1

To receive continuing education, you must:

1. Complete sign-in sheet located at the back of today's handouts and return to hcourson@khconline.org.
2. Participate in all polling questions.
3. Complete the evaluation at the end of the presentation.

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2

KDHE-KHC Antibiotic Stewardship Series

April 7	What is Antibiotic Stewardship: Emphasis on Accountability and Leadership Recording available: https://www.khconline.org/
May 5	Antibiotic Stewardship Measurement and Metrics
June 2	Antibiotic Stewardship Metrics: How and what to report
July 7	Antibiotic Stewardship Activities: Implementing practical interventions tailored to your facility

3

Nikki Wilson, PharmD BCIS

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Antibiotic Stewardship Clinical Coordinator,
The University of Kansas Health System
nwilson5@kumc.edu

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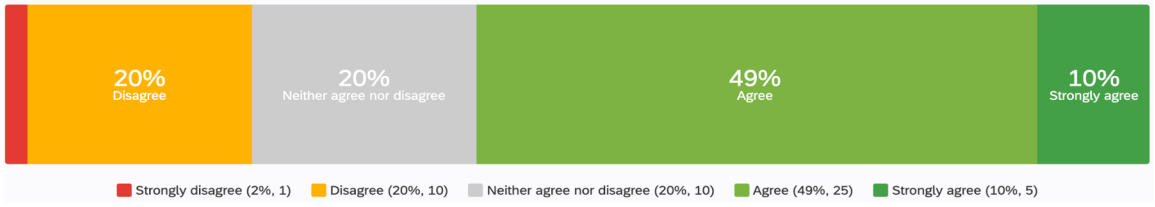
Session 2 Objectives

- Describe ways in which antibiotic use and antibiotic resistance can be monitored
- Review how and what data to track to develop effective antibiotic stewardship actions
- Define metrics that can be used to measure antibiotic use and stewardship program's performance
- Describe strengths and weaknesses of these metrics

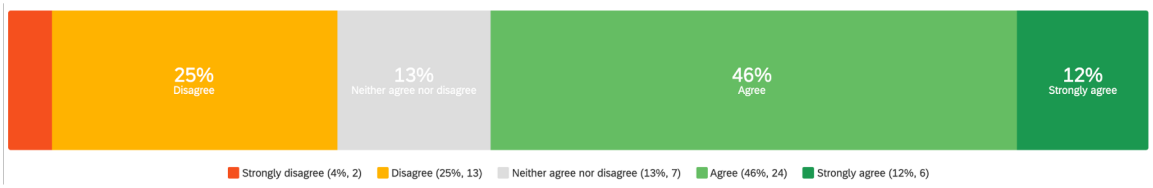
5

Tracking: Examination of Current State

- CAH ASPs which regularly monitor abx prescribing / guideline adherence



- CAH ASPs which monitor total abx consumption (DOT, DDD or purchasing costs)



KDHE CAH ASP survey, 2019. Unpublished

6

Polling Question #1

Which of the following best describes your involvement in creating, reviewing and interpreting antimicrobial stewardship metrics in your institution?

1. I don't know if metrics are tracked or what metrics are utilized
2. I know we have metrics but I'm not heavily involved.
3. I am responsible for the ASP metrics in my institution and I am comfortable interpreting and reporting the data.
4. I am responsible for the ASP metrics in my institution and I am **NOT** comfortable with interpreting and reporting the data.

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Tracking: Regulatory Landscape

Agency	Statement on Tracking
The Joint Commission (TJC)	• Monitoring the antimicrobial stewardship program which may include • Information on antimicrobial prescribing • Resistance patterns • No requirements for specific metrics
Center for Medicare and Medicaid Services (CMS)	• The program must demonstrate best practices for improving antibiotic use • Reduce development and transmission of antibiotic-resistant organisms • Antimicrobial use issues must be addressed in quality assessment and performance improvement program (QAPI) • Documents improvements in antibiotic use • Program reflects scope and complexity of hospital services • Documents evidence based use of antibiotics • Systems in place for tracking of antibiotic use activities

The Joint Commission Standards Manual January 2022

Code of Federal Regulations: 42 CFR 482.42 (2021)

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Tracking: Guideline Based Recommendations

Organization and Publication		Measurement of Antibiotic Use Recommendations
IDSA/SHEA	**2016 Guideline: Implementing an Antibiotic Stewardship Program**	Recommended • Days of therapy (DOT) preferred over defined daily dose (DDD) → if unable to obtain patient-level abx use • Cost Measures based on actual administration • Normalize cost by patient day or admission Proceed with caution • Hospital onset C. difficile • Resistance patterns Limited by feasibility • Guideline adherence • Global expenditures

BarlamT, et.al CID 2016;62(10):e51-e77

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Tracking: Consensus Statements

Consensus Group		Recommendations
Stewards Panel	**2017**	• C. diffiicile infections • Rate of resistant pathogens • Days of therapy per admission • Days of therapy per patient days • Redundant therapy events
Expert Panel	**2012**	• Days of therapy per 1000 patient days • Drug resistant infections • Mortality due to antimicrobial resistant pathogens • Avoided days of therapy for key disease states • Hospital readmission due to CAP, SSTI, Sepsis or BSI

Moehring R, et.al CID 2017;64(13):377-83
Morris AM, et. Al ICHE 2012;33(5):500-506

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Consistent Themes

Days of Therapy

- Patient days
- Admissions
- 1000 patient days
- 1000 days present

C. difficile infections

- Hospital onset
- All CDI

Resistance

- Trends
- Rate of resistant infections

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Polling Question #2

Which of the following statements about recommended antimicrobial stewardship metrics is true?

