

DUKE ANTIMICROBIAL STEWARDSHIP OUTREACH NETWORK (DASON)

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“You cannot manage what you cannot measure”: understanding nuances in antimicrobial use metrics

Antimicrobial stewards must have a functional understanding of antimicrobial utilization metrics to support their data-driven decisions [1]. Measures of aggregate antimicrobial use, the most common metrics for antimicrobial stewardship (AS), are often expressed as a rate: x divided by y (x/y). The numerator (x) typically consists of a count of days of antimicrobial use. The denominator (y) can vary, but is generally considered a measure of the number of opportunities for antimicrobial use. By using a standard approach to rate calculations, antimicrobial stewards are in a better position to make meaningful comparisons across locations where antibiotics are used – hospitals, wards, or patients. The purpose of this newsletter is to discuss the different numerators and denominators commonly used in aggregate antimicrobial use metrics.

Numerator Data

The three most commonly used numerators in antimicrobial use metrics are days of therapy (DOT), length of therapy (LOT), and defined daily doses (DDD). DDD is the measure developed by the World Health Organization when the only available information available is tonnage of drugs used. DDDs have fallen out of favor due to poor estimation of drug use in the pediatric population and in patients with reduced drug excretion (e.g., those with renal dysfunction) [2]. Also availability of data from electronic medical records has improved in recent years.

Most hospitals and national organizations, including the CDC’s NHSN, measure antimicrobial use using DOT [3]. DOT is a count of the number of individual antimicrobial agents given to a patient on each calendar day. Electronic medication administration records (eMAR), or bar code medication administration (BCMA) data are now readily available in most US hospitals to calculate DOT. DOT is useful to evaluate the total burden of antimicrobial use because it is based the number of agents given as well as the number of days of antimicrobial exposure. DOT is calculated by calendar day regardless of the number of doses given.

LOT is another choice for numerators and can be thought of as days of antimicrobial exposure [1]. LOT is calculated as the number of calendar days’ duration of therapy regardless of the number of agents used. LOT is useful to evaluate durations (in days) of antimicrobial therapy.

The **Exercise** below provides a scenario with examples of both LOT and DOT counts.

Denominator Data

Three denominators may be used in antimicrobial use metrics: patient days, admissions, and days present. Remember, the denominator is a measure of opportunities. That is, the purpose of the denominator in antimicrobial use metrics is to provide information on the number of opportunities “at risk” for receiving antibiotics. When evaluating over larger populations, the rates may be presented per 1,000 units of admissions or person-time.

The most commonly used denominator for DASON member hospitals is **patient days (PD)** [4]. PD are calculated by counting the number of patients present in any given location (e.g., hospital or ward) at a single time point during a 24-hour period (e.g. the number of patients on a ward at midnight). While there are some subtleties about how patient days are calculated that we will not get into in this newsletter (e.g., admission vs. observation status), patient days essentially provide a sum of the total number of days that patients spent in the targeted location over an amount of time (e.g., month or year). PD is by no means a perfect denominator, as it can be affected by differences in patient lengths of stay. It is, however, the denominator traditionally used in other healthcare utilization metrics and is readily available at most hospitals from administrative and/or infection prevention databases.

Admissions, as the name implies, is calculated by counting the number of patient admissions to a facility [4]. Admissions may have some benefit over PD for tracking antimicrobial use and resistance because admissions are less influenced by lengths of stay. On the other hand, admissions data are typically tracked at the hospital-level; thus, unit-specific antimicrobial use measurements are more difficult with this denominator. This measure is not impacted by changes in length of stay, but it may be subject to changes in admission/transfer practices in a hospital.

Days present is a newly created method of defining a person-time denominator, specifically created for the NHSN AU module [3]. As a result, there is less familiarity with days present and how it compares to the other denominators. Days present is defined as the number of days that a patient received care in a specific patient-care location for any portion of time during a calendar day. Days present is more difficult to directly measure, as most hospitals don’t regularly track unit-level, granular bed movement data or unit-to-unit transfers. Days present is affected by lengths of stay and the number of unit-to-unit transfers; however, this measure provides an advantage when it is used for unit-level analyses. For example, if a patient starts the day on the general ward, but is then transferred to the ICU, then this patient has a day present in BOTH the general ward and the ICU for the same calendar day. If one were to use patient days instead, some of the time at risk on the ward or ICU would not be adequately captured in the denominator as it is in the numerators. The day of transfer would be attributed to either the general ward OR the ICU due to the method of counting at a certain time each day. Despite the difficulty in obtaining the necessary data to directly measure days present, hospitals that report to the NHSN AU module must use this denominator.

