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Research Article

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Antimicrobial Stewardship in the Era of Antibiotic Resistance: From Appropriate Prescribing to Precision Therapy

Francesco Saturno[1]*, Giulia Monaco[1], Angela Salerno[2], Antonio Cianciola[3], Nicole Cianciola[3] and Emidio Cianciola[1]

[1]UOC Anestesia, Rianimazione e Terapia del Dolore, P.O. Sapri, ASL Salerno, Italy

[2]UdR - Servizio Trasfusionale, P.O. Sapri, ASL Salerno, Italy

[3]Saint Camillus International University of Health and Medical Sciences (UniCamillus), Rome, Italy.

***Corresponding Author**
Francesco Saturno, UOC Anestesia, Rianimazione e Terapia del Dolore, P.O. Sapri, ASL Salerno, Italy.

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Abstract

Background: *Antimicrobial resistance (AMR) represents one of the most important threats to modern healthcare. The progressive emergence and dissemination of antimicrobial-resistant microorganisms compromises the effectiveness of established therapies and increases the complexity, duration and cost of patient care. Inappropriate antimicrobial exposure, including unnecessary treatment, excessive duration, inappropriate spectrum and inadequate dosing, contributes to the selection of resistant organisms.*

Objective: *This narrative review examines the principal challenges associated with antibiotic prescribing and evaluates the role of antimicrobial stewardship (AMS) in promoting appropriate, individualized and precision-oriented antimicrobial therapy.*

Methods: *A narrative review of international recommendations, stewardship frameworks and major scientific literature was undertaken. Particular attention was given to antimicrobial prescribing, diagnostic stewardship, empirical therapy, microbiological reassessment, antimicrobial susceptibility testing, pharmacokinetic/pharmacodynamic optimization, therapeutic drug monitoring, de-escalation, intravenous-to-oral conversion, treatment duration, antimicrobial consumption and One Health strategies.*

Results: *Effective AMS requires an integrated multidisciplinary approach. Antibiotic prescribing should be based on clinical probability, severity of infection, local epidemiology, previous microbiological data, individual patient characteristics and pharmacological principles. Empirical therapy should provide adequate initial coverage when clinically indicated, but treatment must be reassessed after the initial diagnostic and therapeutic phase. De-escalation, discontinuation, spectrum narrowing, optimization of dose and duration, and intravenous-to-oral conversion represent fundamental stewardship interventions. Contemporary stewardship is increasingly evolving toward precision antimicrobial therapy, integrating rapid diagnostics, susceptibility data, patient-specific pharmacokinetics and pharmacodynamics, and real-time clinical response.*

Conclusions: *Antimicrobial stewardship should not be regarded simply as a strategy to reduce antibiotic consumption. Its primary objective is to optimize antimicrobial therapy for the individual patient while preserving antimicrobial effectiveness at the population level. The integration of AMS with diagnostic stewardship, infection prevention and control, microbiological surveillance, pharmacokinetic/pharmacodynamic optimization and the One Health framework represents a central strategy for addressing AMR.*

Keywords: Antimicrobial Resistance, Antimicrobial Stewardship, Antibiotic Prescribing, Precision Antimicrobial Therapy, Diagnostic Stewardship, De-Escalation, Pharmacokinetics, Pharmacodynamics, Multidrug-Resistant Organisms, One Health

1. Introduction

Antimicrobial resistance represents a major global health and healthcare challenge. Resistance occurs when microorganisms no longer respond adequately to antimicrobial medicines, making infections more difficult or, in some circumstances, impossible to treat. According to the World Health Organization (WHO), bacterial antimicrobial resistance was associated with more than 4.7 million deaths globally in 2021, and approximately one in six laboratory-confirmed bacterial infections worldwide was resistant to antibiotic treatment in 2023. (Organizzazione Mondiale della Sanità) The consequences of AMR extend beyond individual treatment failure. Resistant infections may result in prolonged hospitalization, increased healthcare expenditure, greater use of toxic or less effective antimicrobial agents, increased need for invasive procedures and higher mortality.