1. All hospitals are required to report their antimicrobial use to the National Healthcare Safety Network
2. IDSA and SHEA recommend tracking defined daily doses over days of therapy
3. CMS Conditions of Participation state that systems must be in place and functional to support tracking of antimicrobial use activities
4. Tracking of resistance patterns is not a recognized strategy for tracking antimicrobial stewardship activities

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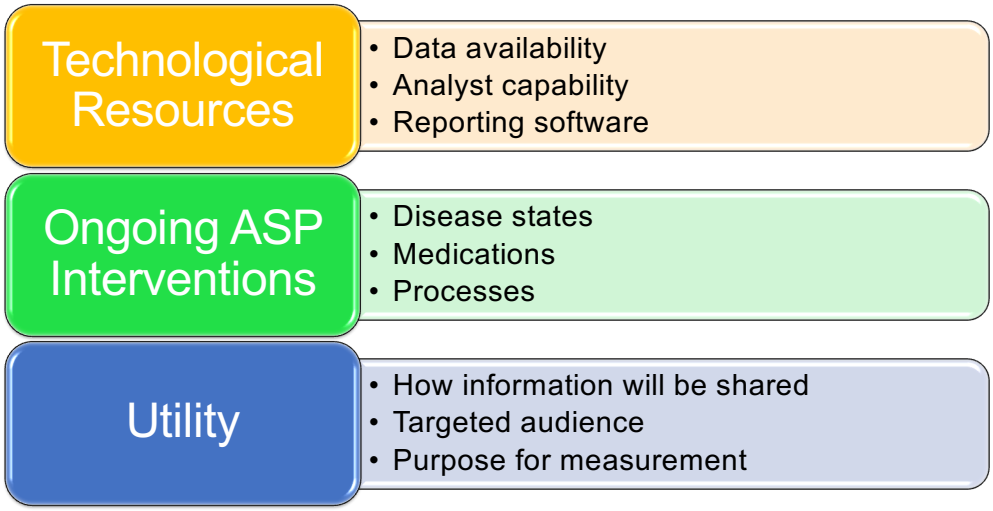
Considerations for Selection of Metrics



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The Best Metric?

What is feasible and meaningful for your institution!

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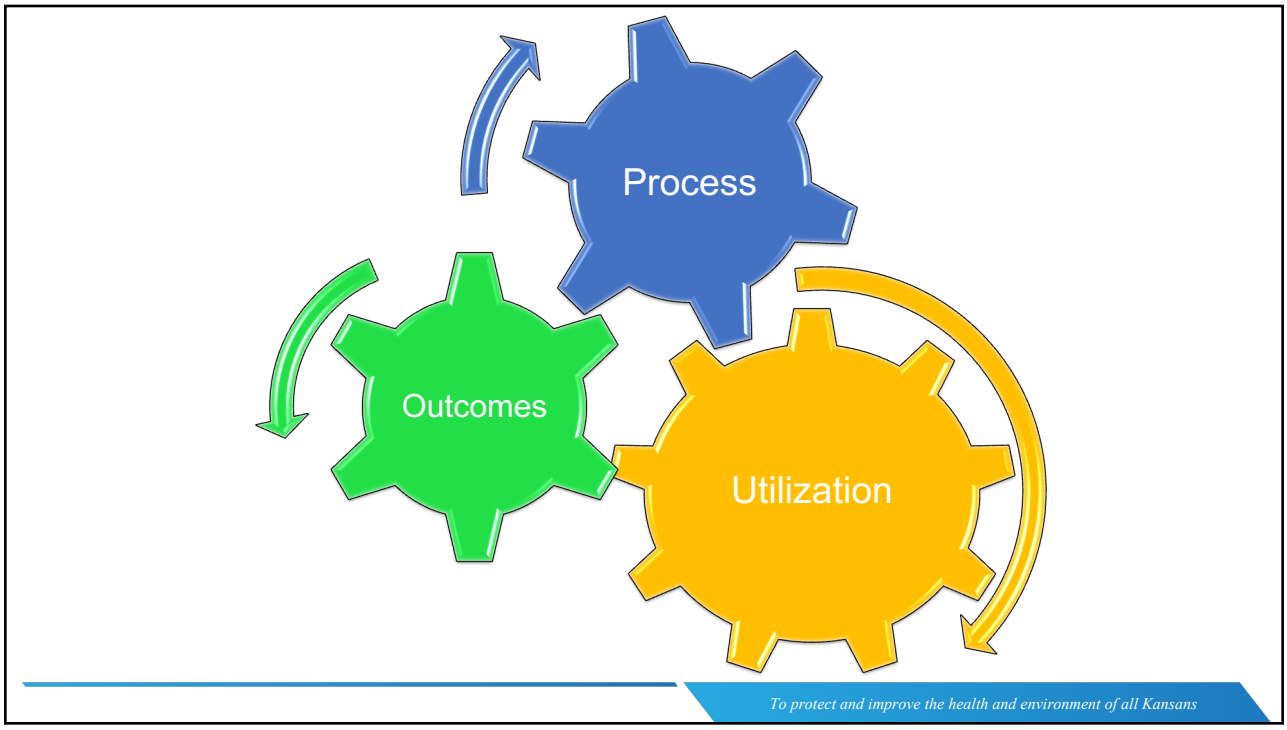
Process
Outcomes
Utilization
To protect and improve the health and environment of all Kansans

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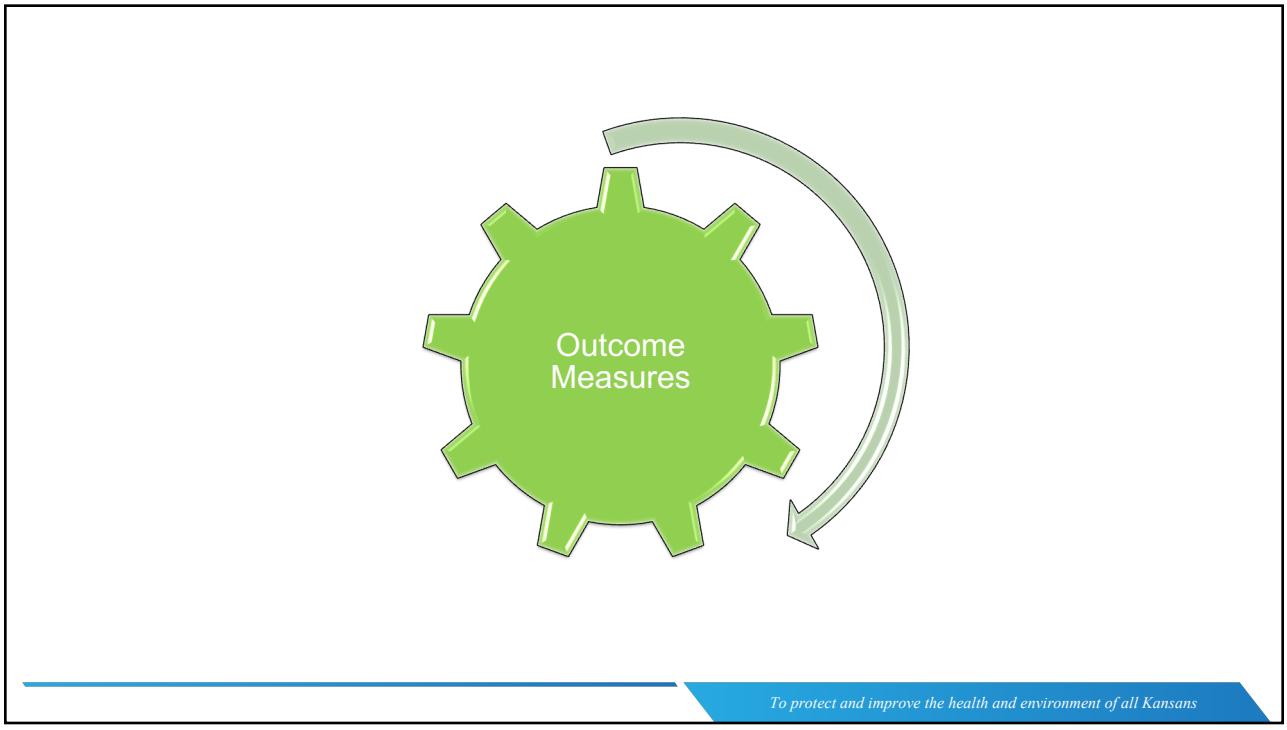
Outcome Measures
To protect and improve the health and environment of all Kansans

