HARDYDISK™ ANTIMICROBIAL SENSITIVITY TEST (AST) IVD ℞ only

INTENDED USE

HardyDisk™ AST Disks are used for semi-quantitative *in vitro* susceptibility testing by the agar diffusion test procedure (Kirby-Bauer) of rapidly growing and certain fastidious bacterial pathogens. Standardized methods for agar diffusion testing have been described for Enterobacteriaceae, *Staphylococcus* spp., *Pseudomonas* spp., *Acinetobacter* spp., *Listeria monocytogenes*, *Enterococcus* spp., and by modified procedures, *Haemophilus* spp., *Neisseria gonorrhoeae, N. meningitidis* and *Streptococcus* spp., including *Streptococcus pneumoniae*.[5,6]

SUMMARY

Agar diffusion methods employing dried filter paper disks impregnated with specific concentrations of antimicrobial agents were developed in the 1940's. In order to eliminate or minimize variability in this testing, Bauer et al. developed a standardized procedure in which Mueller Hinton Agar was selected as the test medium.[1,2]

Various regulatory agencies and standards-writing organizations subsequently published standardized reference procedures based on the Kirby-Bauer method. Among the earliest and most widely accepted of these standardized procedures were those published by the U.S. Food and Drug Administration (FDA) and the World Health Organization (WHO).[3-5] The procedure was adopted as a consensus standard by the Clinical and Laboratory Standards Institute (CLSI - formerly NCCLS) and is periodically updated.[6,7] Mueller Hinton Agar is currently recommended for disk diffusion testing of non-fastidious organisms such as Enterobacteriaceae, *Staphylococcus* spp., *Pseudomonas* spp., *Acinetobacter* spp., *Listeria monocytogenes*, *Enterococcus* spp. and other streptococci.[1,2] Using modified procedures, Haemophilus Test Medium (HTM) is now recommended for disk diffusion testing of *Haemophilus* species. Similarly, GC Base with Supplements is recommended for *Neisseria gonorrhoeae* and Mueller Hinton with 5% Sheep Blood is recommended for *Streptococcus* spp., and *N. meningitidis*.[5,6] The latest FDA approved pharmaceutical package insert and the CLSI documents should be consulted for current recommendations.[6-7] For antimicrobial disks that have no CLSI interpretive criteria, consult the most recent FDA approved pharmaceutical package insert for the drug-specific interpretive criteria.

FORMULA

HardyDisk™ AST Disks are prepared by impregnating high-quality 6mm diameter white filter paper disks with accurately determined amounts of antimicrobics or other chemotherapeutic agents. The disks are clearly marked on both sides with letters and numbers designating the agent and the drug content (See Table 1).

HardyDisk™ AST Disks are supplied in plastic cartridges containing 50 disks each. The cartridges are for use in single disk dispensers or multi-place dispensers such as BBL™ Sensi-Disc™ dispensers and BBL™ Self-Tamping dispensers.

STORAGE AND SHELF LIFE

Storage: Upon receipt store at -20 to +8 degrees C. away from direct light. **Do not store at less than -20 degrees C.** Disks should not be used if there are any signs of deterioration, discoloration, contamination, or if the expiration date has passed. Some disks (e.g. beta-lactams) should be kept frozen at -20 degrees C. A one week supply could be stored at 2-8 degrees C.

It is recommended that the disks be stored in a sealed container (Cat. no. 1922) with a desiccant (DesiView™, Cat. no. DV10). Return unused disks to the refrigerator/freezer as soon as possible after use.

The expiration date applies to the product in its intact packaging when stored as directed.

Products must be brought to room temperature before use.

Refer to the keyword "Storage", in the Hardy Diagnostics' software program HUGO™, for more information on storing culture media.

PRECAUTIONS

For *in vitro* diagnostic use only. Observe approved biohazard precautions and aseptic techniques. This product is to be used only by adequately trained and qualified laboratory personnel. Sterilize all biohazard waste before disposal.

Refer to the keyword "Precautions", in the Hardy Diagnostics' software program HUGO™, for more information regarding general precautions when using culture media.

Refer to the keyword "MSDS", in the Hardy Diagnostics' software program HUGO™, for more information on handling potentially hazardous material.

PROCEDURE

Direct specimen testing is not recommended. It is recommended that isolated organisms, established isolation techniques and tests for purity be performed before inoculating medium for disk diffusion testing. Direct inoculation will produce erroneous results.

Preparation of inoculum with test and control cultures[6]

1. Perform a Gram stain using only pure cultures.

2. Select three to five similar colonies and transfer with inoculation needle or loop into 4-5ml of a suitable broth such as Tryptic Soy Broth or Mueller Hinton Broth for fastidious microorganisms.

3. Incubate the broth cultures at 35 degrees C. for 2 to 6 hours to develop a turbidity that exceeds or is equivalent to the 0.5 McFarland Standard (Cat. no. ML05). Alternatively, make a direct broth or saline suspension of colonies selected from an overnight culture (a non-selective medium such as Blood Agar, or Chocolate Agar for *Haemophilus* spp. and *N. gonorrhoeae* should be used). This procedure is preferred for *Streptococcus* spp., *Haemophilus* spp., *N. gonorrhoeae, N. meningitidis* and methicillin/oxacillin-resistant staphylococci.

4. Dilute to obtain turbidity equivalent to the 0.5 McFarland Standard (Cat. no. ML05). For diluent, use sterile broth or saline. Alternatively, standardize the inoculum photometrically to facilitate adjustment of rapidly growing microorganisms.

Note: Overnight broth cultures should not be used as inoculum.

Inoculation[6]
1. Within 15 minutes dip a sterile swab into the properly adjusted inoculum, rotate it several times and press firmly against the upper inside wall of the tube to express excess fluid.

2. Streak the entire agar plate surface 3 times, turning the plate 60 degrees between streakings to obtain even inoculation. Mueller Hinton (MH) Agar is recommended for non-fastidious organisms; Mueller Hinton with 5% Sheep Blood for *Streptococcus* spp. and *N. meningitidis*; GC Base with Supplements for *N. gonorrhoeae*, and Haemophilus Test Medium (HTM) for *Haemophilus* spp.

3. The lid may be left ajar for 3 to 5 minutes, but no more than 15 minutes, to allow for any surface moisture to be absorbed before applying the drug-impregnated disks.

4. Select appropriate test disks.[6]

5. Apply the disks by means of a dispenser, using aseptic precautions. Deposit disks so that the centers are at least 24mm apart; up to 12 disks may be placed on a 150mm plate, 5 disks on a 100mm plate. In all cases, however, it is best to place disks that give predictably small zones (e.g. cephalosporins) in an effort to avoid overlapping zones. It is also important to pay attention to how close the disks are to the edge of the plate, no matter how many disks are dispensed. If disks are placed too close to the edge of the plate, the

zones may not be fully round with some drugs. Because some of the drug diffuses almost instantaneously, a disk should not be relocated once it has come into contact with the agar surface. Instead, place a new disk in another location on the agar. If the D-test for inducible clindamycin resistance is being performed, refer to the current version of the M02 or M100 for guidance on disk placement. With *Haemophilus* spp., *N. gonorrhoeae,* and *S. pneumoniae*, use no more than nine disks per 150mm plate or four disks per 100mm plate. For *N. meningitidis*, use no more than five disks per 150mm plate or two disks per 100mm plate. If disks have been placed on the agar with other than a self-tamping dispenser, press the disks down with a sterile needle or forceps to make contact with the surface.

Note: It is important that the HardyDisk™ AST Cartridges are properly loaded into the multi-place dispensers to ensure proper dispensing. When using BBL™ Sensi-Disc™ dispensers, move the lever into the "Unlocked" position, insert the cartridge until an audible snap is heard, then move the lever into the locked position. Failure to properly load cartridges into dispensers may result in equipment malfunction and damaged cartridge(s).

6. Within 15 minutes, place the plates agar side up in a 35 +/- 2 degrees C. incubator (testing at temperatures above 35 degrees C. may not detect MRS [methicillin-resistant *Staphylococcus*]). *Haemophilus* spp., *N. gonorrhoeae, N. meningitidis* and *Streptococcus* spp. should be incubated in an atmosphere enriched with 5% CO_2.

7. Examine the plates after 16 to 18 hours of incubation (20 to 24 hrs. for *Streptococcus* spp., *N. meningitidis* and *N. gonorrhoeae*). A full 24 hours of incubation is recommended for *Staphylococcus aureus* to detect methicillin-resistant staphylococci. Measure only zones showing complete inhibition as determined by gross visual inspection and record the diameters of zones to the nearest millimeter. For further details in measuring zones of inhibition, consult the listed reference.(6) If only isolated colonies grow, the inoculum is too light and the test should be repeated. Zone sizes around disks containing different drugs are not comparable for the purpose of comparing activity of drugs.

8. Control tests using prescribed cultures should be included each day susceptibility testing is performed or weekly if satisfactory performance can be documented according to the CLSI standard.(6) Typical zone sizes of *E. coli* ATCC® 25922, *S. aureus* ATCC® 25923, *P. aeruginosa* ATCC® 27853, *H. influenzae* ATCC® 49247, *H. influenzae* ATCC® 49766, *N. gonorrhoeae* ATCC® 49226, *S. pneumoniae* ATCC® 49619, *E. coli* ATCC® 35218 (beta-lactamase-producing strain) are given in the chart (or footnotes) and indicate the correct performance of the entire procedure. *E. faecalis* ATCC® 29212 (for quality control testing of gentamicin 120ug and streptomycin 300ug disks) and *E. faecalis* ATCC® 33186 are also recommended for evaluating new lots of Mueller-Hinton Agar for low thymine and thymidine content (refer to the current version of the M02). *H. influenzae* ATCC® 10211 is recommended as a useful additional quality control strain to verify the growth promotion properties of Haemophilus Test Medium (HTM) Agar.(6)

INTERPRETATION OF RESULTS

For antimicrobial disks that have no CLSI interpretive criteria, consult the latest FDA approved pharmaceutical package insert for the drug-specific interpretive criteria. Refer to the current revision of the CLSI M100 document for the most updated recommendations, footnotes and comments for testing conditions, reporting suggestions, warnings, interpretive criteria and QC information.(7)

RESISTANT indicates that clinical efficacy has not been reliably shown in treatment studies.

INTERMEDIATE implies clinical applicability in body sites where the drug is physiologically concentrated or when a higher than normal dosage of the drug can be used. The MIC of the isolate may approach usually attainable blood and tissue levels but the response rate may be lower than for susceptible isolates.

SUSCEPTIBLE implies that an infection due to the organism may be treated with the concentration of antimicrobial agent used, unless otherwise contraindicated.

NONSUSCEPTIBLE is a category used for organisms that have only a susceptible interpretive category, but not intermediate or resistant interpretive categories (i.e. susceptible-only interpretive category). A susceptible-only interpretive category may be applied to new antimicrobial agents for which no resistant isolates have been encountered at the time the initial interpretive criteria were determined. Isolates that test with a MIC above or a zone measurement below the susceptible interpretive breakpoint are designated as nonsusceptible. A designation of nonsusceptible does not necessarily mean that a resistance mechanism exists in the isolate. The MIC (or zone measurement) of the isolate in the nonsusceptible range may be within the previously recognized wild-type distribution of susceptibility results; however, there is limited clinical experience with these isolates in clinical trials.

LIMITATIONS:

Disk performance and results depend not only on disk potency, but on use of proper inoculum and control cultures, functional plated media, proper storage conditions and other factors.

The test applies primarily to rapidly growing aerobic pathogens. Fastidious bacteria, other than *Haemophilus* spp., *N. gonorrhoeae*, *N. meningitidis* and *Streptococcus* spp., should be tested by a dilution method.

Antimicrobial agents other than those listed in Table 1 may be in current use. Susceptibility tests employing these agents should be interpreted on the basis of presence or absence of a definite zone of inhibition and should be considered only as qualitative until such time as interpretive zones have been established. All zone diameters should be recorded. The approved pharmaceutical package insert and the latest CLSI documents should be consulted for current recommendations and definitive information.[6-8]

Refer to the keyword "Limitations", in the Hardy Diagnostics' software program HUGO™, for more information regarding general limitations when using culture media.

MATERIALS REQUIRED BUT NOT PROVIDED:

Standard microbiological supplies and equipment such as loops, swabs, slides, staining supplies, culture and susceptibility test media, 0.5 McFarland Standard (Cat. no. ML05), calipers, microscope, incinerators, and incubators, etc., are not provided.

QUALITY CONTROL

See Table 1 for acceptable quality control zone diameters. Quality control acceptance is specific to the procedure, control organism and antimicrobial agent combination. Please refer to the latest FDA approved pharmaceutical package insert for the drug-specific QC information and the current revision of the CLSI M100 document for the most updated QC information and footnotes.[7]

User Quality Control: Check for signs of contamination and deterioration. Control tests using prescribed cultures should be included each day susceptibility testing is performed or weekly if satisfactory performance can be documented according to the CLSI standard.[6]

Quality Control Organism Maintenance: Avoid repeated subcultures of the organism. Retrieve new QC strains from stock. If using lyophilized strains, follow the maintenance recommendations provided by the manufacturer. Store *E. coli* ATCC® 35218 and *K. pneumoniae* ATCC® 700603 QC stock cultures at -60 degrees C. or below and prepare working stock cultures weekly.

