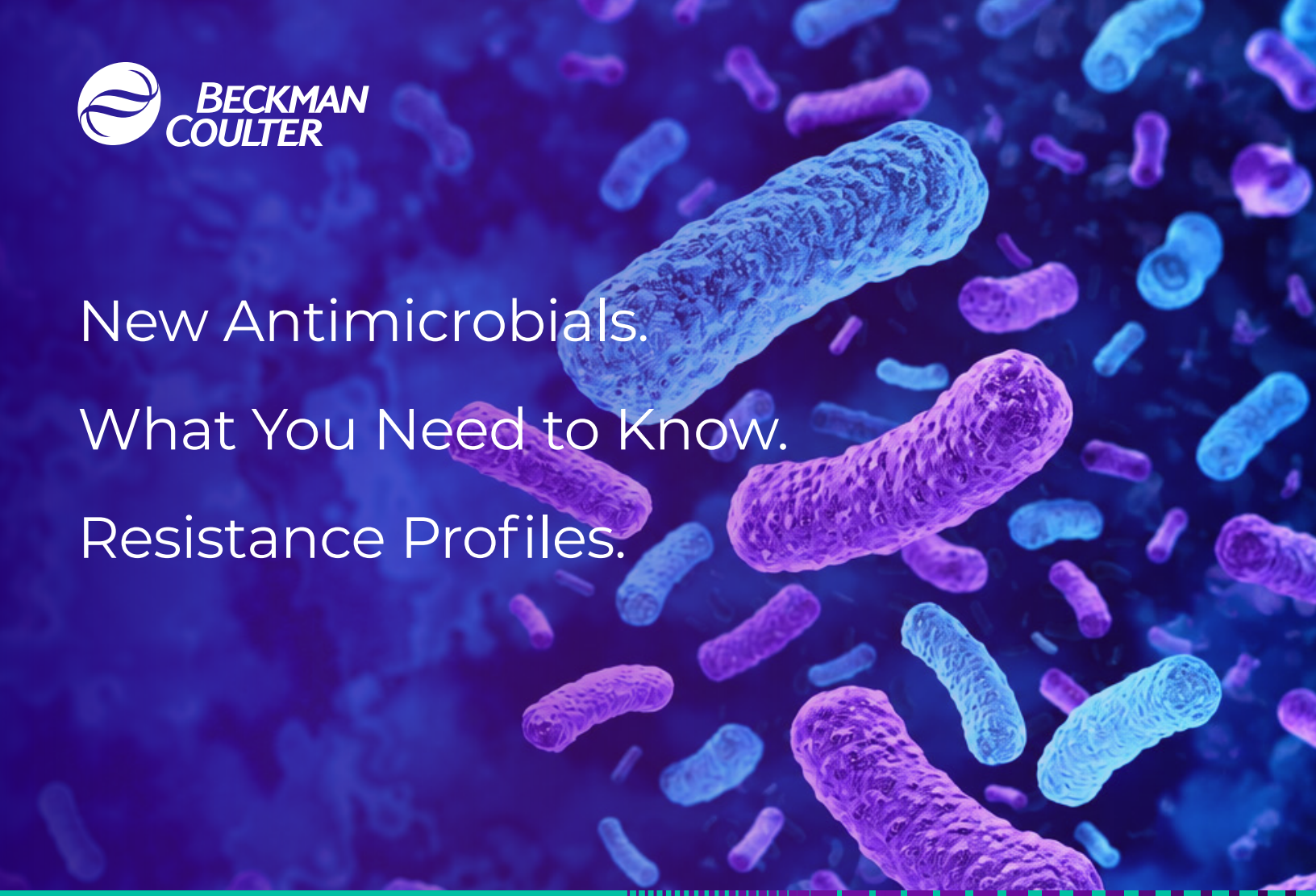
BECKMAN COULTER



New Antimicrobials.

What You Need to Know.

Resistance Profiles.

2027 Antimicrobial Forecast Guide

Support Your Lab

Guide Appropriate Use

Combat Resistance

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New Antimicrobials: A Primer for the Clinical Microbiologist

As new antimicrobials become available, microbiology lab personnel should understand new drugs, their clinical use and laboratory testing considerations, and when resistance might be expected. This document covers antibiotics new to market, keeping the lab informed of advances in antimicrobial development, and takes a glimpse into the future for some promising drugs in the pipeline.

