UNIVERSITY of MARYLAND
SCHOOL OF PHARMACY
THE PETER LAMY CENTER
ON DRUG THERAPY AND AGING

MARYLAND
Department of Health

How to Measure the Effectiveness of Incorporating Antibiogram Data at Your Facility

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A collaboration between

University of Maryland School of Pharmacy, Peter Lamy Center on Drug Therapy and Aging, and Maryland Department of Health

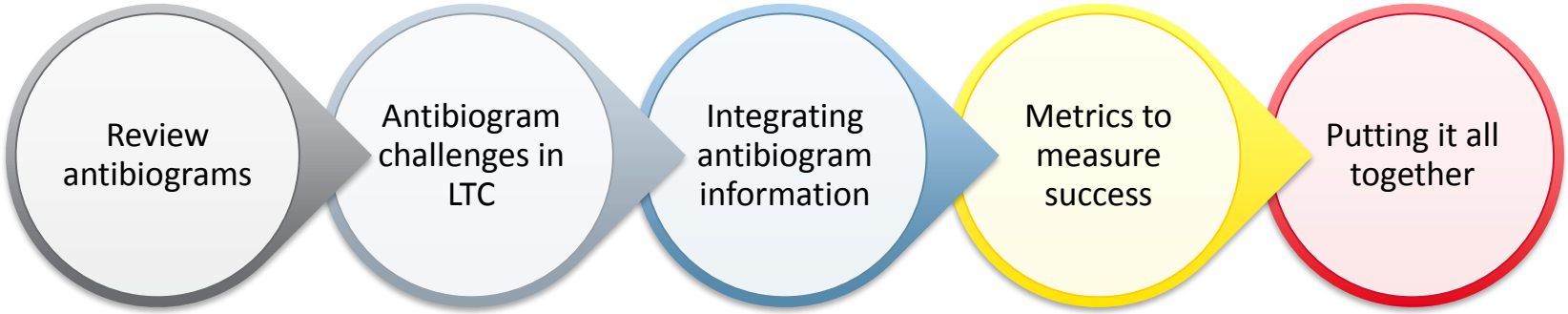
Conflict of Interest Disclosures

Kimberly Claeys has served on an advisory board for Melinta Therapeutics and Nabriva Therapeutics and is a speaker for Luminex Corporation.

Objectives

1. Identify properties of antibiograms that can be incorporated into facility's policies and procedures.
2. Select key concepts for optimizing use of local susceptibility data at your practice site.
3. Determine process and outcome metrics to evaluate incorporating antibiogram data at your practice site.

Lecture Outline



Recall: Susceptibility Testing

- Clinical microbiology completes susceptibility testing on individual samples
- Testing to determine minimum inhibitory concentration (MIC)
- MICs referenced against clinical breakpoints for microorganism-drug combination
  - Susceptible
  - Intermediate
  - Resistant
- Table refers to the *susceptibility of the individual sample from the individual patient*

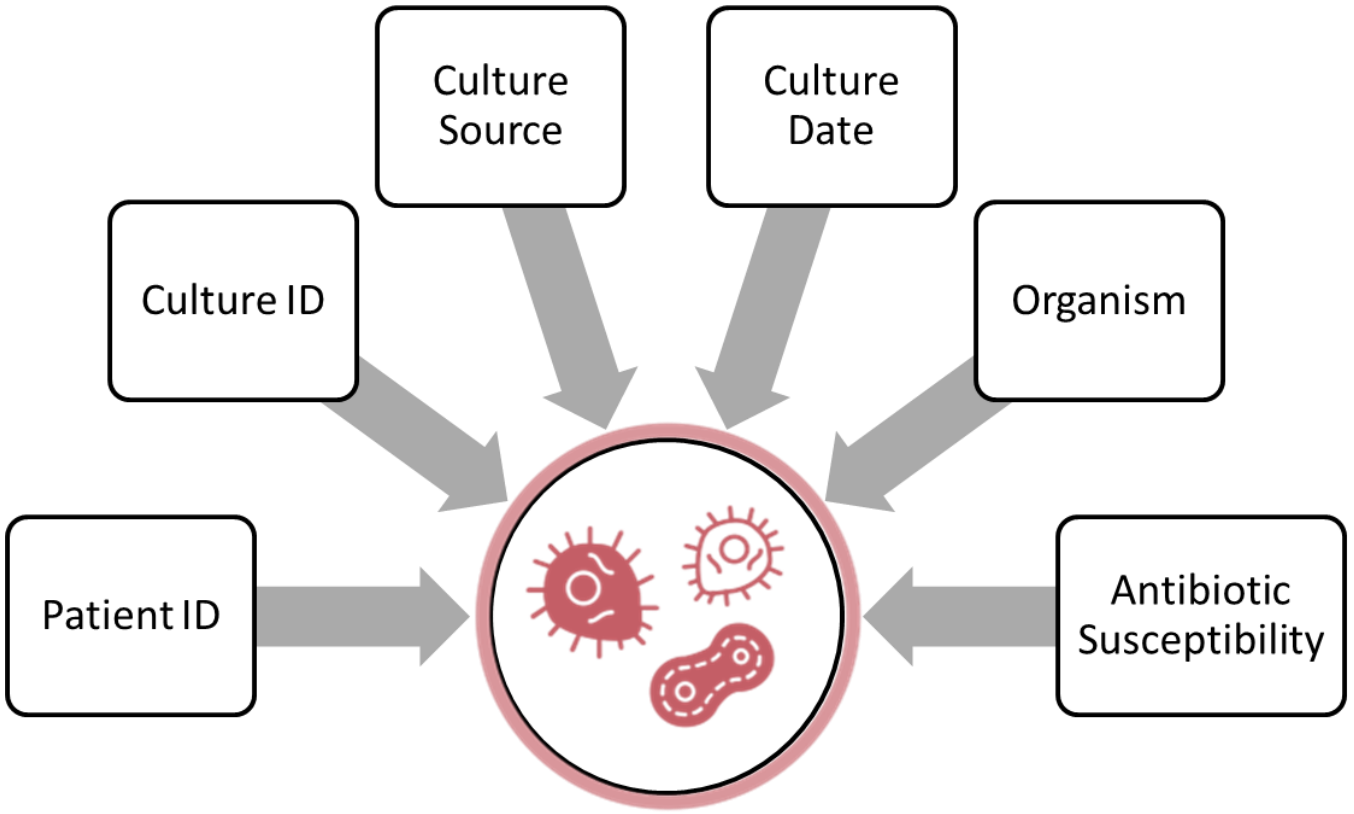
Antibiotic	MIC (µg/mL)	MIC interpretation
Ceftriaxone	0.5	Sensitive
Clindamycin	≤0.03	Sensitive
Daptomycin	4	Sensitive
Erythromycin	0.5	Sensitive
Gentamicin	≤0.12	Sensitive
Linezolid	2	Sensitive
Penicillin	≤0.03	Sensitive
Vancomycin	1	Sensitive

