



Stanford
HEALTH CARE

CLINICAL MICROBIOLOGY LABORATORY

SHC ANTIBIOGRAM DATA FOR BACTERIAL AND YEAST ISOLATES

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SITUATIONS FOR WHICH THE USE OF VANCOMYCIN IS APPROPRIATE AND ACCEPTABLE:

- For treatment of serious infections due to β -lactam-resistant gram-positive bacteria. Clinicians should be aware that vancomycin is usually less active and less rapidly bactericidal than β -lactam agents for organisms that are susceptible to the β -lactams. Clinicians should also be aware that vancomycin sensitive MIC 2mcg/ml is associated with increased treatment failures.
- For treatment of infections due to gram-positive organisms in patients with serious allergy to β -lactam-antibiotics.
- Prophylaxis, (infused 60-120 min before the first incision), in penicillin-allergic patients, as recommended by the Amer. Heart Assoc., for endocarditis following certain procedures in patients at high risk for endocarditis. Cephalosporins are still recommended for non-allergic patients.
- Prophylaxis for major surgical procedures involving implantation of prosthetic materials or devices, e.g., cardiac and vascular procedures and total hip replacements, at institutions with a high rate of infections due to MRSA or MRCoNS. Currently MRSA and MRCoNS rates are 22% and 48% at SHC, respectively. A single dose administered 60-120 min before surgery is sufficient unless the procedure lasts more than 6 hours, in which case the dose should be repeated. Prophylaxis should be repeated after 2 doses maximum.

| Streptococci and Enterococci | | | | | | | | | | | | | | | | | | | |
|---|----------------|--------------------------|----|----|------------|-------------|------------|--------------|-----------------|-----------|--------------------|----------------------------|---------------------------------|-----------------------------------|--------------|---------------------------|-------------------------|--------------------------|-----------|
| Percent Susceptible | No. Tested (a) | Penicillin or Ampicillin | | | Cefuroxime | Ceftriaxone | Vancomycin | Erythromycin | Clindamycin (b) | Meropenem | Trimethoprim/sulfa | Tetracycline (Doxycycline) | Gentamicin Synergy with Pen/Amp | Streptomycin Synergy with Pen/Amp | Moxifloxacin | Nitrofurantoin (UTI only) | Levofloxacin (UTI only) | Ciprofloxacin (UTI only) | Linezolid |
| | | %S | %I | %R | | | | | | | | | | | | | | | |
| Streptococci | | | | | | | | | | | | | | | | | | | |
| Grp. B (Strep. agalactiae) | 371 | 100 | 0 | 0 | - | - | - | 49 | 56 | - | - | - | - | - | - | - | - | 96 | - |
| Viridans (various species) | 201 | 76 | 24 | 0 | - | 99 | 100 | 62 | 80 | - | - | - | - | - | - | - | - | - | - |
| Strep. pneumoniae (c) | 48 | 65d | - | 35 | 81 | 96d | 100 | 56 | 79 | 94 | 77 | Doxy | 58 | - | 100 | - | - | - | - |
| Enterococcus (no species I.D.) (e) | | | | | | | | | | | | | | | | | | | |
| Enterococcus faecalis (e) | 130 | 100 | 0 | 0 | - | - | 100 | - | - | - | - | 23 | - | - | - | 95 | 80 | 71 | 100 |
| Enterococcus faecium (e) | 126 | 26 | 0 | 74 | - | - | 48 | - | - | - | - | 100 | 61 | - | - | - | - | - | 98 |
| Cost (\$) | | \$ | \$ | \$ | \$ | \$ | \$ | \$ | \$ | \$ | \$ | \$ | \$ | \$ | \$ | \$ | \$ | \$ | \$ |

