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Antimicrobial Stewardship Programs (ASPs)
Metrics Examples

The following table contains examples of metrics used in ASPs. This table is not all-inclusive; additional metrics have been used or proposed. There are advantages and disadvantages to each metric and no ideal metric exists. As outlined in the Metrics and Evaluation Presentation when choosing metrics to be used in your institution, it is most important the metric be measured reliably and consistently over time. For further information: Refer to the PHO Antimicrobial Stewardship Webpage or email asp@oahpp.ca.

Metric	Definition	Sample Calculation	Advantages	Disadvantages
Antimicrobial Utilization Measures				
Grams of antimicrobials	Grams of antimicrobial based on: acquisition (purchased), dispensed or administered over a defined time period Serves as an integral step in determining DDD		Relatively easy to determine grams of antimicrobial from purchasing records Grams adjusted by patient days for comparisons between clinical services may help to broadly identify potential areas for stewardship initiatives Grams of use is not affected by changes in price of antimicrobials over time and therefore, may be a more accurate reflection of the impact of antimicrobial stewardship initiatives compared to before and after analyses comparing cost	Provides a very rough approximation of antimicrobial use

Metric	Definition	Sample Calculation	Advantages	Disadvantages
Antimicrobial Expenditures	Antimicrobial costs can be based on: acquisition (purchased), dispensed or administered over a defined time period Costs can be expressed as absolute dollar value, percent of total (purchased, dispensed or administered) and/or per patient-days Antimicrobials can be tracked monthly and annually hospital wide, for specific clinical services (e.g. ICU), classes of antimicrobials (e.g. fluoroquinolones), individual drugs (e.g. linezolid), or types of infections/indications (e.g. ventilator-associated pneumonia)	2009 Pharmacy drug budget of $3,000,000 Antimicrobial acquisition costs $750,000 (25% of budget) Cost savings (percent reduction in antimicrobial costs): a) overall antibiotic acquisition costs 2010 $750,000 2011 $675,000 Absolute decrease of $75,000, equals 10% reduction b) ICU antibiotic acquisition costs 2010 $100,000 (patient days = 2000, $50/patient-day) 2011 $75,000 (patient days = 2000, $37.50/patient-day) Absolute decrease of $25,000, equivalent to a reduction of $12.50/patient-day	Expenditures are easily understood by and relevant to administrators May be viewed favourably in offsetting costs of stewardship program Relatively easy to determine acquisition costs from purchasing records Costs adjusted by patient days for comparisons between clinical services may help to broadly identify potential areas for stewardship initiatives	Purchased and dispensed costs are surrogate markers for administered costs (what the patient actually receives) Difficulty in retrieving data and accuracy of actual consumption is greatest for administered, followed by dispensed and then purchased costs Acquisition costs can fluctuate with contracts/suppliers, generics and with patient volume (patient-days to normalize), and therefore calculated cost reductions will not necessarily be reflective of stewardship interventions Dispensed costs may not account for “returns” to pharmacy Medication Administration Record reviews to obtain administered drug data is time consuming and not easily performed (bar coding is not generally available) It may be difficult to retrieve antimicrobial costs for specific clinical services or wards depending on the capability of the pharmacy computer system Cannot generally retrieve antimicrobial costs for specific infections/indications from the pharmacy system

