Guideline for Implementing an Antimicrobial Stewardship Program

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Index

1. List of Abbreviations

- **AMR:** Antimicrobial Resistance
- **AMS:** Antimicrobial Stewardship
- **ASP:** Antimicrobial Stewardship Program
- **AWaRe:** Access, Watch, and Reserve
- **CDC:** Centers for Disease Control and Prevention
- **CDI:** *Clostridioides* Difficile Infection
- **DDT:** Defined Daily Dose
- **DOT:** Days Of Therapy
- **EMR:** Electronic Medical Record
- **HIS:** Hospital Information System
- **ID:** Infectious Disease
- **IPC:** Infection and Prevention Control
- **IT:** Information Technology
- **IV to PO:** Intravenous to oral therapy
- **KPIs:** Key Performance Indicators
- **MRSA:** Methicillin-Resistant Staphylococcus Aureus
- **WHO:** World Health Organization

2. Glossary

- **Antimicrobial Resistance (AMR):** Microorganisms such as bacteria, fungi, viruses and parasites change when exposed to antimicrobial drugs such as antibiotics (= antibacterials), antifungals, antivirals, antimalarials and anthelmintics. As a result, the medicines become ineffective.
- **Antimicrobial Stewardship (AMS):** A coherent set of actions which promote the responsible use of antimicrobials. This definition can be applied to actions at the individual level as well as the national and global level, and across human health, animal health and the environment.
- **Antimicrobial Stewardship Program (ASP):** An organizational or system-wide health-care strategy to promote appropriate use of antimicrobials through the implementation of evidence-based interventions
- **Days of Therapy (DOTs): The** number of days a patient receives an antibiotic independent of dose.
- **Defined Daily Dose (DDD):** Assumed average maintenance dose per day for a medicine used for its main indication in adults as established by the WHO Collaborating Centre for Drug Statistics and Methodology.
- **Empirical Antibiotic Treatment:** Initial antibiotic treatment targeted at the most probable causative microorganism. The recommendations should be based on local susceptibility data, available scientific evidence or expert opinion, when evidence is lacking.

3. Executive Summary

Antimicrobial stewardship programs (ASPs) are a focused effort by a health care system to optimize the use of antimicrobial agents. The goals of an ASP are to improve patient outcomes, decrease adverse consequences including from adverse drug reactions and antimicrobial associated infections (eg, *Clostridium difficile* diarrhea), reduce or prevent antimicrobial resistance, and deliver cost-effective therapy. The emphasis is on appropriate use, selection, dosing, and duration of antimicrobial therapy.

Recommendations
1. Program structure & governance
AMS team should include a microbiologist, an info-systems specialist, an infection control professional, and a hospital epidemiologist **(Strong Recommendation).**
Maintain close collaboration among AMS team, Microbiology, Pharmacy, and Infection and Prevention Control (IPC) departments **(Strong Recommendation)**
Implement an antimicrobial stewardship program as part of MDRO prevention **(Good Practice Statement)**
Ensure enabling infrastructure: IT that supports alerts and data capture; adequate lab support; leadership **(Good Practice Statement)**
2. Core AMS interventions
Perform regular prospective audits with direct feedback to prescribers and administration to reduce inappropriate antibiotic use **(Strong Recommendation)**
Enforce formulary restriction & preauthorization to reduce antimicrobial use **(Strong Recommendation)**
Educate all stakeholders to build foundational knowledge **(Good Practice Statement)**
Clinical pharmacy interventions should be implemented **(Good Practice Statement)**
Avoid antimicrobial cycling **(Good Practice Statement)**
3. Prescribing & optimization practices
De-escalate empiric therapy once culture/susceptibility results are available **(Strong Recommendation)**
Audit and education on de-escalation should be part of AMS **(Strong Recommendation)**
We recommend early switch from IV to PO where clinically appropriate - cost-saving and desirable, especially in resource-limited settings **(Strong Recommendation)**

