The Devil is in the Details: Data Discrepancies in Stewardship

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Disclosures

- I have no relevant financial disclosures

Objectives

- Identify data sources to support stewardship activities
- Outline how to identify common errors in EHR data commonly used in stewardship
- List validation steps to assess an antibiogram generated from outside software platforms

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38 community hospitals

5 states

Augusta Health
Carteret Health Care
Chatham Hospital UNC Health Care
Chesapeake Regional Medical Center
Community Memorial Hospital
Conway Medical Center
Granville Health System
Atrium Health Wake Forest Baptist High Point Medical Center
Indian River Medical Center
Iredell Health System
Johnston UNC Health Care
Maria Parham Medical Center
Nash UNC Health Care
Northern Regional Hospital
Piedmont Athens Regional
Piedmont Atlanta Hospital
Piedmont Cartersville Medical Center
Piedmont Columbus and Midtown
Piedmont Eastside Medical Center
Piedmont Fayette Hospital
Piedmont Henry Hospital
Piedmont Macon North Hospital
Piedmont Macon Medical Center
Piedmont Mountainside Hospital
Piedmont Newnan Hospital
Piedmont Newton Hospital
Piedmont Rockdale
Piedmont Walton
UNC Health Southeastern
UNC Lenoir Healthcare
UNC Rex Healthcare
UNC Rockingham Healthcare
Sovah Health Danville
Sovah Health Martinsville
Tidelands Georgetown Memorial Hospital
Tidelands Waccamaw Community Hospital
Wayne UNC Health Care

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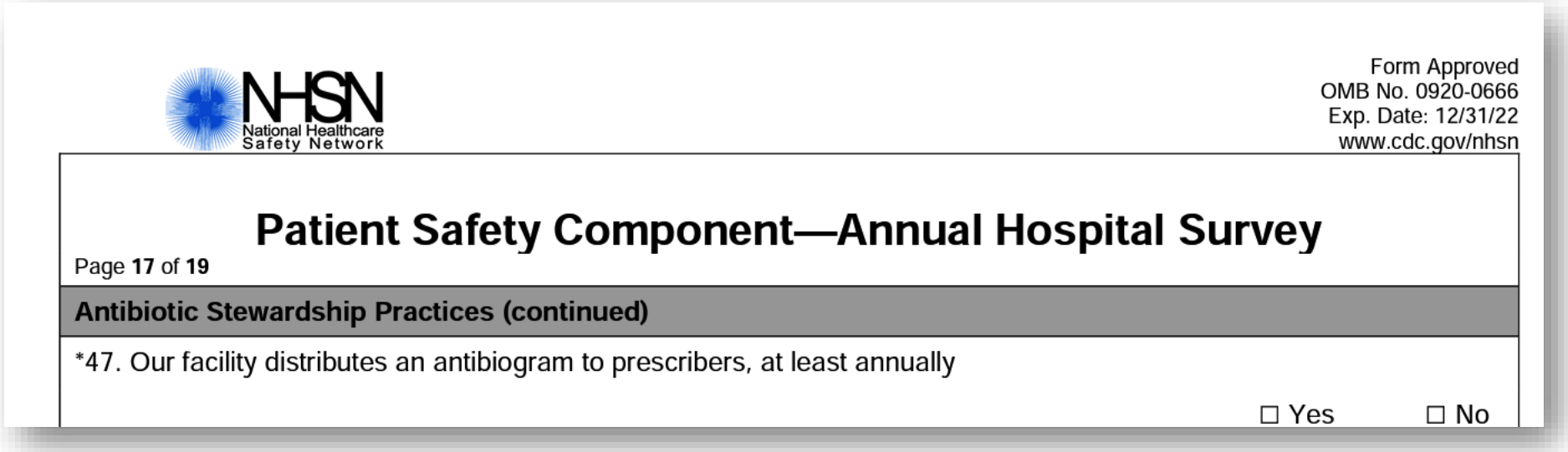
Antibiograms- Background

- We check the box- every year on our NHSN Annual Survey



NHSN National Healthcare Safety Network

Form Approved
OMB No. 0920-0666
Exp. Date: 12/31/22
www.cdc.gov/nhsn

Patient Safety Component—Annual Hospital Survey

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Antibiotic Stewardship Practices (continued)

*47. Our facility distributes an antibiogram to prescribers, at least annually

☐ Yes ☐ No

- That means I am compliant right?

