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 2015, the Florida Department of Health (DOH) 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) were required to submit such results for people ≥6 years old. All laboratories were still 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.
  - ◊ Samples for all suspected or confirmed tuberculosis cases are forwarded to the DOH 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
  - ◊ In addition to case-based 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.
- DOH partnered with one of the largest commercial laboratories in the state to receive susceptibility testing results for all *S. aureus* isolates tested there since 2004.

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.

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 431 *S. pneumoniae* invasive disease cases were reported to DOH in 2015 by health care providers and laboratories. Of those reported cases, 167 (39%) 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, as well as 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.

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.

Antimicrobial Resistance Surveillance

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 2011 to 2015, 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 64% in 2011 to 60% in 2015.
  - ◊ 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 2011 and 2015 to 93% in 2013 and 2014.
  - ◊ Group C (alternative antibiotics): susceptibility remained high in 2015 with 86% 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 are identified in adults ≥25 years old, so susceptibility data in children is sparse. Susceptibility to individual antibiotics is 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, 2011-2015
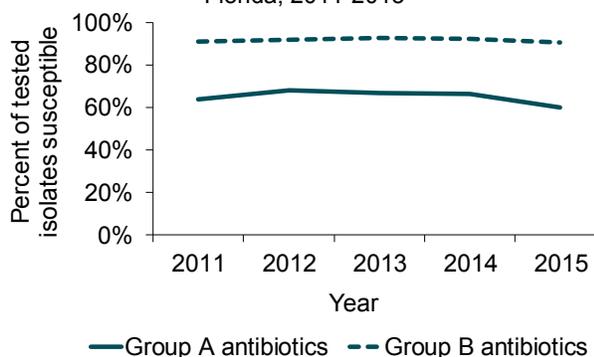
Note that this figure includes data from cases that were reported to DOH by health care providers and laboratories as part of mandatory case-based disease reporting.

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.

- The small number of isolates tested makes it difficult to draw conclusions about susceptibility patterns by region (Table 3). Susceptibility to erythromycin ranges from 36% in the east central region to 49% in the southeast region. Susceptibility to penicillin ranges 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, 2011-2015

CLSI group[1]	Antibiotic name	2011 Number tested	2011 Percent susceptible	2012 Number tested	2012 Percent susceptible	2013 Number tested	2013 Percent susceptible	2014 Number tested	2014 Percent susceptible	2015 Number tested	2015 Percent susceptible
Group A	Erythromycin	1,017	57%	760	61%	841	58%	582	56%	187	49%
	Penicillin	1,164	69%	854	72%	967	72%	619	72%	158	69%
	Trimethoprim/sulfamethoxazole	841	67%	578	72%	681	70%	463	73%	114	68%
Group B	Cefepime	156	94%	117	89%	157	96%	114	91%	24	--
	Cefotaxime	607	86%	432	88%	526	92%	330	93%	93	94%
	Ceftriaxone	1,103	91%	832	91%	901	93%	600	93%	177	92%
	Clindamycin	437	80%	309	83%	396	82%	307	81%	79	73%
	Levofloxacin	900	99%	690	99%	774	99%	568	99%	138	98%
	Meropenem	316	82%	235	85%	338	87%	230	89%	49	84%
	Moxifloxacin	297	100%	194	100%	194	99%	159	99%	37	97%
	Ofloxacin	87	97%	61	95%	55	96%	65	94%	19	--
	Tetracycline	701	77%	473	79%	566	81%	407	78%	98	73%
	Vancomycin	1,179	100%	882	100%	963	100%	655	100%	174	100%

Note that this table includes data from cases that were reported to DOH by health care providers and laboratories as part of mandatory case-based disease 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.
-- 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, 2015
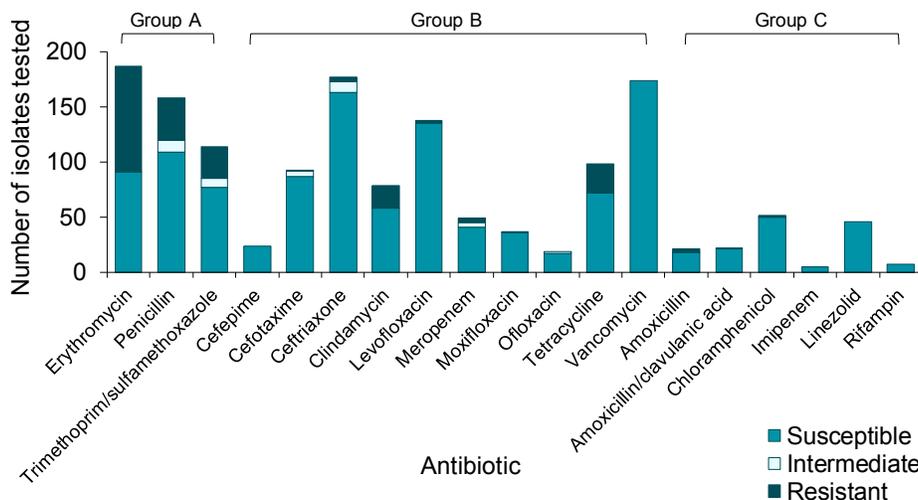