MIC, minimal inhibitory concentration.

Recall: Antibiograms

- Also known as *cumulative susceptibility tests*
- Report usually generated by clinical microbiology lab
  - Bacterial isolates from patients at your facility/local facilities
  - Percent of isolates susceptible to given antibiotic agents (microorganism-drug combination)
- Goal of guiding providers *empiric* antibiotic choices based on local susceptibility data
- Can also be used to monitor trends in resistance at your facility

Recall: Antibiograms



Gram Negative Organism	N	Amikacin	Gentamicin	Ampicillin-sulbactam	Imipenem	Ertapenem	Piperacillin-tazobactam	Cephalosporins: Cefazolin	Cephalosporins: Ceftriaxone	Cephalosporins: Cefepime	Quinolones: Ciprofloxacin	Quinolones: Levofloxacin	Others: Nitrofurantoin	Others: Tigecycline	Others: TMP/SMX
Acine	279	75					38	0	31	46	35			88	39
Citrobacter spp	173	99					92	50	87	98	92	92	95	100	85
Enterobacter spp	444	99	96	43	99	94	80	11	78	98	95	96	78	97	88
Escherichia coli	987	99	87	68	100	100	93	86	92	93	60	67	98	100	65
Klebsiella spp	776	95	90	74	99	95**	86	78	85	85	83	88	72	94	78
Morganella mo	43	100	79	49	100	100	100	7	93	100	76	72	6		63
Proteus spp	378	99	90	88	100	100	99				3	82			77
Serratia marcescens	142	99	99	11	100	100	96				98	100	0	99	95
Pseudomonas aeruginosa	697	98	87		79		81			91	77	65			0

