Antibiotic Stewardship Metrics: How do you measure up?

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Objectives and Disclosures

1. Define metrics that can be used to measure antibiotic utilization
2. Define metrics that can be used to measure an antibiotic stewardship program's performance
3. Describe the strengths and weaknesses of these metrics

I have no disclosures

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What do the CDC Core Elements Say About Measuring Antibiotic Use?

Category	Statement
Acute care	Measurement is critical to identify opportunities for improvement and assess the impact of improvement efforts (87). For antibiotic stewardship, measurement may involve evaluation of both process (Are policies and guidelines being followed as expected?) and outcome (Have interventions improved antibiotic use and patient outcomes?).
Long term care	Provide regular feedback on antibiotic use and resistance to prescribing clinicians, nursing staff and other relevant staff
Critical access hospitals	Days of therapy is considered the most useful measure of antibiotic use to inform stewardship efforts. Facilities can electronically capture, analyze and benchmark days of therapy through the CDC's AU option. Tracking adherence to treatment recommendations and performance of interventions such as antibiotic time-outs can be useful to further guide quality improvement efforts. In addition, small and critical access hospitals are well positioned to monitor antibiotic use at the provider level.
Outpatient	Monitor antibiotic prescribing practices and offer regular feedback to clinicians, or have clinicians assess their own antibiotic prescribing practices themselves.

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Source: CDC Core Elements of Antibiotic Stewardship , Barlam TF, Cosgrove SE, Abbo LM, et al., Clin Infect Dis. 2016;62:e51-e77

What Do Other Organizations Say About Measuring Antibiotic Use?

Organization	Statement
IDSA/SHEA (2016)	We recommend measuring antibiotic costs based on prescriptions or administrations instead of purchasing data (good practice recommendation).
Joint Commission	The organization collects and analyzes data on its antimicrobial stewardship program, including antimicrobial prescribing and resistance patterns
DNV	No info available
Leap Frog	Does your facility monitor antibiotic use (consumption) at the unit, service, and/or facility wide?
US News and World Report [Children's Hospital Ranking]	At least 0.2 FTE support for a dedicated analyst to support ASP program

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Antibiotic Metrics 101

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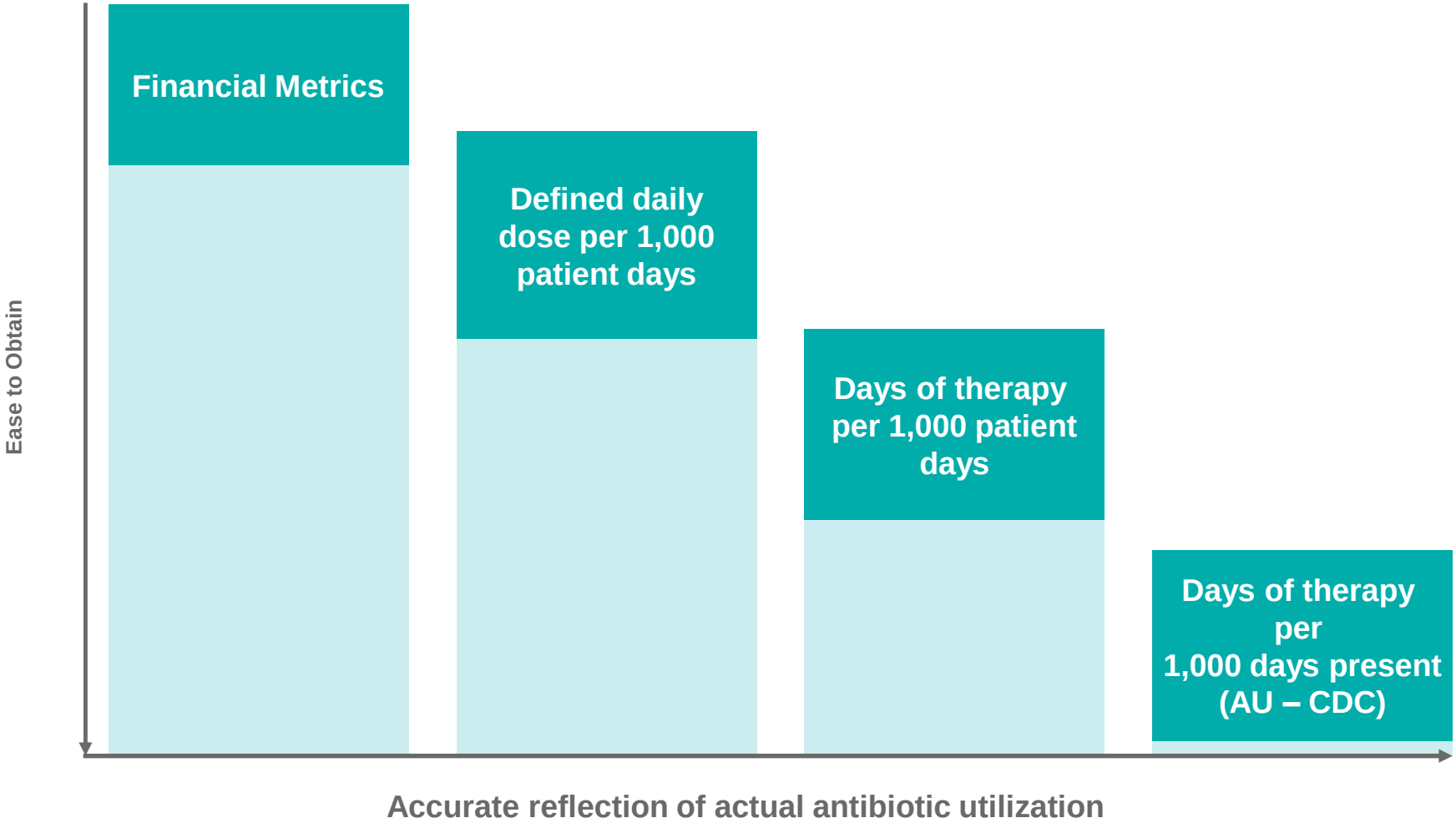
Measuring antibiotic use