According to a 2024 publication by the Lancet, antimicrobial resistance (AMR) is a global public health threat forecasted to increase deaths associated with or attributable to AMR by 67% and 69.6%, respectively, by 2050.[1] Global changes, like the COVID-19 pandemic, have impacted this threat. Although reported rates of AMR infections decreased slightly during the COVID-19 pandemic, this is believed to be a temporary dip caused by restrictions on travel and potentially reduced surveillance activities leading to delayed or unavailable data.[2]

In 2020 in the United States, the Centers for Disease Control and Prevention (CDC) reported 80% of patients hospitalized with COVID-19 received antibiotics and, subsequently, a 15% increase in resistance infections was observed.[3] In September of 2025, CDC reported a 460% surge in infections from 2019-2023 caused by the very difficult to treat Carbapenem-resistant Enterobacterales (CRE) harboring the metallo ß-lactamase NDM.[4] Clearly, the AMR pandemic continues, fueled by COVID-19, and progress made prior to the pandemic has been lost.

Diagnostics, like Antimicrobial Susceptibility Testing (AST), have the potential to significantly impact antimicrobial use and, by extension, AMR. The CDC reports high rates of inappropriate antimicrobial use for community-associated infections and urinary tract infections. For each of these, the limited use of diagnostics and the unavailability of effective diagnostics are a significant contributor to the problem. These findings are further corroborated by other studies and efforts are underway to utilize Antimicrobial Stewardship Program (ASP) interventions, alongside proper use of AST, to improve prescribing habits.[5,6,7] In an era of increasing AMR, microbiology laboratories face challenges in performing AST and interpreting complex or abnormal AST results. Proper ID and AST are arguably some of the most important tests for assisting ASP in prescribing the right therapy for the right patient. The laboratory, and the tests they perform, play a critical role in curbing the spread of AMR.

In addition to improved testing through diagnostic stewardship and prescribing protocols through ASP, new drugs have become available to address the challenges of treating Multi-Drug Resistant Organisms (MDROs) and prevent further spread of AMR. As new drugs come to market, continued development and investment in the antimicrobial pipeline is critical. The tables on the following pages highlight some of the most important MDRO infections, recommend current and new therapies available today, and highlight some promising new therapeutic in the pipeline and resistance trends and/or mechanisms for these antimicrobials. This information, alongside other clinical practice guidelines, can be used to help guide the laboratory in their development of testing and quality assurance protocols, as well as discussions with clinicians and ASP.

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New Antimicrobials: What You Need to Know

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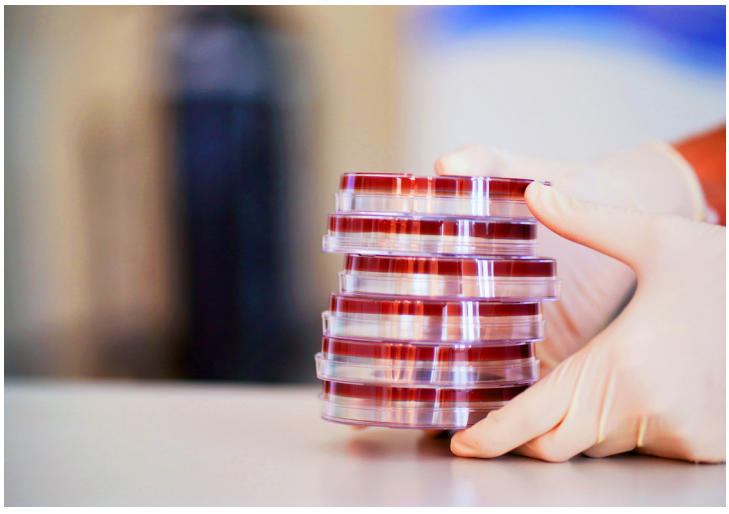
MDRO Infections: Current, New and Promising Antimicrobial	Key Therapy Guidelines Recommendations* and Recently Approved Antimicrobials	Promising Antimicrobials in Late-phase Development†	What else do you need to know?
URINARY TRACT INFECTIONS CAUSED BY:			
ESßL-producing Enterobacterales	*Summary of Current recommendations:* Uncomplicated UTI treatment (cystitis): ▶Nitrofurantoin# ▶Trimethoprim-sulfamethoxazole ▶Oral Fosfomycin (*E. coli* only) ▶Pivmecillinam ▶Etrapenem ▶Ciprofloxacin/Levofloxacin§ Complicated UTI§ (including pyelonephritis and urosepsis): ▶Trimethoprim-sulfamethoxazole** ▶Ciprofloxacin/Levofloxacin§ ▶Ertapenem ▶Imipenem ▶Meropenem ▶Doripenem *New Antimicrobials Available:* ▶Cefepime-enmetazobactam ▶Cefepime-zidebactam ▶Gepotidacin‖ ▶Sulopenem‖[3] ▶Tebipenem†	▶Cefepime-taniborbactam[4] ▶Cefepime/Nacubactam ▶Aztreonam/Nacubactam	With increasing frequency, UTIs caused by ESßL-producing Enterobacterales are seen in outpatients with no previous healthcare exposures, and trends of ESßL-producing Enterobacterales in patients at risk for MDRO cUTIs continues to rise. The most common ESßL-producing species causing UTIs are: *E. coli, Klebsiella species, Proteus mirabilis*. New drugs, such as those listed under "New Antimicrobials Available" may be active for these infections, but these drugs should be reserved for serious infections with limited treatment options. Laboratories should implement updated 2010 cephalosporin CLSI breakpoints, if not done so already, to ensure accurate detection of ESßLs. Testing antibiotics that are active against ESßL-producing bacteria should be made available and laboratories may consider selective or cascade reporting or testing by request of these new drugs to aid in appropriate use, in collaboration with the institutional ASP.
SERIOUS INFECTIONS CAUSED BY:			
MRSA	*Current Recommendations:* ▶Ceftaroline/Ceftobiprole ▶Vancomycin ▶Linezolid ▶Daptomycin¶ ▶Telavancin *New Antimicrobials Available:* ▶Eravacycline ▶Omadacycline ▶Lefamulin ▶Gepotidacin ▶Delafloxacin	▶Contezolid ▶Levonadifloxacin[5]	New drugs, such as those listed under "New Antimicrobials Available" may be active for these infections, but these drugs should be reserved for serious infections with limited treatment options. Testing antibiotics that are active against MRSA should be made available and laboratories may consider selective or cascade reporting or testing by request of these new drugs to aid in appropriate use, in collaboration with the institutional ASP. See Resistant Profile table for more information.

