Section 5

Antimicrobial Resistance Surveillance

Antimicrobial Resistance Surveillance

Antibiotics are one of the most impressive medical achievements of the twentieth century. Unfortunately, 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.

The Florida Department of Health (DOH) conducts surveillance for antibiotic resistance in four microorganisms:

1) Health care providers and laboratories are required to report antibiotic susceptibility testing results for isolates of *Streptococcus pneumoniae* from normally sterile sites, such as blood or cerebrospinal fluid, as well as testing results for isolates of *Staphylococcus aureus* that are not susceptible to vancomycin.
2) Laboratories participating in electronic laboratory reporting are required to report antibiotic susceptibility testing results for all *S. aureus* isolates from normally sterile sites.
3) *Neisseria gonorrhoeae* isolates from the first 25 men with urethral gonorrhea seen each month in one sexually transmitted disease (STD) clinic in Miami are forwarded to the Centers for Disease Control and Prevention (CDC) for susceptibility testing as part of the Gonococcal Isolate Surveillance Project (GISP).
4) Additionally, 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.

A cumulative or community antibiogram can provide useful operational information for the selection of an empiric therapy for a presumptive diagnosis, help track antibiotic resistance patterns of clinically important microorganisms and detect trends towards antimicrobial resistance.

Streptococcus pneumoniae

Streptococcus 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 988 *S. pneumoniae* invasive disease cases were reported in 2012; eight (0.8%) did not have antibiotic susceptibility data, most often because the patient died and further testing was not done. Tables 1-3 and Figure 1 include data on the percent of cases susceptible to antibiotics by Clinical and Laboratory Standards Institute (CLSI) groups A-C, age group and geography.

Key points for *S. pneumoniae* data:

- Susceptibility by CLSI groups (Table 1, Figure 1):
    - Group A (appropriate for primary testing and routine reporting): 61 to 72% of isolates were susceptible.
    - Group B (may warrant primary testing, but reported selectively): 82 to 100% of isolates were susceptible.
    - Group C (alternative antibiotics): 89 to 100% of isolates were susceptible.
    - Note that 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.
    - Susceptibility to ofloxacin and cefepime decreased from 2011 to 2012; susceptibility to other Group A and B antibiotics increased.

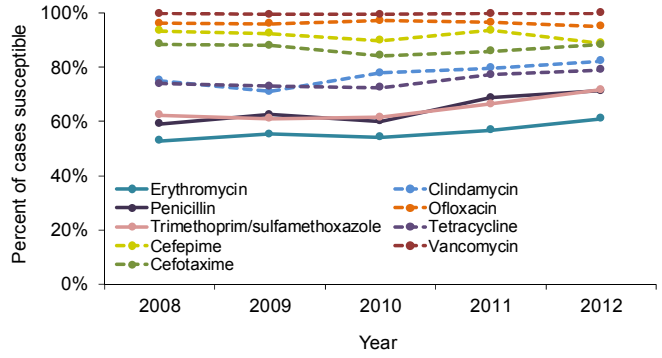
- Susceptibility to selected antibiotics varies by region and age group with no clear trends (Tables 2, 3, Map 1).

Table 1. Number Tested and Percent of *S. pneumoniae* Isolates Susceptible by Clinical and Laboratory Standards Institute (CLSI) Antibiotic Groups[1] for Reported Cases of *S. pneumoniae* Invasive Disease, Florida, 2012

CLSI group[1]	Antibiotic name	Number of cases tested	Percent of cases tested		
			Susceptible	Intermediate	Resistant
Group A	Erythromycin	764	61%	1%	38%
	Penicillin	858	71%	11%	17%
	Trimethoprim/sulfamethoxazole	580	72%	8%	20%
Group B	Cefepime	117	89%	9%	3%
	Cefotaxime	433	89%	6%	6%
	Clindamycin	311	82%	1%	17%
	Levofloxacin	693	99%	1%	0%
	Meropenem	235	85%	7%	8%
	Moxifloxacin	198	100%	0%	0%
	Ofloxacin	62	95%	5%	0%
	Tetracycline	475	79%	0%	21%
	Vancomycin	887	100%	0%	0%
Group C	Amoxicillin/clavulanic acid	114	91%	2%	7%
	Amoxicillin	141	91%	4%	6%
	Chloramphenicol	244	96%	0%	4%
	Imipenem	35	89%	11%	0%
	Linezolid	165	99%	0%	1%
	Rifampin	51	100%	0%	0%

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.