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Financial Metrics

- Antibiotic cost per patient day (inpatient only)
- Antibiotic cost per adjusted patient day (inpatient + outpatient)
- Antibiotic cost (%) to total drug budget
- Total spend
- Wastage - % wastage for specific drugs
- Antibiotic cost per discharge
- CMI adjusted __fill in the blank __
- Cost per MS DRG (ID related)
- Cost per length of stay
- Cost due to readmissions

Financial Metrics

Annual Purchases: 1000 doses

COST = UTILIZATION X PRICE

Cost influencers

- Inventory builds or burns
- DSH (inpatient)
- 340B (outpatient)
- Generic launches
- Drug shortages

Year	Price per dose	Total Spend
2011	$335	$335,000
2012	$300	$300,000
2013	$200	$200,000
2014	$125	$125,000
2015	$ 75	$ 75,000

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Defined Daily Dose

Standardized definition of daily antibiotic dose

Created by the World Health Organization

Correction factor: $\frac{\text{Total Units (i.e. mg) Drug}}{\text{DDD Correction Factor}}$

Pros:

Attempts to convert raw purchasing data into utilization data

Allows comparisons with other institutions

Easy to calculate

Cons:

Not everyone agrees with the DDDs – International vs US

Many use institution-specific correction factors (prescribed daily dose)

Not patient level information

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WHO Website

Address http://www.whocc.no/atc_ddd_index/?code=J01CR05

Home | ATC/DDD application form | Order publications | WHO Centre | Contact us | Log i

WHO Collaborating Centre for Drug Statistics Methodology

Norwegian Institute of

- News
- ATC/DDD Index
  - Updates included in the ATC/DDD Index
- ATC/DDD methodology
- ATC
- DDD
- ATC/DDD alterations, cumulative lists
- ATC/DDD publications
- Use of ATC/DDD
- Courses
- Meetings/open session
- Deadlines
- Links

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J ANTIINFECTIVES FOR SYSTEMIC USE
J01 ANTIBACTERIALS FOR SYSTEMIC USE
J01C BETA-LACTAM ANTIBACTERIALS, PENICILLINS
J01CR Combinations of penicillins, incl. beta-lactamase inhibitors

ATC code	Name	DDD	U	Adm.R	Note
J01CR05	piperacillin and enzyme inhibitor	14	g	P	Refers to piperacillin

List of abbreviations

Last updated: 2009-10-27

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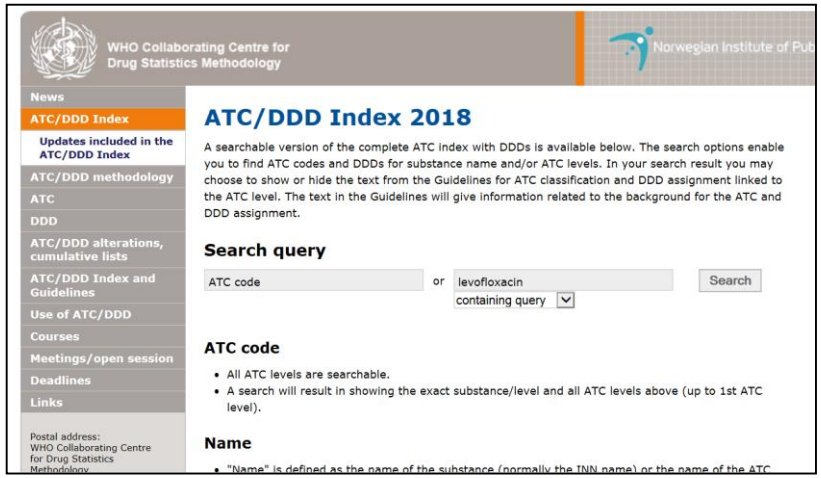
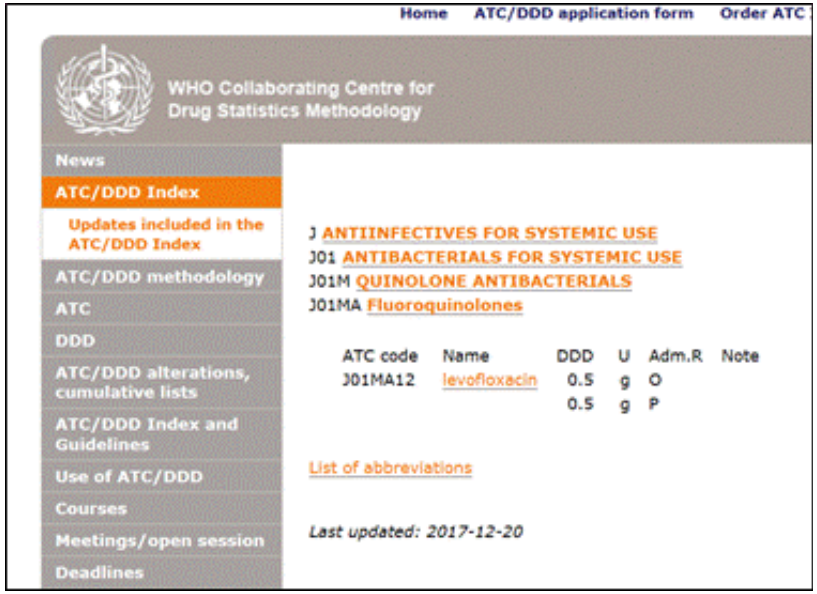
Calculating the DDD

