

MC 6.012 Pseudomonas aeruginosa Susceptibility Reporting

Purpose

This procedure provides instruction and guidance for routine testing and selective and cascade susceptibility reporting on *Pseudomonas aeruginosa*.

Principal and Clinical Significance

The decisions for the most appropriate antimicrobial agents to test and report are made with input from Pharmacy, Infectious Disease and the Clinical Laboratory. The goal is to provide clinically relevant information that will decrease the chance of developing antibiotic resistance, harmful effects of inappropriate antimicrobial use and avoid reporting results that could adversely affect patient care using selective and cascade reporting rules.

Policy Statements

This procedure applies to Microbiologists who perform susceptibility testing.

Special Safety Precautions

Microbiologists are subject to occupational risks associated with specimen handling.

- Biohazard Containment
- Biohazardous Spills
- Safety in the Microbiology Laboratory

Procedure

- Antibiotics appropriate for routine testing and reporting for Pseudomonas aeruginosa include:
 - Ceftazidime
 - Cefepime
 - Piperacillin-tazobactam
 - Tobramycin
 - Ciprofloxacin
 - Levofloxacin
 - Imipenem
 - Meropenem
 - Cefiderocol
 - Ceftazidime-avibactam
 - Ceftolozane-tazobactam
 - Imipenem-relebactam
 - Aztreonam-CF patients only
 - Amikacin-urine only
- Perform susceptibilities using Vitek cards N806 and XN30, MicroScan NUC101 or Kirby Bauer Method.
- 3. Not all antibiotics are available on every panel.
 - Vitek will be the primary method of testing. Both Vitek cards will be required for testing Pseudomonas aeruginosa.
 - MicroScan and Kirby Bauer are back up if testing fails.
 - Kirby Bauer is required for CF patients for mucoid strains.
 - Do not perform testing on multiple methods to cover all the antibiotics. It is acceptable if cascaded antibiotics are not reported.
 - Cefiderocol is not available in house and would need to be sent out if requested.



- 4. Vitek results will be accepted under the Online Results tab. Modifications will be under the **VITMIC** keyboard under the Susceptibility tab.
- 5. MicroScan and Kirby Bauer results will be entered manually under the **MMIC** and **KB** keyboards respectively under the Susceptibility tab.

CF Patient Testing

CF patients testing have specific requirements

- 1. Mucoid Pseudomonas aeruginosa (PMUC)- perform KB testing using the NF stamper.
- Matte Pseudomonas aeruginosa (PMAT). Set up both Vitek cards and perform KB testing for Aztreonam.

Selective Reporting

- Antibiotics will be reported in a specific order indicating the first and subsequent preferences of the Antimicrobial Stewardship Committee and Infectious Disease physicians
- Antibiotics will be reported depending on the source, if the sample is a urine or nonurine source.
- 3. There will be exceptions based on the method used for testing, location of the patient and diagnosis of the patient.
- 4. For **urine sources**, only 3 antibiotics will be reported routinely, in this order.
 - 1. Ceftazidime
 - 2. Ciprofloxacin
 - 3. Tobramycin



Figure 1 -Only the CAZ, CP, and TO are reported. All other antibiotics are in HIDE.

- 5. For non-urine sources, these 5-6 antibiotics will be reported routinely, in this order.
 - Ceftazidime
 - 2. Piperacillin-tazobactam
 - 3. Ciprofloxacin
 - 4. Meropenem
 - 5. Tobramycin
 - 6. Aztreonam-CF patients only, using the KB or MicroScan method

Online Instrument Data Organism #4 - PSEUDOMONAS AERUGINOSA			
#4.1	ID-NS16(VK2)	4.1	SUS-NS16 (VK2)
	PSEUDOMONAS AERUGINOSA	SS	CP(<=0.25),MERO(1),TO(<=1)
		R	CAZ(>=64),PIPT(>=128)
		HIDE	CZT(2-SS),IMP(2-SS),LEVO(<=0.12-SS)

Figure 2-CAZ, PIPT, CP, MERO, TO are reported. All other antibiotics are in HIDE.