https://www.cdc.gov/nhsn/forms/57.103_pshospsurv_blank.pdf

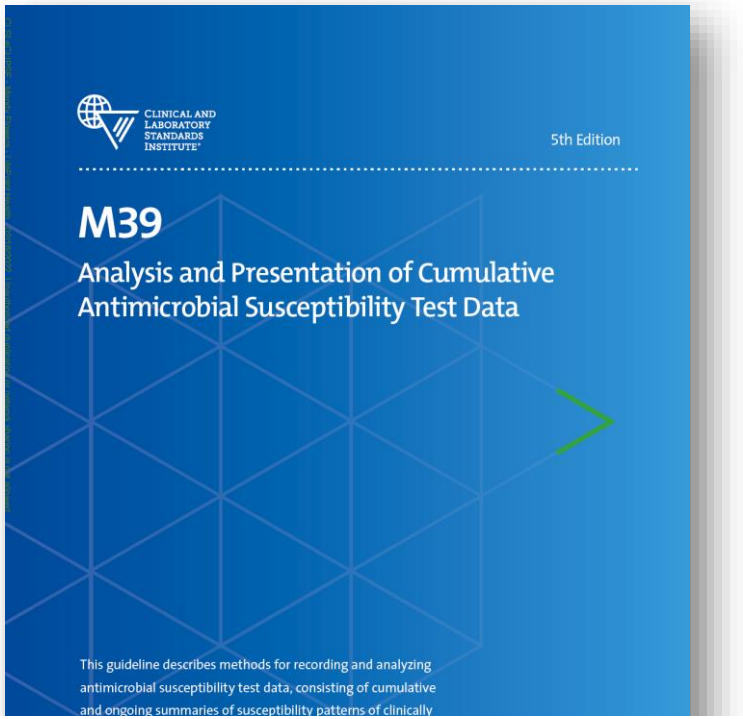
How Often Are Antibiograms Correct?

Indicates non-duplicate isolates only

38%

Includes at least a year of data

94%



At least 30 isolates

52%

Reports only CLSI approved combinations

38%

Full Compliance: 9%

Moehring RW et al *J Clin Microbiol* 2015;53:2977-82.

Example 1

10 or more Isolates — **Any Source - Any Location**

☐ Indicates less than 30 isolates tested

Organisms	Total Isolates	Ampicillin	Ampicillin/Sulbactam	Cefazolin	Cefepime	Ceftazidime	Ceftriaxone	Ciprofloxacin	Clindamycin	Gentamicin	Imipenem	Levofloxacin	Oxacillin	Penicillin G	Piperacillin/Tazobactam	Sulfamethoxazole/Trimethoprim	Tetracycline	Tobramycin	Vancomycin
Gram Negative																			
Acinetobacter baumannii	10		100		80	90		80		90		80				80		0	
Citrobacter freundii	15	27	73	20			73	100		100	100	100			93	93			
Enterobacter aerogenes	22	18	59	5			86	100		100	100	100			86	95			
Enterobacter cloacae	35	6	20	0			63	83		97	100	83			91	89		0	
Escherichia coli	575	54	58	94			99	76		92	100	76			99	74		60	
Klebsiella oxytoca	11		82	73			100	91		100	100	86			100	91			
Klebsiella pneumoniae	172	0	87	96			98	95		97	99	97			98	88		0	
Morganella morganii	19	11	16	5			84	63		95	74	70			100	74		0	
Proteus mirabilis	106	97	98	98			100	80		92	75	84			100	88		38	
Pseudomonas aeruginosa	71				89	92		79		89	92	76			100			100	

Blank cells indicate drug not tested or drug not indicated.

Reporting When Testing Not Done/Indicated

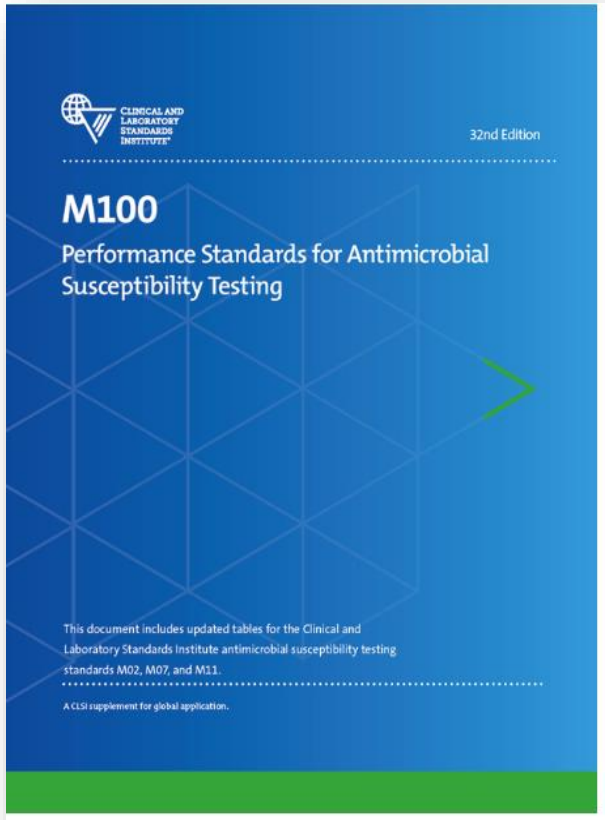
Bacterial Isolates (January through December 2021)

