Section 5

Antimicrobial Resistance Surveillance

Antimicrobial Resistance Surveillance

Background

Antibiotics are one of the most impressive medical achievements of the twentieth century. However, the continuing emergence and spread of antimicrobial resistance jeopardizes the utility of antibiotics and threatens health globally. Resistant pathogens are often associated with prolonged hospital stays, increased intensity and duration of treatment, and increased mortality.

As of January 2016, the Florida Department of Health conducts the following surveillance to identify antibiotic resistance:

- Case-based surveillance
  - ◊ Health care providers and laboratories must report antibiotic susceptibility testing results for isolates of *Streptococcus pneumoniae* from normally sterile sites, such as blood or cerebrospinal fluid. Starting in June 2014, only laboratories participating in electronic laboratory reporting (ELR) are required to submit such results for people ≥6 years old. All laboratories are required to submit test results for children <6 years old.
  - ◊ Health care providers and laboratories must report antibiotic susceptibility testing results for isolates of *Staphylococcus aureus* that are not susceptible to vancomycin.
  - ◊ Health care providers and laboratories must report tuberculosis and associated laboratory results to the Department. Samples for all suspected or confirmed tuberculosis cases are forwarded to the Florida Department of Health Bureau of Public Health Laboratories for *Mycobacterium tuberculosis* testing; any sample positive for *M. tuberculosis* undergoes a rapid test for isoniazid and rifampin resistance.
- Electronic laboratory reporting (ELR) surveillance
  - ◊ Laboratories participating in ELR must report antibiotic susceptibility testing results for all *Acinetobacter baumannii*, *Citrobacter* species, *Enterococcus* species, *Enterobacter* species, *Escherichia coli*, *Klebsiella* species, *Pseudomonas aeruginosa*, *Serratia* species, and *S. aureus* isolates from normally sterile sites.
- The Department has been partnering with one of the largest commercial laboratories in the state to receive susceptibility testing results for all *S. aureus* isolates tested there since 2006.

Case-Based Surveillance

Streptococcus pneumoniae

S. pneumoniae causes many clinical syndromes depending on the site of infection (e.g., otitis media, pneumonia, bacteremia, meningitis, sinusitis, peritonitis, and arthritis). Invasive disease, for reporting purposes, includes cultures obtained from a normally sterile site, such as blood or cerebrospinal fluid.

A total of 619 *S. pneumoniae* invasive disease cases were reported to the Department in 2015 by health care providers and laboratories. Of those reported cases, 207 (33%) were classified as drug resistant because they had an isolate with at least intermediate resistance to at least one antibiotic.

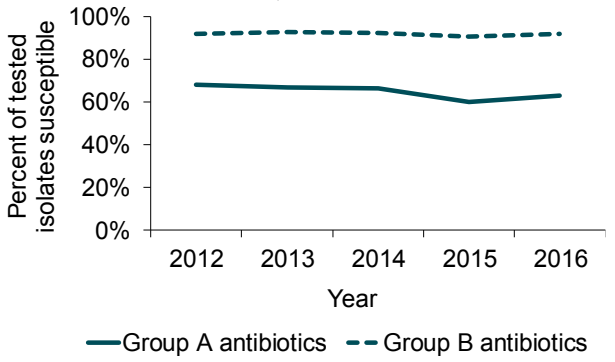
Antimicrobial susceptibility data are presented by Clinical and Laboratory Standards Institute (CLSI) Groups A-C, age group, and geography. CLSI Group A includes antibiotics that are considered appropriate for inclusion in a routine primary testing panel and for routine reporting of results for the specific organism groups. Group B includes antibiotics that may warrant primary testing but facilities can decide whether to report results based on specific conditions. Group C includes antibiotics considered to be alternative or supplemental. Susceptibility to Group A antibiotics is generally lower than susceptibility to Group B antibiotics, but susceptibility to both groups has only varied slightly since 2010 and has remained comparable from year to year.

For cases with more than one isolate tested, results for the most recent isolate were included in the analysis. Please note that due to inconsistencies in laboratory reporting formats, meningitis and non-meningitis breakpoints for penicillin and ceftriaxone results cannot be separated. When both a susceptible and resistant result were reported for one of these antibiotics on the same laboratory result, the resistant result was used for analysis.

Key points for isolates from reported *S. pneumoniae* invasive disease cases with antimicrobial resistance testing:

- Susceptibility by CLSI groups (Table 1, Figures 1 and 2):
  - ◊ From 2012 to 2016, the number of isolates tested decreased dramatically, but the percent of isolates susceptible to individual antibiotics remained relatively stable.
  - ◊ Group A (appropriate for primary testing and routine reporting): the percent of tested isolates susceptible to Group A antibiotics decreased from 68% in 2011 to 63% in 2016.
  - ◊ Group B (may warrant primary testing, but reported selectively): the percent of tested isolates susceptible to Group B antibiotics remained relatively stable, varying between 91% in 2015 to 93% in 2013.
  - ◊ Group C (alternative antibiotics): susceptibility remained high in 2016 with 88% to 100% of tested isolates susceptible to Group C antibiotics.
  - ◊ Susceptibility results for Group B and C antibiotics may underestimate the actual susceptibility rates in the community if only those isolates resistant to Group A antimicrobials are tested against Group B or C antibiotics.
- Most *S. pneumoniae* invasive disease cases were identified in adults ≥25 years old, so susceptibility data in children were sparse. Susceptibility to individual antibiotics was slightly lower in adults ≥65 years old than adults 25-64 years old for all antibiotics except levofloxacin (Table 2).

Figure 1. Percent of Tested Isolates From Reported *S. pneumoniae* Invasive Disease Cases That Were Susceptible to Clinical and Laboratory Standards Institute (CLSI) Antibiotic Groups A and B,[1] Florida, 2012-2016



Note that this figure includes data from cases that were reported to the Department by health care providers and laboratories as part of mandatory case-based disease reporting. If multiple isolates were tested for one case, the most recent results were included in the analysis.

1 Group A includes antibiotics that CLSI considers appropriate for primary testing and routine reporting and Group B includes antibiotics that may warrant primary testing but should be reported selectively.

- The small number of isolates tested makes it difficult to draw conclusions about susceptibility patterns by region (Table 3). Susceptibility to erythromycin ranged from 36% in the east central region to 49% in the southeast region. Susceptibility to penicillin ranged from 47% in the southeast region to 80% in the west central region.