We recommend against routine combination therapy to prevent resistance **(Good Practice Statement).**
Avoid treating colonization or contaminants **(Good Practice Statement).**
4. Microbiology & surveillance enablers
Provide MDRO data/outcomes to stakeholders to maintain engagement **(Good Practice Statement).**
Educate healthcare personnel about MDRO and prevention practices **(Good Practice Statement).**
Educate patients and families about MDRO **(Good Practice Statement).**
Incorporate lab-based MRSA alerts and readmission alerts to inform AMS and IPC teams **(Good Practice Statement).**

4. Introduction

Antimicrobial stewardship (AMS) is a systematic effort to optimize the use of antimicrobial medications (antibiotics, antifungals, antivirals, and antiparasitics) to improve patient outcomes, reduce the emergence of antimicrobial resistance (AMR), and minimize healthcare costs. In healthcare facilities, implementing a robust AMS program is crucial for safeguarding the effectiveness of these vital medications for current and future patients.

The increasing threat of AMR poses a significant global public health challenge. Overuse and misuse of antimicrobials in healthcare contribute significantly to this crisis, leading to:

- **Increased treatment failures:** Infections become harder, and sometimes impossible, to treat.
- **Prolonged hospital stays:** Patients with resistant infections often require longer and more complex treatment.
- **Increased morbidity and mortality:** Resistant infections can lead to more severe illness and higher death rates.
- **Higher healthcare costs:** Treating resistant infections often involves more expensive and toxic medications.
- **Spread of resistant organisms:** Resistant bacteria can spread within healthcare facilities and into the community.
- **Limited development of new antimicrobials:** The pace of new antimicrobial development is slow, further exacerbating the problem.

Key Principles of Antimicrobial Stewardship:

Effective AMS programs are built upon several core principles:

1. **Leadership Support:** Strong commitment and active involvement from hospital leadership are essential for providing the necessary resources and authority for the program.
2. **Multidisciplinary Team:** Collaboration among infectious disease physicians, clinical pharmacists, microbiologists, infection preventionists, nurses, and other healthcare professionals is crucial for a comprehensive approach.
3. **Drug Expertise:** A clinical pharmacist with expertise in infectious diseases plays a vital role in optimizing antimicrobial prescribing and monitoring.
4. **Evidence-Based Practices:** Decisions regarding antimicrobial use should be guided by current clinical guidelines, local antibiograms (reports summarizing

antimicrobial susceptibility patterns of local isolates), and patient-specific factors.

5. **Monitoring and Surveillance:** Regular collection and analysis of data on antimicrobial use and resistance patterns are essential for identifying areas for improvement and tracking the impact of interventions.
6. **Interventions to Improve Antimicrobial Use:** Implementing targeted strategies to promote optimal prescribing, such as:
    - **Prospective audit and feedback:** Reviewing antimicrobial orders and providing feedback to prescribers.
    - **Pre-authorization:** Requiring approval for the use of certain restricted antimicrobials.
    - **Formulary restriction:** Limiting the availability of specific antimicrobials.
    - **Clinical pathways and guidelines:** Developing and implementing standardized treatment approaches for common infections.
    - **Antimicrobial "time-outs":** Encouraging prescribers to reassess the ongoing need for antimicrobials after a defined period.
    - **Dose optimization:** Ensuring appropriate dosing based on patient factors (e.g., weight, renal function).
    - **De-escalation:** Switching from broad-spectrum to narrow-spectrum antibiotics when the pathogen and its susceptibilities are known.
7. **Education and Training:** Providing ongoing education and training to all healthcare professionals on principles of antimicrobial stewardship and best practices for antimicrobial use.
8. **Reporting and Feedback:** Regularly communicating data on antimicrobial use and resistance to prescribers, hospital committees, and leadership to promote accountability and drive change.

Implementing an AMS program is a step-wise process. Initial steps may include:

- **Conducting a baseline assessment:** Evaluating current antimicrobial prescribing practices and identifying areas of concern.
- **Establishing an AMS team:** Assembling a multidisciplinary group to lead the initiative.
- **Developing an AMS policy:** Outlining the program's goals, strategies, and responsibilities.
- **Prioritizing initial interventions:** Focusing on a few key areas with the greatest potential for impact.
- **Developing a system for monitoring antimicrobial use:** Tracking which drugs are being used, for what indications, and for how long.