Numbers reflect percent susceptible based on achievable concentrations.
Data obtained from bioMérieux Vitek 2
R indicates intrinsic resistance or 0% susceptibility
Blank indicates no data available
Green font indicates >5% increase year-over-year
Red font indicates >5% decrease year-over-year
1. Amoxicillin tested on *Streptococcus pneumoniae*
2. Ceftazidime susceptibility reported for Aztreonam (*Pseudomonas aeruginosa*)
3. Interpret results with less than 30 isolates with caution
Version Date: March 31, 2022

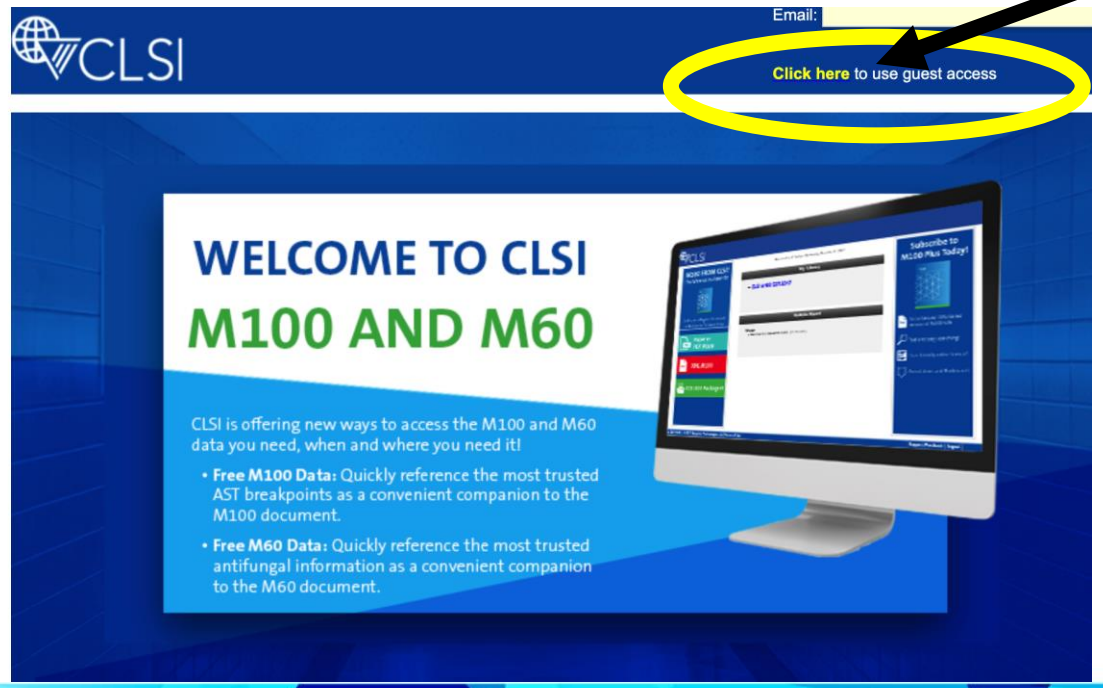
	Number of Isolates	Amikacin	Ampicillin (Amoxicillin tested on *Streptococcus Pneumoniae*)	Ampicillin/Sulbactam	Aztreonam[2]	Cefazolin	Cefepime	Cefotaxime
Gram Negative Bacilli								
Acinetobacter spp.	**48**	-	R	91	R	R	74	N
Citrobacter freundii	**42**	N	R	R	N	R	98	N
Citrobacter koseri	**50**	N	R	N	N	96	100	N
Enterobacter aerogenes	**67**	N	R	R	N	R	100	N
Enterobacter cloacae	**137**	N	R	R	N	R	96	N
Escherichia coli	**2592**	N	53	64	N	88	92	N
Klebsiella oxytoca	**57**	N	R	65	N	67	88	N
Klebsiella pneumoniae	**720**	N	R	80	N	91	93	N
Morganella moganii	**55**	N	R	6	N	R	98	N
Proteus mirabilis	**538**	N	72	90	N	88	93	N
Providencia stuartii	**46**	N	R	41	N	R	100	N
Pseudomonas aeruginosa	**356**	97	R	R	89	R	88	R
Serratia marcescens	**98**	N	R	R	N	R	99	N
Stenotrophomonas maltophilia	**35**	R	R	R	R	R	N	R