Levofloxacin

- Dose varies in US – 250mg, 500mg, or 750mg daily
- Available in IV or PO
- Let's say you get a report of levofloxacin 750mg use for the month of January and you have given **300** doses of levofloxacin 750mg IV and **150** doses of 500mg PO
- **What is the total DDD?**





https://www.whocc.no/atc_ddd_index/

O= Oral ; P= Parenteral

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Calculating Levofloxacin DDD

Dose	Route	Total Dispensed	Total amount (mg)	Total amount (grams)	WHO DDD	Levo DDD
500mg	PO	150	75000	75	0.5	150
750mg	IV	300	225000	225	0.5	450

Typically expressed per 1000 patient days

Levo-floxacin	Route	DDD	Total patient days	DDD/1000 pt days
500mg	PO	150	7,500	20
750mg	IV	450	7,500	60

= (DDD/pt days) x 1000

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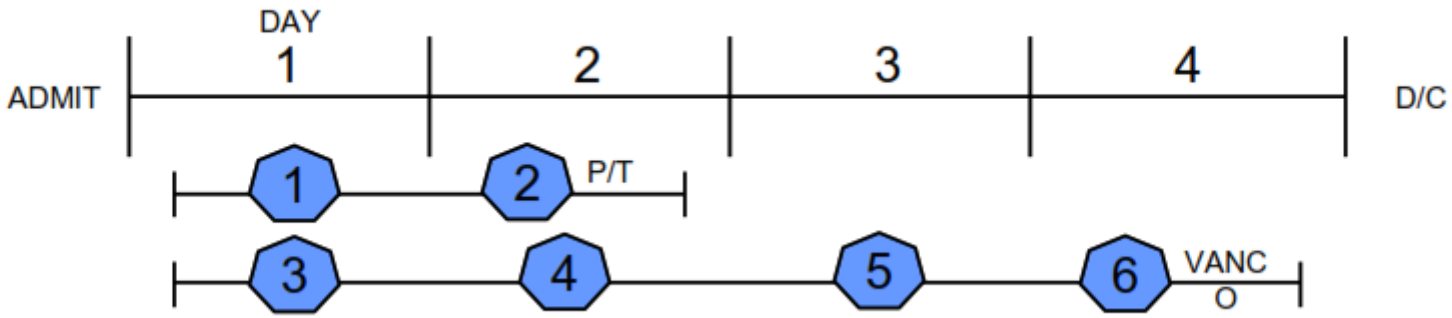
Lessons learned from calculating DDDs

- **It's not perfect**
- **It's not always straightforward**
  - Combination products are tricky
    - Piperacillin /tazobactam = only count piperacillin (14g)
  - Drugs dosed in other units besides grams can be a challenge
    - If low use, consider counting doses vs units
- **Using alternate correction factors matters less if you are comparing yourself to yourself**
- **If all you have is purchase data, you can still calculate it – use units purchased**

Days of Therapy

Aggregate sum of days for which any amount of specific antimicrobial agent was administered to individual patients



Obtained from electronic medication administration record (eMAR) or bar code medication administration (BCMA) data

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Days of Therapy per 1,000 patient days

- Total days of vancomycin 1 gm every 12 hours = 20
- Total days of vancomcyin 1gm every 24 hours = 30
- Total days of vancomycin 750mg every 24 hours = 10
- Total days of vancomcyin therapy this month = 60
- Total patient days = 500

DOT = Vancomycin days /patient days x 1000

DOT = 60/500 x 1000

DOT = 120 DOT/1000 patient days

DDD vs DOT

DDD	DOT
Pros: Standard comparisons using aggregate utilization data Will change estimate of drug use if high doses are use, but standard is not changed **Cons:** Not a surrogate for DOT when dose is different than standard: • Cannot be used for: children, renal dysfunction DDD can change with time	**Pros:** Can be used in children Not influenced by changes in the DDD standards Not subject to differences in institutional preference Patient-specific information **Cons:** Overestimates use for drugs given multiple times per day More difficult to measure without computerized records

Polk RE. *Clin Infect Dis* 2007; 44:664-70.