Metric	Definition	Sample Calculation	Advantages	Disadvantages
Defined Daily Dose (DDD)	"The assumed average maintenance dose per day for a drug used for its main indication in adults" as specified by the World Health Organization (WHO). (e.g. Levofloxacin = 500mg daily) DDD are often standardized to 1000 patient days (DDD/1000 patient days) to allow comparison between hospitals or services of different sizes	Refer to the WHO-approved Defined Daily Dose values 1 levofloxacin DDD = 0.5 g Rx: Levofloxacin 500mg po od x 7 days DDD = (0.5g dose / 0.5g DDD) x 7d = 1 DDD x 7d = 7 DDD Rx: Levofloxacin 750mg po od x 7 days DDD = (0.75g dose / 0.5g DDD) x 7d = 1.5 DDD x 7d = 10.5 DDD Rx: Levofloxacin 750mg po q48h x 7 days DDD = (0.75g/0.5g DDD) x 4 (# days on which patient received a dose) = 6 DDD In 2011, hospital XYZ dispensed 13,000 grams of meropenem; WHO DDD for meropenem: 2 g = 6500 DDD (13,000 / 2) If 391,116 occupied bed days in 2011, then 6500 DDD / 391,116 X 1000 = 16.6 DDD / 1000 patient days	Provides a method of measure to benchmark both within and between institutions if normalized to patient days. Caution should be exercised when making comparisons between services and institutions with different case mixes. Can be calculated in the absence of computerized pharmacy records by using purchasing data	Doses recommended by WHO as DDD may not be the currently recommended doses for optimization of activity of the antibiotic (e.g. Levofloxacin 750mg po daily = 1.5 DDD according to WHO and would result in a hospital having an apparently higher antibiotic utilization than an institution using 500mg po daily) and thus may not be reflective of 'Days of Therapy' or DOTs Inaccurate in certain populations (e.g. renal impairment, pediatrics) The denominator of patient days is required to standardize DDDs for benchmarking between institutions or services; this information must be available to the institution or service When DDD is used as a measure of overall antibiotic use, rather than as a measure of a specific antibiotic, then benchmarking between institutions would need to account for formulary differences. Similarly, if a hospital changed their formulary antibiotic this may change the overall antibiotic DDD, although use has not decreased (e.g. for either institutional formulary differences or change in formulary within an institution: cefotaxime 1g iv q8h = 0.75 DDD to ceftriaxone 1g q24h = 0.5 DDD) Potential for confusion with historic data if DDD is changed by WHO

Metric	Definition	Sample Calculation	Advantages	Disadvantages
Days of Therapy (DOT)	The number of days that a patient receives an antimicrobial agent (regardless of dose). Any dose of an antibiotic that is received during a 24-hour period represents 1 DOT. The DOT for a given patient on multiple antibiotics will be the sum of DOT for each antibiotic that the patient is receiving. DOT is often standardized to 1000 patient days (DOT/1000 patient days) to allow comparison between hospitals or services of different sizes.	Rx: Levofloxacin 500mg po od x 7 days DOT = 1 DOT x 7d = 7 DOT Rx: Levofloxacin 750mg po od x 7 days DOT = 1 DOT x 7d = 7 DOT Rx: Levofloxacin 750mg po q48h x 7days = 4 DOT Rx: Cefazolin 2 g q8h iv X 1 day = 1 DOT Rx: Cefazolin 1 g iv X 1 dose = 1 DOT Rx: Levofloxacin 750mg po od x 7 days + Vancomycin 1g iv q12h x 7 days: DOT Levofloxacin = 1 DOT x 7d = 7 DOT DOT Vancomycin = 1 DOT x 7d = 7 DOT Total DOT = 14 DOT	Provides a method of measure to benchmark both within and between institutions if normalized to patient days. Caution should be exercised when making comparisons between services and institutions with different case mixes. Allows for multiple patient populations to be compared accurately Is NOT affected by change in dosing (e.g. Levofloxacin 500mg vs. 750 mg) or WHO DDD Is currently the most accurate and preferred measure of antibiotic use and is used by CDC and National Healthcare Safety Network (formerly the Nosocomial Infection Surveillance)	The denominator of patient days is required to standardize DOTs for benchmarking between institutions or services; this information must be available to the institution or service Requires computerized pharmacy records to obtain data. Manual determination of days a patient receives antimicrobials, although more precise, is not practical Favours those who use broad spectrum mono-therapy over those who use narrow spectrum combination therapy. For example, meropenem x 7 days = 7 DOTs, ceftriaxone + metronidazole x 7 days = 14 DOTs Since 1 DOT is any dose of antibiotic received during a 24 hour period, the DOT for patients that receive a dosing interval >24 hours (e.g. renal failure patients) does not reflect patient exposure; it only reflects antibiotic administration Overestimation with one time doses (e.g. surgical prophylaxis) since one dose of a multi-daily dose regimen counted the same as multiple doses received in a day.