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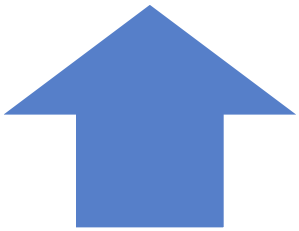
Outcome Measures Paradox



Ideal Metric

Infrequent use and conflicting evidence

Hermsen ED, et.al. CID; 2014;59(S3):S112-21

Morris AM, et.al. Curr Opin Infect Dis 2014;6:101-112

17

Outcomes: Potential Metrics

- *C. difficile* and Healthcare Associated Infections
- Antimicrobial Resistance
- ICU or Hospital Length of Stay
- Infection related mortality or readmissions

Brotherton A, et.al. Med Clin N Am 2018; 120:965-976

Morris AM, et.al. Curr Opin Infec Dis;2014

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C. difficile and HAI

Strengths

- Routinely monitored by infection prevention
- Publicly reported
- High visibility to stakeholders

Limitations

- Significant confounding
- Infection prevention practices

Brotherton A, et.al. Med Clin N Am 2018; 120:965-976. Moehring RM, et.al. CID;2017;64(3):377-83
Morris AM, et.al. Curr Opin Infec Dis;2014

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Antimicrobial Resistance

Strengths

- Obtained from antibiogram
- Objective data available from medical records

Limitations

- Influenced by patient origin and community antimicrobial use
- Delayed improvement in resistance rates (2-6 years!)

Moehring RM, et.al. CID;2017;64(3):377-83 Developing Stewardship Measures | Duke Antimicrobial Stewardship Outreach Network (DASON)
Tartof SY, et.al. CID 2021; 73(11):e4454-62.

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Antimicrobial Resistance

Table 3. Crude and Multivariable Associations Between Antibiotic Stewardship Programs and Antibiotic-resistant Infections of Interest

	Crude Association With ASP[a]		Multivariable Association With ASP[b]		Multivariable Association With ASP + Period[c]	
Outcome	RR	*P* Value	RR	*P* Value	RR	*P* Value
Extended-spectrum beta-lactamase	1.10 (1.07–1.13)	<.001	1.08 (1.05–1.11)	<.001	1.01 (0.95–1.08)	.675
Vancomycin-resistant enterococci	0.73 (0.65–0.81)	<.001	0.73 (0.66–0.81)	<.001	1.37 (1.10–1.69)	.004
Carbapenem-resistant Enterobacteriaceae	2.55 (1.87–3.48)	<.001	2.55 (1.87–3.48)	<.001	1.43 (0.80–2.57)[d]	.225
Multidrug-resistant *Pseudomonas aeruginosa*	0.88 (0.82–0.95)	<.001	0.88 (0.82–0.95)	<.001	0.99 (0.83–1.17)[d]	.893

n = 765 111.

Abbreviation: ASP, antibiotic stewardship program; RR, rate ratio.

[a]RRs were estimated using the generalized linear mixed-effects model with a Poisson distribution, offset term = log of the length of stay.

[b]RRs were estimated using the multivariate generalized linear mixed-effects model with a Poisson distribution, offset term = log of the length of stay, adjusted for medical center, age, race, gender, prior inpatient utilization, prior outpatient utilization, prior emergency department (ED) utilization, diagnosis-related group bucket, Charlson group, infection present on admission, and unit type.

[c]RRs were estimated using the multivariate generalized linear mixed-effects model with a Poisson distribution, offset term = log of the length of stay, adjusted for period, medical center, age, race, gender, prior inpatient utilization, prior outpatient utilization, prior ED utilization, diagnosis-related group bucket, Charlson group, infection present on admission, and unit type.

[d]Estimated based on regression model without random effects.

Tartof SY, et.al. CID 2021; 73(11):e4454-62.

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DASON Technical Manual for Stewardship Metrics

Feasible and Useful	• C. difficile infections
Feasible but not for routine use	• Infection related readmission

Developing Stewardship Measures | Duke Antimicrobial Stewardship Outreach Network (DASON)

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Outcomes: General Considerations

Strengths

- Ideal metric
- Primary goal of stewardship programs
- Clinician preferred
- Tells the story!

Limitations

- Significant confounding with mortality and length of stay
- Data availability
- Significant data manipulation
- Variable definitions

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Outcomes Metrics: Practical Application

- Draw inspiration from literature
- Focus on targeted interventions
  - Disease states
  - New diagnostics
  - Institutional stewardship interventions
- "One-and-done" strategy

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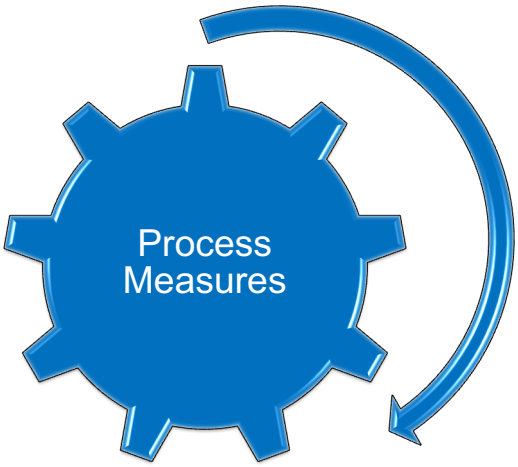