- (a) First isolate from each patient was included.
 (b) Penicillin is the drug of choice for all beta hemolytic streptococci; penicillin resistance has not been documented. Clindamycin induction test performed on all beta hemolytic streptococci and S. pneumoniae.
 (c) Penicillin-susceptible isolates are also susceptible to all other β -lactam agents. β -lactamase inhibitor combination drugs do not add additional efficacy to penicillin alone.
 (d) Based on meningitis interpretive criteria (more conservative). Nonmeningitis interpretation is 98% for penicillin. Infectious diseases consultation is recommended for meningitis in penicillin-allergic patients or those with resistant ceftriaxone or cefotaxime results.
 (e) If susceptible, ampicillin is the drug of choice when enterococci must be treated. Nitrofurantoin or ampicillin is recommended for uncomplicated UTI. Serious infections (septicemia, endocarditis) require both a β -lactam agent and an aminoglycoside. Use vancomycin+aminoglycoside only if strain is ampicillin-resistant or patient is penicillin allergic. High level resistance to gentamicin also indicates lack of synergy for tobramycin, amikacin and kanamycin.

| Candida | | | | | |
|---|------------|--------------------|-------------|-----------------|--------------|
| Percent Susceptible or Susceptible-Dose Dependent by Broth Microdilution Method | No. Tested | Amphotericin B (a) | Caspofungin | Fluconazole (b) | Voriconazole |
| Candida albicans | 60 | 100 | 100 | 97 | 95 |
| Candida glabrata | 43 | 100 | 93 | 86 | - |
| Candida parapsilosis | 18(c) | 100 | 100 | 100 | 95 |
| C. tropicalis | 20(c,d) | 100 | 100 | 85 | 67 |
| Other Candida spp. | 11(c,d) | 100 | 50 | (d) | 78 |
| Costs (\$) | | \$\$\$\$ | \$\$\$\$ | \$ | \$\$\$\$ |

- (a) Based on suggested resistant breakpoint MIC ≥ 2 μ g/ml.
 (b) Susceptible dose-dependent breakpoint MIC was used.
 (c) Data from <30 isolates may be statistically unreliable.
 (d) Includes isolates from 2018.
 (e) C. krusei is intrinsically resistant to fluconazole.

Gram negative rods

| Percent Susceptible | PENICILLINS | | | | CEPHEMS | | | LACTAMS | | | AMINOGLYC's | | | OTHERS | | | Urine | |
|----------------------------------|----------------|-----------------|--------------|----------------|------------------------|-------------|-----------------|---------------|----------|-----------|-------------|------------|------------|----------|---------------|--------------|-------|---------------------|
| | No. Tested (a) | Ampicillin | Amp/Subactam | Pip/Tazobactam | Cefazolin [Urine Only] | Ceftriaxone | Cefepime | Aztreonam (b) | Imipenem | Meropenem | Ertapenem | Gentamicin | Tobramycin | Amikacin | Ciprofloxacin | Levofloxacin | | Trimeth/Sulfamethox |
| Achromobacter xylosoxidans | 27(c) | - | - | 89 | - | - | 11 | 0 | 85 | 70 | - | 4 | 7 | 7 | 15 | 56 | 85 | - |
| Acinetobacter baumannii | 25(c) | - | 96 | - | - | - | 80 | - | 88 | - | 84 | 92 | 92 | 84 | 84 | 80 | - | - |
| Burkholderia cepacia complex (d) | 12(c) | Ceftazidime 75% | - | - | - | - | Minocycline 83% | - | 67 | - | - | - | - | - | - | - | - | - |
| Citrobacter freundii complex | 128 | 0 | 0 | 83 | 0 | 73 | 97 | 72 | 97 | 99 | 98 | 93 | 96 | 100 | 95 | 96 | 82 | 97 |
| Citrobacter koseri | 84 | 0 | 94 | 95 | 94 | 96 | 100 | 100 | 100 | 100 | 100 | 99 | 99 | 100 | 96 | 98 | 99 | 88 |
| Enterobacter cloacae complex | 192 | 0 | 0 | 86 | 0 | 80 | 95 | 88 | 90 | 98 | 94 | 98 | 97 | 100 | 98 | 98 | 88 | 54 |
| Escherichia coli | 3544 | 51 | 50 | 96 | 83 | 88 | 78 | 78 | 99 | 100 | 100 | 90 | 90 | 100 | 80 | 80 | 72 | 96 |
| Klebsiella aerogenes (e) | 114 | 0 | 0 | 78 | 0 | 75 | 100 | 71 | 87 | 99 | 96 | 100 | 99 | 100 | 97 | 97 | 100 | 14 |
| Klebsiella oxytoca | 133 | 0 | 64 | 94 | 56 | 90 | 91 | 88 | 100 | 100 | 100 | 95 | 91 | 100 | 96 | 98 | 81 | 86 |
| Klebsiella pneumoniae | 710 | 0 | 70 | 95 | 89 | 91 | 89 | 87 | 99 | 99 | 99 | 95 | 94 | 100 | 92 | 93 | 85 | 23 |
| Morganella morganii | 70 | 0 | 0 | 99 | 0 | 90 | 100 | 97 | - | 100 | 100 | 84 | 93 | 100 | 79 | 80 | 70 | 0 |
| Proteus mirabilis | 333 | 75 | 87 | 99 | 87 | 96 | 95 | 98 | - | 100 | 99 | 87 | 88 | 100 | 82 | 83 | 74 | 0 |
| Proteus vulgaris group | 20(c) | 0 | 86 | 100 | 0 | 60 | 100 | 86 | - | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 90 | 0 |
| Pseudomonas aeruginosa | 571 | - | - | 94 | - | - | 92 | 84 | 91 | 92 | - | 88 | 99 | 96 | 87 | 83 | - | - |
| Ps. aeruginosa CF mucoid (d) | 144 | - | - | 84 | C/T 97% | 74 | 75 | 78 | 82 | - | - | 91 | 65 | 67 | 57 | - | - | - |
| Ps. aeruginosa CF non-mucoid (d) | 92 | - | - | 79 | C/T 87% | 60 | 67 | 61 | 70 | - | - | 65 | 36 | 50 | 48 | - | - | - |
| Salmonella enterica | 28(c) | 89 | - | - | 96 | - | - | - | - | - | - | - | - | - | 85 | - | 100 | - |
| Serratia marcescens | 90 | 0 | 0 | 97 | 0 | 92 | 100 | 98 | 100 | 100 | 100 | 96 | 100 | 93 | 96 | 98 | 0 | - |
| Stenotrophomonas maltophilia | 78 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 87 | 99 | - |
| Cost | | \$\$ | \$ | \$\$ | \$ | \$ | \$\$\$ | \$\$\$ | \$\$ | \$\$ | \$ | \$ | \$ | \$ | \$ | \$ | \$ | \$ |

