CLINICAL AND LABORATORY STANDARDS INSTITUTE®

29th Edition

M100

Performance Standards for Antimicrobial Susceptibility Testing

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This document includes updated tables for the Clinical and Laboratory Standards Institute antimicrobial susceptibility testing standards M02, M07, and M11.

A CLSI supplement for global application.

M100, 29th ed.
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Replaces M100, 28th ed.

Performance Standards for Antimicrobial Susceptibility Testing

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Abstract

The data in the tables are valid only if the methodologies in CLSI documents M02,[1] M07,[2] and M11[3] are followed. These standards contain information about disk diffusion (M02[1]) and dilution (M07[2] and M11[3]) test procedures for aerobic and anaerobic bacteria. Clinicians depend heavily on information from the microbiology laboratory for treating their seriously ill patients. The clinical importance of antimicrobial susceptibility test results demands that these tests be performed under optimal conditions and that laboratories have the capability to provide results for the newest antimicrobial agents. The tables presented in M100 represent the most current information for drug selection, interpretation, and quality control using the procedures standardized in M02,[1] M07,[2] and M11.[3] Users should replace previously published tables with these new tables. Changes in the tables since the previous edition appear in boldface type.

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Overview of Changes

M100, 29th ed. replaces the previous edition of the supplement, M100, 28th ed., published in 2018. The major changes in M100, 29th ed., are listed below. Other minor or editorial changes were made to the general formatting and to some of the table footnotes and comments. Changes to the tables since the previous edition appear in boldface type. The following are additions or changes unless otherwise noted as a **"*deletion*."**

- **General:**
  - Terminology:
    - Coagulase-negative staphylococci (CoNS) designation removed in Surrogate Agent Tests table (for cefoxitin testing only), in Tables 1A, 2C, and 3E, and in direct references to these tables and replaced with language to reflect species-dependent testing recommendation
    - CoNS designation retained in all other locations for this edition of M100

- **CLSI Breakpoint Additions/Revisions Since 2010:**
  - Added:
    - Cefiderocol investigational minimal inhibitory concentration (MIC) breakpoints for *Enterobacteriaceae* (p. xxix), *Pseudomonas aeruginosa* (p. xxx), *Acinetobacter* spp. (p. xxx), and *Stenotrophomonas maltophilia* (p. xxx)
    - Meropenem-vaborbactam disk diffusion and MIC breakpoints for *Enterobacteriaceae* (p. xxix)
    - Azithromycin susceptible-only MIC breakpoint for *Neisseria gonorrhoeae* (p. xxxi)

  - Revised:
    - Ciprofloxacin disk diffusion and MIC breakpoints for *Enterobacteriaceae* (p. xxix) and *P. aeruginosa* (p. xxx)
    - Levofloxacin disk diffusion and MIC breakpoints for *Enterobacteriaceae* (p. xxix) and *P. aeruginosa* (p. xxx)
    - Ceftaroline disk diffusion and MIC breakpoints for *Staphylococcus aureus* (p. xxx)
    - Daptomycin MIC breakpoints for *Enterococcus* spp. (p. xxx)

- **CLSI Epidemiological Cutoff Value Additions/Revisions Since 2015:**
  - ***Deleted*** azithromycin epidemiological cutoff value (ECV) for *N. gonorrhoeae* (now assigned a breakpoint in Table 2F)

- **CLSI Archived Resources:**
  - Updated the Web address for the archived table of breakpoints eliminated from M100 since 2010 (p. xxxii)

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Overview of Changes (Continued)

- **Instructions for Use of Tables:**
  - In **Breakpoint and Interpretive Category Definitions** section, revised the susceptible-dose dependent (SDD) definition (p. 4)
  - In **Reporting Results** section, added **MIC Reporting Concentrations,** which provides revised and restated guidance for reporting MICs (previously listed in M100, 28th ed. in Table 7 only) (p. 7)