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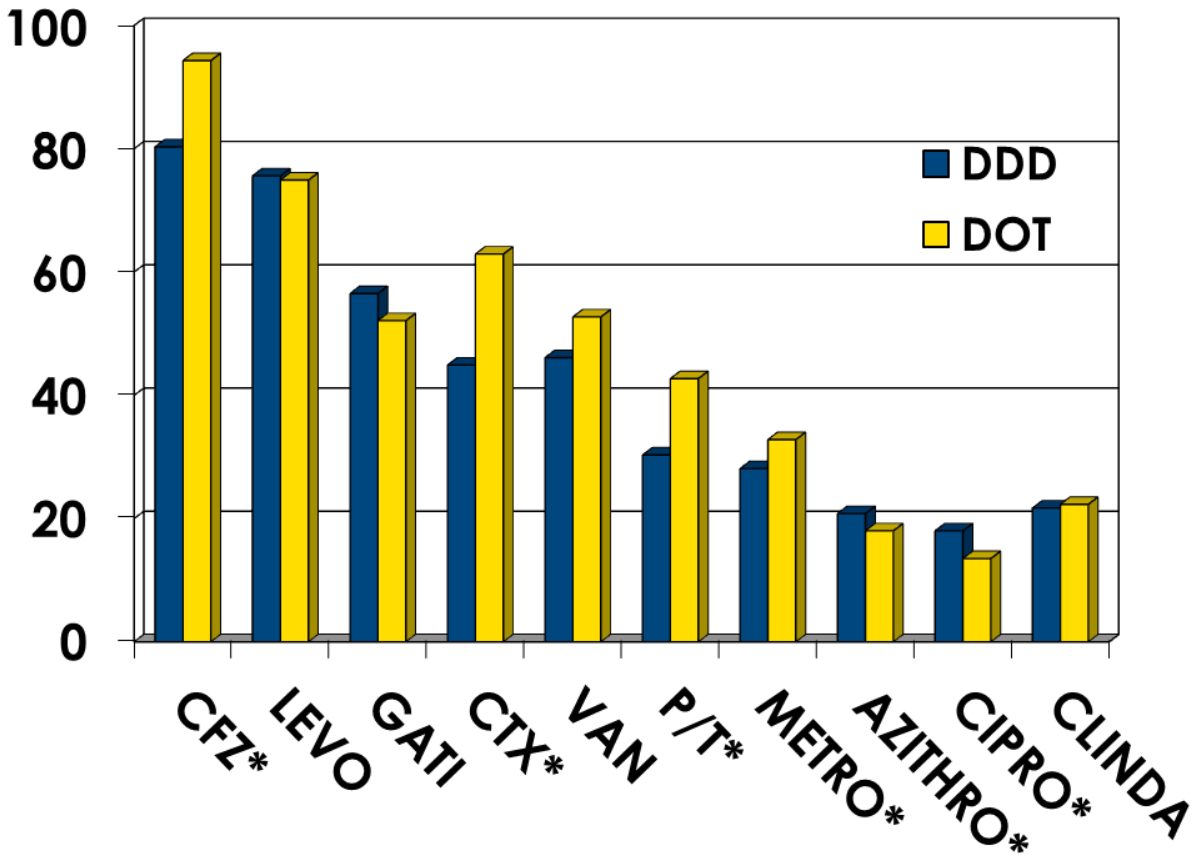
Slide courtesy of Libby Dodds Ashley, PharmD, MHS, FCCP, BCPS - DASON

DDD vs. DOT



Polk RE. *Clin Infect Dis* 2007; 44:664-70.

Slide courtesy of Libby Dodds Ashley, PharmD, MHS, FCCP, BCPS - DASON

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Other Common Denominators

Admissions

CDC Definition: The aggregate number of patients admitted to the facility starting on the first day of each month through the end of the calendar month

Discharges

Excludes patients who expire in the hospital

Also should exclude healthy newborns

Case Mix Index Adjusted

Commonly used in hospital systems to account for variations in location acuity

Other Utilization Metrics

DOT/1000 patient days present (AU)

IV to PO Percentage or Percentage PO

LOT/1000 pt days

Number of patients on antibiotics

- Day
- Per Visit

DOT = Days of Therapy
LOT = Length of Therapy

Long Term Care

Tracking: Data Sources for Tracking Antibiotic Use

- Monitor antibiotic use and health outcomes to guide practice changes
  - Antibiotic Use Reports can be obtained from:
    - Long-term Care (LTC) Pharmacies: dispense and deliver medications, provide drug regimen reviews and clinical consulting, can provide antibiotic use reports.
    - Electronic Health Record Systems (EHR): interface and capability of different EHR systems can vary by facility, can provide accurate antibiotic use reports.
    - Manual Chart Review: may be only the possible way to collect antibiotic use data in some facilities.

Slide credit: Sarah Kabbani, MD, CDC, SHEA 2018

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Long Term Care

Tracking: Antibiotic Use Measures

- Antibiotic starts:
  - Many nursing home IPC programs track new antibiotic starts as part of their infection surveillance activity.
  - Antibiotic starts may a better measure to track the effect of stewardship initiatives designed to educate prescribers on situations when antibiotics are not appropriate.
- Antibiotic days of therapy (DOT):
  - Multiple antibiotic orders can be found in the LTC pharmacy or EHR systems for every antibiotic course, tracking DOT may be easier and more accurate when using those data sources.
  - Antibiotic DOT may be a better measure to track changes in antibiotic use over time.

Slide credit: Sarah Kabbani, MD, CDC, SHEA 2018

Great Reference

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.

