



MTS™ Technical Sheet Gram-negative Aerobes

Enterobacterales, *Pseudomonas*, *Burkholderia*, *Acinetobacter* and *Stenotrophomonas* spp.

Specimen

Blood, Cerebrospinal Fluid, sterile sites (joint, fluids, tissues), wounds, respiratory (sputum, transtracheal aspirate) and urines.

Procedure

Medium	Mueller Hinton II Agar (ref. 10031).
Inoculum	Suspension in physiological solution to 0.5 McFarland (ref. 80400), mucoid strains: 1 McFarland (ref. 80401).
Incubation	35 ± 2°C/ ambient / 16-20 hours non-fermenters: in case of low growth at 24 hours, confirm at 48 hours.
Evaluating the results	Bactericidal drugs: interpret the MIC at complete growth inhibition including microcolonies, hazes and isolated colonies. Bacteriostatic drugs: interpret the MIC at 80% inhibition when trailing is seen.
ESBL Extended Spectrum β-Lactamases	Materials and procedure as above. Test Intensive Care Unit and critical isolates directly with MTS™ CAZ/CAL and CTX/CTL strips. For other isolates, review aztreonam, cefotaxime, ceftazidime, ceftriaxone susceptibility results and use the interpretation criteria in the latest CLSI M100-S document. Confirm ESBL suspects using both MTS™ CTX/CTL and CAZ/CAL. MTS™ FEP/FEL may be used to test strains with non-determinable (ND) CTX/CTL and CAZ/CAL results.

		Quality Control (MIC µg/mL)			CLSI INTERPRETATION MIC Criteria (µg/mL)				EUCAST INTERPRETATION MIC Criteria (µg/mL)	
		<i>E. coli</i> ATCC® 25922	<i>P. aeruginosa</i> ATCC® 27853	<i>E. coli</i> ATCC® 35218	S	SDD	I	R	S	R
AK	AMIKACIN	0.5-4	1-4							
	Enterobacterales				≤16		32	≥64		
CLSI	<i>P. aeruginosa</i>				≤16		32	≥64		
	<i>Acinetobacter</i> spp.				≤16		32	≥64		
	Other Non-Enterobacterales				≤16		32	≥64		
	Enterobacterales								≤8	>8
EUCAST	<i>Pseudomonas</i> spp.								≤16	>16
	<i>Acinetobacter</i> spp.								≤8	>8
AMS	AMPICILLIN-SULBACTAM (2/1) ¹	2-8		8-32						
	Enterobacterales				≤8		16	≥32		
CLSI	<i>Acinetobacter</i> spp.				≤8		16	≥32		
SAM	AMPICILLIN-SULBACTAM (4 µg/mL) ¹	1-4		16-128					≤8	>8
EUCAST	Enterobacterales									
ATM	AZTREONAM	0.06-0.25	2-8	0.03-0.12						
	Enterobacterales				≤4		8	≥16		
CLSI	<i>P. aeruginosa</i>				≤8		16	≥32		
	Other Non-Enterobacterales				≤8		16	≥32		
	Enterobacterales								≤1	>4
EUCAST	<i>Pseudomonas</i> spp.								≤0.001	>16
FEP	CEFEPIME	0.016-0.12	0.5-4	0.008-0.06						
	Enterobacterales				≤2	4-8	-	≥16		
CLSI	<i>P. aeruginosa</i>				≤8		16	≥32		
	<i>Acinetobacter</i> spp.				≤8		16	≥32		
	Other Non-Enterobacterales				≤8		16	≥32		
	Enterobacterales								≤1	>4
EUCAST	<i>Pseudomonas</i> spp.								≤0.001	>8
CTX	CEFOTAXIME	0.03-0.12	8-32							
	Enterobacterales				≤1		2	≥4		
CLSI	<i>Acinetobacter</i> spp.				≤8		16-32	≥64		
	Other Non-Enterobacterales				≤8		16-32	≥64		
EUCAST	Enterobacterales								≤1	>2
CAZ	CEFTAZIDIME	0.06-0.5	1-4							
	Enterobacterales				≤4		8	≥16		
	<i>P. aeruginosa</i>				≤8		16	≥32		
CLSI	<i>Acinetobacter</i> spp.				≤8		16	≥32		
	<i>B. cepacia</i>				≤8		16	≥32		
	<i>S. maltophilia</i>				≤8		16	≥32		
	Other Non-Enterobacterales				≤8		16	≥32		
	Enterobacterales								≤1	>4
EUCAST	<i>Pseudomonas</i> spp.								≤0.001	>8

