NH DIVISION OF
Public Health Services
Improving health, preventing disease, reducing costs *for all*
Department of Health and Human Services

STATE OF NEW HAMPSHIRE

2018 STATE ANTIBIOGRAM & IMPLICATIONS FOR ANTIBIOTIC PRESCRIBING

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New Hampshire Department of Health and Human Services
Division of Public Health Services

Antibiogram and Clinical Messaging Update

The New Hampshire State Antibiogram and Clinical Summary uses local antibiotic resistance data to help guide prescribing of antibiotics for common clinical syndromes and avoid unnecessary broad spectrum therapy that can put patients at increased risk for adverse side effects and contribute to development of antibiotic resistance. This document can also be used to help facility antibiotic stewardship programs craft more local messaging about appropriate antibiotic prescribing.

This 2018 State Antibiogram and Clinical Summary incorporates the updated American Thoracic Society and Infectious Diseases Society of America (IDSA) Official Clinical Practice Guidelines for the Diagnosis and Treatment of Adults with Community Acquired Pneumonia [1]*, and the 2019 IDSA Clinical Practice Guideline for the Management of Asymptomatic Bacteriuria* [2]*. Our 2016 and 2017 State Antibiograms and Clinical Summaries can be found here.*

The arrow bullet points [➢] indicate new or significant changes to our clinical messaging. The dot bullet points [•] are important clinical messages that remain from last year's antibiograms' clinical summary, but may have updated antibiogram numbers.

Table 1 below offers considerations and evidence for short duration of antimicrobial therapy, an important strategy that when compared to longer courses, is associated with similar treatment efficacy, lower rates of subsequent infection with multidrug-resistant organisms, and fewer systemic adverse reactions [3] [4] [5]. The suggested short course duration of antibiotics is not intended to supplant clinician judgement about individual patients or special clinical situations.

Table 1: Short Course Antibiotic Therapy for Specific Infectious Syndromes in Adults

Syndrome	**Short Course of Therapy (Days)**
Uncomplicated urinary tract infections	3-5 days (depending on antibiotic)
Complicated urinary tract infections, including acute pyelonephritis	May be as short as 7 days
Community-acquired pneumonia (CAP)	May be as short as 5 days
Hospital-acquired pneumonia (HAP)	7 days
Skin and soft tissue infections (SSTI), including Cellulitis	May be as short as 5 days
References: • Spellberg B. The new antibiotic mantra – "Shorter Is Better" [6] • IDSA treatment guidelines for HAP/VAP [7] • IDSA treatment guidelines for CAP in adults [1] • IDSA treatment guidelines for UTIs [8] • IDSA treatment guidelines for skin and soft tissue infections (SSTIs) [9]	

Clostridioides difficile (*C. diff,* formerly *Clostridium difficile*):

- Every year in the United States, there are an estimated 450,000 people diagnosed with *C. diff* infections, including 29,000 deaths (i.e., more than 1-in-20 estimated to die of their infection) [10] [11].
- The U.S. Centers for Disease Control and Prevention (CDC) has listed *C. diff* as one of the five top "Urgent" antibiotic-related threats to human health. See the newly release 2019 CDC Antibiotic Resistance Threats report here [12].
- Antibiotic use is associated with a 7-10 times increased risk of a patient developing a *C. diff* infection within the first month of antibiotic use, and the increased risk of *C. diff* extends for up to three months after a patient stops taking antibiotics [13].
- Any antibiotic can cause C. *diff* infection, but the highest risk antibiotics include fluoroquinolones, 3rd and 4th generation cephalosporins, carbapenems, and clindamycin.
- Appropriate narrow-spectrum antibiotic use, de-escalation of empiric broad-spectrum antibiotics based on microbiology results, and addressing appropriate treatment duration (Table 1) can help prevent the emergence of antibiotic resistance and minimize complications such as *C. diff* infection.
- Testing for *C. diff* should occur only in patients with clinically significant new-onset or unexplained diarrhea (e.g. ≥3 unformed stool in 24 hours). Patients can be colonized with *C. diff*, and testing can detect asymptomatic carriage which doesn't need treatment [14] [15].
- Repeat testing should not be performed within 7 days during the same episode of diarrhea, but may be indicated for patients with recurrent diarrhea after successful treatment for *C. diff* that resulted in resolution of diarrhea [15].
- A test of cure is not necessary because more than 60% of patients may have a *C. diff* positive test result even after successful treatment [15].

Urinary Tract Infections (UTIs):

- Classic symptoms of a UTI include focal genitourinary symptoms (e.g., urinary frequency, urgency, dysuria, costovertebral angle tenderness). Patients without these focal symptoms are generally considered asymptomatic.
- In most patients, asymptomatic bacteriuria should not be treated with antibiotics. Treatment may be indicated during pregnancy, before certain urologic procedures, and after renal transplantation, particularly within the first month after renal transplantation. The Infectious Disease Society of America updated their Clinical Practice Guideline for the Management of Asymptomatic Bacteriuria in 2019 [2].
- Asymptomatic bacteriuria is common. For instance, 10-20% of people over the age of 60 have asymptomatic bacteriuria, with rates as high as 50% in women over the age of 80 and in patients who are in nursing homes. Patients with indwelling urethral catheters incur a 5% per day risk of bacteriuria, with at least 25% of patients with a catheter in place for a week developing bacteriuria. Treatment of patients with asymptomatic bacteriuria does not reduce symptomatic UTI, pyelonephritis, urosepsis, or death. Instead, it merely increases local rates of resistant Enterobacteriaceae and *C. diff* infections [2] [16] [17] [18] [19] [20] [21] [22] [23] [24].
- Elderly patients with delirium or who experience falls are often found to have bacteriuria, but this bacteriuria is usually unrelated to the patient's delirium or fall. These events on their own are not indications to evaluate for a UTI. Instead, for clinically stable patients, first attempt hydration, evaluate medications for potential interactions/adverse effects, and discontinue diuretic/psychotropic medication if possible [21] [25]. Similarly, work-up for a UTI should not be initiated based on cloudy or foul-smelling urine alone; these typically indicate dehydration rather than a UTI [26].