Refer to the keyword "Inoculation Procedures", in the Hardy Diagnostics' software program HUGO™, for a description of the inoculation method.

Disk Diffusion Zone Diameter Chart (Table 1)

Antimicrobial Agent	Code	Disk Potency	Zone Diameter Interpretive Stds (mm)[a]			QC Zone Diameter Limits (mm)							
			Resistant[b]	Intermediate[c]	Susceptible[d]	*E. coli* ATCC® 25922[i]	*S. aureus* ATCC® 25923	*P. aeruginosa* ATCC® 27853	*E coli* ATCC® 35218[x]	*H. influenzae* ATCC® 49247	*H. influenzae* ATCC® 49766	*N. gonorrhoeae* ATCC® 49226	*S. pneumoniae* ATCC® 49619[v]
Amdinocillin	AMD-10	10ug				23-29	–	–	–	–	–	–	–
for Enterobacteriaceae			≤15	–	≥16								
Amikacin[5]	AN-30	30ug				19-26	20-26	18-26	–	–	–	–	–
for *Staphylococcus* species			≤14	15--16	≥17								
for *Acinetobacter* species			≤14	15--16	≥17								
for Enterobacteriaceae[17,19]			≤14	15--16	≥17								
for *Pseudomonas aeruginosa*			≤14	15--16	≥17								
Amoxicillin/Clavulanic Acid[5,103,104,vi] (Augmentin)	AmC-30	20/10ug				18-24	28-36	–	17-22	15-23	–	–	–
for *Staphylococcus* species[45,50,62]			≤19	–	≥20								
for *H. influenzae* and *parainfluenzae*[86,91]			≤19	–	≥20								
for Enterobacteriaceae			≤13	14--17	≥18								
Ampicillin[9,13]	AM-10	10ug				16-22	27-35	–	6	13-21	–	–	30-36
for Enterobacteriaceae[14,17]			≤13	14--16	≥17								
for *Staphylococcus* species[45,55,59,60]			≤28	–	≥29								
for *Enterococcus* species[76,77,80,81]			≤16	–	≥17								
for *H. influenzae* and *parainfluenzae*[85,87,91]			≤18	19--21	≥22								
for beta-hemolytic streptococci[53,119,120]			–	–	≥24								
for *Vibrio cholerae*[17]			≤13	14-16	≥17								
for *N. meningitidis*[135]			–	–	–								
Ampicillin/Sulbactam[5]	SAM-20	10/10ug				19-24	29-37	–	13-19	14-22	–	–	–
for Enterobacteriaceae			≤11	12--14	≥15								
for *Staphylococcus* species[45,50,62]			≤11	12--14	≥15								
for *H. influenzae* and *parainfluenzae*[91]			≤19	–	≥20								
for *Acinetobacter* species			≤11	12--14	≥15								
Azithromycin[4]	AZM-15	15ug				–	21-26	–	–	13-21	–	–	19-25
for *H. influenzae* and *parainfluenzae*[53]			–	–	≥12								
for *Staphylococcus* species			≤13	14--17	≥18								
for *Streptococcus* other than *S. pneumoniae*[7]			≤13	14--17	≥18								
for *Streptococcus pneumoniae*[7]			≤13	14--17	≥18								
for *N. meningitidis*[53,134,136]			–	–	≥20								
Azlocillin[9,13]	AZ-75	75ug				–	–	24-30	–	–	–	–	–
for *Pseudomonas aeruginosa*[44]			≤17	–	≥18								
Aztreonam[5,6,13]	ATM-30	30ug				28-36	–	23-29	–	30-38	–	–	–
for *H. influenzae* and *parainfluenzae*[53]			–	–	≥26								
for Enterobacteriaceae[16,26]			**≤17**	**18--20**	**≥21**								
for *Pseudomonas aeruginosa*			≤15	16--21	≥22								
Bacitracin	B-10	10U	≤8	9--12	≥13	–	12-22	–		–	–	–	–
Carbencillin[9,13]	CB-100	100ug				23-29	–	18-24	–	–	–	–	–
for *Pseudomonas aeruginosa*[44]			≤13	14--16	≥17								
for Enterobacteriaceae			≤19	20--22	≥23								
Cefaclor[13]	CEC-30	30ug				23-27	27-31	–	–	–	25-31	–	24-32
for *H. influenzae* and *parainfluenzae*[86,91]			≤16	17--19	≥20								
for *Staphylococcus* species[45,50,60]			≤14	15--17	≥18								
for Enterobacteriaceae			≤14	15--17	≥18								
Cefamandole[11,13,91]	MA-30	30ug				26-32	26-34	–	–	–	–	–	–
for Enterobacteriaceae[16,19,20]			≤14	15--17	≥18								
for *Staphylococcus* species[45,50,62]			≤14	15--17	≥18								
Cefazolin[11,13]	CZ-30	30ug				21-27	29-35	–	–	–	–	–	–
for Enterobacteriaceae[16,19,20,21,22]			–	–	–								
for *Staphylococcus* species[45,50,62]			≤14	15--17	≥18								

Antimicrobial Agent	Code	Disk Potency	Zone Diameter Interpretive Stds (mm)[a]			QC Zone Diameter Limits (mm)							
			Resistant[b]	Intermediate[c]	Susceptible[d]	*E. coli* ATCC® 25922[i]	*S. aureus* ATCC® 25923	*P. aeruginosa* ATCC® 27853	*E. coli* ATCC® 35218[x]	*H. influenzae* ATCC® 49247	*H. influenzae* ATCC® 49766	*N. gonorrhoeae* ATCC® 49226	*S. pneumoniae* ATCC® 49619[v]
Cefdinir[13]	CDR-5	5ug				24-28	25-32	–	–	–	24-31	40-49	26-31
for *Staphylococcus* species[45,50,60]			≤16	17--19	≥20								
for *H. influenzae* and *parainfluenzae*[53,86]			–	–	≥20								
for Enterobacteriaceae[28]			≤16	17--19	≥20								
Cefditoren[13]		5ug				22-28	20-28	-	-	25-34	-	-	27-35
Cefepime[5,11,13,110,111]	FEP-30	30ug				31-37	23-29	24-30	–	25-31	–	37-46	28-35
for *Staphylococcus* species[45,50,62]			≤14	15--17	≥18								
for *H. influenzae* and *parainfluenzae*[53]			–	–	≥26								
for *N. gonorrhoeae*[53]			–	–	≥31								
for beta-hemolytic streptococci[53,119]			–	–	≥24								
for viridans group streptococci			≤21	22--23	≥24								
for Enterobacteriaceae[16,19,20,23]			≤14	15--17	≥18								
for *Pseudomonas aeruginosa*			≤14	15--17	≥18								
for *Acinetobacter* species			≤14	15--17	≥18								
Cefixime[13]	CFM-5	5ug				23-27	–	–	–	25-33	–	37-45	16-23
for *H. influenzae* and *parainfluenzae*[53,86]			–	–	≥21								
for *N. gonorrhoeae*[53]			–	–	≥31								
for Enterobacteriaceae[29]			≤15	16--18	≥19								
Cefmetazole	CMZ-30	30ug				26-32	25-34	–	–	16-21	–	31-36	–
for *Staphylococcus* species[45,50,62]			≤12	13--15	≥16								
for *N. gonorrhoeae*[94]			≤27	28--32	≥33								
for Enterobacteriaceae[19]			≤12	13--15	≥16								
Cefonicid[11,13]	CID-30	30ug				25-29	22-28	–	–	–	30-38	–	–
for *H. influenzae* and *parainfluenzae*[91]			≤16	17--19	≥20								
for *Staphylococcus* species[45,50,62]			≤14	15--17	≥18								
for Enterobacteriaceae[16,19,20]			≤14	15--17	≥18								
Cefoperazone[11,13]	CFP-75	75ug				28-34	24-33	23-29	–	–	–	–	–
for *Staphylococcus* species[45,50,62]			≤15	16--20	≥21								
for Enterobacteriaceae[16,19,20,32]			≤15	16--20	≥21								
for *Pseudomonas aeruginosa*			≤15	16--20	≥21								
Cefotaxime[5,11,13,103,107,109,112]	CTX-30	30ug				29-35	25-31	18-22	–	31-39	–	38-48	31-39
for *H. influenzae* and *parainfluenzae*[53,85]			–	–	≥26								
for *N. gonorrhoeae*[53]			–	–	≥31								
for *N. meningitidis*[53]			–	–	≥34								
for beta-hemolytic streptococci[53,119]			–	–	≥24								
for viridans group streptococci			≤25	26--27	≥28								
for *Staphylococcus* species[45,50,62]			≤14	15--22	≥23								
for Enterobacteriaceae[14,15,16,19,20,24,32,40]			**≤22**	**23--25**	**≥26**								
for *Pseudomonas aeruginosa*			≤14	15--22	≥23								
for *Acinetobacter* species			≤14	15--22	≥23								
Cefotetan[5,12]	CTT-30	30ug				28-34	17-23	–	–	–	–	30-36	–
for *N. gonorrhoeae*[95]			≤19	20--25	≥26								
for *Staphylococcus* species[45,50,62]			≤12	13--15	≥16								
for Enterobacteriaceae[19]			≤12	13--15	≥16								
Cefoxitin[15,12]	FOX-30	30ug				23-29	23-29	–	–	–	–	33-41	–
for *N. gonorrhoeae*[94,95]			≤23	24--27	≥28								
for Enterobacteriaceae[19]			≤14	15--17	≥18								
for *S. aureus* and *S. lugdunensis*			≤21	–	≥22								
for coag-neg *Staph*. (not *S. lugdunensis*)			≤24	–	≥25								

Antimicrobial Agent	Code	Disk Potency	Zone Diameter Interpretive Stds (mm)[a]			QC Zone Diameter Limits (mm)							
			Resistant[b]	Intermediate[c]	Susceptible[d]	*E. coli* ATCC® 25922[i]	*S. aureus* ATCC® 25923	*P. aeruginosa* ATCC® 27853	*E. coli* ATCC® 35218[x]	*H. influenzae* ATCC® 49247	*H. influenzae* ATCC® 49766	*N. gonorrhoeae* ATCC® 49226	*S. pneumoniae* ATCC® 49619[v]
Cefpodoxime[13]	CPD-10	10ug				23-28	19-25	–	–	25-31	–	35-43	28-34
for *H. influenzae* and *parainfluenzae*[53,86]			–	–	≥21								
for *N. gonorrhoeae*[53]			–	–	≥29								
for *Staphylococcus* species[45,50,60]			≤17	18--20	≥21								
for Enterobacteriaceae[29,40]			≤17	18--20	≥21								
Cefprozil[13]	CPR-30	30ug				21-27	27-33	–	–	–	20-27	–	25-32
for *Staphylococcus* species[45,50,60]			≤14	15--17	≥18								
for *H. influenzae* and *parainfluenzae*[86,91]			≤14	15--17	≥18								
for Enterobacteriaceae[30]			≤14	15--17	≥18								
Ceftaroline	CPT-30	30ug				26-34	26-35	–	–	29-39	–	–	31-41
Ceftazidime[6,11,13]	CAZ-30	30ug				25-32	16-20	22-29	–	27-35	–	35-43	–
for *H. influenzae* and *parainfluenzae*[53,85]			–	–	≥26								
for *N. gonorrhoeae*[53]			–	–	≥31								
for *Staphylococcus* species[45,50,62]			≤14	15--17	≥18								
for Enterobacteriaceae[16,19,20,26,32,40]			**≤17**	**18--20**	**≥21**								
for *Pseudomonas aeruginosa*			≤14	15--17	≥18								
for *Acinetobacter* species			≤14	15--17	≥18								
for *Burkholderia cepacia*			≤17	18--20	≥21								
Ceftibuten[13]	CTB-30	30ug				27-35	–	–	–	29-36	–	–	–
for *H. influenzae* and *parainfluenzae*[53]			–	–	≥28								
Ceftizoxime[11,13]	ZOX-30	30ug				30-36	27-35	12-17	–	29-39	–	42-51	28-34
for *H. influenzae* and *parainfluenzae*[53]			–	–	≥26								
for *N. gonorrhoeae*[53]			–	–	≥38								
for *Staphylococcus* species[45,50,62]			≤14	15--19	≥20								
for Enterobacteriaceae[16,19,20,27,32]			**≤21**	**22--24**	**≥25**								
for *Pseudomonas aeruginosa*			≤14	15--19	≥20								
Ceftobiprole[ix]		30ug				30-36	26-34	24-30	–	28-36	30-38	-	33-39
Ceftolozane/Tazobactam	C/T40	30/10µg				24-32	10-18	25-31	25-31	23-29	–	–	21-29
for *Pseudomonas aeruginosa*			≤16	17-20	≥21								
Ceftriaxone[5,11,13,103,107,109,112]	CRO-30	30ug				29-35	22-28	17-23	–	31-39	–	39-51	30-35
for *H. influenzae* and *parainfluenzae*[53,85]			–	–	≥26								
for *N. gonorrhoeae*[53]			–	–	≥35								
for *N. meningitidis*[53]			–	–	≥34								
for beta-hemolytic streptococci[53,119]			–	–	≥24								
for viridans group streptococci			≤24	25--26	≥27								
for *Staphylococcus* species[45,50,62]			≤13	14--20	≥21								
for Enterobacteriaceae[14,15,16,19,20,24,32]			**≤19**	**20--22**	**≥23**								
for *Pseudomonas aeruginosa*			≤13	14--20	≥21								
for *Acinetobacter* species			≤13	14--20	≥21								
Cefuroxime (oral)[5,13]	CXM-30	30ug				20-26	27-35	–	–	–	28-36	33-41	–
for *Staphylococcus* species[45,50,60]			≤14	15--22	≥23								
for Enterobacteriaceae			≤14	15--22	≥23								
for *H. influenzae* and *parainfluenzae*[91]			≤16	17--19	≥20								
Cefuroxime (parenteral)[5,11,13]	CXM-30	30ug				20-26	27-35	–	–	–	28-36	33-41	–
for *H. influenzae* and *parainfluenzae* (parenteral)[91]			≤16	17--19	≥20								
for *N. gonorrhoeae* (parenteral)[94,95]			≤25	26--30	≥31								
for *Staphylococcus* species (parenteral)[45,50,62]			≤14	15--17	≥18								
for Enterobacteriaceae (parenteral)[16,19,20,25]			≤14	15--17	≥18								
Cephalothin[1,11,13]	CF-30	30ug				15-21	29-37	–	–	–	–	–	26-32
for *Staphylococcus* species[45,50,62]			≤14	15--17	≥18								
for Enterobacteriaceae[16,19,20]			≤14	15--17	≥18								

