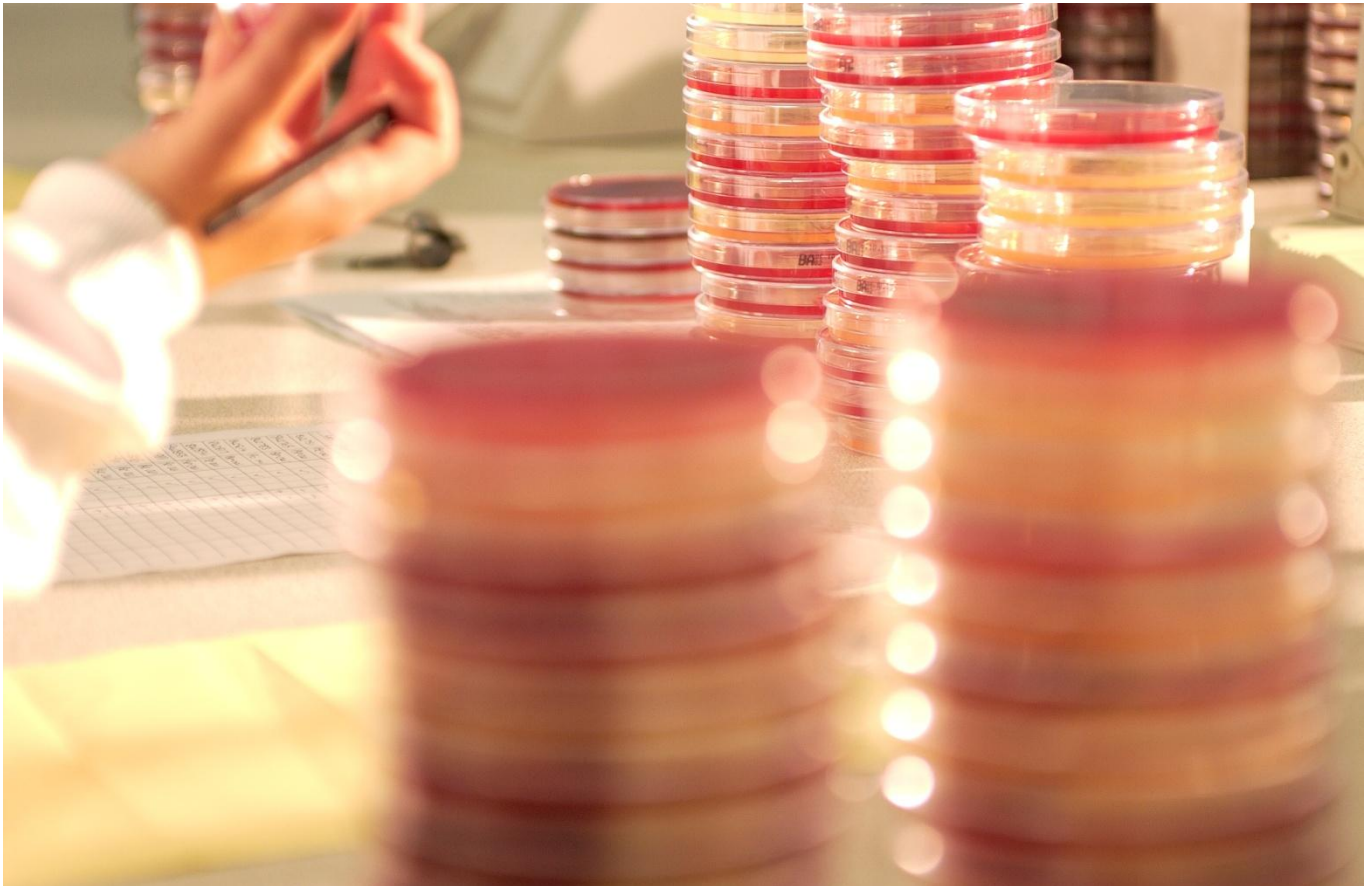


Microbiology Guide to Interpreting Minimum Inhibitory Concentration (MIC)



Historically, most in vitro susceptibility testing was performed by disk diffusion (Kirby-Bauer) method. The size of the growth-free zone determined whether the bacterium was considered to be susceptible, resistant or intermediate to a particular antibiotic.