Figure 1. Percent of Reported *S. pneumoniae* Invasive Disease Cases Susceptible to Selected Antibiotics in Clinical and Laboratory Standards Institute (CLSI) Antibiotic Groups A and B[1], Florida, 2008-2012



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. Prior to 2010, susceptibility results are not available for levofloxacin, moxifloxacin and meropenem and they are not included on this graph.

Map 1. Florida Regions (see Tables 2 and 5)

Table 2. Percent of Reported *S. pneumoniae* Invasive Disease Cases Susceptible to Antibiotics by Clinical and Laboratory Standards Institute (CLSI) Antibiotic Groups[1] and Region (See Map 1), Florida, 2012

CLSI group[1]	Antibiotic name	Percent of cases susceptible by region (see Figure 2)						
		Northwest (60 cases)	North Central (31 cases)	Northeast (121 cases)	West Central (181 cases)	East Central (187 cases)	Southwest (101 cases)	Southeast (307 cases)
Group A	Erythromycin	53%	57%	58%	66%	60%	62%	61%
	Penicillin	78%	-	64%	66%	65%	79%	77%
	Trimethoprim/sulfamethoxazole	71%	-	74%	66%	76%	63%	72%
Group B	Cefepime	93%	-	85%	-	-	-	-
	Cefotaxime	89%	-	86%	92%	84%	91%	89%
	Clindamycin	87%	-	66%	83%	80%	-	86%
	Levofloxacin	100%	95%	97%	100%	100%	100%	98%
	Meropenem	86%	-	84%	92%	79%	92%	76%
	Moxifloxacin	-	-	-	100%	100%	-	100%
	Ofloxacin	-	-	-	-	95%	-	-
	Tetracycline	89%	-	74%	78%	77%	85%	79%
	Vancomycin	100%	100%	100%	100%	100%	100%	100%

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 <20 isolates were tested for susceptibility to a particular drug.

Table 3. Percent of Reported *S. pneumoniae* Invasive Disease Cases Susceptible to Antibiotics by Clinical and Laboratory Standards Institute (CLSI) Antibiotic Groups[1] and Age Group, Florida, 2012

CLSI group[1]	Antibiotic name	Percent of cases susceptible by age group (in years)					
		<1 (22 cases)	1-4 (58 cases)	5-14 (25 cases)	15-24 (21 cases)	25-64 (498 cases)	65+ (364 cases)
Group A	Erythromycin	71%	67%	74%	-	66%	53%
	Penicillin	80%	63%	71%	47%	73%	71%
	Trimethoprim/sulfamethoxazole	-	58%	80%	-	74%	69%
Group B	Cefepime	-	-	-	-	91%	-
	Cefotaxime	-	-	-	-	90%	88%
	Clindamycin	-	96%	-	-	80%	84%
	Levofloxacin	-	100%	-	-	99%	99%
	Meropenem	-	83%	-	-	86%	83%
	Moxifloxacin	-	100%	100%	-	100%	100%
	Ofloxacin	-	-	-	-	93%	96%
	Tetracycline	-	-	-	-	82%	78%
	Vancomycin	-	-	-	-	100%	100%

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 <20 isolates were tested for susceptibility to a particular drug.

Staphylococcus aureus

Staphylococcus aureus bacteria are commonly found on the skin of healthy people, but have the potential to cause serious disease. About 20% of healthy people are persistent carriers of *S. aureus*, usually in the nose and on the skin, and over 60% of the population may be intermittent carriers. Methicillin-resistant *S. aureus* (MRSA) is a strain of *S. aureus* that is resistant to all β-lactam antibiotics (including penicillins, cephalosporins, cephamicins and monobactams) and may also be resistant to other antibiotics. Resistance testing for oxacillin is used to detect methicillin resistance.

Health care providers and laboratories are required to report all infections due to *S. aureus* that are not susceptible to vancomycin; however, DOH does not require health care providers to report individual MRSA infections. In 2008, antibiotic susceptibility testing results for all *S. aureus* isolates became reportable for laboratories participating in electronic laboratory reporting. This electronic laboratory data stream is still being improved and as of the time of this report, not enough data has been successfully submitted for meaningful analysis. In the interim, DOH partnered with one of the largest commercial laboratories in the state and has been receiving antibiotic susceptibility testing results for all *S. aureus* isolates tested since 2004, which is the source of the data included in this report. Note that only the first isolate per person per 365 days was included in the analysis, per CLSI guidelines.