Antimicrobial Agent	Code	Disk Potency	Zone Diameter Interpretive Stds (mm)[a]			QC Zone Diameter Limits (mm)							
			Resistant[b]	Intermediate[c]	Susceptible[d]	*E. coli* ATCC® 25922[i]	*S. aureus* ATCC® 25923	*P. aeruginosa* ATCC® 27853	*E. coli* ATCC® 35218[x]	*H. influenzae* ATCC® 49247	*H. influenzae* ATCC® 49766	*N. gonorrhoeae* ATCC® 49226	*S. pneumoniae* ATCC® 49619[v]
Chloramphenicol[4,6]	C-30	30ug				21-27	19-26	–	–	31-40	–	–	23-27
for *H. influenzae* and *parainfluenzae*[85]			≤25	26--28	≥29								
for *S. pneumoniae*			≤20	–	≥21								
for *Staphylococcus* species[53]			≤12	13--17	≥18								
for *Enterococcus* species			≤12	13--17	≥18								
for Enterobacteriaceae[14]			≤12	13--17	≥18								
for *N. meningitides*			≤19	20--25	≥26								
for *Streptococcus* other than *S. pneumoniae*			≤17	18--20	≥21								
for *Vibrio cholerae*[129]			≤12	13--17	≥18								
Cinoxacin	CIN-100	100ug				26-32	–	–	–	–	–	–	–
for Enterobacteriaceae[31]			≤14	15--18	≥19								
Ciprofloxacin[5,6]	CIP-5	5ug				30-40	22-30	25-33	–	34-42	–	48-58	–
for *H. influenzae* and *parainfluenzae*[53]			–	–	≥21								
for *N. gonorrhoeae*[95]			≤27	28--40	≥41								
for *N. meningitidis*[136]			≤32	33--34	≥35								
for *Staphylococcus* species[53,70]			≤15	16--20	≥21								
for *Enterococcus* species			≤15	16--20	≥21								
for Enterobacteriaceae[14,34]			≤15	16--20	≥21								
for *Pseudomonas aeruginosa*			≤15	16--20	≥21								
for *Acinetobacter* species			≤15	16--20	≥21								
Clarithromycin[4,151]	CLR-15	15ug				–	26-32	–	–	11-17	–	–	25-31
for *H. influenzae* and *parainfluenzae*[53]			≤10	11--12	≥13								
for *Streptococcus* other than *S. pneumoniae*			≤16	17--20	≥21								
for *S. pneumoniae*[7]			≤16	17--20	≥21								
for *Staphylococcus* species			≤13	14--17	≥18								
Clinafloxacin		5ug				31-40	28-37	27-35	-	34-43	-	-	27-34
Clindamycin[4,iii]	CC-2	2ug				–	24-30	–	–	–	–	–	19-25
for *Streptococcus* other than *S. pneumoniae*[116,121]			≤15	16--18	≥19								
for *S. pneumoniae*			≤15	16--18	≥19								
for *Staphylococcus* species[72]			≤14	15--20	≥21								
Daptomycin[5,viii]		30ug				-	18-23	-	-	-	-	-	19-26
Dirithromycin[4]		15ug				–	18-26	–	–	–	–	–	18-25
for *Staphylococcus* species[53,69]			≤15	16--18	≥19								
for *S. pneumoniae*[7]			≤13	14--17	≥18								
for *Streptococcus* other than *S. pneumoniae*			≤13	14--17	≥18								
Doripenem	DOR-10	10ug				27-35	33-42	28-35	-	21-31	-	-	30-38
Doxycycline[2,5,128,146,150]	D-30	30ug				18-24	23-29	–	–				
for *Staphylococcus* species[53]			≤12	13--15	≥16								
for *Enterococcus* species			≤12	13--15	≥16								
for Enterobacteriaceae			≤10	11--13	≥14								
for *Acinetobacter* species			≤9	10--12	≥13								
Enoxacin	ENX-10	10ug				28-36	22-28	22-28	–	–	–	43-51	–
for *Staphylococcus* species[7,70]			≤14	15--17	≥18								
for *N. gonorrhoeae*[95]			≤31	32--35	≥36								
for Enterobacteriaceae[14,34]			≤14	15--17	≥18								
Ertapenem[5]	ETP-10	10ug				29-36	24-31	13-21	–	20-28	27-33	–	28-35
for *Staphylococcus* species[45,50,53,62]			≤15	16--18	≥19								
for *H. influenzae* and *parainfluenzae*[53]			–	–	≥19								
for Enterobacteriaceae[32]			≤15	16--18	≥19								

Antimicrobial Agent	Code	Disk Potency	Zone Diameter Interpretive Stds (mm)[a]			QC Zone Diameter Limits (mm)							
			Resistant[b]	Intermediate[c]	Susceptible[d]	*E. coli* ATCC® 25922[i]	*S. aureus* ATCC® 25923	*P. aeruginosa* ATCC® 27853	*E. coli* ATCC® 35218[x]	*H. influenzae* ATCC® 49247	*H. influenzae* ATCC® 49766	*N. gonorrhoeae* ATCC® 49226	*S. pneumoniae* ATCC® 49619[v]
Erythromycin[4,7,iii]	E-15	15ug				–	22-30	–	–	–	–	–	25-30
for *S. pneumoniae*			≤15	16--20	≥21								
for *Staphylococcus* species			≤13	14--22	≥23								
for *Streptococcus* other than *S. pneumoniae*[116]			≤15	16--20	≥21								
for *Enterococcus* species			≤13	14--22	≥23								
Fosfomycin[38]	FOS-200	200ug				22-30	25-33	–	–				
for *Enterococcus* species[38,39,83]			≤12	13--15	≥16								
for Enterobacteriaceae[18,38,39]			≤12	13--15	≥16								
Garenoxacin		5ug				28-35	30-36	19-25	-	33-41	-	-	26-33
Gatifloxacin[8]	GAT-5	5ug				30-37	27-33	20-28	–	33-41	–	45-56	24-31
for *Staphylococcus* species[70]			≤19	20--22	≥23								
for *Enterococcus* species			≤14	15--17	≥18								
for *H. influenzae* and *parainfluenzae*[53]			–	–	≥18								
for *N. gonorrhoeae*[95]			≤33	34--37	≥38								
for *S. pneumoniae*			≤17	18--20	≥21								
for *Streptococcus* other than *S. pneumoniae*			≤17	18--20	≥21								
for Enterobacteriaceae[14,34]			≤14	15--17	≥18								
for *Pseudomonas aeruginosa*			≤14	15--17	≥18								
for *Acinetobacter* species			≤14	15--17	≥18								
Gemifloxacin		5ug				29-36	27-33	19-25	–	30-37	–	–	28-34
for *H. influenzae* and *parainfluenzae*[53]			–	–	≥18								
for *S. pneumoniae*			≤19	20--22	≥23								
for Enterobacteriaceae[14,34,35]			≤15	16--19	≥20								
Gentamicin[6,iii]	GM-10	10ug				19-26	19-27	16-21	–	–	–	–	–
for *Staphylococcus* species[53]			≤12	13--14	≥15								
for Enterobacteriaceae[19]			≤12	13--14	≥15								
for *Pseudomonas aeruginosa*			≤12	13--14	≥15								
for *Acinetobacter* species			≤12	13--14	≥15								
Grepafloxacin	GRX-5	5ug				28-36	26-31	20-27	–	32-39	–	44-52	21-28
for *Staphylococcus* species[70]			≤14	15--17	≥18								
for *H. influenzae* and *parainfluenzae*[53]			–	–	≥24								
for *N. gonorrhoeae*[95]			≤27	28--36	≥37								
for *S. pneumoniae*			≤15	16--18	≥19								
for *Streptococcus* other than *S. pneumoniae*			≤15	16--18	≥19								
for Enterobacteriaceae[14,34]			≤14	15--17	≥18								
Imipenem[5]	IPM-10	10ug				26-32	–	20-28	–	21-29	–	–	–
for *H. influenzae* and *parainfluenzae*[53]			–	–	≥16								
for *Staphylococcus* species[45,50,62]			≤13	14--15	≥16								
for Enterobacteriaceae[32]			≤13	14--15	≥16								
for *Pseudomonas aeruginosa*			≤13	14--15	≥16								
for *Acinetobacter* species			≤13	14--15	≥16								
Kanamycin	K-30	30ug				17-25	19-26	–	–	–	–	–	–
for *Staphylococcus* species			≤13	14--17	≥18								
for Enterobacteriaceae[19]			≤13	14--17	≥18								

Antimicrobial Agent	Code	Disk Potency	Zone Diameter Interpretive Stds (mm)[a]			QC Zone Diameter Limits (mm)							
			Resistant[b]	Intermediate[c]	Susceptible[d]	*E. coli* ATCC® 25922[i]	*S. aureus* ATCC® 25923	*P. aeruginosa* ATCC® 27853	*E. coli* ATCC® 35218[x]	*H. influenzae* ATCC® 49247	*H. influenzae* ATCC® 49766	*N. gonorrhoeae* ATCC® 49226	*S. pneumoniae* ATCC® 49619[v]
Levofloxacin[5,6,136]	LVX-5	5ug				29-37	25-30	19-26	–	32-40	–	–	20-25
for *H. influenzae* and *parainfluenzae*			–	–	≥17								
for *S. pneumoniae*			≤13	14--16	≥17								
for *Streptococcus* other than *S. pneumoniae*			≤13	14--16	≥17								
for *Enterococcus* species			≤13	14--16	≥17								
for Enterobacteriaceae[14,34]			≤13	14--16	≥17								
for *Staphylococcus* species[53,70]			≤15	16--18	≥19								
for *Pseudomonas aeruginosa*			≤13	14--16	≥17								
for *Acinetobacter* species			≤13	14--16	≥17								
for *Stenotrophomonas maltophilia*			≤13	14--16	≥17								
Linezolid[5]	LZD-30	30ug				–	25-32	–	–	–	–	–	25-34
for *Staphylococcus* species[74]			**≤20**	–	≥21								
for *Enterococcus* species			≤20	21--22	≥23								
for *S. pneumoniae*[53]			–	–	≥21								
for *Streptococcus* other than *S. pneumoniae*[53]			–	–	≥21								
Linopristin-flopristin	LFE-10	10ug				–	25-31	–	–	25-31	–	–	22-28
Lomefloxacin	LOM-10	10ug				27-33	23-29	22-28	–	33-41	–	45-54	–
for *H. influenzae* and *parainfluenzae*[53]			–	–	≥22								
for *N. gonorrhoeae*[95]			≤26	27--37	≥38								
for *Staphylococcus* species[70]			≤18	19--21	≥22								
for Enterobacteriaceae[14,34]			≤18	19--21	≥22								
for *Pseudomonas aeruginosa*			≤18	19--21	≥22								
Loracarbef	LOR-30	30ug				23-29	23-31	–	–	–	26-32	–	22-28
for *Staphylococcus* species[45,50,60]			≤14	15--17	≥18								
for *H. influenzae* and *parainfluenzae*[86,91]			≤15	16--18	≥19								
for Enterobacteriaceae[28]			≤14	15--17	≥18								
Mecillinam	MEL-10	10ug				24-30	–	–	–	–	–	–	–
for Enterobacteriaceae[18]			≤11	12--14	≥15								
Meropenem[5,103]	MEM-10	10ug				28-34	29-37	27-33	–	20-28	–	–	28-35
for *Staphylococcus* species[45,50,53,62]			≤13	14--15	≥16								
for *H. influenzae* and *parainfluenzae*[86]			–	–	≥20								
for *N. meningitidis*			–	–	≥30								
for Enterobacteriaceae[32]			≤13	14--15	≥16								
for *Pseudomonas aeruginosa*			≤13	14--15	≥16								
for *Acinetobacter* species			≤13	14--15	≥16								
for *Burkholderia cepacia*			≤15	16--19	≥20								
Methicillin[10,13]	MET-5	5ug				–	17-22	–	–	–	–	–	–
for *Staphylococcus* species[45,55,61]			≤9	10--13	≥14								
Mezlocillin[9,13]	MZ-75	75ug				23-29	–	19-25	–	–	–	–	–
for *Pseudomonas aeruginosa*[44]			≤15	–	≥16								
for Enterobacteriaceae			≤17	18--20	≥21								
for *Acinetobacter* species			≤17	18--20	≥21								
Minocycline[2]	MI-30	30ug				19-25	25-30	–	–	–	–	–	–
for *Staphylococcus* species			≤14	15--18	≥19								
for *Enterococcus* species			≤14	15--18	≥19								
for *N. meningitides*[53,136]			–	–	≥26								
for Enterobacteriaceae			≤12	13--15	≥16								
for *Pseudomonas aeruginosa*			≤14	15--18	≥19								
for *Acinetobacter* species			≤12	13--15	≥16								
for *Burkholderia cepacia*			≤14	15--18	≥19								
for *Stenotrophomonas maltophilia*			≤14	15--18	≥19								