Table 1. Percent of Tested Isolates From Reported *S. pneumoniae* Invasive Disease Cases That Were Susceptible to Selected Antibiotics by Clinical and Laboratory Standards Institute (CLSI) Antibiotic Groups A and B,[1] Florida, 2012-2016

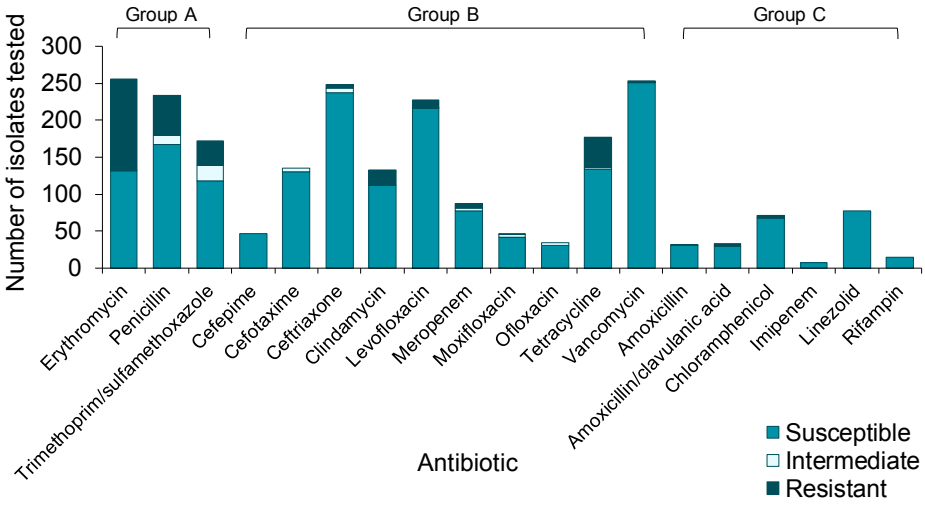
CLSI group[1]	Antibiotic name	2012		2013		2014		2015		2016	
		Number tested	Percent susceptible	Number tested	Percent susceptible	Number tested	Percent susceptible	Number tested	Percent susceptible	Number tested	Percent susceptible
Group A	Erythromycin	759	61%	840	58%	581	56%	187	49%	256	52%
	Penicillin	854	72%	967	72%	618	72%	158	69%	234	71%
	Trimethoprim/sulfamethoxazole	577	72%	680	70%	462	73%	114	68%	172	69%
Group B	Cefepime	117	89%	157	96%	113	91%	24	--	46	100%
	Cefotaxime	432	88%	525	92%	329	93%	93	94%	135	96%
	Ceftriaxone	831	91%	900	93%	599	93%	177	92%	249	96%
	Clindamycin	309	83%	396	82%	306	81%	79	73%	133	84%
	Levofloxacin	689	99%	774	99%	567	99%	138	98%	227	95%
	Meropenem	234	85%	338	87%	229	89%	49	84%	87	89%
	Moxifloxacin	193	100%	194	99%	159	99%	37	97%	47	89%
	Ofloxacin	60	95%	55	96%	65	94%	19	--	34	91%
	Tetracycline	472	79%	566	81%	406	78%	98	73%	177	76%
	Vancomycin	881	100%	962	100%	654	100%	174	100%	253	99%

Note that this table includes data from cases that were reported to the Department by health care providers and laboratories as part of mandatory case-based disease reporting. If multiple isolates were tested for one case, the most recent results were included in the analysis.

1 Group A includes antibiotics that CLSI considers appropriate for primary testing and routine reporting and Group B includes antibiotics that may warrant primary testing but should be reported selectively.

-- Percent susceptible was suppressed if <30 isolates were tested for susceptibility to a particular antibiotic.

Figure 2. Antibiotic Susceptibility Patterns for Tested Isolates From Reported *S. pneumoniae* Invasive Disease Cases by Clinical and Laboratory Standards Institute (CLSI) Antibiotic Groups,[1] Florida, 2016



Note that this table includes data from cases that were reported to the Department by health care providers and laboratories as part of mandatory case-based disease reporting. If multiple isolates were tested for one case, the most recent results were included in the analysis.

1 Group A includes antibiotics that CLSI considers appropriate for primary testing and routine reporting, Group B includes antibiotics that may warrant primary testing but should be reported selectively, and Group C includes antibiotics considered to be alternative or supplemental.

Table 2. Percent of Tested Isolates From Reported *S. pneumoniae* Invasive Disease Cases That Were Susceptible to Selected Antibiotics by Clinical and Laboratory Standards Institute (CLSI) Antibiotic Groups[1] and Age Group, Florida, 2016

CLSI group[1]	Antibiotic name	<1-year-olds		1-4-year-olds		5-14-year-olds		15-24-year-olds		25-64-year-olds		>64-year-olds	
		Number tested	Percent susceptible	Number tested	Percent susceptible	Number tested	Percent susceptible	Number tested	Percent susceptible	Number tested	Percent susceptible	Number tested	Percent susceptible
Group A	Erythromycin	10	--	31	58%	8	--	7	--	118	51%	82	51%
	Penicillin	13	--	33	79%	10	--	6	--	106	73%	66	68%
	Trimethoprim/sulfamethoxazole	7	--	21	--	5	--	5	--	82	74%	52	67%
Group B	Cefepime	1	--	2	--	0	--	2	--	26	--	15	--
	Cefotaxime	5	--	22	--	4	--	4	--	61	97%	39	97%
	Ceftriaxone	10	--	33	97%	11	--	7	--	114	97%	74	96%
	Clindamycin	6	--	15	--	6	--	5	--	62	85%	39	85%
	Levofloxacin	9	--	24	--	9	--	6	--	104	96%	75	93%
	Meropenem	3	--	13	--	0	--	3	--	42	88%	26	--
	Moxifloxacin	0	--	6	--	0	--	2	--	26	--	13	--
	Ofloxacin	1	--	6	--	0	--	1	--	17	--	9	--
	Tetracycline	5	--	20	--	5	--	5	--	83	75%	59	78%
	Vancomycin	11	--	36	97%	9	--	6	--	111	100%	80	99%

Note that this table includes data from cases that were reported to the Department by health care providers and laboratories as part of mandatory case-based disease reporting. If multiple isolates were tested for one case, the most recent results were included in the analysis.

1 Group A includes antibiotics that CLSI considers appropriate for primary testing and routine reporting and Group B includes antibiotics that may warrant primary testing but should be reported selectively.

-- Percent susceptible was suppressed if <30 isolates were tested for susceptibility to a particular antibiotic.

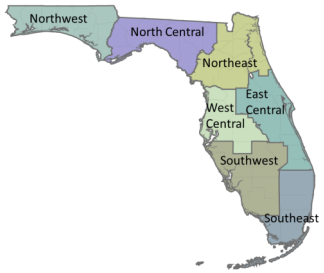
Table 3. Percent of Tested Isolates From Reported *S. pneumoniae* Invasive Disease Cases That Were Susceptible to Selected Antibiotics by Clinical and Laboratory Standards Institute (CLSI) Antibiotic Groups[1] and Region, Florida, 2016

CLSI group[1]	Antibiotic name	Northwest		North central		Northeast		West central		East central		Southwest		Southeast	
		Number tested	Percent susceptible	Number tested	Percent susceptible	Number tested	Percent susceptible	Number tested	Percent susceptible	Number tested	Percent susceptible	Number tested	Percent susceptible	Number tested	Percent susceptible
Group A	Erythromycin	36	36%	5	--	35	46%	56	66%	64	48%	11	--	49	53%
	Penicillin	21	--	2	--	30	77%	54	72%	58	71%	11	--	58	57%
	Trimethoprim/sulfamethoxazole	15	--	4	--	33	79%	24	--	47	62%	8	--	41	61%
Group B	Cefepime	20	--	0	--	19	--	4	--	2	--	0	--	1	--
	Cefotaxime	31	97%	2	--	26	--	15	--	41	98%	10	--	10	--
	Ceftriaxone	38	95%	4	--	34	94%	47	98%	58	98%	10	--	58	95%
	Clindamycin	27	--	2	--	22	--	28	--	17	--	3	--	34	76%
	Levofloxacin	33	85%	5	--	31	100%	49	92%	48	96%	14	--	47	100%
	Meropenem	25	--	1	--	20	--	3	--	27	--	7	--	4	--
	Moxifloxacin	9	--	0	--	0	--	10	--	24	--	2	--	2	--
	Ofloxacin	8	--	0	--	0	--	0	--	24	--	0	--	2	--
	Tetracycline	33	82%	4	--	23	--	38	82%	45	56%	7	--	27	--
	Vancomycin	36	100%	5	--	38	100%	54	98%	58	98%	13	--	49	100%

Note that this table includes data from cases that were reported to the Department by health care providers and laboratories as part of mandatory case-based disease reporting. If multiple isolates were tested for one case, the most recent results were included in the analysis.