Antimicrobial use is one of the major modifiable drivers of resistance. The relationship is not simply quantitative. The antimicrobial selected, its spectrum, dose, duration, route of administration and exposure relative to pathogen susceptibility all influence selection pressure.

This has shifted the focus from the traditional concept of antibiotic treatment toward **antimicrobial stewardship (AMS).** AMS can be defined as a coordinated set of interventions designed to improve antimicrobial prescribing and use, with the goals of optimizing clinical outcomes, minimizing toxicity and adverse effects, reducing unnecessary antimicrobial exposure and limiting the emergence and transmission of resistance. The international response has also evolved. In May 2026, the World Health Assembly adopted the updated **Global Action Plan on Antimicrobial Resistance 2026–2036**, reinforcing a multisectoral One Health approach involving human, animal, plant, food-system and environmental health. (Organizzazione Mondiale della Sanità) The contemporary challenge is therefore not simply to prescribe fewer antibiotics, but to prescribe them more precisely.

2. Antimicrobial Resistance: Mechanisms and Clinical Consequences

Bacterial resistance may arise through spontaneous genetic mutations or acquisition of resistance determinants through horizontal gene transfer.

Major mechanisms include:

- enzymatic inactivation of antimicrobial agents,
- modification of antimicrobial targets,
- reduction in membrane permeability,
- active efflux,
- metabolic bypass,
- acquisition of mobile genetic elements carrying resistance genes.

The clinical consequences are particularly relevant when resistance affects pathogens responsible for severe healthcare-associated infections.

Multidrug-resistant organisms can substantially restrict therapeutic options and may require:

- broader-spectrum antibiotics,
- combination therapy in selected circumstances,
- prolonged hospitalization,
- increased microbiological surveillance,
- therapeutic drug monitoring,
- more complex pharmacological strategies.

Consequently, preserving the effectiveness of existing antimicrobials is a central component of modern patient safety.

3. Antibiotic Exposure as a Driver of Resistance

Antibiotic exposure creates selective pressure within microbial ecosystems.

When an antimicrobial is administered:

1. susceptible organisms are inhibited or eliminated,
2. organisms carrying resistance mechanisms may survive,
3. resistant populations may subsequently expand,
4. resistance determinants may be transmitted to other organisms.

This process can occur at the individual and institutional levels. Importantly, antimicrobial stewardship should not equate “less antibiotic” with “better care.”In a patient with severe bacterial infection, inadequate initial therapy may result in treatment failure and adverse outcomes. The stewardship objective is therefore: the minimum antimicrobial exposure necessary to achieve the maximum probability of an appropriate clinical outcome. This concept is particularly important in critically ill patients, immunocompromised patients and patients at high risk for multidrug-resistant infection.

4. The Challenges of Antibiotic Prescribing

Antibiotic prescribing is characterized by substantial diagnostic uncertainty.

The prescriber must frequently make decisions before definitive microbiological information is available.

The principal prescribing challenges include:

- uncertainty regarding the presence of bacterial infection,
- difficulty distinguishing infection from colonization,
- incomplete microbiological information,
- variable local resistance patterns,
- previous antimicrobial exposure,
- inappropriate empirical broad-spectrum therapy,
- excessive treatment duration,
- inadequate dose,
- inappropriate route,
- failure to adjust therapy according to renal function,
- failure to reassess therapy,
- failure to de-escalate.

The first stewardship question should therefore not be:

"Which antibiotic should I prescribe?"
but:
"Does this patient require antimicrobial therapy?"
Only after this question has been addressed should selection of the antimicrobial agent occur.

5. Diagnostic Stewardship

Antimicrobial stewardship and diagnostic stewardship are closely interconnected.
Diagnostic stewardship aims to ensure that diagnostic investigations are appropriately selected, obtained, processed and interpreted.
An inappropriate diagnostic strategy may generate two opposite problems:

5.1. False Reassurance

A pathogen is not identified because cultures were not obtained or were obtained after antimicrobial administration.

5.2. False-Positive Treatment

A microorganism is detected but represents colonization or contamination rather than true infection, leading to unnecessary antimicrobial therapy.
Appropriate microbiological sampling should therefore be performed whenever feasible before initiation of antimicrobial therapy, particularly when:

- infection is severe,
- bacteremia is suspected,
- multidrug-resistant infection is possible,
- prolonged treatment may be required,
- microbiological confirmation could substantially change therapy.