Antimicrobial Agent	Code	Disk Potency	Zone Diameter Interpretive Stds (mm)[a]			QC Zone Diameter Limits (mm)							
			Resistant[b]	Intermediate[c]	Susceptible[d]	*E. coli* ATCC® 25922[i]	*S. aureus* ATCC® 25923	*P. aeruginosa* ATCC® 27853	*E. coli* ATCC® 35218[x]	*H. influenzae* ATCC® 49247	*H. influenzae* ATCC® 49766	*N. gonorrhoeae* ATCC® 49226	*S. pneumoniae* ATCC® 49619[v]
Moxalactam	MOX-30	30ug				28-35	18-24	17-25	–	–	–	–	–
for *Staphylococcus* species[45,50,62]			≤14	15--22	≥23								
for Enterobacteriaceae[16]			≤14	15--22	≥23								
for *Pseudomonas aeruginosa*			≤14	15--22	≥23								
Moxifloxacin[6]	MXF-5	5ug				28-35	28-35	17-25	–	31-39	–	–	25-31
for Staphylococcus species[70]			≤20	21--23	≥24								
for *H. influenzae* and *parainfluenzae*[53]			–	–	≥18								
for *S. pneumoniae*			≤14	15--17	≥18								
Nafcillin[10,13]	NF-1	1ug				–	16-22	–	–	–	–	–	–
for *Staphylococcus* species[45,55]			≤10	11--12	≥13								
Nalidixic Acid	NA-30	30ug				22-28	–	–	–	–	–	–	–
for Enterobacteriaceae[31,34,36]			≤13	14--18	≥19								
for *N. meningitidis*			≤25	–	≥26								
Neomycin	N-30	30ug	≤12	13--16	≥17	17-23	18-26	–	–	–	–	–	–
Netilmicin	NET-30	30ug				22-30	22-31	17-23	–	–	–	–	–
for *Staphylococcus* species			≤12	13--14	≥15								
for Enterobacteriaceae[19]			≤12	13--14	≥15								
for *Pseudomonas aeruginosa*			≤12	13--14	≥15								
Nitrofurantoin	F/M-300	300ug				20-25	18-22	–	–	–	–	–	23-29
for *Staphylococcus* species			≤14	15--16	≥17								
for *Enterococcus* species			≤14	15--16	≥17								
for Enterobacteriaceae			≤14	15--16	≥17								
Norfloxacin	NOR-10	10ug				28-35	17-28	22-29	–	–	–	–	15-21
for *Staphylococcus* species[70]			≤12	13--16	≥17								
for *Enterococcus* species			≤12	13--16	≥17								
for Enterobacteriaceae[14,34]			≤12	13--16	≥17								
for *Pseudomonas aeruginosa*			≤12	13--16	≥17								
Novobiocin	NB-30	30ug				–	22-31	–	–	–	–	–	–
on Mueller Hinton agar			≤17	18--21	≥22								
on Mueller Hinton/Sheep Blood (veterinary use)			≤14	15--16	≥17								
Ofloxacin[6,13]	OFX-5	5ug				29-33	24-28	17-21	–	31-40	–	43-51	16-21
for *H. influenzae* and *parainfluenzae*[53]			–	–	≥16								
for *N. gonorrhoeae*[95]			≤24	25--30	≥31								
for *S. pneumoniae*			≤12	13--15	≥16								
for *Streptococcus* other than *S. pneumoniae*			≤12	13--15	≥16								
for Enterobacteriaceae[14,34]			≤12	13--15	≥16								
for *Staphylococcus* species[70]			≤14	15--17	≥18								
for *Pseudomonas aeruginosa*			≤12	13--15	≥16								
Oxacillin[10]	OX-1	1ug				–	18-24	–	–	–	–	–	≤12[vii]
for *S. aureus*[45,55,57,58]			≤10	11--12	≥13								
for coag-neg *Staph.* and *S. lugdunensis*[45,55]			–	–	–								
for *S. pneumoniae*[105] (penicillin G susceptibility)			–	–	≥20								
Oxolinic Acid	OA-2	2ug				20-24	10-13	–	–	–	–	–	–
Penicillin[9,13,45,55,103,104,119,124,125,126,147,148]	P-10	10U				–	26-37	–	–	–	–	26-34	24-30
for *Staphylococcus* species[56]			≤28	–	≥29								
for *N. gonorrhoeae*[93,95,97,98]			≤26	27--46	≥47								
for beta-hemolytic streptococci[53,106,107,108,109,120]			–	–	≥24								
for *Enterococcus* species[76,77,80,81]			≤14	–	≥15								
for *N. meginitidis*[135]			–	–	–								

Antimicrobial Agent	Code	Disk Potency	Zone Diameter Interpretive Stds (mm)[a]			QC Zone Diameter Limits (mm)							
			Resistant[b]	Intermediate[c]	Susceptible[d]	*E. coli* ATCC® 25922[i]	*S. aureus* ATCC® 25923	*P. aeruginosa* ATCC® 27853	*E. coli* ATCC® 35218[x]	*H. influenzae* ATCC® 49247	*H. influenzae* ATCC® 49766	*N. gonorrhoeae* ATCC® 49226	*S. pneumoniae* ATCC® 49619[v]
Piperacillin[5,9,13]	PIP-100	100ug				24-30	–	25-33	12-18	–	–	–	–
for *Pseudomonas aeruginosa*[44]			≤17	–	≥18								
for Enterobacteriaceae			≤17	18--20	≥21								
for *Acinetobacter* species			≤17	18--20	≥21								
Piperacillin/Tazobactam[5]	TZP-110	100/10ug				24-30	27-36	25-33	24-30	33-38	–	–	–
for Enterobacteriaceae			≤17	18--20	≥21								
for *Pseudomonas aeruginosa*[44]			≤17	–	≥18								
for *Acinetobacter* species			≤17	18--20	≥21								
for *Staphylococcus* species[45,50,62]			≤17	–	≥18								
for *H. influenzae* and *parainfluenzae*[91]			–	–	≥21								
Quinupristin-dalfopristin[5,6]	QD-15	15ug				–	21-28	–	–	15-21	–	–	19-24
for *Enterococcus* species[84]			≤15	16--18	≥19								
for *S. pneumoniae*			≤15	16--18	≥19								
for *Streptococcus* other than *S. pneumoniae*[115]			≤15	16--18	≥19								
for *Staphylococcus* species[47]			≤15	16--18	≥19								
Razupenem	**RZM**	**10ug**				**21-26**	–	–	–	**24-30**	–	–	**29-36**
Rifampin[3,5]	RA-5	5ug				8-10	26-34	–	–	22-30	–	–	25-30
for *H. influenzae* and *parainfluenzae*			≤16	17--19	≥20								
for *N. meningitidis*[136]			≤19	20--24	≥25								
for *Staphylococcus* species			≤16	17--19	≥20								
for *S. pneumoniae*			≤16	17--18	≥19								
for *Enterococcus* species			≤16	17--19	≥20								
Sparfloxacin	SPX-5	5ug				30-38	27-33	21-29	–	32-40	–	43-51	21-27
for *Staphylococcus* species[53,70]			≤15	16--18	≥19								
for *S. pneumoniae*			≤15	16--18	≥19								
Spectinomycin	SPT-100	100ug								–	–	23-29	–
for *N. gonorrhoeae*[94]			≤14	15--17	≥18								
Streptomycin[6,53,146,149,iii]	S-10	10ug				12-20	14-22	–	–	–	–	–	–
for Enterobacteriaceae[19]			≤11	12--14	≥15								
Sulfisoxazole[37,136,138,iv]	G-0.25	0.25mg				15-23	24-34	–	–	–	–	–	–
for *Staphylococcus* species[73]			≤12	13--16	≥17								
for *Vibrio cholerae*			≤12	13--16	≥17								
for Enterobacteriaceae			≤12	13--16	≥17								
Telavancin	TLV-30	30ug				-	16-20	-	-	-	-	-	17-24
Telithromycin[4,5]	TEL-15	15ug				–	24-30	–	–	17-23	–	–	27-33
for *Staphylococcus* species			≤18	19--21	≥22								
for *H. influenzae* and *parainfluenzae*[86]			≤11	12--14	≥15								
Tetracycline[2,5,6,146,150]	Te-30	30ug				18-25	24-30	–	–	14-22	–	30-42	27-31
for *H. influenzae* and *parainfluenzae*[92]			≤25	26--28	≥29								
for *N. gonorrhoeae*[92,99]			≤30	31--37	≥38								
for *Streptococcus* other than *S. pneumoniae*[92]			≤18	19--22	≥23								
for *S. pneumoniae*[92]			≤18	19--22	≥23								
for *Staphylococcus* species[53]			≤14	15--18	≥19								
for *Enterococcus* species			≤14	15--18	≥19								
for Enterobacteriaceae			≤11	12--14	≥15								
for *Acinetobacter* species			≤11	12--14	≥15								
for *Vibrio cholerae*[128]			≤14	15--18	≥19								

Antimicrobial Agent	Code	Disk Potency	Zone Diameter Interpretive Stds (mm)[a]			QC Zone Diameter Limits (mm)							
			Resistant[b]	Intermediate[c]	Susceptible[d]	*E. coli* ATCC® 25922[i]	*S. aureus* ATCC® 25923	*P. aeruginosa* ATCC® 27853	*E. coli* ATCC® 35218[x]	*H. influenzae* ATCC® 49247	*H. influenzae* ATCC® 49766	*N. gonorrhoeae* ATCC® 49226	*S. pneumoniae* ATCC® 49619[v]
Ticarcillin[5,9,13]	TIC-75	75ug				24-30	–	21-27	6	–	–	–	–
for *Pseudomonas aeruginosa*[44]			≤14	–	≥15								
for *Acinetobacter* species			≤14	15--19	≥20								
for Enterobacteriaceae			≤14	15--19	≥20								
Ticarcillin/Clavulanic Acid[5] (Timentin)	TIM-85	75/10ug				24-30	29-37	20-28	21-25	–	–	–	–
for *Pseudomonas aeruginosa*[44]			≤14	–	≥15								
for Enterobacteriaceae			≤14	15--19	≥20								
for *Acinetobacter* species			≤14	15--19	≥20								
for *Staphylococcus* species[45,50,62]			≤22	–	≥23								
Tigecycline	TGC-15	15ug				20-27	20-25	9-13	–	23-31	-	30-40	23-29
for *Staphylococcus aureus*			–	–	≥19								
for *Streptococcus* other than *S. pneumoniae*			–	–	≥19								
for *Enterococcus faecalis*			–	–	≥19								
for Enterobacteriaceae			≤14	15-18	≥19								
Tobramycin	NN-10	10ug				18-26	19-29	19-25	–	–	–	–	–
for *Staphylococcus* species			≤12	13--14	≥15								
for Enterobacteriaceae[19]			≤12	13--14	≥15								
for *Pseudomonas aeruginosa*			≤12	13--14	≥15								
for *Acinetobacter* species			≤12	13--14	≥15								
Trimethoprim[iv]	TMP-5	5ug				21-28	19-26	–	–	–	–	–	–
for *Staphylococcus* species			≤10	11--15	≥16								
for Enterobacteriaceae			≤10	11--15	≥16								
Trimethoprim/Sulfamethoxazole[5,iv]	SXT	1.25/23.75 ug				23-29	24-32	–	–	24-32	–	–	20-28
for *H. influenzae* and *parainfluenzae*			≤10	11--15	≥16								
for *S. pneumoniae*			≤15	16--18	≥19								
for *Staphylococcus* species[53]			≤10	11--15	≥16								
for Enterobacteriaceae[14]			≤10	11--15	≥16								
for *N. meningitidis*[136,138]			≤25	26--29	≥30								
for *Burkholderia cepacia*[146]			≤10	11--15	≥16								
for *Stenotrophomonas maltophilia*			≤10	11--15	≥16								
for *Vibrio cholerae*			≤10	11--15	≥16								
for *Acinetobacter* species			≤10	11--15	≥16								
Trospectomycin		30ug				10-16	15-20	-	-	22-29	-	28-35	-
Trovafloxacin	TVA-10	10ug				29-36	29-35	21-27	–	32-39	–	42-55	25-32
for *H. influenzae* and *parainfluenzae*[53]			–	–	≥22								
for *N. gonorrhoeae*[53,95]			–	–	≥34								
for *S. pneumoniae*			≤15	16--18	≥19								
for *Streptococcus* other than *S. pneumoniae*			≤15	16--18	≥19								
Ulifloxacin (prulifloxacin)[xi]		**5ug**				**32-38**	**20-26**	**27-33**	–				
Vancomycin[5]	Va-30	30ug				–	17-21	–	–	–	–	–	20-27
for *S. pneumoniae*[103]			–	–	≥17								
for *Streptococcus* other than *S. pneumoniae*[69]			–	–	≥17								
for *Enterococcus* species[77,79,82]			≤14	15--16	≥17								
for *Staphylococcus* species[53,63,64,65,66,67]			–	–	–								