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Cascade Reporting- Vitek Method

If resistance is encountered, additional antibiotics will automatically be released.

1. For Vitek method, hidden antibiotics will be released when Accept Selected is clicked.

The released results will be visible in Results Summary.

Result can be edited under the VITMIC keyboard but is not needed to report the cascaded antibiotics.

Method: Vitek -urine source

- If patient location is HOC/L7 → report Cefepime
 - o If Ceftazidime Is R → report Cefepime
 - If Cefepime is R→ report Piperacillin tazobactam
 - o If Piperacillin tazobactam is R → report Meropenem
 - o If Meropenem is R → report Imipenem
 - o If Tobramycin is R → report Amikacin**
- 3. **Perform Amikacin testing using the KB method and perform day of use QC.

Organism #1 - APPROXIMATELY 100000 COL/ML PSEUDOMONAS AERUGINOSA				
- VITMIC - (ZZ00)				
	SS	CAZ(2),CP(<=0.25),T0(<=1),CI	EFE(2)	
	HIDE	AK(<=2-SS),CZT(0.5-SS),IMP(1-55),LI	EVO(0.25-SS),MERO(<=0.25-SS),PIPT(<=4-SS)
Online	Instrument Data			
#1.1	ID-NS16(VK2)	1.	.1	SUS-NS16 (VK2)
	PSEUDOMONAS AERUGINOSA	SS	5	CAZ(2),CP(<=0.25),T0(<=1)
		н	IDE	AK(<=2-SS),CEFE(2-SS),CZT(0.5-SS),IMP(1-SS),LEVO(0.25- SS),MERO(<=0.25-SS),PIPT(<=4-SS)

Figure 3-CEFE is released from HIDE because the patient location is L7.

Method: Vitek: -non-urine sources

- If patient location is HOC/L7 → report Cefepime
 - o If Ceftazidime Is R → report Cefepime
 - If Meropenem is R → report Imipenem