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Process Metrics

- Used to determine how stewardship interventions are driving antimicrobial prescribing
- "Process measures quantify the actions of stewardship programs and this is essential to determine which actions may or may not be associated with a given outcome"

Hermsen ED, et.al. CID; 2014;59(S3):S112-21

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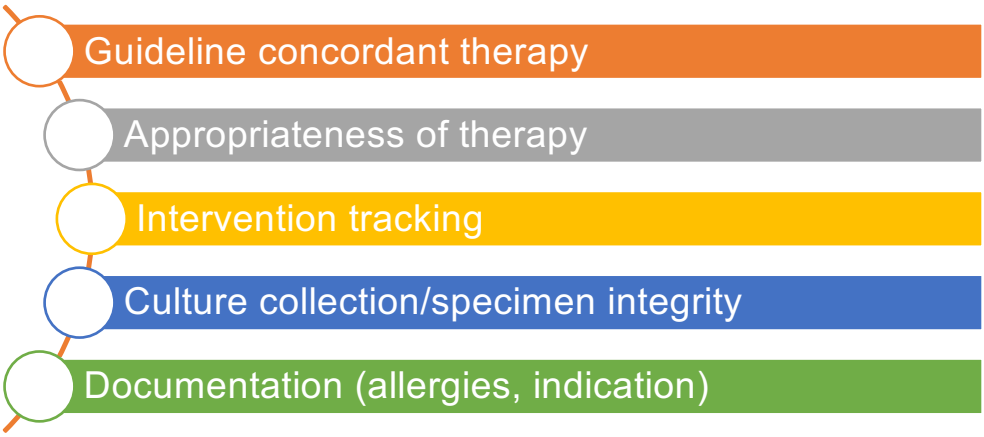
Process Measures



Brotherton A, et.al. Med Clin N Am 2018; 120:965-976 Core Elements of Hospital Antibiotic Stewardship Programs | Antibiotic Use | CDC

Morris AM, et.al. Curr Opin Infec Dis;2014

27

Intervention Tracking

Strengths

- Ease of recording
- Consistent access to data
- Demonstrates productivity and improvement in physician acceptance over time

Limitations

- Self reported
- Does not describe appropriateness
- Not reflective of true impact

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Appropriateness of Therapy

Strengths

- Ease of recording
- Consistent access to data
- Demonstrates productivity and improvement in physician acceptance over time

Limitations

- Self reported
- Does not describe appropriateness
- Not reflective of true impact

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Process Measures: General Considerations

Strengths

- Productivity
- Success (or failure) of process changes
- Lack of correlation with outcomes

Limitations

- Data available
- Likely more feasible than outcomes
- Patient level assessment typically necessary

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DASON Technical Manual for Stewardship Metrics

Feasible and Useful	• Redundant therapy • De-escalation
Feasible but not for routine use	• Guideline adherence
Failed Feasibility Testing	• Excess use avoided • Appropriateness

Developing Stewardship Measures | Duke Antimicrobial Stewardship Outreach Network (DASON)

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Polling Question #3

Which of the following examples would be considered as a process metric?

1. Rate of physician utilization of the new pneumonia order set to prescribe optimal antimicrobials
2. Incidence of nephrotoxicity with new vancomycin protocol
3. Antimicrobial days of therapy per 1000 days present
4. Time to appropriate antimicrobial therapy after the implementation of a new disease state guideline and rapid diagnostic test.

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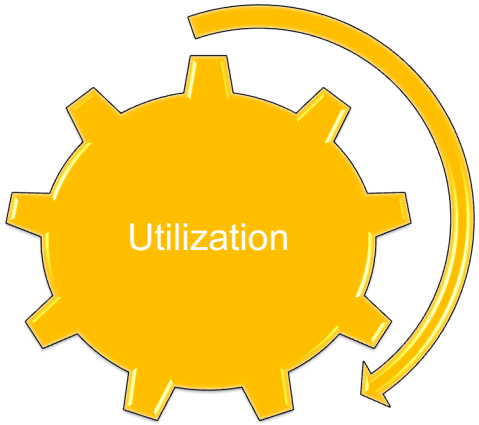

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Utilization Measures

- Describes total antimicrobial use
- Historically used to justify the value of antimicrobial stewardship practices
- Well established in literature and guidelines

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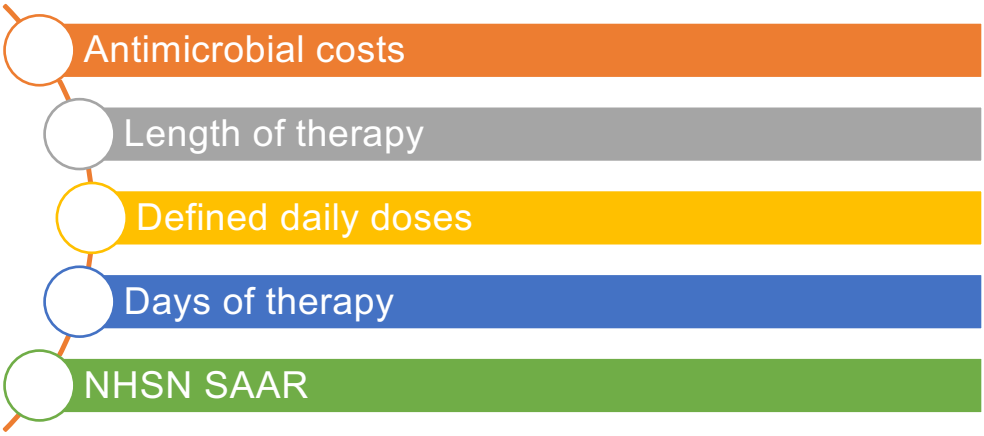
Utilization Measures



Hermsen ED, et.al. CID; 2014;59(S3):S112-21 Moehring RM, et.al. CID;2017;64(3):377-83