1 Group A includes antibiotics that CLSI considers appropriate for primary testing and routine reporting and Group B includes antibiotics that may warrant primary testing but should be reported selectively.
-- Percent susceptible was suppressed if <30 isolates were tested for susceptibility to a particular antibiotic.

Map of regions:



Staphylococcus aureus - Non-Susceptible to Vancomycin

S. aureus bacteria are commonly found on the skin and in the noses of healthy people. Most *S. aureus* infections are minor, but sometimes serious or fatal bloodstream infections, wound infections, or pneumonia can occur. *S. aureus* is also an important cause of health care-associated infections, especially among chronically ill patients who have recently had invasive procedures or who have indwelling medical devices. *S. aureus* is transmitted person-to-person by direct contact. Commonly found among health care workers, *S. aureus* is spread by hands that become contaminated by contact with colonized or infected patients, colonized or infected body sites of the health care workers themselves, or devices, items, or other environmental surfaces contaminated with body fluids containing *S. aureus*.

Methicillin-resistant *S. aureus* (MRSA) is typically resistant to many antibiotics and has become more common in the last decade. Consequently, physicians rely heavily on vancomycin as the primary antibiotic for treating patients with serious MRSA infections, and resistance to vancomycin limits the available treatment options for MRSA. Vancomycin-intermediate *S. aureus* (VISA) and vancomycin-resistant *S. aureus* (VRSA) have acquired intermediate or complete resistance to vancomycin. VISA emerges when a patient with preexisting MRSA infection or colonization is exposed to repeated vancomycin use and the *S. aureus* strain develops a thicker cell wall. This resistance mechanism is not transferrable to susceptible strains. In contrast, VRSA emerges when a strain of *S. aureus* acquires the *vanA* gene from a vancomycin-resistant *Enterococcus* (VRE) organism. Recent exposure to vancomycin is not necessary. This type of gene-mediated resistance is theoretically transferable to susceptible strains of organisms, so there is potential for person-to-person transmission. No VRSA infection has ever been detected in Florida. Surveillance for VISA and VRSA is intended to identify infected people, evaluate their risk factors for infection, assess the risk of a patient transmitting the bacteria to others, and to prevent such transmission. Additionally, it is important to track the emergence of a relatively new and rare clinically important organism. Few VISA cases are reported in Florida. For additional information about cases reported in Florida in 2016, please see Section 3: Narratives for Selected Reportable Diseases/Conditions of Infrequent Occurrence.

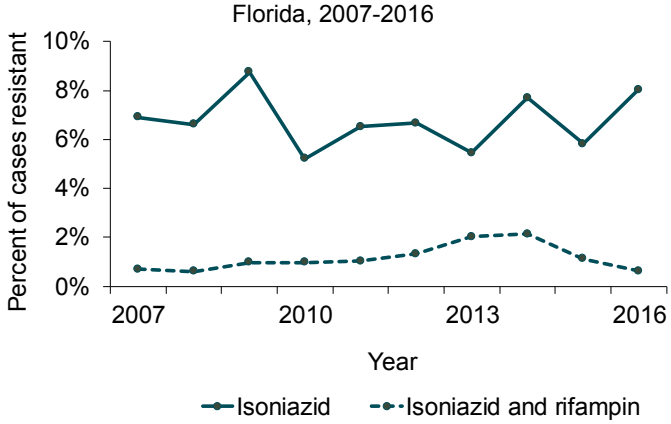
Mycobacterium tuberculosis

Mycobacterium tuberculosis bacteria cause tuberculosis (TB). The bacteria are spread through the air from one person to another and if not treated properly, infections can be fatal. *M. tuberculosis* usually attack the lungs, causing a severe cough and pain in the chest, but can attack any part of the body such as the kidney, spine, and brain. TB drug resistance is a major public health problem that threatens the progress made in TB care and control worldwide. Drug resistance arises due to improper use of antibiotics in the chemotherapy of drug-susceptible TB patients. Multidrug-resistant TB is caused by *M. tuberculosis* bacteria that are resistant to at least isoniazid and rifampin, the two most potent TB drugs. In 2016, 485 TB cases were tested in Florida for resistance to isoniazid and rifampin.

Key points for *M. tuberculosis* (Figure 3):

- Resistance to isoniazid alone ranged from 5% to 9% over the past 10 years and was 8% (39 cases) in 2016.
- Multidrug-resistant TB remains uncommon in Florida and resistance to both isoniazid and rifampin decreased in 2016 to 0.6% (3 cases).

Figure 3. Percent of Counted Tuberculosis Cases With Isolates Resistant to Isoniazid Alone and Isoniazid and Rifampin, Florida, 2007-2016



Note that this table includes data for all suspected and confirmed tuberculosis cases identified in Florida with specimens forwarded to the Bureau of Public Health Laboratories for additional testing.

Electronic Laboratory Reporting (ELR) Surveillance

A cumulative or community antibiogram provides useful information for the selection of empiric therapy for a presumptive diagnosis, helps track antibiotic resistance patterns of clinically important bacteria, and detects trends toward antimicrobial resistance. Laboratories participating in ELR are required to submit antimicrobial susceptibility testing for a variety of bacteria. ELR continues to expand, the Department enrolls more laboratories every year, and laboratories continue to improve their ability to send antimicrobial resistance data, resulting in more results received via ELR. The Department received results for 138,155 isolates in 2016, compared to 25,085 isolates in 2015. Note that due to the high volume of susceptibility results received electronically, the Department does not review results individually. Susceptibility results are processed electronically in the state's reportable disease surveillance system. Any results that do not meet technical standards for reporting or contain errors are excluded from processing and from this report. The Department identifies such errors or technical deficiencies and works with each laboratory to correct the data. Note that only the first isolate per person organism per 365 days was included in the analysis per CLSI guidelines.