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Susceptibility Summary
  Org #4.
                 PSEUDOMONAS AERUGINOSA ISOLATED.
    VITMIC -
                 SS
                         CP(<=0.25),MERO(1),TO(<=1)
                         CAZ(>=64),PIPT(>=128),CEFE(32)
                 R
                         CZT(2-SS), IMP(2-SS), LEVO(<=0.12-SS)
                 HIDE
  Online Instrument Data
  #4.1 ID-NS16(VK2)
                                              SUS-NS16 (VK2)
                                        4.1
        PSEUDOMONAS AERUGINOSA
                                              CP(<=0.25),MERO(1),TO(<=1)
                                        SS
                                              CAZ(>=64),PIPT(>=128)
                                        HIDE
                                              CZT(2-SS), IMP(2-SS), LEVO(<=0.12-
```

Figure 4-CEFE released due to the resistant CAZ.

- 4. All other antibiotics on the panel that are not part of the cascade are hidden. Do not release and report. Hidden antibiotics include:
 - Levofloxacin

Children's

- Ceftazidime-avibactam
- Ceftolozane-tazobactam
- Imipenem-relebactam
- 5. Requested antibiotics may be released with a provider request.

Cascade Reporting-MicroScan Method

If resistance is encountered, additional antibiotics will automatically be released.

- For MicroScan method, hidden antibiotics will be released when File is clicked.
 Results will be visible in Results Summary.
- Enter all results manually under the MMIC keyboard. Antibiotics will be released following the cascade rules.

Method: **MicroScan** – urine source

- If patient location is HOC/L7 → report Cefepime
 - If Ceftazidime Is R → report Cefepime
 - o If Cefepime is R → report Piperacillin tazobactam
 - o If Piperacillin tazobactam is R → report Meropenem



Figure 5 MMIC

3. It will appear as the results are hidden but Sunquest will release from HIDE automatically after results are filed.

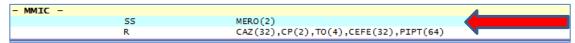


Figure 6

Method: MicroScan - non-urine sources

Children's.

- If patient location is HOC/L7 → report Cefepime
 - If patient has a CF diagnosis → report Aztreonam (respiratory sources)
 - If Ceftazidime Is R → report Cefepime

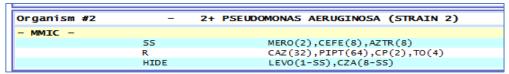


Figure 7 Example of CF patient with resistance.

- 4. All other antibiotics on the panel that are not part of the cascade are hidden. Do not release and report. Hidden antibiotics include:
 - Levofloxacin
 - Ceftazidime-avibactam
- 5. Requested antibiotics may be released with a provider request.

Cascade Reporting- Kirby Bauer Method If resistance is encountered, additional antibiotics will automatically be released.

1. Enter **all** results manually under the **KB** keyboard. Antibiotics will be released following the cascade rules.

Method: **Kirby Bauer** – urine source

- If patient location is HOC/L7 → report Cefepime
 - If Ceftazidime Is R → report Cefepime
 - If Cefepime is R → report Piperacillin tazobactam
 - If Piperacillin tazobactam is R → report Meropenem
 - If Meropenem is R → report Imipenem

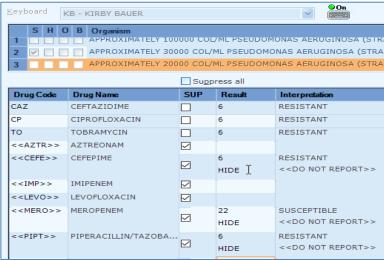


Figure 8 KB keyboard

Organism #3	-	APPROXIMATELY 20000 COL/ML PSEUDOMONAS AERUGINOSA (STRAIN 3)
- KB -		
	SS	MERO(22)
	R	CAZ(6),CP(6),TO(6),CEFE(6),PIPT(6)

Figure 9 -Resistance to CAZ, CEFE, PIPT so Mero is released

Method: Kirby Bauer - non-urine source

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- If patient location is HOC/L7 → report Cefepime
 - If patient has a CF diagnosis → report Aztreonam (respiratory sources)
 - o If Ceftazidime Is R → report Cefepime
 - o If Meropenem is R → report Imipenem

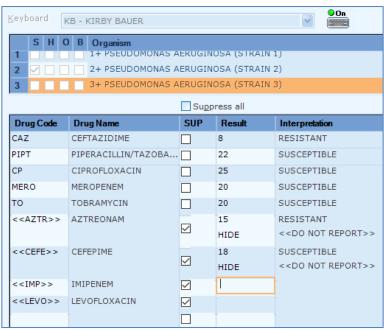


Figure 10 KB keyboard

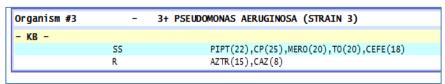


Figure 11 -Example of CF patient with resistance to ceftazidime.

- 2. All other antibiotics on the panel that are not part of the cascade are hidden. Do not release and report. Hidden antibiotics include:
 - Levofloxacin
- Requested antibiotics may be released with a provider request.

Method Performance Specifications

- 1. **CF patients**: *Pseudomonas aeruginosa* matte requires Aztreonam to be performed by Kirby Bauer or MicroScan as it is a product limitation on the Vitek extension cards.
- 2. **CF patients:** Pseudomonas aeruginosa mucoid requires testing by Kirby Bauer method.
- 3. Both Gram negative Vitek cards N806 and XN30 will be required for all *Pseudomonas aeruginosa* isolates.
- 4. Gentamicin is no longer reported on *Pseudomonas aeruginosa* as it is considered intrinsically resistant.



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- 5. Non-CF patients: Do not use the PMAT or PMUC codes. Report as PSAR.
- 6. Mucoid isolate susceptibility testing should be performed with the Kirby Bauer method.

Carbapenemase detection

- If Imipenem or Meropenem exhibits resistance, non-susceptible results, confirm the intermediate or resistant result with an alternate method before reporting results.
 - Confirmation is not needed if patient has known resistance.
- 2. If resistance is not confirmed, report the MicroScan or KB result.
- 3. With known or confirmed resistance:
 - o Report MIC results as tested. Do not change interpretations.
 - Label as MDRO
 - Notify provider
 - Send isolate to MDH Project 1380
 - Add MDHADD comment
 - o Freeze isolate
- 4. Notify Infection Control with positive mCIM result
- 5. Report MDH results with NCPO with negative mCIM result or the appropriate Carbapenemase Producer code. e.g. VIM, KPC, NDM, etc.

Reporting

- 1. Result Pseudomonas aeruginosa matte with code PMAT on CF patients.
- 2. Result Pseudomonas aeruginosa mucoid with code PMUC on CF patients.
- 3. Result *Pseudomonas aeruginosa* with resistance to a carbapenem and negative mCIM result as: example-PSAR-MDRO-NCPO
- Result Pseudomonas aeruginosa with resistance to a carbapenem and positive mCIM result as: example-PSAR-MDRO-VIM
- 5. Add SCAND when MDH reports are scanned.
- 6. Add PRAC with known or previous resistance.

Vitek Product Limitations

Results for an antibiotic/organism combination may have limitations and may be suppressed from reporting. Refer to table below for specific limitations.

Vitek Card	Antibiotic	Action
N806	Ceftazidime MIC =8	Confirm with alternate method
N806	Cefepime MIC = 8 or 16	Confirm with alternate method
XN30	Aztreonam	Perform alternate method
XN30	Ceftazidime/Avibactam MIC = >=16	Confirm with MicroScan



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Appendix

Additional Tables and Flowcharts

Table 1 Antibiotics available on Vitek cards-run both cards for all Pseudomonas aeruginosa isolates

N806	XN30
Ampicillin	Amikacin
Ampicillin Sulbactam	Amoxicillin Clavulanic Acid
Cefazolin	Aztreonam
Cefepime	Cefotaxime
Ceftazidime	Cefpodoxime
Ceftriaxone	Ceftazidime/Avibactam
Ciprofloxacin	Ceftolozane/Tazobactam
Ertapenem	Doxycycline
ESBL	Imipenem
Gentamicin	Imipenem/Relebactam
Levofloxacin	Meropenem/Vaborbactam
Meropenem	Minocycline
Nitrofurantoin	Tigecycline
Piperacillin/Tazobactam	Tobramycin
Trimethoprim/Sulfa	

Table 2 Antibiotic reportable per CLSI for Pseudomonas aeruginosa

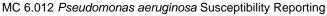
Table 2 Antibiotic reportable per CLSI for Pseudomonas aeruginosa				
Antibiotics on Pseudomonas aeruginosa per CLSI				
Sunquest code	Antibiotic name			
CAZ	Ceftazidime			
CEFE	Cefepime			
TO	Tobramycin			
PIPT	Piperacillin/Tazobactam			
CIP	Ciprofloxacin			
LEVO	Levofloxacin			
IMP	Imipenem			
MERO	Meropenem			
CZA	Ceftazidime/Avibactam			
CZT	Ceftolozane/Tazobactam			
IMIR	Imipenem/Relebactam			
AZT	Aztreonam			
AK	Amikacin			
CEF	Cefiderocol			



Drugs reported on Urine	Cascade Rules
Ceftazidime	If patient is in HOC/L7
Ciprofloxacin	Report Cefepime
Tobramycin	If Ceftazidime is resistant
Hidden Drugs	Report Cefepime
Cefepime	If Cefepime is resistant