Am J Health-Syst Pharm. 2018; 75:230-8

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Other Metrics

- **Advanced Utilization**
- **Process**
- **Prescriber**
- **Outcome**
- **Quality/Safety**

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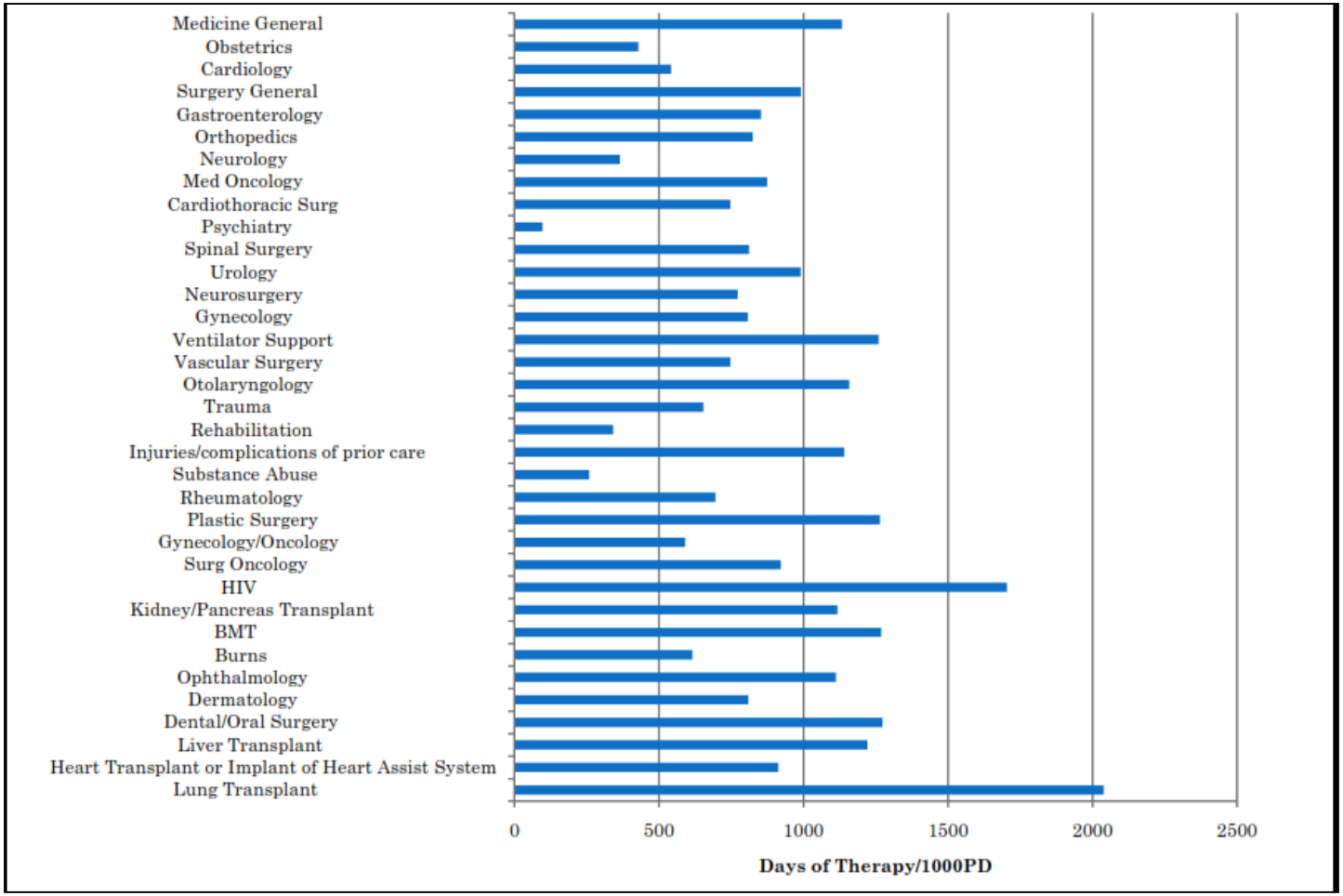
Advanced Utilization Metrics

- % admissions that received certain antibiotics
- Point prevalence study – looking at what is happening house wide at a pre-selected time
- DOT by provider
- Average LOT for specific antibiotics
- % of therapy appropriate indication or ICD9/10 codes
- % of time empiric therapy was appropriate for a certain indication
- Choice/Change/Completion – looking at empiric, narrow, complete therapy
- DOT/LOT

DOT by Service Line
MS DRG Groupings



Clin Infect Dis. 2011 Dec;53(11):1100-10

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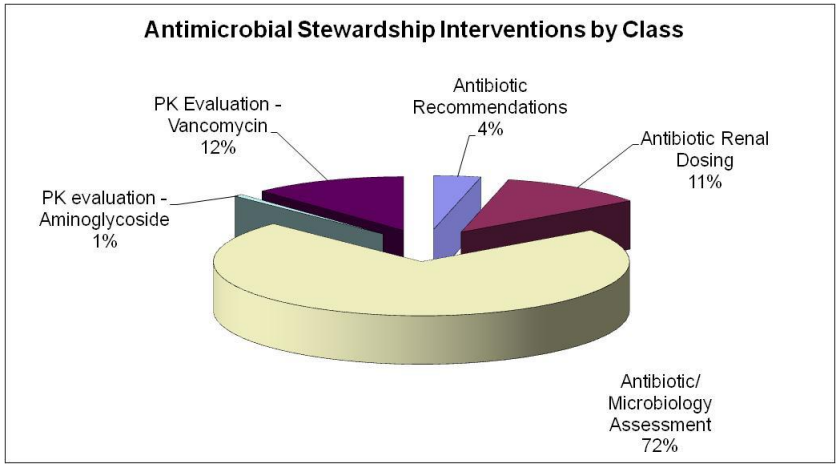
Process Measures



- **Interventions**
  - Renal dosing
  - IV to PO
  - De escalation
  - Therapy Cessation
- **Percent ordered per protocol/guidelines**
- **Culture collected before antimicrobial being administered**
- **Intervention acceptance rate**
- **Average number of interventions per patient reviewed**
- **Redundant therapy events**
- **% orders with start and stop date**
- **MSSA and receiving a beta lactam**
- **Compliance to best practice bundles**