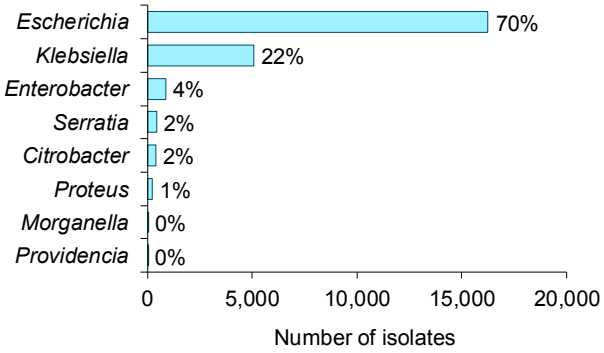
Enterobacteriaceae

Enterobacteriaceae are a family of bacteria that includes many different organisms. Some of the more familiar organisms found in this family include *Escherichia coli*, *Klebsiella pneumoniae*, *Salmonella* species, and *Shigella* species. These species can cause a wide range of illnesses and cause some of the most common health care-associated infections and foodborne illnesses. The family includes some of the most highly resistant organisms identified in outbreaks across the U.S. and the world.

Carbapenem-resistant Enterobacteriaceae (CRE) are bacteria that are resistant to carbapenems, powerful antibiotics that are often used as a last line of defense. Healthy people usually do not get

CRE infections. They usually happen to patients in hospitals, nursing homes, and other health care settings. Patients whose care requires devices like ventilators, urinary catheters, or intravenous catheters and patients who are taking long courses of certain antibiotics are most at risk for CRE infections. Some CRE bacteria have become resistant to most available antibiotics. Infections with these bacteria are very difficult to treat, and can be deadly.

Figure 4. Number and Percent of Isolates Received by Electronic Laboratory Reporting by Genus, Florida, 2016 (N=23,353)



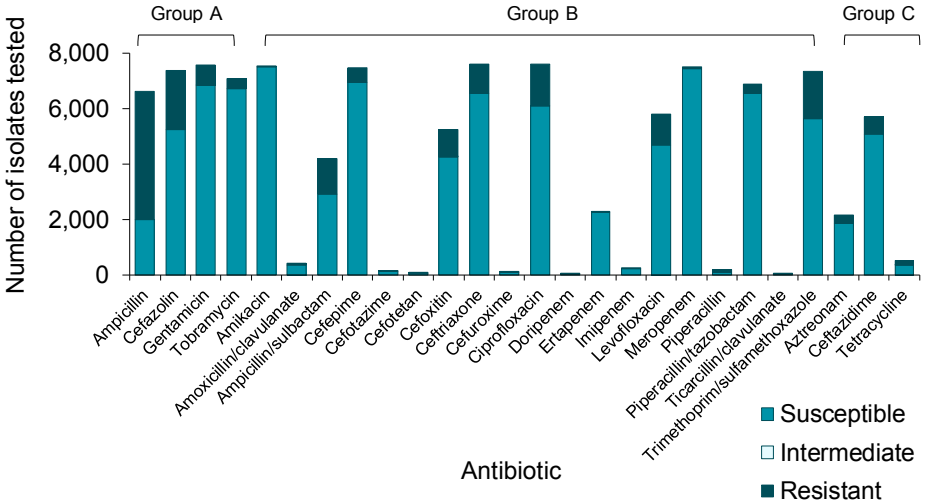
Key points for Enterobacteriaceae (Figures 4 and 5):

- The Department received results for 23,353 Enterobacteriaceae isolates in 2016 (Figure 4). The most common organisms received via ELR were *E. coli* (70%) and *Klebsiella* (22%).
- In 2016, 152 isolates met the definition of CRE (similar proportion to 2015).
- Susceptibility patterns are difficult to interpret when few isolates are tested for an individual antibiotic.
- Group A (appropriate for primary testing and routine reporting): the percent of tested isolates susceptible to Group A antibiotics ranged from 30% for ampicillin to 90% for gentamycin.
- Group B (may warrant primary testing, but reported selectively): the percent of tested isolates susceptible to Group B antibiotics ranged from 50% for piperacillin to 100% for ertapenem.
- Group C (alternative antibiotics): the percent of tested isolates susceptible to Group C antibiotics ranged from 71% for tetracycline to 89% for ceftazidime.

Key points for *E. coli* (Figure 6):

- A total of 16,242 *E. coli* isolates were tested for at least one antibiotic.
- Susceptibility was higher in *E. coli* than Enterobacteriaceae overall for cefazolin (80% versus 69%), cefoxitin (87% versus 76%), and ampicillin (44% versus 30%). More than 3,300 isolates were tested for each of these antibiotics.

Figure 5. Antibiotic Susceptibility Patterns for Enterobacteriaceae Isolates Received by Clinical and Laboratory Standards Institute (CLSI) Antibiotic Groups,[1] Florida, 2016 (N=23,353)



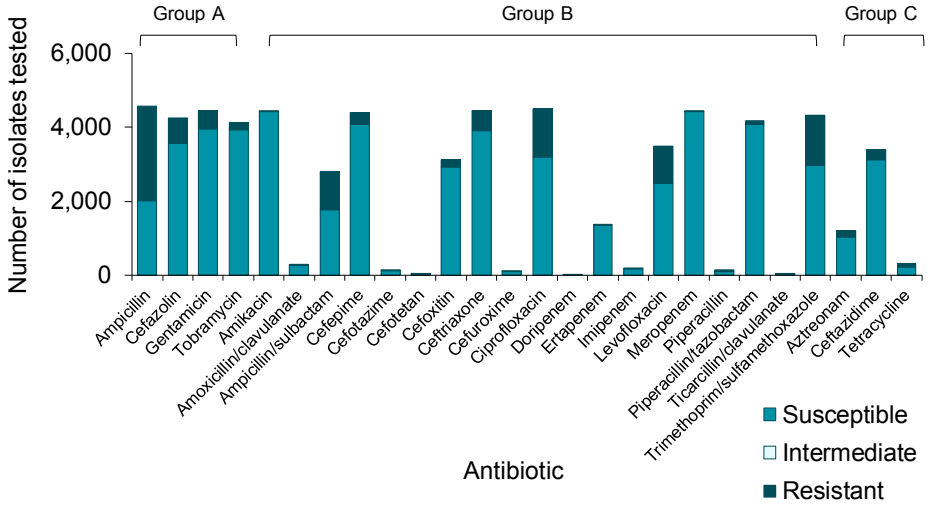
Note that this table includes data reported to the Department via electronic laboratory reporting.

1 Group A includes antibiotics that CLSI considers appropriate for primary testing and routine reporting, Group B includes antibiotics that may warrant primary testing but should be reported selectively, and Group C includes antibiotics considered to be alternative or supplemental. Note that <30 isolates were tested for chloramphenicol and therefore it is excluded from this figure.

Key points for *Klebsiella* species (Figure 7):

- A total of 5,065 *Klebsiella* isolates were tested for at least one antibiotic.
- Susceptibility was higher in *Klebsiella* than Enterobacteriaceae overall for trimethoprim/sulfamethoxazole (86% versus 77%), ciprofloxacin (91% versus 79%), levofloxacin (91% versus 79%), cefazolin (83% versus 69%), ampicillin/sulbactam (76% versus 59%), and cefoxitin (93% versus 76%). Susceptibility was lower in *Klebsiella* than Enterobacteriaceae overall for ampicillin (0% versus 30%) and sulfamethoxazole (87% versus 78%); >900 isolates were tested for each of these antibiotics.