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New Antimicrobials: What You Need to Know

MDRO Infections: Current, New and Promising Antimicrobial	Key Therapy Guidelines Recommendations* and Recently Approved Antimicrobials	Promising Antimicrobials in Late-phase Development†	What else do you need to know?
SERIOUS INFECTIONS CAUSED BY:			
VRE	*Current Recommendations:* ▶Daptomycin¶ ▶Linezolid *New Antimicrobials Available:* ▶Eravacycline ▶Omadacycline (*E. faecalis* only) ▶Gepotidacin (*E. faecalis* only)	› ▶Contezolid	*E. faecium* are the most common VRE species. CLSI revised Daptomycin breakpoints in 2019 to account for high dose Daptomycin treatment of VR-*E. faecium* infections. This breakpoint is reported as Susceptible Dose Dependent (SDD) to help inform clinicians that a higher dose is required for treatment. New drugs, such as those listed under "New Antimicrobials Available" may be active for these infections, but these drugs should be reserved for serious infections with limited treatment options.
CRE-KPC (most common class A carbapenemase)	*Current Recommendations:*[6] ▶Ceftazidime-avibactam ▶Meropenem-vaborbactam ▶Imipenem-relebactam‡ ▶ Cefiderocol† *New Antimicrobials Available:* ▶Aztreonam-avibactam ▶Delafloxacin ▶Cefepime-zidebactam[7]	▶Cefepime-taniborbactam ▶Cefepime/Nacubactam ▶Aztreonam/Nacubactam	Some variants of KPC may test susceptible to Cefepime and rarely can test susceptible to Ceftazidime and/or Meropenem.[8] For isolate non-susceptible to carbapenems, CLSI[9] and IDSA recommends detection and differentiation of carbapenemase enzyme to inform treatment decisions. Testing antibiotics that are active against CRE-KPC should be made available and laboratories may consider selective or cascade reporting or testing by request of these new drugs to aid in appropriate use, in collaboration with the institutional ASP. New drugs, such as those listed under "New Antimicrobials Available" may be active for these infections, but these drugs should be reserved for serious infections with limited treatment options.





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New Antimicrobials: What You Need to Know

