Antibiogram Development and Utilization for Antimicrobial Stewardship Programs

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Objectives

- Understand how antimicrobial stewardship teams can collaborate with microbiology laboratories to develop institutional antibiograms
- Describe the principles of antibiogram development
- Identify antibiogram applications for antimicrobial stewardship program (ASP) initiatives

What is an Antibiogram?

- Antibiogram: A report that displays cumulative antimicrobial susceptibility testing (AST) data from an institution on an annual basis

Gram Negative Organisms (%Susceptible)		Penicillins/Beta-lactam Combinations			Cephalosporins					Aminoglycosides			Fluoro-quinolones		Carbapenems		Other		
					1st	Cepha-mycin	3rd		4th										
	Number of Isolates*	Ampicillin	Ampicillin-Sulbactam	Piperacillin-Tazobactam	Cefazolin	Cefoxitin	Ceftazidime 3rd	Ceftriaxone 3rd	Cefepime 4th	Gentamicin	Tobramycin	Amikacin	Ciprofloxacin**	Levofloxacin**	Ertapenem	Meropenem	Aztreonam	Tetracycline	Trimethoprim-Sulfamethoxazole
AVERAGE OF ALL FACILITIES																			
Enterobacterales																			
Escherichia coli	8806	49	54	93	72	95	91	91	91	91	90	100	79	81	99	100	91	73	72
Klebsiella oxytoca	318		34	90	25	95	91	91	91	94	94	100	93	98	99	99	91	87	89
Klebsiella pneumoniae	2279		77	90	81	92	90	90	90	95	94	100	91	95	99	99	90	83	87
Proteus mirabilis	672	71	83	96		97	93	89	91	90	89	99	74	77	99	100	92		77
ampC Mediated Resistance																			
Citrobacter amalonaticus complex	54			94					96	91	93	100	83	83	98	100		82	80
Citrobacter freundii complex	233			82					94	93	93	99	88	92	98	99		76	81
Citrobacter koseri	146			97					98	99	99	100	96	97	99	99		96	97
Enterobacter cloacae complex	588			82					90	96	96	100	95	97	94	99		90	88
Klebsiella aerogenes	262			81					94	98	98	100	98	99	99	99		92	98
Morganella morganii	99			96					93	87	82	99	68	75	100	100		51	68
Providencia stuartii	37			97					87			100	43	46	97	100			89
Serratia marcescens	138			99					98	100	95	100	95	99	99	99			91
Non-Enterobacterales																			
Acinetobacter baumannii/calcoaceticus complex	145		65	53			63	41	60	60	82	88	55	57		61		55	61
Pseudomonas aeruginosa	1534			89			90		91	95	98	99	84	83		92	79		
Stenotrophomonas maltophilia	126						49							66					96

Breakpoints and Interpretations

- Breakpoint
  - Minimum inhibitory concentration (MIC) used to categorize an organism as susceptible, intermediate, or resistant
- Ex: Ceftriaxone breakpoints for *Escherichia coli*

Interpretative Category	Breakpoint
Susceptible	≤ 1 mcg/mL
Intermediate	2 mcg/mL
Resistant	≥ 4 mcg/mL

- Susceptible (S)
  - MIC is ***below*** "S" breakpoint
  - Isolates are inhibited by standard antibiotic doses
  - High probability of clinical efficacy
- Intermediate (I)
  - MIC ***above*** "S" and **approaches** "R" breakpoint
  - Higher-than-normal dose needed
  - Lower response rate than "S" isolates
- Resistant (R)
  - MIC ***above*** "R" breakpoint
  - Unachievable concentrations with maximal antibiotic doses
  - Likely lead to treatment failure

CLSI. M39-Antibiogram.

