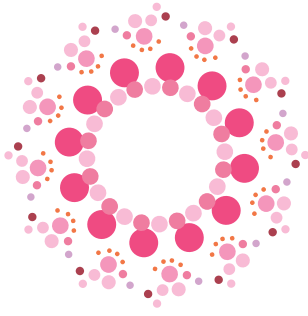# Guide to Using Key Performance Indicators to Monitor AMS Program Progress

AMR&S
WORKING GROUP

Guide to Using Key Performance Indicators to Monitor AMS Program Progress

Antimicrobial stewardship (AMS) program key performance indicators (KPIs) are used to evaluate the level of progress towards program goals, and when reporting program performance to hospital administration and other key stakeholders.[1,2] This guide describes some of the most commonly used AMS process and outcome KPIs used to assess the performance of Asian hospital AMS programs in relation to antibiotic use and costs, clinical outcomes and antimicrobial resistance (AMR) (Table 1). It also provides a framework for tracking KPIs over time.

Table 1

Some of the most commonly used KPIs* for AMS programs[3,4]

Process measures	Outcome measures
<u>Antibiotic consumption</u>	<u>Microbiological</u>
• Defined daily dose (DDD)	• AMR rates
• Days of therapy (DOT)	• *Clostridium difficile* infection rate
• Length of therapy (LOT)	<u>Clinical</u>
<u>Appropriateness of antibiotic use</u>	• Length of stay (LOS)
• Adherence to hospital guidelines	• Unexpected readmission rate
• Rate of acceptance of interventions	<u>Financial</u>
	• Antibiotic expenditure

*Collected for a defined population over a specified time, usually standardized to 1,000 patient-days.

Choosing KPIs

As shown in Table 1, KPIs are classified into two main categories[2,5]:

- Process measures, including quantity and quality measures of antibiotic use
- Outcome measures, including microbiological, clinical and financial outcome measures

A combination of process and outcome measures should be chosen to evaluate the impact of AMS program interventions.[5,6]

Some of the most commonly used measures are described below.

Antibiotic consumption

When possible, all AMS programs should measure antibiotic consumption using days of therapy (DOT) or defined daily doses (DDDs),[5,6] usually standardized per 1,000 patient-days.[4,7] Length of therapy (LOT) is also a useful measure of antibiotic use.[4,8]

Calculating patient-days[9]

Patient-days are calculated by counting the number of patients present in any given location (eg, hospital or ward) at a single time point during a 24-hour period

Days of therapy (DOT)

DOT (the number of days that a patient receives at least one dose of an antibiotic summed for each antibiotic) is the preferred measure of antibiotic consumption.[6] However, many hospitals are unable to easily calculate DOT, which requires patient-level data, ideally from electronic health records.[4,6] Hospitals without electronic health records and data mining software may be able to manually count DOT for targeted antibiotics in specific hospital locations or patient populations.[10,11]

Calculating DOT[10]

- Any antibiotic that is received in a 24-hour period represents one DOT regardless of dosage strength or number of doses
- The DOT for a patient receiving multiple antibiotics is the sum of DOT for each antibiotic

Defined daily doses (DDD)

DDD is a commonly used alternative to DOT for measuring antibiotic consumption.[7] DDD takes the total number of grams of an antibiotic purchased, dispensed or administered and divides it by the World Health Organization (WHO)-defined DDD (assumed average daily dose of a drug for its main indication in an adult with normal renal function).[5,7] Most hospital pharmacy departments have a mechanism to calculate overall prescription or dispensing of a quantity of antibiotics,[4] and the WHO publishes antibiotic DDD values (**https://atcddd.fhi.no/atc_ddd_index/**). DDD is therefore often a viable AMS program KPI in hospitals with pharmacy systems that can't calculate DOT, and despite being less accurate than DOT and inapplicable to pediatric patients, it is a useful measure of AMS program progress when tracked using consistent methodology over time.[5,7]

Length of therapy (LOT)

LOT (the number of days a patient receives antibiotic therapy irrespective of the number of antibiotics administered) provides an accurate assessment of the true duration of antibiotic therapy per discharge.[8] LOT differs from DOT in that the number of antibiotics is irrelevant and it accounts for dosing intervals longer than 24 hours.[4] LOT can be used with DOT to estimate the frequency of combination antibiotic therapy[8,10]:

- **DOT/LOT ratio = 1 indicates monotherapy**
- **DOT/LOT ratio >1 indicates combination therapy**

Appropriateness of antibiotic use

When an AMS program implements **hospital-specific antibiotic treatment guidelines**, the appropriateness of prescribing should be assessed by measuring the level of compliance with the guidelines.[6] This should indicate whether the right agent, with the appropriate spectrum of activity to treat the infection of concern, is being prescribed at the right dose, route and schedule for the right duration.[6] The number of AMS interventions made and the level of acceptance of AMS program interventions (eg, number of prospective audit recommendations made and percentage accepted) are other commonly used KPIs that indicate the appropriateness of prescribing.[2]

Antimicrobial resistance (AMR)

Preventing AMR is one of the main goals of AMS, so **measuring AMR** is important for AMS programs whenever it is possible.[7] It may be possible to query the microbiology database for AMR data on a monthly or quarterly basis, or manually count cases in small hospitals with low volumes of resistance.[11]

When interpreting AMR data in relation to AMS interventions, it is important to recognize that the development and spread of resistance is multifactorial, and that it may take years for the impact of an AMS intervention on AMR to become apparent.[2,5-7] At the patient level, measurement of AMR is most useful in relation to selected bacterial pathogens and focused patient populations receiving a targeted AMS intervention (eg, percentage of patients with carbepenem-resistant *Acinetobacter baumanni* infections in an intensive care unit [ICU] with restricted carbapenem use).[5,6]

Length of stay (LOS)

AMS programs have the potential to decrease LOS, primarily as a result of timely intravenous (IV)-to-oral conversion or by stopping unnecessary IV treatment.[4,6] Unlike some other potential clinical outcome metrics, such as mortality and readmission rates, LOS data is often relatively easy to obtain. LOS in the ICU can be used instead of hospital LOS as a measure of clinical improvement.[4]

Antibiotic expenditure

It is important to measure the financial impact of AMS programs.[4-6] Measuring antibiotic costs can show that the AMS program is resulting in cost savings for the hospital, and can be used to help justify continuing administrative support of the AMS program.[5,6] When possible, antibiotic costs should be measured using prescription or administration data rather than purchasing data.[6] As with antibiotic consumption measures, antibiotic costs are usually standardized per 1,000 patient-days.[4]

Sources of antibiotic consumption and cost data[7]

- Doses purchased: Easy to obtain but the least accurate reflection of true antibiotic use
- Doses dispensed: Relatively easy to obtain and able to link use to patient and day, but may overestimate antibiotic use by including wasted and missing doses
- Doses administered: Most accurate reflection of true antibiotic-linked use to patient and time, but most difficult to obtain (relies on accurate charting/use of electronic medical records)

Tracking KPIs

When tracking KPIs, AMS programs should:

- Focus on high-profile antibiotics, multidrug-resistant pathogens, patient populations and hospital locations that are most likely to be affected by AMS program interventions[5,7]
- Create graphs showing KPI trends over time, ideally in monthly or quarterly units (worksheet templates can be found **here**)[7]
- Compare data obtained after AMS program implementation to data obtained before implementation[7]

As one antibiotic is restricted, another may be used in its place, resulting in no net change in antibiotic use (known as 'squeezing the balloon').[7,11] As well as monitoring individual antibiotics, tracking key antibiotic classes can help to provide the clearest picture of overall antibiotic consumption (Figure 1).[7,11] As is the case for AMR, total antibiotic consumption and costs may take longer than a year to show noticeable changes from pre-AMS program baseline.[2]

