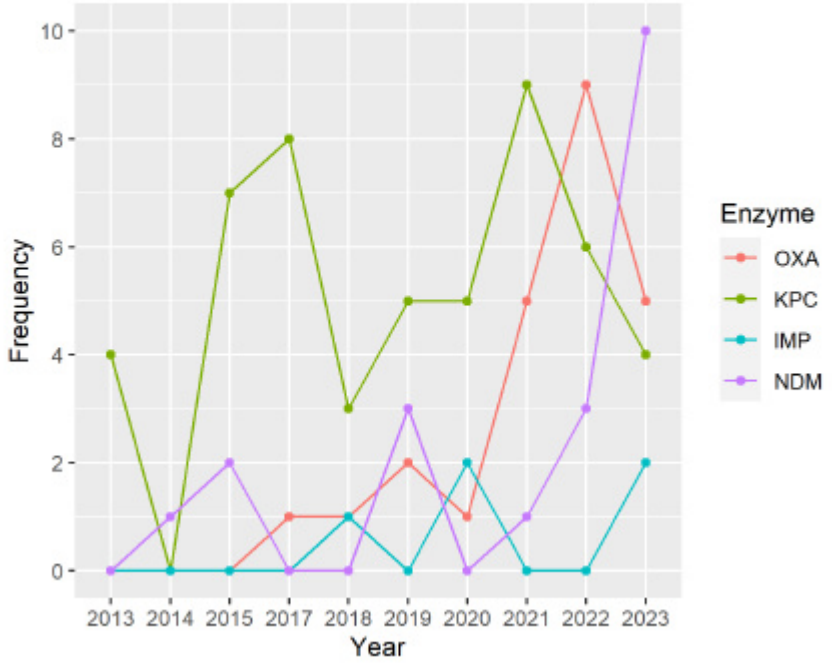
Carbapenemases

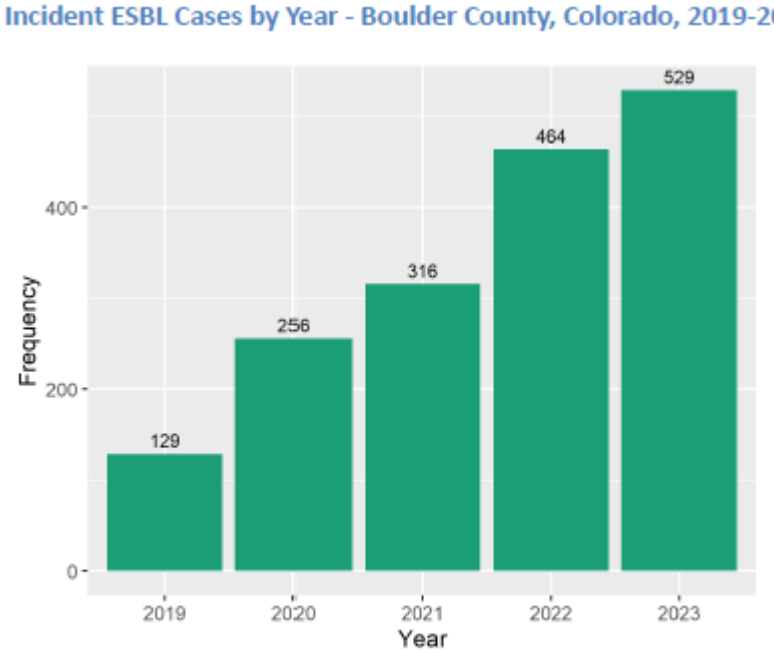
Carbapenemase Counts by Enzyme and Year — Adams, Arapahoe, Denver, Douglas, and Jefferson Counties, Colorado, 2013-2023



- KPC is the most common carbapenemase in the U.S.
- NDM is a less-common metallo-beta-lactamase and is harder to treat.
- Colorado experienced an increase in KPC in 2021 and 2022, followed by an increase in NDM in 2023.
- Increases in community-onset infections, KPC, NDM, and association with long-term care has been described elsewhere.

Lee EID 2023.

ESBL-producing *Enterobacterales* in Boulder County



*There were only 6 months of surveillance in 2019.

	Overall (N=1694)
Sex	
F	1345 (79.4%)
M	349 (20.6%)
Ethnicity	
Hispanic	188 (11.1%)
Not Hispanic	813 (48.0%)
Unknown	245 (14.5%)
Missing	448 (26.4%)
Race	
American Indian/Alaska Native	9 (0.5%)
Asian	54 (3.2%)
Black	5 (0.3%)
Multiple	6 (0.4%)
Native Hawaiian/Pacific Islander	1 (0.1%)
Unknown	654 (38.6%)
White	965 (57.0%)
Age	
Mean (SD)	60.5 (21.4)
Median [Min, Max]	66.0 [1.00, 99.0]