Antibiotics tested

Organisms

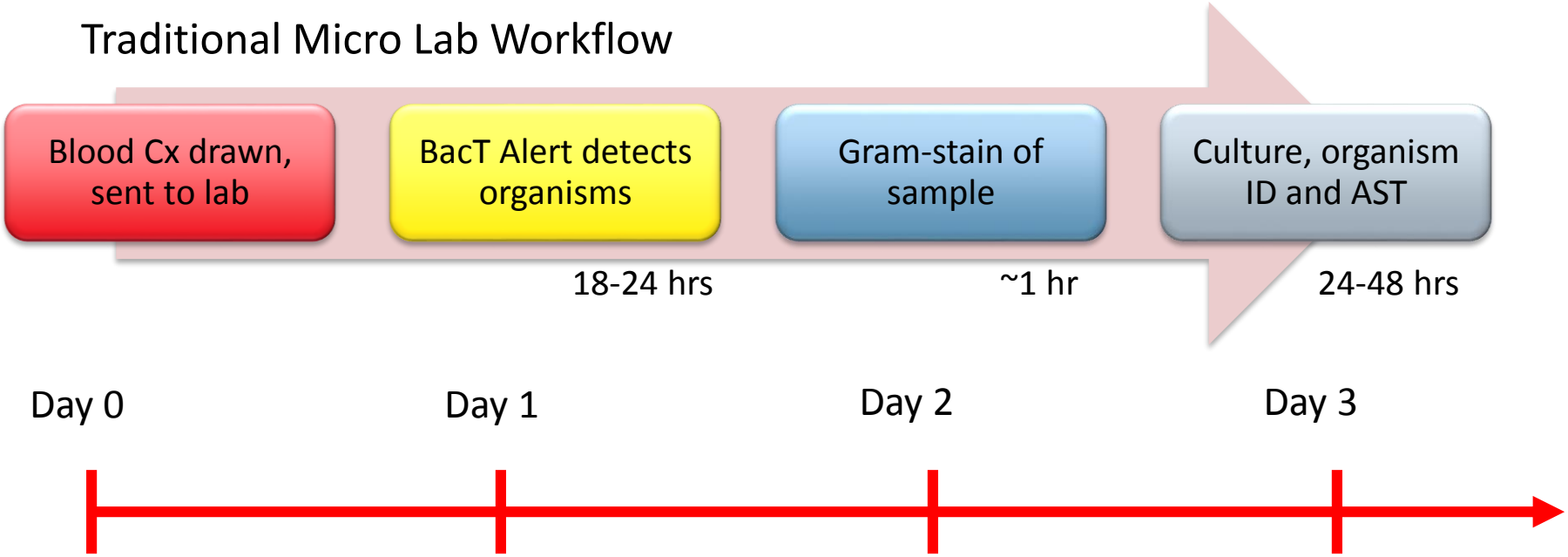
Percent susceptible

Number of isolates

Not tested

Note: Information is based on one isolate per patient admission or visit. The most resistant result for each antibiotic per organism is collected.
*** 5% of Klebsiella are considered KPC producers*

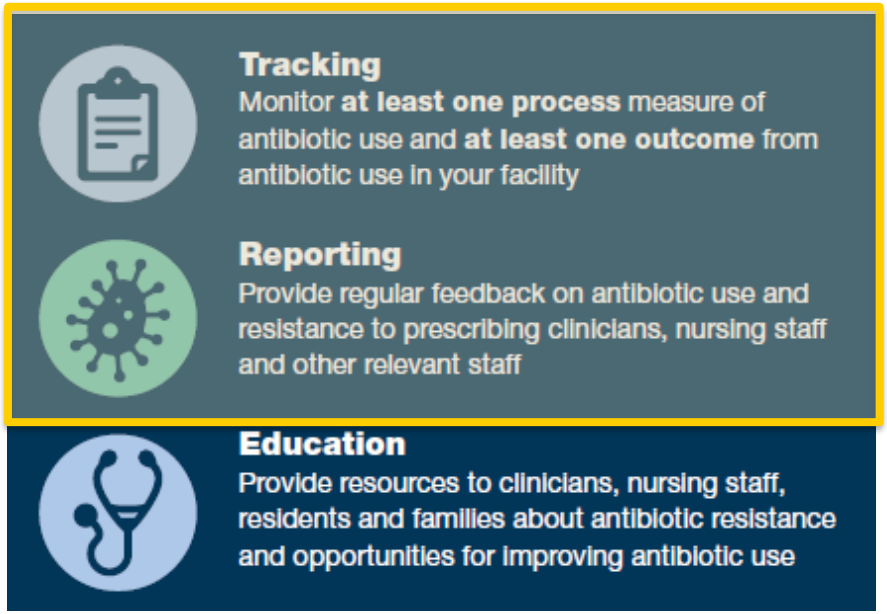
Importance of Antibiograms



- After collection of specimen, organism ID can take several days
  - Susceptibility results may take an additional day
- Cannot target/tailor antibiotics until results are known

Importance of Antibiograms

- CDC Core Elements for ASP in Long-Term Care



- *Excellent tool to monitor trends in antibiotic resistance*

CDC Core Elements of Antimicrobial Stewardship for Nursing Homes, 2013

Antibiogram Limitations

- Not generalizable
- Only report phenotypic susceptibility
  - No MIC data, no data on intrinsic resistance
- Does not take in to account individual patient factors
  - History of drug resistance (i.e. prior ESBL)
  - Surveillance culture at other body site
  - Past antibiotic exposure
  - Patient comorbidities (risk for resistance)
  - Patient acuity (level of critical illness)

Antibiogram Challenges in Long-Term Care

- Long-term care facilities have unique challenges when developing antibiograms
  - Facility with small number of patients
  - Limited number of diagnostic isolates
  - Working with multiple laboratories
  - Lack of electronic medical records

Antibiogram Challenges in Long-Term Care

Approach	Advantages/Disadvantages
Extending the antibiogram data beyond 1 year	• Technically simple/easy to create • Resistance patterns may change from year to year
Creating a regional antibiogram	• Helpful if residents access facilities throughout the region • Requires coordination between multiple laboratories and facilities
Using antibiograms of nearby hospitals	• Antibiograms created annually by hospitals • Bacteria that infect LTCF residents may not have similar antimicrobial susceptibilities to those of the hospital population
Collapsed antibiograms	• Help guide infection-specific antibiotic choices • Intrinsic resistance of some bacteria to specific antibiotics would not be listed

Incorporating Antibiogram Information

- Validated available antibiogram
- Policies & procedures for antibiogram
- Educate nursing and prescribers
- Disseminate antibiogram

