

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.

As of 2013, the Florida Department of Health (DOH) conducts surveillance for antibiotic resistance in four microorganisms:

- 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.
- Laboratories participating in electronic laboratory reporting are required to report antibiotic susceptibility testing results for all *S. aureus* isolates from normally sterile sites.
- *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).
- 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 toward 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 1,089 *S. pneumoniae* invasive disease cases were reported to DOH in 2013 by health care providers and laboratories. Tables 1-3 and Figure 1 include data on the percent of cases with isolates that were susceptible to selected antibiotics 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 routing 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.

Key points for *S. pneumoniae* data:

- Susceptibility by CLSI groups (Table 1, Figure 1):
 - Group A (appropriate for primary testing and routine reporting): 58 to 72% of cases had isolates that were susceptible.
 - Group B (may warrant primary testing, but reported selectively): 81 to 100% of cases had isolates that were susceptible.
 - Group C (alternative antibiotics): 85 to 99% of cases had isolates that 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 erythromycin and trimethoprim/sulfamethoxazole decreased from 2012 to 2013; susceptibility to other Group A and B antibiotics remained constant or increased.
- Susceptibility to selected antibiotics varies by region and age group with no clear trends (Tables 2, 3, Map 1).

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Table 1. Number Tested and Percent of Reported *S. pneumoniae* Invasive Disease Cases With Isolates Susceptible to Selected Antibiotics by Clinical and Laboratory Standards Institute (CLSI) Antibiotic Groups¹, Florida,

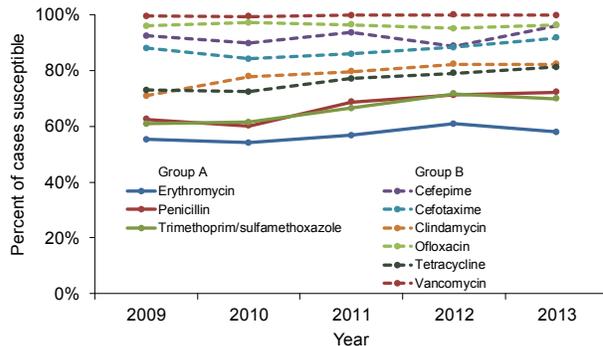
CLSI group ¹	Antibiotic name	Number of cases with isolate tested	Percent of cases with isolate tested		
			Susceptible	Intermediate	Resistant
Group A	Erythromycin	840	58%	1%	41%
	Penicillin	966	72%	11%	16%
	Trimethoprim/sulfamethoxazole	680	70%	9%	21%
Group B	Cefepime	157	96%	2%	2%
	Cefotaxime	525	92%	5%	3%
	Clindamycin	396	82%	1%	16%
	Levofloxacin	774	99%	0%	1%
	Moxifloxacin	194	99%	1%	1%
	Ofloxacin	55	96%	4%	0%
	Meropenem	338	87%	8%	5%
	Tetracycline	565	81%	1%	18%
	Vancomycin	962	100%	0%	0%
	Group C	Amoxicillin/clavulanic acid	138	95%	4%
Amoxicillin		182	90%	4%	5%
Chloramphenicol		238	96%	0%	3%
Imipenem		27	NA	NA	NA
Linezolid		193	99%	1%	0%
Rifampin		42	98%	2%	0%

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 reportable disease reporting.

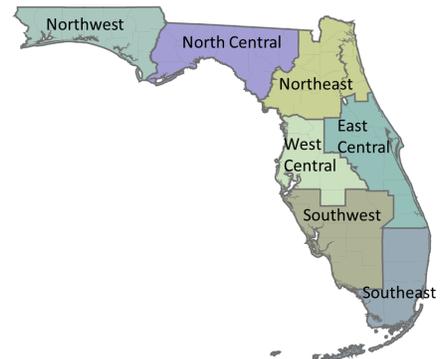
1 Group A includes antibiotics that CLSI considers appropriate for primary testing and routine reporting, Group B includes antibiotics that may warrant primary testing but should be reported selectively, and Group C includes antibiotics considered to be alternative or supplemental.