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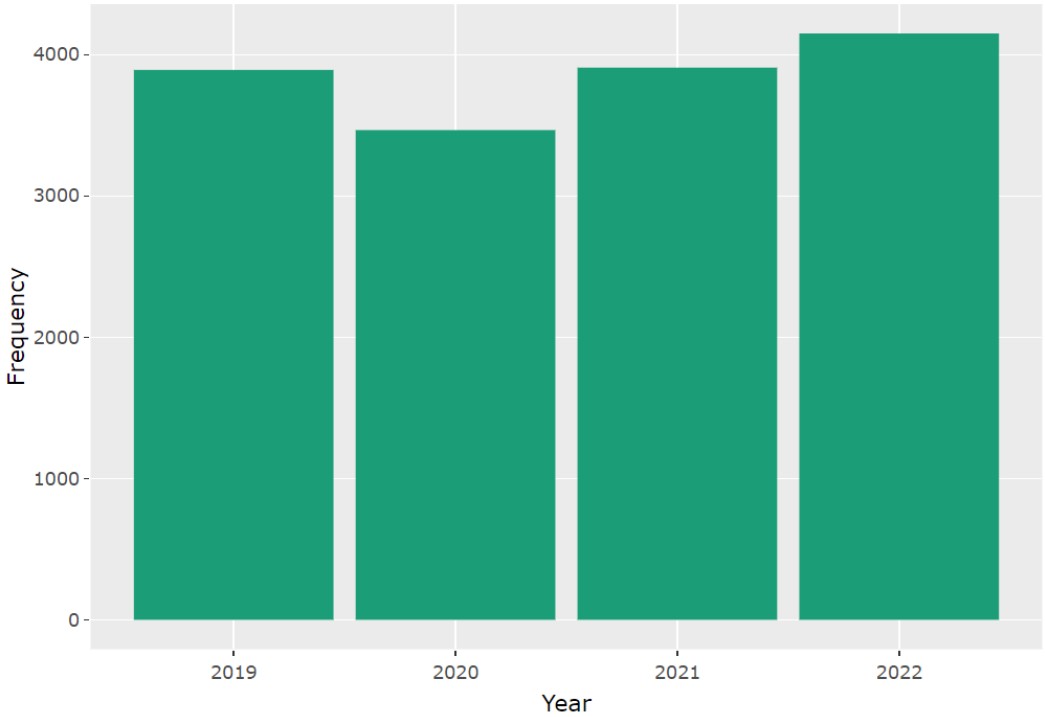
C. difficile in Adams, Arapahoe, Denver, Douglas, and Jefferson Counties



Demographic Characteristics - 2019-2022

	Overall (N=15416)
County	
Adams	2529 (16.4%)
Arapahoe	3897 (25.3%)
Denver	4091 (26.5%)
Douglas	1924 (12.5%)
Jefferson	2975 (19.3%)
Age	
Mean (SD)	56.1 (22.0)
Median [Min, Max]	60.0 [1.00, 104]
Sex	
Male	6754 (43.8%)
Female	8662 (56.2%)

*58% community-associated.

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Transmission, risk factors, presentation

Transmission

- Person-to-person, direct or indirect contact
- Asymptomatic carriers
- Contamination and persistence in the healthcare environment
- Patient movement between health care facilities

Risk factors

- Older age
- Medical comorbidities
- Medical devices, procedures, or surgeries
- Prior antibiotic use
- Prolonged hospital stays
- Post-acute care
- Prior colonization
- Travel

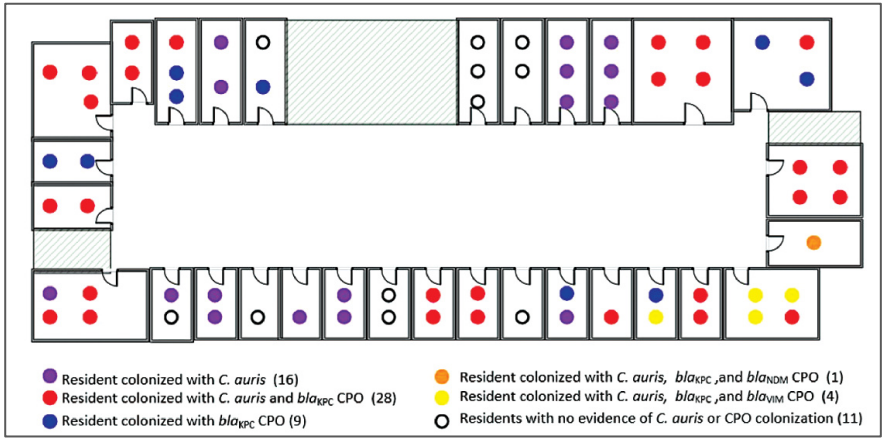
Presentation

- *C. auris*: Blood > urine, respiratory, wound
- CRE, ESBL: Urinary tract infection, bacteremia, pneumonia
- CDI: Diarrhea, ileus, shock, toxic megacolon, intestinal perforation, recurrence
- Hospitalization, intensive care, death

Adams. Emerging Infect Dis 2018; Donskey. IDCNA 2023; Duffy, ICHE 2022; Guh. OFID 2023; Guh JAMA 2015; Lockhart. Clin Infect Dis 2017; Rossow. Clin Infect Dis 2021; .