Note that this table includes data from cases that were reported to DOH by health care providers and laboratories as part of mandatory case-based disease reporting.

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.

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, 2015

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	21	--	28	--	10	--	1	--	71	49%	56	41%
	Penicillin	20	--	22	--	13	--	1	--	61	67%	41	63%
	Trimethoprim/sulfamethoxazole	12	--	21	--	6	--	0	--	46	70%	29	--
Group B	Cefepime	5	--	1	--	1	--	0	--	11	--	6	--
	Cefotaxime	13	--	17	--	5	--	0	--	39	97%	19	--
	Ceftriaxone	21	--	31	90%	12	--	1	--	66	97%	46	85%
	Clindamycin	14	--	13	--	3	--	0	--	27	--	22	--
	Levofloxacin	13	--	19	--	8	--	1	--	56	96%	41	98%
	Meropenem	9	--	3	--	3	--	0	--	21	--	13	--
	Moxifloxacin	4	--	3	--	3	--	0	--	19	--	8	--
	Ofloxacin	1	--	1	--	1	--	0	--	12	--	4	--
	Tetracycline	14	--	15	--	3	--	0	--	44	59%	22	--
	Vancomycin	22	--	30	100%	10	--	1	--	64	100%	47	100%

Note that this table includes data from cases that were reported to DOH by health care providers and laboratories as part of mandatory case-based disease 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.

-- 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, 2015

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	15	--	7	--	33	48%	42	67%	47	36%	4	--	39	49%
	Penicillin	7	--	5	--	28	--	40	80%	39	69%	3	--	36	47%
	Trimethoprim/sulfamethoxazole	10	--	6	--	27	--	21	--	18	--	5	--	27	--
Group B	Cefepime	6	--	0	--	16	--	0	--	1	--	0	--	1	--
	Cefotaxime	14	--	5	--	30	90%	19	--	18	--	0	--	7	--
	Ceftriaxone	15	--	7	--	32	91%	40	93%	43	95%	5	--	35	94%
	Clindamycin	7	--	6	--	18	--	11	--	10	--	3	--	24	--
	Levofloxacin	13	--	7	--	19	--	28	--	35	100%	2	--	34	97%
	Meropenem	13	--	1	--	16	--	2	--	12	--	0	--	5	--
	Moxifloxacin	9	--	1	--	0	--	12	--	11	--	0	--	4	--
	Ofloxacin	5	--	1	--	0	--	2	--	10	--	0	--	1	--
	Tetracycline	13	--	7	--	19	--	21	--	21	--	4	--	13	--
	Vancomycin	14	--	7	--	32	100%	41	100%	40	100%	3	--	37	100%

Note that this table includes data from cases that were reported to DOH by health care providers and laboratories as part of mandatory case-based disease 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.

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

Map of regions:
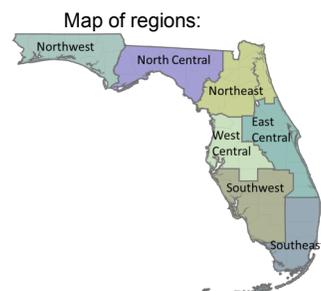
Staphylococcus aureus - Non-Susceptible to Vancomycin

S. aureus is a type of bacteria 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 or 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 infection 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 2015, 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 chemotherapy of drug-susceptible TB patients. Multidrug-resistant TB is caused by *M. tuberculosis* that is resistant to at least isoniazid and rifampin, the two most potent TB drugs. In 2015, 447 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 6% (26 cases) in 2015.
- Multidrug-resistant TB remains uncommon in Florida and resistance to both isoniazid and rifampin decreased in 2015 to 1.1% (5 cases).