Ways to Integrate Antibiogram Information

- Nursing and provider education is key
- Need to make aware of antibiogram and application of data
  - Available through institutional webpage
  - Hand out pocket cards with most recent antibiogram
  - Provide in-services when new antibiogram becomes available

Incorporating Antibiogram Information

- Do not reinvent the wheel

- AHRQ Toolkit 3, Phase 3: Implementation
  - Provides sample policies and procedures
  - Educational materials
  - Draft emails and communications

- AHRQ Toolkit 3, Phase 4: Monitoring
  - Antibiotic use tracking forms
  - Antibiogram feedback survey

Policies & Procedures for Antibiogram

1. Development of facility-specific policies, procedures, and clinical pathways
2. Changes in order-sets and/or clinical decision support services
3. Decisions regarding changes in facility formulary
4. Outcome metrics
5. Frequency of updating data

Arizona Department of Health Services Antibiogram Toolkit. https://www.azdhs.gov/documents/preparedness/epidemiology-disease-control/healthcare-associated-infection/advisory-committee/antimicrobial-stewardship/antibiogram-toolkit.pdf

Example – Incorporating Local Susceptibility Information

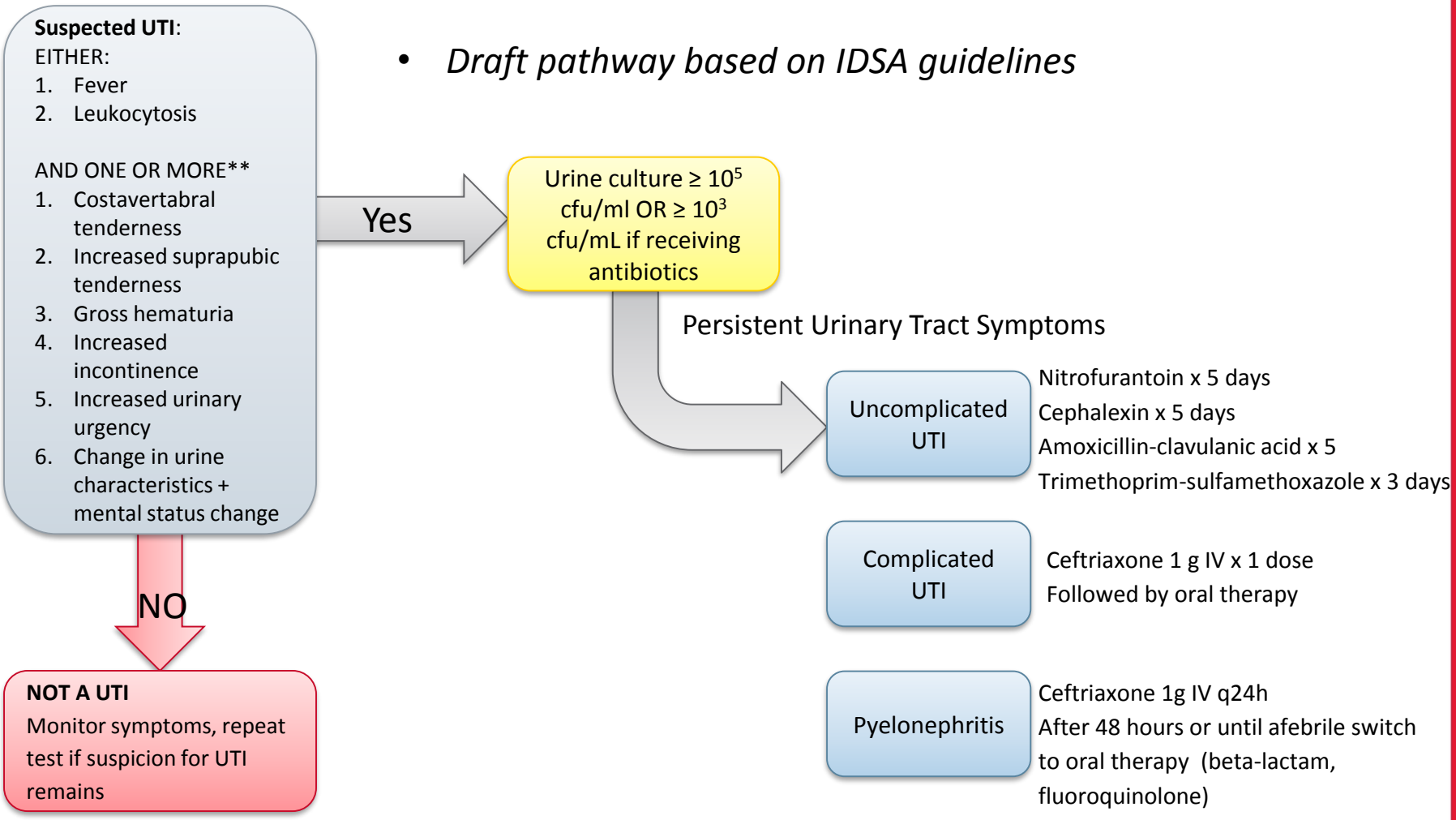
- An antibiogram for Gram-negative microorganisms with data over the last calendar year has been developed and validated for your facility
- You are developing a new treatment pathway for management of UTIs