CID 2017:64 (1 February)

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Prescriber Metrics

- Drug utilization by prescriber
  - Debate about whether to blind info or use name
  - Challenge when you can only get attending physician's name. When at academic medical center, consider by service
- Percent of orders for antimicrobials that required action
- Acceptance rates
- ID physician consult rates

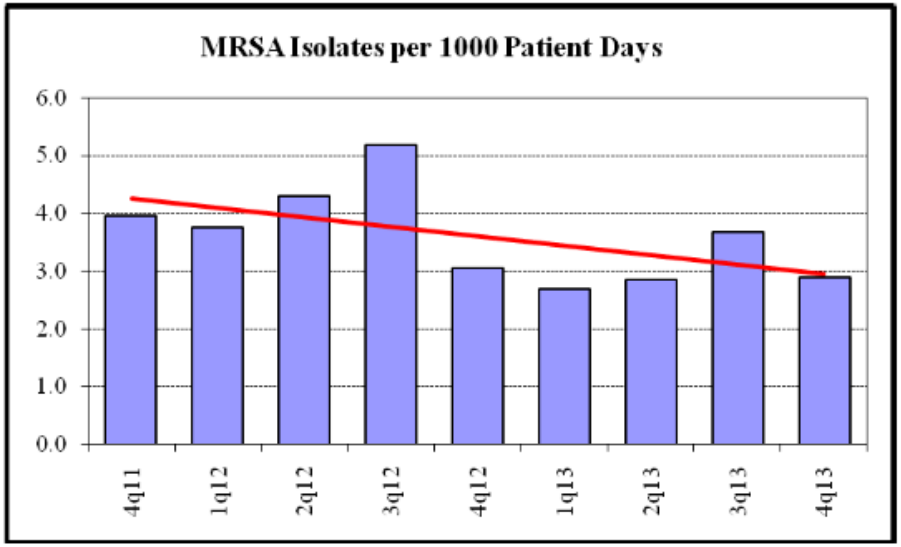
Outcomes Metrics

Resistance rates

Theoretical, difficult to measure short term

Clostridium difficile rates

Balancing measure – pts that were de-escalated that were then escalated



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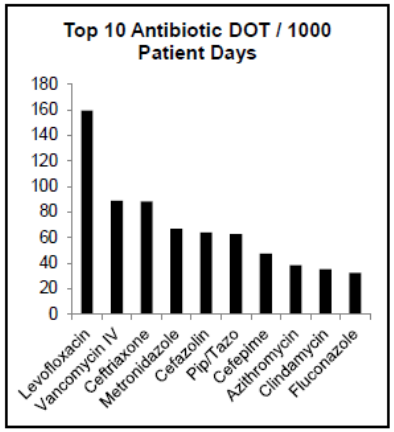
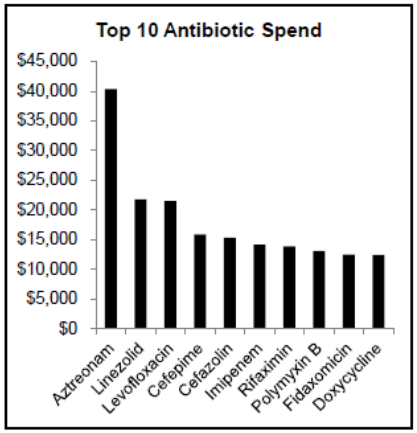
Quality/Safety Measures

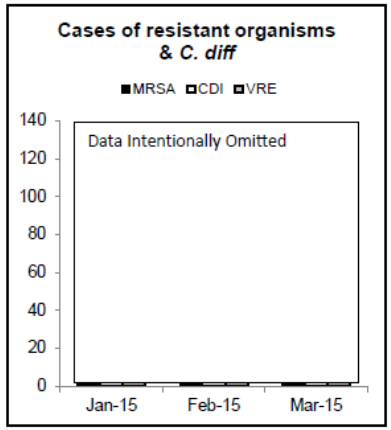
- Percent of time diseases specific order set was used
- Adverse drug events reported
- Time to appropriate therapy
- Time to therapeutic concentrations
- Adverse drug event rates
- Time to appropriate antibiotic trough levels (vancomycin)
- Time to PO conversion
- CLABSI rates
- Mortality
- PICC line complications

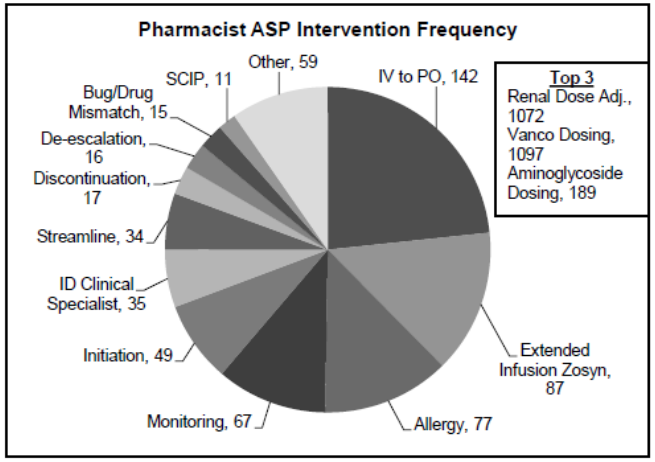
Sample Dashboard

2015 Q1 Antimicrobial Stewardship Dashboard









Pharmacist ASP Notable Interventions

Positive Cultures, No antibiotics x >24 hrs

Provides clinical detail and specifics about how issue(s) were resolved

Pt being discharged on wrong antibiotics

Provides clinical detail and specifics about how issue(s) were resolved

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Using Your Metrics to Drive Change

Who?