- In New Hampshire, the most common Gram-negative bacteria isolated from urine were *Escherichia coli* (70% of isolates) followed by *Klebsiella* spp. (16%) and *Proteus mirabilis* (5%). *Pseudomonas aeruginosa* was recovered in fewer than 4% of urine specimen cultures; therefore, empiric UTI coverage with a fluoroquinolone to cover *Pseudomonas* is not usually needed.

Urinary Tract Infections (UTIs), continued:

- Nitrofurantoin remains the most likely active agent against *Escherichia coli* (98% susceptible), followed by cephalexin (predicted by cefazolin, 90% susceptible). Trimethoprim-sulfamethoxazole and ciprofloxacin are less likely to be active (83% and 88% susceptible, respectively), and we recommend avoiding ciprofloxacin as first-line therapy because of the potential for toxicity and *C. difficile* infection.
- We recognize that many providers are prescribing antibiotic therapy for UTIs by phone. We recommend providers obtain a urine culture before antibiotics are started in cases where the provider elects initial broad spectrum antibiotic therapy (e.g., third-generation cephalosporin or fluoroquinolone), or when a patient has failed the above recommended narrow spectrum therapy.
- For patients with antibiotic allergies or risk for resistant bacteria, fosfomycin can be considered for *E. coli* and enterococcal UTIs. While most hospital laboratories do not routinely test susceptibilities for this antibiotic, testing can be requested. According to national and limited local data, >90% of *E. coli* are susceptible to fosfomycin.
- The most common Gram-positive bacterial pathogen isolated from urine are *Enterococcus faecalis* (69%). The majority of *E. faecalis* isolates in the urine were susceptible to ampicillin/amoxicillin (99% susceptible). Susceptible uncomplicated enterococcal UTIs can be treated with high-dose amoxicillin.
- *Staphylococcus aureus* is an infrequent isolate from urine. In the absence of ureteral hardware (e.g., stents), finding *Staphylococcus aureus* (either MSSA or MRSA) in aseptically obtained urine specimens should lead a provider to consider that the urine culture result is due to a bloodstream infection.
- For most patients hospitalized for a complicated UTI or acute pyelonephritis, empiric initial treatment with ceftriaxone while awaiting culture results is appropriate, assuming that there is no history of a UTI with a ceftriaxone-resistant bacteria. Gram-negative organisms cause the majority of UTIs (87%), and ceftriaxone maintains very good activity against the most common Gram-negative bacteria in the urine. Among the more than 37,800 NH urine cultures that grew either *E. coli*, *K. pneumoniae*, or *P. mirabilis* (the three most common Gram-negative bacteria cultured from urine) in 2018, 95% were susceptible to ceftriaxone.

Community Acquired Pneumonia (CAP) and Hospital Acquired Pneumonia (HAP):

- National data shows that 44% of outpatient antibiotic prescriptions are written for acute respiratory conditions, at least half of which are caused by viruses and will not respond to antibiotics [27].
- The most commonly prescribed antibiotic in the outpatient setting is azithromycin [28], but approximately 40% of *Streptococcus pneumoniae* (Pneumococcus) isolates in NH are resistant to azithromycin (predicted by erythromycin susceptibility). As a result, azithromycin should not be prescribed for suspected pneumococcal pneumonia (e.g., when the clinical presentation is acute with a focal infiltrate on chest x-ray).
- ➢ Empiric treatment of CAP in healthy outpatient adults without comorbidities should be with either amoxicillin 1000 mg by mouth three times daily or doxycycline 100 mg by mouth twice daily (about 80 and 83% of *S. pneumoniae* isolates in NH are susceptible to penicillin and tetracyclines, respectively).
- ➢ Empiric treatment of CAP in outpatient adults with comorbidities (e.g., chronic heart, lung, liver, or renal disease; diabetes mellitus; alcoholism; malignancy; asplenia) should include combination therapy with either amoxicillin/clavulanate (875mg/125mg by mouth twice a day) or a cephalosporin (either cefpodoxime 200 mg by mouth twice a day or cefuroxime 500 mg by mouth twice a day) PLUS doxycycline 100 mg by mouth twice a day. All these antibiotics still maintain sufficient activity against *S. pneumoniae* isolates in NH.

Community Acquired Pneumonia (CAP) and Hospital Acquired Pneumonia (HAP), continued:

- The respiratory fluoroquinolones (e.g., levofloxacin and moxifloxacin) remain highly active against *Streptococcus pneumoniae* and cover atypical bacterial pathogens; however, we do not recommend fluoroquinolones as first line therapy for the treatment of outpatient CAP because of class toxicities, their ability to cause *C. difficile* infection even months after antibiotics have completed, and the availability of suitable alternatives. The FDA has issued black box warnings related to fluoroquinolone class antibiotics [29].
- For patients with CAP requiring hospitalization, we recommend treatment with ceftriaxone and either doxycycline or azithromycin (for atypical bacterial pathogens).