While used as a guide to select an effective antibiotic, Kirby-Bauer testing could not tell the clinician the exact concentration of antibiotic needed to achieve a therapeutic result. Now, by a quantitative method of susceptibility testing known as the minimum inhibitory concentration (MIC), the precise concentration of antibiotic required to inhibit growth of a pathogen can be determined.

Your IDEXX microbiology results will show the identity of the organism and the appropriate antibiotic sensitivity pattern against each organism. Most antibiograms will include MICs in order to determine the most effective antibiotic that will result in effective treatment.

This guide provides a detailed explanation of the following concepts important in implementing the MIC:

- The MIC number is the lowest concentration (in $\mu\text{g/ml}$) of an antibiotic that inhibits the growth of a given strain of bacteria. (See the "What Is an MIC?" section.)
- An MIC number for one antibiotic CANNOT be compared to the MIC number for another antibiotic. (See the "How Are MICs Used?" section.)
- The choice of antibiotic should be based on the MIC number, the site of infection and an antibiotic's breakpoint. Consider safety, ease of use and cost when determining the optimum antibiotic.

What Is an MIC?

The MIC, or minimum inhibitory concentration, is the lowest concentration (in µg/ml) of an antibiotic that inhibits the growth of a given strain of bacteria. At IDEXX, a commercial automated system is used to determine MICs. A quantitative method of susceptibility testing, an MIC helps determine which class of antibiotic is most effective. This information can lead to an appropriate choice of an antibiotic that will increase chances of treatment success and help in the fight to slow antibiotic resistance.

How Is the MIC reported?

Next to each antibiotic is the susceptibility interpretation: S (sensitive), I (intermediate) or R (resistant), followed by the MIC in µg/ml. Sensitive implies that the organism is inhibited by the serum concentration of the drug that is achieved using the recommended dosage; intermediate includes isolates with MIC's that approach usually attainable blood and tissue levels and for which response rates may be lower than for susceptible isolates; and implies clinical efficacy in body sites where the drug is physiologically concentrated or when a higher than normal dosage of the drug can be used; and resistant implies that the organisms are resistant to the usually achievable serum drug levels. These interpretive standards have been established by the Clinical and Laboratory Standards Institute (CLSI), formerly the National Committee for Clinical Laboratory Standards (NCCLS).

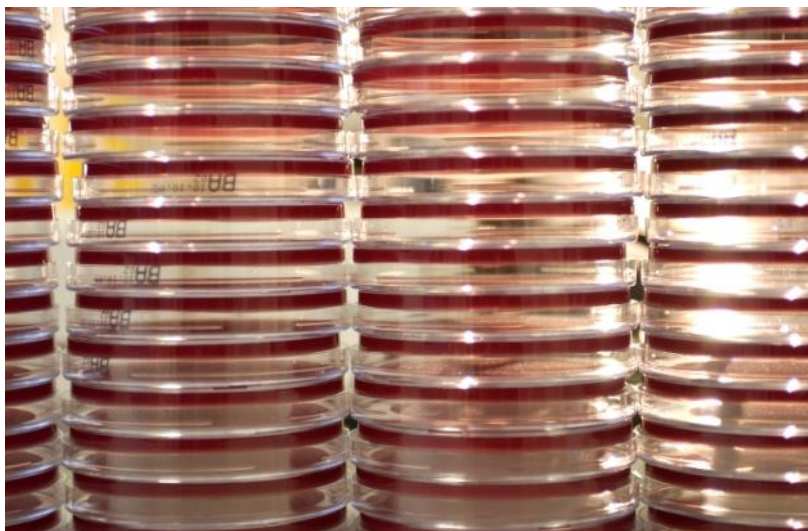
Test	VITEK 2® results	Manual results
Organism	E. coli	E. coli
Amoxicillin	S 2 µg/mL	Sensitive
Amox/Clav Acid	S 8 µg/mL	Sensitive
Piperacillin	S ≤ 4 µg/mL	Sensitive
Cephalexin	S 8 µg/mL	Sensitive
Cefpodoxime	S ≤ 0.25 µg/mL	Sensitive
Ceftiofur	S ≤ 1 µg/mL	Sensitive
Cefovecin	S ≤ 1 µg/mL	Sensitive
Amikacin	S ≤ 2 µg/mL	Sensitive
Gentamicin	s ≤ 0.5 µg/mL	Sensitive
Tobramycin	S ≤ 1 µg/mL	Sensitive
Enrofloxacin	S 0.5 µg/mL	Sensitive
Marbofloxacin	S 0.5 µg/mL	Sensitive
Tetracycline	R ≥ 16 µg/mL	Resistant
Nitrofurantoin	S 32 µg/mL	Sensitive
Chloramphenicol	S 8 µg/mL	Sensitive
Trimethoprim/Sulfa	S ≤ 10 µg/mL	Sensitive