Morris AM, et.al. Curr Opin Infec Dis;2014

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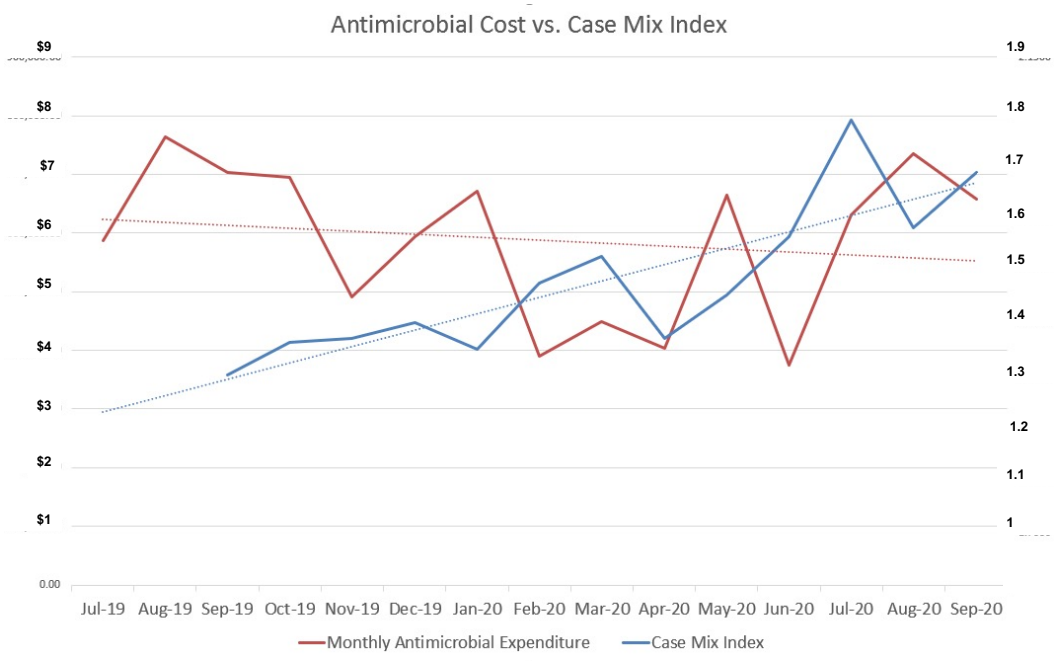
Antimicrobial Costs

- Origin of Data
  - **Administrations**
  - Direct purchasing costs
  - Products dispensed
- Denominators
  - Patient admissions
  - Patient days
- Consider trending against case mix index

Barlam T et al CID 2016; 15(62):e51-77.

36



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Antimicrobial Costs

Strengths

- Easy to communicate
- Objective measure
- Routinely reported in literature

Limitations

- Plateau over time
- Impacted by acuity
- Inflation
- Contracting and generic conversions

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Polling Question #4

Ideal assessment of antimicrobial costs should be based on which of the following data:

1. Total antimicrobial purchases
2. Doses dispensed
3. Administration data
4. Antimicrobial waste

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Table 1. Examples of Calculating Antimicrobial Consumption Metrics[a,b]

Hypothetical Regimens
Patient 1: vancomycin 1 g i.v. every 12 hr for 5 days, meropenem 1 g i.v. every 8 hr for 7 days
Patient 2: vancomycin 500 mg i.v. every 12 hr for 10 days, meropenem 1 g i.v. every 12 hr for 10 days
Patient 3: vancomycin 1 g i.v. every 12 hr for 7 days, meropenem 1 g i.v. every 8 hr for 14 days

Metric	Equation for Calculating Consumption per 1,000 Patient-Days	Calculations[c]
Defined daily doses (DDDs)[18]	DDD = (amount of antimicrobial used/WHO standard)/patient volume × 1,000	With use of WHO-defined standard DDDs (vancomycin, 2 g/day; meropenem, 2 g/day), calculations proceed as follows: Meropenem DDD = ([83 g used/2 g]/200) × 1,000 = 207.5 DDD per 1,000 patient-days Vancomycin DDD = ([34 g used/2 g]/200) × 1,000 = 85 DDD per 1,000 patient-days
Days of therapy (DOT)[23]	DOT = antimicrobial days/patient volume × 1,000	Vancomycin days = 22 Vancomycin DOT = (22/200) × 1,000 = 110 DOT per 1,000 patient-days Meropenem days = 31 Meropenem DOT = (31/200) × 1,000 = 155 DOT per 1,000 patient-days
Length of therapy (LOT)[18]	LOT = duration of antimicrobial use/patient volume × 1,000	Patient 1 duration = 7 days Patient 2 duration = 10 days Patient 3 duration = 14 days LOT = ([7 + 10 + 14]/200) × 1,000 = 155 LOT per 1,000 patient-days

[a]WHO = World Health Organization.
[b]Calculations are hypothetical and likely not representative of expected use values.
[c]Calculations assume a patient volume during the reporting period of 200.

Bennett et al. AJHP. 2018; https://doi.org/10.2146/ajhp160335

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Antimicrobial Utilization: Numerators and Denominators

- Variation in origin of data and calculations
- Numerators
  - **Days of therapy (DOT)**
  - Defined daily doses (DDD) expressed in total cumulative antimicrobial dose administered per day
  - Length of therapy (LOT) in total duration of use, regardless of dose or frequency
- Denominators
  - 1000 days present
  - 1000 patient days
  - Admissions

Barlam T et al CID 2016; 15(62):e51-77.

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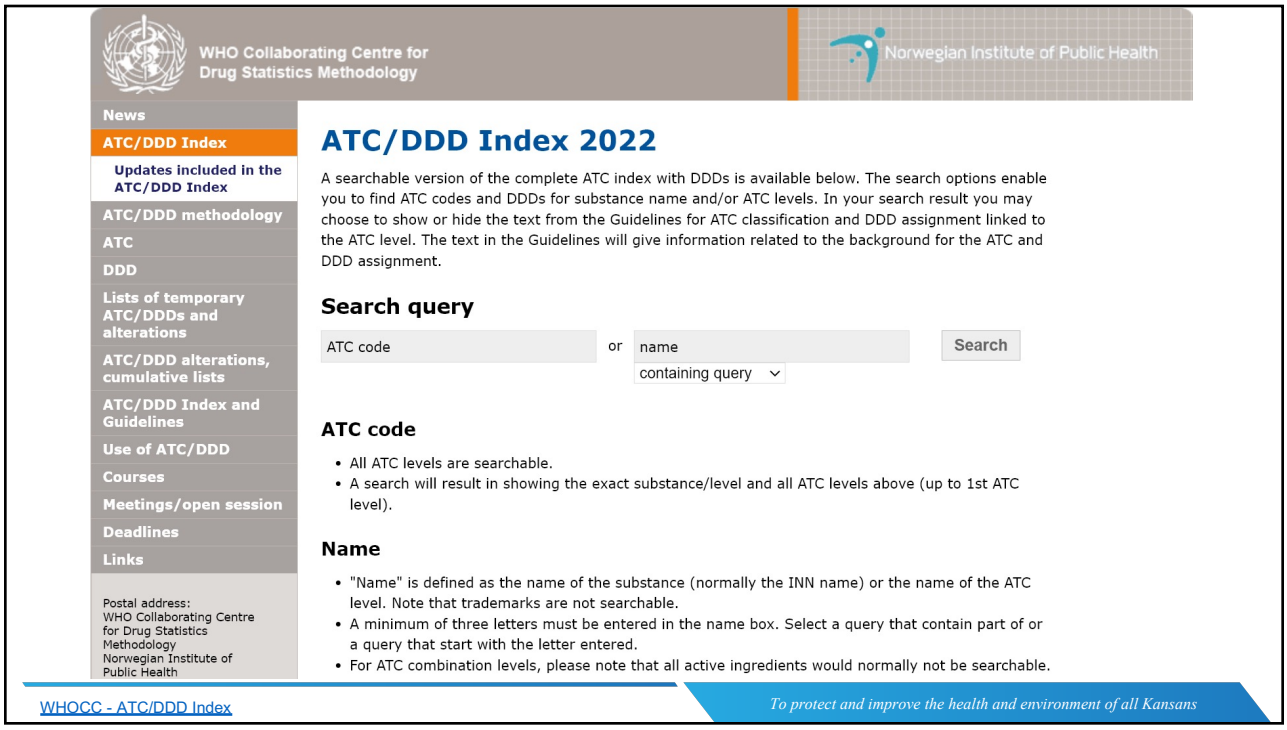
Defined Daily Doses