Rapid molecular and phenotypic diagnostic technologies may shorten the time required to identify pathogens and resistance mechanisms. Their greatest stewardship value lies not simply in faster diagnosis, but in enabling **earlier therapeutic precision**.

6. Empirical Antibiotic Therapy

Empirical therapy remains essential when delaying treatment could compromise patient outcomes.
The choice of empirical therapy should incorporate:

6.1. Patient Factors

- age,
- renal function,
- hepatic function,
- allergy history,
- immunosuppression,
- previous antimicrobial exposure.

6.2. Infection Factors

- suspected anatomical site,
- severity,
- likely pathogens,
- source control,
- presence of prosthetic material or invasive devices.

6.3. Epidemiological Factors

- local antibiogram,
- previous colonization or infection with resistant organisms,
- recent hospitalization,
- recent antibiotic exposure,
- healthcare-associated exposure.

The empirical regimen should provide adequate initial coverage while avoiding unnecessary expansion of the antimicrobial spectrum.
This creates a central stewardship balance:
adequate initial treatment ↔ avoidance of unnecessary antimicrobial exposure.

7. From Empirical Therapy to Precision Therapy

The traditional antibiotic model can be represented as:
Clinical suspicion → empirical antibiotic → clinical response
A precision antimicrobial model adds several intermediate steps:
Clinical suspicion → diagnostic sampling → empirical therapy → rapid microbiological identification → susceptibility data → individualized PK/PD optimization → de-escalation → defined duration

This represents an important conceptual evolution.
The antibiotic is no longer selected solely according to the suspected infection. Treatment increasingly incorporates:

- pathogen identity,
- antimicrobial susceptibility,
- MIC,
- site of infection,
- tissue penetration,
- patient-specific pharmacokinetics,
- organ function,
- severity,
- clinical response.

This approach may appropriately be described as **precision antimicrobial therapy.**

8. The WHO AWaRe Framework

The WHO AWaRe classification divides antibiotics into:

- Access
- Watch
- Reserve

The framework is intended to support responsible antibiotic selection and monitoring.
The WHO AWaRe antibiotic book provides evidence-based recommendations regarding antimicrobial choice, dose, route and duration for more than 30 common infectious syndromes in adults and children. (Organizzazione Mondiale della Sanità) The **Access** group includes antibiotics generally considered first- or second-choice options for many common infections and is central to efforts to improve appropriate antibiotic use. **Watch** antibiotics generally have greater potential to drive resistance and should be used selectively. **Reserve** antibiotics are intended primarily for infections caused by multidrug-resistant organisms when

alternative treatments are inappropriate or ineffective. The AWaRe framework provides a useful population-level stewardship tool, although individual prescribing decisions must remain clinically contextualized.

9. The "Start Smart – Then Focus" Approach

A practical approach to stewardship is to divide antimicrobial treatment into two phases.

9.1. Start Smart

At initiation:

- confirm the clinical indication,
- assess severity,
- obtain appropriate cultures when feasible,
- identify risk factors for resistance,
- select empirical therapy according to local epidemiology,
- administer treatment promptly when indicated,
- document the indication,
- define an anticipated review date and duration.

9.2. Then Focus

At reassessment:

- review the diagnosis,
- review microbiological results,
- assess clinical response,
- discontinue unnecessary treatment,
- narrow the antimicrobial spectrum,
- switch therapy according to susceptibility,
- change IV to oral administration when appropriate,
- establish definitive duration.

The 48–72-hour reassessment is therefore a critical stewardship checkpoint.

10. De-escalation

De-escalation is one of the most important components of antimicrobial stewardship.

It may include:

- discontinuation of an unnecessary agent,
- narrowing the antimicrobial spectrum,
- conversion from combination therapy to monotherapy,
- switching from empirical to targeted treatment,
- discontinuation of therapy when bacterial infection is no longer supported.