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

Figure 1. Percent of Reported *S. pneumoniae* Invasive Disease Cases With Isolates Susceptible to Selected Antibiotics by Clinical and Laboratory Standards Institute (CLSI) Antibiotic Groups A and B¹, Florida, 2009-2013



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



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

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Table 2. Percent of Reported *S. pneumoniae* Invasive Disease Cases With Isolates Susceptible to Selected Antibiotics by Clinical and Laboratory Standards Institute (CLSI) Antibiotic Groups¹ and Region (See Map 1), Florida, 2013

CLSI group ¹	Antibiotic name	Percent of cases with susceptible isolate by region (see Map 1)						
		Northwest (88 cases)	North Central (28 cases)	Northeast (144 cases)	West Central (189 cases)	East Central (193 cases)	Southwest (113 cases)	Southeast (334 cases)
Group A	Erythromycin	65%	NA	54%	64%	60%	64%	53%
	Penicillin	76%	NA	71%	73%	65%	78%	72%
	Trimethoprim/sulfamethoxazole	79%	NA	72%	69%	67%	72%	67%
Group B	Cefepime	96%	NA	97%	NA	NA	NA	NA
	Cefotaxime	97%	NA	97%	90%	89%	94%	88%
	Clindamycin	92%	NA	80%	80%	84%	NA	78%
	Levofloxacin	97%	NA	100%	100%	100%	100%	98%
	Meropenem	90%	NA	88%	84%	85%	90%	85%
	Moxifloxacin	NA	NA	NA	100%	100%	NA	100%
	Ofloxacin	NA	NA	NA	NA	94%	NA	NA
	Tetracycline	89%	NA	79%	79%	80%	88%	80%
	Vancomycin	100%	NA	99%	100%	100%	100%	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 reportable 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.

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

Table 3. Percent of Reported *S. pneumoniae* Invasive Disease Cases With Isolates Susceptible to Selected Antibiotics by Clinical and Laboratory Standards Institute (CLSI) Antibiotic Groups¹ and Age Group, Florida, 2013

CLSI group ¹	Antibiotic name	Percent of cases with susceptible isolate by age group (in years)					
		<1 (27 cases)	1-4 (68 cases)	5-14 (30 cases)	15-24 (22 cases)	25-64 (534 cases)	65+ (408 cases)
Group A	Erythromycin	NA	58%	NA	NA	58%	58%
	Penicillin	NA	71%	77%	NA	74%	70%
	Trimethoprim/sulfamethoxazole	NA	69%	NA	NA	70%	69%
Group B	Cefepime	NA	NA	NA	NA	NA	NA
	Cefotaxime	NA	NA	NA	NA	91%	94%
	Clindamycin	NA	76%	NA	NA	83%	85%
	Levofloxacin	NA	NA	NA	NA	99%	99%
	Meropenem	NA	95%	NA	NA	86%	87%
	Moxifloxacin	NA	100%	NA	NA	98%	100%
	Ofloxacin	NA	NA	NA	NA	93%	100%
	Tetracycline	NA	NA	NA	NA	NA	NA
	Vancomycin	NA	100%	NA	NA	100%	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 reportable 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.

NA Percent susceptible was suppressed if <30 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, cephamycins, 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

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laboratory data stream is still being improved and as of the time of this report, not enough data have 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 there 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. Data collected from this one laboratory may or may not be representative of statewide

Key points for *S. aureus* data:

- Overall resistance patterns (Table 4, Figure 2):
 - Penicillin is not recommended for treating *S. aureus* due to known resistance, and is therefore excluded here.
 - Resistance to oxacillin (i.e., MRSA) ranged from 43 to 57% depending on age, similar to other β -lactam antibiotics.
 - 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. This trend has been consistently observed since surveillance started in 2006.
- Age patterns (Table 6):
 - 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.

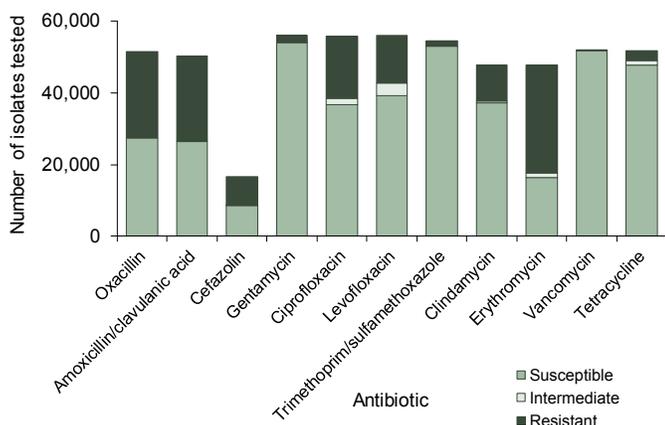
Table 4. Number Tested and Percent of *S. aureus* Isolates Susceptible to Selected Antibiotics, A Commercial Outpatient Laboratory, Florida, 2009-2013