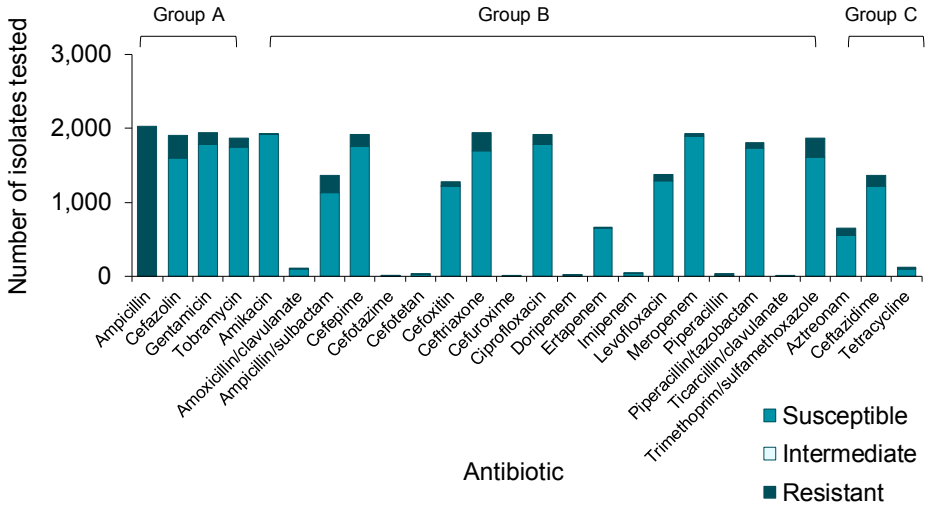
Figure 6. Antibiotic Susceptibility Patterns for *Escherichia coli* Isolates Received by Clinical and Laboratory Standards Institute (CLSI) Antibiotic Groups,[1] Florida, 2016 (N=16,242)



Note that this table includes data reported to the Department via electronic laboratory reporting.

1 Group A includes antibiotics that CLSI considers appropriate for primary testing and routine reporting, Group B includes antibiotics that may warrant primary testing but should be reported selectively, and Group C includes antibiotics considered to be alternative or supplemental. Note that <30 isolates were tested for chloramphenicol and therefore it is excluded from this figure.

Figure 7. Antibiotic Susceptibility Patterns for *Klebsiella* Isolates Received by Clinical and Laboratory Standards Institute (CLSI) Antibiotic Groups,[1] Florida, 2016 (N=5,065)



Note that this table includes data reported to the Department via electronic laboratory reporting.

1 Group A includes antibiotics that CLSI considers appropriate for primary testing and routine reporting, Group B includes antibiotics that may warrant primary testing but should be reported selectively, and Group C includes antibiotics considered to be alternative or supplemental. Note that <30 isolates were tested for chloramphenicol and therefore it is excluded from this figure.

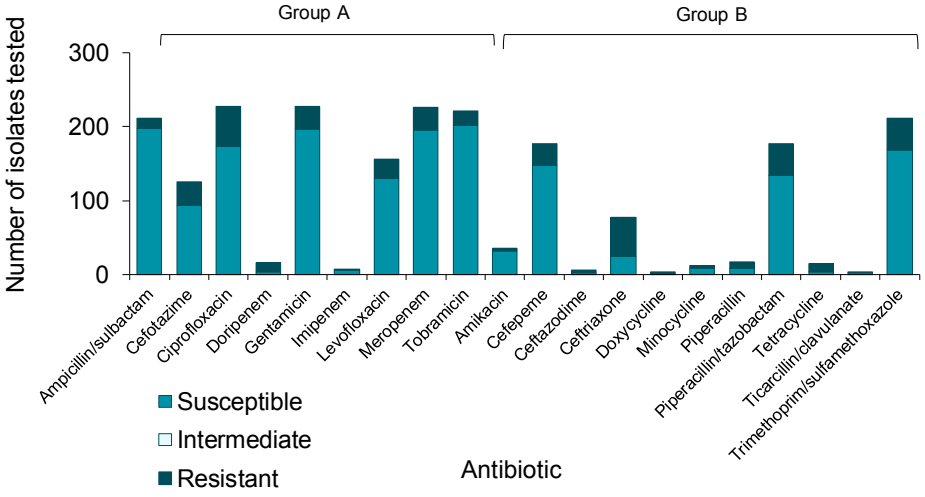
Acinetobacter Species

Acinetobacter species are frequently found in soil and water in the environment. The most common species that causes disease in humans is *Acinetobacter baumannii*. Outbreaks are most common in intensive care units and other health care settings with high acuity patients. *Acinetobacter* is not common outside of the health care system and usually does not pose a risk to healthy people. Although not as commonly found as for Enterobacteriaceae, antimicrobial resistance is increasing for *Acinetobacter baumannii* and more infections are being identified within health care facilities.

Key points for *A. baumannii* (Figure 8):

- A total of 525 *A. baumannii* isolates were tested for at least one antibiotic.
- Susceptibility of *A. baumannii* to CLSI Group A and B antibiotics ranged from 10% for ceftriaxone to 90% for ampicillin/sulbactam.
- Of all *A. baumannii* isolates, 19% were multidrug resistant (resistant to at least three classes of antibiotics). This in an increase from 16% in 2015.

Figure 8. Antibiotic Susceptibility Patterns for *A. baumannii* Isolates Received by Clinical and Laboratory Standards Institute (CLSI) Antibiotic Groups,[1] Florida, 2016 (N=525)



Note that this table includes data reported to the Department via electronic laboratory reporting.

1 Group A includes antibiotics that CLSI considers appropriate for primary testing and routine reporting and Group B includes antibiotics that may warrant primary testing but should be reported selectively. Note that <30 isolates were tested for cefotaxime, doripenem, doxycycline, imipenem, minocycline, piperacillin, tetracycline, and ticarcillin/clavulanate and therefore those antibiotics are excluded from this figure.

ELR Antibiogram

An antibiogram is a report used frequently by clinicians to see patterns of resistance in a given location across organisms and antibiotics. A summary report (called a cumulative antibiogram) usually provides the name of the organism, the name of the antibiotic, and the percentage of isolates that were either susceptible or resistant to the antibiotic. The antibiogram helps providers select the most effective therapy for patients until test results return from the lab to confirm the exact organism and resistance for that patient.

Antibiograms can also be used to see the general resistance patterns in regions or states. Florida has created a statewide antibiogram using data from ELR for 2016 (Table 4). Because of the number of individual species received, the antibiogram in this report includes those organisms which are of most concern and most commonly found in reports on antimicrobial resistance.

