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

1. 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

2. 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.
2. Matte *Pseudomonas aeruginosa* (PMAT). Set up both Vitek cards and perform KB testing for Aztreonam.

Selective Reporting

1. Antibiotics will be reported in a specific order indicating the first and subsequent preferences of the Antimicrobial Stewardship Committee and Infectious Disease physicians
2. Antibiotics will be reported depending on the source, if the sample is a urine or non-urine 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
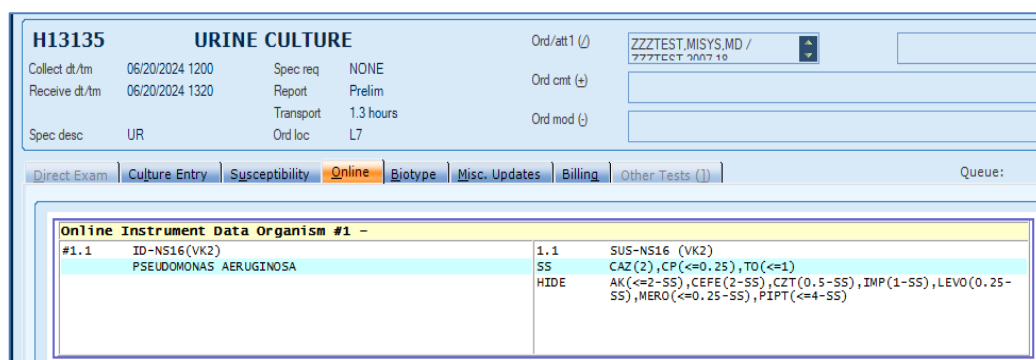   3. Tobramycin

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.
    1. Ceftazidime
    2. Piperacillin-tazobactam
    3. Ciprofloxacin
    4. Meropenem
    5. Tobramycin
    6. Aztreonam-CF patients only, using the KB or MicroScan method
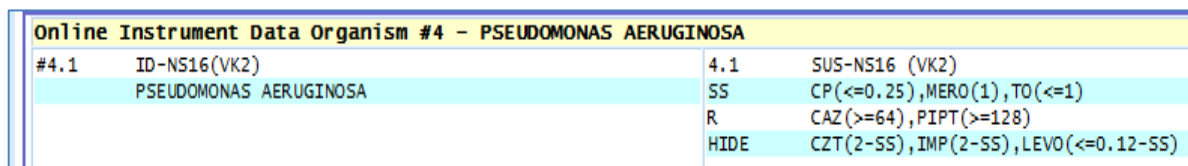

Figure 2-CAZ, PIPT, CP, MERO, TO are reported. All other antibiotics are in HIDE.

6. If any carbapenem is resistant, confirm result by alternate method. Report in Sunquest if confirmed resistant and submit isolate to MDH. See Carbapenemase Detection section of procedure for further instructions. Resistant carbapenems will be reported regardless of selective or cascade reporting.
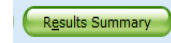
Cascade Reporting- Vitek Method

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

1. For Vitek method, hidden antibiotics will be released when Accept Selected is clicked.
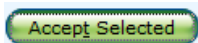
    [Accept Selected] The released results will be visible in Results Summary. [Results Summary]

2. Results 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
  - 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
          - 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),TO(<=1),CEFE(2)
                HIDE        AK(<=2-SS),CZT(0.5-SS),IMP(1-SS),LEVO(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      CAZ(2),CP(<=0.25),TO(<=1)
                                                  HIDE    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
  - If Ceftazidime Is R → report Cefepime
    - If Meropenem is R → report Imipenem


```
Susceptibility Summary

Org #4.         PSEUDOMONAS AERUGINOSA ISOLATED.
- VITMIC -
        SS      CP(<=0.25),MERO(1),TO(<=1)
        R       CAZ(>=64),PIPT(>=128),CEFE(32)
        HIDE    CZT(2-SS),IMP(2-SS),LEVO(<=0.12-SS)


Online Instrument Data
#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)
```
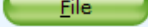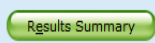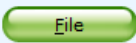
Figure 4-CEFE released due to the resistant CAZ

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
    - 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.

1. For MicroScan method, hidden antibiotics will be released when File [File] is clicked. Results will be visible in Results Summary. [Results Summary]

2. 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
    - If Cefepime is R → report Piperacillin tazobactam
      - 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. [File]

Figure 6

Method**: MicroScan** – non-urine sources

- 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


```
Organism #2        -    2+ PSEUDOMONAS AERUGINOSA (STRAIN 2)
- MMIC -
                SS          MERO(2),CEFE(8),AZTR(8)
                R           CAZ(32),PIPT(64),CP(2),TO(4)
                HIDE        LEVO(1-SS),CZA(8-SS)
```
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
    o   If Ceftazidime Is R → report Cefepime
        o   If Cefepime is R → report Piperacillin tazobactam
            o   If Piperacillin tazobactam is R → report Meropenem
                o   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

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

3. 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. 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	1. If a carbapenem exhibits resistance, confirm the resistant result with an alternate method before reporting results.
	   o 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.
	   o Label as **MDRO**
	   o Notify provider
	   o Send isolate to MDH Project 1380
	   o 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 4. 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

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

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

Table 3 Selective and Cascade for Urine isolates

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
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	

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

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
Cpe	CEFE	CEFEPIME
Cp	CP	CIPROFLOXACIN
Lvx	LEVO	LEVOFLOXACIN
Mer	MERO	MEROPENEM
P/T	PIPT	PIP/TAZ (ZOSYN)
To	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 Imipenem or Meropenem		
• 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

Table 9 mCIM results and reporting

CPO positive from MDH	CPO Negative from MDH
• Notify Infection Prevention	o Remove MDHADD code
• Add KPC, NDM, VIM, etc code	o Add NCPO after organism ID
• Result will stay in prelim status until hard copy for MDH is received	o Add SCAND comment
• Remove MDHADD code	o 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
2. 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, MicroScan® Dried Gram Negative (8/2022).
4. CLSI M100 edition 34 Performance Standards for Antimicrobial Susceptibility Testing 2024

Training Plan/ Competency Assessment

Training Plan	Initial Competency Assessment
1. Employee must read the procedure. 2. Employee will observe trainer performing the procedure. 3. 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 of Revisions
1	Susan DeMeyere	7/30/2024	Initial version
2	Susan DeMeyere	7/31/2024	Removed rule for Imipenem resistance. Added rule for carbapenem resistance.