Key points for *S. aureus* data:

- Overall resistance patterns (Table 4, Figure 2):
  - Susceptibility of isolates to penicillin decreased from 7% in 2008 to 1% in 2012.
  - Resistance to oxacillin (i.e., MRSA) was 48-52%, similar to other β-lactam antibiotics, so empiric treatment of skin and soft tissue infections with β-lactam antibiotics is not recommended.
  - Susceptibility remained high for gentamycin, trimethoprim/sulfamethoxazole, linezolid, vancomycin and tetracycline.

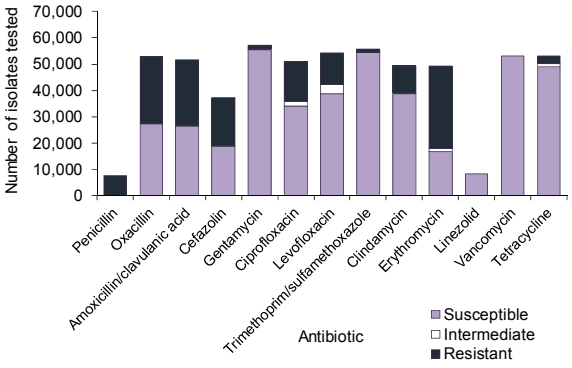
- Geographic patterns (Map 1, Map 2, Table 5):
  - North Florida county residents had the highest proportion of *S. aureus* isolates that were MRSA while south Florida county residents had the lowest.

- Age patterns (Table 6):
  - Susceptibility to most antibiotics did not differ substantially by age group, with a few exceptions.
  - Resistance to oxacillin (i.e., MRSA) was highest in 1 to 4-year-olds.
  - Susceptibility to gentamicin, ciprofloxacin, levofloxacin, trimethoprim/sulfamethoxazole and clindamycin was lowest in people 65 years and older.

Table 4. Number Tested and Percent of *S. aureus* Isolates Susceptible to Selected Antibiotics, Commercial Outpatient Laboratory, Florida, 2008-2012

Antibiotic class	Antibiotic name	2008		2009		2010		2011		2012	
		Number tested	Percent susceptible	Number tested	Percent susceptible	Number tested	Percent susceptible	Number tested	Percent susceptible	Number tested	Percent susceptible
β-Lactams	Penicillin	54,367	7%	55,486	5%	50,751	4%	32,497	4%	7,586	1%
	Oxacillin	56,263	48%	58,666	50%	56,544	49%	54,817	51%	52,949	52%
	Amoxicillin-clavulanic acid	58,732	48%	60,794	50%	58,079	49%	54,998	51%	51,665	51%
	Cefazolin	58,689	48%	60,733	50%	42,792	47%	39,156	49%	37,199	51%
Non-β-Lactams	Gentamicin	60,805	98%	63,077	97%	60,654	97%	59,084	97%	57,298	97%
	Ciprofloxacin	57,029	73%	24,722	73%	33,639	67%	44,629	68%	51,182	66%
	Levofloxacin	8,526	80%	42,917	74%	57,634	72%	56,949	72%	54,356	71%
	Trimethoprim/sulfamethoxazole	58,989	98%	61,628	98%	59,311	98%	57,573	98%	55,770	98%
	Clindamycin	52,999	83%	54,961	82%	53,166	80%	51,634	79%	49,440	78%
	Erythromycin	15,270	33%	16,493	35%	35,180	32%	51,639	34%	49,446	34%
	Linezolid	15,457	100%	38,267	100%	52,282	100%	34,210	100%	8,279	100%
	Vancomycin	55,947	100%	58,722	100%	56,652	100%	54,876	100%	52,996	100%
	Tetracycline	55,665	95%	58,469	94%	56,461	93%	54,872	93%	53,008	93%

Figure 2. Antibiotic Resistance Patterns of *S. aureus* Isolates for Selected Antibiotics, Commercial Outpatient Laboratory, Florida, 2008-2012



Map 2. Percent of *S. aureus* Isolates that were Oxacillin-Resistant (MRSA) by County of Residence, Commercial Outpatient Laboratory, Florida, 2012