MDRO Infections: Current, New and Promising Antimicrobial	Key Therapy Guidelines Recommendations* and Recently Approved Antimicrobials	Promising Antimicrobials in Late-phase Development†	What else do you need to know?
SERIOUS INFECTIONS CAUSED BY:			
CRE-OXA 48-like carbapenemase (most common class D carbapenemase)	*Current Recommendations:* ▶Ceftazidime-avibactam ▶Cefiderocol *New Antimicrobials Available:* ▶Aztreonam-avibactam ▶Cefepime-enmetazobactam ▶Plazomycin ▶Delafloxacin ▶Cefepime-zidebactam	▶Cefepime-taniborbactam ▶Cefepime/Nacubactam ▶Aztreonam/Nacubactam	Isolate harboring OXA-48 may test susceptible to the following cephalosporins: Cefotaxime, Ceftazidime, Ceftriaxone. Meropenem-vaborbactam and Imipenem-relebactam are NOT recommended for testing or treatment as both vaborbactam and relebactam are unlikely to inhibit OXA-48 like enzymes. CLSI recommends the following reporting guidance for OXA-48 positive isolates: 1. "Enterobacterales that harbor OXA-48-family enzymes may test susceptible to meropenem-vaborbactam but may not respond to this therapy in vivo. If OXA-48 is detected, suppress or report as resistant" 2. "Cefepime S/SDD results should be suppressed or reported as R for isolates that demonstrate carbapenemase production". For isolate non-susceptible to carbapenems, CLSI[9] and IDSA recommends detection and differentiation of carbapenemase enzyme to inform treatment decisions. Testing antibiotics that are active against CRE-OXA-48 should be made available and laboratories may consider selective or cascade reporting or testing by request of these new drugs to aid in appropriate use, in collaboration with the institutional ASP. New drugs, such as those listed under "New Antimicrobials Available" may be active for these infections, but these drugs should be reserved for serious infections with limited treatment options.





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New Antimicrobials: What You Need to Know



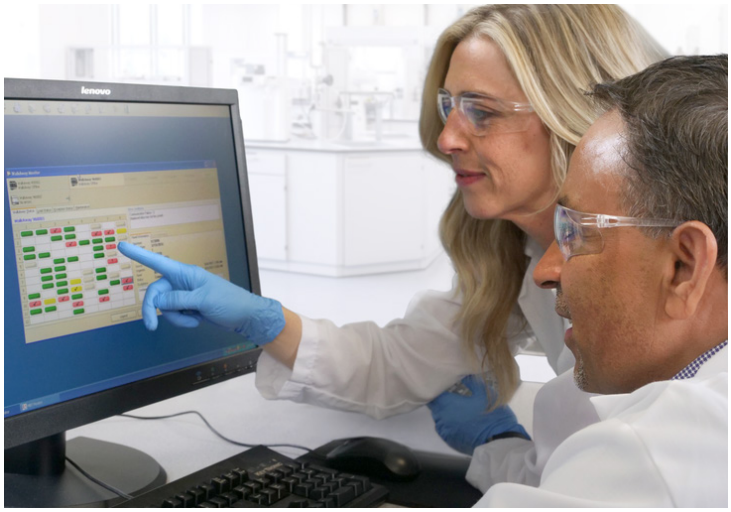
MDRO Infections: Current, New and Promising Antimicrobial	Key Therapy Guidelines Recommendations* and Recently Approved Antimicrobials	Promising Antimicrobials in Late-phase Development†	What else do you need to know?
SERIOUS INFECTIONS CAUSED BY:			
CRE-NDM (most common class B carbapenemase)	*Current Recommendations:* ▶Ceftazidime-avibactam + Aztreonam ▶Cefiderocol† *New Antimicrobials Available:* ▶Plazomycin†† ▶Aztreonam-avibactam ▶Delafloxacin ▶Cefepime-zidebactam	▶Cefepime-taniborbactam ▶Cefepime/Nacubactam ▶Aztreonam/Nacubactam	††With increasing frequency, CRE-NDM isolates also carry a 16S rRNA methylase which confers resistance to all aminoglycosides, including Plazomicin. With the recent FDA approval of Aztreonam-avibactam in 2025,[12] this new agent is likely to replace the recommendation of combination therapy of Ceftazidime-avibactam + Aztreonam. For isolate non-susceptible to carbapenems, CLSI[9] and IDSA recommends detection and differentiation of carbapenemase enzyme to inform treatment decisions. Testing antibiotics that are active against CRE-NDM should be made available and laboratories may consider selective or cascade reporting or testing by request of these new drugs to aid in appropriate use, in collaboration with the institutional ASP. New drugs, such as those listed under "New Antimicrobials Available" may be active for these infections, but these drugs should be reserved for serious infections with limited treatment options.
CR-*Pseudomonas aeruginosa* (can be referred to as "difficult-to-treat", DTR)	*Current Recommendations:* ▶Non-carbapenem ß-lactam (e.g., Cefepime) if tests susceptible ▶Ceftolozane-tazobactam ▶Ceftazidime-avibactam ▶Imipenem-relebactam‡ ▶Cefiderocol *New Antimicrobials Available:* ▶Cefepime-enmetazobactam# ▶Delafloxacin ▶Cefepime-zidebactam	▶Cefepime-taniborbactam ▶Cefepime/Nacubactam ▶Aztreonam/Nacubactam	Most CR-*P. aeruginosa* do not produce a carbapenemase and instead become resistant via altered porins. However, with increasing frequency, VIM-producing CR-*P. aeruginosa* are causes of outbreaks in healthcare facilities. Because the more common mechanism of resistance is via porin and efflux pump alternations, *P. aeruginosa* may test resistant to the carbapenems (e.g., imipenem and/or meropenem) but test susceptible to other non-carbapenem b-lactam agents (e.g., cefepime) [d]Cefepime-enmetazobactam may be active to isolates that harbor OXA-48. IDSA does not recommend testing CR-*P. aeruginosa* against Meropenem-vaborbactam as vaborbactam only marginally restores Meropenem activity against CR-*P. aeruginosa*. There are no FDA or CLSI breakpoints for Meropenem-vaborbactam and *P. aeruginosa* at this time New drugs, such as those listed under "New Antimicrobials Available", including Ceftolozane-tazobactam, Ceftazidime-avibactam and Imipenem-relebactam, may be active for these infections, but these drugs should be reserved for serious infections with limited treatment options.