What ?

When ?

Where ?

Why?

References

http://www.antimicrobialstewardship.com/sites/default/files/article_files/how_to_calculate_ddds_final.pdf

Bennett N, et al. “Understanding inpatient antimicrobial stewardship metrics” . Am J Health Systems Pharmacists 2018;75:230-8.

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Appendix

AUR/SAAR

Antibiotic Use Tracking

NHSN Antibiotic Utilization and Resistance (AUR) Module

- Module designed to capture antibiotic use data through electronic input through NHSN
- AU measures antibiotic days per 1000 days present
- AR measures resistance and resistance trends
- Standardized Antibiotic Administration Ratio (SAAR)

AU Outputs

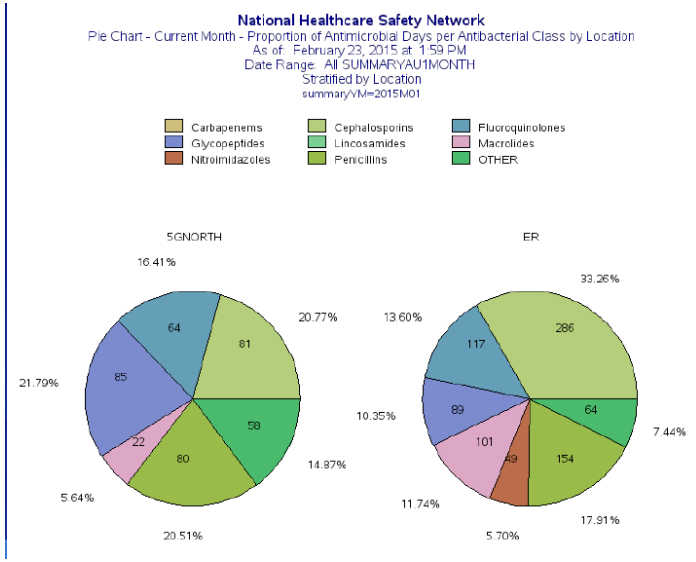
- Antimicrobial Use and Resistance Module
  - Antimicrobial Use Data
    - CDC Defined Output

Line Listing - Most Recent Month of AU Data for ...more	Run	Modify
Line Listing - Most Recent Month of AU Data by L...more	Run	Modify
Line Listing - All Submitted AU Data for FACWIDEIN	Run	Modify
Line Listing - All Submitted AU Data by Location	Run	Modify
Rate Table - Most Recent Month of AU Data - Anti...more	Run	Modify
Rate Table - All Submitted AU Data - Antimicrobi...more	Run	Modify
Rate Table - Most Recent Month of AU Data - Anti...more	Run	Modify
Rate Table - All Submitted AU Data - Antimicrobi...more	Run	Modify
Pie Chart - Most Recent Month of AU Data by Anti...more	Run	Modify
Pie Chart - All AU Data by Antibacterial Class a...more	Run	Modify
Pie Chart - Most Recent Month of AU Data by Anti...more	Run	Modify
Pie Chart - All AU Data by Antifungal Class and ...more	Run	Modify
Pie Chart - Most Recent Month of AU Data by Anti...more	Run	Modify
Pie Chart - All AU Data by Anti-influenza Class ...more	Run	Modify
Bar Chart - Most Recent Month of AU Data by Anti...more	Run	Modify
Bar Chart - All AU Data by Antibacterial Class a...more	Run	Modify
Bar Chart - Most Recent Month of AU Data by Anti...more	Run	Modify
Bar Chart - All AU Data by Antifungal Class and ...more	Run	Modify
Bar Chart - Most Recent Month of AU Data by Anti...more	Run	Modify
Bar Chart - All AU Data by Anti-influenza Class ...more	Run	Modify

National Healthcare Safety Network
Rate Table - Most Recent Month of AU Data - Antimicrobial Utilization Rates for FACWIDEIN
Rate per 1,000 Days Present
As of: February 23, 2015 at 1:44 PM
Date Range: All AU_RATES1MONTHFACWIDEIN

Facility Org ID=13860

Summary Year/Month	Antimicrobial Category	Antimicrobial Class	Antimicrobial Days	Days Present	Rate per 1000 Days Present
2015M01	Antibacterial	-- All --	1626	2177	746.899
2015M01	Antibacterial	Aminoglycosides	22	2177	10.106
2015M01	Antibacterial	Carbapenems	101	2177	46.394
2015M01	Antibacterial	Cephalosporins	337	2177	154.8
2015M01	Antibacterial	Fluoroquinolones	244	2177	112.081
2015M01	Antibacterial	Folate pathway inhibitors	32	2177	14.699



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Standardized Antibiotic Administration Ratio (SAAR)

- CDC's 1st attempt at developing a quality improvement measure for antibiotic use.
- Similar in principle to the Standardized Infection Ration (SIR).
- SAAR expresses observed antibiotic use compared to predicted use.
- CDC worked with many partners to develop the SAAR measure to try and make it most useful for stewardship.