		Aminoglycoside					Cephalosporins			Quinolones		Others	
Gram Negative Organism	**N**	**Gentamicin**	**Ampicillin-sulbactam**	**Meropenem**	**Ertapenem**	**Piperacillin-tazobactam**	**Cefazolin**	**Ceftriaxone**	**Cefepime**	**Ciprofloxacin**	**Levofloxacin**	**Nitrofurantoin**	**TMP/SMX**
Enterobacter spp.	24*	97	43	97	94	80	11	78	98	73	83	78	88
Escherichia coli	142	99	68	96	93	93	73	92	93	60	62	92	65
Klebsiella spp.	57	95	71	95	94	86	78	85	85	69	71	72	73
Proteus spp.	31	95	88	100	100	99	84	93	95	73	82		77
Serratia marcescens	21*	94	11	100	100	96	2	93	99	88	85	0	95
Pseudomonas aeruginosa	13*	87		83		79			90	77	65		0

Note: Information is based on one isolate per patient admission or visit.
** Fewer than 30 isolates available, use caution when interpreting results*

Example – Incorporating Local Susceptibility Information

- *Draft pathway based on IDSA guidelines*



Example – Incorporating Local Susceptibility Information

- How well is *E. coli* covered by antibiotics recommended on your facility formulary?

		Aminoglycoside					Cephalosporins			Quinolones		Others	
Gram Negative Organism	**N**	**Gentamicin**	**Ampicillin-sulbactam**	**Meropenem**	**Ertapenem**	**Piperacillin-tazobactam**	**Cefazolin**	**Ceftriaxone**	**Cefepime**	**Ciprofloxacin**	**Levofloxacin**	**Nitrofurantoin**	**TMP/SMX**
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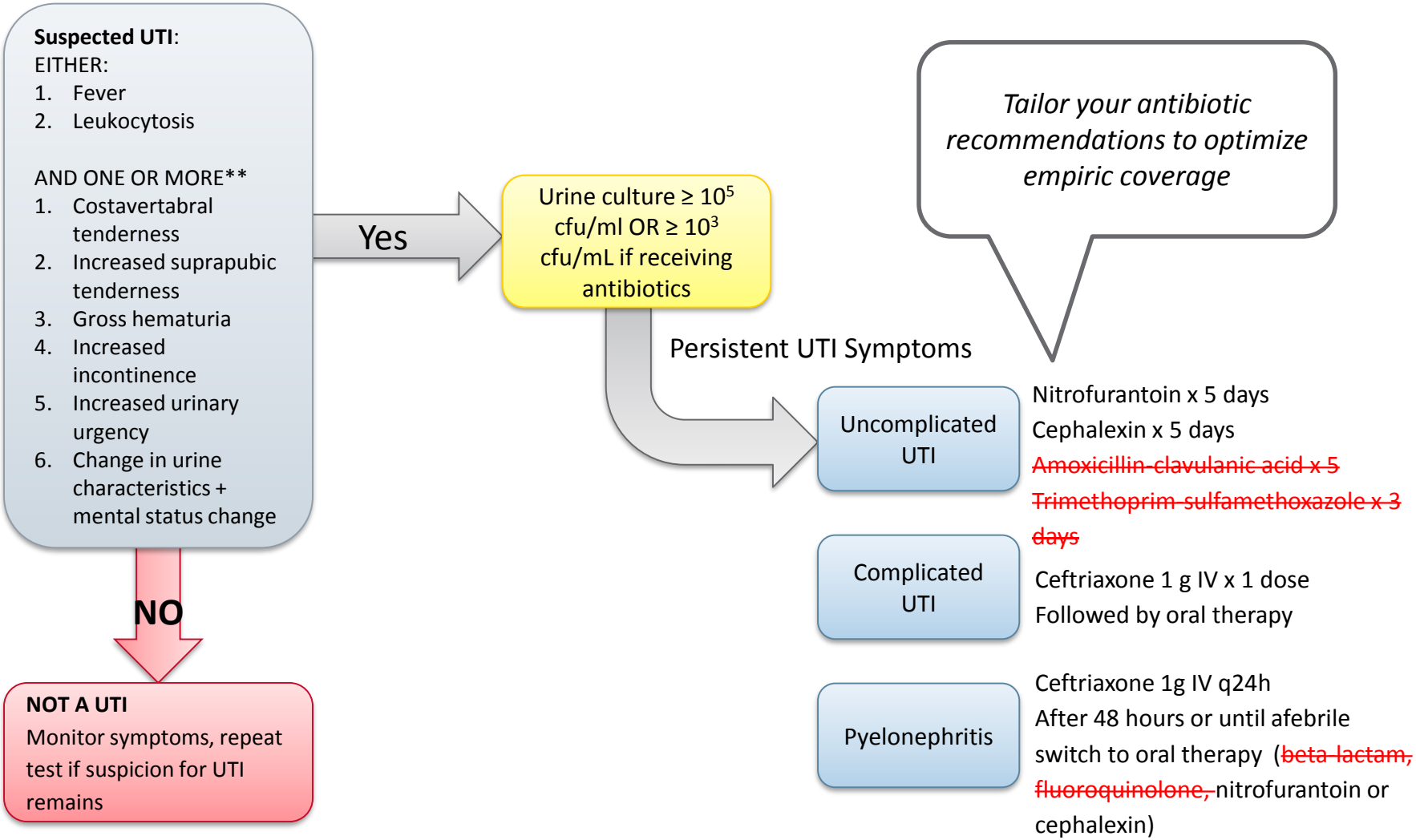
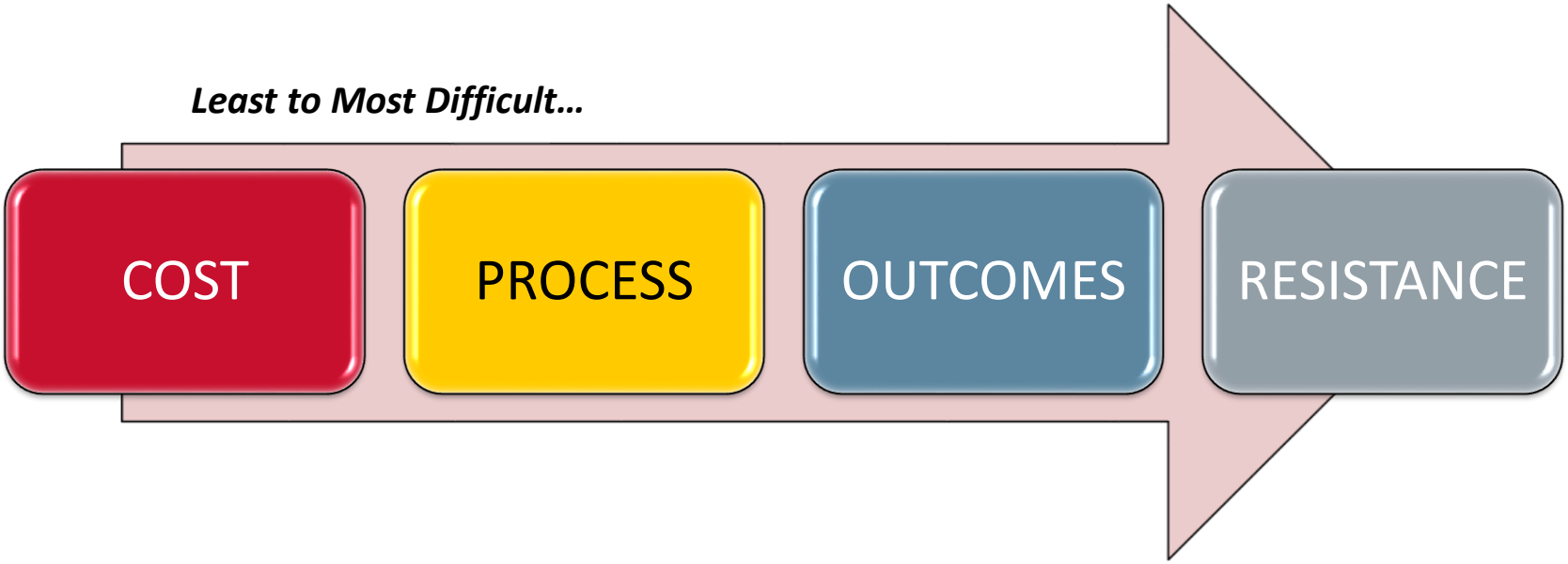
Incorporate Local Susceptibility Information in Pathways