➢ The category of "healthcare-associated pneumonia" (HCAP) is no longer a recognized category. Many studies have shown the factors previously used to define HCAP (e.g., residence in a long-term care facility, hospitalization in the last 90 days, chronic dialysis) do NOT predict more antibiotic resistance, and instead led to inappropriate broad spectrum antibiotic use without improved patient outcomes. Unnecessary broad spectrum antibiotics targeting MRSA and/or *Pseudomonas* have been associated with longer hospitalization, more *C. difficile* infections, and increased mortality. Standard therapy for CAP is typically appropriate for non-critically ill patients meeting the former HCAP criteria, unless patients have a prior history of resistant pathogens [30] [31] [32].

- Hospital-acquired pneumonia (HAP) is pneumonia in a hospitalized patient with onset at least 48 hours after being admitted. HAP still warrants treatment with broad-spectrum empiric therapy pending respiratory culture results; however, vancomycin is not needed in all cases of HAP. Indications for empiric vancomycin include septic shock, worsening respiratory failure (+/- necrotizing pneumonia or empyema), IV antibiotics within the past 90 days, prior MRSA colonization or infection, and MRSA known to be cultured in >5% of all respiratory cultures sent [7].

➢ Patients who are hospitalized for CAP with concern for MDROs or patients being treated for HAP should have sputum obtained for culture, ideally before antibiotic administration, and antibiotic therapy should be de-escalated (narrowed) after 48 hours if the cultures do not grow a resistant organism.

Chronic Obstructive Pulmonary Disease (COPD) Exacerbations:

➢ Bacteria are isolated in only 40-50% of patients with COPD exacerbations. The most commonly isolated organisms include *Haemophilus influenzae*, *Streptococcus pneumoniae*, and *Moraxella catarrhalis* [33] [34].

➢ The role that bacteria play in many cases of COPD exacerbation, however, remains uncertain; and the role for antibiotics in treatment of COPD exacerbations remains controversial [35] [36].

➢ In general, antibiotics are not routinely needed in patients with a mild COPD exacerbation not requiring hospitalization.

➢ Antibiotics can be considered in patients with moderate to severe COPD exacerbations based on the presence of increased dyspnea, increased sputum volume, and increased sputum purulence, according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines [36]. Antibiotics are also recommended for patients with severe COPD exacerbations that require mechanical ventilation [36].

➢ Empiric antibiotic therapy should target the most common bacterial contributors to COPD exacerbations. We suggest empiric therapy that is consistent with revised CAP guidelines, including either amoxicillin/clavulanate, or a 2nd/ 3rd generation cephalosporin, which maintain good activity against *S. pneumoniae*, *H. influenza*, and *M. catarrhalis*. Doxycycline also maintains good activity against these organisms and can be considered, but may be less effective [36] [37]. Providers should also be aware that S. *pneumoniae* isolates show increasing resistance to macrolides (e.g., azithromycin), which could potentially limit its effectiveness.

Chronic Obstructive Pulmonary Disease (COPD) Exacerbations, continued:

- The use of fluoroquinolones should be reserved for patients with known colonization of fluoroquinolone-susceptible Gram-negative organisms like *Pseudomonas aeruginosa*.
- If there is concern for a more resistant Gram-negative bacteria due to patient factors (e.g. frequent exacerbations, bronchiectasis, failure of prior therapy, severe airflow limitation, exacerbations requiring mechanical ventilation), then we suggest a respiratory culture be performed to help with more targeted antibiotic therapy [36].
- The recommended antibiotic duration of therapy for COPD exacerbations may be as short as 5 days [36].

Skin and Soft Tissue Infections (SSTIs), including Cellulitis:

- Most SSTIs are due to either streptococcal infection or *S. aureus*. Non-purulent SSTIs (i.e., cellulitis) are usually not caused by methicillin-resistant *S. aureus* (MRSA), so empiric coverage of this organism is typically not necessary. 68% all non-urine *S. aureus* isolates in New Hampshire were methicillin-sensitive *S. aureus* (MSSA). There are many options that treat both streptococci and MSSA, including ceftriaxone, cefazolin, cephalexin, and dicloxacillin.
- For non-purulent SSTIs, studies have demonstrated no benefit in adding an empiric MRSA antibiotic to the more standard therapy targeted at streptococci and MSSA [38] [39].
- In the case of skin abscess (i.e. purulent SSTI), the abscess should be incised and drained with drainage sent for bacterial Gram-stain and culture. Preferred empiric outpatient antibiotic regimens for MRSA SSTIs are either trimethoprim-sulfamethoxazole or doxycycline (96% and 93% susceptibility against MRSA, respectively). Adjunctive antibiotic therapy does improve cure rates when paired with incision and drainage [40] [41].
- Clindamycin should not be prescribed empirically for MRSA, because approximately one-third (32%) of isolates are resistant.
- MRSA is present in up to 15% of diabetic foot infections, so empiric vancomycin may be appropriate, although it is worth noting that over 60% are caused by streptococci and MSSA [42]. In temperate environments such as in New Hampshire, *Pseudomonas aeruginosa* is rare in diabetic foot infections. Most patients improve on regimens that do not cover *Pseudomonas aeruginosa* [43] [44].