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New Antimicrobials: What You Need to Know

MDRO Infections: Current, New and Promising Antimicrobial	Key Therapy Guidelines Recommendations* and Recently Approved Antimicrobials	Promising Antimicrobials in Late-phase Development†	What else do you need to know?
SERIOUS INFECTIONS CAUSED BY:			
CR-*Acinetobacter* baumanii (CRAB).	*Current Recommendations:* ▶Sulbactam-durlobactam (in combination with a carbapenem) ▶High dose Ampicillin-sulbactam (in combination with another active agent) if Sulbactam-durlobactam is not available. ▶Cefiderocol	No drugs in late stage development for treatment of CRAB	Minocycline may be active. If testing by disk diffusion, CLSI confirms testing by an MIC method for zones of 18-21mm to avoid reporting false-intermediate results.[9] Acquisition of OXA23 or OXA24/40 by Acinetobacter mediated resistance to *β-lactams* including carbapenems and Sulbactam. Once carbapenem resistant, the isolate most often has also acquired resistance to other alternative antibiotics, leaving few remaining therapeutic options.





* See treatment guidelines for additional information regarding recommended use of antimicrobials by infection type.
† First oral carbapenem to market.
‡ Imipenem-relebactam announced discontinuation for commercial sale in the US in September 2026.[10]
§ Empiric therapy to be guided by antibiogram and final therapy to be guided by AST results.
| Uncomplicated UTI only.
¶ Not used for treatment of respiratory infections.
# Recommended agent for CRE uUTIs.
** Recommended agent for CRE cUTIs.

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Resistant Profiles for New Antimicrobials

Antimicrobial	Target Organisms and AMR	Resistance and Expected Resistant Profiles	Common Resistance Mechanisms
Aztreonam-avibactam	▶Enterobacterales Retains activity against ESßLs, AmpC and Class A, B and D carbapenemases.	Resistant rates are low but may be increasing.[11] Resistance can occur if a beta-lactamase enzyme is not inhibited by avibactam. If resistance emerges, expected to test resistant to penicillin/aminopenicillin, 1st-4th generations cephalosporins, carbapenems, and legacy and newer generation beta-lactam/inhibitor combinations (e.g., Ceftolozane-tazobactam, Ceftazidime-avibactam, Meropenem-vaborbactam, Imipenem-relebactam).	None known to date. Permeability changes via porin mutations and/or increased efflux-pump activity may result in resistance.
Cefepime-enmetazobac-tam	▶Enterobacterales ▶*Pseudomonas aeruginosa* Retains activity against ESßLs, AmpC and OXA-48.	Resistance to this drug may be common among isolates that produce a carbapenemase or isolates that carry multiple beta-lactamase enzymes. If resistance emerges, expected to test resistant to penicillin/aminopenicillin, 1st-3rd generations cephalosporins. Due to similarity to tazobactam, may test resistant to some legacy an/or newer generation beta-lactam/inhibitor combinations (e.g., Ceftolozane-tazobactam).	A, B, D carbapenemases.. Permeability changes via porin mutations and/or increased efflux-pump activity may result in resistance.
Cefepime-zidebactam	▶Enterobacterales ▶*Pseudomonas aeruginosa* Retains activity against ESßLs, AmpC, Class A, B and D (e.g., OXA-48-like) carbapenemases and *P. aeruginosa* isolates harboring *oprD* mutations.	Resistance is considered rare. Isolates that test resistant to other beta-lactam antibiotics, including newer beta-lactam beta-lactamase inhibitor combination agents may test susceptible to Cefepime-zidebactam.	Mutations in PBPs, decreased outer membrane permeability, overexpression of efflux pumps, or hyperproduction of beta-lactamases. Mutations in MexAB-OprM has been described to confer resistance in *P. aeruginosa*.
Cefiderocol	▶Enterobacterales ▶*Pseudomonas aeruginosa* ▶*Acinetobacter* spp. Retains activity against ESßLs, AmpC, OXA-48 and Class A carbapenemases.	Resistance is overall uncommon in the general population to date, however some specific cohorts have reported increased resistance. Expected resistance profile: test resistant to penicillin/aminopenicillin, 1st-4th generations cephalosporins and carbapenems. Resistance may be observed with some legacy an/or newer generation beta-lactam/inhibitor combinations (e.g., Ceftolozane-tazobactam) depending on presence of specific mechanisms in the isolate.	Isolates with NDM carbapenemases and PER ESßLs can test resistant in vitro, but the enzyme alone is not sufficient for in vivo resistance, leading to clinical failures. PER ESßL is relatively uncommon. It is found in *P. aeruginosa* and *Acinetobacter* spp. Other currently unknown factors likely contribute to the elevated Cefiderocol MIC, however it is likely multiple resistance mechanisms acting in concert is needed for resistance. Permeability changes via porin mutations and/or increased efflux-pump activity alongside enzymatic mechanisms of resistance may result in resistance.