Figure 3. Percent of Counted Tuberculosis Cases With Isolates Resistant to Isoniazid Alone and Isoniazid and Rifampin, Florida, 2006-2015
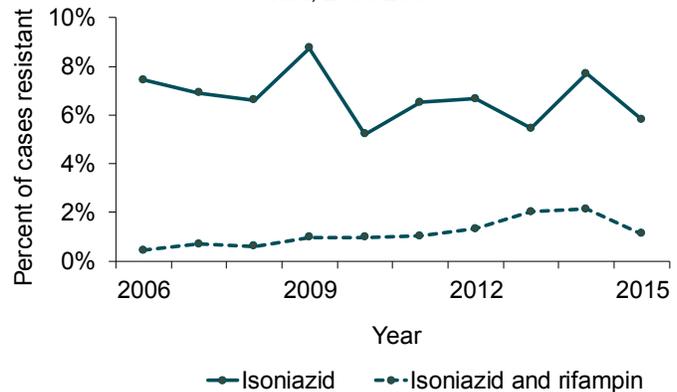
Note that this table includes data for all suspected or confirmed tuberculosis cases identified in Florida with specimens forwarded to the Bureau of Public Health Laboratories for additional testing.

Electronic Laboratory Reporting Surveillance

Laboratories participating in ELR are required to submit antimicrobial susceptibility testing for a variety of bacteria. DOH received results for 25,058 isolates from 72 clinical laboratories in 2015. Note that due to the high volume of susceptibility results received electronically, DOH 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. DOH identifies such errors or technical deficiencies and works with each laboratory to correct the data. Note that only the first isolate per person 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 illness and cause some of the most common health care-associated 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; one report cites they can contribute to death in up to 50% of patients who become infected.

Antimicrobial Resistance Surveillance

Key points for Enterobacteriaceae (Figures 4 and 5):

- DOH received results for 9,666 Enterobacteriaceae isolates in 2015 (Figure 4). The most common organisms received via ELR were *E. coli* (61%) and *Klebsiella* (24%).
- In 2015, 65 isolates met the definition of CRE.
- 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 33% for ampicillin to 91% for gentamycin and tobramycin.
- Group B (may warrant primary testing, but reported selectively): the percent of tested isolates susceptible to Group B antibiotics ranged from 41% for piperacillin to 100% for amikacin, ertapenem, and imipenem.
- Group C (alternative antibiotics): the percent of tested isolates susceptible to Group C antibiotics ranged from 72% for tetracycline to 91% for ceftazidime.

Figure 4. Number and Percent of Isolates Received by Electronic Laboratory Reporting by Genus, Florida, 2015 (N=9,666)
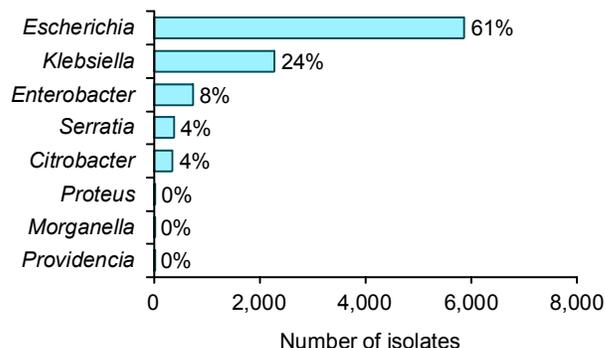
Key points for *E. coli* (Figure 6):

- A total of 5,859 *E. coli* isolates were tested for ≥1 antibiotic.
- Susceptibility was higher in *E. coli* than Enterobacteriaceae overall for ampicillin (47% versus 33%), cefoxitin (88% versus 75%), and cefazolin (84% versus 71%); >3,500 *E. coli* isolates were tested for each of these antibiotics.
- Susceptibility was lower in *E. coli* than Enterobacteriaceae overall for ciprofloxacin (70% versus 80%); >4,500 *E. coli* isolates were tested for ciprofloxacin .