Antibiotic class	Antibiotic name	2009		2010		2011		2012		2013	
		Number tested	Percent susceptible								
β -Lactams	Oxacillin	58,666	50%	56,544	49%	54,817	51%	52,949	52%	51,579	53%
	Amoxicillin/clavulanic acid	60,794	50%	58,079	49%	54,998	51%	51,665	51%	50,178	53%
	Cefazolin	60,733	50%	42,792	47%	39,156	49%	37,199	51%	16,740	52%
Non- β -Lactams	Gentamicin	63,077	97%	60,654	97%	59,084	97%	57,298	97%	56,032	97%
	Ciprofloxacin	24,722	73%	33,639	67%	44,629	68%	51,182	66%	55,714	66%
	Levofloxacin	42,917	74%	57,634	72%	56,949	72%	54,356	71%	56,151	70%
	Trimethoprim/sulfamethoxazole	61,628	98%	59,311	98%	57,573	98%	55,770	98%	54,468	97%
	Clindamycin	54,961	82%	53,166	80%	51,634	79%	49,440	78%	47,831	78%
	Erythromycin	16,493	35%	35,180	32%	51,639	34%	49,446	34%	47,843	35%
	Linezolid	38,267	100%	52,282	100%	34,210	100%	8,279	100%	189	100%
	Vancomycin	58,722	100%	56,652	100%	54,876	100%	52,996	100%	51,686	100%
	Tetracycline	58,469	94%	56,461	93%	54,872	93%	53,008	93%	51,678	93%

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

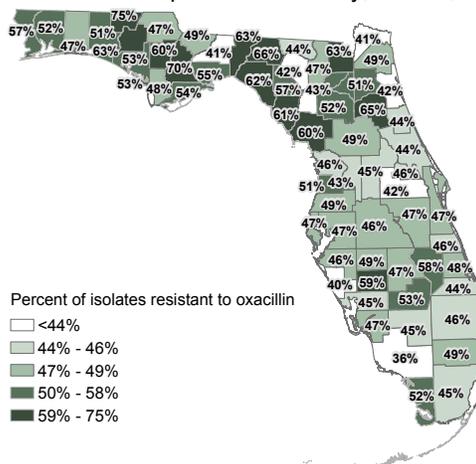
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Figure 2. Antibiotic Resistance Patterns of *S. aureus* Isolates for Selected Antibiotics, A Commercial Outpatient Laboratory, Florida, 2013



Note that this table includes data from a single commercial outpatient laboratory that receives isolates from health care providers across the state. Linezolid is not included in this figure due to the small number of isolates with susceptibility testing.

Map 2. Percent of *S. aureus* Isolates That Were Resistant to Oxacillin (MRSA) by County of Residence, A Commercial Outpatient Laboratory, Florida, 2013



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: Jefferson (19 isolates tested), Hamilton (27 isolates tested), Holmes (20 isolates tested), Liberty (23 isolates tested), and Washington (27 isolates tested).

Table 5. Percent of *S. aureus* Isolates Susceptible to Selected Antibiotics by Region (See Map 1), A Commercial Outpatient Laboratory, Florida, 2013

Antibiotic class	Antibiotic name	Percent of susceptible by region (see Map 1)						
		Northwest (1,463 isolates)	North Central (1,216 isolates)	Northeast (7,258 isolates)	West Central (10,649 isolates)	East Central (9,584 isolates)	Southwest (6,542 isolates)	Southeast (14,270 isolates)
β-Lactams	Oxacillin	48%	51%	51%	53%	55%	56%	54%
	Amoxicillin/clavulanic acid	48%	51%	50%	53%	55%	56%	54%
	Cefazolin	49%	52%	50%	52%	53%	54%	52%
Non-β-Lactams	Gentamicin	99%	98%	98%	97%	97%	98%	93%
	Ciprofloxacin	63%	69%	68%	66%	68%	67%	64%
	Levofloxacin	68%	74%	72%	70%	71%	71%	68%
	Trimethoprim/sulfamethoxazole	98%	98%	98%	96%	98%	97%	96%
	Clindamycin	82%	85%	79%	80%	79%	79%	73%
	Erythromycin	31%	35%	33%	36%	35%	37%	34%
	Linezolid	NA	NA	NA	NA	100%	NA	100%
	Vancomycin	100%	100%	100%	100%	100%	100%	100%
	Tetracycline	94%	93%	94%	94%	93%	94%	89%