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Resistant Profiles for New Antimicrobials

Antimicrobial	Target Organisms and AMR	Resistance and Expected Resistant Profiles	Common Resistance Mechanisms
Ceftazidime-avibactam*	▶Enterobacterales ▶*P. aeruginosa* Retains activity against ESßLs, AmpC, Class D (e.g., OXA-48) and Class A carbapenemases.	Resistance has been observed in both Enterobacterales and *P. aeruginosa*. Data suggests that frequency for resistance to emerge may be highest for Ceftazidime-avibactam.[10] Expected resistance profile: test resistant to penicillin/aminopenicillin, 1st-4th generations cephalosporins, carbapenems, and may test resistant to legacy and newer generation beta-lactam/inhibitor combinations (e.g., Ceftolozane-tazobactam, Meropenem-vaborbactam, Imipenem-relebactam) depending on presence of specific mechanisms in the isolate.	Mutations can occur in the KPC gene or increases in blaKPC copy numbers can confer resistance to Ceftazidime-avibactam. Ceftazidime-avibactam is not active against Gram-negative bacteria producing class B carbapenemases, such as NDM, IMP, and VIM. Permeability changes via porin mutations and/or increased efflux-pump activity may result in resistance.
Delafloxacin	▶Enterobacterales ▶*Pseudomonas aeruginosa* Retains activity against ESßLs.	Like other fluoroquinolones, Delafloxacin resistance is common among Gram-negative bacteria. Resistance to Delafloxacin has already been observed. Less active for treatment of *P. aeruginosa* than Ciprofloxacin.[2] Expected resistance profile: because resistance is determined by the specific mechanisms present, isolates may test resistant or susceptible to drugs like Ciprofloxacin and Levofloxacin. However, cross resistance has been reported.	Multiple mutations in fluoroquinolone resistance determining (QRDR) region, such as gyrA and parC, and/or plasmid mediate quinolone resistance, such as qnr.
	▶*Staphylococcus* spp. (including MRSA) ▶*Streptococcus* spp. ▶*Enterococcus* spp.	Resistance to Delafloxacin has already been observed in Staphylococcus spp. The other fluoroquinolones, such a Levofloxacin and Ciprofloxacin, can become resistant after only one mutation in each gene. Expected resistance profile: because resistance is determined by both the number of mutations and genes mutated and are different amongst the fluoroquinolones, isolates may test resistant or susceptible to drugs like Ciprofloxacin and Levofloxacin. However, cross resistance has been reported.	Multiple mutations in the fluoroquinolone resistance determining (QRDR) region, such as double mutations in gyrA and parC, and acquisition of efflux pump.