Figure 4 (Part 1). Antibiogram for Susceptibility Data Received Via Electronic Laboratory Reporting for Organisms of Concern, Florida, 2016

Class	Antimicrobial Agent	*Acinetobacter baumannii*		*Citrobacter freundii*		*Citrobacter koseri*		*Enterobacter aerogenes*		*Enterobacter cloacae*		*Enterococcus avium*		*Enterococcus faecalis*		*Enterococcus faecium*	
		Total Tested	Percent Susceptible	Total Tested	Percent Susceptible	Total Tested	Percent Susceptible	Total Tested	Percent Susceptible	Total Tested	Percent Susceptible	Total Tested	Percent Susceptible	Total Tested	Percent Susceptible	Total Tested	Percent Susceptible
β-Lactam	Amoxicillin/clavulanate	--	--	--	--	--	--	--	--	32	0%	--	--	--	--	--	--
	Ampicillin	--	--	--	--	--	--	--	--	--	--	53	72%	1,577	98%	418	19%
	Ampicillin/Sulbactam	342	87%	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Aztreonam	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Cefazolin	--	--	214	0%	138	90%	170	1%	607	0%	--	--	--	--	--	--
	Cefepime	321	68%	209	100%	138	97%	162	96%	604	91%	--	--	--	--	--	--
	Cefotazime	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Cefotetan	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Cefoxitin	--	--	151	0%	105	89%	165	0%	593	0%	--	--	--	--	--	--
	Ceftazidime	241	56%	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Ceftriaxone	358	10%	212	82%	140	91%	164	69%	606	71%	--	--	--	--	--	--
	Cefuroxime	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Doripenem	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Ertapenem	--	--	62	100%	37	100%	--	--	39	97%	--	--	--	--	--	--
	Imipenem	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Meropenem	357	81%	207	98%	138	100%	161	96%	598	97%	--	--	--	--	--	--
	Oxacillin	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Penicillin	--	--	--	--	--	--	--	--	--	--	46	70%	1,416	98%	346	15%
	Piperacillin	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Piperacillin/tazobactam	305	65%	190	85%	104	100%	164	71%	603	74%	--	--	--	--	--	--
Non β-Lactam	Amikacin	51	84%	208	100%	139	100%	161	100%	603	100%	--	--	--	--	--	--
	Chloramphenicol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Ciprofloxacin	361	71%	210	91%	141	90%	161	96%	605	94%	43	84%	1,252	67%	100	27%
	Clindamycin	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Daptomycin	--	--	--	--	--	--	--	--	--	--	--	--	897	100%	68	99%
	Doxycycline	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Erythromycin	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Fosfomycin	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Gentamicin	362	78%	211	94%	139	99%	162	94%	605	92%	--	--	--	--	--	--
	Levofloxacin	248	77%	151	90%	107	90%	161	95%	599	93%	43	88%	1,258	68%	252	15%
	Linezolid	--	--	--	--	--	--	--	--	--	--	--	--	1,435	100%	379	100%
	Minocycline	31	42%	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Moxifloxacin	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Nitrofurantoin	--	--	76	92%	48	92%	71	17%	110	37%	--	--	--	--	--	--
	Norfloxacin	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Ofloxacin	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Rifampin	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Tetracycline	--	--	--	--	--	--	--	--	--	--	--	--	81	14%	--	--
	Tobramycin	354	86%	211	95%	139	99%	161	94%	605	92%	--	--	--	--	--	--
	Trimethoprim	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Trimethoprim/sulfamethoxazole	334	76%	209	89%	136	91%	158	97%	575	87%	--	--	--	--	--	--
	Vancomycin	--	--	--	--	--	--	--	--	--	--	53	96%	1,586	96%	424	41%

Note that this table includes data reported to the Department via electronic laboratory reporting.

-- Total tested and percent susceptible were suppressed if <30 isolates were tested for susceptibility to a particular antibiotic.

Figure 4 (Part 2). Antibiogram for Susceptibility Data Received Via Electronic Laboratory Reporting for Organisms of Concern, Florida, 2016

Class	Antimicrobial Agent	*Escherichia coli*		*Haemophilus influenzae*		*Klebsiella pneumoniae*		*Klebsiella oxytoca*		*Pseudomonas aeruginosa*		*Serratia marcescens*		*Staphylococcus epidermidis*	
		Total Tested	Percent Susceptible	Total Tested	Percent Susceptible	Total Tested	Percent Susceptible	Total Tested	Percent Susceptible	Total Tested	Percent Susceptible	Total Tested	Percent Susceptible	Total Tested	Percent Susceptible
β-Lactam	Amoxicillin/clavulanate	398	82%	--	--	131	91%	--	--	--	--	--	--	--	--
	Ampicillin	5,491	43%	817	66%	2,419	0%	272	0%	--	--	--	--	--	--
	Ampicillin/Sulbactam	4,094	51%	--	--	1,790	77%	205	53%	--	--	--	--	--	--
	Aztreonam	--	--	--	--	--	--	--	--	321	66%	--	--	--	--
	Cefazolin	5,329	79%	--	--	2,320	83%	267	63%	--	--	518	0%	--	--
	Cefepime	5,340	91%	--	--	2,335	89%	264	93%	2,498	86%	502	98%	--	--
	Cefotazime	130	98%	726	99%	--	--	--	--	--	--	--	--	--	--
	Cefotetan	34	94%	--	--	41	78%	--	--	--	--	--	--	--	--
	Cefoxitin	3,961	87%	--	--	1,572	93%	168	99%	--	--	293	17%	--	--
	Ceftazidime	--	--	--	--	--	--	--	--	1,792	87%	--	--	--	--
	Ceftriaxone	5,372	86%	50	92%	2,356	85%	265	88%	--	--	503	96%	--	--
	Cefuroxime	123	89%	48	85%	--	--	--	--	--	--	--	--	--	--
	Doripenem	--	--	--	--	--	--	--	--	111	80%	--	--	--	--
	Ertapenem	1,708	100%	--	--	769	100%	107	100%	--	--	235	100%	--	--
	Imipenem	196	99%	--	--	49	96%	--	--	94	90%	--	--	--	--
	Meropenem	5,311	100%	--	--	2,327	97%	264	99%	2,457	86%	501	100%	--	--
	Oxacillin	--	--	--	--	--	--	--	--	--	--	--	--	159	34%
	Penicillin	--	--	--	--	--	--	--	--	--	--	--	--	139	9%
	Piperacillin	155	61%	--	--	44	25%	--	--	105	72%	--	--	--	--
	Piperacillin/tazobactam	5,137	94%	--	--	2,221	92%	254	95%	2,283	88%	119	92%	--	--
Non β-Lactam	Amikacin	5,329	99%	--	--	2,332	98%	264	100%	2,462	95%	502	100%	--	--
	Chloramphenicol	--	--	735	98%	--	--	--	--	--	--	--	--	--	--
	Ciprofloxacin	5,412	69%	--	--	2,355	88%	265	100%	2,517	82%	507	97%	--	--
	Clindamycin	--	--	--	--	--	--	--	--	--	--	--	--	139	50%
	Daptomycin	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Doxycycline	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Erythromycin	--	--	--	--	--	--	--	--	--	--	--	--	149	26%
	Fosfomycin	--	--	--	--	32	59%	--	--	--	--	--	--	--	--
	Gentamicin	5,369	88%	--	--	2,350	89%	265	96%	2,518	87%	503	97%	--	--
	Levofloxacin	4,143	70%	--	--	1,710	89%	170	99%	2,001	77%	291	96%	--	--
	Linezolid	--	--	--	--	--	--	--	--	--	--	--	--	141	100%
	Minocycline	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Moxifloxacin	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Nitrofurantoin	2,648	95%	--	--	871	39%	53	85%	--	--	40	5%	--	--
	Norfloxacin	--	--	--	--	--	--	--	--	34	47%	--	--	--	--
	Ofloxacin	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Rifampin	--	--	--	--	--	--	--	--	--	--	--	--	146	93%
	Tetracycline	--	--	--	--	--	--	--	--	--	--	--	--	151	86%
	Tobramycin	5,360	87%	--	--	2,338	88%	265	95%	2,485	95%	507	81%	--	--
	Trimethoprim	263	72%	--	--	108	85%	--	--	--	--	--	--	--	--
	Trimethoprim/sulfamethoxazole	5,154	68%	742	58%	2,237	85%	251	95%	--	--	483	98%	128	47%
	Vancomycin	--	--	--	--	--	--	--	--	--	--	--	--	161	100%

Note that this table includes data reported to the Department via electronic laboratory reporting.