Specific Antibiotic Recommendations:

- In 2018, 54 CRE cases in NH patients were reported to the NH DPHS. We recommend antimicrobial stewardship programs continue to restrict the use of carbapenem antibiotics, because healthcare settings with more liberal use of carbapenems have seen a more rapid rise in carbapenem-resistance.
    - For example, outcomes in intra-abdominal infections are no better with an empiric carbapenem (or with piperacillin-tazobactam) compared with ceftriaxone (or ciprofloxacin) plus metronidazole [45] [46].
- In hospitalized patients with a presumed Gram-negative infection, use of two different classes of antibiotics as empiric treatment may be indicated in cases with septic shock, respiratory failure, intravenous antibiotics in the prior 90 days, and/or structural lung disease (e.g. bronchiectasis, cystic fibrosis). Otherwise, monotherapy is typically appropriate when selecting an antibiotic for which resistance on the local antibiogram is <10%. Once susceptibilities return, this empiric treatment with multiple agents should be tailored to monotherapy in most cases.

Penicillin Allergies:

- When assessing penicillin allergies in patients, it is important to take a detailed clinical history of when the allergic reaction occurred and symptoms of the reaction.
- Over 90% of patients with a penicillin allergy listed in their medical record are not allergic to penicillin. A common reason for this is a viral rash as a child was misattributed to a penicillin class antibiotic. Many people will also lose their penicillin allergy over time; about 80% of patients will lose their penicillin allergy after 10 years [47].
- In patients with a confirmed penicillin allergy, less than 2% have a reaction to cephalosporins as a class [47] [48] [49]. Reactions to first generation cephalosporins are most common, but still fewer than 10% of patients with a penicillin allergy will also react to first generation cephalosporins [50]. Reactions to second generation or higher cephalosporins are negligible [47] [51].
- Patients with a confirmed mild penicillin allergy (e.g., benign drug rash or even isolated hives) can safely receive any 3rd or 4th generation cephalosporin. Administration of 1st and 2nd generation cephalosporins should be done in a monitored setting, potentially with a test dose followed by 60 minutes of observation, especially if the prior reaction was immediate [51] [52].
- For patients with more severe reported penicillin reactions, referral to Allergy/Immunology is recommended for penicillin allergy testing.

New Hampshire Statewide Antibiogram 2018

All Sources Other Than Urine

Percent Susceptible

Bureau of Infectious Disease Control
Infectious Disease Surveillance Section

Gram Negative Organisms	**Total Number of Isolates**	Ampicillin (Amoxicillin)	Ampicillin/Sulbactam*	Piperacillin/Tazobactam	Cefazolin (Cephalexin)	Cefuroxime	Cefoxitin	Ceftriaxone	Ceftazidime	Cefepime	Aztreonam	Ertapenem	Meropenem	Imipenem	Doripenem	Ciprofloxacin	Levofloxacin	Amikacin	Gentamicin	Tobramycin	Tigecycline	Tetracycline (Doxycyline)	Trimethoprim/Sulfamethoxazole
Escherichia coli	2775	59	65	97	87	88	95	92	92	94	93	99	100	98	100	84	85	99	93	94	99	79	82
Klebsiella (Enterobacter) aerogenes	129			89				83	85	99	89	100	100	96		96	96	100	100	99	99	88	99
Enterobacter cloacae	667			92				82	88	95	86	97	99	97	100	97	98	100	99	98	99	94	96
Klebsiella pneumoniae	771		87	98	94	88	92	95	96	97	95	100	100	100	100	95	97	99	99	96	97	84	90
Klebsiella oxytoca	470		79	96	59	90	98	96	97	98	94	100	100	100		99	99	100	99	99	99	94	96
Proteus mirabilis	600	79	90	100	92	98	93	98	99	99	97	100	100			85	88	100	92	93			84
Serratia marcescens	423			84				86	77	99	85	100	100	96	100	98	98	99	98	94	99	15	100
Citrobacter freundii	140			97				82	85	99	82	99	100	100		93	94	100	98	97	97	84	90
Morganella morganii	203		4	100			86	92	89	98	88	100	100			92	97	100	93	96		35	90
Pseudomonas aeruginosa	1550			96					93	92	84		96	93	99	88	86	98	90	98			
Acinetobacter baumannii	158		85					62	92	87			92			87	93	93	92	91		91	86
Stenotrophomonas maltophilia	342								41								85						97
Haemophilus influenzae	325	65				91		99															70

Gram Positive Organisms	**Total Number of Isolates**	Penicillin	Ampicillin (Amoxicillin)	Oxacillin (Nafcillin)	Ampicillin/Sulbactam*	Cefazolin (Cephalexin)	Cefuroxime	Ceftriaxone	Levofloxacin	Moxifloxacin	Tetracycline (Doxycyline)	Trimethoprim/Sulfamethoxazole	Clindamycin	Erythromycin (Azithromycin)	Vancomycin	Linezolid	Daptomycin	Rifampin
Methicillin-**Sensitive** *Staphylococcus aureus* (MSSA)	7721	13		100	100	100		100	93	96	94	99	82		100	100	100	99
Methicillin-**Resistant** *Staphylococcus aureus* (MRSA)	3663								56	75	93	96	68		100	100	100	99
Enterococcus faecalis	1130	99	99												96	99	100	
Enterococcus faecium	140	30	36												45	93	92	
Enterococcus spp. (all hospital data)	1817	93	93												92	98	99	
Coagulase negative *Staphylococcus*	1478	7		54	52	52		52	73	82	82	73	67		99	99	99	97
Streptococcus pneumoniae (non-meningitis)	421	80					81	98	99	100	83	84	89	63	100	100		

Important Notes for Interpreting the antibiogram:

- High resistance to an antibiotic is a percent suceptibility of less than 80%

- The following antibiotics indicate susceptibility to others in the same/related class:

- Oxacillin predicts nafcillin susceptibility
- Tetracycline predicts doxycycline susceptibility
- Erythromycin predicts azithromycin susceptibility
- Ampicillin predicts amoxicillin susceptibility
- Cefazolin predicts cephalexin susceptibility
- Ampicillin/sulbactam predicts amoxicillin/clavulanate susceptibility (except for *Acinetobacter baumannii* which is intrinsically resistant)

Indicates data have been censored because of intrinsic resistance and/or inappropriate clinical use.