		Quality Control (MIC µg/mL)			CLSI INTERPRETATION MIC Criteria (µg/mL)				EUCAST INTERPRETATION MIC Criteria (µg/mL)	
		<i>E. coli</i> ATCC® 25922	<i>P. aeruginosa</i> ATCC® 27853	<i>E. coli</i> ATCC® 35218	S	SDD	I	R	S	R
C	CHLORAMPHENICOL	2-8								
	Enterobacterales				≤8		16	≥32		
CLSI	<i>B. cepacia</i>				≤8		16	≥32		
	<i>S. maltophilia</i>				≤8		16	≥32		
	Other Non-Enterobacterales				≤8		16	≥32		
EUCAST	Enterobacterales								≤8	>8
CIP	CIPROFLOXACIN	0.004-0.016	0.12-1							
	Enterobacterales (except <i>Salmonella</i> spp.)				≤0.25		0.5	≥1		
CLSI	<i>Salmonella</i> spp.				≤0.06		0.12-0.5	1		
	<i>P. aeruginosa</i>				≤1		2	≥4		
	<i>Acinetobacter</i> spp.				≤1		2	≥4		
	Other Non-Enterobacterales				≤1		2	≥4		
EUCAST	Enterobacterales								≤0.25	>0.5
	<i>Salmonella</i> spp.								≤0.06	>0.06
	<i>Pseudomonas</i> spp.								≤0.001	>1
	<i>Acinetobacter</i> spp.								≤0.001	>1
CS	COLISTIN	0.25-2	0.5-4							
	Enterobacterales				-		2	≥4		
CLSI	<i>P. aeruginosa</i>				-		2	≥4		
	<i>Acinetobacter</i> spp.				-		2	≥4		
EUCAST	Enterobacterales								≤2	>2
	<i>Pseudomonas</i> spp.								≤2	>2
	<i>Acinetobacter</i> spp.								≤2	>2
CN	GENTAMICIN	0.25-1	0.5-2							
	Enterobacterales				≤4		8	≥16		
CLSI	<i>P. aeruginosa</i>				≤4		8	≥16		
	<i>Acinetobacter</i> spp.				≤4		8	≥16		
EUCAST	Enterobacterales								≤2	>2
	<i>Pseudomonas</i> spp.								≤4	>4
	<i>Acinetobacter</i> spp.								≤4	>4
IMI	IMIPENEM	0.06-0.25	1-4							
	Enterobacterales				≤1		2	≥4		
CLSI	<i>P. aeruginosa</i>				≤2		4	≥8		
	<i>Acinetobacter</i> spp.				≤2		4	≥8		
	Other Non-Enterobacterales				≤4		8	≥16		
EUCAST	Enterobacterales								≤2	>4
	<i>M. morgani</i> , <i>Proteus</i> spp., <i>Providencia</i> spp.								≤0.001	>4
	<i>Pseudomonas</i> spp.								≤0.001	>4
	<i>Acinetobacter</i> spp.								≤2	>4
LEV	LEVOFLOXACIN	0.008-0.06	0.5-4							
	Enterobacterales except <i>Salmonella</i> spp.				≤0.5		1	≥2		
	<i>Salmonella</i> spp.				≤0.12		0.25-1	≥2		
CLSI	<i>P. aeruginosa</i>				≤1		2	≥4		
	<i>Acinetobacter</i> spp.				≤2		4	≥8		
	<i>B. cepacia</i>				≤2		4	≥8		
	<i>S. maltophilia</i>				≤2		4	≥8		
	Other Non-Enterobacterales				≤2		4	≥8		
EUCAST	Enterobacterales								≤0.5	>1
	<i>Pseudomonas</i> spp.								≤0.001	>1
	<i>Acinetobacter</i> spp.								≤0.5	>1
MRP	MEROPENEM	0.008-0.06	0.12-1							
	Enterobacterales				≤1		2	≥4		
CLSI	<i>P. aeruginosa</i>				≤2		4	≥8		
	<i>Acinetobacter</i> spp.				≤2		4	≥8		
	Other Non-Enterobacteriaceae				≤4		8	≥16		
EUCAST	Enterobacterales								≤2	>8
	<i>Pseudomonas</i> spp.								≤2	>8