Measuring Success - Metrics

- After implementation, measure success through process and outcomes metrics
- Process metrics
- Outcomes metrics
- CMS State Operations Manual
  - Tracking of *C. difficile*, MRSA, CRE
  - Monitoring of antibiotic use

Measuring ASP Success – Metrics



Beganovic M, LePlante KL. *R I Med J* (2013). 2018 Jun 1;101(5):45-4; Barlam TF, et al. *Clin Infect Dis*. 2016 May 15;62(10):1197-1202.

Examples of Metrics from the CDC

- Process metrics:
  - Review resident medical records for new antibiotics
  - Adherence to antibiotic prescribing policies
  - Acceptance of antibiotic stewardship interventions
  - Duration of antibiotic courses
- Outcomes metrics:
  - Monitor institutional rates of *C. difficile* infection
  - Record incidence of antibiotic-related adverse drug events

Antibiotic Consumption Metrics

Metric	Definition	Advantages	Disadvantages
Incidence	• Number of antibiotic courses started per 1000 resident care days	• Useful to monitor impact of interventions to lower use	• Doesn't measure duration • Requires resident-level data
Antibiotic utilization ratio (AUR)	• Ratio of total antibiotic days to total resident care days	• Most common metric used in published studies (usually expressed as total days per 1000 resident days) • Used by CDC NHSN	• Doesn't measure duration • Requires resident-level data
Cost per antibiotic day	• Ratio of total antibiotic cost to total antibiotic days	• May provide insight into prescribing of high cost antibiotics	• Requires cost data and resident-level data
Cost per resident care day	• Ratio of total antibiotic cost to total resident care days	• May appeal to administrators because it relates cost to whole population	• Requires cost data • Not all residents treated with an antibiotic