Indicates data have been censored because of insufficient sample or less than 3 hosptials. CLSI guidelines suggest total isolate counts of less than 30 are excluded.

* Predicts amoxicillin/clavulanate susceptibility, except for *Acinetobacter baumannii* which is intrinsically resistant

New Hampshire Statewide Antibiogram 2018

All Sources Other Than Urine

Total Number of Susceptible Isolates/Total Tested

Gram Negative Organisms	**Total Number of Isolates**	Ampicillin (Amoxicillin)	Ampicillin/Sulbactam*	Piperacillin/Tazobactam	Cefazolin	Cefuroxime	Cefoxitin	Ceftriaxone	Ceftazidime	Cefepime	Aztreonam	Ertapenem	Meropenem	Imipenem	Doripenem	Ciprofloxacin	Levofloxacin	Amikacin	Gentamicin	Tobramycin	Tigecycline	Tetracycline	Trimethoprim/Sulfamethoxazole
Escherichia coli	2775	1607 \ 2725	1490 \ 2292	2682 \ 2769	2027 \ 2332	1350 \ 1530	1815 \ 1912	2547 \ 2760	1827 \ 1983	2595 \ 2759	2070 \ 2235	2746 \ 2765	1955 \ 1963	1627 \ 1664	502 \ 502	2122 \ 2528	1752 \ 2063	2143 \ 2157	2107 \ 2263	2376 \ 2535	1261 \ 1271	1134 \ 1432	2246 \ 2748
Klebsiella (Enterobacter) aerogenes	129			96 \ 108				104 \ 126	89 \ 105	118 \ 119	138 \ 155	125 \ 125	109 \ 109	53 \ 55		122 \ 127	75 \ 78	118 \ 118	110 \ 110	122 \ 123	77 \ 78	68 \ 77	128 \ 129
Enterobacter cloacae	667			464 \ 506				543 \ 662	481 \ 544	608 \ 642	413 \ 482	639 \ 661	525 \ 530	325 \ 334	163 \ 163	633 \ 653	348 \ 356	567 \ 567	584 \ 592	617 \ 627	319 \ 323	367 \ 390	639 \ 666
Klebsiella pneumoniae	771		642 \ 736	726 \ 743	600 \ 637	484 \ 549	530 \ 575	733 \ 769	621 \ 647	746 \ 769	631 \ 661	757 \ 760	631 \ 632	405 \ 407	153 \ 153	729 \ 767	512 \ 530	643 \ 648	682 \ 692	703 \ 733	408 \ 419	361 \ 429	687 \ 764
Klebsiella oxytoca	470		337 \ 428	388 \ 406	236 \ 397	287 \ 319	306 \ 313	449 \ 470	370 \ 380	460 \ 470	357 \ 378	464 \ 464	374 \ 374	250 \ 251		465 \ 470	337 \ 341	385 \ 386	419 \ 424	427 \ 433	241 \ 243	265 \ 281	453 \ 470
Proteus mirabilis	600	467 \ 591	493 \ 550	599 \ 600	442 \ 483	379 \ 387	359 \ 387	586 \ 599	456 \ 461	591 \ 599	487 \ 501	591 \ 593	471 \ 471			512 \ 603	368 \ 418	480 \ 481	476 \ 520	499 \ 537			486 \ 580
Serratia marcescens	423			321 \ 383				365 \ 423	260 \ 336	419 \ 423	316 \ 370	408 \ 409	346 \ 346	173 \ 180	109 \ 109	415 \ 423	291 \ 296	370 \ 373	359 \ 366	374 \ 399	243 \ 245	39 \ 263	414 \ 416
Citrobacter freundii	140			121 \ 125				115 \ 140	100 \ 117	139 \ 140	98 \ 119	136 \ 137	114 \ 114	75 \ 75		130 \ 140	92 \ 98	119 \ 119	126 \ 129	128 \ 132	71 \ 73	68 \ 81	122 \ 135
Morganella morganii	203		7 \ 181	201 \ 202			126 \ 146	186 \ 203	163 \ 184	199 \ 203	139 \ 158	198 \ 198	150 \ 150			186 \ 202	157 \ 162	176 \ 176	186 \ 199	183 \ 191		50 \ 141	181 \ 201
Pseudomonas aeruginosa	1550			1479 \ 1539					1356 \ 1460	1324 \ 1442	976 \ 1163		1189 \ 1243	803 \ 868	324 \ 327	1339 \ 1526	972 \ 1136	1250 \ 1272	1201 \ 1332	1485 \ 1522			
Acinetobacter baumannii	158		111 \ 130					85 \ 138	121 \ 132	110 \ 127			114 \ 124			138 \ 158	104 \ 112	114 \ 122	131 \ 142	123 \ 135		94 \ 103	130 \ 152
Stenotrophomonas maltophilia	342								117 \ 288								214 \ 251						330 \ 341
Haemophilus influenzae	325	144 \ 221				63 \ 69		148 \ 150															111 \ 159