Standardized Antibiotic Administration Ratio (SAAR): Patient Location Groupings

Adult

Medical and Surgical ICUs

Medical and Surgical wards

All medical and surgical locations combined

Pediatric

Medical and Surgical ICUs

Medical and Surgical wards

All medical and surgical locations combined

Standardized Antibiotic Administration Ratio (SAAR): Antibiotic Groupings

- ***Broad spectrum agents for hospital-onset/multi-drug resistant infections***
- Amikacin, aztreonam, cefepime, ceftazidime, ceftazidime/avibactam, ceftolozane/tazobactam, colistimethate, doripenem, gentamicin, imipenem/cilastatin, meropenem, piperacillin, piperacillin/tazobactam, polymixin B, ticarcillin/clavulanate, tigecycline, tobramycin
- ***Broad spectrum agents predominantly used for community-acquired infections***
- Cefotaxime, ceftriaxone, ciprofloxacin, ertapenem, gemifloxacin, levofloxacin, moxifloxacin
- ***Anti-MRSA agents***
- Ceftaroline, dalbavancin, daptomycin, linezolid, oritavancin, quinupristin/dalfopristin, tedizolid, telavancin, vancomycin
- ***Agents for surgical site infection prophylaxis***
- Cefazolin, cefotetan, cefoxitin, cefuroxime, cephalexin
- ***All agents***

Slide courtesy of Libby Dodds Ashley, PharmD, MHS, FCCP, BCPS - DASON

SAAR Report Output

National Healthcare Safety Network

SAARs Table - All Standardized Antimicrobial Administration Ratios (SAARs) High-Level Indicators and High-Value Targets

As of: November 17, 2015 at 3:10 PM
Date Range: All AU_SAAR

SAAR title

All antimicrobials used in adult ICUs and wards

Denominator

Facility Org ID	Summary Yr/Qtr	SAAR Type	Antimicrobial Days	Predicted Antimicrobial Days	Days Present	SAAR	SAAR p-value	95% Confidence Interval
13860	2014Q1	IND-Adult-1	4416	4421.364	6326	0.999	0.9437	0.970, 1.029
13860	2014Q2	IND-Adult-1	3998	3856.677	5668	1.037	0.0240	1.005, 1.069
13860	2014Q3	IND-Adult-1	3568	3952.912	5765	0.903	0.0000	0.873, 0.933
13860	2014Q4	IND-Adult-1	6835	5731.061	9247	1.193	0.0000	1.165, 1.221
13860	2015Q1	IND-Adult-1	4060	3113.877	5358	1.304	0.0000	1.264, 1.344

Observed Use

Predicted Use

Calculated SAAR Values

Includes data for January 2014 and forward.
Data restricted to medical, medical/surgical and surgical locations.
Source of aggregate data: 2014 NHSN AU Data
Data contained in this report were last generated on November 11, 2015 at 5:57 PM.

Data for Example Only. Slide source: CDC

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SAAR Report Output

National Healthcare Safety Network
SAARs Table - All Standardized Antimicrobial Administration Ratios (SAARs) High-Level Indicators and High-Value Targets
As of: November 18, 2015 at 3:40 PM
Date Range: All AU_SAAR

Antimicrobials used for hospital-onset/multi-drug resistant infections in adult ICUs

orgID	summaryYQ	SAARType	antimicrobialDays	numAUDaysPredicted	numDaysPresent	SAAR	SAAR_pval	SAAR95CI
13860	2014Q1	TAR-Adult-1	931	676.939	2800	1.375	0.0000	1.289, 1.466
13860	2014Q2	TAR-Adult-1	1066	563.535	2215	1.892	0.0000	1.781, 2.008
13860	2014Q3	TAR-Adult-1	926	591.879	2339	1.565	0.0000	1.466, 1.668
13860	2014Q4	TAR-Adult-1	955	547.620	2143	1.744	0.0000	1.636, 1.857
13860	2015Q1	TAR-Adult-1	265	180.954	700	1.464	0.0000	1.296, 1.649

Includes data for January 2014 and forward.
Data restricted to medical, medical/surgical and surgical locations.
Source of aggregate data: 2014 NHSN AU Data
Data contained in this report were last generated on November 11, 2015 at 5:57 PM.

National Healthcare Safety Network
SAARs Table - All Standardized Antimicrobial Administration Ratios (SAARs) High-Level Indicators and High-Value Targets
As of: November 18, 2015 at 3:40 PM
Date Range: All AU_SAAR

Antimicrobials used for hospital-onset/multi-drug resistant infections in adult wards

orgID	summaryYQ	SAARType	antimicrobialDays	numAUDaysPredicted	numDaysPresent	SAAR	SAAR_pval	SAAR95CI
13860	2014Q1	TAR-Adult-2	151	381.046	3526	0.396	0.0000	0.337, 0.463
13860	2014Q2	TAR-Adult-2	175	373.157	3453	0.469	0.0000	0.403, 0.542
13860	2014Q3	TAR-Adult-2	131	370.239	3426	0.354	0.0000	0.297, 0.418
13860	2014Q4	TAR-Adult-2	846	775.749	7104	1.091	0.0134	1.019, 1.166
13860	2015Q1	TAR-Adult-2	789	512.183	4658	1.540	0.0000	1.436, 1.651

Includes data for January 2014 and forward.
Data restricted to medical, medical/surgical and surgical locations.
Source of aggregate data: 2014 NHSN AU Data
Data contained in this report were last generated on November 11, 2015 at 5:57 PM.

Data for Example Only. Slide source: CDC

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