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

- A total of 2,283 *Klebsiella* isolates were tested for ≥1 antibiotic.
- Susceptibility was higher in *Klebsiella* than Enterobacteriaceae overall for ampicillin/sulbactam (78% versus 62%), cefazolin (85% versus 71%), cefoxitin (91% versus 75%), ciprofloxacin (92% versus 80%), levofloxacin (93% versus 82%), and trimethoprim/sulfamethoxazole (87% versus 78%); >900 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, 2015 (N=9,666)
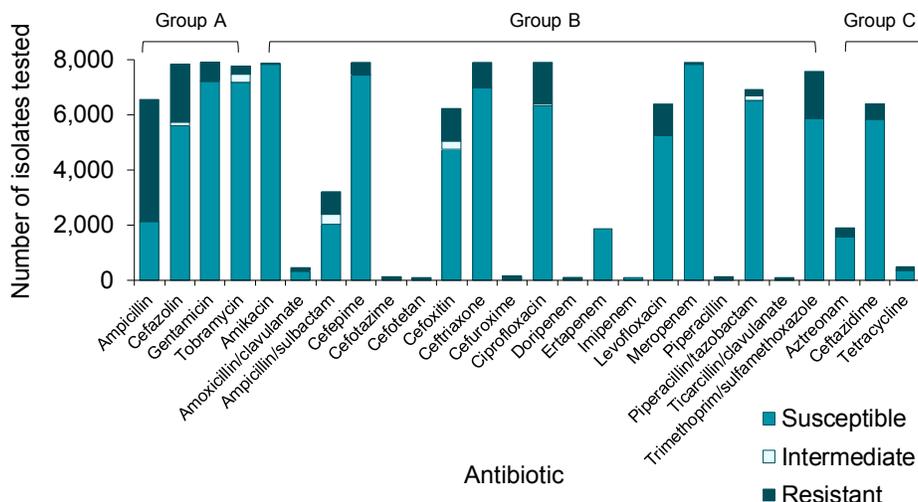
Note that this table includes data reported to DOH via ELR.

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 6. Antibiotic Susceptibility Patterns for *Escherichia coli* Isolates Received by Clinical and Laboratory Standards Institute (CLSI) Antibiotic Groups,[1] Florida, 2015 (N=5,859)

Note that this table includes data reported to DOH via ELR.

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, 2015 (N=2,283)

Note that this table includes data reported to DOH via ELR.

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.

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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 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 285 *A. baumannii* isolates were tested for ≥1 antibiotic.
- Susceptibility of *A. baumannii* to CLSI Group A and B antibiotics ranged from 10% for ceftriaxone to 88% for ampicillin/sulbactam.
- Of all *A. baumannii* isolates, 16% were multi-drug resistant (resistant to ≥3 classes of antibiotics).

Figure 8. Antibiotic Susceptibility Patterns for *A. baumannii* Isolates Received by Clinical and Laboratory Standards Institute (CLSI) Antibiotic Groups,[1] Florida, 2015 (N=285)
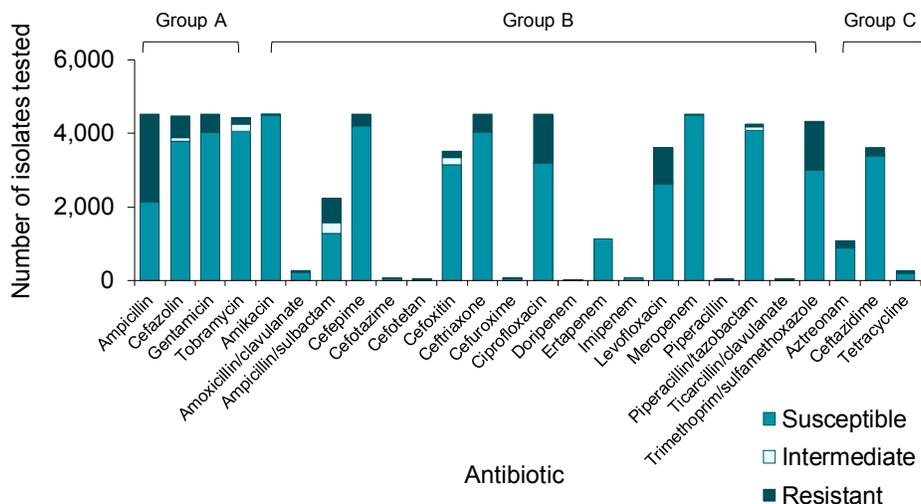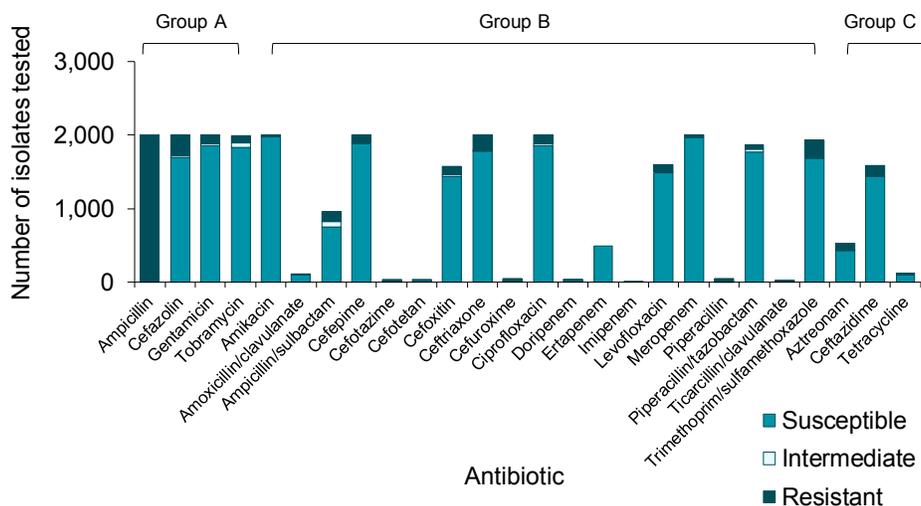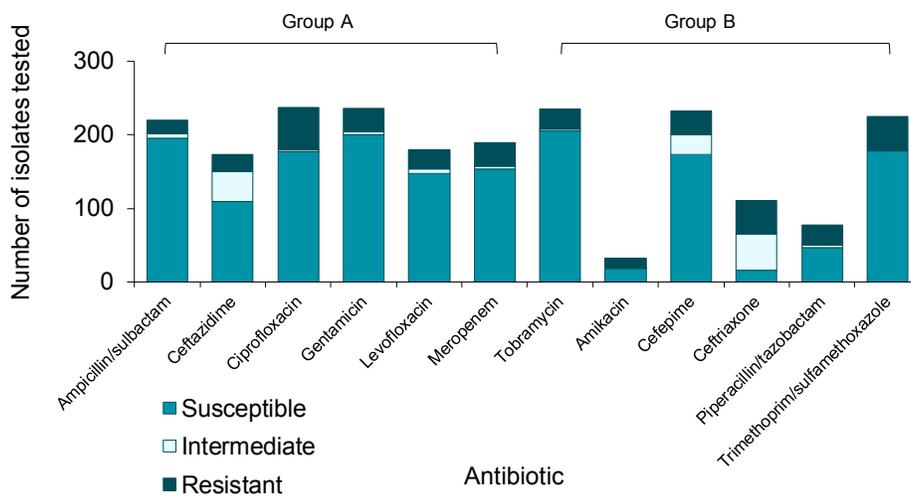