-- Total tested and percent susceptible were suppressed if <30 isolates were tested for susceptibility to a particular antibiotic.

Staphylococcus aureus

In 2008, antibiotic susceptibility testing results for all *S. aureus* isolates became reportable for laboratories participating in ELR. This electronic laboratory data stream continues to be improved. The Department has also partnered with one of the largest commercial laboratories in the state to receive antibiotic susceptibility testing results for all *S. aureus* isolates tested there since 2006, until their data can be submitted via ELR. This is the source of data included in this report. Note that only the first isolate per person per 365 days was included in the analysis per CLSI guidelines. Data collected from this laboratory may or may not be representative of statewide trends.

Key points for *S. aureus*:

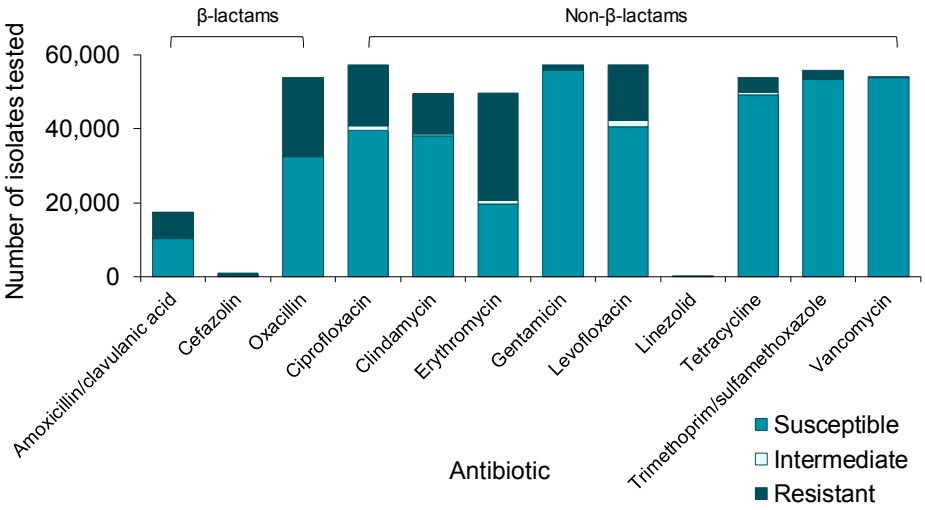
- Overall resistance patterns (Table 5, Figure 9):
  - ◊ Penicillin is not recommended for treating *S. aureus* infections due to known resistance (excluded here).
  - ◊ Susceptibility to cefazolin decreased dramatically from 51% in 2014 to 26% in 2015 and continued to decrease to 17% in 2016. Susceptibility to other β-lactam antibiotics has increased slightly over the past five years, but is still low (59% for amoxicillin/clavulanic acid and 60% for oxacillin).
  - ◊ Empiric treatment of skin and soft tissue infections with β-lactam antibiotics is not recommended.
  - ◊ Susceptibility remained greater than 90% for non-β-lactam antibiotics, including linezolid (100%), vancomycin (100%), gentamicin (97%), trimethoprim/sulfamethoxazole (95%), and tetracycline (91%).
- Susceptibility to most antibiotics varied slightly by age group. Isolates from people aged 65 years and older had reduced susceptibility to ciprofloxacin and levofloxacin (Table 6).
- North Florida had a higher proportion of MRSA isolates while central and south Florida had a lower proportion (Map 1). This trend has been consistently observed since surveillance started in 2006 (Table 7).

Table 5. Number Tested and Percent of *S. aureus* Isolates Susceptible to Selected Antibiotics, Commercial Outpatient Laboratory, Florida, 2012-2016

Antibiotic type	Antibiotic name	2012		2013		2014		2015		2016	
		Number tested	Percent susceptible	Number tested	Percent susceptible	Number tested	Percent susceptible	Number tested	Percent susceptible	Number tested	Percent susceptible
β-lactams	Amoxicillin/clavulanic acid	51,665	51%	50,178	53%	53,455	54%	29,442	56%	17,424	59%
	Cefazolin	37,199	51%	16,740	52%	717	51%	723	26%	909	17%
	Oxacillin	52,949	52%	51,579	53%	55,990	54%	55,303	58%	53,902	60%
Non-β-lactams	Ciprofloxacin	51,182	66%	55,714	66%	57,633	63%	57,895	67%	57,371	69%
	Clindamycin	49,440	78%	47,831	78%	52,191	76%	51,506	77%	49,553	77%
	Erythromycin	49,446	34%	47,843	35%	52,192	35%	51,519	38%	49,596	40%
	Gentamicin	57,298	97%	56,032	97%	57,629	96%	57,921	97%	57,378	97%
	Levofloxacin	54,356	71%	56,151	70%	57,690	68%	57,958	70%	57,422	71%
	Linezolid	8,279	100%	189	100%	262	100%	203	100%	178	100%
	Tetracycline	53,008	93%	51,678	93%	56,103	92%	55,353	92%	53,933	91%
	Trimethoprim/sulfamethoxazole	55,770	98%	54,468	97%	56,951	97%	56,821	96%	55,925	95%
	Vancomycin	52,996	100%	51,686	100%	56,097	100%	55,394	100%	53,967	100%

Note that this table includes data from a single commercial outpatient laboratory that receives isolates from health care providers across the state.

Figure 9. Antibiotic Susceptibility Patterns of *S. aureus* Isolates for Selected Antibiotics, Commercial Outpatient Laboratory, Florida, 2016



Note that this table includes data from a single commercial outpatient laboratory that receives isolates from health care providers across the state.

Cefazolin and linezolid are excluded from this figure due to the small number of isolates tested.