Piperacillin/Tazobactam	Report Piperacillin/Tazobactam
Meropenem	If Piperacillin/Tazobactam is resistant
Imipenem	Report Meropenem
Amikacin	If Meropenem is resistant
Levofloxacin	Report Imipenem
Ceftazidime/Avibactam	If Tobramycin is resistant
Ceftolozane/Tazobactam	Report Amikacin-KBS
Imipenem/Relebactam	

Table 4 Selective and Cascade for non-urine isolates

Drugs reported on Non-Urine	Cascade Rules
<u> </u>	
Ceftazidime	If patient is HOC/L7
Piperacillin/Tazobactam	Report Cefepime
Ciprofloxacin	If Ceftazidime is resistant
Meropenem	Report Cefepime
Tobramycin	If Meropenem is resistant
Aztreonam-CF patient only (KBS or MSCN)	Report Imipenem
Hidden Drugs	
Cefepime	
Imipenem	
Levofloxacin	
Ceftazidime/Avibactam	
Ceftolozane/Tazobactam	
Imipenem/Relebactam	



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Alternative methods: when reported drugs fail, have a product limitation or a physician wants to add a drug**

Table 5 KBS Antibiotics and codes

NF KBS				
Disc (Abbrev.)	Sunquest Code	Drug Name (Trade Name)		
ATM	AZTR	AZTREONAM		
CAZ	CAZ	CEFTAZIDIME		
CIP	CP	CIPROFLOXACIN		
FEP	CEFE	CEFEPIME		
IMP	IMP	IMIPENEM		
LVX	LEVO	LEVOFLOXACIN		
MEM	MERO	MEROPENEM		
NN	TO	TOBRAMYCIN		
TZP	PIPT	PIP/TAZ (ZOSYN)		
	Need QC day of testing			
AK	AK	AMIKACIN- Urine only		



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Table 6 MicroScan antibiotics and codes

MicroScan MIC Neg Urine Combo (NUC) 101			
MSCN (Abbrev.)	Sunquest Code	Drug Name (Trade Name)	
Azt	AZTR	AZTREONAM	
Caz	CAZ	CEFTAZIDIME	
Сре	CEFE	CEFEPIME	
Ср	CP	CIPROFLOXACIN	
Lvx	LEVO	LEVOFLOXACIN	
Mer	MERO	MEROPENEM	
P/T	PIPT	PIP/TAZ (ZOSYN)	
То	TO	TOBRAMYCIN	

^{**}If a physician wants to add-on a drug that we do not have, send to UM Fairview Medical Center**

Table 7 CF patients

If organism is from CF patient			
Determine if is PMAT or PMUC			
PMAT	PMUC		
Add Aztreonam by KBS or MicroScan	All drugs set up by KBS		

Table 8 Carbapenem resistance

If resistant or intermediate Impenem or Meropenem

in resistant of intermediate impenent of weropenent					
Confirm by pa	Confirm by patient history, MicroScan or Kirby Bauer				
Confirmed by History Resistance not confirmed		Resistance confirmed by KB or MicroScan			
Report result	 Report KB or MicroScan result 	 Report Vitek Results as tested 			
Add MDRO		 Add MDRO 			
> Add PRAC		Freeze isolate			
		Notify provider			
		 Send isolate to MDH 			
		 Add MDHADD code 			
		Wait for MDH report			



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Table 9 mCIM results and reporting

Table 9 menti results and reporting			
CPO positive from MDH	CPO Negative from MDH		
 Notify Infection Prevention 	 Remove MDHADD code 		
 Add KPC, NDM, VIM, etc code 	 Add NCPO after organism ID 		
 Result will stay in prelim status until hard copy for MDH is received 	 Add SCAND comment 		
Remove MDHADD code	 Final culture 		
Add DRO code			
Add SCAND code			
 Final culture when hard copy is received 			
Future positive with same ID can be PRAC, no call to IP			

References

- 1. bioMerieux Vitek 2 AST-N806 Gram Negative Susceptibility Card 424709 2023-07
- bioMerieux Vitek 2 AST-XN30 Gram Negative Susceptibility Card 424639 20235-04
- 3. Beckman Coulter Diagnostics. 250 South Kraemer Boulevard. Brea, CA 92821-6232 USA,



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MicroScan® Dried Gram Negative (8/2022).
4. CLSI M100 edition 34 Performance Standards for Antimicrobial Susceptibility Testing 2024

	Training Plan		Initial Competency Assessment				
Training Plan/ Competency Assessment	 Employee must read the procedure. Employee will observe trainer performing the procedure. Employee will demonstrate the ability to perform procedure, record results and document corrective action after instruction by the trainer. 			1.	Direct observation.		
Historical Record		Version	Written/Revised by:		Effective Date:	Summary Revisions	of
		1	Susan DeMeyere		7/30/2024	Initial version	