- **Routine, Supplemental, Screening, Surrogate Agent, and Equivalent Agent Testing to Determine Susceptibility and Resistance to Antimicrobial Agents:**
  - In **Surrogate Agent Tests** table:
    - Changed *Klebsiella* spp. to *Klebsiella pneumoniae* in the list of organisms for testing cefazolin (p. 12)
    - Revised the list of organisms for testing cefoxitin and the **NOTE** regarding overcalling of resistance when testing for oxacillin MICs (p. 12)
    - Added colistin as a surrogate for polymyxin B when testing *Enterobacteriaceae, P. aeruginosa,* and *Acinetobacter baumannii* complex (p. 12)

- **Table 1A. Suggested Groupings of Antimicrobial Agents Approved by the US Food and Drug Administration for Clinical Use That Should Be Considered for Testing and Reporting on Nonfastidious Organisms by Microbiology Laboratories in the United States:**
  - *Enterobacteriaceae:*
    - Added meropenem-vaborbactam to group B (p. 18)
    - Relocated to its own box:
      - Ceftazidime-avibactam (p. 18)
      - Ceftolozane-tazobactam (p. 18)
      - Piperacillin-tazobactam (p. 18)
  - *Pseudomonas aeruginosa:*
    - Relocated to its own box:
      - Ceftazidime-avibactam (p. 18)
      - Ceftolozane-tazobactam (p. 18)
  - Revised the footnote regarding MIC testing for *Staphylococcus* spp. (p. 18)

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Overview of Changes (Continued)

- **Table 1B. Suggested Groupings of Antimicrobial Agents Approved by the US Food and Drug Administration for Clinical Use That Should Be Considered for Testing and Reporting on Fastidious Organisms by Microbiology Laboratories in the United States:**
  - *N. gonorrhoeae:*
    - Added azithromycin to group A (p. 24)
  - Added dirithromycin to general footnote (a) (p. 24)
  - *Streptococcus* spp. β-hemolytic group:
    - Relocated dalbavancin, oritavancin, and telavancin to a single box in group C (p. 25)
- **Table 1C. Suggested Groupings of Antimicrobial Agents Approved by the US Food and Drug Administration for Clinical Use That Should Be Considered for Testing and Reporting on Anaerobic Organisms by Microbiology Laboratories in the United States:**
  - Updated:
    - Nomenclature in the *Bacteroides fragilis* group column heading to "Gram-Negative Anaerobes" (p. 30)
    - Nomenclature in **NOTE 2** from *B. fragilis* group to *Bacteroides* spp. and *Parabacteroides* spp. (p. 31)
- **Table 2A. Zone Diameter and MIC Breakpoints for *Enterobacteriaceae:***
  - Added:
    - Instructions for performing MIC testing for ceftazidime-avibactam with specific disk diffusion zone diameters (p. 33)
    - Disk diffusion and MIC breakpoints and a dosage regimen for meropenem-vaborbactam (p. 33)
    - Investigational MIC breakpoints, a dosage regimen, and a comment regarding special media needed for testing cefiderocol (p. 36)
  - Clarified carbapenems section comment (p. 37)
  - Revised:
    - Ciprofloxacin disk diffusion and MIC breakpoints and added a dosage regimen for the revised breakpoints (p. 38)
    - Levofloxacin disk diffusion and MIC breakpoints and added a dosage regimen for the revised breakpoints (p. 38)
  - Reinforced the reporting comments that fosfomycin testing recommendations and breakpoints are for *E. coli* urinary tract isolates only (p. 40)
  - ***Deleted*** disk diffusion and MIC breakpoints for norfloxacin

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Overview of Changes (Continued)

