AUSTRALIAN COMMISSION ON SAFETY AND QUALITY IN HEALTH CARE

Antimicrobial Stewardship in Australian Health Care

2018

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AUSTRALIAN COMMISSION ON SAFETY AND QUALITY IN HEALTH CARE

Summary

Antimicrobial Stewardship in Australian Health Care

2018

Summary

Key issues

The challenge

Antimicrobial resistance (AMR) is an issue of great significance for health care in Australia and has been declared a significant threat to human health. Infections with pathogens resistant to antimicrobials lead to prolonged or serious illness, escalation in therapy with associated healthcare costs, hospitalisation or death. With few new antimicrobials coming onto the market in the foreseeable future, the options for treating resistant infections are becoming increasingly limited.

High levels of antimicrobial use and inappropriate use of antimicrobials cause increasing AMR and other patient harms. Australia's use of antimicrobials is high compared with other high-income countries. In 2015, almost 40% of patients admitted to Australian hospitals were prescribed an antimicrobial, and in the community 45% of the population were dispensed one or more antimicrobials during the year. Around one-third to one-half of this antimicrobial use was considered inappropriate. That is, antimicrobials were prescribed for conditions that did not require antimicrobial treatment – such as acute undifferentiated upper respiratory tract infection, acute tonsillitis, or acute otitis media – or were prescribed inappropriately or suboptimally; for example, using a poor choice of antimicrobial, or suboptimal dose, route or duration.

The response

Antimicrobial stewardship (AMS) promotes optimal antimicrobial prescribing. AMS programs have been shown to reduce unnecessary and inappropriate use of antimicrobials, reduce patient morbidity and mortality, and reduce bacterial resistance rates and healthcare costs. AMS is considered an integral component of patient safety and an important strategy for preserving the effectiveness of those antimicrobials currently available.

Australian framework for AMS

In Australia, AMS programs are required by the National Safety and Quality Health Service (NSQHS) Preventing and Controlling Healthcare-Associated Infection Standard, and supported by the Australian Commission on Safety and Quality in Health Care Antimicrobial Stewardship Clinical Care Standard, the Antimicrobial Use and Resistance in Australia (AURA) Surveillance System, and the work of many government and non-government organisations, health service organisations, professional bodies and research organisations. Australia's first National Antimicrobial Resistance Strategy 2015–2019 aims to implement effective AMS practices across human and animal health and agriculture sectors.

Essential elements of antimicrobial stewardship

Successful AMS programs in human health are multidisciplinary, and operate within an organisation's governance systems with the support of the organisation's executive. They comprise a suite of coordinated strategies and interventions to promote the optimal use of antimicrobials, tailored to patients' needs. The essential elements and strategies for AMS programs are outlined in the box below.

Although much of the experience in AMS has been in the hospital sector, the benefits of the use of AMS interventions to influence antimicrobial use in community settings, such as primary care and aged care homes, are significant for patients, consumers and residents. There is considerable experience of AMS in hospitals across all peer groups, in rural and remote areas, and in private hospitals.

This publication

Aim

This publication is designed to provide clinicians and managers working in all healthcare sectors with the evidence, expert guidance and tools they need to initiate and sustain AMS activities in a diverse range of practice settings – hospitals (public and private, metropolitan and rural), primary care and aged care homes. It describes the roles of those responsible for establishing and implementing AMS programs, as well as how prescribers, pharmacists, infection control practitioners, nurses and midwives can contribute to program success by incorporating AMS principles within their clinical practice.

Structure

This publication summarises current evidence about AMS strategies and interventions, and their implementation, and each chapter begins with a summary of the key points relevant to the topic.

Chapters 1–7 provide strategies for implementing and sustaining AMS. These chapters include guidance on establishing and sustaining AMS programs, strategies and interventions that change prescribing behaviour, use of electronic clinical decision support systems, clinician education, monitoring of antimicrobial use and evaluation of program outcomes, and strategies for engaging consumers in AMS.

Chapters 8–12 examine the roles of the different clinicians in AMS. These chapters focus on the roles and responsibilities that clinicians can have in formal AMS programs, as well as how clinicians can incorporate AMS principles into their clinical practice. Chapters cover infectious diseases physicians; clinical microbiology services; prescribers; pharmacists; and nurses, midwives and infection control practitioners.

The publication will continue to evolve with additional chapters to follow that address AMS in specific settings such as primary care. As new resources become available, they will be added as hyperlinks to the resources section in each chapter or to the appendices.