Culture and Sensitivity (C&S) Report

- **Source:** Urine, clean catch
- **Culture result:** 100,000 CFU/mL *Escherichia coli*
- **Susceptibilities**

Drug	MIC (mcg/mL)	Interpretation
Ampicillin	> 32	Resistant
Cefazolin	4	Susceptible
Ciprofloxacin	0.25	Susceptible
Nitrofurantoin	<32	Susceptible
TMP/SMX	>4/76	Resistant

MIC Interpretations

- Susceptibility *in vitro* does not uniformly predict clinical success *in vivo*
  - The only true measure of bacterial response to an antibiotic is the clinical response of the patient

- A common misconception is to choose the antibiotic with the lowest MIC number
  - Interpretation of quantitative susceptibility tests is based on the relationship of the MIC to the achievable concentration of antibiotic in body fluids with the dosage given for a given organism
  - MIC interpretations are specific to both the bacterial organism and the antibiotic

Creating an Antibiogram

- Clinical and Laboratory Standards Institute (CLSI) provides guidance for development
  - CLSI M39 – Antibiograms: Developing Cumulative Reports
- Computer skills would be ideal
- Microbiology data from your facility's primary laboratory (may be electronic or paper-based)
  - Culture ID number
  - Patient name and MRN
  - Culture date/specimen type
  - Culture results
  - Antibiotic susceptibilities
  - Any other relevant information you may want to assess

Antibiogram Essentials

- Include only final, verified test results
- Include only diagnostic (NOT surveillance) cultures
- Include only bacterial species with ≥ 30 isolates per reporting period
- Include the 1st isolate of a given species per patient per reporting period regardless of:
  - Body site
  - Antimicrobial susceptibility profile
  - Phenotypic characteristics
- Include antibiotics that are routinely tested
  - Do not report supplemental agents selectively tested on resistant isolates only
- Report percent susceptible (%S)
  - Do not include percent intermediate (%I) in the statistic*

*Exceptions: For Viridans group streptococci and penicillin: list both %I and %S.
For *Staphylococcus aureus*: list %S for all and MRSA subset.