- **Table 2B-1. Zone Diameter and MIC Breakpoints for *Pseudomonas aeruginosa:***
  - Added:
    - Investigational MIC breakpoints, a dosage regimen, and a comment regarding special media needed for testing cefiderocol (p. 43)
    - Comment regarding the use of colistin as a surrogate for testing and reporting polymyxin B (ie, colistin MICs predict polymyxin B MICs) (p. 44)
  - Revised:
    - Ciprofloxacin disk diffusion and MIC breakpoints and added a dosage regimen for the revised breakpoints (p. 44)
    - Levofloxacin disk diffusion and MIC breakpoints and added a dosage regimen for the revised breakpoints (p. 44)
  - ***Deleted*** disk diffusion and MIC breakpoints for norfloxacin
- **Table 2B-2. Zone Diameter and MIC Breakpoints for *Acinetobacter* spp.:**
  - Added:
    - Investigational MIC breakpoints, a dosage regimen, and a comment regarding special media needed for testing cefiderocol (p. 47)
    - Comment regarding the use of colistin as a surrogate for testing and reporting polymyxin B for *A. baumannii* complex (ie, colistin MICs predict polymyxin B MICs) (p. 48)
- **Table 2B-4. Zone Diameter and MIC Breakpoints for *Stenotrophomonas maltophilia:***
  - Added investigational MIC breakpoints, a dosage regimen, and a comment regarding special media needed for testing cefiderocol (p. 53)
- **Table 2B-5. MIC Breakpoints for Other Non-*Enterobacteriaceae***
  - ***Deleted*** MIC breakpoints for norfloxacin
- **Table 2C. Zone Diameter and MIC Breakpoints for *Staphylococcus* spp.:**
  - General:
    - Added a column listing the indications for specific *Staphylococcus* spp. with each agent
  - General Comments section:
    - Revised the table with the methods available for detecting oxacillin resistance for specific *Staphylococcus* spp. (p. 59)
    - Revised the comments regarding reporting oxacillin resistance results (p. 59)

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Overview of Changes (Continued)

- Oxacillin:
  - Added:
    - Comment regarding the reliability of cefoxitin MIC testing for detecting *mecA*-mediated resistance in *Staphylococcus epidermidis* (p. 62)
    - Breakpoints specific for *S. epidermidis* (p. 62)
  - Revised:
    - The testing comment regarding *S. aureus* and *Staphylococcus lugdunensis* that grow poorly on Mueller-Hinton agar or cation-adjusted Mueller-Hinton broth (p. 61)
    - The testing comment regarding overcalling oxacillin resistance for other *Staphylococcus* spp. (except *S. aureus, S. lugdunensis, S. epidermidis, Staphylococcus pseudintermedius,* and *Staphylococcus schleiferi*) (p. 62)
- Ceftaroline:
  - Added SDD interpretive category and appropriate dosage regimen (p. 63)
  - Revised zone diameter and MIC breakpoints for *S. aureus* only (including methicillin-resistant *S. aureus* [MRSA]) (p. 63)
- Telithromycin:
  - ***Deleted*** disk diffusion and MIC breakpoints for all *Staphylococcus* spp.
- Norfloxacin
  - ***Deleted*** all disk diffusion and MIC breakpoints

- **Table 2D. Zone Diameter and MIC Breakpoints for *Enterococcus* spp.:**
  - Revised susceptible MIC breakpoint and added SDD and resistant interpretive categories and dosage regimens for daptomycin (p. 70)
  - ***Deleted*** disk diffusion and MIC breakpoints for norfloxacin

- **Table 2E. Zone Diameter and MIC Breakpoints for *Haemophilus influenzae* and *Haemophilus parainfluenzae:***
  - Revised the comment providing additional guidance on results interpretation for tetracyclines (p. 76)
  - ***Deleted*** disk diffusion and MIC breakpoints for telithromycin

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Overview of Changes (Continued)

- **Table 2F. Zone Diameter and MIC Breakpoints for *Neisseria gonorrhoeae:***
  - Added a susceptible-only MIC breakpoint and dosage regimen comment for azithromycin (p. 80)

  - ***Deleted*** disk diffusion and MIC breakpoints for:
    - Cefuroxime
    - Cefmetazole
    - Ceftazidime
    - Cefetamet
    - Enoxacin
    - Fleroxacin
    - Lomefloxacin
    - Ofloxacin

- **Table 2G. Zone Diameter and MIC Breakpoints for *Streptococcus pneumoniae:***
  - Revised the comment providing additional guidance on results interpretation for tetracyclines (p. 85)
  - ***Deleted*** disk diffusion and MIC breakpoints for telithromycin

- **Table 2H-1. Zone Diameter and MIC Breakpoints for *Streptococcus* spp. β-Hemolytic Group:**
  - Revised:
    - Comment providing additional guidance on results interpretation for tetracyclines (p. 90)