- Using standard abbreviations gives better data to prescribers than blank cells
  - N for non-tested and
  - R for intrinsic resistance

Resource: CLSI M-100 Document



- It is FREE!
  - https://clsi.org/standards/products/free-resources/access-our-free-resources/



Resource: Testing Recommendations

Table 1A: Agents to Test

Table 1A. Suggested Groupings of Antimicrobial Agents Approved by the US Food and Drug Administration for Clinical Use That Should Be Considered for Testing and Reporting on Nonfastidious Organisms by Microbiology Laboratories in the United States

Group A: Includes antimicrobial agents considered appropriate for inclusion in a routine, primary testing panel, as well as for routine reporting of results for the specific organism group.			
Enterobacterales	***Pseudomonas aeruginosa***	***Staphylococcus* spp.**	***Enterococcus* spp.[a]**
Ampicillin[b]	Ceftazidime	Azithromycin[c] or clarithromycin[c] or erythromycin[c]	Ampicillin[d] Penicillin[e]
Cefazolin[f]	Gentamicin Tobramycin		
Gentamicin[b] Tobramycin[b]	Piperacillin-tazobactam	Clindamycin[c]	
		Oxacillin[g,h,i,j,k] Cefoxitin[g,h,j] (surrogate test for oxacillin)	
		Penicillin[g]	
		Trimethoprim-sulfamethoxazole	

Appendix B: Intrinsic Resistance

Antimicrobial Agent → / Organism ↓	Ampicillin	Amoxicillin-clavulanate	Ampicillin-sulbactam	Ticarcillin	Cephalosporins I: Cefazolin, Cephalothin	Cephamycins: Cefoxitin, Cefotetan	Cephalosporin II: Cefuroxime	Imipenem	Tetracyclines	Tigecycline	Nitrofurantoin	Polymyxin B Colistin	Aminoglycosides
Citrobacter freundii	R	R	R		R	R	R						
Citrobacter koseri, Citrobacter amalonaticus group[a]	R			R									
Enterobacter cloacae complex[b]	R	R	R		R	R							
Escherichia coli	There is no intrinsic resistance to β-lactams in this organism.												

Clinical and Laboratory Standards Institute (CLSI). *Performance Standards for Antimicrobial Susceptibility Testing*. 32nd ed. CLSI supplement M100 (2022)

