

Content	Page
MTS™ Instructions For Use US: General part (valid for all FDA-cleared MTS™)	1
MTS™ Imipenem-relebactam 0.002/4-32/4 µg/mL US Supplement	4


Liofilchem® MTS™

Rx only

IVD

SUMMARY AND EXPLANATION OF THE TEST

The Liofilchem® MTS™ (MIC Test Strip) are gradient tests used to determine the minimum inhibitory concentration (MIC) of select bacteria to indicate appropriate patient treatment and for identifying resistance patterns. The MIC is the minimum inhibitory concentration of an antibiotic that will inhibit the growth of bacteria under standardized *in vitro* conditions. Broth and agar dilution MIC procedures based on two-fold serial dilutions of antibiotics are the reference methodologies; expected reproducibility of which is within ± 1 two-fold dilution (1).

PRINCIPLE OF THE METHOD

MTS™ are made of special high quality paper impregnated with a predefined concentration gradient of antibiotic, across 15 two-fold dilutions like those of a conventional MIC method. When the MTS™ is applied onto an inoculated agar surface, the preformed exponential gradient of antimicrobial agent diffuses into the agar for over an hour. After incubation, a symmetrical inhibition ellipse centered along the strip is formed. The MIC is read directly from the scale in terms of µg/mL at the point where the edge of the inhibition ellipse intersects the strip MTS™.

REAGENTS

MTS™ is supplied in 3 different packaging options (no additional reagents are included):

- The 10-test box contains 10 strips individually packed in desiccant envelopes.
- The 30-test box contains 30 strips individually packed in desiccant envelopes.
- The 100-test box contains 100 strips in a canister with a desiccant built into the lid.

This instruction sheet is available from www.liofilchem.com/MTS/US

DIRECTIONS FOR USE

Storage

Unopened foil packages and canisters: On receipt, store MTS™ at -20°C to $+8^{\circ}\text{C}$ until the given expiry date. Some MTS™ (e.g. carbapenems) should be stored frozen at -20°C . Check the drug-specific MTS™ supplement for the specific storage temperature.

Opened canisters: MTS™ in canister can be used for up to 2 months from first opening (record the date on which the canister was open) and must be stored at the label storage temperature. Before using the remaining strips, check the expiry date indicated on the packaging. Do not store near sources of heat and do not expose to excessive temperature variations.

Protect MTS™ from moisture, heat and direct exposure to strong light at all times.

Handling

Before using the MTS™ from an unopened package, visually inspect to ensure the package is intact. Do not use the strips if the package has been damaged. When removed from the refrigerator/freezer, allow the package or storage container to reach room temperature for about 30 minutes. Moisture condensing on the outer surface must evaporate completely before opening the package. Use forceps or a similar device to pick up a strip.

When using MTS™ from a canister, replace the lid immediately after use and store as outlined under STORAGE.

Precautions

The MTS™ is not classified as being hazardous according to current regulations. The MTS™ is a disposable product. The MTS™ is only for diagnostic *in vitro* use and is intended for professional use. They must be used in the laboratory by properly trained operators using approved aseptic and safety methods for pathogenic agents.

Per the FDA-Recognized Susceptibility Test Interpretive Criteria website, the safety and efficacy of antimicrobial drugs, for which antimicrobial susceptibility is tested by this AST device, may or may not have been established in adequate and well-controlled clinical trials for treating clinical infections due to microorganisms outside of those found in the indications and usage in the drug label. The clinical significance of susceptibility information in those instances is unknown. The approved labeling for specific antimicrobial drugs provides the uses for which the antimicrobial drug is approved.