	Quality Control (MIC µg/mL)			CLSI INTERPRETATION MIC Criteria (µg/mL)				EUCAST INTERPRETATION MIC Criteria (µg/mL)	
	<i>E. coli</i> ATCC® 25922	<i>P. aeruginosa</i> ATCC® 27853	<i>E. coli</i> ATCC® 35218	S	SDD	I	R	S	R
<i>Acinetobacter</i> spp.								≤2	>8
TZP PIPERACILLIN-TAZOBACTAM (4 µg/mL) ^{1,2}	1-4	1-8	0.5-2						
CLSI Enterobacterales				≤16		32-64	≥128		
CLSI <i>P. aeruginosa</i>				≤16		32-64	≥128		
CLSI <i>Acinetobacter</i> spp.				≤16		32-64	≥128		
CLSI Other Non-Enterobacterales				≤16		32-64	≥128		
EUCAST Enterobacterales								≤8	>16
EUCAST <i>Pseudomonas</i> spp.								≤0.001	>16
PB POLYMYXIN B	0.25-2	0.5-2							
CLSI Enterobacterales				-		2	≥4		
CLSI <i>P. aeruginosa</i>				-		2	≥4		
CLSI <i>Acinetobacter</i> spp.				-		2	≥4		
TE TETRACYCLINE	0.5-2	8-32							
CLSI Enterobacterales				≤4		8	≥16		
CLSI <i>Acinetobacter</i> spp.				≤4		8	≥16		
CLSI Other Non-Enterobacterales				≤4		8	≥16		
TTC TICARCILLIN-CLAVULANIC ACID (2 µg/mL) ¹	4-16	8-32	8-32						
CLSI Enterobacterales				≤16		32-64	≥128		
CLSI <i>P. aeruginosa</i>				≤16		32-64	≥128		
CLSI <i>Acinetobacter</i> spp.				≤16		32-64	≥128		
CLSI <i>B. cepacia</i>				≤16		32-64	≥128		
CLSI <i>S. maltophilia</i>				≤16		32-64	≥128		
CLSI Other Non-Enterobacterales				≤16		32-64	≥128		
EUCAST Enterobacterales								≤8	>16
EUCAST <i>Pseudomonas</i> spp.								≤0.01	>16
SXT TRIMETHOPRIM-SULFAMETHOXAZOLE (1/19) ¹	≤0.5	8-32							
CLSI Enterobacterales				≤2		-	≥4		
CLSI <i>Acinetobacter</i> spp.				≤2		-	≥4		
CLSI <i>B. cepacia</i>				≤2		-	≥4		
CLSI <i>S. maltophilia</i>				≤2		-	≥4		
CLSI Other Non-Enterobacterales				≤2		-	≥4		
EUCAST Enterobacteriaceae								≤2	>4
EUCAST <i>S. maltophilia</i>								≤0.001	>4
EUCAST <i>Acinetobacter</i> spp.								≤2	>4

Susceptible (S), Susceptible-Dose Dependent (SDD), Intermediate (I), Resistant (R)

For several agents, EUCAST has introduced breakpoints which categorise wild-type organisms (organisms without phenotypically detectable acquired resistance mechanisms to the agent) as "Susceptible, increased exposure (I)" instead of "Susceptible, standard dosing regimen (S)"

Footnote

- Value on the MIC scale refers to the first component of the combination.
- MTS™ Piperacillin-tazobactam TZP is available in two different concentration ranges of Piperacillin, each intended for specific applications:
 - 0.016 - 256 µg/mL for determining MIC of Enterobacterales, *Pseudomonas aeruginosa* and *Acinetobacter* spp. (Ref. 921081 - 92108 - 921080)
 - 0.064 - 1024 µg/mL for determining MIC of *Haemophilus* spp. and Anaerobes (Ref. 921131 - 92113 - 921130)
 The concentration of Tazobactam is fixed at 4 µg/mL in both cases.

Disclaimer: The above table is intended for general guidance only and may not contain all the necessary information. Also reported interpretive criteria and QC MIC ranges might be out of date. Always current guidelines from CLSI and/or EUCAST should be consulted.

Examples of ANTIBIOGRAM						
	Enterobacteriaceae	Acinetobacter spp.	Burkholderia spp.	Pseudomonas spp.	Stenotrophomonas spp.	Mucoid organisms e.g. <i>Klebsiella</i> spp., <i>Enterobacter</i> spp. and <i>P. aeruginosa</i>
	140 mm petri dish	140 mm petri dish	140 mm petri dish	140 mm petri dish	140 mm petri dish	140 mm petri dish
AK	AMIKACIN	✓ or CN		✓ or CN	✓	✓
AMS	AMPICILLIN-SULBACTAM (2/1)	✓ or TTC			✓ or TTC	
ATM	AZTREONAM	✓		✓		
C	CHLORAMPHENICOL					
CIP	CIPROFLOXACIN	✓ or LEV	✓ or LEV	✓ or LEV	✓ or LEV	✓ or LEV
CS	COLISTIN					
CN	GENTAMICIN	✓ 0.016 - 256 or AK				
IMI	IMIPENEM	✓	✓ or MRP	✓ or MRP		✓
LEV	LEVOFLOXACIN		✓			
MRP	MEROPENEM		✓			
TZP	PIPERACILLIN-TAZOBACTAM (4 µg/mL)	✓		✓		✓
TTC	TICARCILLIN-CLAVULANIC ACID (2 µg/mL)					
SXT	TRIMETHOPRIM- SULFAMETHOXAZOLE (1/19)		✓		✓	
CAZ	CEFTAZIDIME		✓			✓
CTX	CEFOTAXIME					
FEP	CEFEPIME	✓ or CTX	✓ or CAZ	✓ or CAZ	✓ or CAZ	✓