Example 2

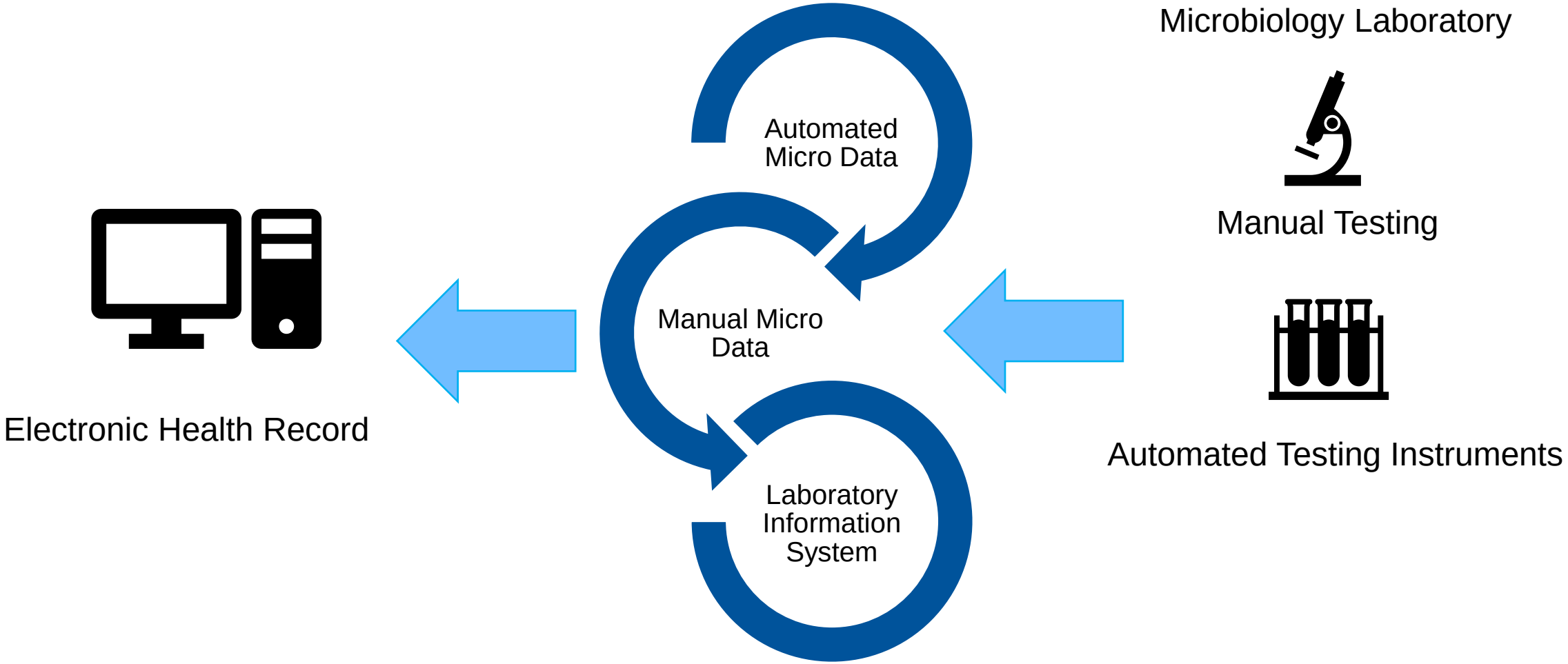
10 or more Isolates — **Any Source - Any Location**

☐ Indicates less than 30 isolates tested

Organisms	Total Isolates	Ampicillin	Ampicillin/Sulbactam	Cefazolin	Cefepime	Ceftazidime	Ceftriaxone	Ciprofloxacin	Clindamycin	Gentamicin	Imipenem	Levofloxacin	Oxacillin	Penicillin G	Piperacillin/Tazobactam	Sulfamethoxazole/Trimethoprim	Tetracycline	Tobramycin	Vancomycin
Gram Negative																			
Pseudomonas aeruginosa	71				89	92		79		89	92	76			100			43	

Blank cells indicate drug not tested or drug not indicated.

Know Your Data Source: Tiered Reporting



Example 2: Cascaded Susceptibility Data

10 or more Isolates — **Any Source - Any Location**

☐ Indicates less than 30 isolates tested

Organisms	Total Isolates	Ampicillin	Ampicillin/Sulbactam	Cefazolin	Cefepime	Ceftazidime	Ceftriaxone	Ciprofloxacin	Clindamycin	Gentamicin	Imipenem	Levofloxacin	Oxacillin	Penicillin G	Piperacillin/Tazobactam	Sulfamethoxazole/Trimethoprim	Tetracycline	Tobramycin	Vancomycin
Gram Negative																			
Pseudomonas aeruginosa	71				89	92		79		89	92	76			100			43	

Blank cells indicate drug not tested or drug not indicated.

- Of the 71 isolates, all were tested against gentamicin (8 resistant), those 8 were tested against tobramycin, 3 of those were resistant

How to figure this out

- You need access to numerator and denominator data
  - Some automated programs show this by simply hovering over the cell
  - For others, you need to go to the raw output

	Enterococcus faecium (54)		Enterococcus gallinarum (8)		Escherichia coli (2538)	
	S	Total	S	Total	S	Total
Amikacin					100%	(9)
Gentamicin					92%	(2530)

Example 3

	P. aeruginosa
# Isolates	77
Amikacin	88%(77)
Ampicillin	
Amp/Sublac	
Cefazolin	
Cefepime	71%(77)
Cefoxitin	
Ceftazidime	75%(77)
Ceftriaxone	
Ciprofloxicin	73%(77)
ESBL	
Gentamicin	67%(77)
Levofloxacin	69%(77)
Meropenem	90%(77)
Nitrofurantoin	
Pip/Taz	100%(60)
Tobramycin	86%(77)
SXT	