Note: Information in **boldface** type is considered tentative for one year.

REPORTING RESULTS:

a. Measure the diameter of the zones of complete inhibition (as judged by the unaided eye), including the diameter of the disk. Hold the Petri plate a few inches above a black, nonreflecting background illuminated with reflected light. The zone margin should be considered the area showing no obvious visible growth that can be detected with the unaided eye. Ignore faint growth of tiny colonies that can be detected only with a magnifying lens at the edge of the zone of inhibited growth. Strains of *Proteus* spp. may swarm into areas of inhibited growth around certain antimicrobial agents. With *Proteus* spp., ignore the thin veil of swarming growth in an otherwise obvious zone growth inhibition. With trimethoprim and the sulfonamides, antagonists in the medium may allow some slight growth; therefore, disregard slight growth (20% or less of the lawn of growth) and measure the more obvious margin to determine the zone diameter.

b. The “resistant” (R) category implies that isolates are not inhibited by the usually achievable concentrations of the agent with normal dosage schedules, and/or that demonstrate MICs or zone diameters that fall in the range where specific microbial resistance mechanisms (e.g. beta lactamases) are likely, and clinical efficacy of the agent against the isolate has not been reliably shown in treatment studies.

c. The "intermediate" (I) category includes isolates with antimicrobial agent MICs that approach usually attainable blood and tissue levels and for which response rates may be lower than for susceptible isolates. The intermediate category implies clinical efficacy in body sites where the drugs are physiologically concentrated (e.g. quinolones and beta-lactams in urine) or when a higher than normal dosage of drug can be used (e.g. beta-lactams). This category also includes a "buffer zone" which should prevent small, uncontrolled technical factors from causing major discrepancies in interpretations, especially for drugs with narrow pharmacotoxicity margins.

d. The “susceptible” (S) category implies that isolates are inhibited by the usually achievable concentrations of antimicrobial agent when the recommended dosage is used for the site of infection.

e. **The “nonsusceptible” category is used for isolates for which only a susceptible interpretive criteria have been designated because of the absence or rare occurrence of resistant strains. Isolates that have MICs above or zone diameters below the value indicated for the susceptible breakpoint should be reported as nonsusceptible.**

f. For some organisms excluded from this document, the current CLSI guidelinet M45—*Methods for Antimicrobial Dilution and Disk Susceptibility Testing of Infrequently Isolated or Fastidious Bacteria* provides suggestions for standardized methods for susceptibility testing, including information about drug selection, interpretation, and QC testing. The organism groups covered in that document are *Abiotrophia* and *Granulicatella* spp. (formerly known as nutritionally deficient or nutritionally variant streptococci); the *Aeromonas hydrophila* complex; *Bacillus* spp. (not *B. anthracis*); *Campylobacter jejuni*/*coli*; *Corynebacterium* spp. (including *C. diptheriae*); *Erysipelothrix rhusiopathiae*; the HACEK group: *Aggregatibacter* spp. (formerly the *Aphrophilus* cluster of the genus *Haemophilus* [i.e. *H. aphrophilus*, *H. paraphrophilus*, *H. segnis*]), *Actinobacillus actinomycetemcomitans*, *Cardiobacterium* spp., *Eikenella corrodens*, and *Kingella* spp.; *Lactobacillus* spp.; *Leuconostoc* spp.; *Listeria monocytogenes*; *Moraxella catarrhalis*; *Pasteurella* spp.; *Pediococcus* spp.; and *Vibrio* spp. For organisms other than those outlined above, studies are not yet adequate to develop reproducible, definitive standards to interpret results. These organisms may require different media or different atmospheres of incubation, or they may show marked strain-to-strain variation in growth rate. For these microorganisms, consultation with an infectious disease specialist is recommended for guidance in determining the need for susceptibility testing and in the interpretation of results. Published reports in the medical literature and current consensus recommendations for therapy of uncommon microorganisms may obviate the need for testing. If necessary, a dilution method is usually the most appropriate testing method, and this may require submitting the organism to a reference laboratory. Physicians should be informed of the limitations of results and advised to interpret results with caution.

g. Policies regarding the generation of cumulative antibiograms should be developed in concert with the infectious disease service, infection control personnel and the pharmacy and therapeutics committee. Under most circumstances, the percentage of susceptible and intermediate results should not be combined into the same statistics. See the current CLSI document M39—*Analysis and Presentation of Cumulative Antimicrobial Susceptibility Test Data*.

h. Therapy-related comments, where specific dosage regimens are important for proper application of breakpoints, are denoted by an ***Rx*** symbol.

i. Multiple test parameters are monitored by following the QC recommendations described in the current CLSI M100 standard. However, acceptable results derived from testing QC strains do not guarantee accurate results when testing patient isolates. It is important to review all results obtained from all drugs tested on patient isolates before reporting results. This should include, but are not be limited to, ensuring that 1) the antimicrobial susceptibility results are consistent with the proper identification of the isolate; 2) the results from individual agents within a specific drug class follows the established hierarchy of activity rules; and 3) the isolate is susceptible to those agents for which resistance has not been documented and for which only “susceptible” interpretive criteria exist in the M100 document.
Each laboratory must develop its own policies for verification of unusual or inconsistent antimicrobial susceptibility test results. This list should emphasize those results that are most likely to affect patient care.

j. Isolates that are initially susceptible may become intermediate or resistant after initiation of therapy. Therefore, subsequent isolates of the same species from a similar body site should be tested in order to detect resistance that may have developed after initiation of therapy. This can occur within as little as three to four days and has been noted most frequently in *Enterobacter*, *Citrobacter*, and *Serratia* spp. with third-generation cephalosporins; in *P. aeruginosa* with all antimicrobial agents; and in staphylococci with quinolones. For *S. aureus*, vancomycin-susceptible isolates may become vancomycin intermediate during the course of prolonged therapy. Laboratory guidelines on when to perform susceptibility testing on repeat isolates should be determined after consultation with medical staff.

k. Some comments may relate to dangerously misleading results that can occur when certain antimicrobial agents are tested and reported as susceptible against specific organisms. These are denoted with the word “***warning***.”

l. **For screening and confirmatory tests for ESBLs: If laboratories have not yet implemented the new cephalosporin and aztreonam interpretive criteria, the test interpretation should be reported as resistant for all penicillins, cephalosporins, and aztreonam. If the laboratory has implemented the new cephalosporin and aztreonam interpretive criteria, then test interpretations for these agents do not need to be changed.**

m. It is not necessary to test an isolate for a carbapenemase by the modified Hodge test when all of the carbapenems that are reported by a laboratory test either intermediate or resistant (i.e. these carbapenem susceptibility results should be reported as tested). However, the modified Hodge test may be useful in this case for infection control and epidemiological purposes.

n. If the revised cephalosporin and aztreonam breakpoints are used, ESBL testing is not required; but if the ESBL screen is performed, the confirmatory test must be performed to establish the presence of an ESBL.

FOOTNOTES AND COMMENTS:

1. **Cephalothin interpretive criteria should be used only to predict results to the oral agents, cefadroxil, cefpodoxime, cephalexin, and loracarbef. Older data that suggest that cephalothin results could predict susceptibility to some other cephalosporins may still be correct, but there are no recent data to confirm this finding**.
2. Organisms that are susceptible to tetracycline are also considered susceptible to doxycycline and minocycline. However, some organisms that are intermediate or resistance to tetracycline may be susceptible to doxycycline, minocycline, or both.
3. ***Rx***: Rifampin should not be used alone for antimicrobial therapy.
4. Not routinely reported on organisms isolated from the urinary tract.
5. Group B in the CLSI M100 document represents antimicrobial agents that may warrant primary testing, but that should be reported only selectively, such as when the organism is resistant to agents of the same family. Other indications for reporting the result might include selected specimen sources (e.g. selected third-generation cephalosporins for isolates of enteric bacteria from CSF or trimethoprim-sulfamethoxazole for urinary tract isolates); stated allergy or intolerance, or failure to respond to an agent; polymicrobial infections; infections involving multiple sites with different microorganisms; or reports to infection control for epidemiological aid.
6. Group C in the CLSI M100 document represents alternative or supplemental antimicrobial agents that may require testing in those institutions that harbor endemic or epidemic strains resistant to one or more of the primary drugs (especially in the same family, e.g. beta-lactams), or for treatment of unusual organisms (e.g. chloramphenicol for extraintestinal isolates of *Salmonella* spp.) or reporting to infection control as an epidemiological aid.
7. Susceptibility and resistance to azithromycin, clarithromycin, and dirithromycin can be predicted by testing erythromycin.
8. These interpretive criteria apply to isolates from the urinary tract only.
9. Penicillinase labile; hydrolyzed by staphylococcal penicillinase.
10. Not hydrolyzed by staphylococcal penicillinase.
11. Cephalosporin I, II, III, and IV are sometimes referred to as 1st-, 2nd-, 3rd-, and 4th-generation cephalosporins, respectively. Cephalosporin III and IV are also referred to as "extended-spectrum cephalosporins." This does not imply activity against ESBL-producing gram-negative bacteria.
12. Although often referred to as a 2nd-generation cephalosporin, cephamycins are not included with the other cephalosporins with regard to reporting of ESBL-producing strains.
13. For all confirmed ESBL-producing strains, the test interpretation should be reported as resistant for this antimicrobial class or subclass.