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Resistant Profiles for New Antimicrobials

Antimicrobial	Target Organisms and AMR	Resistance and Expected Resistant Profiles	Common Resistance Mechanisms
Eravacycline*	▶*Enterobacterales* Retains activity against ESßL and carbapenemases, tet efflux pumps (tetA/B/K) and tetM/Q resistance mechanisms.	Resistance to Eravacycline can occur in isolates of Enterobacterales, *S. aureus* and *Enterococcus* spp. Isolates harboring ESßLs and/or carbapnemeases often can also carry resistance mechanisms to tetracycline drug class. Expected resistance profile: depending on the mechanisms present, resistance may be observed to the other tetracyclines, such as Tetracycline or Minocycline. Cross-resistance can occur between Tigecycline and Eravacycline in Enterobacterales, *Staphylococcus* and *Enterococcus*.	Efflux pumps and target-site modifications to the 16s rRNA or certain 30S ribosomal proteins.
	▶*Staphylococcus aureus* ▶*Enterococcus* spp. ▶*Streptococcus anginosus* Group Retains activity against tet efflux pumps (tetA/B/K) and tetM/Q resistance mechanisms.		
Gepotidacin	▶Enterobacterales ▶*S. saprophyticus* ▶*E. faecalis*	No described cross resistance between other fluroquinolones. Isolates that test resistant to Ciprofloxacin or Levofloxacin may test susceptible to Gepotidacin.	No clear mechanisms of resistance have been identified to date. Potential mechanisms of resistance include of DNA gyrase (*gyrA, gyrB*) and/or topoisomerase IV (*parC, 1are*) gene targets, plasmid-mediated quinolone resistance genes (especially *qnr*), and efflux.
Imipenem-relebactam†	▶Enterobacterales ▶*P. aeruginosa* Retains activity against ESLß, AmpC and Class A carbapenems.	Resistance is more commonly seen in DTR *P. aeruginosa* isolates. Resistance for Enterobacterales is uncommon at this time. Imipenem-relebactam is most active against CRE with class A enzymes (e.g., KPC). Expected resistance profile: test resistant to penicillin/aminopenicillin, 1st-4th generations cephalosporins, carbapenems, and may test resistant to legacy and newer generation beta-lactam/inhibitor combinations (e.g., Ceftolozane-tazobactam, Ceftazidime-avibactam, Meropenem-vaborbactam) depending on presence of specific mechanisms in the isolate.	Imipenem-relebactam has reduced activity for isolates producing class D carbapenemases (e.g., OXA-48 like), and CRE producing class B carbapenemases (e.g., NDM, IMP, and VIM). Permeability changes via porin mutations and/or increased efflux-pump activity may result in resistance.
Lefamulin	▶*Staphylococcus aureus* (methicillin-susceptible isolates) ▶*Streptococcus pneumoniae*	Resistance to Lefamulin occurs in gram-positive bacteria but is uncommon at this time. Resistance is more likely to occur in isolates of animal origin than isolates of human origin. If resistance emerges, may test resistant to lincosamids (e.g., Clindamycin) and/or oxazolidinones (e.g., Linezolid).	Protection or modification of ribosomoal target (e.g., vga, lsa, sal), Cfr methy transferase, or by mutations of ribosomal proteins. Cfr methyl transferase may mediate cross resistance to lincosamides and oxazolidinones antibacterials.

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Resistant Profiles for New Antimicrobials

Antimicrobial	Target Organisms and AMR	Resistance and Expected Resistant Profiles	Common Resistance Mechanisms
Meropenem-vaborbactam*	▶Enterobacterales Retains activity to ESßLs, AmpC and Class A carbapenemases.	Resistance is uncommon but has been reported. Expected resistance profile: test resistant to penicillin/aminopenicillin, 1st-4th generations cephalosporins, carbapenems, and may test resistant to legacy and newer generation beta-lactam/inhibitor combinations (e.g., Ceftolozane-tazobactam, Ceftazidime-avibactam, Imipenem-relebactam) depending on presence of specific mechanisms in the isolate.	Permeability changes via porin mutations and/or increased efflux-pump activity may result in resistance. Note that Meropenem-vaborbactam is not active against CRE producing class D or class B carbapenemases and should not be used to treat infections with organisms harboring these mechanisms.
Omadacycline	▶Enterobacterales Retains activity against tet efflux pump (tetB). ▶*Staphylococcus* spp. (including MRSA) ▶*Enterococcus* spp. ▶*Streptococcus* spp. Retains activity against tet efflux pumps (*tetK/L*), tetM resistance mechanisms and erm.	Resistance has been reported. Some, but not all, mechanisms of tetracycline resistance can also confer resistance to Omadacycline. Expected resistance profile: Tetracycline-resistant Gram-positive isolates can test susceptible to Omadacycline. Tetracycline-resistant Enterbacterales are more likely to test resistant to Omadacycline but may test susceptible.	Other tet efflux pumps and/or mutations in the ribosomal binding site.
Plazomycin Retains activity against most common aminoglycoside modifying enzymes (AMEs) that impact Gentamicin, Amikacin and Tobramycin.	▶Enterobacterales	Resistance has been reported. Cross resistance to all aminoglycosides can occur in the presence of 16S methyltransferase. Expected resistance profile: test resistant to all or some other aminoglycosides depending on the mechanism of resistance present in the isolate.	Plasmid-mediated 16S methytransferase genes. These are most commonly found in CRE harboring Class B carbapenemases and only rarely in CRE containing other carbapenemase classes. Other mechanisms include uncommon/novel aminoglycosides modifying enzymes, efflux and/or permeability alternations.
Sulbactam-durlobactam Retains activity against ESßLs, ADC-type Class C, Class A and D carbapenemases	▶*Acinetobacter baumannii-calcoaceticus complex*	Resistance has been reported, with higher rates in CRAB. Note that Sulbactam-durlobactam is not active against Class B carbapenemases.	Mechanisms may include production of other beta-lactamases, modification of PBP and/or efflux and/or permeability alternations. Increased expression of TEM-1, ADC-30, and Class B carbapenemases can cause resistance in *Acinetobacter* species.
Tebipenem	▶Enterobacterales ▶*E. faecalis* Retains activity against ESßLs, AmpC, non-carbapenemase OXAs.	Cross resistance can occur with other carbapenems.	Class A, B, and D carbapenemases. Alterations of PBPs, overexpression of efflux pumps, and alterations of outer membrane transport proteins.