5. Scope and Purpose

The scope of implementing antimicrobial stewardship program:

Encompasses all activities aimed at optimizing the use of antimicrobial agents (antibiotics, antifungals, antivirals, and antiparasitic) across the entire healthcare system. This includes:

- **All patient populations:** Inpatient, outpatient, long-term care residents, and those receiving home healthcare services.
- **All healthcare professionals involved in prescribing, dispensing, administering, and monitoring antimicrobials:** Physicians, pharmacists, nurses, dentists, and other allied health professionals.
- **All antimicrobial agents:** Ensuring appropriate selection, dosage, route, and duration for all types of antimicrobials.
- **All clinical settings:** Addressing antimicrobial use for treatment of active infections, prophylaxis (prevention), and empirical therapy (treatment based on likely pathogens before identification).
- **Integration with other healthcare programs:** Collaborating with infection prevention and control, diagnostic stewardship, and quality improvement initiatives.
- **Monitoring and reporting:** Tracking antimicrobial use, resistance patterns, and the impact of stewardship interventions.

The **purpose** of **implementing antimicrobial stewardship program is to:**

1 **Optimize clinical outcomes:** Improve the success rate of treating infections and reduce patient morbidity and mortality associated with antimicrobial use.

2 **Minimize the development and spread of antimicrobial resistance:** Reduce the selective pressure that drives the emergence of drug-resistant microorganisms.

3 **Reduce adverse drug events:** Minimize the toxicities, side effects, and complications associated with antimicrobial therapy, such as *Clostridioides difficile* infection (CDI).

4 **Ensure cost-effectiveness:** Promote the use of the most appropriate and cost-effective antimicrobials, avoiding unnecessary broad-spectrum or prolonged therapies.

5 **Promote adherence to evidence-based guidelines:** Implement and monitor compliance with local, national, and international guidelines for antimicrobial use.

6 **Educate healthcare professionals:** Improve knowledge and understanding of appropriate antimicrobial prescribing and resistance.

7 **Improve patient safety:** Ensure patients receive the right antimicrobial, at the right dose, at the right time, and for the right duration.

8 **Support public health efforts:** Contribute to local, regional, and national efforts to combat AMR.

9 **Meet regulatory and accreditation requirements:** Comply with mandates related to antimicrobial stewardship programs.

10 **Provide data for benchmarking and quality improvement:** Track progress, identify areas for improvement, and compare practices with other facilities.

6. Target Audience

All healthcare professionals involved in prescribing, dispensing, administering, and monitoring antimicrobials: Physicians, pharmacists, nurses, dentists, and other allied health professionals.

7. Methodology

A comprehensive search for guidelines was undertaken to identify the most relevant guidelines to consider for adaptation.

Inclusion/ exclusion criteria followed in the search and retrieval of guidelines to be adapted:

- Selecting only evidence-based guidelines (guideline must include a report on systematic literature searches and explicit links between individual recommendations and their supporting evidence)
- Selecting only national and/or international guidelines
- Specific range of dates for publication (using Guidelines published or within the last 3 years)
- Selecting peer reviewed publications only
- Selecting guidelines written in English language
- Excluding guidelines written by a single author, not on behalf of an organization to be valid and comprehensive, a guideline ideally requires multidisciplinary input.
- Excluding guidelines published without references as the panel needs to know whether a thorough literature review was conducted and whether current evidence was used in the preparation of the recommendations.

The following characteristics of the retrieved guidelines were summarized in:

- Developing organization/authors
- Date of publication, posting, and release
- Country/language of publication
- Date of posting and/or release
- Dates of the search used by the source guideline developers.

All retrieved Guidelines were screened and appraised using AGREE II instrument (www.agreetrust.org) by at least three members. The panel decided on a cut-off point or ranked the guidelines (any guideline scoring above 50% on the rigor dimension was retained). The committee decided to adapt from:

1. Tamma PD, Heil EL, Justo JA, Mathers AJ, Satlin MJ, Bonomo RA. Infectious Diseases Society of America 2024 Guidance on the Treatment of Antimicrobial-Resistant Gram-Negative Infections. Clin Infect Dis. 2024;78(6):995–1024 (1)
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Evidence assessment