De-escalation represents a transition from uncertainty to precision. For example, a patient may initially require broad-spectrum therapy because of severe infection and risk factors for resistant pathogens. Once microbiological results become available and the clinical situation stabilizes, continued broad-spectrum treatment may no longer be justified.

The stewardship principle is therefore:

Start appropriately broad when necessary, become appropriately narrow as soon as evidence permits.

11. Pharmacokinetic and Pharmacodynamic Optimization

Antimicrobial efficacy depends on the relationship between drug exposure and pathogen susceptibility.

The three principal PK/PD indices are:

- **fT>MIC** — fraction of the dosing interval during which free drug concentrations remain above the MIC,
- **AUC/MIC** — ratio between the area under the concentration-time curve and the MIC,
- **Cmax/MIC** — peak concentration relative to the MIC.

Different antimicrobial classes depend preferentially on different PK/PD indices. This is particularly important in critically ill patients.

Critical illness may produce major pharmacokinetic changes because of:

- fluid resuscitation,
- capillary leak,
- altered volume of distribution,
- hypoalbuminemia,
- augmented renal clearance,
- acute kidney injury,
- renal replacement therapy,
- extracorporeal membrane oxygenation.

Consequently, standard doses may not always produce predictable exposure.

Antimicrobial dosing should therefore be individualized whenever clinically appropriate.

12. Therapeutic Drug Monitoring

Therapeutic drug monitoring (TDM) can contribute to precision antimicrobial therapy for selected drugs and patient populations.

The objective is to ensure adequate exposure while minimizing toxicity.

TDM may be particularly useful when:

- pharmacokinetic variability is substantial,
- the therapeutic window is relatively narrow,
- the infection is severe,
- renal function is unstable,
- extracorporeal support is present,
- achieving adequate exposure is clinically critical.

TDM should not replace clinical judgment. It should be integrated with:

- MIC,
- infection site,
- microbiological response,
- renal function,
- clinical status.

13. Duration of Antibiotic Therapy

Duration is one of the most frequently overlooked components of antimicrobial prescribing.

Historically, prolonged antibiotic courses were often perceived as safer. Contemporary stewardship increasingly supports individualized and evidence-based durations.

Duration should be determined according to:

- infection site,
- pathogen,
- source control,
- severity,
- immune status,
- clinical response,
- microbiological findings,
- evidence from clinical trials and guidelines.

The relevant question is not:
"What is the longest safe duration?"
but:
"What is the shortest duration that provides an acceptable probability of cure?"
Prolonged treatment increases antimicrobial exposure without necessarily improving clinical outcomes.

14. Intravenous-to-Oral Conversion

The route of administration should be reassessed continuously.
Intravenous therapy is appropriate when:

- the patient is clinically unstable,
- gastrointestinal absorption is unreliable,
- an effective oral option is unavailable,
- the infection requires a specific parenteral agent.

Once the patient becomes clinically stable, oral therapy should be considered when:

- gastrointestinal absorption is adequate,
- an effective oral agent is available,
- the infection is appropriate for oral therapy,
- microbiological data support the selected agent.

This approach can reduce:

- catheter-related complications,
- nursing workload,
- healthcare resource utilization,
- unnecessary hospitalization.

15. Antimicrobial Stewardship in Intensive Care

The ICU represents one of the most challenging environments for antimicrobial stewardship.
Critically ill patients frequently present with:

- severe sepsis or septic shock,
- multiple invasive devices,
- previous antimicrobial exposure,
- prolonged hospitalization,
- immunosuppression,
- high risk of multidrug-resistant organisms,
- altered antimicrobial pharmacokinetics.

The ICU stewardship strategy should therefore recognize two distinct phases.

Initial phase
Rapid administration of adequate empirical therapy.

Reassessment phase
Optimization, narrowing, de-escalation or discontinuation.
The initial use of broad-spectrum therapy may be justified in selected patients. However, its continuation should be reassessed according to evolving clinical and microbiological evidence.

16. Multidisciplinary Antimicrobial Stewardship Programs

AMS is most effective when integrated into institutional structures.
A multidisciplinary stewardship team may include:

- infectious disease specialists,
- intensivists,
- anesthesiologists,
- clinical pharmacists,
- microbiologists,
- infection prevention specialists,
- epidemiologists,
- nurses,
- hospital management,
- information technology specialists.