Enterobacteriaceae

14. When fecal isolates of *Salmonella* and *Shigella* spp. are tested, only ampicillin, a fluoroquinolone, and trimethoprim/sulfamethoxazole should be reported routinely. In addition, chloramphenicol and a third-generation cephalosporin should be tested and reported for extraintestinal isolates of *Salmonella* spp.
15. Cefotaxime and ceftriaxone should be tested and reported on isolates from CSF in place of cephalothin and cefazolin.
16. **Following evaluation of pharmacokinetics-pharmacodynamics (PK-PD) properties and limited clinical data, new (revised) interpretive criteria for cephalosporins (cefazolin, cefotaxime, ceftazidime, ceftizoxime, and ceftriaxone) and aztreonam were established. Cefepime and defuroxime (parenteral) were also evaluated; however, no change in interpretive criteria was required for the dosages indicated in the current CLSI M100 document. When using the new interpretive criteria, routine ESBL testing is no longer necessary before reporting results (i.e. it is no longer necessary to edit results for cephalosporins, aztreonam, or penicillins from susceptible to resistant). However, until laboratories implement the new interpretive criteria, ESBL testing should be performed as previously described. ESBL testing may still be useful for epidemiological or infection control purposes. Note that interpretive criteria for drugs with limited availability in many countries (e.g. moxalactam, cefonicid, cefamandole, and cefoperazone) were not evaluated. If considering use of these drugs for *E. coli*, *Klebsiella*, or *Proteus* spp., ESBL testing should be performed (see previous supplemental table in the M100). If isolates test ESBL positive, the results for moxalactam, cefonicid, cefamandole, and cefoperazone should be reported as resistant.**
17. Class representative for ampicillin and amoxicillin.
18. Indicated for use against *E. coli* urinary tract isolates only.
19. **Warning**: For *Salmonella* spp. and *Shigella* spp., first- and second-generation cephalosporins and cephamycins may appear active *in vitro* but are not effective clinically and should not be reported as susceptible.
20. *Enterobacter, Citrobacter,* and *Serratia* may develop resistance during prolonged therapy with third-generation cephalosporins. Therefore, isolates that are initially susceptible may become resistant within three to four days after initiation of therapy. Testing of repeat isolates may be warranted.
21. **Disk diffusion interpretive criteria for cefazolin when using the revised MIC interpretive criteria listed in the CLSI M100 document have not yet been established.**
22. **MIC interpretive criteria are based on a dosage regimen of at least 1gm every 8hr.**
23. **Interpretive criteria are based on a dosage regimen of 1.0gm every 8hr or 2.0gm every 12hr.**
24. **Interpretive criteria are based on a dosage regimen of 1.0gm every 24hr for ceftriaxone and 1.0gm every 8hr for cefotaxime.**
25. **Interpretive criteria are based on a dosage regimen of 1.5gm every 8hr.**
26. **Interpretive criteria are based on a dosage regimen of 1.0gm every 8hr.**
27. **Interpretive criteria are based on a dosage regimen of 1.0gm every 12hr.**
28. Because certain strains of *Citrobacter, Providencia,* and *Enterobacter* spp. have been reported to give false-susceptible results with cefdinir and loracarbef disks, strains of these genera should not be tested by disk diffusion and reported with these disks.
29. For disk diffusion, not applicable for testing *Morganella* spp.
30. Because certain strains of *Providencia* spp. have been reported to give false-susceptible results with cefprozil disks, strains of this genus should not be tested and reported with this disk.
31. Indicated for urine isolates only.
32. *Enterobacteriaceae* that are resistant to one or multiple agents in cephalosporin subclass III and that demonstrate elevated MICs or reduced disk zone diameters to carbapenems may produce a carbapenemase despite the fact that the MICs or zone diameters may fall within the

current susceptible range. Screening tests using MIC or zone diameter cutoffs and a confirmatory test, the modified Hodge test, which has shown sensitivity and specificity exceeding 90% in the detection of carbapenemase production in *Enterobacteriaceae*, are shown in the current CLSI M100 document; thus, the usefulness of the imipenem MIC screen test for the detection of carbapenemases in these three genera is not established. The clinical efficacy of carbapenems in the treatment of infections due to carbapenemase-producing *Enterobacteriaceae* that test susceptible using established susceptibility **interpretive criteria** have not been confirmed. For isolates with confirmed carbepenemase production, MICs should be determined and reported but without an interpretation. Clinicians and infection control practitioners caring for patients with infections due to these isolates should be informed, and alternative antimicrobial agents should be considered.

33. There are no MIC interpretive standards.
34. Fluoroquinolone-susceptible strains of *Salmonella* that test resistant to naladixic acid may be associated with clinical failure or delayed response in fluoroquinolone-treated patients with extraintestinal salmonellosis. Extraintestinal isolates of *Salmonella* should also be tested for resistance to nalidixic acid. For isolates that test susceptible to fluoroquinolones and resistant to nalidixic acid, the physician should be informed that the isolate may not be eradicated by fluoroquinolone treatment. A consultation with an infectious disease practitioner is recommended.
35. FDA-approved for *Klebsiella pneumonia*.
36. In addition to testing urine isolates, nalidixic acid may be used to test for reduced fluoroquinolone susceptibility in isolates from patients with extraintestinal *Salmonella* infections.
37. Sulfisoxazole can be used to represent any of the currently available sulfonamide preparations.
38. The 200ug fosfomycin disk contains 50ug of glucose-6-phosphate.
39. The approved MIC susceptibility testing method is agar dilution. Agar media should be supplemented with 25ug/ml of glucose-6-phosphate. Broth dilution testing should not be performed.
40. Screening of *Proteus mirabilis* for ESBL production is recommended only when it is deemed clinically relevant (e.g. a bacteremic isolate).

See note (n) above.
See note (1) above.
See note (2) above.
See note (4) above.
See note (12) above.

<u>*Pseudomonas aeruginosa* and Other Non-*Enterobacteriaceae*</u>

41. Other non-*Enterobacteriaceae* include *Pseudomonas* spp. and other nonfastidious, glucose-nonfermenting, gram-negative bacilli, but exclude *Pseudomonas aeruginosa*, *Acinetobacter* spp., *Burkholderia cepacia*, *B. mallei*, *B. pseudomallei*, and *Stenotrophomonas maltophilia*, because there are separate lists of suggested drugs to test and report for these isolates.
42. The susceptibility of *P. aeruginosa* isolated from patients with cystic fibrosis can be reliably determined by disk diffusion or dilution methods, but may require extended incubation for up to 24 hours before reporting as susceptible.
43. *P. aeruginosa* may develop resistance during prolonged therapy with all antimicrobial agents. Therefore, isolates that are initially susceptible may become resistant within three to four days after initiation of therapy. Testing of repeat isolates may be warranted.
44. ***Rx***: The susceptible category for these drugs implies the need for high-dose therapy for serious infections caused by *P. aeruginosa*. For these infections, monotherapy has been associated with clinical failure.

See note (2) above.
See note (4) above.
See note (8) above.

<u>*Acinetobacter* spp.</u>

See note (2) above.

<u>*Burkholderia cepacia*</u>

See note (4) above.

<u>*Stenotrophomonas maltophilia*</u>

See note (2) above.
See note (8) above.

<u>*Staphylococcus* spp.</u>

45. Penicillin-susceptible staphylococci are also susceptible to other penicillins, **beta-lactams/beta-lactamase inhibitor combinations**, cephems, and carbapenems approved for use by the FDA for staphylococcal infections. Penicillin-resistant, oxacillin-susceptible strains are resistant to penicillinase-labile penicillins but susceptible to other penicillinase-stable penicillins, beta-lactam/beta-lactamase inhibitor combinations, relevant cephems, and carbapenems. Oxacillin-resistant staphylococci are resistant to all currently available beta-lactam antimicrobial agents **with the exception of the newer cephalosporins with anit-MRSA activity**. Thus, susceptibility or resistance to a wide array of beta-lactam antimicrobial agents may be deduced from testing only penicillin **and either cefoxitin or oxacillin**. Routine testing of other penicillins, beta-lactam/beta-lactamase inhibitor combinations, cephems, or carbapenems is not advised.
46. The results of either cefoxitin disk diffusion or cefoxitin MIC tests can be used to predict the presence of *mecA*-mediated oxacillin resistance in *S. aureus* and *S. lugdunensis*. For coagulase-negative staphylococci (except *S. lugdunensis*), the cefoxitin disk diffusion test is the preferred method for detection of *mecA*-mediated oxacillin resistance. Cefoxitin is used as a surrogate for detection of oxacillin resistance; report oxacillin as susceptible or resistant based on cefoxitin results. **If a penicillinase-stable penicillin is tested, oxacillin is the preferred agent and results can be applied to the other penicillinase-stable penicillins, cloxacillin, dicloxacillin, and flucloxacillin.**
47. For reporting against methicillin-susceptible *S. aureus*.

48. Historically, resistance to the penicillinase-stable penicillins has been referred to as "methicillin resistance" **or "oxacillin resistance."** MRSAs are **those strains of *S. aureus* that express *mecA* or another mechanism of methicillin resistance, such as changes in affinity of penicillin binding proteins for oxacillin (modified *S. aureus* [MOD-SA] strains)**.
49. For oxacillin-susceptible *S. aureus* and coagulase-negative staphylococci, results for parenteral and oral cephems, beta-lactam/beta-lactamase inhibitor combinations, and carbapenems, if tested, should be reported according to the results generated using routine interpretive criteria. See note (50) for reporting beta-lactam results on oxacillin-resistant strains.
50. **Warning**: For oxacillin-resistant *S. aureus* and coagulase-negative staphylococci (MRS), other beta-lactam agents, i.e. penicillins, beta-lactam/beta-lactamase inhibitor combinations, cephems (**with the exception of the newer "cephalosporins with anti-MRSA activity"**), and carbapenems, may appear active *in vitro* but are not effective clinically. Results for **beta-lactam agents other than the cephalosporins with anti-MRSA activity** should be reported as resistant or should not be reported. This is because most cases of documented MRS infections have responded poorly to beta-lactam therapy, or because convincing clinical data have yet to be presented that document clinical efficacy for those agents.
51. Detection of oxacillin resistance: Tests for *mecA* or for the protein expressed by *mecA*, the penicillin-binding protein 2a (PBP 2a, also called PBP2'), are the most accurate methods for prediction of resistance to oxacillin and can be used to confirm results for isolates of staphylococci from serious infections. Isolates of staphylococci that carry the *mecA* gene, or that produce PBP 2a should be reported as oxacillin resistant. Isolates that do not carry *mecA* or do not produce PBP 2a should be reported as oxacillin susceptbile. Because of the rare occurance of resistance mechanisms other than *mecA*, if MIC tests are performed in addition to disk diffusion, isolates for which oxacillin MICs are ≥4ug/ml and are *mecA* negative or PBP 2a negative should be reported as oxacillin resistant. These isolates may test as susceptible to cefoxitin by disk diffusion.
52. Routine testing of urine isolates of *S. saprophyticus* is not advised, because infections respond to concentrations achieved in urine of antimicrobial agents commonly used to treat acute, uncomplicated urinary tract infections (e.g. nitrofurantoin, trimethoprim +/- sulfamethoxazole, or a fluoroquinolone).
53. For some organisms/antimicrobial agent combinations, the absence or rare occurance of resistant strains precludes defining any results categories other than "susceptible." For strains yielding results suggestive of a "nonsusceptible" category, organism identification and antimicrobial susceptibility test results should be confirmed.
54. For screening tests for beta-lactamase production, oxacillin resistance, *mecA*-mediated oxacillin resistance using cefoxitin, reduced susceptibility to vancomycin, and inducible clindamycin resistance, refer to the current CLSI tables in the M100 document for *S. aureus* and for coagulase-negative staphylococci. In addition, further explanation on the use of cefoxitin for prediction of *mecA*-mediated oxacillin resistance can be found in current versions of the CLSI M07 and M02 documents.
55. **If a penicillinase-stable penicillin is tested, oxacillin is the preferred agent and results can be applied to the other penicillinase-stable penicillins, cloxacillin, dicloxacillin, flucoxacillin, methicillin, and nafcillin**.
56. Penicillin-resistant strains of staphylococci produce beta-lactamase, and the testing of penicillin instead of ampicillin is preferred. Penicillin should be used to test the susceptibility of all staphylococci to all penicillinase-labile penicillins, such as ampicillin, amoxicillin, azlocillin, carbenicillin, mezlocillin, piperacillin, and ticarcillin. An induced beta-lactamase test should be performed on staphylococcal isolates with penicillin MICS ≤ 0.12ug/ml or zone diameters ≥ 29mm before reporting the isolates as penicillin susceptible. **However, the prevalence of penicillin-susceptible *S. aureus* strains is low. Isolates that test as susceptible to penicillin may still produce beta-lactamase, which is usually detected by an induced beta-lactamase test. Occasional isolates are not detected by induced beta-lactamase testing. Thus, for serious infections, laboratories should consider performing MIC tests for penicillin and testing for induced beta-lactamase production on subsequent isolates from the same patient**. A positive beta-lactamase test predicts resistance to penicillin, ampicillin, amoxicillin, carbenicillin, ticarcillin, mezlocillin, and piperacillin. For oxacillin-resistant staphylococci, report penicillin as resistant or do not report.
57. Cefoxitim is used as a surrogate for oxacillin resistance; report oxacillin susceptible or resistant based on the cefoxitin result. **If both cefoxitin and oxacillin are tested against *S. aureus* or *S. lugdunensis* and either result is resistant, the organism should be reported as oxacillin resistant**.
58. **Oxacillin interpretive criteria may overcall resistance for some coagulase-negative staphylococci because some non-*S. epidermidis* strains for which the oxacillin MICs are 0.5 to 2ug/ml lack *mecA*. For serious infections with coagulase-negative staphylococci other than *S. epidermidis*, testing for *mecA* or for PBP 2a or with cefoxitin disk diffusion may be appropriate for strains for which the oxacillin MICs are 0.5 to 2ug/ml**.
59. Class representative for ampicillin and amoxicillin.
60. For oxacillin-resistant staphylococci, report ampicillin as resistant or do not report.
61. For use with *S. aureus* only.
62. For oxacillin-resistant staphylococci, report as resistant or do not report.
63. MIC tests should be performed to determine the susceptibility of all isolates of staphylococci to vancomycin. The disk test does not differentiate vancomycin-susceptible isolates of *S. aureus* from vancomycin-intermediate isolates, nor does the test differentiate among vancomycin-susceptible, intermediate, and resistant isolates of coagulase-negative staphylococci, all of which will give similar zones of inhibition.
64. The vancomycin **30ug** disk test detects *S. aureus* isolates containing the *vanA* vancomycin resistance gene (VRSA). Such isolates will show no zone of inhibition around the disk (zone = 6mm). The identification of isolates showing no zone of inhibition should be confirmed. Isolates of staphylococci producing vancomycin zones of ≥ 7mm should not be reported as susceptible without performing a vancomycin MIC test.
65. Send any *S. aureus* for which the vancomycin is ≥ **8**ug/ml to a reference laboratory.
66. Disk testing is not reliable for testing vancomycin.
67. Send any coagulase-negative *Staphylococcus* for which the vancomycin MIC is ≥ **32**ug/ml to a reference laboratory.
68. There is no content for this footnote.
69. Disk testing is not reliable for testing daptomycin.
70. *Staphylococcus* spp. may develop resistance during prolonged therapy with quinolones. Therefore, isolates that are initially susceptible may become resistant within three to four days after initiation of therapy. Testing of repeat isolates may be warranted.
71. FDA approved for *S. saprophyticus* and *S. epidermidis* (but not for *S. aureus*).