Asymptomatic carriage

ID	Total Number of Tests	Positive Tests	BSI Prior to start of colonization testing	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	Disposition	Percent Positive
1	2	2		1	1																																Admitted	100%
2	2	2		1	1																																Discharged	100%
3	2	2		1	1																																Discharged	100%
4	2	2		1	1																																Discharged	100%
5	2	2		1	1																																Discharged	100%
6	3	3		1				1		1																											Discharged	100%
7	3	3		1	1	1																															Expired	100%
8	3	3		1		*			1	1																											Expired	100%
9	3	3		1	1	1																															Admitted	100%
10	4	3		2	1	0																															Discharged	75%
11	4	4		1	1	2																															Discharged	100%
12	4	4		1	1	1	1																														Admitted	100%
13	4	4		1	1	1	1																														Discharged	100%
14	4	4		1	1	1	1																														Admitted	100%
15	4	4		1	2	1																															Expired	100%
16	5	4		1	1	1					1	0																									Expired	80%
17	5	5		1	1	1	1	1																													Discharged	100%
18	5	5		1	1	1	1	1																													Discharged	100%
19	5	5		2		1	1	1																													Discharged	100%
20	6	6		1	1	1	1	1	1																												Admitted	100%
21	7	7		1	2	1	1	1	1	1																											Discharged	100%
22	9	8		1	0	1	1	1	1	1	1	1																									Discharged	89%
23	9	9		1	1	1	1	1	1	2	1																										Expired	100%
24	9	9		1	1	1	1	1	1	1		1	1	1																							Expired	100%
25	10	10		1	2	1	1	1	1	1	1	1	1																								Admitted	100%
26	11	4		1	1	1	0	0	0	0	0	0	0	1																							Expired	36%
27	11	10	**	1	1	1	1	1	1	1	1	1	1	0																							Admitted	91%
28	12	11		1	1	0	1	1	1	1	1	1	1	1	1																						Admitted	92%
29	15	15		1	1	1	1	1	1	1	1	1			1	1	1	1	1	1																	Admitted	100%
30	15	15		1	2	1	2	2	1	2	1		1	1		1																					Discharged	100%
31	15	15		1	2	1	1	1	1	1	1	1	1	1	1	1	1																				Admitted	100%
32	16	16		1	2		1	2	2	2	1	1	1	1		1	1																				Expired	100%
33	18	11	***	1	1	1	1	2			1	1	1	1	0	0	0	0	0	1	0								0	0							Admitted	61%
34	19	18	***	1	2	1	2	2	1	2	1	1	1	1	1	1		1	1																		Discharged	95%
35	19	19		1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1														Discharged	100%
36	20	19		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0													Expired	95%
37	20	19		2				1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1														Admitted	95%
38	23	23		1	2	1	1	2	1	2	1	1	1	1		1	1	1	1	1	1	1	1	1													Discharged	100%
39	30	29		1	2	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1		Discharged	97%
40	31	18		1	2	1		2			1	1	0	1	1	1	1	1	0	1	0	0	1	0	1	1	0	0	0	0	0		0	0			Discharged	58%
41	31	27		1	2	1	1	2	0	2	1	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0							Discharged	87%
42	34	30		1	2	1	1	2	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1		0	1	1	1	Admitted	88%
43	34	33		1	2	1	2	2			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Expired	97%
44	35	28		0	2	2	1	1			0	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Discharged	74%
45	35	32		1	2		1	2	2		0	1	0	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Admitted	91%
46	35	32		1	2	1	1	2	2	1	1	1	1	1	1	1	0	0		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	Admitted	91%
47	35	33	**	2	2	1	2	2	1	1	1	1	1	1	1		0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1					Discharged	94%
48	35	35		1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	Admitted	100%
49	36	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Admitted	3%
50	36	23		1	2	1	0	2	1	2	1	1	1	1	1	1	1	1	1	0	0	1	0	0	0	1	0	0	0	0	1	1	0	1	0	0	Admitted	64%



- *C. auris*: 40-70%
- CRE: 11% (14% in post-acute care)

Arenas. ICHE 2023. Pacilli. Clin Infect Dis 2020; Woodworth. MMWR 2018.

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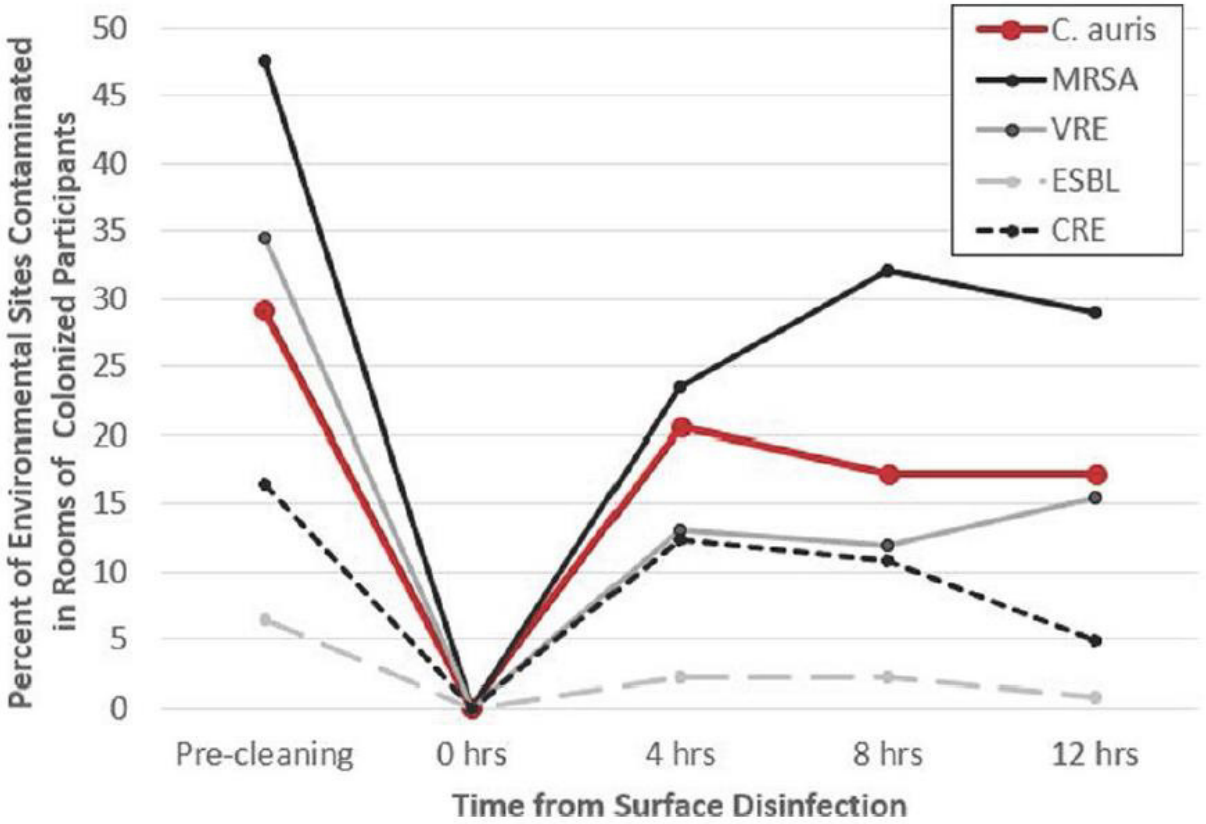
Environmental contamination