Note that this table includes data reported to DOH via ELR.

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. The 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 2015 (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, 2015

Class	Antibiotic	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	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Ampicillin	--	--	--	--	--	--	--	--	--	--	39	82%	1,358	97%	323	15%
	Ampicillin/sulbactam	223	88%	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Aztreonam	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Cefazolin	--	--	170	0%	107	96%	172	1%	470	0%	--	--	--	--	--	--
	Cefepime	240	73%	170	99%	107	100%	173	95%	470	95%	--	--	--	--	--	--
	Cefotazime	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Cefotetan	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Cefoxitin	--	--	129	0%	85	96%	170	0%	464	0%	--	--	--	--	--	--
	Ceftazidime	184	59%	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Ceftriaxone	153	10%	170	79%	107	98%	173	75%	469	79%	--	--	--	--	--	--
	Cefuroxime	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Doripenem	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Ertapenem	--	--	43	100%	--	--	--	--	--	--	--	--	--	--	--	--
	Imipenem	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Meropenem	189	81%	170	96%	105	100%	168	98%	470	98%	--	--	--	--	--	--
	Oxacillin	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Penicillin	--	--	--	--	--	--	--	--	--	--	34	79%	1,223	97%	284	13%
	Piperacillin	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Piperacillin/tazobactam	78	59%	49	82%	--	--	169	76%	465	83%	--	--	--	--	--	--
	Ticarcillin/clavulanate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Non β-lactam	Amikacin	33	55%	168	98%	107	100%	171	100%	467	100%	--	--	--	--	--	--
	Chloramphenicol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Ciprofloxacin	238	74%	170	88%	107	97%	172	94%	471	93%	--	--	--	--	--	--
	Clindamycin	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Daptomycin	--	--	--	--	--	--	--	--	--	--	--	--	377	100%	37	97%
	Doxycycline	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Erythromycin	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Gentamicin	238	84%	170	88%	107	100%	172	95%	470	93%	--	--	--	--	--	--
	Levofloxacin	183	81%	131	86%	86	99%	172	96%	471	94%	--	--	1,175	100%	300	100%
	Linezolid	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Minocycline	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Moxifloxacin	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Ofloxacin	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Rifampin	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Tetracycline	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Tobramycin	237	87%	170	89%	107	99%	171	95%	470	93%	--	--	--	--	--	--
	Trimethoprim/sulfamethoxazole	225	79%	164	79%	105	100%	166	95%	448	87%	--	--	--	--	--	--
	Vancomycin	--	--	--	--	--	--	--	--	--	--	39	97%	1,368	95%	323	32%

Note that this table includes data reported to DOH via ELR.