Gram Negative Bacilli	Piperacillin/Tazobactam
Acinetobacter baumannii	69
Citrobacter freundii	90
Citrobacter koseri	100
Enterobacter aerogenes	77
Enterobacter cloacae	79
Escherichia coli	97
Klebsiella oxytoca	96
Klebsiella pneumoniae	92
Morganella morganii	98
Proteus mirabilis	99
Providencia stuartii	98
Pseudomonas aeruginosa	100
Serratia marcescens	

30 or more Isolates **Any Sc**

Indicates less than 30 isolates tested
Increase of 5% or more
Decrease of 5% or more
Not enough data

Organisms	Total Isolates	Piperacillin/Tazobactam
		–
Gram Negative		
Escherichia coli	128	96
Klebsiella pneumoniae	58	97
Proteus mirabilis	32	100
Pseudomonas aeruginosa	65	100

Example 3: Know your reporting limitations

LIMITATIONS

Perform an alternative method of testing prior to reporting of results for the following antibiotic/organism combination(s):

- Amikacin: *Acinetobacter baumannii*
- Ampicillin/Sulbactam: *Citrobacter* spp., *Enterobacter* spp., *Pantoea* spp., *Serratia* spp., *Cronobacter sakazakii*
- Aztreonam: *Pseudomonas* spp.
- Imipenem: *Serratia marcescens*
- Piperacillin/Tazobactam: *Serratia marcescens*

Perform an alternative method of testing prior to reporting results when a resistant result is obtained with the following antibiotic/organism combination(s):

- Imipenem: *Aeromonas* spp.
- Meropenem: *Aeromonas* spp.

bioMérieux SA English - 2

VITEK® 2 AST-N308 9310748-P1EN1 - 2015/08

- Piperacillin/Tazobactam: *Pseudomonas aeruginosa*

https://www.ilexmedical.com/files/Vitk2%20MSDS/Package_Insert_-_AST-N308_-_B_-_416913.pdf

Example 3: Local reporting rules

(95) - TZP PL PSEUDO R (Enabled)
Type: Custom

Conditions

If	Organism is Pseudomonas aeruginosa
And	Antibiotic is Piperacillin/Tazobactam, Interpretation R, Antibiotic Type: Tested