72. Inducible clindamycin resistance can be detected by disk diffusion using the D-zone test and by broth microdilution using a single well containing a combination of erythromycin and clindamycin. See the appropriate tables in the current CLSI M02 and M07 documents for current recommendations.
73. Sulfisoxazole can be used to represent any of the currently available sulfonamide preparations.
74. When testing linezolid, disk diffusion zones should be examined using transmitted light. Organisms with resistance results by disk diffusion should be confirmed using and MIC method.

See note (2) above.
See note (3) above.
See note (4) above.
See note (45) above.

Enterococcus spp.

75. **Warning**: For *Enterococcus* spp., cephalosporins, aminoglycosides (except for high-level resistance screening), clindamycin, and trimethoprim-sulfamethoxazole may appear active *in vitro* but are not effective clinically and should not be reported as susceptible.
76. Enterococci susceptible to penicillin are predictably susceptible to ampicillin, amoxicillin, ampicillin-sulbactam, amoxicillin-clavulanate, piperacillin, and piperacillin-tazobactam for non-beta-lactamase producing enterococci. However, enterococci susceptible to ampicillin cannot be assumed to be susceptible to penicillin. If penicillin results are needed, testing of penicillin is required.
77. ***Rx***: Combination therapy with ampicillin, penicillin, or vancomycin (for susceptible strains) plus an aminoglycoside is usually indicated for serious enterococcal infections, such as endocarditis, unless high-level resistance to both gentamicin and streptomycin is documented; such combinations are predicted to result in synergistic killing of the *Enterococcus*.
78. For reporting against vancomycin-resistant *Enterococcus faecium*.
79. Synergy between ampicillin, penicillin, or vancomycin and an aminoglycoside can be predicted for enterococci by using a high-level aminoglycoside (gentamicin and streptomycin) screening test. Other aminoglycosides need not be tested, because their activities against enterococci are not superior to gentamicin and streptomycin.
80. Ampicillin is the class representative for ampicillin and amoxicillin. Ampicillin results may be used to predict susceptibility to amoxicillin-clavulanic acid, ampicillin-sublactam, piperacillin, and piperacillin-tazobactam among non-beta-lactamase-producing enterococci. Ampicillin susceptibility can be used to predict imipenem susceptibility, providing the species is confirmed to be *E. faecalis*.
81. **Penicillin or ampicillin** resistance among enterococci due to beta-lactamase production **has been reported very rarely. Penicillin or ampicillin resistance due to beta-lactamase production** is not reliably detected **with** routine disk or dilution methods **but is detected using** a direct, nitrocefin-based beta-lactamase test. **Because of the rarity of beta-lactamase-positive enterococci, this test need not be performed routinely, but can be used in selected cases**. A positive beta-lactamase test predicts resistance to penicillin, as well as amino- and ureidopenicillins.
82. When testing vancomycin against enterococci, plates should be held a full 24 hours for accurate detection of resistance. For isolates for which the vancomycin MICs are 8 to 16ug/ml, perform biochemical tests for identification as listed under the CLSI "vancomysin resistance" test tables found in the current version of the M100 document. Zones should be examined as described in the current CLSI document, M07.
83. Indicated for use against *E. faecalis* urinary tract isolates only.
84. For reporting against vancomycin-resistant *E. faecalis*.

See note (2) above.
See note (3) above.
See note (4) above.
See note (8) above.
See note (33) above.
See note (34) above.
See note (53) above.
See note (69) above.

Haemophilus spp.

85. Only results of testing with ampicillin, one of the third-generation cephalosporins; chloramphenicol; and meropenem should be routinely reported with CSF isolates of *H. influenzae*.
86. Amoxicillin-clavulanic acid, azithromycin, cefaclor, cefdinir, cefixime, cefpodoxime, cefprozil, cefuroxime, clarithromycin, loracarbef, and telithromycin are oral agents that may be used as empiric therapy for respiratory tract infections due to *Haemophilus* spp. The results of susceptibility tests with these antimicrobial agents are often not useful for management of individual patients. However, susceptibility testing of *Haemophilus* spp. with these compounds may be appropriate for surveillance or epidemiological studies.
87. The results of ampicillin susceptibility tests should be used to predict the activity of amoxicillin. The majority of isolates of *H. influenzae* that are resistant to ampicillin and amoxicillin produce a TEM-type beta-lactamase. In most cases, a direct beta-lactamase test can provide a rapid means of detecting ampicillin and amoxicillin resistance.
88. Clinical indications and relevant pathogens include bacterial meningitis and concurrent bacteremia in association with meningitis cause by *H. influenzae* (beta-lactamase- and non-beta-lactamase-producing strains).
89. For isolates of *H. influenzae* from CSF, only results of testing with ampicillin, one of the third-generation cephalosporins, chloramphenicol, and meropenem should be reported routinely.
90. To make *Haemophilus* Test Medium (HTM): Prepare a fresh hematin stock solution by dissolving 50mg of hematin powder in 100ml of 0.01mol/L NaOH with heat and stirring until the powder is thoroughly dissolved. Add 30ml of the hematin stock solution and 5gm of yeast extract to 1.0 liter of Mueller-Hinton agar (MHA) and autoclave. After autoclaving and cooling, add 3ml of a nicotinamide adenine dinucleotide (NAD) stock solution (50mg of NAD dissolved in 10ml of distilled water, filter sterilized) aseptically.
91. Rare beta-lactamase-negative, ampicillin-resistant (BLNAR) strains of *H. influenzae* should be considered resistant to amoxicillin-clavulanic acid, ampicillin-sulbactam, cefaclor, cefonicid, cefprozil, cefuroxime, loracarbef, and piperacillin-tazobactam, despite apparent *in vitro* susceptibility of some BLNAR strains to these agents.

92. Organisms that are susceptible to tetracycline are also considered susceptible to doxycycline and minocycline.

See note (3) above.
See note (4) above.
See note (53) above.

Neisseria gonorrhoeae

93. A beta-lactamase test detects one form of penicillin resistance in *N. gonorrhoeae* and also may be used to provide epidemiological information. Strains with chromosomally mediated resistance can be detected only by additional susceptibility testing, such as the disk diffusion method or the agar diffusion MIC method.
94. The clinical effectiveness of cefmetazole, cefotetan, cefoxitin, and spectinomycin for treating organisms that produce intermediate results with these agents is unknown.
95. For disk diffusion testing of *N. gonorrhoeae*, an intermediate result for an antimicrobial agent indicates either a technical problem that should be resolved by repeat testing or a lack of clinical experience in treating organisms with these zones. Strains with intermediate zones to agents other than cefmetazole, cefotetan, cefoxitin, and streptinomycin have a documented lower clinical cure rate (85% to 95%) compared with > 95% for susceptible strains.
96. The recommended medium for testing *N. gonorrhoeae* consists of GC agar to which a 1% defined growth supplement (1.1gm L-cysteine, 0.03gm guanine HCl, 3mg thiamine HCl, 13mg para-aminobenzoic acid (PABA), 0.01gm B_{12}, 0.1gm cocarboxylase, 0.25gm NAD, 1gm adenine, 10gm L-glutamine, 100gm glucose, 0.02gm ferric nitrate [in 1.0 liter H_2O] is added after autoclaving.
97. A positive beta-lactamase test predicts resistance to penicillin, ampicillin, and amoxicillin.
98. Gonococci with 10-unit penicillin disk zone diameters of ≤ 19mm are likely to be beta-lactamase-producing strains. However, the beta-lactamase test remains preferable to other susceptibility methods for rapid, accurate recognition of this plasmid-mediated penicillin resistance.
99. Gonococci with 30-ug tetracycline disk zone diameters of ≤ 19mm usually indicate a plasmid-mediated tetracycline-resistant *N. gonorrhoeae* (TRNG) isolate. Resistance in these strains should be confirmed by a dilution test (MIC ≥ 16ug/ml).

See note (53) above.
See note (93) above.

Streptococcus pneumoniae

100. *S. pneumoniae* isolates susceptible to levofloxacin are predictably susceptible to gemifloxacin and moxifloxacin. However, *S. pneumoniae* susceptible to gemifloxacin or moxifloxacin cannot be assumed to be susceptible to levofloxacin.
101. Penicillin and cefotaxime or ceftriaxone or meropenem should be tested by a reliable MIC method (such as that described in the current version of the CLSI M07 document) and reported routinely with CSF isolates of *S. pneumoniae*. Such isolates should also be tested against vancomycin using the MIC or disk method. With isolates from other sites, the oxacillin disk screening test may be used. If the oxacillin zone size is ≤ 19mm, penicillin or cefotaxime or ceftriaxone or meropenem MICs should be determined.
102. Amoxicillin, ampicillin, cefepime, cefoxatime, ceftriaxone, cefuroxime, ertapenem, imipenem, and meropenem may be used to treat pneumococcal infections; however, reliable disk diffusion susceptibility tests with these agents do not yet exist. Their *in vitro* activity is best determined using an MIC method.
103. Penicillin and cefoxatime or ceftriaxone or meropenem should be tested by a reliable MIC method (such as that described in the current CLSI M07 document) and reported routinely with CSF isolates of *S. pneumoniae*. Such isolates should also be tested against vancomycin using the MIC or disk method.
104. For nonmeningitis isolates, the penicillin MIC can predict susceptibility to other beta-lactams as follows: Penicillin MICs ≤ 0.06ug/ml (or oxacillin zones ≥ 20mm) indicate susceptibility to ampicillin (oral or parenteral), ampicillin-sulbactam, cefdinir, cefditoren, cefpodoxime, cefprozil, ceftizoxime, cefuroxime, imipenem, loracarbef, and meropenem. Penicillin MICs ≤ 2ug/ml indicate susceptibility to: amoxicillin-clavulanic acid, cefepime, cefotaxime, ceftriaxone, and ertapenem.
105. Isolates of pneumococci with oxacillin zone sizes of ≥ 20mm are susceptible (MIC ≤ 0.06ug/ml) to penicillin. Penicillin and cefotaxime or ceftriaxone or meropenem MICs should be determined for those isolates with oxacillin zone diameters of ≤ 19mm, because zones of ≤ 19mm occur with penicillin-resistant, intermediate, or certain susceptible strains. For isolates with oxacillin zones ≤ 19mm, do not report penicillin as resistant without performing a penicillin MIC test.
106. ***Rx***:Doses of intravenous penicillin of at least 2 million units every four hours in adults with normal renal function (12 million units per day) can be used to treat nonmeningeal pneumococcal infections due to strains with penicillin MICs ≤ 2ug/ml. Strains with an intermediate MIC of 4ug/ml may require penicillin doses of 18 to 24 million units per day.
107. For all isolates other than those from CSF, report interpretations for both meningitis and nonmeningitis.
108. ***Rx***: Use of penicillin in meningitis requires therapy with maximum doses of intravenous penicillin (e.g. at least 3 million units every four hours in adults with normal renal function).
109. For CSF isolates, report only meningitis interpretations.
110. For CSF isolates, report only meningitis interpretations. There is not an FDA-approved indication for the use of cefepime for meningitis.
111. In the United States, only report interpretations for nonmeningitis and include the nonmeningitis notation on the report.
112. ***Rx***: Use of cefotaxime or ceftriaxone in meningitis requires therapy with maximum doses.

See note (3) above.
See note (4) above.
See note (7) above.
See note (53) above.
See note (93) above.

Streptococcus spp. Beta-Hemolytic Group

113. ***Rx***: Penicillin- or ampicillin-intermediate isolates may require combined therapy with an aminoglycoside for bactericidal action.