According to the World Health Organization (WHO) Handbook for Guidelines, we used the GRADE (Grading of Recommendations, Assessment, Development and Evaluation) approach to assess the quality of a body of evidence, develop and report recommendations. GRADE methods are used by WHO because these represent internationally agreed standards for making transparent recommendations. Detailed GRADE information is available on the following sites:

- GRADE working group: https://www.gradeworkinggroup.org/
- GRADE online training modules: http://cebgrade.mcmaster.ca/

Table (1) Quality and Significance of the four levels of evidence in GRADE

Quality	Definition	Implications
High	The guideline development group is very confident that the true effect lies close to that of the estimate of the effect	Further research is very unlikely to change confidence in the estimate effect
Moderate	The guideline development group is moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibly that it is substantially different	Further research is likely to have an important impact on confidence in the estimate of the effect and may change the estimate
Low	Confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the true effect	Further research is very likely to have an important on confidence in the estimate of effect and is unlikely to change the estimate
Very low	The group has very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of the effect	Any estimate of the effect is very uncertain

Table (2) Factors that determine How to upgrade or downgrade the quality of evidence.

Downgrade in presence of	Upgrade in presence of
Study limitations. **1-** Serious limitations **2-** Very serious limitations	Dose- response gradient. +1 Evidence of a dose-response gradient
Consistency **1-** Important inconsistency	Direction of plausible bias + All plausible confounders would have reduced the effect
Directness **1-** Some uncertainty **2-** Major uncertainty	Magnitude of the effect +1 Strong, no plausible Confounder, consistent and direct evidence
Precision **1-** Imprecise data	+2 very strong, no major threats to validity and direct evidence
Reporting bias **1.** High probability of reporting bias	

The strength of the recommendations

The strength of a recommendation communicates the importance of adherence to the recommendation.

- **Strong recommendations**

With strong recommendations, the guideline communicates the message that the desirable effects of adherence to the recommendation outweigh the undesirable effects. This means that in most situations the recommendation can be adopted as policy.

- **Conditional recommendations**

These are made when there is greater uncertainty about the four factors above or if local adaptation has to account for a greater variety in values and preferences, or when resource use makes the intervention suitable for some, but not for other locations. This means that there is a need for substantial debate and involvement of stakeholders before this recommendation can be adopted as policy.

When not to make recommendations?

When there is lack of evidence on the effectiveness of an intervention, it may be appropriate not to make a recommendation.

8. Recommendations

1. Program structure & governance
AMS team should include a microbiologist, an info-systems specialist, an infection control professional, and a hospital epidemiologist **(Strong Recommendation, Moderate Grade Evidence).**
Maintain close collaboration among AMS team, Microbiology, Pharmacy, and Infection and Prevention Control (IPC) departments **(Strong Recommendation, Moderate Grade Evidence)**
Implement an antimicrobial stewardship program as part of MDRO prevention **(Good Practice Statement)**
Ensure enabling infrastructure: IT that supports alerts and data capture; adequate lab support; leadership **(Good Practice Statement)**
2. Core AMS interventions
Perform regular prospective audits with direct feedback to prescribers and administration to reduce inappropriate antibiotic use **(Strong Recommendation, High Grade Evidence)**

Enforce formulary restriction & preauthorization to reduce antimicrobial use **(Strong Recommendation, Moderate Grade Evidence)**
Educate all stakeholders to build foundational knowledge **(Good Practice Statement)**
Clinical pharmacy interventions should be implemented **(Good Practice Statement)**
Avoid antimicrobial cycling **(Good Practice Statement)**
3. Prescribing & optimization practices
De-escalate empiric therapy once culture/susceptibility results are available **(Strong Recommendation, Moderate Grade Evidence)**
Audit and education on de-escalation should be part of AMS **(Strong Recommendation, Moderate Grade Evidence)**
We recommend early switch from IV to PO where clinically appropriate - cost-saving and desirable, especially in resource-limited settings **(Strong Recommendation, Moderate Grade Evidence)**
We recommend against routine combination therapy to prevent resistance **(Good Practice Statement).**
Avoid treating colonization or contaminants **(Good Practice Statement).**
4. Microbiology & surveillance enablers
Provide MDRO data/outcomes to stakeholders to maintain engagement **(Good Practice Statement).**
Educate healthcare personnel about MDRO and prevention practices **(Good Practice Statement).**
Educate patients and families about MDRO **(Good Practice Statement).**
Incorporate lab-based MRSA alerts and readmission alerts to inform AMS and IPC teams **(Good Practice Statement).**