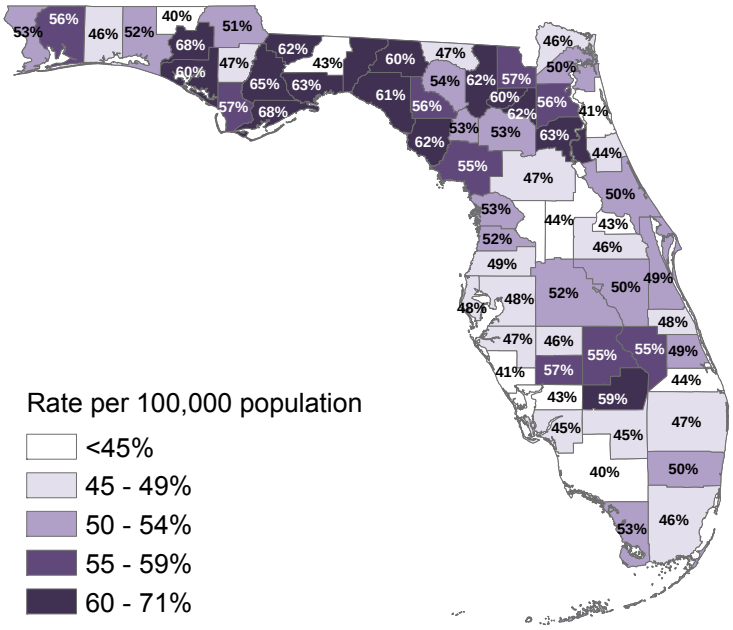


Table 5. Percent of *S. aureus* Isolates Susceptible to Selected Antibiotics by Region (See Map 1), Commercial Outpatient Laboratory, Florida, 2012

Antibiotic class	Antibiotic name	Percent of *S. aureus* isolates susceptible by region (see Figure 2)						
		Northwest (1,172 isolates)	North Central (1,303 isolates)	Northeast (7,452 isolates)	West Central (10,952 isolates)	East Central (9,884 isolates)	Southwest (6,166 isolates)	Southeast (14,373 isolates)
β-Lactams	Penicillin	-	-	-	-	2%	-	0%
	Oxacillin	47%	46%	50%	51%	53%	55%	52%
	Amoxicillin-clavulanic acid	46%	45%	49%	51%	53%	56%	52%
	Cefazolin	45%	45%	49%	51%	52%	55%	53%
Non-β-Lactams	Gentamicin	99%	99%	98%	98%	98%	98%	93%
	Ciprofloxacin	63%	66%	68%	66%	68%	68%	64%
	Levofloxacin	71%	70%	73%	72%	73%	74%	67%
	Trimethoprim/sulfamethoxazole	99%	99%	98%	97%	98%	98%	97%
	Clindamycin	82%	82%	78%	80%	79%	81%	73%
	Erythromycin	31%	28%	33%	34%	35%	37%	33%
	Linezolid	-	-	-	-	100%	-	100%
	Vancomycin	100%	100%	100%	100%	100%	100%	100%
	Tetracycline	93%	93%	94%	94%	94%	94%	89%

- Percent susceptible was suppressed if <50 isolates were tested for susceptibility to a particular drug.

Table 6. Percent of *S. aureus* Isolates Susceptible to Selected Antibiotics by Age Group, Commercial Outpatient Laboratory, Florida, 2012

Antibiotic class	Antibiotic name	Percent of *S. aureus* isolates susceptible by age group (in years)					
		<1 (1,209 isolates)	1-4 (4,672 isolates)	5-14 (6,730 isolates)	15-24 (6,344 isolates)	25-64 (24,249 isolates)	65+ (14,215 isolates)
β-Lactams	Penicillin	1%	0%	0%	0%	0%	1%
	Oxacillin	52%	39%	56%	55%	52%	51%
	Amoxicillin-clavulanic acid	53%	40%	55%	54%	51%	52%
	Cefazolin	51%	40%	54%	53%	51%	53%
Non-β-Lactams	Gentamicin	98%	98%	98%	98%	97%	94%
	Ciprofloxacin	75%	68%	75%	75%	67%	56%
	Levofloxacin	79%	72%	79%	79%	71%	62%
	Trimethoprim/sulfamethoxazole	99%	99%	99%	99%	98%	96%
	Clindamycin	81%	84%	78%	81%	81%	68%
	Erythromycin	33%	24%	35%	35%	35%	34%
	Linezolid	100%	100%	100%	100%	100%	100%
	Vancomycin	100%	100%	100%	100%	100%	100%
	Tetracycline	94%	95%	94%	92%	92%	92%