Sansom. CID 2023.

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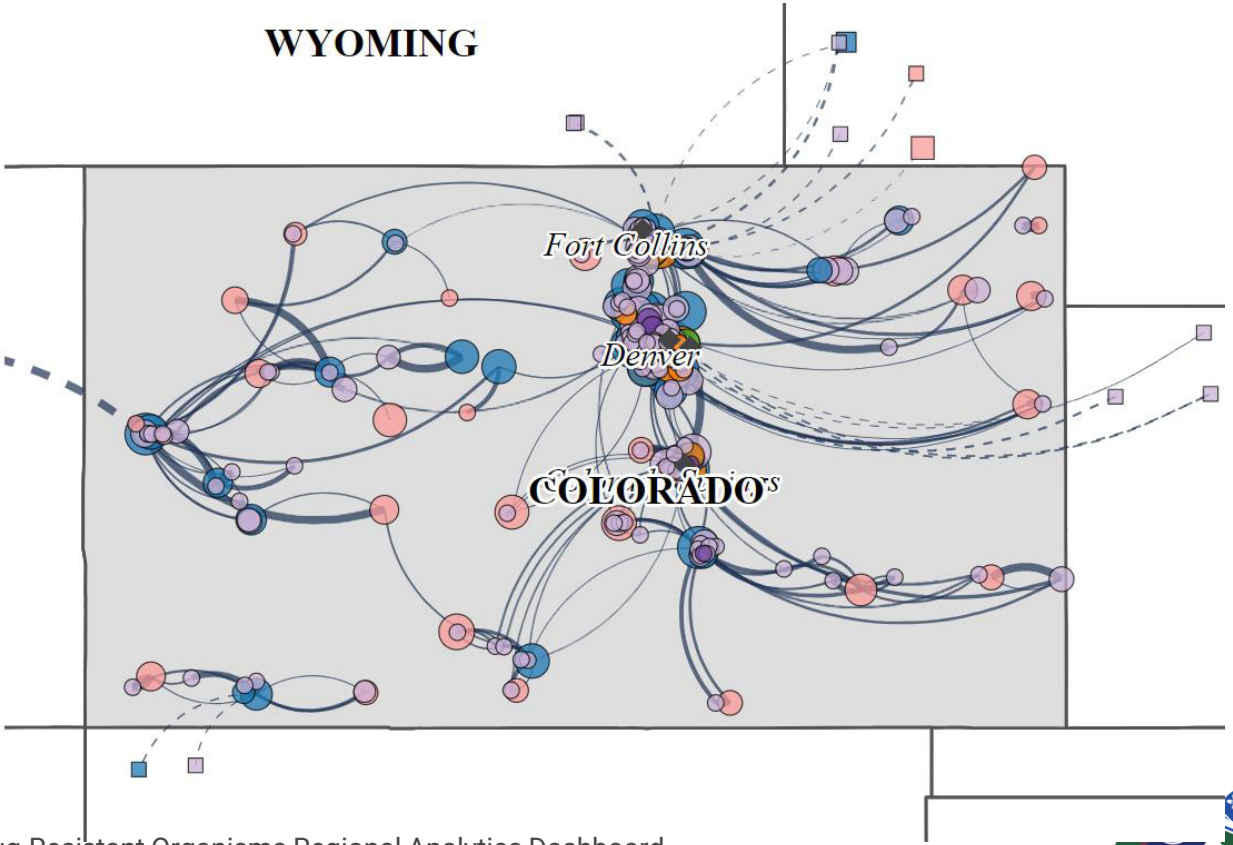
Interfacility transmission



Rany et al. (2023): Multidrug-Resistant Organisms Regional Analytics Dashboard.

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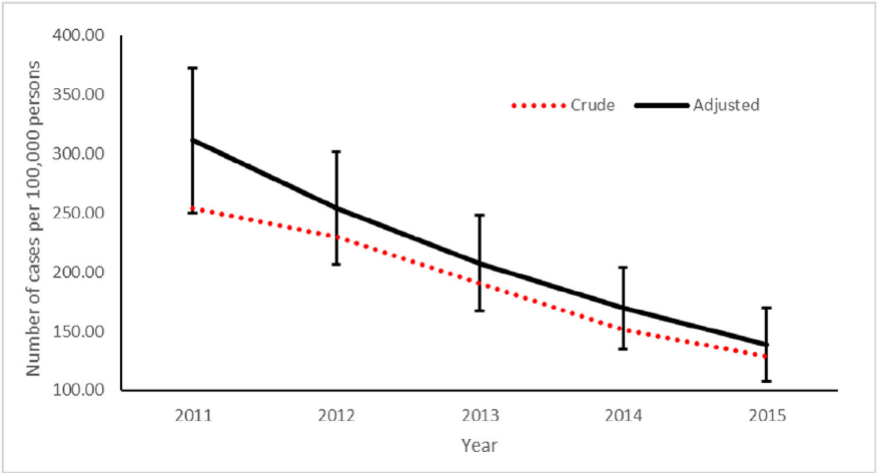
Long-term care

- Prevalence of ESBL, CRE, *C. difficile*, and *C. auris* carriage varies by location but can be high.
- Carriage contributes to transmission.
- Patients with infection often have a history of long-term care residence or onset of infection in long-term care.
- Hospitalized patients with infection are often discharged to long-term care.