Materials Required but Not Provided:

- Agar plate medium (validated by the media manufacturer for use with antimicrobial susceptibility testing, 90 or 150 mm plates)
 - Suspension medium
 - McFarland turbidity standard
 - Sterile loops, swabs (not too tightly spun), test tubes, pipettes and scissors
 - Forceps
 - Incubator ($35 \pm 2^{\circ}\text{C}$)
 - Quality control organisms
 - Additional technical information from www.liofilchem.com
- (The medium to be used as well as the inoculum suspension will depend on the organism under investigation, see the MTS™ Supplement for more information)

Inoculum Preparation

Suspend well-isolated colonies from an overnight agar plate into the suspension medium to achieve the turbidity of the recommended McFarland standard. If the inoculum concentration is correct, a confluent lawn of growth will be obtained after incubation. If insufficient growth occurs, the testing should be repeated.

McFarland turbidity standards do not guarantee the correct number of viable cells in the suspension. In order to verify that your procedure gives the correct inoculum density in terms of CFU/mL performing regular colony counts is recommended. An acceptable inoculum should give approximately $1-2 \times 10^8$ CFU/mL.

Inoculation

Dip a sterile swab in the broth culture or in a diluted form thereof and squeeze it on the wall of the test tube to eliminate excess liquid. Streak the swab over the entire sterile agar surface. Repeat this procedure by streaking 2 more times, rotating the plate approximately 60 degrees each time to ensure an even distribution of inoculum. Allow excess moisture to be absorbed so that the surface is completely dry before applying MTS™.

Use well-defined, high quality media for AST that supports good growth. The brand chosen should have good batch-to-batch reproducibility to ensure that accurate and reliable MIC values are obtained.

The agar medium should have a depth of 4.0 ± 0.5 mm, a pH of 7.3 ± 0.1 and all other quality specifications should be fulfilled. Refer to the media manufacturer's instructions for more information.

Application

Apply the strip to the agar surface with the scale facing upwards and code of the strip to the outside of the plate, pressing it with sterile forceps on the surface of the agar and ensure that whole length of the antibiotic gradient is in complete contact with the agar surface. Once applied, do not move the strip.

Incubation

Incubate the agar plates in an inverted position at the appropriate temperature, atmosphere and time. Refer to the drug-specific MTS™ Supplement for specific incubation instructions.

Reading the MIC

After the required incubation period, and only when an even lawn of growth is distinctly visible, read the MIC value where the relevant inhibition ellipse intersects the strip. Do not read the plate if the culture appears mixed or if the lawn of growth is too light or too heavy.

NOTES:

- Antimicrobial drugs can be either “-static” (e.g. bacteriostatic, fungistatic) or “-cidal” in their interactions with target organisms and this needs to be considered for determining correctly the MIC endpoint. For bactericidal drugs, e.g. beta-lactams, read the MIC at the point of complete inhibition of all growth. Haze and macrocolonies or microcolonies within 3 mm from the strip should be read as growth. For bacteriostatic drugs, e.g. trimethoprim-sulfamethoxazole, in case of trailing endpoints, read at 80% inhibition, i.e. the first point of significant inhibition as judged by the naked eye. Consult MTS30 (cidal-static technical sheet) for more information.
- Growth along the entire gradient i.e. no inhibition ellipse indicates that the value is greater than or equal to (\geq) the highest value on the scale. An inhibition ellipse that intersects below the lower end of the scale is read as less than ($<$) the lowest value. Intersection between two scale segments should be rounded up to the higher value. An MIC of 0.125 µg/mL is considered the same as 0.12 µg/mL for reporting purposes. See the appropriate MTS™ technical sheets for example specific drug-organism photographs. Also consult the MTS™ Photographic Guide.
- Excessively wet plates prior to inoculation, insufficient drying before applying strips and/or unevenly streaked surfaces may give non confluent growth or jagged ellipse edges. Repeat the test if MIC endpoints are difficult to read. In the case of uneven MIC intersections, read the higher value. Repeat the test if the discrepancy is >1 dilution.
- Occasionally, certain antimicrobial agent/microorganism combinations may give unusual results. In these cases, judgment of the MIC endpoint may be difficult for the inexperienced personnel. However, individuals can be trained through regular use of quality control strains, MTS™ reading guides and comparison with experienced personnel to correctly assess MIC endpoints.