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

Section 5: Antimicrobial Resistance Surveillance

Section 5: Antimicrobial Resistance Surveillance

Figure 4 (Part 2). Antibiogram for Susceptibility Data Received Via Electronic Laboratory Reporting
for Organisms of Concern, Florida, 2015

Class	Antibiotic	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	271	78%	--	--	85	95%	--	--	--	--	--	--	--	--
	Ampicillin	4,525	47%	271	66%	1,732	0%	259	0%	--	--	--	--	--	--
	Ampicillin/sulbactam	2,300	55%	--	--	815	80%	141	65%	--	--	--	--	--	--
	Aztreonam	--	--	--	--	--	--	--	--	282	69%	--	--	--	--
	Cefazolin	4,524	84%	--	--	1,732	87%	259	70%	--	--	336	0%	--	--
	Cefepime	4,528	93%	--	--	1,731	93%	259	98%	1,766	86%	338	99%	--	--
	Cefotaxime	45	84%	241	97%	36	17%	--	--	--	--	--	--	--	--
	Cefotetan	--	--	--	--	36	50%	--	--	--	--	--	--	--	--
	Cefoxitin	3,585	88%	--	--	1,374	91%	191	92%	--	--	237	22%	--	--
	Ceftazidime	--	--	--	--	--	--	--	--	1,359	89%	--	--	--	--
	Ceftriaxone	4,521	89%	58	98%	1,730	88%	259	89%	--	--	336	95%	--	--
	Cefuroxime	64	70%	107	98%	39	21%	--	--	--	--	--	--	--	--
	Doripenem	--	--	--	--	--	--	--	--	38	58%	--	--	--	--
	Ertapenem	1,140	100%	--	--	411	100%	79	100%	--	--	108	100%	--	--
	Imipenem	63	100%	--	--	--	--	--	--	65	74%	--	--	--	--
	Meropenem	4,516	100%	--	--	1,732	98%	259	98%	1,753	89%	338	99%	--	--
	Oxacillin	--	--	--	--	--	--	--	--	--	--	--	--	88	27%
	Penicillin	--	--	--	--	--	--	--	--	--	--	--	--	88	7%
	Piperacillin	48	56%	--	--	39	8%	--	--	101	79%	--	--	--	--
	Piperacillin/tazobactam	4,303	95%	--	--	1,614	94%	255	94%	1,604	89%	--	--	--	--
	Ticarcillin/clavulanate	34	59%	--	--	--	--	--	--	--	--	--	--	--	--
Non β-lactam	Amikacin	4,504	100%	--	--	1,727	99%	259	100%	1,760	96%	335	99%	--	--
	Chloramphenicol	--	--	256	98%	--	--	--	--	--	--	--	--	--	--
	Ciprofloxacin	4,528	70%	--	--	1,734	91%	259	99%	1,777	80%	338	96%	80	61%
	Clindamycin	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Daptomycin	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Doxycycline	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Erythromycin	--	--	--	--	--	--	--	--	--	--	--	--	81	28%
	Gentamicin	4,523	89%	--	--	1,735	92%	259	93%	1,776	88%	338	96%	81	96%
	Levofloxacin	3,622	72%	--	--	1,394	92%	191	99%	1,472	75%	242	96%	--	--
	Linezolid	--	--	--	--	--	--	--	--	--	--	--	--	81	100%
	Minocycline	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Moxifloxacin	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Ofloxacin	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Rifampin	--	--	--	--	--	--	--	--	--	--	--	--	81	94%
	Tetracycline	--	--	--	--	--	--	--	--	--	--	--	--	81	81%
	Tobramycin	4,524	90%	--	--	1,730	91%	259	93%	1,765	94%	337	88%	--	--
	Trimethoprim/sulfamethoxazole	4,317	69%	273	69%	1,659	86%	247	96%	--	--	321	99%	--	--
	Vancomycin	--	--	--	--	--	--	--	--	--	--	--	--	88	100%

Note that this table includes data reported to DOH via ELR.