Good news: long-term care facility onset *Clostridioides difficile* infection incidence rates across 10 US sites.

Duffy. ICHE 2022; Donskey. ICHE 2018; Guh. AJIC 2018; Guh. JAMA 2015; Park. BMC ID 2024; van Dulm. PLoS One 2019.

Infection prevention

Admission screening for *C. auris* and carbapenemases

- Patients who have had an overnight stay or invasive medical or surgical procedure in a healthcare facility outside the U.S. in the previous year.
- Patients who have had an overnight stay in a long-term acute care hospital (LTACH) or ventilator-capable skilled nursing facility (vSNF) anywhere in the U.S. in the previous year.

CDPHE. Health Advisory 2023.

Standard and enhanced barrier precautions

Standard Precautions

- Hand hygiene with alcohol-based hand sanitizer or soap and water
- Personal protective equipment (PPE) as needed
- Injection safety and respiratory hygiene

Enhanced Barrier Prec.

- Targeted gown and glove use during high contact activities
- For residents with colonization, wounds, or medical devices
- No isolation or restriction from group activities

Environ. disinfection

- Daily and terminal room cleaning
- Environmental surfaces and reusable equipment
- EPA-registered products: List P for *C. auris*, List K for *C. difficile*

*Notification upon transfer!

CDC: https://www.cdc.gov/hai/containment/PPE-Nursing-Homes.html

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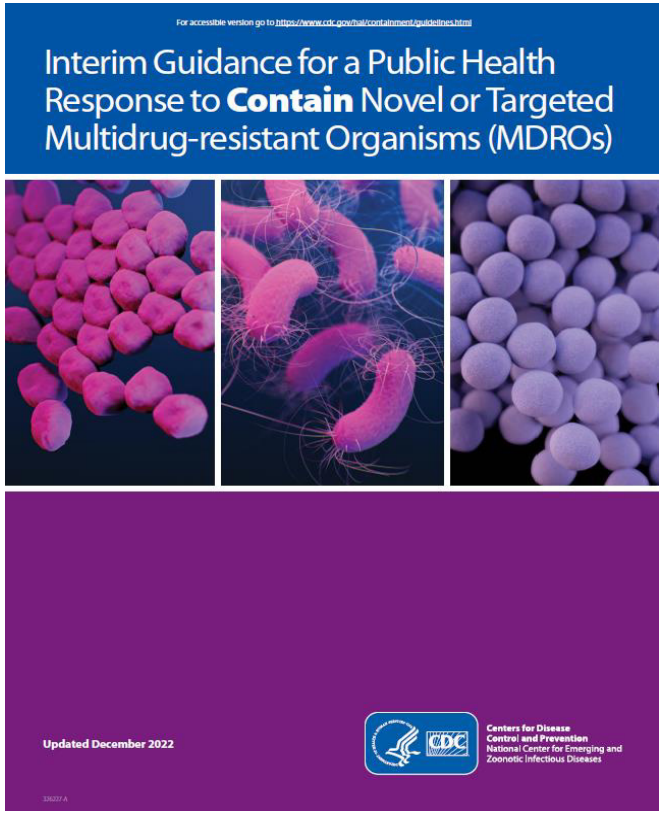
Public health response



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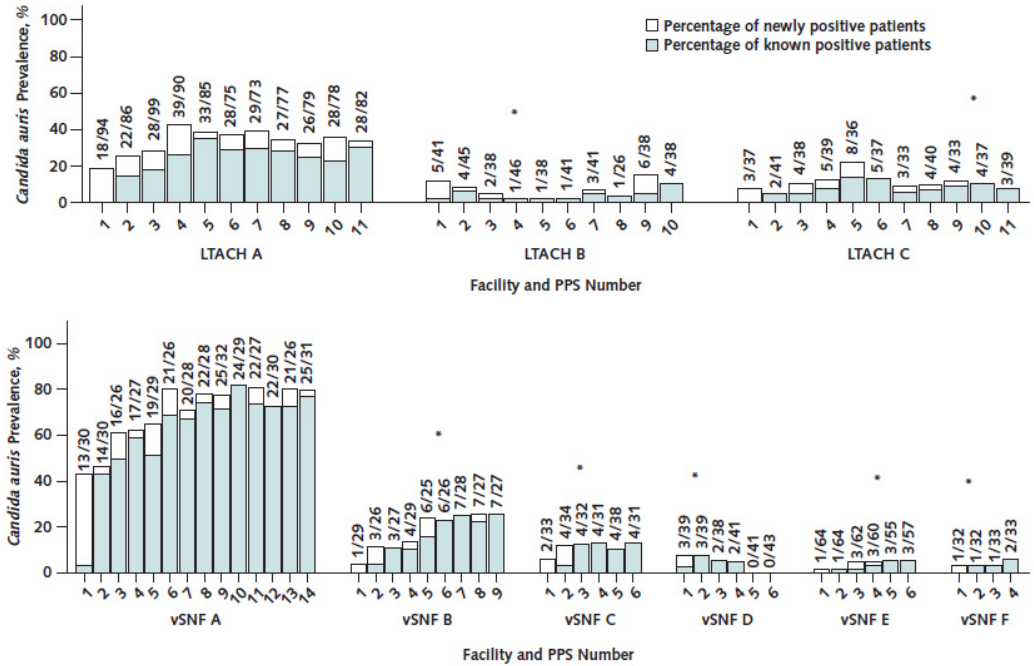
Containment - *C. auris* - Orange County, 2018