Gram Positive Organisms	**Total Number of Isolates**	Penicillin	Ampicillin (Amoxicillin)	Oxacillin (Nafcillin)	Ampicillin/Sulbactam*	Cefazolin	Cefuroxime	Ceftriaxone	Levofloxacin	Moxifloxacin	Tetracycline (Doxycyline)	Trimethoprim/ Sulfamethoxazole	Clindamycin	Erthromycin	Vancomycin	Linezolid	Daptomycin	Rifampin
Methicillin-**Sensitive** *Staphylococcus aureus* (MSSA)	7721	808 \ 6114		7721 \ 7721	6335 \ 6335	5999 \ 5999		5508 \ 5508	7182 \ 7700	6208 \ 6445	7251 \ 7710	6796 \ 6898	6247 \ 7613		7706 \ 7706	7640 \ 7647	6692 \ 6718	7631 \ 7706
Methicillin-**Resistant** *Staphylococcus aureus* (MRSA)	3663								2010 \ 3615	2312 \ 3081	3396 \ 3649	3104 \ 3239	2462 \ 3605		3661 \ 3661	3619 \ 3625	3201 \ 3217	3605 \ 3656
Enterococcus faecalis	1130	903 \ 908	1092 \ 1098												1087 \ 1127	1085 \ 1098	948 \ 949	
Enterococcus faecium	140	37 \ 122	49 \ 138												61 \ 136	128 \ 138	104 \ 113	
Enterococcus spp. (all hospital data)	1817	1336 \ 1438	1537 \ 1644												1543 \ 1670	1620 \ 1647	1457 \ 1471	
Coagulase negative *Staphylococcus*	1478	89 \ 1203		778 \ 1454	602 \ 1162	579 \ 1110		513 \ 978	1067 \ 1459	1086 \ 1320	1210 \ 1467	940 \ 1289	973 \ 1453		1466 \ 1479	1465 \ 1478	1319 \ 1339	1431 \ 1477
Streptococcus pneumoniae (non-meningitis)	421	302 \ 376					126 \ 155	307 \ 314	300 \ 303	108 \ 108	188 \ 226	220 \ 262	144 \ 162	174 \ 275	211 \ 211	69 \ 69		

Indicates data have been censored because of intrinsic resistance and/or inappropriate clinical use.

Indicates data have been censored because of insufficient sample or less than 3 hosptials. CLSI guidelines suggest total isolate counts of less than 30 are excluded.

* Predicts amoxicillin/clavulanate susceptibility, except for *Acinetobacter baumannii* which is intrinsically resistant

New Hampshire Statewide Antibiogram 2018

Urine Only Sources

Percent Susceptible

Gram Negative Organisms	**Total Number of Isolates**	Ampicillin (Amoxicillin)	Piperacillin/Tazobactam	Cefazolin (Cephalexin)	Cefuroxime	Cefoxitin	Ceftriaxone	Ceftazidime	Cefepime	Aztreonam	Ertapenem	Meropenem	Imipenem	Doripenem	Ciprofloxacin	Levofloxacin	Amikacin	Gentamicin	Tobramycin	Tigecycline	Tetracycline (Doxycyline)	Trimethoprim/Sulfamethoxazole	Nitrofurantoin
Escherichia coli	30364	64	98	90	92	96	95	95	96	95	100	100	100	100	88	88	99	93	95	100	81	83	98
Klebsiella (Enterobacter) aerogenes	533		91				86	90	100	92	100	100	90		98	98	100	100	100	99	95	98	20
Enterobacter cloacae	972		85				73	79	95	80	94	100	97	100	96	99	100	98	98	98	87	91	31
Klebsiella pneumoniae	5304		98	95	94	96	96	96	97	96	100	100	100	100	96	98	100	98	97	99	86	92	45
Klebsiella oxytoca	976		96	52	90	98	95	99	99	96	100	100	100	100	98	98	100	99	99	100	94	96	88
Proteus mirabilis	2244	80	100	92	98	99	96	94	99	98	100	100			81	84	100	91	93			82	
Serratia marcescens	342		85				87	86	98	88	98	100	99		94	98	100	100	93	100	9	98	
Citrobacter freundii	702		93				82	84	99	86	100	100	95	100	94	94	100	95	97	99	83	87	95
Morganella morganii	312		99			88	87	85	99	91	100	100			84	92	100	88	95	1		82	
Pseudomonas aeruginosa	1674		97					94	93	84		96	90	99	81	79	98	87	97				
Acinetobacter baumannii	80						49	89	93			92			87	93	98	98	99		82	83	

Gram Positive Organisms	**Total Number of Isolates**	Penicillin	Ampicillin (Amoxicillin)	Oxacillin (Nafcillin)	Cefazolin (Cephalexin)	Ceftriaxone	Levofloxacin	Moxifloxacin	Tetracycline (Doxycyline)	Trimethoprim/Sulfamethoxazole	Clindamycin	Vancomycin	Linezolid	Daptomycin	Rifampin	Nitrofurantoin
Methicillin-**Sensitive** *Staphylococcus aureus* (MSSA)	721	21		100	100	100	87	85	97	96	75	100	100	100	99	
Methicillin-**Resistant** *Staphylococcus aureus* (MRSA)	373						23		92	95	52	100	99	99	98	
Enterococcus faecalis	3044	99	99									98	98	100		99
Enterococcus faecium	261	18	22									49	96	92		43
Enterococcus spp. (all hospital data)	5168	94	94									95	98	99		95

Indicates data have been censored because of intrinsic resistance and/or inappropriate clinical use.