Neisseria gonorrhoeae

Neisseria gonorrhoeae bacteria grow easily in the warm, moist areas of the reproductive tract, urethra, mouth, throat, eyes and anus and cause the STD gonorrhea. Resistance to several antibiotics over time has challenged the treatment and control of gonorrhea. In the 1970's, the standard treatments, penicillin and tetracycline, were abandoned due to increased resistance to these agents. As recently as 2007, an increase in fluoroquinolone-resistant isolates prompted recommendations for new treatment guidelines supporting the use of cephalosporins, including ceftriaxone and cefixime, for gonococcal infections. In some parts of the world, *N. gonorrhoeae* is now showing potential resistance to cephalosporins, which are the only recommended class of antibiotics left to treat this common infection.

The Gonococcal Isolate Surveillance Project (GISP) was established in 1986 to continuously monitor trends in antimicrobial resistance of *N. gonorrhoeae* across 30 cities in the U.S. The Miami-Dade STD clinic has served as one of 29 GISP sites since 1998. The Miami-Dade GISP site collects specimens each month from symptomatic men and the first 25 *N. gonorrhoeae* isolates are tested by the CDC for susceptibility to penicillin, tetracycline, spectinomycin, ciprofloxacin, ceftriaxone, cefixime and azithromycin.

Key points for *N. gonorrhoeae* (Table 7):

- Resistance to penicillin and tetracycline remained high in 2012 and resistance to ciprofloxacin increased.
- All isolates were susceptible to azithromycin, ceftriaxone, cefixime and spectinomycin in 2012.

Table 7. Percent of *N. gonorrhoeae* Isolates Susceptible to Selected Antibiotics, Miami-Dade Gonococcal Isolate Surveillance Project Site, 2008-2012

Antibiotic name	2008 (259 isolates)	2009 (219 isolates)	2010 (209 isolates)	2011 (166 isolates)	2012 (188 isolates)
Penicillin	87%	88%	79%	81%	81%
Tetracycline	61%	65%	67%	63%	63%
Spectinomycin	100%	100%	100%	100%	100%
Ciprofloxacin	84%	88%	85%	77%	75%
Ceftriaxone	100%	100%	100%	100%	100%
Cefixime	-	100%	100%	100%	100%
Azithromycin	100%	100%	99%	100%	100%

- Isolates were not tested for cefixime susceptibility in 2008.

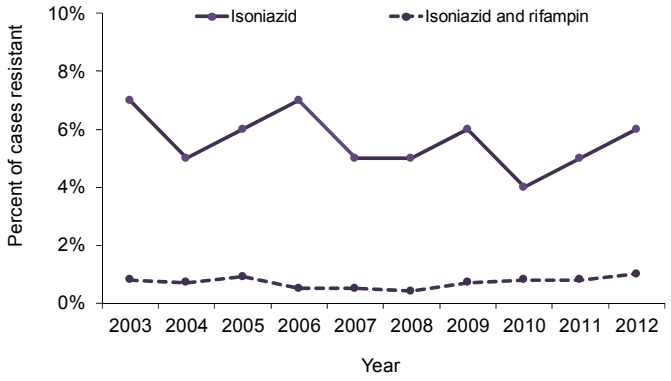
Mycobacterium tuberculosis

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 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.

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

- Resistance to isoniazid alone ranged from 4% to 7% over the past 10 years and was 6% in 2012.
- Multidrug-resistant TB remains uncommon given that only 1% of TB cases in 2012 have isolates resistant to both isoniazid and rifampin.

Figure 3. Percent of Counted Tuberculosis Cases Resistant to Isoniazid Alone and Isoniazid and Rifampin, Florida, 2003-2012



References

Clinical and Laboratory Standards Institute. 2008. Performance Standards for Antimicrobial Susceptibility Testing; Eighteenth Informational Supplement. CLSI document M100-S18. Wayne, PA: Clinical and Laboratory Standards Institute.