C/T= Cefzolozane/Tazobactam

- (a) First isolate from each patient was included.
- (b) Unlike aztreonam, aminoglycosides have synergistic activity with β-lactams (ex: piperacillin, ampicillin) against aerobic gram negative rods and enterococci. Aztreonam should only be used for treating documented infections due to susceptible organisms in patients with anaphylactic reactions to β-lactams. In patients with renal insufficiency, aminoglycosides can be administered safely when doses are adjusted for patient's renal function. For information on dosing, including single daily dosing, please contact a Clinical Pharmacist (beeper # available from unit secretary).
- (c) Data from isolate totals <30 may be statistically unreliable.
- (d) Cystic fibrosis patient isolates tested by disk diffusion.
- (e) Formerly known as Enterobacter aerogenes.

Interpretation of susceptibility results

Results are reported as minimum inhibitory concentrations (MICs), the minimum amount of drug needed to inhibit growth *in vitro*. Interpretive criteria are based on achievable serum levels. For certain antibiotics, the amount excreted into the urine via the kidneys is above the MIC, and the agent is effective clinically in this site even though reported as "resistant". Intermediate results (I), especially for beta-lactam agents, indicate that doses higher than standard recommendations may be effective. In other cases, "I" results indicate that the organism may be susceptible or resistant but the *in vitro* tests are not sensitive enough to determine specifically. For this antibiogram, Intermediate results are NOT included within the "%S" category.