Figure 1

Hypothetical data showing a reduction in overall DOT/1,000 patient-days over time, and an example of 'squeezing the balloon' (decrease in carbapenem consumption with an increase in cephalosporin and aminoglycoside consumption in Jul-Sep 2016, resulting in no change in overall antibiotic consumption vs Jan-Mar 2016)[11]
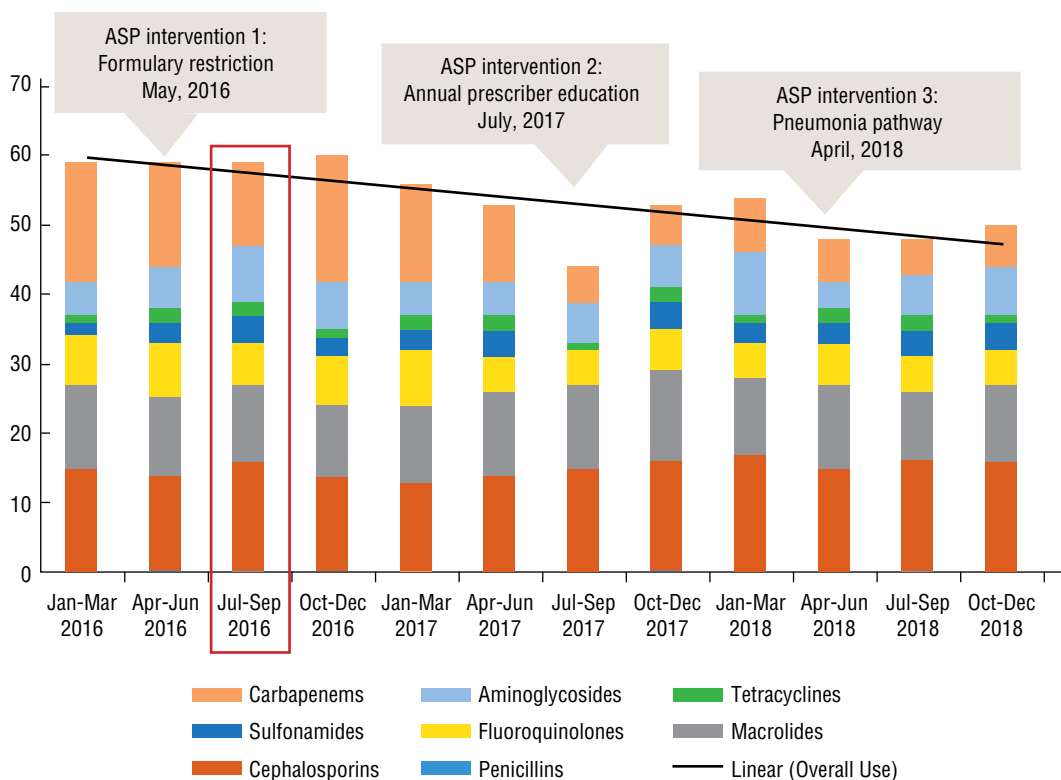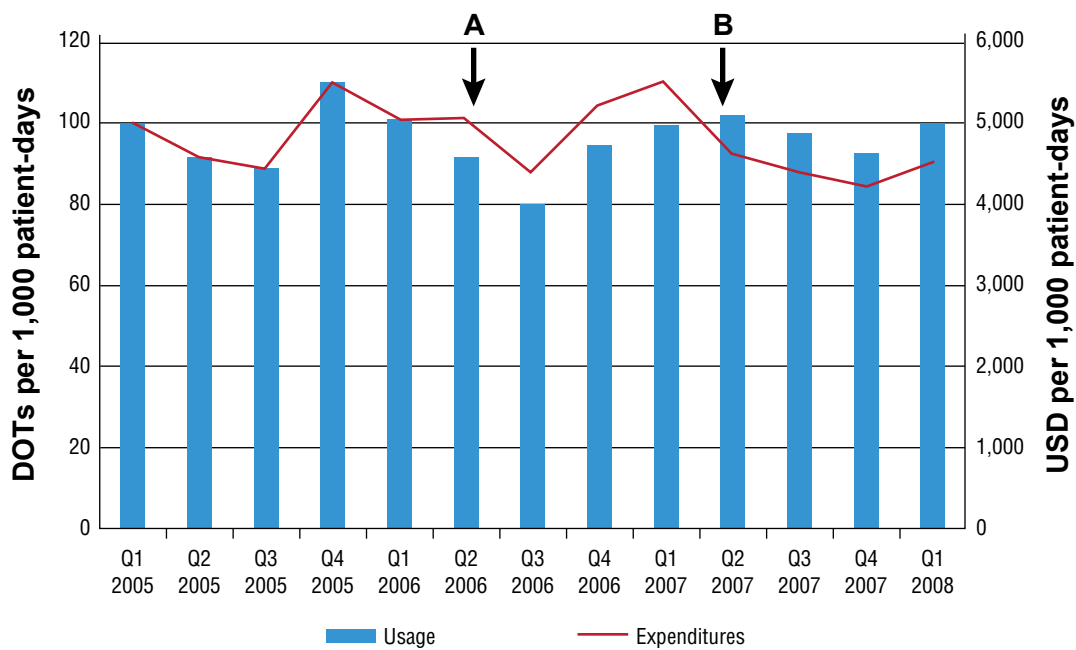