When Are MICs Not Performed?

MICs are not performed when:

- The growth requirements of some organisms require the sensitivity testing to be performed by another method.
- Interpretive criteria is not available from CLSI. In these cases, recommended antibiotics will usually be reported based on clinical efficacy studies.
- The drug is known to be clinically ineffective against the organism, regardless of the in vitro results.

If you would like testing for a particular drug that is not listed, please note in the history box of the Request Form, or contact the Laboratory, and we will perform the test if we are able.



How Are MICs Used?

The breakpoint and range of dilutions **differ by drug and bacterial species**

(see chart). Therefore, comparing MICs of different antibiotics is not based solely on the numerical value but on how far the MIC is from the breakpoint, the site of the infection and other considerations, such as the age, species and health of the animal. Possible side effects of the drug, price, frequency and route of administration are also important factors.

For example: A strain of *Escherichia coli* has an MIC of 2 µg/ml for amoxicillin and an MIC of 8 µg/ml for cephalexin. Looking at the dilutions for amoxicillin, at 2 µg/ml this strain of *E. coli* is four dilutions away from the breakpoint. For cephalexin, the same strain of *E. coli* at an MIC of 8 µg/ml is two dilutions away from the breakpoint. So, based on MICs, this strain of *E. coli* is more susceptible to amoxicillin than cephalexin. Other factors to take into consideration are the site of the infection, the animal's health, frequency and route of administration and cost of the antibiotic.

An antibiotic breakpoint is the dilution where bacteria begin to show resistance.

In vitro efficacy of amoxicillin-Clavulanic acid

Sensitive (MIC)			Intermediate	Resistant
S	S	S	S	S
0.25	0.5	1	2	4
Tested concentrations of amoxicillin (µg/mL)			8	16
			32	Breakpoint

In vitro efficacy of cephalexin (predicts first generation cephalosporins, except cephalazolin)

Sensitive (MIC)		Intermediate	Resistant
S	S	S	S
2	4	8	16
Tested concentrations of cephalexin (µg/mL)		32	Breakpoint

How this appears on your report:

ANTIBIOTIC	RESULT	MIC	SENSITIVITY RANGE
Amoxycillin-Clavulanic acid	SENSITIVE	2	0.25 sssSsir 32
Cephalexin	SENSITIVE	8	2 ssSir 32

For example: Amoxicillin is four dilutions away from its breakpoint while cephalexin is only two dilutions away from its breakpoint. Therefore, in this case, the *E. coli* strain is more susceptible to amoxicillin.