See the **Exercise** below to compare these three denominators and their use in calculating counts for antimicrobial use metrics with DOT and LOT.

Take Home Points:

- Aggregate antimicrobial use is typically expressed as a rate with the numerator reflecting antibiotic use and the denominator reflecting the population that is “at risk” for antibiotic use

- No specific numerator or denominator is perfect. All have advantages and disadvantages.
- DOT is the most commonly used numerator for antimicrobial use.
- Patient days is the easiest to obtain and most commonly used denominator.
- Days present provides the best data for the at risk population in a specific location (i.e., unit), but obtaining the data necessary to use this denominator is difficult.
- Ultimately, we are committed to ensuring that all DASON hospitals will have multiple options for evaluating antimicrobial utilization data, including the days present denominator required for reporting to the NHSN AU module.

Exercise: Example Calculations of Counts for Antimicrobial Use Metrics

A patient is admitted with abdominal pain at midnight on hospital day 1. He initially receives piperacillin-tazobactam (pip-tazo) for therapy. He clinically deteriorates and requires transfer to the ICU on hospital day 3, when a second antibiotic, vancomycin (vanco), is added. He dies on HD 4. (Blue=general medical ward; Red = ICU)

Hospital Days	1	2	3	4
Patient Location	Gen Med Ward, admit 00:00	Gen Med Ward, the whole day	Gen Med Ward, transfer to ICU @ 15:30	ICU until death @ 21:00
Antibiotic administrations				
Vancomycin	None	None	2 g loading dose @13:00	1.25 g daily dose @13:00
Pip-tazo	3.375 g @ 01:00 3.375 g @ 0:900 3.375 g @ 17:00	3.375 g @ 01:00 3.375 g @ 0:900 3.375 g @ 17:00	3.375 g @ 01:00 3.375 g @ 0:900 3.375 g @ 17:00	3.375 g @ 01:00 3.375 g @ 0:900 3.375 g @ 17:00

Numerator					Total counts
LOT	1	1	1	1	4 Hospital
Gen Med	1-Gen med	1-Gen med	1-Gen med		3 Gen Med
ICU			1-ICU	1-ICU	2 ICU
DOT	1	1	2	2	6 Hospital
Gen med	1-pip-tazo	1-pip-tazo	1-vanco 1-pip-tazo	1-vanco 1-pip-tazo	2 vanco 4 pip-tazo
ICU	1	1	2 1	2	4 Gen med 3 ICU
Denominator					Total counts
<i>Patient Days (midnight spent on a ward)</i>					
Hospital	1 midnight	1 midnight	1 midnight	0 midnight	3
Gen Med	1 midnight	1 midnight			2
ICU			1 midnight		1
Admissions	1				1
<i>Days Present (any time spent on a ward)</i>					
Hospital	1	1	1	1	4
Gen Med	1	1	1		3
ICU			1	1	2

Antibiotic Measurement Rate Calculations

Denominator	Numerator	
	DOT	LOT
Hospital Patient Days	6/3	4/3
Gen Med Patient Days	4/2	3/2
ICU Patient Days	3/1	2/1
Hospital Admissions	6/1	4/1
Hospital Days Present	6/4	4/4
Gen Med Days Present	4/3	3/3
ICU Days Present	3/2	2/2

References

1. Ibrahim, O.M. and R.E. Polk, *Antimicrobial use metrics and benchmarking to improve stewardship outcomes: methodology, opportunities, and challenges*. *Infect Dis Clin North Am*, 2014. **28**(2): p. 195-214.
2. Polk, R.E., et al., *Measurement of adult antibacterial drug use in 130 US hospitals: comparison of defined daily dose and days of therapy*. *Clin Infect Dis*, 2007. **44**(5): p. 664-70.
3. Centers for Disease Control and Prevention. *National Healthcare Safety Network: Antimicrobial Use and Resistance (AUR) Options*. [March 31, 2016]; Available from: <http://www.cdc.gov/nhsn/acute-care-hospital/aur/index.html>
4. Centers for Disease Control and Prevention, *National Healthcare Safety Network: MDRO Module*. [March 31, 2016]; Available from: http://www.cdc.gov/nhsn/PDFs/pscManual/12pscMDRO_CDADcurrent.pdf.