The CDC Core Elements framework identifies seven fundamental components for hospital stewardship programs:

1. leadership commitment,
2. accountability,
3. pharmacy expertise,
4. action,
5. tracking,
6. reporting,
7. education. (CDC)

The CDC emphasizes that stewardship programs should be adapted to the characteristics and resources of individual healthcare facilities rather than implemented as a single universal model. (CDC) The IDSA/SHEA guidelines similarly support structured stewardship interventions for hospitalized patients. (IDSA)

17. Stewardship Interventions

17.1. Prospective audit and feedback

The stewardship team reviews antimicrobial prescriptions and provides recommendations regarding:

- indication,
- antimicrobial selection,
- dose,
- route,
- duration,
- microbiological data,
- de-escalation.

17.2. Preauthorization

Selected antimicrobial agents may require approval before use.
This strategy is particularly applicable to:

- Reserve antibiotics,
- newly introduced agents,
- highly broad-spectrum agents,
- agents with substantial resistance-selection potential.

17.3. Clinical guidelines

Local guidelines should integrate:

- institutional antibiograms,
- local resistance patterns,
- national recommendations,
- microbiological surveillance,
- formulary availability.

17.4. Clinical Decision Support

Electronic prescribing systems can facilitate:

- allergy checks,
- renal-dose adjustment,
- duration alerts,
- antimicrobial review reminders,
- drug interactions,
- local guideline integration.

17.5. Education

Education should be continuous and directed toward prescribers, pharmacists, nurses and other healthcare professionals. Education alone is generally insufficient, its impact is greater when combined with active stewardship interventions.

18. Measuring Stewardship Performance

A stewardship program should be measurable.

18.1. Process indicators

- percentage of prescriptions with documented indication,
- percentage reviewed within 48–72 hours,
- rate of de-escalation,
- rate of IV-to-oral conversion,
- compliance with institutional guidelines.

18.2. Antimicrobial consumption

- Days of Therapy (DOT),
- Defined Daily Dose (DDD),
- consumption of broad-spectrum agents,
- use of Watch and Reserve antibiotics.

18.3. Microbiological indicators

- prevalence of MDR organisms,
- antimicrobial susceptibility patterns,
- incidence of selected resistant pathogens.

18.4. Safety indicators

- *Clostridioides difficile infection,*
- antibiotic-associated adverse events,
- nephrotoxicity,
- allergic reactions.

18.5. Clinical outcomes

- mortality,
- length of stay,
- treatment failure,
- readmission,
- infection recurrence.

Tracking and reporting are fundamental components of the CDC Core Elements approach. (CDC)

19. The 0–24–48–72 Hour Stewardship Model

Time	Principal Objective	Key Actions
0 h	Decide whether treatment is necessary	Clinical assessment, cultures, severity assessment
0–24 h	Optimize empirical therapy	Correct drug, dose, route, resistance risk
48 h	Reassess diagnosis	Microbiology, clinical response, adverse effects
72 h	Focus therapy	De-escalation, discontinuation, IV-to-oral switch,

Table 1: A Practical Model for Clinical Implementation can be Structured Around four Time Points

This model transforms stewardship from a retrospective activity into a **continuous therapeutic process.**

Clinical domain	Key assessment	Stewardship action
Diagnosis	Is bacterial infection clinically likely? Are appropriate samples available?	Avoid unnecessary antibiotics, obtain cultures/ rapid diagnostics before therapy when feasible.
Empirical therapy	Severity, infection site, likely pathogens, MDR risk and local epidemiology	Select the narrowest regimen that still provides adequate initial coverage.
Microbiology	Pathogen identification, susceptibility profile and MIC	Move from empirical to targeted therapy, narrow spectrum or discontinue unnecessary agents.
PK/PD optimization	Renal/hepatic function, volume of distribution, extracorporeal support and PK/PD target	Individualize dose, interval and infusion strategy, use TDM when appropriate.
48–72 h reassessment	Clinical response, microbiology, adverse effects and source control	De-escalate, stop combination therapy when unnecessary, and define final duration.