- **Table 2H-2. Zone Diameter and MIC Breakpoints for *Streptococcus* spp. Viridans Group:**
  - Revised:
    - Comment clarifying viridans streptococcal groups for which dalbavancin testing is appropriate (p. 93)
    - Comment providing additional guidance on results interpretation for tetracyclines (p. 94)

- **Table 2J. MIC Breakpoints for Anaerobes:**
  - Updated nomenclature from *Bacteroides fragilis* group to *Bacteroides* spp. and *Parabacteroides* spp. throughout the table and comments
  - Revised the comment regarding intrinsic resistance to ampicillin and penicillin (p. 101)

- **Introduction to Tables 3B and 3C. Tests for Carbapenemases in *Enterobacteriaceae* and *Pseudomonas aeruginosa:***
  - Revised the paragraph regarding the use of MIC breakpoints for carbapenems described in M100-S20 (p. 108)

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Overview of Changes (Continued)

- **Table 3E. Test for Detecting Methicillin (Oxacillin) Resistance in *Staphylococcus* spp.:**
  - Revised:
    - Table title and first column heading
    - CoNS designation to other *Staphylococcus* spp. (excluding *S. pseudintermedius* and *S. schleiferi*)

- **Table 4A-1. Disk Diffusion QC Ranges for Nonfastidious Organisms and Antimicrobial Agents Excluding β-Lactam Combination Agents:**
  - Added:
    - Footnote regarding the use of *K. pneumoniae* ATCC® 700603 as a supplemental QC strain with imipenem and tebipenem (p. 151)
    - Footnote with recommendations for reading zones of inhibition for *S. aureus* ATCC® 25923 with linezolid (p. 151)
    - *E. coli* ATCC® 25922 and *P. aeruginosa* ATCC® 27853 QC ranges for tebipenem (p. 152)

  - ***Deleted*** all QC ranges for:
    - Methicillin
    - Mezlocillin
    - Norfloxacin

- **Table 4A-2. Disk Diffusion QC Ranges for Nonfastidious Organisms and β-Lactam Combination Agents:**
  - Added:
    - *A. baumannii* NCTC 13304 as a QC strain
    - Footnote regarding use of data from a single disk manufacturer to establish QC ranges for imipenem-relebactam (p. 154)

  - Added QC ranges for:
    - *E. coli* ATCC® 25922
      - Cefepime-zidebactam
      - Imipenem-relebactam

    - *P. aeruginosa* ATCC® 27853
      - Cefepime-zidebactam
      - Imipenem-relebactam

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Overview of Changes (Continued)

- *K. pneumoniae* ATCC® 700603
  - Cefepime
  - Cefepime-zidebactam
  - Imipenem
  - Imipenem-relebactam

- *E. coli* NCTC 13353
  - Cefepime
  - Cefepime-zidebactam

- *K. pneumoniae* ATCC® BAA-1705™
  - Imipenem
  - Imipenem-relebactam

- *K. pneumoniae* ATCC® BAA-2814™
  - Imipenem
  - Imipenem-relebactam

- *A. baumannii* NCTC 13304
  - Cefepime
  - Cefepime-zidebactam

- **Table 4B. Disk Diffusion QC Ranges for Fastidious Organisms:**
  - Added *N. gonorrhoeae* ATCC® 49226 QC ranges for azithromycin and gepotidacin
  - ***Deleted*** all QC ranges for norfloxacin

- **Table 4D. Disk Diffusion Troubleshooting Guide:**
  - Revised general comment (1) and various agent observations (pp. 164, 166)
  - Added troubleshooting recommendations for cefepime and imipenem (p. 164)
  - ***Deleted*** single-agent rows for β-lactam antimicrobial agents and replaced with troubleshooting recommendations for β-lactam combination agents

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Overview of Changes (Continued)