Rationale

With rates of AMR increasing worldwide, and very few new antibiotics being developed, existing antibiotics are becoming a limited resource. It is therefore essential that antibiotics only be prescribed – and that last-resort antibiotics (AWaRe

RESERVE group) be reserved – for patients who truly need them. Hence, AMS and its defined set of actions for optimizing antibiotic use are of paramount importance

Program structure & governance

An AMS committee in the health-care facility should provide leadership and overall coordination of the AMS programme. The AMS committee can be a stand-alone committee or be integrated into an existing structure, such as the infection control, patient safety or drug and therapeutics committee with clear terms of reference.

Stewardship programs are greatly enhanced by strong support from the following groups:

- **Infection prevention and control**: It is often the same people involved in issues related to IPC and AMS both at the facility level and the national (state/regional) level. This is because IPC and AMS are two sides of the same coin when it comes to development and spread of AMR, optimizing antibiotic use and providing quality health care. IPC team role involve ensuring that effective strategies to reduce the spread of infections and AMR are integrated into patient care.
- **Clinicians:** It is vital that all clinicians are fully engaged in and supportive of efforts to improve antibiotic use. Hospitalists are especially important to engage because they are one of the largest prescribers of antibiotics in hospitals. They also often have experience with quality improvement work.
- **Department or program heads**: Support from clinical department heads, as well as the director of pharmacy, is especially important in embedding stewardship activities in daily workflow.
- **Pharmacy and therapeutics committee:** Can play a key role in helping to develop and implement policies that will improve antibiotic use (e.g. incorporating stewardship into order sets and clinical pathways).

  Some hospitals have created a multidisciplinary stewardship subcommittee of the Pharmacy and Therapeutics Committee. Infection preventionists and hospital epidemiologists can assist with educating staff and with analyzing and reporting data on antibiotic resistance and C. difficile infection trends.

- **Quality improvement, patient safety and regulatory staff:** can help advocate for adequate resources and integrate stewardship interventions into other quality improvement efforts, especially sepsis management. They might also be able to support implementation and outcome assessments.

- **Microbiology laboratory staff** can:

  - Guide the proper use of tests and the flow of results as part of "diagnostic stewardship".
  - Help optimize empiric antibiotic prescribing by creating and interpreting a facility cumulative antibiotic resistance report or antibiogram.
  - Laboratory and stewardship personnel can work collaboratively to present data from lab reports in a way that supports optimal antibiotic use and is consistent with hospital guidelines.
  - Guide discussions on the potential implementation of rapid diagnostic tests and new antibacterial susceptibility test interpretive criteria (e.g., antibiotic breakpoints) that might impact antibiotic use. Microbiology labs and stewardship programs can work together to optimize the use of such tests and the communication of results.
  - Collaborate with stewardship program personnel to develop guidance for clinicians when changes in laboratory testing practices might impact clinical decision making. Hospitals where microbiology services are contracted to an external organization should ensure that information is available to inform stewardship efforts.

- **Information technology staff** are critical to integrating stewardship protocols into existing workflow. Some examples include:

  - Embedding relevant information and protocols at the point of care (e.g., order sets, access to facility-specific guidelines).
  - Implementing clinical decision support for antibiotic use and creating prompts for action to review antibiotics in key situations.
  - Facilitating and maintaining reporting.

Core AMS interventions

- Improve awareness and understanding of AMR through effective communication, education and training.
- Strengthen the knowledge and evidence base through surveillance and research.
- Reduce the incidence of infection through effective sanitation, hygiene and infection prevention measures.
- Optimize the use of antimicrobial medicines in human and animal health.

Prescribing & optimization practices

Early IV-to-PO switch: Hospitalized patients initially on intravenous antibiotics can be safely switched to an oral equivalent within the third day of admission once clinical stability is established. This conversion has many advantages as fewer complications, less healthcare costs and earlier hospital discharge.