-- 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 is still being improved and as of the time of this report, 2015 data were not sufficient for analysis. In the interim, DOH 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 2004, which 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* due to known resistance (excluded here).
    ◊ Susceptibility to cefazolin decreased dramatically from 51% in 2014 to 26% in 2015.
    ◊ Susceptibility to other β-lactam antibiotics has increased over the past five years, but is still low (56% for amoxicillin/clavulanic acid and 58% for oxacillin).
    ◊ Empiric treatment of skin and soft tissue infections with β-lactam antibiotics is not recommended.
    ◊ Susceptibility remained high to gentamicin (97%), linezolid (100%), tetracycline (92%), trimethoprim/sulfamethoxazole (96%), and vancomycin (100%).

- Susceptibility to most antibiotics varied slightly by age group. Isolates from people aged 65 years and older have slightly reduced susceptibility to gentamicin, ciprofloxacin, levofloxacin, trimethoprim/sulfamethoxazole, and clindamycin (Table 6).
- North Florida had a higher proportion of MRSA isolates while central and south Florida had a lower proportion. This trend has been consistently observed since surveillance started in 2006 (Table 7, Map 1).
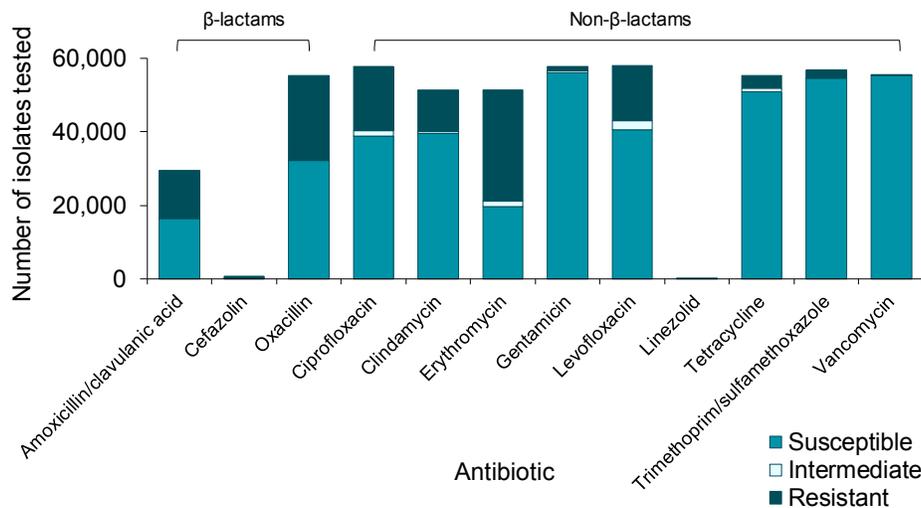
Table 5. Number Tested and Percent of *S. aureus* Isolates Susceptible to Selected Antibiotics, Commercial Outpatient Laboratory, Florida, 2011-2015

Antibiotic type	Antibiotic name	2011		2012		2013		2014		2015	
		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	54,998	51%	51,665	51%	50,178	53%	53,455	54%	29,442	56%
	Cefazolin	39,156	49%	37,199	51%	16,740	52%	717	51%	723	26%
	Oxacillin	54,817	51%	52,949	52%	51,579	53%	55,990	54%	55,303	58%
Non-β-lactams	Ciprofloxacin	44,629	68%	51,182	66%	55,714	66%	57,633	63%	57,895	67%
	Clindamycin	51,634	79%	49,440	78%	47,831	78%	52,191	76%	51,506	77%
	Erythromycin	51,639	34%	49,446	34%	47,843	35%	52,192	35%	51,519	38%
	Gentamicin	59,084	97%	57,298	97%	56,032	97%	57,629	96%	57,921	97%
	Levofloxacin	56,949	72%	54,356	71%	56,151	70%	57,690	68%	57,958	70%
	Linezolid	34,210	100%	8,279	100%	189	100%	262	100%	203	100%
	Tetracycline	54,872	93%	53,008	93%	51,678	93%	56,103	92%	55,353	92%
	Trimethoprim/sulfamethoxazole	57,573	98%	55,770	98%	54,468	97%	56,951	97%	56,821	96%
	Vancomycin	54,876	100%	52,996	100%	51,686	100%	56,097	100%	55,394	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, 2015

