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

Testing Conditions

Medium: Disk diffusion: MHA
Broth dilution: CAMHB; iron-depleted CAMHB for cefiderocol (see Appendix I)[1]
Agar dilution: MHA

Inoculum: Broth culture method or colony suspension, equivalent to a 0.5 McFarland standard; positive blood culture broth for select antimicrobial agents with disk diffusion (see general comment [7]).

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®[a] 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.

General Comments

(1) Refer to Table 1C for antimicrobial agents that should be considered for testing and reporting by microbiology laboratories.

(2) 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,[2] 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 (see the *M02 Disk Diffusion Reading Guide*[3]). 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.

(3) 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.

(4) *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.

(5) 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 the antimicrobial stewardship team **and other relevant institutional stakeholders.**

(6) An intermediate (I) with a ^ in Tables 2 indicates agents that have the potential to concentrate in the urine. The I^ is for informational use only. The decision to report I^ is best made by each laboratory based on institution-specific guidelines and in consultation with appropriate medical personnel.

Table 2B-1. *Pseudomonas aeruginosa* (Continued)

(7) Positive blood culture broth can be used as the inoculum for direct disk diffusion testing of select antimicrobial agents against *P. aeruginosa* (using methods described in Table 3E-1 and applying breakpoints in Table 3E-3). For antimicrobial agents not listed in Table 3E-3 for *P. aeruginosa*, CLSI has not yet evaluated this direct disk diffusion method.

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

Table 2B-1. *Pseudomonas aeruginosa* (Continued)

Antimicrobial Agent	Disk Content	Interpretive Categories and Zone Diameter Breakpoints, nearest whole mm			Interpretive Categories and MIC Breakpoints, µg/mL			Comments
		S	I	R	S	I	R	
PENICILLINS								
Piperacillin*	100 µg	**≥22**	**18-21^**	**≤17**	≤16	**32^**	**≥64**	**(8)** Breakpoints for piperacillin (alone or with tazobactam) are based on a piperacillin dosage regimen of **4 g administered every 6 h over 30 minutes or over 3 h.**
β-LACTAM COMBINATION AGENTS								
(9) Organisms that test susceptible to the β-lactam agent alone are also considered susceptible to the β-lactam combination agent. However, organisms that test susceptible to the β-lactam combination agent cannot be assumed to be susceptible to the β-lactam agent alone. Similarly, organisms that test intermediate or resistant to the β-lactam agent alone may be susceptible to the β-lactam combination agent.								
Piperacillin-tazobactam	100/10 µg	**≥22**	**18-21^**	**≤17**	≤16/4	**32/4**	**≥64**/4	**(10) Breakpoints for susceptible are based on a dosage regimen of 4.5 g administered every 6 h over 30 minutes or over 3 h. Breakpoints for intermediate are only to provide a buffer zone to prevent small uncontrolled technical factors from causing major discrepancies in interpretations.**
Ceftazidime-avibactam	30/20 µg	≥21	-	≤20	≤8/4	-	≥16/4	**(11)** Breakpoints are based on a dosage regimen of 2.5 g administered every 8 h over 2 h.
Ceftolozane-tazobactam	30/10 µg	≥21	17-20^	≤16	≤4/4	8/4^	≥16/4	**(12)** Breakpoints are based on a dosage regimen of 3 g administered every 8 h for pneumonia and 1.5 g administered every 8 h for other indications.
Imipenem-relebactam	10/25 µg	≥23	20-22^	≤19	≤2/4	4/4^	≥8/4	**(13)** Breakpoints are based on a dosage regimen of 1.25 g administered every 6 h.
Ticarcillin-clavulanate*	75/10 µg	≥24	16-23^	≤15	≤16/2	32/2-64/2^	≥128/2	**(14)** Breakpoints for ticarcillin (alone or with clavulanate) are based on a ticarcillin dosage regimen of at least 3 g administered every 6 h.
CEPHEMS (PARENTERAL) (Including cephalosporins I, II, III, and IV. Please refer to Glossary I.)								
Ceftazidime	30 µg	≥18	15-17^	≤14	≤8	16^	≥32	**(15)** Breakpoints are based on a dosage regimen of 1 g administered every 6 h or 2 g administered every 8 h.
Cefepime	30 µg	≥18	15-17^	≤14	≤8	16^	≥32	**(16)** Breakpoints are based on a dosage regimen of 1 g administered every 8 h or 2 g administered every 12 h.
Cefiderocol	30 µg	≥18	13-17^	≤12	≤4	8^	≥16	**(17)** Breakpoints are based on a dosage regimen of 2 g every 8 h administered over 3 h. **(18) The accuracy and reproducibility of cefiderocol testing results by disk diffusion and broth microdilution are markedly affected by iron concentration and inoculum preparation and may vary by disk and media manufacturer. Depending on the type of variance observed, false-resistant or false-susceptible results may occur. Testing subsequent isolates is encouraged. Discussion with prescribers and antimicrobial stewardship members regarding the potential for inaccuracies is recommended.**

Table 2B-1. *Pseudomonas aeruginosa* (Continued)