Figure 1. Prevalence of *Candida auris* and the total number of screening cases (new and known) among total facility census, identified on serial PPSs within all OC LTACHs and 6 vSNFs (A to F), by PPS number–OC, California, March to October 2019.



LTACH = long-term acute care hospital; OC = Orange County; PPS = point prevalence survey; vSNF = ventilator-capable skilled-nursing facility.
* First facility instances of 2 consecutive PPSs with no new positive detections.

Karmarkar et al. Annals Intern Med 2021.

Lessons Learned

- Single regional introduction with undetected transmission.
- Containment efforts can control transmission if initiated early.

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Antimicrobial stewardship

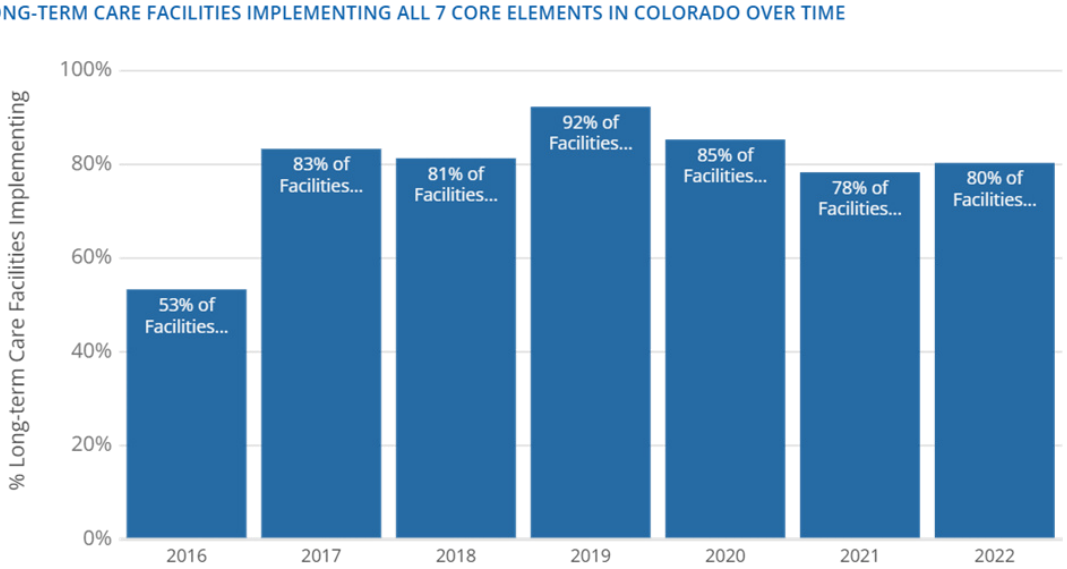
Antimicrobial stewardship core elements

LONG-TERM CARE ANTIBIOTIC STEWARDSHIP CHANGES OVER TIME

CORE ELEMENT ALL 7 CORE ELEMENTS

STATE COLORADO

This graphic shows the change over time in long-term care implementation of antibiotic stewardship by state and Core Element from 2016 to 2022. Click on the bar in the graphic to see the number of facilities reporting the implementation of the Core Elements by year.



CDC. Antimicrobial Resistance & Patient Safety Portal: https://arpsp.cdc.gov/profile/ltc/united-states-United%20States.

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Antibiograms

Statewide Antibiogram[1] for Gram Negative Bacteria in Assisted Living Facilities and Skilled Nursing Facilities[2] - Colorado, 2017

Organism	Number of Isolates Tested for Each Antibiotic[3]		Aminoglycosides		Beta-lactams										Fluoroquinolones		Other	
	Median	Range	Gentamicin	Tobramycin	Ampicillin	Ampicillin-Subactam	Amoxicillin-Clavulanate	Cefazolin	Cefepime	Ceftriaxone	Ceftazidime	Ertapenem	Imipenem	Piperacillin-Tazobactam	Ciprofloxacin	Levofloxacin	Nitrofurantoin	Trimethoprim-Sulfamethoxazole
Citrobacter freundii	148	133-151	95	96	R	R	R	R	99	85	85	100	100	88	89	89	94	79
Enterobacter species[4]	217	192-219	96	96	R	R	R	R	94	74	74	100	95	74	94	94	41	91
Enterobacter aerogenes	73	72-74	100	100	R	R	R	R	100	77	78	100	100	77	96	96	24	100
Enterobacter cloacae	144	120-146	94	94	R	R	R	R	90	73	73	99	93	73	92	93	51	87
Escherichia coli	2544	585-2628	89	88	49	57	80	14	88	87	87	100	100	95	61	60	94	74
Klebsiella species[5]	975	168-987	97	97	R	83	95	21	95	95	95	100	99	95	96	96	62	92
Klebsiella oxytoca	176	108-177	98	98	R	66	90	30	98	97	97	100	100	93	98	98	86	95
Klebsiella pneumoniae	800	60-810	97	97	R	87	96	5	95	94	94	100	99	96	96	96	57	92
Proteus mirabilis	737	237-747	82	84	62	74	100	42	86	85	85	100	R	97	51	58	R	60
Pseudomonas aeruginosa	377	372-383	89	--	R	R	R	R	87	R	--	R	83	--	70	65	R	R

CDPHE: https://cdphe.colorado.gov/healthcare-associated-infections-hais/hai-data/colorado-antibiogram.