Actions

Then	Suppress from reporting Piperacillin/Tazobactam

Data Discrepancies: Not Just for Antibiograms

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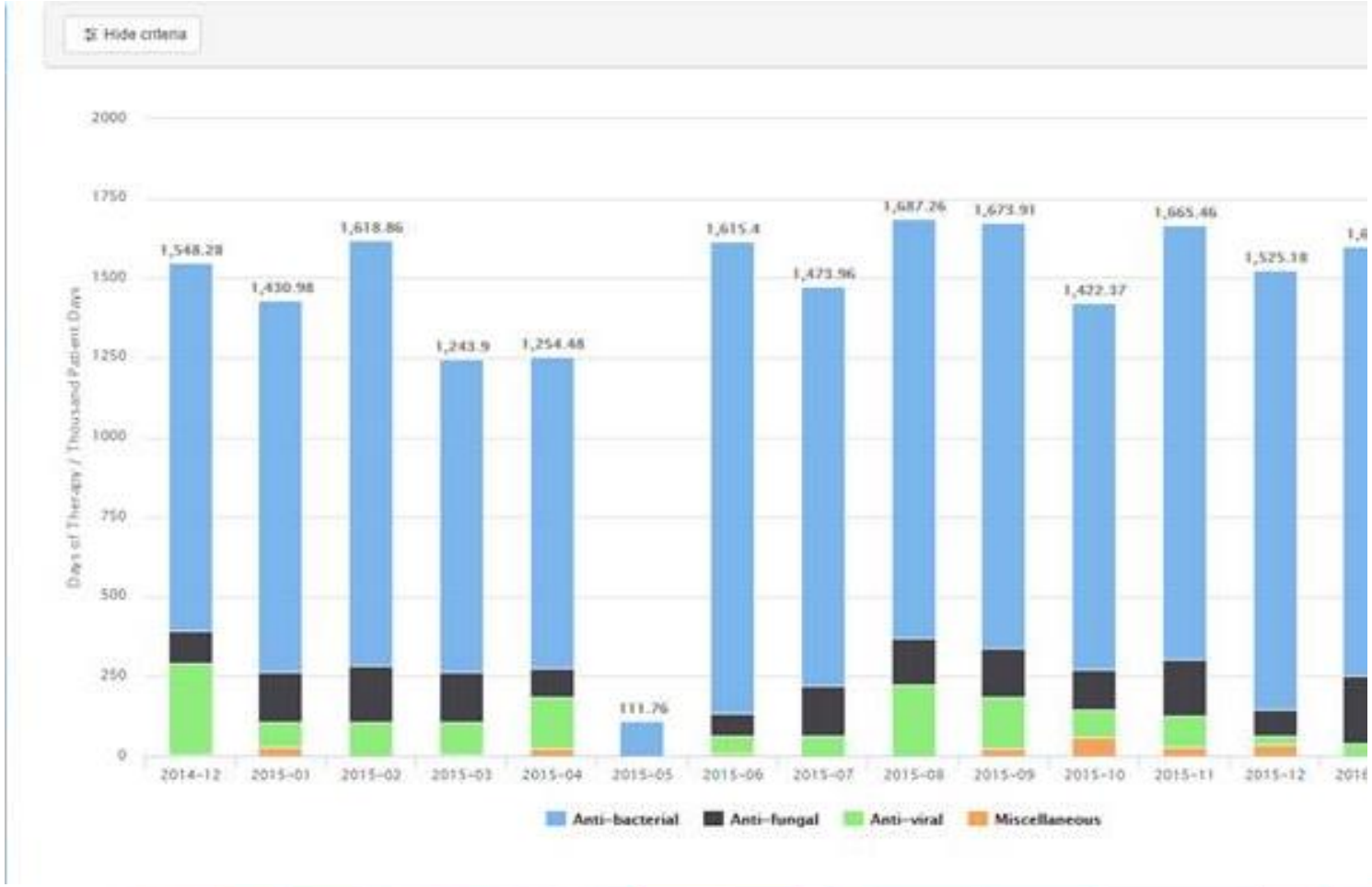
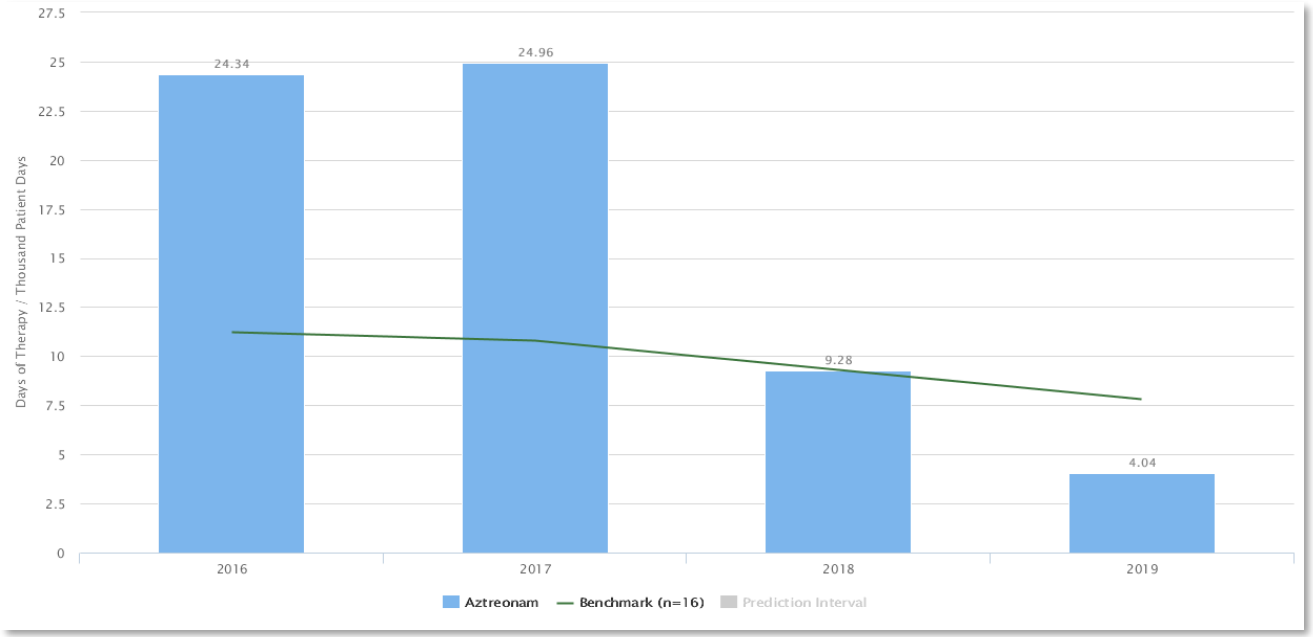
Ongoing Data Validation: Missing Data



When the data are just too good to be true…



~3000 administrations of Azithromycin reported in the form “AZITHROMYCIN 500 MG/250 ML MINIBAG PLUS” were incorrectly mapped to Aztreonam. Changing these will lower the total number of Aztreonam administrations in the database from ~7400 to ~4400, and increase the number of Azithromycin administrations from ~3600 to ~6600.