- Average **adult** maintenance dose per day determined by World Health Organization (WHO)
- Alternative to patient level AU data
- Administrations
  - eMAR or BCMA data is ideal
- Denominator
  - 1000 patient days

Bennett et al. AJHP. 2018; https://doi.org/10.2146/ajhp160335 Barlam T et al CID 2016; 15(62):e51-77.

Hollingworth S, et.al. Pharmacy 2021;9,60. doi.org/10.3390/pharmacy9010060

42


WHO Collaborating Centre for Drug Statistics Methodology
Norwegian Institute of Public Health
News
ATC/DDD Index
Updates included in the ATC/DDD Index
ATC/DDD methodology
ATC
DDD
Lists of temporary ATC/DDDs and alterations
ATC/DDD alterations, cumulative lists
ATC/DDD Index and Guidelines
Use of ATC/DDD
Courses
Meetings/open session
Deadlines
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Postal address:
WHO Collaborating Centre for Drug Statistics Methodology
Norwegian Institute of Public Health
ATC/DDD Index 2022
A searchable version of the complete ATC index with DDDs is available below. The search options enable you to find ATC codes and DDDs for substance name and/or ATC levels. In your search result you may choose to show or hide the text from the Guidelines for ATC classification and DDD assignment linked to the ATC level. The text in the Guidelines will give information related to the background for the ATC and DDD assignment.
Search query
ATC code
or
name
containing query
Search
ATC code
All ATC levels are searchable.
A search will result in showing the exact substance/level and all ATC levels above (up to 1st ATC level).
Name
"Name" is defined as the name of the substance (normally the INN name) or the name of the ATC level. Note that trademarks are not searchable.
A minimum of three letters must be entered in the name box. Select a query that contain part of or a query that start with the letter entered.
For ATC combination levels, please note that all active ingredients would normally not be searchable.
WHOCC - ATC/DDD Index
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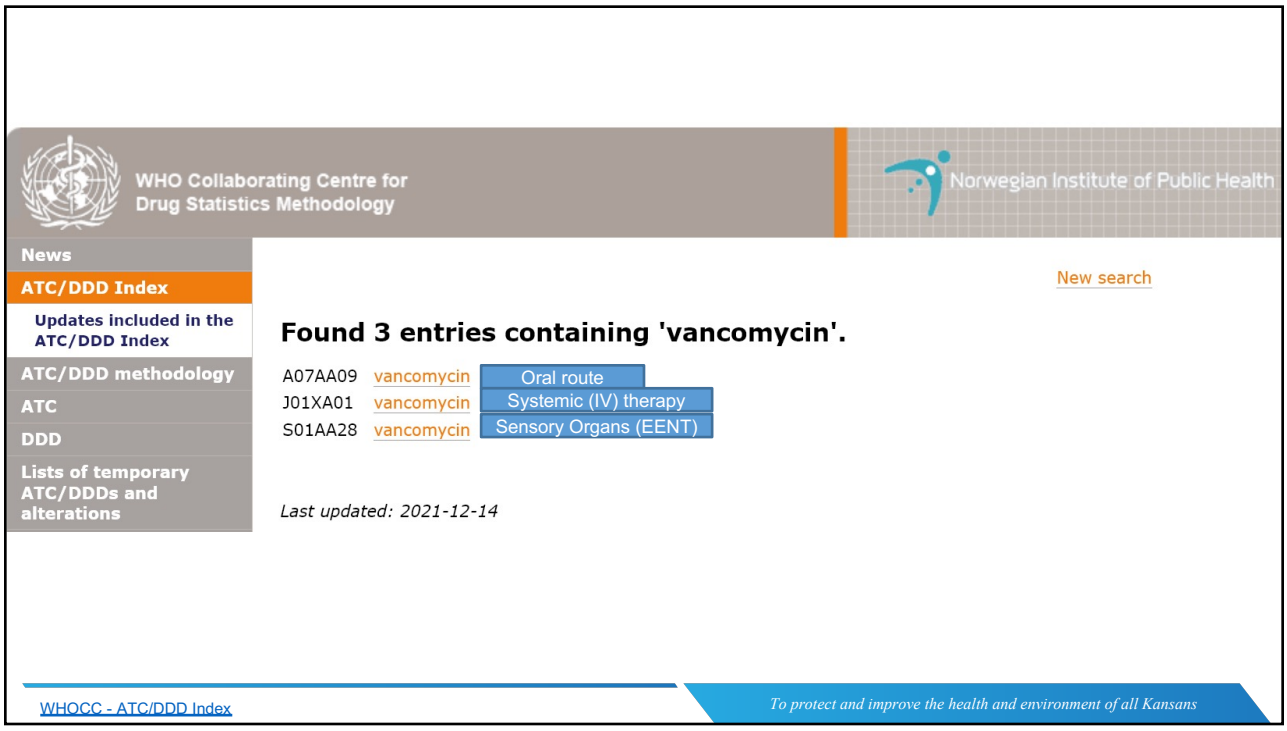
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News
ATC/DDD Index
Updates included in the ATC/DDD Index
ATC/DDD methodology
ATC
DDD
Lists of temporary ATC/DDDs and alterations
New search
Found 3 entries containing 'vancomycin'.
A07AA09 vancomycin Oral route
J01XA01 vancomycin Systemic (IV) therapy
S01AA28 vancomycin Sensory Organs (EENT)
Last updated: 2021-12-14
WHOCC - ATC/DDD Index
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J01XA **Glycopeptide antibacterials**

This group comprises glycopeptide antibacterials, inhibiting the cell wall synthesis of gram positive bacteria. Teicoplanin and intravenous preparations of vancomycin are classified in this group. Oral formulations containing vancomycin are classified in A07A.