Antimicrobial Agent	Disk Content	Interpretive Categories and Zone Diameter Breakpoints, nearest whole mm			Interpretive Categories and MIC Breakpoints, µg/mL			Comments
		S	I	R	S	I	R	
MONOBACTAMS								
Aztreonam	30 µg	≥22	16-21^	≤15	≤8	16^	≥32	**(19)** Breakpoints are based on a dosage regimen of 1 g administered every 6 h or 2 g administered every 8 h.
CARBAPENEMS								
Doripenem*	10 µg	≥19	16-18^	≤15	≤2	4^	≥8	**(20)** Breakpoints for doripenem are based on a dosage regimen of 500 mg administered every 8 h.
Imipenem	10 µg	≥19	16-18^	≤15	≤2	4^	≥8	**(21)** Breakpoints for imipenem are based on a dosage regimen of 1 g administered every 8 h or 500 mg administered every 6 h.
Meropenem	10 µg	≥19	16-18^	≤15	≤2	4^	≥8	**(22)** Breakpoints for meropenem are based on a dosage regimen of 1 g administered every 8 h.
LIPOPEPTIDES								
(23) WARNING: Clinical and PK/PD data demonstrate colistin and polymyxin B have limited clinical efficacy, even if an intermediate result is obtained. Alternative agents are strongly preferred. Colistin and polymyxin B should be used in combination with one or more active antimicrobial agents. Consultation with an infectious diseases specialist is recommended.								
Colistin or polymyxin B*	- -	- -	- -	- -	- -	≤2 ≤2	≥4 ≥4	**(24)** Colistin (methanesulfonate) should be given with a loading dose and maximum renally adjusted doses (see International Consensus Guidelines[4]). **(25)** Polymyxin B should be given with a loading dose and maximum recommended doses (see International Consensus Guidelines[4]). **(26)** When colistin or polymyxin B is given systemically, neither is likely to be effective for pneumonia. **(27)** For colistin, broth microdilution, CBDE, and CAT MIC methods are acceptable. For polymyxin B, broth microdilution is the only approved method. Disk diffusion and gradient diffusion methods should not be performed (see Table 3D).

Table 2B-1. *Pseudomonas aeruginosa* (Continued)

Antimicrobial Agent	Disk Content	Interpretive Categories and Zone Diameter Breakpoints, nearest whole mm			Interpretive Categories and MIC Breakpoints, µg/mL			Comments
		S	I	R	S	I	R	
AMINOGLYCOSIDES								
(28) Breakpoints for tobramycin and amikacin are based on population distributions of various species, PK/PD target attainment analyses with an end point of net bacterial stasis, and limited clinical data. Clinical outcomes data for aminoglycosides as monotherapy for systemic infections are limited and have resulted in worse treatment outcomes (for infections outside of the urinary tract) compared with other therapies. Combination therapy for most indications other than urinary tract infections should be considered. Consultation with an infectious diseases specialist is recommended.								
Tobramycin	10 µg	**≥19**	13-**18**^	≤12	**≤1**	**2**^	≥**4**	**(29) Breakpoints are based on a dosage regimen of 7 mg/kg parenterally administered every 24 h.** **(30) Tobramycin does not predict susceptibility to gentamicin.**
Amikacin **(U)**[b]	30 µg	≥17	15-16^	≤14	≤16	32^	≥64	**(31) Breakpoints are based on a dosage regimen of 15 mg/kg parenterally administered every 24 h.**
Netilmicin*	30 µg	≥15	13-14^	≤12	≤8	16^	≥32	
FLUOROQUINOLONES								
Ciprofloxacin	5 µg	≥25	19-24^	≤18	≤ 0.5	1^	≥2	**(32)** Breakpoints are based on a dosage regimen of 400 mg IV administered every 8 h.
Levofloxacin	5 µg	≥22	15-21^	≤14	≤ 1	2^	≥4	**(33)** Breakpoints are based on a dosage regimen of 750 mg administered every 24 h.
Lomefloxacin* **(U)**[b]	10 µg	≥22	19-21^	≤18	≤ 2	4^	≥8	
Norfloxacin* **(U)**[b]	10 µg	≥17	13-16	≤12	≤ 4	8	≥16	
Ofloxacin*	5 µg	≥16	13-15^	≤12	≤ 2	4^	≥8	
Gatifloxacin*	5 µg	≥18	15-17^	≤14	≤ 2	4^	≥8	

Abbreviations: ATCC®, American Type Culture Collection; CAMHB, cation-adjusted Mueller-Hinton broth; CAT, colistin agar test; CBDE, colistin broth disk elution; I, intermediate; IV, intravenous; MHA, Mueller-Hinton agar; MIC, minimal inhibitory concentration; PK/PD, pharmacokinetic/pharmacodynamic; QC, quality control; R, resistant; S, susceptible; **U, urine.**
Symbols: ^, designation for agents that have the potential to concentrate in the urine; ***, designation for "Other" agents that are not included in Tables 1 but have established clinical breakpoints.**

Footnotes

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

b. Report only on organisms isolated from the urinary tract.

Table 2B-1. *Pseudomonas aeruginosa* (Continued)

References for Table 2B-1

[1] Hackel MA, Tsuji M, Yamano Y, Echols R, Karlowsky JA, Sahm DF. Reproducibility of broth microdilution MICs for the novel siderophore cephalosporin, cefiderocol, determined using iron-depleted cation-adjusted Mueller-Hinton broth. *Diagn Microbiol Infect Dis*. 2019;94(4):321-325.

[2] CLSI. *Performance Standards for Antimicrobial Disk Susceptibility Tests*. 13th ed. CLSI standard M02. Clinical and Laboratory Standards Institute; 2018.

[3] CLSI. *M02 Disk Diffusion Reading Guide*. 1st ed. CLSI quick guide M02QG. Clinical and Laboratory Standards Institute; 2018.

[4] Tsuji BT, Pogue JM, Zavascki AP, et al. International consensus guidelines for the optimal use of the polymyxins: endorsed by the American College of Clinical Pharmacy (ACCP), European Society of Clinical Microbiology and Infectious Diseases (ESCMID), Infectious Diseases Society of America (IDSA), International Society for Anti-Infective *Pharmacology* (ISAP), Society of Critical Care Medicine (SCCM), and Society of Infectious Diseases Pharmacists (SIDP). *Pharmacotherapy*. 2019;39(1):10-39.