Staphylococci

| Percent Susceptible | No. Tested | Penicillin | Nafcillin, Oxacillin (b,c) | 1st Generation Cepheims (c) | Vancomycin | Erythromycin | Clindamycin (d) | Gentamicin | Trimeth/Sulfa | Moxifloxacin | Tetracycline (oxy) | Linezolid | Haemophilus Influenzae | |
|-----------------------------------|------------|------------|----------------------------|-----------------------------|------------|--------------|-----------------|------------|---------------|--------------|--------------------|-----------|--|--|
| | | | | | | | | | | | | | β-lactamase-producing H. influenzae: cefuroxime, cefotaxime, trimethoprim/sulfamethoxazole, amoxicillin/clavulanate or azithromycin is recommended. Cefotaxime or ceftriaxone is drug of choice for CNS infections. At Stanford, 76% of H. influenzae (n=95) are ampicillin susceptible. | |
| Staphylococcus aureus, ALL(b) | 1621 | (a) | 78 | 78 | 100 | 55 | 72 | 96 | 99 | 75 | 96 | 100 | | |
| MRSA (ONLY) (c) | 360 | 0 | 0 | 0 | 100 | 13 | 52 | 91 | 97 | 28 | 90 | 100 | | |
| MSSA (ONLY) | 1261 | (a) | 100 | 100 | 100 | 67 | 78 | 98 | 99 | 88 | 94 | 100 | | |
| Staph. lugdunensis | 65 | (a) | 99 | 99 | 100 | 88 | 88 | 99 | 100 | 100 | 95 | 100 | | |
| Staph. coagulase negative (other) | 205 | (a) | 52 | 52 | 100 | 40 | 63 | 84 | 65 | 67 | 73 | 100 | | |
| Cost (\$) | | \$ | \$\$ | \$ | \$ | \$ | \$ | \$ | \$ | \$ | \$ | \$\$\$ | | |

- (a) Penicillin sensitivity confirmed by request. Penicillin-resistant staphylococci should be considered resistant to all penicillinase-labile penicillins, including ampicillin, amoxicillin, piperacillin and ticarcillin.
- (b) For empiric therapy where S. aureus is a potential pathogen, nafcillin and first generation cephalosporins are recommended drugs of choice for infections other than serious or systemic, for which vancomycin should be used until the susceptibility results are available. Vancomycin MIC 2 mg/ml, currently interpreted sensitive, is associated with increased treatment failure.
- (c) Oxacillin resistant staphylococci (MRSA & MRSE) should be considered resistant to all penicillins, cephalosporins (except ceftazolin), imipenem and beta-lactams including combinations with clavulanic acid, sulbactam and tazobactam. Oxacillin susceptibility predicts susceptibility to all other beta-lactams and cephalosporins.
- (d) Clindamycin induction test performed on all staphylococcal isolates.

Anaerobes (selected species)

| Percent Susceptible by Etest | No. Tested (a,e) | Penicillin | Amp/subactam | Pip/tazobactam | Meropenem | Clindamycin | Metronidazole | (a) Not all isolates tested with every drug | |
|---------------------------------|------------------|------------|--------------|----------------|-----------|-------------|---------------|--|---|
| | | | | | | | | (b) Include Fusobacterium, Prevotella, Porphyromonas, & other. | (c) Non-sporeforming rods include Actinomyces, Bifidobacterium, Lactobacillus, Clostridium, and others. |
| Bacteroides fragilis | 36 | 0 | 92 | - | 100 | 33 | 100 | | |
| Bacteroides sp. NOT fragilis | 32 | 0 | 75 | - | 94 | 22 | 100 | | |
| Gram negative rods (other) (b) | 46 | 60 | 100 | - | 100 | 61 | 100 | | |
| Clostridium perfringens | 14 | 100 | 100 | - | 100 | 71 | 100 | | |
| Clostridium sp. NOT perfringens | 35 | 63 | 100 | - | 100 | 43 | 100 | | |
| Gram positive cocci (other) (c) | 32 | 78 | 100 | - | 100 | 88 | 22 | | |
| Gram positive cocci | 29 | 100 | 100 | - | 100 | 62(d) | 100 | | |
| Cost (\$) | | \$ | \$ | \$\$ | \$\$ | \$\$ | \$ | | |

- (d) Notify Micro Lab to perform antibiotic susceptibility testing if clindamycin is being considered for a Peptostreptococcus.
- (e) <30 isolates may be statistically unreliable

Campylobacter sp. (n = 49)

| Drug | %Susceptible |
|---------------|--------------|
| Ciprofloxacin | 39 |
| Doxycycline | 37 |
| Erythromycin | 90 |

M. tuberculosis (n = 20)

| Drug (mcg/mL) | %Susceptible |
|--------------------|--------------|
| Isoniazid (0.1) | 90 |
| Rifampin (1) | 100 |
| Ethambutol (5) | 100 |
| Pyrazinamide (100) | 90 |