Proposed Ongoing Data Validation

- Simple:
  - Alert if any antibiotic that previously had use reported is now 0
  - Confirm oral vancomycin in each data dump
  - Alert if any antibiotic has more than a 20% increase or decrease in use over previous month
  - Antibiotics administered each day and each hour of each day for all locations
  - Use on any unit with previous antibiotic use drops to 0
- Other places to check:
  - Has unit mapping changed
  - Has construction changed where patients are (some automated dispensing cabinets do not change names when moved!)
  - Of course- have any shortages resulted in drug changes?

CDC Tools for Data Validation

Data Validation

AU Option Validation

AU Option Implementation Data Validation – February 2021 [PDF – 1 MB] (print version)

- Customizable Form [DOC – 250 KB] (print version)

AU Option Annual Data Validation – February 2021 [PDF – 1 MB]

- Customizable Form [DOC – 1 MB]

AU Option Data Quality Line List – August 2020 [PDF – 550 KB]

AR Option Validation

AR Option Data Validation – April 2021 [PDF – 400 KB]

- Customizable Form [DOC – 200 KB]

Use the Data Quality Line List

The AU Option Data Quality Line List provides facilities with a quick v

1. Zero or missing antimicrobial days
2. Antimicrobial days reported with patients were not present
3. Antimicrobial days ≥ Days present
4. Sum of routes < Total Antimicrobial days

https://www.cdc.gov/nhsn/psc/aur/index.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fnhsn%2Facute-care-hospital%2Faur%2Findex.html

Assessment question #1

- Which of the following data sources is the best for generated automated microbiology reports to support stewardship work?

a. Laboratory information system (LIS)
b. Electronic health record
c. Automated testing instrument
d. No single best source

Assessment question #1

- Which of the following data sources is the best for generated automated microbiology reports to support stewardship work?

a. Laboratory information system (LIS)
b. Electronic health record
c. Automated testing instrument
d. No single best source

Answer D is correct because each of the Listed data sources (A, B and C) has unique challenges related to data output, it is important for stewards to understand local implementation strategies to allow best use of available data sources.

Assessment Question #2

- Which of the following should raise concerns during antibiogram validation?

a. Fewer than 30 isolates reported
b. Fluoroquinolone susceptibility that changes by more than 10%
c. Great differences in susceptibility for drugs in same class
d. MRSA rates < 40%

Assessment Question #2

- Which of the following should raise concerns during antibiogram validation?

a. Fewer than 30 isolates reported

b. Fluoroquinolone susceptibility that changes by more than 10%

c. Great differences in susceptibility for drugs in same class

d. MRSA rates < 40%

Assessment Question #2

- As discussed in our example, C is the correct answer- this is often seen with big changes in resistance rates between agents in the fluoroquinolone or aminoglycoside classes. It can also be seen with some cephalosporins. A is incorrect and although it does not follow CLSI standards for antibiogram reporting is not a data integrity issue in most cases. Especially in coming years a 10-15% change in fluoroquinolone susceptibilities are expected due to recently approved breakpoint modifications. Lastly, MRSA rates <40% are common in hospitals and likely does not represent a data validation concern.

Assessment Question #3

- As a stewardship pharmacist, you routinely monitor you antibiotic use data and notice trends for the last quarter had a 25% increase in reported use. What should your first step be to assess this?

a. Check denominator data
b. See if the unit has closed due to construction
c. Schedule a meeting with the prescribers
d. Check if new antibiotic formulations have been added

Assessment Question #3

- As a stewardship pharmacist, you routinely monitor you antibiotic use data and notice trends for the last quarter had a 25% increase in reported use. What should your first step be to assess this?

a. Check denominator data
b. See if the unit has closed due to construction
c. Schedule a meeting with the prescribers
d. Check if new antibiotic formulations have been added

Assessment Question #3

Whenever you observe a great increase in rate of antibiotic use, it is always wise to start by checking if denominator data are missing as this can cause falsely elevated rates of use. Two of the other choices, B and D can be causes of data discrepancies but these would typically result in lower antibiotic use (unless a unit close so all denominator data are absent). It is never wise to schedule a meeting with prescribers (option C) before understanding the cause of the change in use rates.