Result Interpretation

To categorize the result according to the interpretive criteria, refer to the appropriate MTS™ product supplement for the specific antimicrobial agent interpretive criteria. Since MTS™ generates MIC values which fall between two-fold dilutions for interpretation, an MTS™ MIC value which falls between standard two-fold dilutions must be rounded up to the next standard upper two-fold value before categorization. For example a *S. aureus* vancomycin MIC of 1.5 µg/mL is reported as 2 µg/mL.

NOTES:

- As with all AST data, MTS™ results are *in vitro* values only and may provide an indication of the organism's potential *in vivo* susceptibility. The use of results to guide therapy selection must be the sole decision and responsibility of the attending physician. Their judgement should be based on the medical history and knowledge of the patient, pharmacokinetics/pharmacodynamics of the antimicrobial agent, and clinical experience in treating infections caused by the particular microbial pathogen. The drug, dose and dosing regimen must also be considered.
- For details of specific interpretive limitations and/or limitations on the clinical use of an antimicrobial agent in various therapeutic situations, please refer to the tables and footnotes of MIC interpretive standards in the latest CLSI documents.

Eliminating Used Material

After use, MTS™ and the material that comes into contact with the sample must be decontaminated and disposed of in accordance with current laboratory techniques for the decontamination and disposal of potentially infected material.

QUALITY CONTROL

To check the performance of the MTS™ result, test the quality control strain(s) as shown in the appropriate MTS™ product supplement. Patient isolate results are considered satisfactory if the quality control result(s) fall within the expected range(s). Patient isolate results should not be reported if the quality control results are outside of this stated QC range. MIC results for a QC strain that fall a half dilution below the lower QC limit should be rounded up to the next upper two-fold value which would establish QC compliance. MIC results that are a half dilution above the upper limit would be rounded up to the next upper two-fold value which would result in non-QC compliance.

LIMITATIONS

Refer to the drug-specific MTS™ Supplement.

EXPECTED VALUES

Expected results for susceptibility tests will vary based on location and institution. Organism resistance patterns will be directly related to the population of organisms at each site.








PERFORMANCE CHARACTERISTICS

Refer to the drug-specific MTS™ Supplement.

REFERENCES

1. CLSI. *Methods for Dilution Antimicrobial Susceptibility Tests for Bacteria That Grow Aerobically*. 11th ed. CLSI standard M07. Wayne, PA: Clinical and Laboratory Standards Institute; 2018.

GLOSSARY OF TERMS

	Do not reuse	LOT	Batch code		Manufacturer	IVD	<i>In vitro</i> diagnostic medical device		Upper limit of temperature
	Use by	REF	Catalog number		Contains sufficient for <n> tests		Temperature limitation		Consult instructions for use



Drug Specific Supplement for MTS™ Imipenem-relebactam

Rx only

IVD

Indications for Use/Intended Use

The MTS™ (MIC Test Strip) Imipenem-relebactam 0.002/4-32/4 µg/mL is a quantitative method intended for the *in vitro* determination of antimicrobial susceptibility of bacteria. MTS™ consists of specialized paper impregnated with a pre-defined concentration gradient of an antimicrobial agent, which is used to determine the minimum inhibitory concentration (MIC) in µg/mL of antimicrobial agents against bacteria as tested on agar media using overnight incubation and manual reading procedures. The MTS™ Imipenem-relebactam at concentrations of 0.002/4 – 32/4 µg/mL should be interpreted at 16-20 hours of incubation.

Imipenem-relebactam has been shown to be active both clinically and *in vitro* against these bacterial species according to the FDA drug approved label:

Gram-negative bacteria

Citrobacter freundii
Enterobacter cloacae
Escherichia coli
Klebsiella aerogenes
Klebsiella oxytoca
Klebsiella pneumoniae
Pseudomonas aeruginosa

Imipenem-relebactam has been shown to be active *in vitro* only against the non-fastidious bacteria listed below according to the FDA drug approved label:

Gram-negative bacteria

Citrobacter koseri

Specifications

Antibiotic code: I/R

MIC range: 0.002/4-32/4 µg/mL

Antibiotic group: Carbapenem and bicyclic diazabicyclooctane

Directions for Use

Follow the MTS™ package insert instructions.