ASP, antimicrobial stewardship program
Adapted from Moran J, et al.

It may be helpful to plot antibiotic consumption and cost data for individual antibiotics or classes of antibiotics on the same graph to highlight and explain any discrepancies. For example, Figure 2 shows that, with two exceptions, variations in consumption and costs are fairly proportional. Increases or decreases in costs that are out of proportion to usage usually reflect changes in antibiotic purchase prices or recommended doses.[7]

Figure 2

Hypothetical antibiotic consumption and cost data showing (A) increased costs relative to use and (B) decreased costs relative to use[7]


Adapted from The Joint Commission. Antimicrobial Stewardship Toolkit.

When monitoring and reporting KPIs over time, it is important to recognize that initial reductions in the consumption and cost of antibiotics targeted by AMS program interventions tend to stabilize over time.[2,5,6] To illustrate the fact that AMS programs continue to be beneficial even when KPIs remain stable or appear to deteriorate over time,[2,7] create graphs showing actual data after implementation of AMS program interventions relative to the pre-program trend projected from baseline data (Figure 3).

Hypothetical changes in antibiotic use after starting an AMS program in a hospital with increasing baseline total antibiotic use[2]
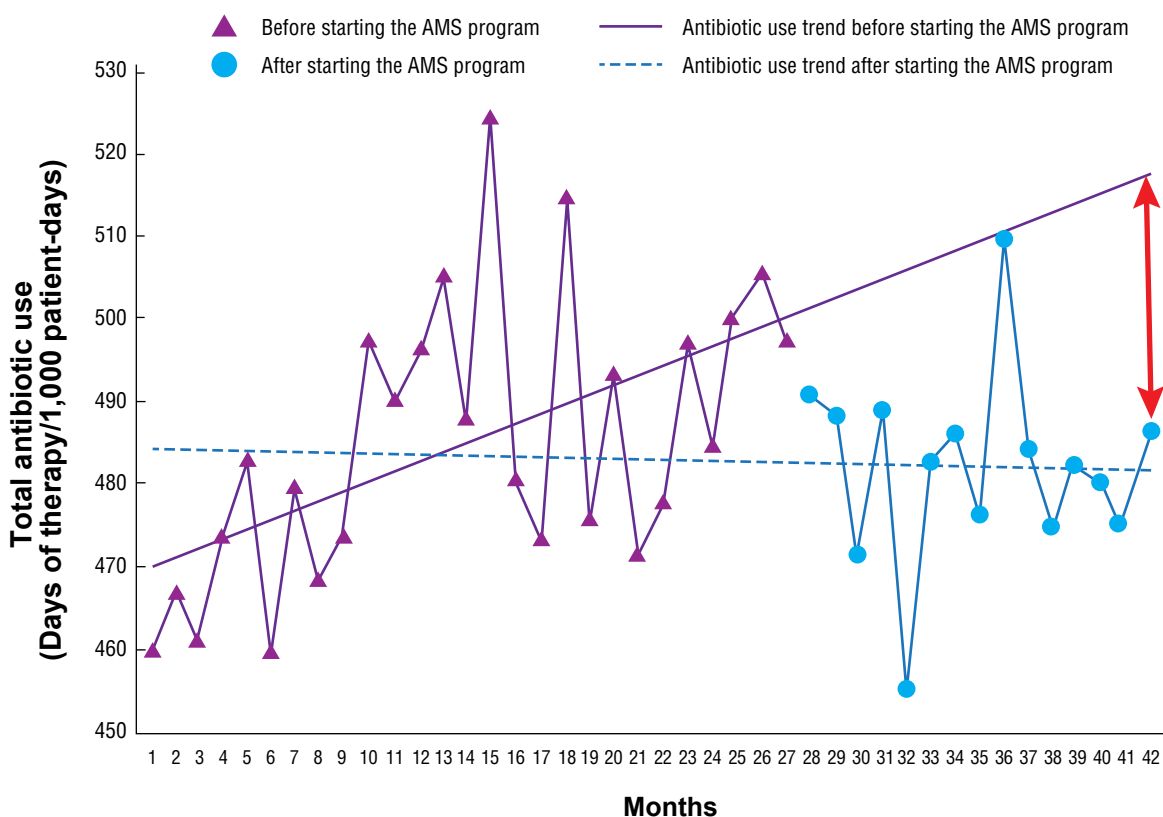
Adapted from Patel D, MacDougall C.