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Tools for diagnosis and antibiotic review

ACTION TOOL

"Does the resident have new or worsening signs or symptoms that meet one of three criteria for suspected urinary tract infection?"

- ☐ **CRITERIA 1.** Painful urination (meets criteria alone) or
- ☐ **CRITERIA 2.** Fever: any fever >100°F or repeated temperatures > 99°F or >2°F over resident's baseline **plus** at least one new or worsening sign or symptom, including:
  - Frequency of urination
  - Sensation of urgency to urinate
  - Incontinence
  - Bloody urine
  - Pain in the area over the urinary bladder, just above the pubic bone (no other known cause)
  - Flank pain or tenderness
- ☐ **CRITERIA 3.** No fever, but **two or more of the signs or symptoms above.**

If the resident meets one of the criteria above, **ask the healthcare provider to consider:**

- ☐ Sending urine for urinalysis and culture **and**
- ☐ Ordering empiric antibiotics until culture results return.

If the resident does not meet the above criteria, **refer to the facility's care paths** for considering alternative diagnoses and when to contact the provider.

Healthcare providers should hold an **antibiotic time-out** to review and document patient signs and symptoms and urine culture results within 48 hours. Healthcare providers should then narrow or stop antibiotics as indicated and determine appropriate duration.

Guidance for management of urinary tract infection and asymptomatic bacteriuria can be found in the *Infectious Diseases Society of America Practice Guidelines* at www.idsociety.org.

Suspected Urinary Tract Infection (UTI) Action Tool

Purpose
Guide nursing staff in the initial evaluation of possible urinary tract infection (UTI) in residents without a urinary catheter.

Setting
Nursing homes.

Rationale
Overuse or misuse of antibiotics leads to antibiotic-resistant bacteria, possible side effects and adverse drug events, added costs and *Clostridium difficile*.

References: 1) Stone, N, et. al., Surveillance Definitions of Infections in Long-Term Care Facilities: Revisiting the McGeer Criteria; Infection Control and Hospital Epidemiology, Vol. 33, No. 10 (October 2012), pp. 965-977; 2) Loeb et al. Development of Minimum Criteria for the Initiation of Antibiotics in Residents of Long-Term-Care Facilities: Results of a Consensus Conference. Infect Control Hosp Epidemiol 2001; 22: 120-124.

This material was prepared by Telligen, the Medicare Quality Innovation Network Quality Improvement Organization, under contract with the Centers for Medicare & Medicaid Services (CMS), an agency of the U.S. Department of Health and Human Services. The contents presented do not necessarily reflect CMS policy. 1 15OW-QIN-C2-10/29/18-3044

www.TelligenQINQIO.com

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Respiratory Viruses and Antimicrobial Stewardship

LONG-TERM CARE TOOLKIT

Care Team

- Assessment of suspected RTI
- Virus or Bacteria?
- Consultant Pharmacists
- Antibiotics Communication Toolkit

Residents and Families

- Talking with residents/family about respiratory infections
- Talking with residents/family about antibiotics

Facility

- Stewardship commitment letter
- CDC Core Elements
- AHRQ Stewardship Toolkit

Check out the CDC and AHRQ for more resources!

ACTION TOOL

Antibiotic Time-Out Checklist

Use this checklist to take a Time-Out to reassess every antibiotic within 48-72 hours after antibiotic start. Refer to practice guidelines and/or facility-specific treatment recommendations, when appropriate.

Resident name or ID _____ Date of review _____

Prescriber (MD, DO, NP, PA) participating in Time-Out _____

Checklist completed by _____

Antibiotic name _____ Start date _____ Stop date _____

Antibiotic indication, dose, route _____

Yes	No	Antibiotic Time-Out	Comments
		Based on review of the clinical assessment, laboratory test results (including culture and sensitivity testing, if available), and/or other diagnostic test results, does this resident have a bacterial infection that will respond to antibiotics?	
		If so, is the resident on the most appropriate antibiotic(s)? Can the spectrum of the antibiotic be narrowed (de-escalation)?	
		Is the antibiotic being given in the correct dose?	
		Is the antibiotic being given by the most appropriate route (example: IV vs PO)?	
		How long will the antibiotic be needed? Can the duration of therapy be shortened?	
		Is the necessary documentation present to support the clinical team's assessment and decisions?	