Procedures specific to MTS™ Imipenem-relebactam:

Storage	Temperature at –20°C
Organism	<i>Enterobacteriaceae</i> , <i>Pseudomonas aeruginosa</i>
Medium	Mueller Hinton Agar
Inoculum	Suspension in saline (0.85% NaCl) to 0.5 McFarland standard (1 if mucoid)
Incubation	Agar plates in inverted position at 35 ± 2°C for 16-20 hours in ambient atmosphere
Reading	Interpret the MIC as 100% inhibition

FDA imipenem-relebactam interpretive criteria (µg/mL)

Use the following breakpoints to categorize the result according to the interpretive criteria (i.e. susceptible or resistant). An MTS™ MIC value which falls between standard two-fold dilutions must be rounded up to the next standard upper two-fold value before categorization. For example a *K. pneumoniae* imipenem-relebactam MIC of 0.19 µg/mL is reported as 0.25 µg/mL (see reading guide section for example pictures).

Bacterial Species	Susceptible	Intermediate	Resistant
<i>Enterobacteriaceae</i>	≤1/4	2/4	≥4/4
<i>Pseudomonas aeruginosa</i>	≤2/4	4/4	≥8/4

US FDA Susceptibility Interpretive Criteria (STIC) Ref:

<https://www.fda.gov/STIC>

Quality Control range (µg/mL) (CLSI M100S Performance Standards for Antimicrobial Susceptibility Testing, 32nd Edition)

To check the performance of the MTS™ Imipenem-relebactam, media and procedure, test *K. pneumoniae* ATCC BAA-1705 or *K. pneumoniae* ATCC BAA-2814 according to the method as outlined in the MTS™ package insert. Results are considered satisfactory if they fall within the following ranges:

Quality Control Strain	Acceptable MIC Range (µg/mL)
<i>Klebsiella pneumoniae</i> , ATCC® BAA-1705	0.03/4 – 0.25/4
<i>Klebsiella pneumoniae</i> , ATCC® BAA-2814	0.06/4 – 0.5/4

Also test the respective QC organism with imipenem to confirm the presence of the resistance mechanism (*K. pneumoniae* ATCC BAA-1705 MIC range = 4-16 µg/mL, *K. pneumoniae* ATCC BAA-2814 MIC range = 16-64 µg/mL).

Additional quality control for MTS™ imipenem-relebactam, which will verify imipenem activity only:

Quality Control Strain	Acceptable MIC Range (µg/mL)
<i>Escherichia coli</i> , ATCC® 25922	0.06/4 – 0.5/4
<i>Pseudomonas aeruginosa</i> , ATCC® 27853	0.25/4 – 1/4

Performance Characteristics

Correlation to Reference Method¹

	N	% Essential Agreement	% Category Agreement
<i>Enterobacteriaceae</i> ²	319	97.5	97.8
<i>Pseudomonas aeruginosa</i>	74	100	91.9

¹ For the plate inoculation procedure, one testing site utilized a plate rotator (Retro C80) to assist even distribution of inoculum. There was no difference in performance for the site using the plate rotator as compared to sites using the manual plate inoculation method.

² MTS™ Imipenem-relebactam MIC values tended to be in exact agreement or at least one doubling dilution higher when testing *C. freundii*, *E. cloacae* and *E. coli* compared to the CLSI reference broth microdilution.