There are so many benefits of reducing unnecessary IV antibiotics, including better patient care, freeing up nursing time, reducing waste, and saving money. Patients taking oral antibiotics are less likely to experience line-related infections, to miss any doses and to suffer adverse effects from medications.

De-escalation of empiric antibiotic therapy is a strategy in antimicrobial stewardship where treatment is modified from a broad-spectrum antibiotic to a narrower-spectrum one, or stopped altogether, based on culture results and the patient's clinical response. This approach is used to match the antibiotic therapy more precisely to the specific pathogen, reduce the overall use of antibiotics, and help prevent the development of antibiotic resistance and other complications.

Infection control practitioners can participate in AMS through:

- Advising on appropriate governance structures for AMS.
- A patient-centric approach to managing risk.
- Making current endorsed therapeutic guidelines on antimicrobial prescribing readily available.

- Participating in multidisciplinary antimicrobial stewardship committees that include infectious diseases physicians, general practitioners, pharmacists, microbiologists, and nurses.
- Educating healthcare workers on infection prevention and control strategies to minimise risk and transmission of antimicrobial resistance, including safe and appropriate antibiotic use.
- Advising healthcare workers on appropriate specimen collection procedures, different types of microbes and infections, and local resistance patterns.
- Undertaking surveillance of antimicrobial-resistant organisms, healthcare-associated infections, and in some circumstances, surveillance of antimicrobial usage and appropriateness.
- Reporting and providing feedback to teams on surveillance data

Microbiology and surveillance enablers: Clinical microbiology laboratories are key to AMS programs, providing specimen collection and testing, rapid diagnostics, susceptibility testing, and production of antibiograms and education activities.

- Antibiograms can provide an overview of the emergence of antibiotic resistance in particular settings over time.
- Combination antibiograms may be particularly useful in managing infections due to multidrug-resistant organisms.
- Cumulative antibiograms can guide empirical therapy and be used as an important teaching tool for enhancing clinician compliance.

Surveillance enablers in AMS programs are the resources, structures, and processes necessary to successfully monitor and optimize antimicrobial use, combat AMR, and protect public health.

Key rationales for enablers include improving clinical outcomes by identifying resistance patterns, ensuring effective treatment, guiding appropriate antimicrobial selection, and ultimately reducing the harms of AMR and preserving the effectiveness of antimicrobials. Enablers, such as IT resources and leadership support, provide the foundation for effective surveillance, while their absence creates challenges that impede AMS program success.

9. Indicators for Monitoring

Key performance indicators (KPIs) in AMS programs provide a balanced approach in measuring the impact of AMS programs, combining clinical outcomes, process improvements, and economic benefits.

These are some indicators which can provide measurable data to assess compliance, identify areas for improvement, drive meaningful change, and contribute to the global fight against AMR. Here are some key indicators that can be included in hospital guidelines for monitoring and evaluating AMS programs.

These KPIs can be divided into several categories:

1. Antimicrobial Utilization

- **Defined Daily Dose (DDD) per 1,000 patient-days:** Measures standardized antimicrobial consumption to assess overall usage trends to allow comparison between hospitals or services of different sizes. This tracks the quantity of antibiotics prescribed relative to patient volume.
  Formula: DDD/1,000 patient-days = (Total grams of antimicrobial used / WHO-assigned DDD) / Total patient-days × 1000

- **Days of Therapy (DOT) per 1,000 patient-days:** Tracks how many days patients receive antibiotics, offering insight into treatment duration and allows comparison between hospitals or services of different sizes. This measures the duration of antibiotic use per patient to assess prescribing patterns.
  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.

  Formula: DOT/1,000 patient-days = (Total number of days antimicrobial was administered / Total patient-days) × 1000

- **Percentage of patients on antibiotics**: Assesses the proportion of admitted patients receiving antimicrobial treatment to assess overall usage.

  Formula: Percentage = (Number of patients receiving antibiotics / Total number of admitted patients) × 100

- **Percentage of restricted antimicrobials usage:** The restriction of certain antimicrobials is a crucial component of the ASP designed to reduce the inappropriate and frequent use of antimicrobial agents that are prone to misuse in hospital settings. Frequently evaluating the percentage of restricted antimicrobial usage, helps to monitor adherence to ASP limiting certain high-risk antimicrobials.