ATC code	Name	DDD	U	Adm.R	Note
J01XA01	vancomycin	2	g	P	

WHOCC - ATC/DDD Index

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DDD per 1000 patient days: Calculation Example

- Patient 1
  - Vancomycin 1g IV every 12 hours for 5 days
  - Total vancomycin: **10g**
- Patient 2
  - Vancomycin 500 mg IV every 12 hours for 10 days
  - Total vancomycin: **10g**
- Patient 3
  - Vancomycin 1g IV every 12 hours for 7 days
  - Total vancomycin: **14g**

Total Vancomycin Administered: 34g

Bennett et al. AJHP. 2018; https://doi.org/10.2146/ajhp160335

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DDD per 1000 patient days: Calculation Example

$$\left[\frac{\text{(Total Administered)/WHO DDD}}{\text{Patient census}}\right] \times 1000$$

$$\left[\frac{(34g/2g)}{200}\right] \times 1000$$

85 DDDs per 1000 patient days

Bennett et al. AJHP. 2018; https://doi.org/10.2146/ajhp160335

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DDD per 1000 patient days

Strengths

- May be more feasible to calculate than DOT
- Objective measure of consumption

Limitations

- Pediatric populations
- Reduced accuracy when prescribed daily dose varies significantly from defined daily dose
- WHO DDD may change over time

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Days of Therapy

- Preferred metric for tracking and benchmarking
- Total days an antimicrobial was administered regardless of dose
  - Each unique antimicrobial
- Patient level administration data needed
- Denominator
  - 1000 patient days
  - 1000 days present (NHSN AU Option)

Barlam T et al CID 2016; 15(62):e51-77.

Bennett et al. AJHP. 2018; https://doi.org/10.2146/ajhp160335

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DOT: Numerator Calculation Example

- Patient 1
  - Vancomycin 1g IV every 12 hours for **5 days**
  - Meropenem 1g IV every 8 hours x **7 days**
- Patient 2
  - Vancomycin 500 mg IV every 12 hours for **10 days**
  - Meropenem 1g IV every 12 hours x **10 days**
- Patient 3
  - Vancomycin 1g IV every 12 hours for **7 days**
  - Meropenem 1g IV every 8 hours x **14 days**

Bennett et al. AJHP. 2018; https://doi.org/10.2146/ajhp160335

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DOT: Numerator Calculation Example

- Vancomycin Days of therapy
  - Patient 1 = 5 days
  - Patient 2 = 10 days
  - Patient 3 = 7 days
- Meropenem Days of therapy
  - Patient 1 = 7 days
  - Patient 2 = 10 days
  - Patient 3 = 14 days

Total Vancomycin days of therapy: 22

Total Meropenem days of therapy : 31

Bennett et al. AJHP. 2018; https://doi.org/10.2146/ajhp160335

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DOT per 1000 patient days: Calculation Example

$$\left[\frac{\text{(Total Days of Therapy)}}{\text{Patient census}}\right] \times 1000$$

Vancomycin

$$\left[\frac{(22)}{200}\right] \times 1000$$

110 DOTs/1000 patient days

Meropenem

$$\left[\frac{(31)}{200}\right] \times 1000$$

110 DOTs/1000 patient days

Bennett et al. AJHP. 2018; https://doi.org/10.2146/ajhp160335

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Days of Therapy per 1000 patient days

Strengths

- Adult and pediatric populations
- Widely utilized in literature

Limitations

- Patient level data needed
- Manual manipulation or database proficiency needed

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Denominators make all the difference!

- Days of therapy numerator is consistent
- Patient days present is selected denominator for reporting to the National Healthcare Safety Network (NHSN) Antimicrobial Use and Resistance option (AU/AR)

Barlam T et al CID 2016; 15(62):e51-77.

Bennett et al. AJHP. 2018; https://doi.org/10.2146/ajhp160335

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Denominators make all the difference!

	12am	10 am	3 pm	9pm
Med-Surg				
ICU				
Operating Room				

Patient days: 1

Days Present: 2
- **Days Present, Med-Surg: 1**
- **Days Present, ICU: 0**
- **Days Present, OR: 1**

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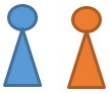
Denominators make all the difference!

	12am	10 am	3 pm	9pm
Med-Surg				
ICU				
Operating Room				

Patient days: 2

Days Present: 4
- Days Present, Med-Surg: 2
- Days Present, ICU: 1
- Days Present, OR: 1

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Days of Therapy per 1000 days present

Strengths

- Unit level observation in addition to facility wide
- Reportable to NHSN
- Benchmarking possible!

Limitations

- Calculating days present is **HARD**
- External software vendor required to abstract and upload to NHSN

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Polling Question #5

Which utilization metric is required for upload into the NHSN AU module?

1. Days of therapy
2. Defined daily doses per 1000 patient days
3. Days of therapy per 1000 days present
4. Days of therapy per 1000 patient days

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Standardized Antimicrobial Administration Ratio

- Generated from data reported to NHSN
- Ratio of observed antimicrobial use to predicted use
  - Facility wide and individual patient care locations