114. Susceptibility testing of penicillins and other beta-lactams approved by the FDA for treatment of *Streptococcus pyogenes* or *S. agalactiae* is not necessary for clinical purposes and need not be performed routinely, because as with vancomycin, resistant strains have not been recognized. Interpretive criteria are provided for pharmaceutical development, epidemiology, or monitoring for emerging resistance. Any strains found to be **nonsusceptible** should be referred to a reference laboratory for confirmation.
115. Report against *S. pyogenes*.
116. ***Rx***: Recommendations for intrapartum prophylaxis for Group B streptococci are penicillin or ampicillin. Although cefazolin is recommended for penicillin-allergic women at low risk for anaphylaxis, those at high risk for anaphylaxis may receive clindamycin or erythromycin. Group B streptococci are susceptible to ampicillin, penicillin, and cefazolin but may be resistant to clindamycin and/or erythromycin. When Group B *Streptococcus* is isolated from a pregnant woman with severe penicillin allergy (high risk for anaphylaxis), clindamycin and erythromycin should be tested and reported.
117. The beta-hemolytic group includes the large-colony-forming pyogenic strains of streptococci with Group A (*S. pyogenes),* C, or G antigens and strains with Group B (*S. agalactiae*) antigen. Small-colony-forming beta-hemolytic strains with Group A, C, F, or G antigens (*S. anginosus* group, previously termed "*S. milleri*") are considered part of the viridans group, and interpretive criteria for the viridans group should be used.
118. Interpretive criteria for streptococci are proposed based on population distributions of various species, pharmacokinetics of the antimicrobial agents, previously published literature, and the clinical experience of certain members of the subcommittee. Systematically collected clinical data were not available for review with many of the compounds in the group.
119. **For the following organism groups, an organism that is susceptible to penicillin can be considered susceptible to the listed antimicrobial agents when used for approved indications and need not be tested against those agents. For beta-hemolytic streptococci (Groups A, B, C, G): ampicillin, amoxicillin, amoxicillin-clavulanic acid, ampicillin-sulbactam, cefazolin, cefepime, cephradine, cephalothin, cefotaxime, ceftriaxone, ceftizoxime, imipenem, ertapenem, and meropenem. In addition, for group A streptococci only: cefaclor, cefdinir, cefprozil, ceftibuten, cefuroxime, cefpodoxime, and cephapirin.**
120. Strains of beta-hemolytic streptococci with penicillin MICs of greater than 0.12 ug/ml or ampicillin MICs of greater than 0.25ug/ml have not been observed; submit such strains to a reference laboratory.
121. Inducible clindamycin resistance can be detected by disk diffusion using the D-zone test. See the appropriate section in the current CLSI M02 and M07 documents.

See note (4) above.
See note (7) above.
See note (53) above.
See note (93) above.

Streptococcus spp. Viridans Group

122. **The viridans group of streptococci includes the following five groups, with several species within each group: *mutans* group, *salivarius* group, *bovis* group, *anginosis* group (previously "*S. milleri*" group), and *mitis* group. The *anginosus* group includes small colony-forming beta-hemolytic strains with groups A, C, F, and G antigens. For detailed information on the species within the groups, please refer to recent clinical microbiology literature.**
123. Interpretive criteria for streptococci other than *S. pneumoniae* are proposed based on population distributions of various species, pharmacokinetics of the antimicrobial agents, previously published literature, and the clinical experience of certain members of the subcommittee. Systematically collected clinical data were not available for review with many of the compounds in the group.
124. Disk testing is not reliable for testing penicillin and ampicillin.
125. Viridans streptococci isolated from normally sterile body sites (e.g. CSF, blood, bone) should be tested for penicillin susceptibility using and MIC method.
126. ***Rx***: Penicillin- or ampicillin-intermediate isolates may require combined therapy with an aminoglycoside for bactericidal action.

See note (4) above.
See note (7) above.
See note (53) above.
See note (83) above.
See note (93) above.

Vibrio cholerae

127. The results of disk diffusion tests for ampicillin, tetracycline, trimethoprim-sulfamethoxazole, and sulfonamides (i.e. percentage of susceptible, intermediate, and resistant) correlate well with results determined by broth microdilution.
128. Tetracycline results can be used to predict the likely susceptibility of isolates to doxycycline; disk diffusion tests should not be used with doxycycline, because there is poor correlation with MIC test results.
129. Use with caution for disk diffusion because the disk diffusion test may misclassify many organisms (higher minor error rate).

See note (4) above.
See note (17) above.
See note (37) above.

Neisseria meningitidis

130. Caution: Perform all antimicrobial susceptibility testing of *N. menigitidis* in a biological safety cabinet (BSC). Manipulating suspensions of *N. meningitidis* outside of a BSC is associated with a high risk of contracting meningococcal disease. Laboratory-acquired meningococcal disease is associated with a case fatality rate of 50%. Exposure to droplets or aerosols of *N. meningitidis* is the most likely risk for laboratory-acquired infection. Rigorous protection from droplets or aerosols is mandated when microbiological procedures (including antimicrobial susceptibility testing) are performed on all *N. meningitidis* isolates.
131. Recommended precautions: Specimens for *N. meningitidis* analysis and cultures of *N. meningitidis* not associated with invasive disease may be handled in Biosafety Level 2 (BSL-2) facilities, with rigorous application of BSL-2 standard practices, special practices, and safety equipment. All sterile-site isolates of *N. meningitidis* should be manipulated within a BSC. If a BSC is unavailable, manipulation of these

isolates should be minimized, limited to Gram staining or serogroup identification using phenolized saline solution while wearing a laboratory coat and gloves and working behind a full face splash shield. Use Biosafety Level 3 (BSL-3) practices, procedures, and containment equipment for activities with a high potential for droplet or aerosol production and for activities involving production quantities or high concentrations of infectious materials. If BSL-2 or BSL-3 facilities are not available, forward isolates to a reference or public health laboratory with a minimum of BSL-2 facilities.

132. Laboratorians who are exposed routinely to potential aerosols of *N. meningitidis* should consider vaccination according to the current recommendations of the Centers for Disease Control and Prevention (CDC) Advisory Committee on Immunization Practices (www.cdc.gov). Vaccination will decrease but not eliminate the risk of infection, because it is less that 100% effective and does not provide protection against serogroup B, a frequent cause of laboratory-acquired cases.
133. Interpretive criteria are based on population distributions of MICs of various agents, pharmacokinetics of the agents, previously published literature, and the clinical experience of certain members of the subcommittee. Systematically collected clinical data were not available to review with many of the antimicrobial agents in this table.
134. With azithromycin, interpretive criteria were developed initially using MICs determined by incubation in ambient air for the pharmacodynamic calculations.
135. Disk diffusion tests with ampicillin and penicillin are unreliable for *N. meningitidis*. MIC tests should be used for this organism.
136. May be appropriate only for prophylaxis of meningococcal case contacts. These interpretive criteria do not apply to therapy of patients with invasive meningococcal disease.
137. For surveillance purposes, a nalidixic acid MIC ≥ 8ug/ml or a zone of ≤ 25mm may correlate with diminished fluroquinolone susceptibility.
138. This is the preferred disk for detection of sulfonamide resistance. Trimethoprim-sulfamethoxazole testing predicts susceptibility and resistance to trimethoprim-sulfamethoxazole and sulfonamides. Sulfonamides may be appropriate only for prophylaxis of meningococcal case contacts.

See note (4) above.
See note (53) above.

Potential Bacterial Agents of Bioterrorism - *Bacillus anthracis*, *Yersinia pestis*, *Francisella tularensis*, *Brucella* spp., *Burkholderia mallei*, *and Burkholderia pseudomallei*

139. **Extreme caution**: Notify public health officials of all isolates presumptively identified as *B. anthracis*, *Y. pestis*, *B. mallei*, *B. psuedomallei*, or *F. tularensis*. Confirmation of isolates of these bacteria may require specialized testing available only in reference or public health laboratories.
140. Organisms that are susceptible to penicillin are also considered susceptible to amoxicillin.
141. Recommended precautions: Use BSL-2 practices, containment equipment, and facilities for activities using clinical materials and diagnostic quantities of infectious cultures. Use BSL-3 practices, containment equipment, and facilities for work involving production quantities or concentrations of cultures, and for activites with a high potential for aerosol production. If BSL-2 or BSL-3 facilities are not available, forward isolates to a reference or public health laboratory with a minimum of BSL-2 facilities for susceptibility testing.
142. Interpretive criteria are based on microorganism MIC population distributions, pharmacokinetics, and pharmacodynamics of the antimicrobial agents, and/or animal model data.
143. Test method and interpretive criteria for *B. anthracis* do not apply to other *Bacillus* spp.
144. **Warning**: For *Y. pestis*, studies have demonstrated that although beta-lactam antimicrobial agents may appear active *in vitro*, they lack efficacy in animal models of infection. *Y. pestis* should be reported as resistant to these antimicrobial agents. ***Rx***: Retrospective clinical data suggest that beta-lactam antimicrobial agents are not effective clinically.
145. The recommended medium for testing *F. tularensis* consists of cation-adjusted Mueller-Hinton broth (CAMHB) to which a 2% defined growth supplement (25.9gm L-cysteine HCl, 1.1gm L-cystine, 1gm adenine, 0.03gm guanine HCl, 0.01gm vitamin B_{12}, 0.1gm cocarboxylase, 0.25gm NAD, 10gm L-glutamine, 0.02gm ferric nitrate, 100gm glucose, 3mg thiamine HCl, and 13mg PABA acid [in H_2O]) is added after autoclaving. The pH of the medium should be adjusted to 7.1 +/- 0.1.
146. Incubation in 5% CO_2 may be required for growth of some strains of *Brucella* spp., especially *B. abortus*. Incubation of broth in CO_2 may increase the MIC of aminoglycosides and decrease the MIC of tetracyclines, usually by one doubling dilution.
147. Class representative for amoxicillin.
148. *B. anthracis* strains may contain inducible beta-lactamases. *In vitro* penicillinase induction studies suggest that penicillin MICs may increase during therapy. This finding is supported by reduced response rates to penicillin in animal treatment studies of *B. anthracis* infection. However, beta-lactamase testing of clinical isolates of *B. anthracis* is unreliable and should not be performed. If MIC susceptibility testing using CLSI methods indicates that *B. anthracis* isolates are susceptible to penicillin, amoxicillin may still be considered for prophylactic use in children and pregnant women. (References: *MMWR* 21October2001 and websites: www.cdc.gov or www.bt.cdc.gov/agent/anthrax/exposure/index.asp.)
149. The streptomycin-susceptible breakpoint is ≤ 16ug/ml when the test is incubated in CO_2 and ≤ 8ug/ml when it is incubated in air.
150. Organisms that are susceptible to tetracycline are also considered susceptible to doxycycline.

See note (53) above.

Helicobacter pylori

151. These interpretive criteria presume that clarithromycin will be used in an FDA-approved regimen that includes a proton-pump inhibitor or an H_2 antagonist (these treatments include omeprazole, lansoprazole, or ranitidine bismuth citrate).

Notes for Quality Control Strains - used to Monitor Accuracy of Disk Diffusion Testing of Non-fastidious and Fastidious Microrganisms (using Mueller Hinton Medium without blood or other supplements)

i. ATCC is a registered trademark of the American Type Culture Collection.

ii. When disk approximation tests are performed with erythromycin and clindamycin, *S. aureus* ATCC® BAA-977 (containing inducible *ermA*-mediated resistance) and *S. aureus* ATCC® BAA-976 (containing *msrA*-mediated macrolide-only efflux) are recommended as supplemental QC strains (e.g. for training, competency assessment, or test evaluation). *S. aureus* ATCC® BAA-977 should demonstrate inducible clindamycin resistance (i.e. a positive D-zone test), whereas *S. aureus* ATCC® BAA-976 should not demonstrate inducible clindamycin resistance. *S. aureus* ATCC® 25923 should be used for routine QC (e.g. weekly or daily) of erythromycin and clindamycin disks using standard MHA.

iii. For control limits of gentamicin 120-ug and streptomycin 300-ug disks, use *E. faecalis* ATCC® 29212 (gentamicin: 16-23mm; streptomycin: 14-20mm).

iv. These agents can be affected by excess levels of thymidine and thymine. See the current version of the CLSI M02 document for guidance should a problem occur with QC.

v. Despite the lack of reliable disk diffusion interpretive criteria for *S. pneumoniae* with certain beta-lactams, *Streptococcus pneumoniae* ATCC® 49619 is the strain designated for QC of all disk diffusion tests with all *Streptococcus* spp.

vi. When testing *Haemophilus* on HTM, the acceptable limits for QC strain *E. coli* ATCC® 35218 are 17 to 22mm for amoxicillin-clavulanic acid when incubated in ambient air.

vii. Deterioration in oxacillin disk content is best assessed with QC organism *S. aureus* ATCC® 25923, with an acceptable zone diameter of 18 to 24mm.

viii. Some lots of Mueller Hinton agar are deficient in calcium and give small zones.

ix. Either *H. influenzae* ATCC® 49247 or 49766 may be used for routine QC testing.

x. **Because this strain may lose its plasmid**, careful organism maintenance is required; refer to the current CLSI M02 document for more information.

xi. **Ulifloxacin is the active metabolite of the prodrug prulifloxacin. Only ulifloxaxin should be used for antimicrobial susceptibility testing**.

See note (38) above.

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