CLSI. M39-Antibiogram. 2019
ADHS. Antibiogram Toolkit 2013

Antibiogram Data Stratification

Hospital unit or healthcare facility

Organism’s resistance profile

Specimen type or infection site
Ex: blood vs. urine isolates

Clinical service or patient population

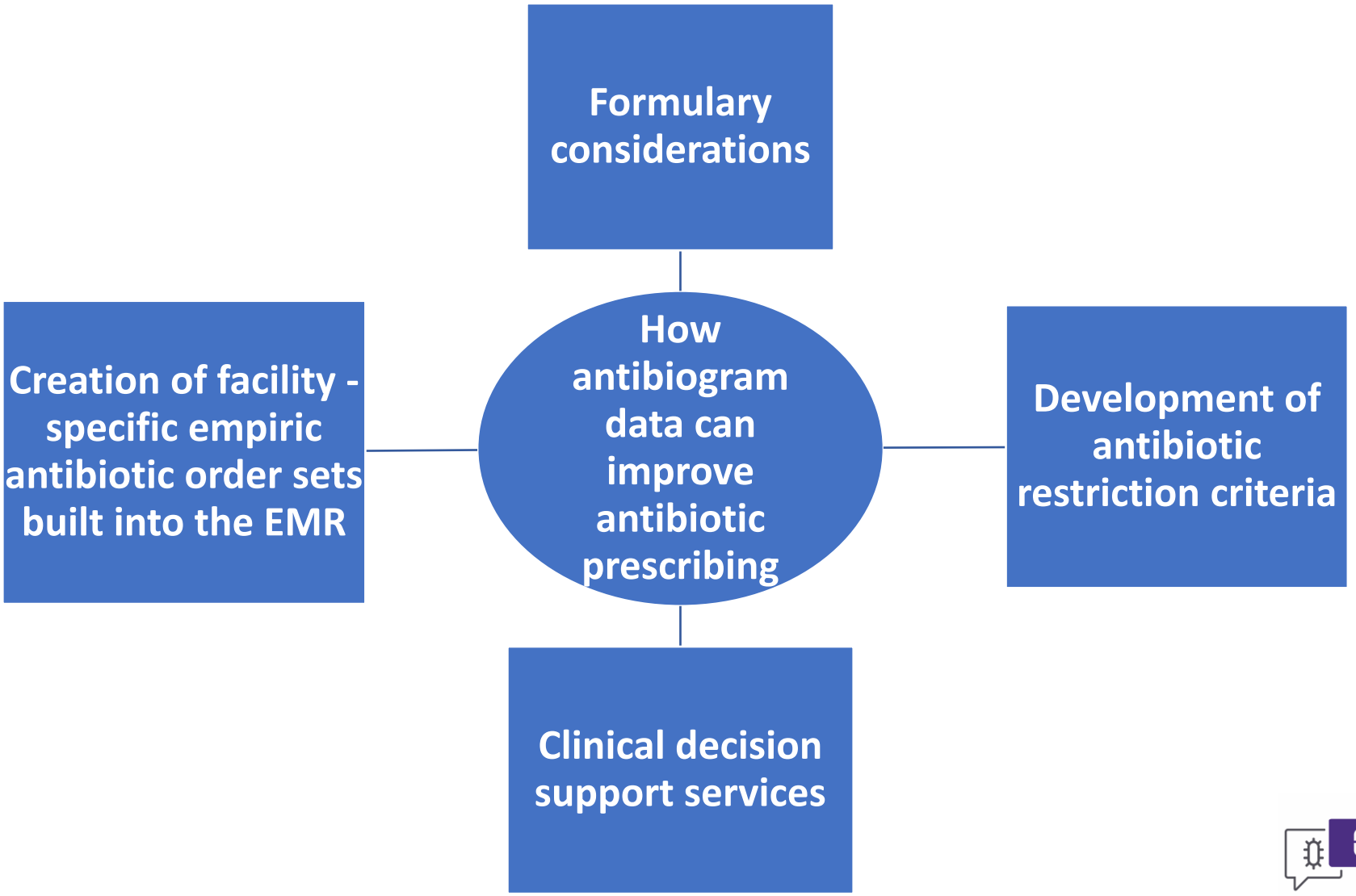
Antibiogram Applications for ASPs

CDC Core Elements

Utilizing Antibiograms

- Used to guide **appropriate empiric antibiotic therapy**
- Used as an educational tool for prescribers
- Raise awareness of antimicrobial resistance trends at a healthcare facility
- Evaluate infection prevention and control interventions
- Optimize microbiology susceptibility testing and reporting
- Guide Pharmacy & Therapeutics Committee formulary decisions

Antibiograms for ASP Initiatives



Limitations

- Smaller facilities may have insufficient numbers of isolates
- No information on specific bacterial infection sites
- Antibiotic resistance may appear different between facilities due to:
  - Patient population demographics
    - Immunocompromised, elderly, immigrant/refugee populations, etc
  - Healthcare services provided
    - Oncology, trauma center, solid organ transplant, obstetrics, etc
  - Antibiotic prescribing and utilization practices
  - Community prevalence of antibiotic resistance

Also Keep in Mind…

- Antibiograms include data on bacterial isolates from patients with infections, but also those that represent bacterial colonizations
- Pooled data from the entire hospital population
- Bacterial isolates in hospitalized patients may represent community-onset infections (cultures obtained in ED or from an outside healthcare facility)

And Remember…

- Difficult to assess the true impact of a specific stewardship initiative on changes in rates of resistance
  - May take months or years for effects to appear
- Decreasing the use of 1 or more antibiotics will cause an increase in the use of another agent or class of antibiotics
  - Consider susceptibility changes for these other agents when assessing impact

Antibiogram Next Steps

- Share current information with your facilities
  - Include instructions for use and interpretation
- Collaborate with other working groups
- Provide targeted antimicrobial stewardship interventions