- **Table 5A-1. MIC QC Ranges for Nonfastidious Organisms and Antimicrobial Agents Excluding β-Lactam Combination Agents:**
  - Added:
    - *P. aeruginosa* ATCC® 27853 QC ranges for meropenem
    - QC ranges for tebipenem
  - Revised:
    - Footnote regarding special media required for testing cefiderocol
    - *P. aeruginosa* ATCC® 27853 QC range for ciprofloxacin
  - ***Deleted*** all QC ranges for:
    - Methicillin
    - Mezlocillin
    - Norfloxacin
- **Table 5A-2. MIC QC Ranges for Nonfastidious Organisms and β-Lactam Combination Agents:**
  - Added QC ranges for:
    - *E. coli* ATCC® 25922:
      - Meropenem-nacubactam
      - Nacubactam
    - *P. aeruginosa* ATCC® 27853:
      - Meropenem-nacubactam
      - Nacubactam
    - *E. coli* ATCC® 35218:
      - Cefpodoxime
    - *K. pneumoniae* ATCC® 700603:
      - Cefpodoxime
    - *E. coli* NCTC 13353:
      - Cefpodoxime

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  - *K. pneumoniae* ATCC® BAA-2814™:
    - Meropenem-nacubactam
    - Nacubactam

- Revised QC ranges for:
  - *E. coli* ATCC® 35218
    - Cefepime

  - *E. coli* NCTC 13353
    - Cefepime

- **Table 5B. MIC QC Ranges for Fastidious Organisms (Broth Dilution Methods):**
  - ***Deleted*** all QC ranges for norfloxacin

- **Table 5D. MIC QC Ranges for Anaerobes (Agar Dilution Method):**
  - ***Deleted*** all QC ranges for mezlocillin

- **Table 5G. MIC Troubleshooting Guide:**
  - Revised general comment (1) and various agent observations (p. 190)

  - ***Deleted*** single-agent rows for β-lactam antimicrobial agents and replaced with troubleshooting recommendations for combination β-lactam agents

- **Table 6A. Solvents and Diluents for Preparing Stock Solutions of Antimicrobial Agents:**
  - Added solvent and diluent information for:
    - Nacubactam
    - Tebipenem
    - Zidebactam

  - ***Deleted*** solvent and diluent information for:
    - Methicillin
    - Mezlocillin
    - Norfloxacin

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Overview of Changes (Continued)

- **Table 6C. Preparing Solutions and Media Containing Combinations of Antimicrobial Agents:**
  - Added preparation instructions for meropenem-nacubactam

- **Appendix A. Suggestions for Confirming Resistant, Intermediate, or Nonsusceptible Antimicrobial Susceptibility Test Results and Organism Identification:**
  - Added azithromycin nonsusceptible (NS) for resistance phenotype detected to *N. gonorrhoeae* (p. 213)
  - Updated nomenclature from *Bacteroides fragilis* group to *Bacteroides* spp. and *Parabacteroides* spp. (p. 215)

- **Appendix B. Intrinsic Resistance:**
  - **B1. *Enterobacteriaceae*** (p. 219):
    - Added:
      - *Citrobacter amalonaticus* group to the *Citrobacter koseri* row with same "R" results and a footnote listing the species included in this group
      - *Klebsiella oxytoca* and *Klebsiella variicola* to the *K. pneumoniae* row with same "R" results
      - *Raoultella* spp., with a footnote listing the species included in this group

  - **B2. Non-*Enterobactericeae:***
    - Added a footnote regarding intrinsic resistance in *Burkholderia cepacia* complex (p. 221)

    - ***Deleted*** the footnote for ampicillin-sulbactam that suggested sulbactam may have activity against isolates in *A. baumannii/ A. calcoaceticus* complex

    - ***Deleted*** "R" results for the following agents for *B. cepacia* complex:
      - Aminoglycosides
      - Aztreonam
      - Cefepime
      - Cefotaxime
      - Ceftriaxone
      - Imipenem
      - Piperacillin-tazobactam
      - Trimethoprim

- **Appendix C. QC Strains for Antimicrobial Susceptibility Tests:**
  - Added *K. pneumoniae* ATCC® BAA-2146™ (p. 227)

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Overview of Changes (Continued)