Antibiotic Consumption Metrics

	DOTs	DDD	SAAR
EXPLANATION	• Days patients received at least one dose of antimicrobial	• Maintenance dose for average weight/renal function adult	• Observed-to-predicted ratio of antimicrobial days (DOTs) by national benchmark
UNIT MEASURED	• DOT/1000 patient days • DOT/1000 days present	• DDD/1000 patient days	• Ratio of observed antibiotic use to predicted
ADVANTAGES	• Standardization and benchmarking within and between facilities	• Does not require patient levels data • Can be used for benchmarking	• Indirect standardization metric • Benchmarking by agent category or patient location
DISADVANTAGES	• Requires patient-level data • Can be technically difficult (i.e. IT)	• Assumes standard dosing and under or over-estimate based on clinical scenario	• Uses NHSN AUR • Certain locations not included (i.e. ED, oncology units)
ENDORSEMENTS	• CDC/NHSN AUR Module	• World Health Organization	• National Quality Forum

DOT = days of therapy; DDD = defined daily dose; SAAR = standardized antibiotic administration ratio; P/T = piperacillin/tazobactam; HO/MDRO = hospital onset/multi-drug resistant organisms; NHSN = National Healthcare Safety Network; AUR = Antibiotic Use Resistance Module

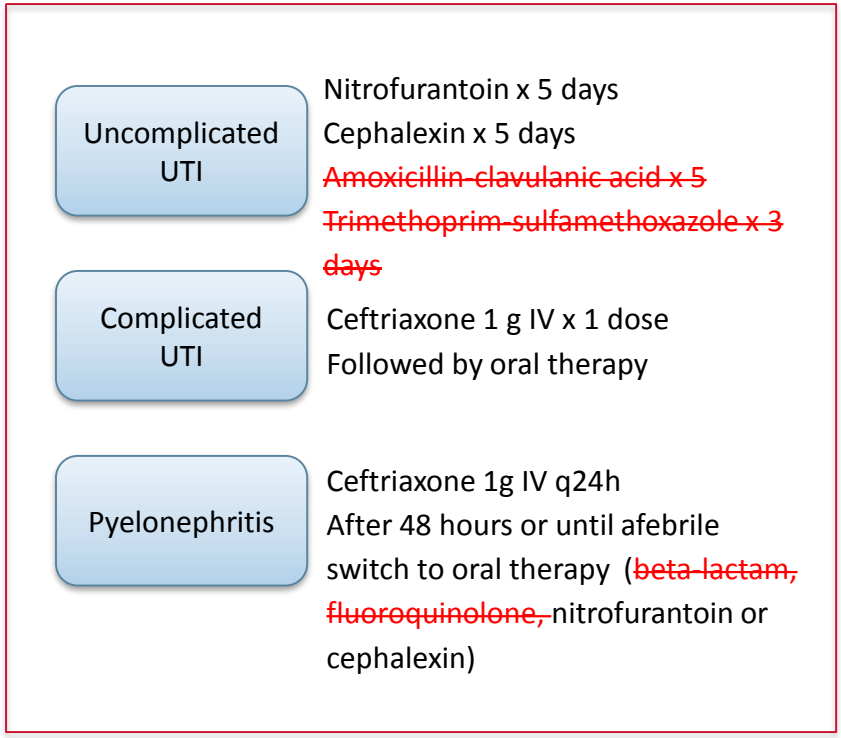
van Santen KL, et al. *Clin Infect Dis*. 2018 Jul 2;67(2):179-185
Polk RE, et al. *Clin Infect Dis*. 2007 Mar 1;44(5):664-70
Beganovic M, LePlent KL. *R I Med J* (2013). 2018 Jun 1;101(5):45-4

Measuring Antibiotic Consumption

- Antibiotic days of therapy (DOT) helps monitor use over time
- Antibiotic day = each calendar day a resident receives the antibiotic
- Antibiotic DOT = sum of all antibiotics for all residents in a given time frame

- Example: Resident received 7 days of cephalexin = 7 DOTs
  - Count each day they received at least one dose
- Example: Received azithromycin AND ceftriaxone for 5 days = 10 DOTs
  - Each antibiotic has its own count!
- Antibiotic DOT/1000 resident days (based on monthly DOT report)
  - (Total monthly antibiotic DOT/total monthly resident days)*1000
- Antibiotic utilization ratio (AUR)
  - Total monthly antibiotic DOT/total monthly resident days

Application – Metrics to Assess?



Over a one-month period:

1. Proportion (%) of antibiotic orders adherent to pathway recommendations
2. How many antibiotic orders with indication for UTI?
3. DOTs for specific antibiotics (i.e. fluoroquinolones)

Examples of Metrics from the CDC

- Process metrics can include looking at all the patients in your facility on one day or week (point prevalence)
  - How many residents are receiving an antibiotic?
  - How many courses of antibiotics have an indication? Is the documentation complete?
  - Is empiric antibiotic selection in agreement with facility guidelines/pathways and antibiogram data?