	Quality Control (M.I.C. µg/mL)			Examples of ANTIBIOGRAM	
	<i>P. aeruginosa</i> ATCC® 27853 ESBL negative strain	<i>E. coli</i> ATCC® 35218 ESBL negative strain	<i>K. pneumoniae</i> ATCC® 700603 ESBL positive strain	Detection of ESBL 90 mm petri dish	Strains with ND results by CTX/CTL and CAZ/CAL 90 mm petri dish
CAZ CEFTAZIDIME ¹		≤ 0.5	≥ 8		
CAL CEFTAZIDIME + CLAV. ACID ¹		≤ 0.064	0.125-0.5		
CTX CEFOTAXIME ^{1,2}		≤ 0.25	1-4		
CTL CEFOTAXIME + CLAV. ACID ¹		0.016-0.064	0.125-1		
FEP CEFEPIME ^{1,2}	0.5-2		0.25-1		
FEL CEFEPIME + CLAV. ACID ¹	1-4		0.064-0.25		
CTX/ CTL CEFOTAXIME / CEFOTAXIME + CLAV. ACID (4 µg/mL)				✓	
CAZ/ CAL CEFTAZIDIME / CEFTAZIDIME + CLAV. ACID (4 µg/mL)				✓	
FEP/ FEL CEFEPIME / CEFEPIME + CLAV. ACID (4 µg/mL)					✓

Footnote

- MIC value below the strip range.
- Deformation of the ellipse is indicative of ESBL production even if the CTX/CTL or FEP/FEL ratio is <8.

ESBL Phenotype Interpretation

Negative	M.I.C. ratio of both CAZ/CAL and CTX/CTL	<8
Positive	M.I.C. for CTX ≥0.5 and CTX/CTL ratio	≥8 OR
Positive	M.I.C. for CAZ ≥ 1 and CAZ/CAL ratio	≥8 OR
Positive	M.I.C. for FEP/FEL	≥8
IMPORTANT Positive	"Phantom" zone or distortion of the CTX, CAZ or FEP inhibition ellipse confirms ESBL production, even if the CAZ/CAL, CTX/CTL or FEP/FEL ratio is < 8.	
Non-determinable (ND)	Off-scale results for both CTX/CTL and CAZ/CAL or one negative and the other off-scale. Strains with ND results for CTX/CTL and CAZ/CAL may be tested with FEP/FEL.	

References

- CLSI M100S. Performance Standards for Antimicrobial Susceptibility Testing. 30th Edition, 2020
- EUCAST. Breakpoint tables for interpretation of MICs and zone diameters. Version 10.0, 2020.
- Routine and extended internal quality control for MIC determination and disk diffusion as recommended by EUCAST. Version 10.0, 2020. <http://www.eucast.org>.
- CLSI M07. Methods for Dilution Antimicrobial Susceptibility Tests for Bacteria That Grow Aerobically. 11th Edition, 2018.
- EUCAST guidelines for detection of resistance mechanisms and specific resistances of clinical and/or epidemiological importance. Version 2.0, 2017.

CLSI is a trademark belonging to Clinical Laboratory and Standards Institute, Inc.

The ATCC trademark and trade name and any and all ATCC catalog numbers are trademarks of the American Type Culture Collection.

This document has been produced in part under ECDC service contracts and made available at no cost by EUCAST at no cost to the user and can be accessed on the EUCAST website: www.eucast.org. EUCAST recommendations are frequently updated and the latest versions are available at www.eucast.org.

Any other name or trademark is the property of its respective owner.

MTS™ (MIC Test Strip)
International Patent

Liofilchem®, the Liofilchem company logo and MTS logo are registered trademarks of LIOFILCHEM s.r.l.



LIOFILCHEM® s.r.l.

Via Scozia, 64026 Roseto degli Abruzzi (TE) Italy
Tel. +39 0858930745 Fax +39 0858930330 www.liofilchem.com