- **Appendix D. Cumulative Antimicrobial Susceptibility Report for Anaerobic Organisms:**
  - General:
    - Updated the nomenclature from *Bacteroides fragilis* group to *Bacteroides* spp. and *Parabacteroides* spp. throughout Appendix D
  - **D1. *Bacteroides* spp. and *Parabacteroides* spp.:**
    - ***Deleted*** rows for *Bacteroides fragilis* group without *B. fragilis* and with all six species and all agents
  - **D2. Anaerobic Organisms Other Than *Bacteroides* spp. and *Parabacteroides* spp.:**
    - Added footnote regarding antibiogram data collection for *Cutibacterium* (formerly *Propionibacterium*) *acnes* (p. 234)
    - ***Deleted*** rows for *Bacteroides fragilis* group without *B. fragilis* and with all six species and all agents

- **Appendix E. Dosage Regimens Used to Establish Susceptible or Susceptible-Dose Dependent Breakpoints:**
  - Added dosage regimens used to establish susceptible and/or SDD breakpoints for:
    - Cefiderocol (pp. 238–239)
    - Ciprofloxacin (pp. 238–239)
    - Levofloxacin (pp. 238–239)
    - Meropenem-vaborbactam (pp. 238–239)
    - Ceftaroline (p. 239)
    - Daptomycin (p. 240)

- **Appendix F. Susceptible-Dose Dependent Interpretive Category:**
  - Revised to provide recommendations for all antimicrobial agents with SDD interpretive categories

- **Appendix G. Epidemiological Cutoff Values:**
  - Added a comment in Table G1 regarding the use of colistin as a surrogate for testing and reporting polymyxin B (p. 249)
  - ***Deleted*** Table G2 (ECVs for *N. gonorrhoeae*); Table G3 (ECVs for Specific Anaerobic Species) is now Table G2

- **Appendix H. Using Molecular Assays for Resistance Detection:**
  - Added new appendix with tables previously located on the CLSI website only:
    - Table H1. Strategies for Reporting Methicillin (Oxacillin) Results When Using Molecular and Phenotypic AST Methods for *S. aureus*
    - Table H2. Strategies for Reporting Vancomycin Results When Using Molecular and Phenotypic Antimicrobial Susceptibility Testing Methods for *Enterococcus* spp.
    - Table H3. Reporting Results From Extended-Spectrum β-Lactamase and Carbapenemase Molecular Tests for *Enterobacteriaceae*

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Overview of Changes (Continued)

- **Glossary I (Part 1). β-Lactams: Class and Subclass Designations and Generic Name:**
  - Added:
    - Meropenem-nacubactam
    - Tebipenem
  - ***Deleted:***
    - Methicillin
    - Mezlocillin
- **Glossary I (Part 2). Non–β-Lactams: Class and Subclass Designations and Generic Name:**
  - ***Deleted*** norfloxacin
- **Glossary II. Antimicrobial Agent Abbreviation(s), Route(s) of Administration, and Drug Class:**
  - Added:
    - Abbreviation for imipenem-relebactam
    - Meropenem-nacubactam
    - Tebipenem
  - ***Deleted:***
    - Methicillin
    - Mezlocillin
    - Norfloxacin
- **Glossary III. List of Identical Abbreviations Used for More Than One Antimicrobial Agent in US Diagnostic Products:**
  - ***Deleted*** SC row because methicillin is no longer available, negating the use of an abbreviation for two agents

NOTE: The content of this document is supported by the CLSI consensus process and does not necessarily reflect the views of any single individual or organization.

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Instructions for Use of Tables

These instructions apply to:

- **Tables 1A and 1B:** suggested groupings of antimicrobial agents that should be considered for testing and reporting by microbiology laboratories. These guidelines are based on antimicrobial agents approved by the US Food and Drug Administration (FDA) for clinical use in the United States. In other countries, placement of antimicrobial agents in Tables 1A and 1B should be based on available drugs approved for clinical use by relevant regulatory organizations.