Reproducibility

100% of MTS™ Imipenem-relebactam results for non-fastidious Gram-negative bacteria (1 *E. cloacae*, 2 *E. coli*, 1 *K. aerogenes*, 1 *K. oxytoca*, 2 *K. pneumoniae*, and 2 *P. aeruginosa* tested in triplicate at 3 sites on 3 days) were within a doubling dilution of reference broth microdilution results. 100% of MTS™ Imipenem-relebactam results for non-fastidious Gram-negative bacteria (1 *C. freundii* tested in triplicate at 1 site on 3 days with 3 readers) were within a doubling dilution of reference broth microdilution results.

Limitations

The ability of the MTS™ to detect resistant isolates with the following drug/bacterial species combinations is unknown because resistant isolates were either not available or an insufficient number was encountered at the time of comparative testing.

Imipenem-relebactam: *C. koseri*

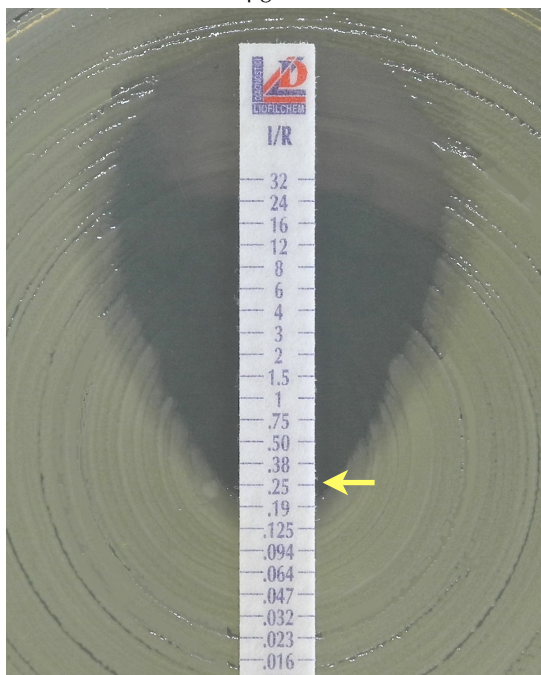
Due to a limited number of isolates for testing, performance for *E. asburiae* could not be adequately evaluated. Therefore, an alternative test should be performed for MTS™ imipenem-relebactam when *E. asburiae* is isolated.

Due to low essential agreement (13/17 = 76.5%) and categorical agreement (12/17 = 70.6%) for *P. mirabilis*, an alternative test should be performed for MTS™ Imipenem-relebactam when *P. mirabilis* is isolated.