Metric	Definition	Sample Calculation	Advantages	Disadvantages
Length of Therapy or Treatment Period (LOT)	The number of days that a patient receives systemic antimicrobial agents, irrespective of the number of different drugs. Therefore, LOT will be lower than or equal to DOT because each antibiotic received is its own DOT.	Rx: Levofloxacin 500mg po od x 7d LOT = 1 LOT x 7d = 7 LOT Rx: Levofloxacin 750mg po od x 7d LOT = 1 LOT x 7d = 7 LOT Rx: Levofloxacin 750mg po od x 7d + Vancomycin 1g iv q12h x 7d LOT = 1 LOT x 7d = 7 LOT Rx: Levofloxacin 750mg po q48h x 7d LOT = 1 LOT x 8d (# of days which patient exposed to active treatment) = 8 LOT	Provides a method of measure to benchmark both within and between institutions if normalized to patient days. Caution should be exercised when making comparisons between services and institutions with different case mixes. Provides a more accurate assessment of treatment duration compared to DOT The ratio of DOT/LOT may be useful as a benchmarking proxy for the frequency of combination antibiotic therapy vs. monotherapy. That is, ratio = 1, identifies monotherapy; ratio > 1 identifies combination therapy Ciprofloxacin x 7 days: DOT = 1 DOT x 7d = 7 DOT LOT = 1 LOT x 7d = 7 LOT DOT/LOT = 1; therefore monotherapy Ciprofloxacin + metronidazole x 7 days: DOT = 2 DOT x 7d = 14 DOT LOT = 1 LOT x 7d = 7 LOT DOT/LOT = 2; therefore combination therapy	Cannot be used to compare use of different drugs DOT/LOT ratio does not provide an indication of the percentage of patients prescribed combination therapy

Metric	Definition	Sample Calculation	Advantages	Disadvantages
Antimicrobial-Free Days (AFD) For critical care units in Ontario hospitals, this metric is available from Critical Care Information System (CCIS). For CCIS, "antimicrobial agents" includes antibacterials and antifungals but excludes antivirals. See page 11 for a list of antibiotic and antifungal agents to assist with data collection and input into CCIS.	The number of days that antimicrobial agents were NOT received during a given period on a given hospital unit. Similar to LOT, this metric is calculated irrespective of the number of antimicrobial agents received. This metric tends to be utilized for patients in critical care units, but can be used in other hospital settings. AFD can be calculated by subtracting the total number of days that any antimicrobial was received from the total patient days.	Patient with a length of stay (LOS) of 10 days. Rx: Levofloxacin 500mg po od x 7d AFD = LOS – antibotic days received AFD = 10d – 7d AFD = 3d Rx: Levofloxacin 750mg po od x 7d + Vancomycin 1g iv q12h x 7d AFD = 10d – 7d AFD = 3d Rx: Levofloxacin 750mg iv q24h x 7d + Fluconazole 400 mg iv q24h x 7d AFD = 10d – 7d AFD = 3d Rx: Levofloxacin 750mg po q48h x 7d AFD = 10d – 4 d AFD = 6d	Provides a method of measure to benchmark both within and between institutions if normalized to patient days. Provides a more accurate assessment of treatment duration compared to DOT. Is usually inversely related to LOT, so it can be easily estimated if LOT and patient days are available.	If a program aims to reduce antibiotic exposure, the expected directionality for AFD is upward whereas the expected directionality for DDD, DOT or LOT is downwards: this may be difficult to understand. Does not provide detail about specific drug or class utilization. When combining antibiotic and antifungal agents to determine total AFD, this metric does not allow for assessment of changes in patterns of antibiotics or antifungals alone.