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, 2015

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	596	60%	1,965	46%	3,303	62%	2,913	60%	12,730	56%	7,869	55%
	Cefazolin	22	--	39	28%	36	25%	47	26%	293	26%	282	26%
	Oxacillin	1,000	63%	3,593	49%	6,237	65%	5,638	65%	23,601	58%	15,142	56%
Non-β-lactams	Ciprofloxacin	1,070	77%	3,729	69%	6,430	78%	5,792	78%	24,610	68%	16,174	57%
	Clindamycin	987	76%	3,553	82%	6,141	77%	5,278	79%	22,140	80%	13,317	70%
	Erythromycin	990	36%	3,558	29%	6,144	40%	5,280	43%	22,143	39%	13,314	37%
	Gentamicin	1,065	98%	3,726	98%	6,435	98%	5,792	98%	24,620	97%	16,184	95%
	Levofloxacin	1,073	80%	3,738	72%	6,434	81%	5,796	80%	24,638	71%	16,189	59%
	Linezolid	1	--	2	--	7	--	4	--	74	100%	113	100%
	Tetracycline	1,003	93%	3,600	92%	6,241	91%	5,636	93%	23,617	92%	15,164	92%
	Trimethoprim/sulfamethoxazole	1,058	99%	3,696	98%	6,351	99%	5,750	98%	24,177	97%	15,693	93%
	Vancomycin	1,005	100%	3,601	100%	6,240	100%	5,641	100%	23,634	100%	15,181	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,
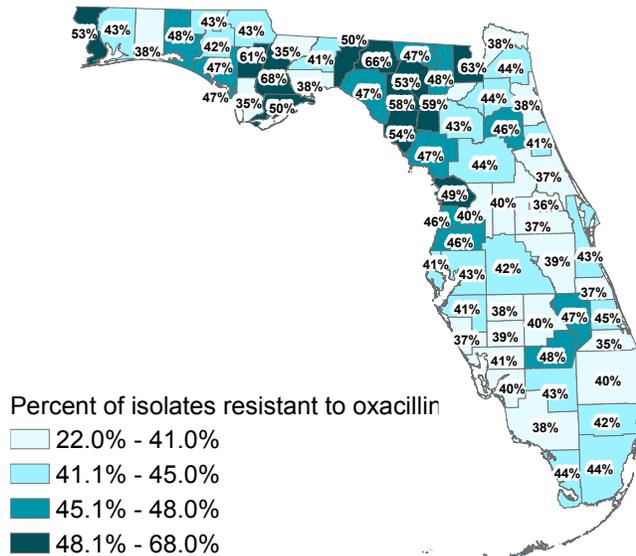Commercial Outpatient Laboratory, Florida, 2015

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	426	48%	420	45%	2,213	52%	3,044	53%	3,626	57%	3,582	58%	12,634	57%
	Cefazolin	12	--	16	--	59	5%	101	5%	116	16%	103	20%	241	46%
	Oxacillin	1,486	55%	1,380	53%	7,201	57%	9,602	57%	9,652	61%	7,116	61%	13,019	58%
Non-β-lactams	Ciprofloxacin	1,546	66%	1,452	71%	7,566	69%	10,108	66%	10,138	70%	7,459	67%	13,516	65%
	Clindamycin	1,395	82%	1,288	81%	6,705	79%	8,745	79%	8,927	78%	6,622	79%	12,228	72%
	Erythromycin	1,396	37%	1,287	34%	6,707	37%	8,750	39%	8,927	40%	6,624	42%	12,233	36%
	Gentamicin	1,543	99%	1,450	99%	7,567	99%	10,107	98%	10,144	98%	7,459	98%	13,522	94%
	Levofloxacin	1,549	69%	1,451	73%	7,572	72%	10,114	68%	10,157	72%	7,464	70%	13,533	69%
	Linezolid	1	--	1	--	16	--	31	100%	31	100%	10	--	97	100%
	Tetracycline	1,487	94%	1,380	92%	7,208	94%	9,611	93%	9,662	92%	7,119	93%	13,035	89%
	Trimethoprim/sulfamethoxazole	1,525	97%	1,418	97%	7,392	98%	9,860	94%	9,937	97%	7,334	95%	13,344	97%
	Vancomycin	1,488	100%	1,382	100%	7,206	100%	9,607	100%	9,664	100%	7,125	100%	13,064	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
Resistant to Oxacillin (MRSA) by County of Residence,
Commercial Outpatient Laboratory, Florida, 2015

Percent of isolates resistant to oxacillin
- 22.0% - 41.0%
- 41.1% - 45.0%
- 45.1% - 48.0%
- 48.1% - 68.0%

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 (28 isolates tested), Jefferson (22 isolates tested), and Liberty (25 isolates tested).