* Drugs on MicroScan panels.

† Imipenem/Relebactam announced discontinuatiuation for commercial sale in the US in September 2026.[10]

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Acquired Carbapenemases

Molecular Class	Examples of Common Carbapenemase Genes	Common Organisms Carrying AMR	Additional Information
A (Serine beta-lactamase)	**KPC, IMI, SME**	**Enterobacterales, *P. aeruginosa***	Not all Class A enzymes are carbapenemases.
B (Metallo beta-lactamase)	**NDM, VIM, IMP**	**Enterobacterales, *P. aeruginosa, Acinetobacter***	Metallo ß-lactamases (MBL): Resistant to many drugs, including most newer beta-lactam/beta-lactamase inhibitor combination drugs. Notable is MBL enzymes do not hydrolyze Aztreonam. Aztrenoman-avibactam only current beta-lactam/beta-lactamase inhibitor combination drug that retains activity against Class B carbapenemases. Often requires zinc for expression.
C	—	—	There are no known Class C enzymes that are classified as carbapenemases.
D (serine beta-lactamase)	**OXA-48 (*K. pneumoniae*)**	***K. pneumoniae***	Others OXA variants can be found in *Pseudomonas* and other non-Enterobacterales.
	OXA-23, -40, -51, -58	***Acinetobacter baumannii complex***	Not all class D enzymes are carbapenemases (e.g., OXA-1).

Acronyms

AMR	Antimicrobial Resistance	**NDM**	New Delhi Metallo-ß-lactamase
ASP	Antimicrobial Stewardship Program	**OXA**	Oxacillinase
AST	Antimicrobial Susceptibility Testing	**PER**	*Pseudomonas* extended resistance
ESßL	Extended-spectrum ß-lactamase	**UTI**	Urinary tract infection
CRE	Carbapenem-resistant Enterobacterales	**cUTI**	Complicated urinary tract infection
KPC	*Klebsiella pneumoniae* carbapenemase	**uUTI**	Uncomplicated urinary tract infection
MDRO	Multidrug-resistant organism	**VIM**	Verona Integron-Borne Metallo-ß-lactamase
MRSA	Methicillin-resistant *Staphylococcus aureus*	**VRE**	Vancomycin-resistant *Enterococcus*





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Introduction: A Primer for the Clinical Microbiologist

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Breakpoints (i.e., Interpretive Criteria)

- CLSI M100: https://clsi.org/standards/products/free-resources/access-our-free-resources/
- EUCAST Clinical Breakpoints: https://www.eucast.org/fileadmin/src/media/PDFs/EUCAST_files/Breakpoint_tables/v_13.0_Breakpoint_Tables.pdf
- FDA Antibacterial Susceptibility Test Interpretive Criteria: https://www.fda.gov/drugs/development-resources/antibacterial-susceptibility-test-interpretive-criteria
- IDSA Guidance for Treatment of Multidrug Resistant Gram-negative Infections (IDSA 2024 Guidance on the Treatment of Antimicrobial Resistant Gram-Negative Infections (idsociety.org)

Antimicrobial Developmental Pipeline

- Antibacterial products in clinical development for priority pathogens (who.int)
- Antibiotic use by infection type: JAMA Network Open. 2021;4(3):e212007. doi:10.1001/jamanetworkopen.2021.2007

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