See reverse for instructions

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Antibiotic use in nursing homes: a summary of guideline

Guidelines summary for urinary tract infection[2-3,5-7]

UTI syndrome	Diagnostic findings	Treatment and duration	Note	Reference
Asymptomatic bacteriuria (ASB)	≥100,000 CFU/mL of bacteria, no signs or symptoms localized to genitourinary tract	No antibiotics	Screening for and treatment of ASB is not recommended Prior to urologic procedure with mucosal trauma is exception-visit Ashraf for details	Ashraf MS, et al. JAMDA. 2020;21:12e24. Hooten TM,et al. Clin Infect Dis.2010;50(5):625-63. Nicolle LE, et al. Clin Infect Dis.2019;68(10):1611-1615.
Simple cystitis	≥100,000 CFU/mL of ≤ 2 species of bacteria or ≥100 CFU/mL of ≥ 1 species of bacteria in specimen by straight catheter Localized symptoms: acute dysuria,frequency, gross hematuria, new/worsening incontinence, suprapubic tenderness, urgency	Nitrofurantoin* x 5 days OR TMP-SMX† x 3 days OR beta-lactams (amox-clav, cefaclor, cefdinir, cephalexin, cefpodoxime) x 5 days OR fosfomycin x 1 dose OR fluoroquinolones (FQ) x 3 days	FQ use should be minimized, not considered first-line TMP-SMX only recommended if local resistance rates < 20% (IDSA) If high-risk for treatment failure, may require 7 days of treatment-visit Ashraf for details Additional doses of fosfomycin required if duration > 3 days	Ashraf MS, et al. JAMDA. 2020;21:12e24. Gupta K, et al. Clin Infect Dis.2011;52(5):e103-20. Jump RLP, et al. J Am Geriatr Soc.2018;66(4):789-803.

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Clinical pathways

https://cdphe.colorado.gov/antimicrobial-stewardship

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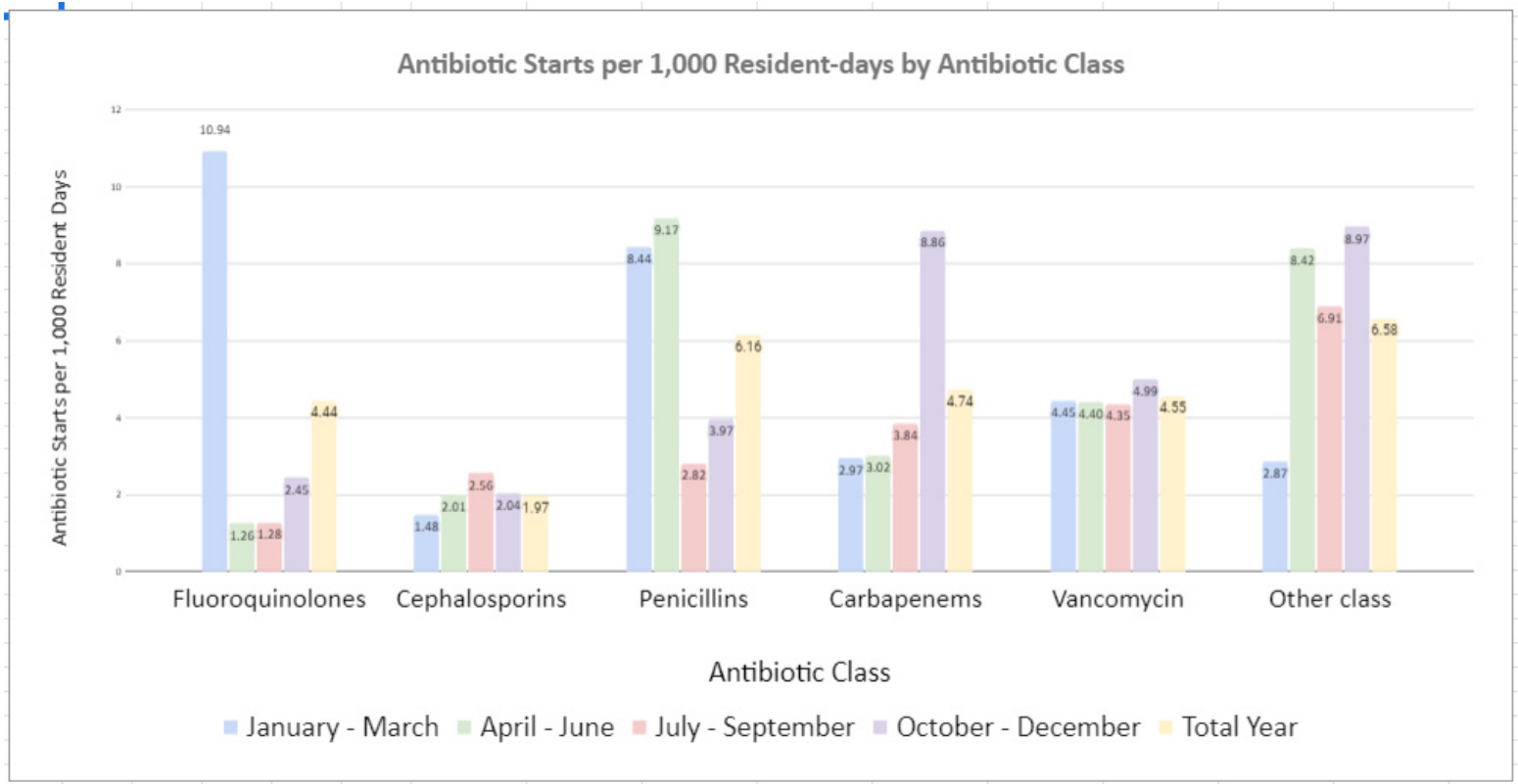
Antibiotic tracking and reporting



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Conclusions

Conclusions

- Antimicrobial resistance is an urgent public health threat.
- Spread is facilitated by asymptomatic carriage, contamination of the healthcare environment, and healthcare-related patient movement.
- Long-term care facilities are intimately connected to a larger network of health care facilities in Colorado.
- Clinical prevention strategies include early identification, infection prevention, and antimicrobial stewardship.
- Public health prevention strategies include antimicrobial resistance containment and enhanced MDRO prevention.

Thank you!

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