Route and duration	Clinical stability, oral bioavailability and evidence-based treatment length	Switch IV to oral therapy when appropriate and use the shortest effective duration.

Table 2: Core Elements of Precision Antimicrobial Stewardship

20. Precision Antimicrobial Therapy

Precision antimicrobial therapy can be conceptualized as the integration of five domains:

- **Pathogen**
  What microorganism is causing the infection?
- **Susceptibility**
  Which antimicrobial agents are active against the pathogen?
- **Patient**
  What characteristics modify antimicrobial exposure and toxicity?
- **Pharmacology**
  What dose and administration strategy achieves the desired PK/PD target?
- **Response**
  Is the patient improving, and can treatment be narrowed or stopped?

This can be represented as:
Pathogen + susceptibility + patient characteristics + PK/PD + clinical response = precision antimicrobial therapy The concept extends antimicrobial stewardship from population-level antibiotic conservation toward individualized therapeutic optimization.

21. One Health Approach

AMR is not confined to hospitals.
Resistant microorganisms and resistance determinants circulate among:

- humans,
- animals,
- food production systems,
- water,
- soil,
- wastewater,
- the broader environment.

The WHO Global Action Plan on AMR 2026–2036 therefore adopts a One Health framework and emphasizes coordinated action across human, animal, plant, food-system and environmental sectors. (Organizzazione Mondiale della Sanità)
Prevention is a fundamental component of this strategy.
Important interventions include:

- vaccination,
- infection prevention and control,
- water, sanitation and hygiene,
- appropriate antimicrobial use,
- surveillance,
- environmental management,
- responsible antimicrobial use in agriculture and veterinary medicine.

The objective is to reduce the demand for antimicrobial therapy while preserving access to effective agents when treatment is necessary.

22. Education and Behavioral Change

Antimicrobial prescribing is influenced by clinical knowledge, diagnostic uncertainty, local culture and perceived risk.
Prescribers may use broad-spectrum therapy because of:

- fear of treatment failure,
- uncertainty about the diagnosis,
- unfamiliarity with local resistance patterns,
- concern regarding severe outcomes,
- lack of rapid microbiological information.

AMS interventions should therefore address not only knowledge but also prescribing behavior.
Useful strategies include:

- regular education,
- prescribing feedback,
- peer comparison,
- clinical pathways,
- electronic decision support,
- local antibiograms,
- standardized documentation,
- stewardship rounds.

The objective is to make appropriate prescribing the easiest and most clinically supported choice.

23. Ethical Dimension of Antimicrobial Stewardship

AMS has both individual and collective ethical dimensions. The clinician has an immediate obligation to provide appropriate treatment to the individual patient.
At the same time, unnecessary antimicrobial exposure may contribute to resistance that affects future patients. Stewardship therefore represents a form of intergenerational responsibility.
The ethical principle can be expressed as: Provide the antimicrobial treatment that the present patient needs while preserving antimicrobial effectiveness for future patients.
This balance is particularly relevant for antibiotics classified as critically important or reserved for multidrug-resistant infections.

24. Discussion

The management of AMR requires a transition from a reactive model to a proactive model.
Historically, antimicrobial prescribing was often based primarily on clinical suspicion and the availability of broad-spectrum agents.
The modern approach integrates:
diagnosis → microbiology → epidemiology → pharmacology → reassessment → precision therapy.
This evolution is particularly important because antimicrobial resistance is not solely a consequence of prescribing too many antibiotics. It may also result from inappropriate selection, inadequate dosing, prolonged exposure and failure to adapt therapy when additional information becomes available.

The WHO AWaRe framework provides a population-oriented approach to antibiotic selection and monitoring, while institutional AMS programs translate these principles into clinical practice. (Organizzazione Mondiale della Sanità) The CDC Core Elements provide an organizational framework for implementing stewardship in healthcare facilities, emphasizing leadership, accountability, pharmacy expertise, intervention, tracking, reporting and education. (CDC) However, the next generation of stewardship should move beyond measuring antibiotic consumption alone.