- **Tables 2A through 2I:** tables for each organism group that contain:
  - Recommended testing conditions
  - Routine QC recommendations (also see Chapter 4 in M02[1] and M07[2])
  - General comments for testing the organism group and specific comments for testing particular agent/organism combinations
  - Suggested agents that should be considered for routine testing and reporting by medical microbiology laboratories, as specified in Tables 1A and 1B (test/report groups A, B, C, U)
  - Additional drugs that have an approved indication for the respective organism group but would generally not warrant routine testing by a medical microbiology laboratory in the United States (test/report group O for "other"; test/report group Inv. for "investigational" [not yet FDA approved])
  - Zone diameter and minimal inhibitory concentration (MIC) breakpoints

- **Tables 1C and 2J:** tables containing specific recommendations for testing and reporting results on anaerobes and some of the information listed in the bullets above

- **Tables 3A to 3I:** tables describing tests to detect particular resistance types in specific organisms or organism groups

I. Selecting Antimicrobial Agents for Testing and Reporting

A. Selecting the most appropriate antimicrobial agents to test and report is a decision best made by each laboratory in consultation with the infectious diseases and pharmacy practitioners, the pharmacy and therapeutics and infection control committees of the medical staff, and the antimicrobial stewardship team. The recommendations for each organism group include agents of proven efficacy that show acceptable *in vitro* test performance. Considerations in the assignment of agents to specific test/report groups include clinical efficacy, prevalence of resistance, minimizing emergence of resistance, cost, FDA clinical indications for use, and current consensus recommendations for first-choice and alternative drugs. Tests on selected agents may be useful for infection control purposes.

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B. Drugs listed together in a single box are agents for which interpretive categories (susceptible, intermediate, or resistant) and clinical efficacy are similar. Within each box, an "or" between agents indicates agents for which cross-resistance and cross-susceptibility are nearly complete. Results from one agent connected by an "or" can be used to predict results for the other agent. For example, *Enterobacteriaceae* susceptible to cefotaxime can be considered susceptible to ceftriaxone. The results obtained from testing cefotaxime could be reported along with a comment that the isolate is also susceptible to ceftriaxone. For drugs connected with an "or," combined major and very major errors are fewer than 3%, and minor errors are fewer than 10%, based on a large population of bacteria tested (see CLSI document M23[4] for description of error types). In addition, to qualify for an "or," at least 100 strains with resistance to the agents in question must be tested, and a result of "resistant" must be obtained with all agents for at least 95% of the strains. "Or" is also used for comparable agents when tested against organisms for which "susceptible-only" breakpoints are provided (eg, cefotaxime or ceftriaxone with *H. influenzae*). When no "or" connects agents within a box, testing of one agent cannot be used to predict results for another, owing either to discrepancies or insufficient data.

C. Test/Report Groups

1. **Group A antimicrobial agents,** as listed in Tables 1A, 1B, and 1C, are considered appropriate for inclusion in a routine, primary testing panel, as well as for routine reporting of results for the specific organism groups.

2. **Group B** includes antimicrobial agents that may warrant primary testing, but they may be reported only selectively, such as when the organism is resistant to agents of the same antimicrobial class, as in group A. Other indications for reporting the result might include a selected specimen source (eg, a third-generation cephalosporin for enteric bacilli from CSF or trimethoprim-sulfamethoxazole for urinary tract isolates); a polymicrobial infection; infections involving multiple sites; cases of patient allergy, intolerance, or failure to respond to an antimicrobial agent in group A; or for infection control purposes.

3. **Group C** includes alternative or supplemental antimicrobial agents that may necessitate testing in those institutions that harbor endemic or epidemic strains resistant to several of the primary drugs (especially in the same class, eg, β-lactams); for treatment of patients allergic to primary drugs; for treatment of unusual organisms (eg, chloramphenicol for extraintestinal isolates of *Salmonella* spp.); or for reporting to infection control as an epidemiological aid.

4. **Group U ("urine")** includes certain antimicrobial agents (eg, nitrofurantoin and certain quinolones) that are used only or primarily for treating UTIs. These agents should not be routinely reported against pathogens recovered from other infection sites. An exception to this rule is for *Enterobacteriaceae* in Table 1A, in which cefazolin is listed as a surrogate agent for oral cephalosporins. Other antimicrobial agents with broader indications may be included in group U for specific urinary pathogens (eg, *Enterococcus* and ciprofloxacin).