  Formula: Percentage = (Number of patients receiving restricted antibiotics / Total number of admitted patients) × 100

2. Appropriateness of Antimicrobial Use

- **Compliance with antimicrobial guidelines (%)**: Indicates how often prescriptions align with institutional or national guidelines.

  Formula: Compliance = (Number of prescriptions compliant with guidelines / Total prescriptions reviewed) × 100

- **Documented indication for antimicrobial use (%)**: Measures the proportion of antimicrobial prescriptions with a clearly stated reason for use.

  Formula: Percentage = (Number of prescriptions with documented indication / Total antimicrobial prescriptions) × 100

- **De-escalation after culture results (%):** Tracks whether antimicrobial therapy is narrowed based on microbiological findings.

  Formula: De-escalation Rate = (Number of de-escalations post-culture / Eligible cases for de-escalation) × 100

3. Clinical Outcomes

- **Antimicrobial resistance rate (%)**: Monitors the percentage of resistant bacterial isolates among all tested samples.

  Formula: Resistance Rate = (Number of resistant isolates / Total isolates tested) × 100

- **Susceptibility rates for key pathogens:** Tracks the sensitivity of pathogens to commonly used antimicrobials. This can also be done through an Antibiogram. An antibiogram is an essential resource for institutions to track changes in antimicrobial resistance and to guide empirical antimicrobial therapy. It summarizes the susceptibility of bacterial pathogens to various antibiotics, over a specific period, providing a snapshot of local resistance patterns.

  Formula: Susceptibility Rate of key pathogen to a certain antibiotic = (Number of sensitive isolates to certain antibiotic/ Total isolates tested for this antibiotic) × 100

- **Clostridioides difficile infection (CDI) rate per 10,000 patient-days**: Evaluates the rate of CDI, which is associated with antibiotic overuse.

  Formula: CDI Rate = (Number of CDI cases / Total patient-days) × 10,000

- **Clostridioides difficile infections (CDI) rate per 1,000 patient days:** This tracks reductions in CDI rates as an indicator of better antimicrobial use.

  Formula: (Number of patients newly diagnosed with institution acquired CDI / the number of inpatient days in that time period) × 1,000. May also be expressed as the number of new CDI cases per 1000 patient admissions.

- **30-day readmission rate due to infection (%)**: Assesses the percentage of patients readmitted within 30 days for infection-related issues.

  Formula: Readmission Rate = (Infection-related readmissions within 30 days / Total discharges) × 100

4. Process Measures

- **Percentage of prescriptions reviewed by ASP team**: Indicates the ASP team's coverage of antimicrobial prescriptions.

  Formula: Review Rate = (Prescriptions reviewed by ASP / Total antimicrobial prescriptions) × 100

- **Acceptance rate of ASP interventions (%)**: Shows the percentage of ASP recommendations accepted by prescribers.

  Formula: Acceptance Rate = (ASP interventions accepted / Total interventions proposed) × 100

5. Education and Awareness

- **Staff trained in ASP activities per year (%)**: Assesses the percentage of healthcare workers trained in stewardship practices annually.

  Formula: Training Coverage = (Number of staff trained / Total target staff) × 100

- **Prescribers receiving regular ASP feedback (%)**: Measures how many prescribers receive feedback on their prescribing habits.

  Formula: Feedback Rate = (Prescribers receiving feedback / Total prescribers) × 100

6. Program Implementation and Resources

- **Availability of a multidisciplinary ASP team**" Tracks the existence of a core team (physician, pharmacist, microbiologist, IPC).

  Formula: Indicator: Yes / No

- **Frequency of ASP committee meetings**: Monitors how often the ASP team meets to review activities.

  Formula: Indicator: Number of meetings per month/quarter

- **Availability and use of electronic decision support tools**: Assesses whether prescribers have access to digital tools aiding stewardship.

  Formula: Indicator: Yes / No or % of units with access

10. Plan to Update this National Clinical Guideline

This guideline will be reviewed and updated when new evidence emerges that is likely to influence the recommendations.

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