Table 6. Percent of *S. aureus* Isolates Susceptible to Selected Antibiotics by Age Group, Commercial Outpatient Laboratory, Florida, 2016

Antibiotic type	Antibiotic name	<1-year-olds		1-4-year-olds		5-14-year-olds		15-24-year-olds		25-64-year-olds		>64-year-olds	
		Number tested	Percent susceptible	Number tested	Percent susceptible	Number tested	Percent susceptible	Number tested	Percent susceptible	Number tested	Percent susceptible	Number tested	Percent susceptible
β-lactams	Amoxicillin/clavulanic acid	312	65%	1,116	53%	1,995	66%	1,682	65%	7,664	59%	4,625	57%
	Cefazolin	24	--	42	21%	59	15%	55	22%	368	20%	360	13%
	Oxacillin	894	61%	3,382	51%	5,856	67%	5,248	68%	23,244	60%	15,210	58%
Non-β-lactams	Ciprofloxacin	957	80%	3,563	71%	6,109	79%	5,483	79%	24,558	70%	16,629	59%
	Clindamycin	884	79%	3,324	82%	5,752	76%	4,842	79%	21,526	79%	13,160	72%
	Erythromycin	889	38%	3,330	30%	5,762	39%	4,841	43%	21,547	41%	13,162	40%
	Gentamicin	954	98%	3,560	98%	6,111	98%	5,484	98%	24,569	98%	16,625	96%
	Levofloxacin	959	81%	3,568	72%	6,118	81%	5,482	81%	24,586	72%	16,637	61%
	Linezolid	3	--	1	--	3	--	7	--	52	100%	110	100%
	Tetracycline	895	92%	3,387	93%	5,860	89%	5,252	91%	23,253	92%	15,221	92%
	Trimethoprim/sulfamethoxazole	956	99%	3,498	98%	6,014	98%	5,402	97%	24,020	96%	15,968	92%
	Vancomycin	894	100%	3,385	100%	5,859	100%	5,250	100%	23,261	100%	15,250	100%

Note that this table includes data from a single commercial outpatient laboratory that receives isolates from health care providers across the state.

-- Percent susceptible was suppressed if <30 isolates were tested for susceptibility to a particular antibiotic.

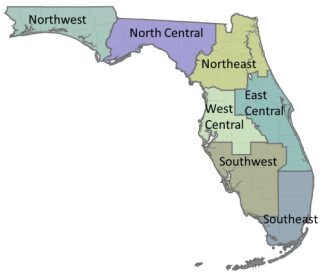
Table 7. Percent of *S. aureus* Isolates Susceptible to Selected Antibiotics by Region, Commercial Outpatient Laboratory, Florida, 2016

Antibiotic type	Antibiotic name	Northwest		North central		Northeast		West central		East central		Southwest		Southeast	
		Number tested	Percent susceptible	Number tested	Percent susceptible	Number tested	Percent susceptible	Number tested	Percent susceptible	Number tested	Percent susceptible	Number tested	Percent susceptible	Number tested	Percent susceptible
β-lactams	Amoxicillin/clavulanic acid	43	51%	52	60%	183	50%	301	60%	1,005	63%	1,344	64%	12,523	59%
	Cefazolin	26	--	25	--	101	2%	136	3%	147	3%	117	9%	267	44%
	Oxacillin	1,523	56%	1,294	58%	6,752	58%	9,790	59%	9,536	63%	6,956	64%	12,976	59%
Non-β-lactams	Ciprofloxacin	1,608	67%	1,392	74%	7,247	70%	10,543	68%	10,215	72%	7,449	71%	13,541	65%
	Clindamycin	1,419	83%	1,176	85%	6,127	79%	8,767	79%	8,686	79%	6,368	80%	12,197	71%
	Erythromycin	1,419	37%	1,176	38%	6,133	38%	8,768	40%	8,689	42%	6,368	44%	12,204	37%
	Gentamicin	1,615	99%	1,394	99%	7,255	99%	10,535	98%	10,206	98%	7,453	98%	13,535	93%
	Levofloxacin	1,613	69%	1,396	75%	7,249	72%	10,541	69%	10,230	73%	7,458	73%	13,553	69%
	Linezolid	2	--	1	--	8	--	16	--	26	--	12	--	94	100%
	Tetracycline	1,525	94%	1,295	93%	6,758	92%	9,793	92%	9,548	92%	6,961	93%	12,985	88%
	Trimethoprim/sulfamethoxazole	1,584	96%	1,363	95%	7,027	97%	10,179	93%	9,926	96%	7,261	93%	13,340	97%
	Vancomycin	1,522	100%	1,292	100%	6,753	100%	9,801	100%	9,546	100%	6,963	100%	13,008	100%

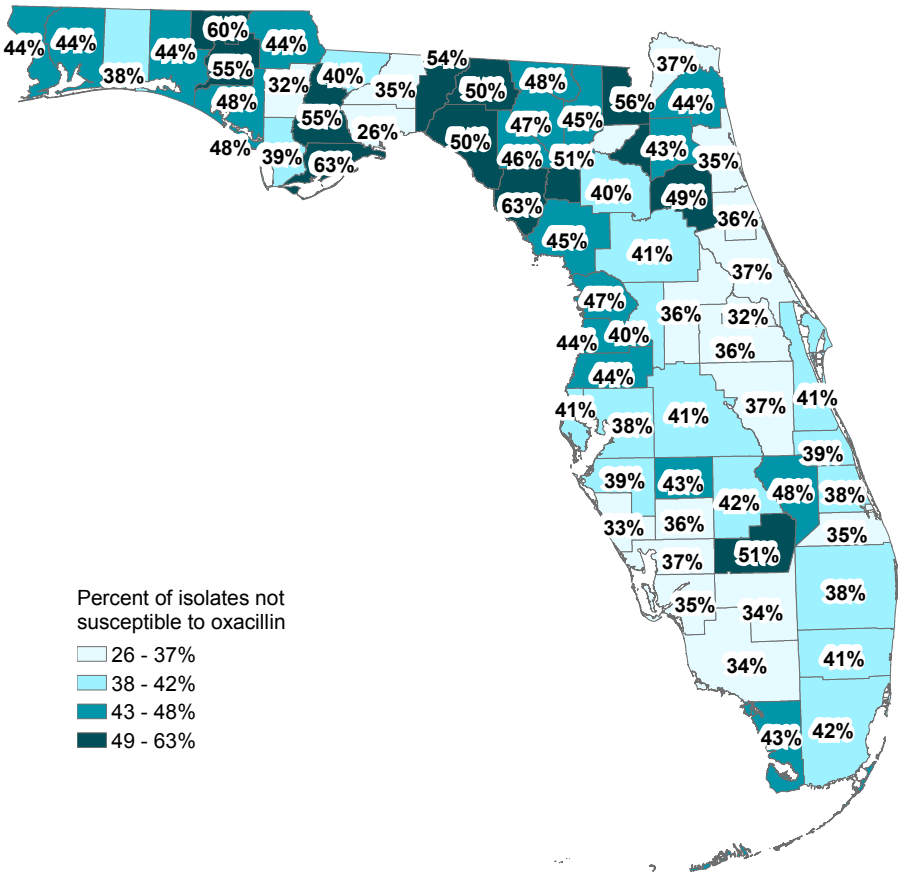
Note that this table includes data from a single commercial outpatient laboratory that receives isolates from health care providers across the state.

-- Percent susceptible was suppressed if <30 isolates were tested for susceptibility to a particular antibiotic.

Map of regions:



Map 1. Percent of *S. aureus* Isolates Not Susceptible to Oxacillin (MRSA) by County of Residence, Commercial Outpatient Laboratory, Florida, 2016



Note that this table includes data from a single commercial outpatient laboratory that receives isolates from health care providers across the state. Some counties had <30 isolates tested, so the proportion that were resistant to oxacillin is unreliable and should be interpreted with caution: Calhoun (25 isolates tested), Hamilton (23 isolates tested), Jefferson (26 isolates tested), and Liberty (20 isolates tested).