5. **Group O ("other")** includes antimicrobial agents that have a clinical indication for the organism group but are generally not candidates for routine testing and reporting in the United States.

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Table 1B. Suggested Groupings of Antimicrobial Agents Approved by the US Food and Drug Administration for Clinical Use That Should Be Considered for Testing and Reporting on Fastidious Organisms by Microbiology Laboratories in the United States

	Haemophilus influenzae[d] and *Haemophilus parainfluenzae*	*Neisseria gonorrhoeae*[i]	*Streptococcus pneumoniae*[j]	*Streptococcus* spp. β-Hemolytic Group[p]	*Streptococcus* spp. Viridans Group[p]
GROUP A PRIMARY TEST AND REPORT	Ampicillin[d,f]	**Azithromycin**[*,†]	Erythromycin[a,c]	Clindamycin[c,o]	Ampicillin[m,*] Penicillin[m,*]
		Ceftriaxone[†] Cefixime[†]			
		Ciprofloxacin[†]	Penicillin[k] (oxacillin disk)	Erythromycin[a,c,o]	
		Tetracycline[b,†]		Penicillin[n,†] or ampicillin[n,†]	
			Trimethoprim-sulfamethoxazole		
GROUP B OPTIONAL PRIMARY TEST REPORT SELECTIVELY	Ampicillin-sulbactam		Cefepime[*] Cefotaxime[k,*] Ceftriaxone[k,*]	Cefepime or cefotaxime or ceftriaxone	Cefepime Cefotaxime Ceftriaxone
	Cefotaxime[d] or ceftazidime[d] or ceftriaxone[d]		Clindamycin[c]	Vancomycin	Vancomycin
			Doxycycline		
	Ciprofloxacin or levofloxacin or moxifloxacin		Levofloxacin[j] Moxifloxacin[j]		
			Meropenem[k,*]		
	Meropenem[d]		Tetracycline[b]		
			Vancomycin[k]		

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Table 2B-1. Zone Diameter and MIC Breakpoints for *Pseudomonas aeruginosa*

Testing Conditions

Medium: Disk diffusion: MHA
Broth dilution: CAMHB;
For cefiderocol, special media is required for testing. See comment (13).
Agar dilution: MHA

Inoculum: Broth culture method or colony suspension, equivalent to a 0.5 McFarland standard

Incubation: 35°C ± 2°C; ambient air
Disk diffusion: 16–18 hours
Dilution methods: 16–20 hours

Routine QC Recommendations (see Tables 4A-1 and 5A-1 for acceptable QC ranges)

Pseudomonas aeruginosa ATCC®* 27853

Refer to Tables 4A-2 and 5A-2 to select strains for routine QC of β-lactam combination agents.

When a commercial test system is used for susceptibility testing, refer to the manufacturer's instructions for QC test recommendations and QC ranges.

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

General Comments

(1) For disk diffusion, test a maximum of 12 disks on a 150-mm plate and no more than 6 disks on a 100-mm plate; disks should be placed no less than 24 mm apart, center to center (see M02,[1] Subchapter 3.6). Each zone diameter should be clearly measurable; overlapping zones prevent accurate measurement. 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 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.

(2) The susceptibility of *P. aeruginosa* isolated from patients with cystic fibrosis can be reliably determined by disk diffusion or dilution methods but may need extended incubation for up to 24 hours before reporting as susceptible.

(3) *P. aeruginosa* may develop resistance during prolonged therapy with all antimicrobial agents. Therefore, isolates that are initially susceptible may become resistant within 3 to 4 days after initiation of therapy. Testing of repeat isolates may be warranted.

(4) The dosage regimens shown in the comments column below are those necessary to achieve plasma drug exposures (in adults with normal renal and hepatic functions) on which breakpoints were derived. When implementing new breakpoints, it is strongly recommended that laboratories share this information with infectious diseases practitioners, pharmacists, pharmacy and therapeutics committees, infection control committees, and the antimicrobial stewardship team.

NOTE: Information in boldface type is new or modified since the previous edition.

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