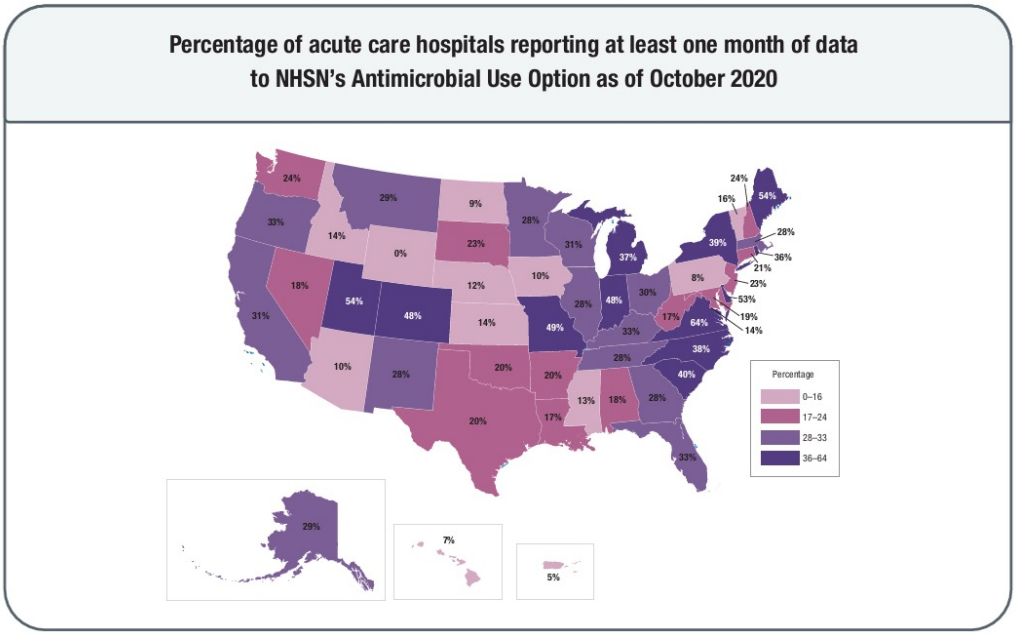
$$SAAR = \frac{Observed\ Antimicrobial\ Use}{Predicted\ Antimicrobial\ Use}$$

Predicted Antimicrobial Use?

- "Calculated using predictive models developed by CDC and applied to nationally aggregated…AU data reported to NHSN from the same group of patient care location types."
- More data reported = better data modeling
- For more detailed methodology, check out

1. OLeary EN. National Healthcare Safety Network Standardized Antimicrobial Administration Ratios (SAARs): A Progress Report and Risk Modeling Update Using 2017 Data. *Clin Infect Dis*. 2020;70(10):e702-9
2. NHSN's Guide to the Standardized Antimicrobial Administration Ratio. 2020 Nov. https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/aur/au-saar-guide-508.pdf

OLeary EN, et.al. CID 2020;70(10):e702-9



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Tracking Tools

- Excel file with patient-level interventions
- Electronic or manual calculation of DDDs
- HAI tracking in collaboration with infection prevention/quality
- Open access tool kits or resources
- Clinical decision support vendors that facilitate upload to NHSN

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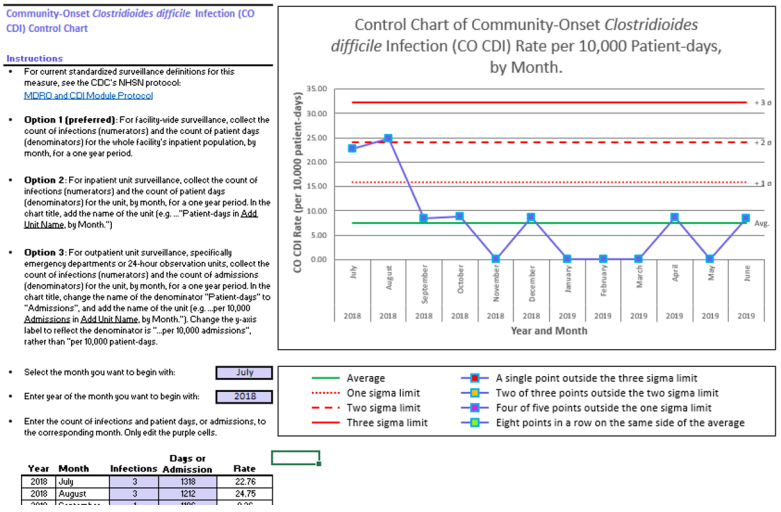
Tools: Interactive HAI Spreadsheets



- Intro/step-by-step
  - CAUTI
  - UTIs
  - Urinary utilization
  - CLABSIs
  - CVC utilization
  - C.diff

Download

Interactive HAI tracking tool:
https://www.kdheks.gov/epi/hai/CAH_Toolkit/Spreadsheet_2_Interactive_HAI_Tracking_Tools.xlsx

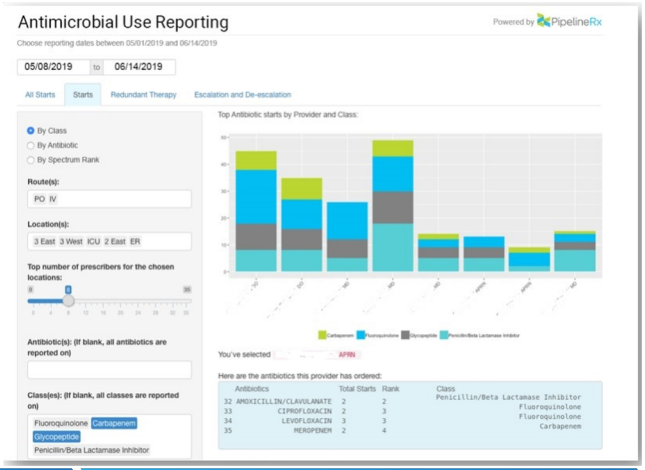
Tracking Efforts in KS: PipelineRx

Join the fight against antimicrobial resistance and the emergence of superbugs!

Actionable Data
Utilizes the exact data elements necessary for ASP, as defined by the Federal Government and following national standards and guidelines.

Automated Process
Automates a typically manual and highly time-consuming process, eliminating data entry and potential for error.

Real-Time Integration
Automated data flow between your EHR and NHSN's AUR module.



Polling Question #6

We are planning to do two parallel sessions next time! One for facilities with beginning metrics and another for advanced metrics.

Which session would you like to participate in?

1. Foundational Metrics for Antimicrobial Stewardship. Foundational metrics include cost, working towards DDDs or DOTs or other metrics.
2. Advanced reporting: focus on NHSN reporting and SAAR. Advanced metrics would include days of therapy per 1000 days present and ability to report to the NHSN AUR Module.

Next Session Preparation

- Identify a utilization metric that is feasible or currently used in your health system
- Obtain raw data and attempt to calculate your metric
- Come prepared with the challenges and barriers you experienced
- We want the next session to be “hands on”!
- **If you have an example you’d like to be used anonymously for next session’s demonstration, please e-mail nwilson5@kumc.edu !**

Thank You/Questions

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Resources & More Information

KDHE wants to help with AS/AR, contact:

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877-427-7317

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We invite your feedback.

Please complete our brief feedback survey

https://www.surveymonkey.com/May5