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

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

Table 6. Percent of *S. aureus* Isolates Susceptible to Selected Antibiotics by Age Group, A Commercial Outpatient Laboratory, Florida, 2013

Antibiotic class	Antibiotic name	Percent of isolates susceptible by age group (in years)					
		<1 (1,083 isolates)	1-4 (4,113 isolates)	5-14 (6,406 isolates)	15-24 (6,042 isolates)	25-64 (23,765 isolates)	65+ (14,856 isolates)
β-Lactams	Oxacillin	51%	43%	57%	57%	54%	51%
	Amoxicillin/clavulanic acid	53%	43%	57%	56%	53%	53%
	Cefazolin	47%	39%	54%	56%	52%	53%
Non-β-Lactams	Gentamicin	98%	98%	98%	98%	97%	94%
	Ciprofloxacin	73%	67%	75%	75%	67%	55%
	Levofloxacin	77%	72%	80%	79%	71%	59%
	Trimethoprim/sulfamethoxazole	98%	99%	99%	99%	98%	94%
	Clindamycin	81%	84%	77%	81%	81%	69%
	Erythromycin	34%	27%	34%	37%	36%	34%
	Linezolid	NA	NA	NA	NA	100%	100%
	Vancomycin	100%	100%	100%	100%	100%	100%
	Tetracycline	94%	95%	93%	92%	92%	92%

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

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

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 sexually transmitted disease (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.

Table 7. Percent of *N. gonorrhoeae* Isolates Susceptible to Selected Antibiotics, Miami-Dade Gonococcal Isolate Surveillance Project (GISP) Site, 2009-2013

Antibiotic name	2009 (219 isolates)	2010 (209 isolates)	2011 (162 isolates)	2012 (188 isolates)	2013 (187 isolates)
Penicillin	88%	79%	81%	81%	72%
Tetracycline	65%	67%	62%	63%	61%
Spectinomycin	100%	100%	100%	100%	100%
Ciprofloxacin	89%	86%	77%	78%	78%
Ceftriaxone	100%	100%	100%	100%	100%
Cefixime	100%	100%	100%	100%	100%
Azithromycin	100%	99%	100%	100%	96%

Note that this table includes data for specimens collected from the first 25 symptomatic men seen at the Miami-Dade GISP site.

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

- Susceptibility to azithromycin, penicillin, and tetracycline decreased in 2013 and remained stable for ciprofloxacin.
- All isolates were susceptible to ceftriaxone, cefixime, and spectinomycin in 2013.

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.

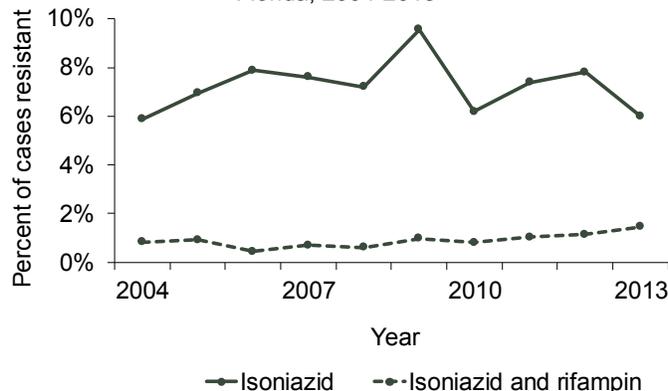
Key points for *M. tuberculosis* (Figure 3):

- Resistance to isoniazid alone ranged from 6% to 10% over the past 10 years and was 6% in 2013.
- Multidrug-resistant TB remains uncommon but increased in 2013, with 1.5% of TB cases in 2013 having isolates resistant to both isoniazid and rifampin.

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.

Figure 3. Percent of Counted Tuberculosis Cases With Isolates Resistant to Isoniazid Alone and Isoniazid and Rifampin, Florida, 2004-2013



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.