Metric	Definition	Sample Calculation	Advantages	Disadvantages
Antimicrobial Resistance Measures				
Antimicrobial Resistance Trends	Number of patients with a specific drug-resistant organism divided by the total number of patients admitted to the ward, service or unit of interest.	Meropenem resistant *Pseudomonas aeruginosa* in critical care: In 2009, of 500 patients admitted to critical care unit, 100 patients had meropenem resistant *P. aeruginosa*: 100/500 = 20% 60 patients with meropenem resistant *P. aeruginosa* in 2012 with 600 patients admitted to critical care unit in 2012: 60/600 = 10% Therefore, the rate of meropenem-resistant *P. aeruginosa* was reduced from 20% in 2009 to 10% in 2012	Enables quantification of resistance trends as a measure of the advantage of antimicrobial stewardship and infection prevention and control	Improvements in resistance patterns lag behind decreases in antimicrobial use and therefore, should be assessed over the long term or extended periods (e.g. $\geq$ 1 year). Since multiple interventions typically take place concurrently (e.g., related to Infection Control) it is difficult to attribute observed changes specifically to antimicrobial use Requires the ability of microbiology or another data base to track susceptibility and a data base to track patient admission to ward, service or unit of interest
	Antibiogram based on unique isolates and susceptibility to given antibiotics	Number or percentage of unique isolates resistant and susceptible to a given antibiotic: *P. aeruginosa* in blood in critical care / number of unique blood cultures that are resistant to meropenem	Easier to do than a per patient approach, since the information can be obtained directly from a microbiology database without a patient denominator	Since multiple interventions typically take place concurrently (e.g., related to Infection Control) it is difficult to attribute observed changes specifically to antimicrobial use Less clinically important than number of episodes of Antibiotic-resistant organisms (AROs) per patient

Metric	Definition	Sample Calculation	Advantages	Disadvantages
C. difficile Infection (CDI) rate	CDI rate per 1,000 patient days: Number of patients newly diagnosed with institution acquired CDI, divided by the number of inpatient days in that time period, multiplied by 1,000 May also be expressed as the number of new CDI cases per 1000 patient admissions For more information on the testing, management and surveillance of CDI see Annex C: Routine Practices and Additional Precautions	2009: 75 cases *C. difficile* and 90,000 patient days in 2009 = (75/90,000)*1000 = 0.83 2011: 43 cases *C. difficile* and 85,000 patient days in 2011 = (43/85,000)*1000 = 0.5 Reduction in *C. difficile rate* = (0.83-0.5)/0.83 = 40% reduction in *C. difficile* rate in 2011 compared to 2009	CDI is a publicly reportable patient safety quality indicator for hospitals in Ontario. Rates are readily accessible and can be compared between institutions. Given mandatory public reporting hospitals are highly invested in reducing rates. For more information on public reporting of CDI rates visit the Health Quality Ontario website	Changes in CDI rate are impacted by a number of factors, including clinical, IPAC and ASP practices. Difficult to attribute a change in rate to a single intervention.

Metric	Definition	Sample Calculation	Advantages	Disadvantages
Hospital Associated Antibiotic Resistant Organism (ARO) Infection Rate	New hospital-associated Methicillin Resistant *Staphylococcus aureus* (MRSA) bacteremia rate per 1,000 patient days or New hospital-associated Vancomycin Resistant *Enterococcus* (VRE) bacteremia rate per 1,000 patient days For more information on the screening, testing, and surveillance of ARO's see Annex A: Routine Practices and Additional Precautions	2 cases MRSA bacteremia April - June Patient days = 2100 Rate = (2/2100)*1000 = 0.95	Hospital associated MRSA and VRE bacteremia rates are publically reportable patient safety quality indicators in Ontario. Rates are readily accessible and can be compared between institutions. Given mandatory public reporting hospitals are highly invested in reducing rates. For more information on public reporting of ARO infection rates visit the Health Quality Ontario website.	Changes in MRSA and VRE bacteremia rates are impacted by a number of factors including clinical, IPAC and ASP practices. Difficult to attribute a change in rate to a single intervention.