A mature AMS program should answer five questions:

1. Was antimicrobial treatment indicated?
2. Was the initial therapy appropriate?
3. Was antimicrobial exposure optimized?
4. Was therapy reassessed and narrowed appropriately?
5. Was the final duration evidence-based?

This approach shifts stewardship from an administrative antibiotic-control program to a **clinical quality and patient-safety system.**

The development of rapid diagnostics, electronic prescribing systems, artificial intelligence-assisted clinical decision support and real-time microbiological surveillance may further enable individualized antimicrobial prescribing. Nevertheless, technological innovation cannot replace clinical judgment. Precision therapy remains dependent on accurate diagnosis, high-quality microbiology, reliable susceptibility testing and continuous clinical reassessment.

25. Future Perspectives

Several developments are likely to shape the next generation of antimicrobial stewardship.

25.1. Rapid Diagnostics

Shortening the interval between specimen collection and pathogen identification may facilitate earlier targeted therapy.

25.2. Artificial Intelligence

AI-based systems may assist in:

- predicting resistant organisms,
- interpreting microbiological data,
- optimizing antimicrobial selection,
- identifying inappropriate prescriptions,
- predicting treatment response.

25.3. Real-Time Surveillance

Integration of microbiological, pharmacological and prescribing data could allow hospitals to detect emerging resistance patterns earlier.

25.4. Precision PK/PD

Individualized dosing based on patient-specific pharmacokinetics, pathogen susceptibility and therapeutic targets may become increasingly important in critically ill patients.

25.5. One Health Surveillance

Integration of human, veterinary and environmental resistance data may provide a more complete picture of antimicrobial resistance transmission.

26. Practical Clinical Algorithm

STEP 1 — Is bacterial infection clinically likely?

No

→ Do not prescribe antibiotics, investigate alternative diagnoses.

Yes

→ Continue evaluation.

Severe infection/high-risk patient

→ Start appropriate empirical therapy promptly.

STEP 2 — Obtain microbiological specimens

Whenever feasible and without clinically significant delay.

STEP 3 — Evaluate resistance risk

Consider:

- previous MDR isolation,
- recent hospitalization,
- recent antibiotic exposure,
- invasive devices,
- immunosuppression,
- local epidemiology.

STEP 4 — Select empirical therapy

Choose the narrowest regimen providing adequate expected coverage.

STEP 5 — Optimize antimicrobial exposure

Evaluate:

- dose,
- dosing interval,
- route,
- renal function,
- hepatic function,
- PK/PD target,
- TDM when appropriate.

STEP 6 — Reassess at 48–72 hours

Ask:

Is the diagnosis correct?
Is bacterial infection confirmed?
What is the pathogen?
What does the susceptibility profile show?
Can treatment be narrowed?
Can an antibiotic be discontinued?
Can combination therapy be stopped?
Can IV treatment be converted to oral therapy?
What is the appropriate duration?

STEP 7 — Document the final plan

Record:

- indication,
- antimicrobial,
- dose,
- route,
- microbiological results,
- reassessment,
- planned duration,

- criteria for discontinuation.

27. Conclusion

Antimicrobial resistance is a complex global health problem that threatens the effectiveness of modern medicine. Antibiotic prescribing is one of the most important modifiable determinants of antimicrobial exposure and therefore represents a major target for intervention. Antimicrobial stewardship should not be interpreted simply as a strategy for reducing antibiotic consumption.

Its fundamental objective is:

to ensure that the right patient receives the right antimicrobial, at the right dose, through the right route, for the right duration, with continuous reassessment.

The future of AMS lies in the transition:

from empirical treatment to targeted treatment,

from broad-spectrum exposure to precision therapy,

from antibiotic consumption monitoring to outcome-oriented stewardship,

and

from isolated hospital interventions to a One Health strategy.

The integration of diagnostic stewardship, rapid microbiology, pharmacokinetic/pharmacodynamic optimization, therapeutic drug monitoring, de-escalation, infection prevention and control, electronic decision support and continuous surveillance represents the most promising approach to preserving antimicrobial effectiveness. Ultimately, antimicrobial stewardship is not about using fewer antibiotics at any cost. It is about **using antibiotics better** [1-20].

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