Indicates data have been censored because of insufficient sample or less than 3 hosptials. CLSI guidelines suggest total isolate counts of less than 30 are excluded.

New Hampshire Statewide Antibiogram 2018

Urine Only Sources

Total Number of Susceptible Isolates/Total Tested

Gram Negative Organisms	**Total Number of Isolates**	Ampicillin (Amoxicillin)	Piperacillin/Tazobactam	Cefazolin (Cephalexin)	Cefuroxime	Cefoxitin	Ceftriaxone	Ceftazidime	Cefepime	Aztreonam	Ertapenem	Meropenem	Imipenem	Doripenem	Ciprofloxacin	Levofloxacin	Amikacin	Gentamicin	Tobramycin	Tigecycline	Tetracycline (Doxycycline)	Trimethoprim/Sulfamethoxazole	Nitrofurantoin
Escherichia coli	30364	16433 \ 25734	29777 \ 30307	26410 \ 29257	18806 \ 20438	19521 \ 20403	28752 \ 30316	23649 \ 24912	29192 \ 30318	24959 \ 26169	29840 \ 29987	24425 \ 24462	17281 \ 17344	6907 \ 6907	26479 \ 30242	19231 \ 21969	22599 \ 22749	28329 \ 30329	26415 \ 27929	17363 \ 17447	15165 \ 18783	24962 \ 30235	29089 \ 29757
Klebsiella (Enterobacter) aerogenes	533		437 \ 480				455 \ 529	397 \ 441	532 \ 533	434 \ 472	527 \ 529	445 \ 445	284 \ 316		519 \ 532	377 \ 384	431 \ 432	532 \ 533	492 \ 493	316 \ 319	330 \ 348	522 \ 532	103 \ 517
Enterobacter cloacae	972		691 \ 816				709 \ 965	602 \ 762	922 \ 971	641 \ 806	892 \ 945	795 \ 795	623 \ 639	204 \ 204	933 \ 971	668 \ 677	770 \ 772	949 \ 972	872 \ 894	515 \ 528	503 \ 575	851 \ 936	285 \ 931
Klebsiella pneumoniae	5304		5024 \ 5141	4840 \ 5095	3406 \ 3630	3478 \ 3608	5109 \ 5297	3911 \ 4059	5138 \ 5297	4384 \ 4552	5228 \ 5239	4259 \ 4262	3743 \ 3761	1194 \ 1194	5092 \ 5294	3716 \ 3803	4052 \ 4064	5199 \ 5303	4793 \ 4922	2974 \ 3003	2768 \ 3213	4842 \ 5289	2360 \ 5227
Klebsiella oxytoca	976		792 \ 829	422 \ 806	596 \ 665	642 \ 655	911 \ 957	796 \ 803	963 \ 970	790 \ 823	959 \ 961	771 \ 771	676 \ 678	208 \ 208	958 \ 976	681 \ 692	766 \ 768	968 \ 975	914 \ 920	559 \ 561	555 \ 591	934 \ 975	852 \ 971
Proteus mirabilis	2244	1704 \ 2135	2223 \ 2234	1987 \ 2160	1485 \ 1512	1433 \ 1453	2104 \ 2196	1749 \ 1864	2221 \ 2243	1793 \ 1829	2195 \ 2202	1742 \ 1742			1792 \ 2224	1372 \ 1634	1703 \ 1704	2037 \ 2240	1927 \ 2074			1824 \ 2227	
Serratia marcescens	342		253 \ 296				296 \ 339	220 \ 256	335 \ 342	261 \ 298	321 \ 326	289 \ 290	132 \ 134		320 \ 341	209 \ 213	278 \ 279	341 \ 342	291 \ 314	189 \ 189	17 \ 187	335 \ 341	
Citrobacter freundii	702		535 \ 574				573 \ 701	442 \ 527	695 \ 702	524 \ 607	689 \ 690	586 \ 586	354 \ 373	121 \ 121	657 \ 702	431 \ 460	532 \ 534	667 \ 702	609 \ 631	374 \ 376	333 \ 399	604 \ 693	666 \ 701
Morganella morganii	312		308 \ 311			146 \ 166	271 \ 311	212 \ 248	308 \ 312	232 \ 256	308 \ 309	245 \ 245			262 \ 311	194 \ 212	255 \ 255	275 \ 311	276 \ 291	1 \ 162		255 \ 311	
Pseudomonas aeruginosa	1674		1605 \ 1660					1465 \ 1558	1338 \ 1436	1068 \ 1277		1372 \ 1427	782 \ 865	337 \ 341	1339 \ 1658	857 \ 1085	1301 \ 1333	1449 \ 1660	1713 \ 1757				
Acinetobacter baumannii	80						38 \ 77	67 \ 75	70 \ 75			54 \ 59			65 \ 75	55 \ 59	52 \ 53	78 \ 80	75 \ 76		37 \ 45	63 \ 76	