Metric	Definition	Sample Calculation	Advantages	Disadvantages
Process Measures				
Interventions	Tally of the number and type of interventions made and acceptance rate Potential types of interventions are listed in the sample calculation and the notes below	1000 antimicrobial orders were reviewed by the stewardship team in 2011 and recommendations were made for 750 (75%) The overall acceptance rate was 650/750 (87%) The types of interventions and their acceptance rates were: Dose optimization n= 152/160 (95%) Escalation of therapy n=45/50 (90%) Discontinuation of therapy n=112/140 (80%) De-escalation of therapy n=250/300 (83%) Route change (eg. IV to PO) n=89/100 (89%)	Cost savings/avoidance (in concert with improved patient outcomes – e.g. reduced *C. difficile*) with documentation of accepted interventions, lends support to the changes being a result of antimicrobial stewardship activities and will be viewed favourably by administrators in offsetting costs of stewardship program	

List of Systemic Antibacterial and Antifungal Agents
Listed alphabetically by non-proprietary name (common brand names listed in brackets)

This list can be provided to those collecting data for and/or inputting data into the Critical Care Information System (CCIS)

Key points for Antimicrobials in CCIS:

☑ Include only systemic (parenteral, intravenous, oral, enteral) antibacterial and antifungal medications.
☒ Do NOT include topical medications (creams, ointments) or drops (eye drops or ear drops).
☒ Do NOT include antiviral medications (e.g., oseltamivir, acyclovir, famciclovir, valacyclovir).

Antibacterial Agents			**Antifungal Agents**
• Amikacin • Amoxicillin • Amoxicillin/clavulanic acid (Clavulin) • Ampicillin • Azithromycin (Zithromax) • Benzathine benzylpenicillin • Cefaclor • Cefadroxil • Cefazolin (Ancef) • Cefepime • Cefixime (Suprax) • Cefotaxime • Cefoxitin • Cefprozil • Ceftazidime • Ceftolozane/tazobactam • Ceftriaxone • Cefuroxime (Ceftin) • Cephalexin (Keflex) • Ciprofloxacin	• Clarithromycin (Biaxin) • Clindamycin • Cloxacillin • Colistin • Daptomycin (Cubicin) • Doxycycline • Doripenem • Ertapenem • Erythromycin • Fidaxomicin (Dificid) • Fosfomycin (Monurol) • Gentamicin • Imipenem-cilastatin • Levofloxacin (Levaquin) • Linezolid (Zyvoxam) • Meropenem (Merrem) • Metronidazole (Flagyl) • Minocycline • Moxifloxacin (Avelox)	• Nitrofurantoin (Macrobid, Macrodantin) • Norfloxacin • Penicillin G or Benzylpenicillin • Penicillin V or Phenoxymethyl Penicillin • Piperacillin • Piperacillin/Tazobactam (Tazocin) • Pivmecillinam • Procaine penicillin • Sulfamethoxazole/trimethoprim (Septra, Bactrim, Co-trimoxazole) • Sulfisoxazole • Telavancin • Tigecycline (Tygacil) • Tetracycline • Tobramycin • Trimethoprim • Tedizolid • Vancomycin	• Amphotericin B (Ambisome, Abelcet, Fungizone) • Anidulafungin (Eraxis) • Caspofungin • Itraconazole • Fluconazole • Flucytosine • Ketoconazole • Micafungin (Mycamine) • Posaconazole • Voriconazole (Vfend)

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