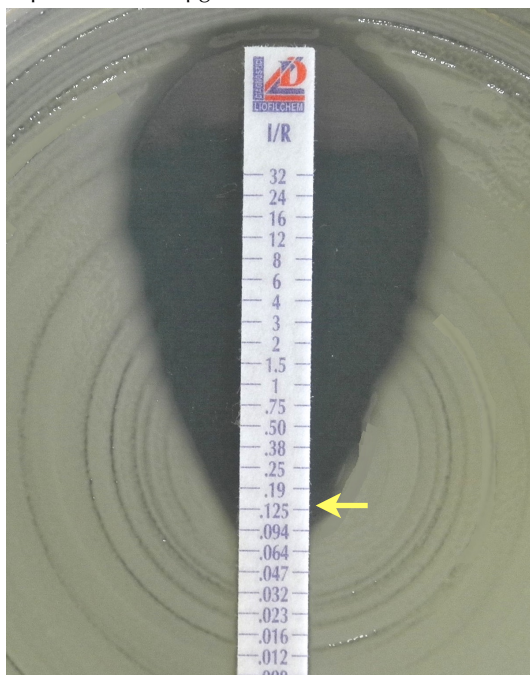
MTS™ Imipenem-relebactam Reading Guide

Note: Interpret the MIC as 100% inhibition

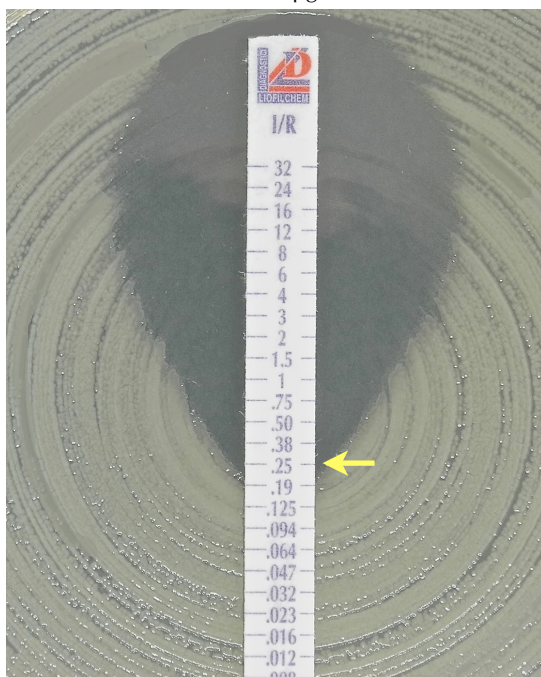
Example 1:
E. coli, I/R MIC = 0.25 µg/mL



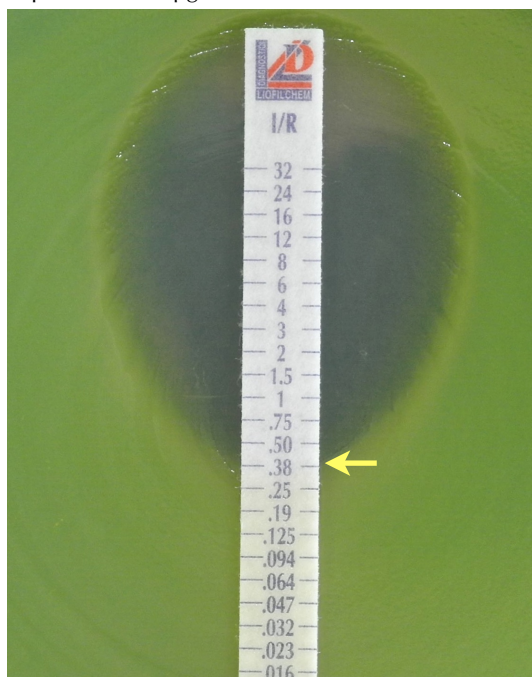
Example 2:
K. pneumoniae, I/R MIC = 0.125 µg/mL,
reported as 0.12 µg/mL



Example 3:
C. freundii, I/R MIC = 0.25 µg/mL



Example 4:
P. aeruginosa, I/R MIC = 0.38 µg/mL,
reported as 0.5 µg/mL



PRESENTATION	µg/mL	Code	Packaging	Ref.
MTS™ Imipenem-relebactam	0.002/4 - 32/4	I/R	10 30 100	920761 92076 920760

REVISION HISTORY

Document	Release Date	Change Summary
Package Insert 92076 PI-0 F00524 v6.2-v0 MTS I-R US	2019-08-23	Not applicable (Initial release)
Package Insert 92076 PI-1 F00524 v6.3-v1 MTS I-R US	2020-04-08	Revised Reading the MIC Updated Quality Control range (Reference to CLSI M100S ED30)
Package Insert 92076 PI-1.1 F00524 v6.4- v1.1 MTS I-R US	2020-07-31	Updated contact info
eIFU 92076 IFU-2 MTS I-R US	2022-04-19	Revised: Reagent, Storage and Handling (new Canister packaging), Inoculum Preparation, Inoculation, Reading the MIC, Results Interpretation Updated: Quality Control range (Reference to CLSI M100S ED32, test <i>K. pneumoniae</i> ATCC BAA-1705 or <i>K. pneumoniae</i> ATCC BAA-2814) Added: Table of Contents, Revision History

Note: Minor typographical, grammar, and formatting changes are not included in the revision history.

For all inquiries please fill out the form at <https://www.liofilchem.com/contact-us.html>

MTS™ (MIC Test Strip), European Patent

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