Gram Positive Organisms	**Total Number of Isolates**	Penicillin	Ampicillin (Amoxicillin)	Oxacillin (Nafcillin)	Cefazolin	Ceftriaxone	Levofloxacin	Moxifloxacin	Tetracycline (Doxycycline)	Trimethoprim/Sulfamethoxazole	Clindamycin	Vancomycin	Linezolid	Daptomycin	Rifampin	Nitrofurantoin
Methicillin-**Sensitive** *Staphylococcus aureus* (MSSA)	721	129 \ 622		687 \ 687	433 \ 433	446 \ 446	620 \ 714	84 \ 99	695 \ 718	661 \ 685	126 \ 169	721 \ 721	703 \ 704	602 \ 602	716 \ 720	
Methicillin-**Resistant** *Staphylococcus aureus* (MRSA)	373						81 \ 355		341 \ 370	336 \ 352	36 \ 69	371 \ 371	363 \ 365	332 \ 334	361 \ 370	
Enterococcus faecalis	3044	2306 \ 2320	2932 \ 2950									2983 \ 3037	2890 \ 2945	2518 \ 2530		2823 \ 2853
Enterococcus faecium	261	40 \ 217	57 \ 261									125 \ 256	249 \ 260	213 \ 232		109 \ 252
Enterococcus spp. (all hospital data)	5168	3610 \ 3858	4757 \ 5064									4893 \ 5135	4931 \ 5017	4426 \ 4466		4695 \ 4951

Indicates data have been censored because of intrinsic resistance and/or inappropriate clinical use.

Indicates data have been censored because of insufficient sample or less than 3 hosptials. CLSI guidelines suggest total isolate counts of less than 30 are excluded.

Methodology

Reporting Requirements:

Reporting requirements are governed by RSA 141:C6 with authority given to DHHS to develop administrative rules to provide specific reporting instructions and methodology. Administrative rules He-P 301 were adopted in fall 2016 "He-P 300 Diseases, PART He-P 301.02 Communicable Diseases," were updated in 2016 with stakeholder input and approved by the Joint Legislative Committee on Administrative Rules. The updated rules require hospital laboratories to report antibiogram data annually to the State of New Hampshire.

Collection Process and Validation:

NH DPHS developed a standardized antibiogram fillable form for reporting susceptibility data, and requested data from hospital microbiology laboratories in January 2018. This form was developed to encompass most relevant antibiotic and organism combinations, created in collaboration between the NH DPHS and stakeholder subject matter experts. All 26 NH hospitals reported antibiogram data as required under He-P301; along with the Veteran's Affairs Hospital whom voluntarily reported data.

The HAI Program reconciled data to confirm reported data and evaluate accuracy and reliability of the data. The HAI Program first conducted an internal assessment to identify outliers or implausible data by comparing the percent susceptibilities between all hospitals for every organism and antibiotic combination and then corrected or confirmed data with each respective microbiology laboratory. The program subsequently convened an infectious disease medical and pharmacy advisory group to review the clinical implications of the data and ensure data was clinically accurate and relevant. The advisory group determined which antibiotic-organism combinations to censor due to clinical inappropriateness. Lastly, the antibiogram data was reviewed by the NH Antimicrobial Resistance Advisory Workgroup (ARAW) to provide feedback and suggestions for use.

Antibiogram Development:

The Clinical and Laboratory Standards Institute (CLSI) guidelines were followed in the aggregation of data from all reported hospital antibiograms. Antibiotic and organism combinations that are either intrinsically resistance or not clinically appropriate were censored from the antibiogram. Per CLSI guidelines, any antibiotic and organism combination with a total number of isolate counts of less than 30 isolates were excluded.

An ARAW subcommittee, made up of infectious disease clinical specialists, drafted and reviewed the antibiogram executive summary to assist with clinical interpretation. The summary focused on treatment of common infections syndromes and was based on review of NH antibiogram data and current national treatment guidelines (https://www.idsociety.org/PracticeGuidelines/).

Data Limitations

- Due to the variation in breakpoints used by clinical laboratories to interpret antibiotic susceptibility results there may be discrepancies between laboratory reported susceptibility results.

- Antibiotic susceptibility data from regional reference labs is not included in this data set and therefore the antibiogram is limited in its representativeness to hospital laboratory isolates.
- The urine only antibiogram includes all urine isolates, not necessarily only those pertaining to urinary tract infections. These isolates may represent other types of infections where bacteria were cultured from other clinical isolates in addition to the urine (e.g. bacteremia with seeding of the urine).
- The lack of reported susceptibility results for an antibiotic against a specific organism doesn't necessarily mean that the antibiotic isn't active. In some cases activity is reliably predicted by the activity of another agent (e.g. cefazolin activity against *Staphylococcus aureus* is predicted by oxacillin susceptibility); while in some other cases it is not possible to test susceptibility due to lack of testing reagents. Conversely, reported activity on *in vitro* susceptibility results does not necessarily mean an agent is clinically effective (or as effective as alternatives). For example, ciprofloxacin may show *in vitro* activity against *Staphylococcus aureus*, but ciprofloxacin should never be used to treat infections caused by this organism. This is because of the potential for rapid development of resistance while being treated with ciprofloxacin.
- The values presented in the antibiogram are rounded and do not show exact values.

Note: All the data in this report are based upon information provided to the New Hampshire Department of Health and Human Services under specific legislative authority. The numbers reported may represent an underestimate of the true absolute number in the state. Any release of personal identifying information is conditioned upon such information remaining confidential. The unauthorized disclosure of any confidential medical or scientific data is a misdemeanor under New Hampshire law. The department is not responsible for any duplication or misrepresentation of surveillance data released in this report. Data are complete as of 1/13/20. Report prepared by the Healthcare-Associated Infections Program, Infectious Disease Surveillance Section, haiprogram@dhhs.nh.gov, (603)-271-4496.

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The NH DPHS HAI Program is a resource for guidance in developing and strengthening your facilities stewardship program, please contact us at haiprogram@dhhs.nh.gov or (603) 271-4496.

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