Our consultants are always available to help you interpret test results

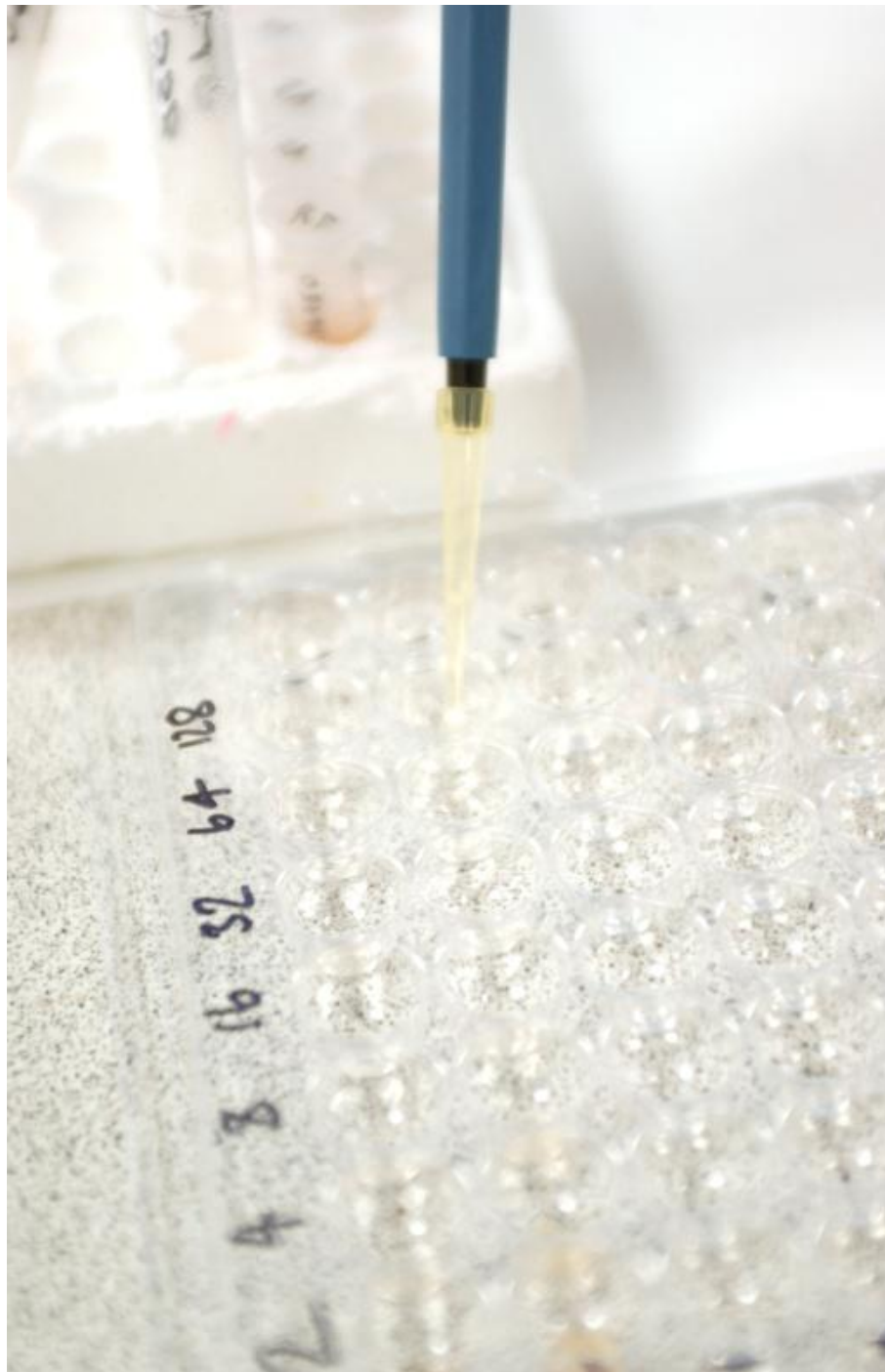
Class-Reference Antibiotics

Some antibiotics are used to determine the susceptibility of other antibiotics in the same class. For example, the presence of methicillin-resistant staphylococci (MRS) is tested in the laboratory with oxacillin and not methicillin. The name MRS is used because of convention over years of use in scientific articles and textbooks.

Cephalexin	Predicts susceptibility of all first-generation cephalosporins, except cefazolin.
Clindamycin	Predicts susceptibility of lincomycin. Should not be used in horses, rabbits and other herbivores. Not effective against aerobic gram-negative bacteria.
Erythromycin	Predicts susceptibility of azithromycin and clarithromycin. Not effective against aerobic gram-negative bacteria.
Tetracycline	Predicts susceptibility of doxycycline and minocycline. Use not recommended in young animals.
Trimethoprim/Sulfa	Predicts susceptibility of other potentiated sulfonamides.

Antibiotics

When selecting an antibiotic, keep in mind that other factors in addition to the MIC are important. The location of the infection is important because lipid-soluble drugs reach higher levels in the tissue than they do in serum. Drugs excreted by the kidney reach much higher bladder levels than serum levels. Also, some drugs are more effective against gram-negative bacteria than gram-positive bacteria and vice versa. Species considerations are also important because certain antibiotics are toxic in some species.



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