Examples of Metrics from the CDC

- Outcomes metrics are more difficult to assess and harder to show change
- Important metrics from regulatory standpoint include tracking *C. difficile* infection (CDI)

- Incidence of CDI = $\frac{\text{number of new cases (confirmed by laboratory)}}{\text{number of residents (over time period, i.e. months)}}$

Refer to Laboratory-identified Event module in NHSN (http://www.cdc.gov/nhsn/ltc/cdiffmrsa/index.html)

Application – Metrics to Assess?

Uncomplicated UTI	Nitrofurantoin x 5 days Cephalexin x 5 days ~~Amoxicillin-clavulanic acid x 5~~ ~~Trimethoprim-sulfamethoxazole x 3 days~~
Complicated UTI	Ceftriaxone 1 g IV x 1 dose Followed by oral therapy
Pyelonephritis	Ceftriaxone 1g IV q24h After 48 hours or until afebrile switch to oral therapy (~~beta-lactam, fluoroquinolone,~~ nitrofurantoin or cephalexin)

Compare time period before and after implementation:

1. Incidence of CDI
2. Adverse antibiotic events in those being treated for UTI
3. Proportion resistant to empiric antibiotic therapy

Trends in Antibiotic Resistance

- Resistance trends can be difficult to measure
- Use annual antibiograms to track resistance of certain drug-microorganism combinations
  - Rates of MRSA – resistant *Staphylococcus aureus*
  - Rates of CRE – resistant *Enterobacteriaceae*
  - Rates of VRE – resistant *Enterococci*

Example: Incorporating Antibiogram Information

- Antibiograms help guide antibiotic choices before patient specific culture/susceptibility information is available
- Guide initial *empiric* therapy recommendations

INFECTION CONTROL AND HOSPITAL EPIDEMIOLOGY OCTOBER 2014, VOL. 35, NO. S3

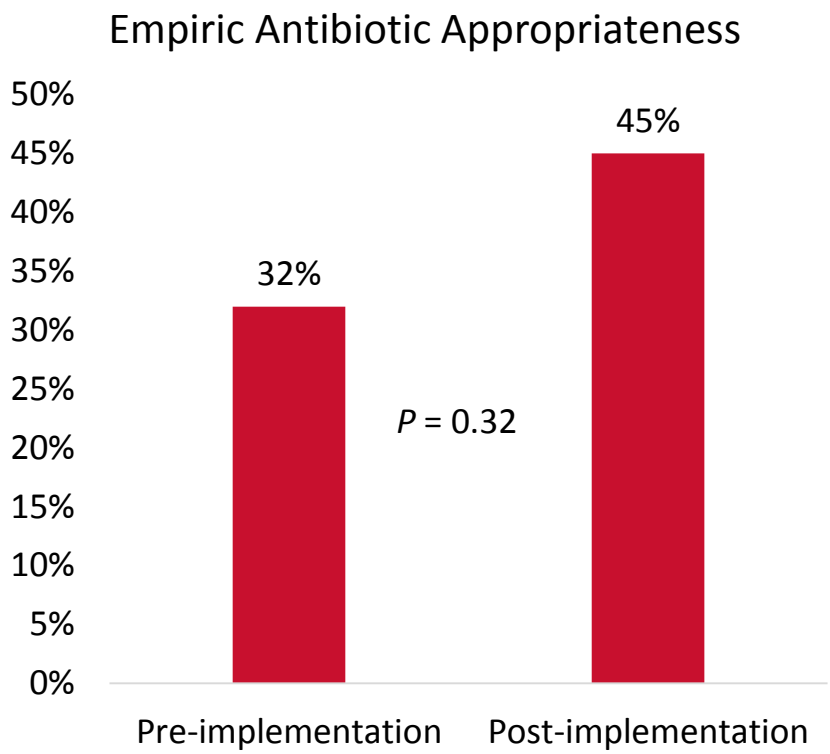
ORIGINAL ARTICLE

Using Antibiograms to Improve Antibiotic Prescribing in Skilled Nursing Facilities

Jon P. Furuno, PhD;[1] Angela C. Comer, MPH;[2,3] J. Kristie Johnson, PhD, D(ABMM);[2,4] Joseph H. Rosenberg, BS;[2] Susan L. Moore, PhD, MSPH;[5] Thomas D. MacKenzie, MD, MSPH;[5] Kendall K. Hall, MD, MS;[6] Jon Mark Hirshon, MD, MPH, PhD[2,3,7]

Using Antibiograms to Improve Antibiotic Prescribing in Skilled Nursing Facilities

- Quasi-experimental study of implementation of SNF-specific antibiograms at three facilities in Maryland
- Evaluate effectiveness through assessment of changes in empiric antibiotic prescribing (SNF 1,118 beds)



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When: WEDNESDAY, FEBRUARY 20TH
1 – 2 PM

Where: ONLINE

Why: ASK QUESTIONS ABOUT ANTIBIOGRAMS

MEET OUR FACULTY EXPERTS WHO ARE WELL VERSED IN THE FIELD OF ANTIMICROBIAL STEWARDSHIP

Questions

Type your Questions in the Chat box.

If you are using the conference phone line for your audio unmute your microphone.

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