Considerations

In general, AMS program KPIs should be selected in accordance with data and resource availability, and align with program goals. When selecting and reporting your KPIs, also consider key stakeholders and their focus. Hospital administrators are likely to be most interested in cost metrics and quality metrics, whereas medical staff may be most interested in quality and clinical outcome metrics.[2] It is therefore advisable to measure KPIs that are relevant to all stakeholders, but to shift the KPI reporting focus to suit the intended audience.

Online resources

Various tools to help with using KPIs have been provided by different organizations and can be found online:

- The Antimicrobial Consumption (AMC) Tool, a computer tool which transforms antibiotic consumption data provided as numbers of packages into DDD, is available at: **amu-tools.org/amctool/amctool.html**
- Examples of a range of KPI calculations, including DOT, DDD, LOT and AMR rates, can be found at: **www.publichealthontario.ca/-/media/documents/A/2017/asp-metrics-examples.pdf**

References

1. Doron S, Davidson LE. Antimicrobial stewardship. *Mayo Clin Proc* 2011;86:1113-1123.
2. Patel D, MacDougall C. How to make antimicrobial stewardship work: Practical considerations for hospitals of all sizes. *Hosp Pharm* 2010;45(11 Suppl 1):S10-S18.
3. Akpan MR, et al. A review of quality measures for assessing the impact of antimicrobial stewardship programs in hospitals. *Antibiotics (Basel)* 2016;5:5.
4. Morris AM. Antimicrobial stewardship programs: Appropriate measures and metrics to study their Impact. *Curr Treat Options Infect Dis* 2014;6:101-112.
5. Centers for Disease Control and Prevention. Core elements of hospital antibiotic stewardship programs. Available at: www.cdc.gov/getsmart/healthcare/pdfs/core-elements.pdf. Accessed December 2017.
6. Barlam TF, et al. Implementing an antibiotic stewardship program: Guidelines by the Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America. *Clin Infect Dis* 2016;62:e51-e77.
7. The Joint Commission. Antimicrobial stewardship toolkit. 2013. Available at: www.jcrinc.com/antimicrobial-stewardship-toolkit. Accessed December 2017.
8. Polk RE, et al. Benchmarking risk-adjusted adult antibacterial drug use in 70 US academic medical center hospitals. *Clin Infect Dis* 2011;53:1100-1110.
9. Centers for Disease Control and Prevention. Determining patient days for summary data collection: Observation vs. inpatients. Available at: https://www.cdc.gov/nhsn/pdfs/commup/patientday_sumdata_guide.pdf. Accessed December 2017.
10. Public Health Ontario. Antimicrobial stewardship programs (ASPs) – Metrics examples. Available at: https://www.publichealthontario.ca/-/media/documents/a/2017/asp-metrics-examples.pdf?la=en. Accessed December 2017.
11. Moran J, et al. Jump start stewardship: Implementing antimicrobial stewardship in a small, rural hospital. March 2016. Available at. https://www.qualishealth.org/sites/default/files/medicare.qualishealth.org/JumpStart_Stewardship_Workbook.pdf. Accessed December 2017.