Essential elements and strategies for antimicrobial stewardship programs

Structure and governance

Overall accountability for antimicrobial stewardship (AMS) is defined by an organisation's corporate and clinical governance.

The NSQHS Standards require health service organisations to implement systems for the safe and appropriate prescribing and use of antimicrobials as part of an AMS program.

The program should include an AMS policy and have an antimicrobial formulary that includes restriction rules and approval processes. The program will also benefit from:

- Establishing a multidisciplinary AMS team that includes, at least, a lead doctor and pharmacist
- Ensuring ongoing education and training for prescribers, pharmacists, nurses, midwives and consumers about AMS, antimicrobial resistance and optimal antimicrobial use.

Essential strategies

The essential strategies that sit within the AMS governance structure are:

- Providing access to and implementing clinical guidelines* consistent with *Therapeutic Guidelines: Antibiotic* that take into account local microbiology and antimicrobial susceptibility patterns
- Implementing formulary† restriction and approval systems that include restricting broad-spectrum and later-generation antimicrobials to patients in whom their use is clinically justified
- Reviewing antimicrobial prescribing, with intervention and direct feedback to the prescriber
- Implementing point-of-care interventions (including directed therapy, intravenous-to-oral switching and dose optimisation)
- Ensuring that the clinical microbiology service
  - provides guidance and support for optimal specimen collection
  - targets reporting of clinically meaningful pathogens and their susceptibilities
  - uses selective reporting of susceptibility testing results
  - generates location-specific antimicrobial susceptibility reports (antibiograms) annually
- Monitoring antimicrobial use and outcomes, and reporting to clinicians and management.

* Guidelines include clinical pathways and care bundles.
† Refers to institutional formularies; in the community, the Pharmaceutical Benefits Scheme and the Repatriation Pharmaceutical Benefits Scheme act as the formulary.

AUSTRALIAN COMMISSION ON SAFETY AND QUALITY IN HEALTH CARE

1 Evidence for antimicrobial stewardship

Antimicrobial Stewardship in Australian Health Care

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Acronyms and abbreviations

Abbreviation	Definition
AMR	antimicrobial resistance
AMS	antimicrobial stewardship
AURA	Antimicrobial Use and Resistance in Australia
CI	confidence interval
Commission	Australian Commission on Safety and Quality in Health Care
ESBL	extended-spectrum β-lactamase
IRR	incidence rate ratio
MRSA	methicillin-resistant *Staphylococcus aureus*
NAPS	National Antimicrobial Prescribing Survey
NAUSP	National Antimicrobial Utilisation Surveillance Program
NHMRC	National Health and Medical Research Council
NSQHS Standards	National Safety and Quality Health Service Standards
RACGP	Royal Australian College of General Practitioners

Key points

- The growing problem of antimicrobial resistance (AMR) presents a threat to public health and patient safety.
- Antimicrobial-resistant infections can lead to prolonged or serious illness, escalation in therapy (and associated healthcare costs), hospitalisation or death.
- Other healthcare interventions, such as surgery and oncology treatments, are also threatened by AMR because antimicrobials are essential to those interventions.
- The decreasing pipeline of new antimicrobials limits options for treating infections.
- High levels of antimicrobial use and inappropriate use of antimicrobials are associated with increasing AMR.
- Reducing inappropriate antimicrobial use is an important strategy to preserve the effectiveness of antimicrobials.
- Antimicrobial stewardship (AMS) programs have been shown to improve the appropriateness of antimicrobial use, reduce patient morbidity and mortality, and reduce bacterial resistance rates and healthcare costs.
- Effective AMS is a suite of coordinated strategies that aims to ensure that antimicrobials are prescribed according to evidence-based guidelines, with antimicrobial choice, dose and duration selected to optimise clinical outcomes and minimise adverse consequences.
- In Australia, AMS programs are required by the National Safety and Quality Health Service Standards, which are mandated for all hospitals in Australia.
- AMS initiatives in human health settings are also supported by the Antimicrobial Stewardship Clinical Care Standard.
- The Australian Commission on Safety and Quality in Health Care has established other programs that support AMS initiatives, such as the Antimicrobial Use and Resistance in Australia (AURA) Surveillance System.
- The work of many states and territories, non-government organisations, professional bodies and research organisations also supports AMS in human health.
- An objective of Australia's first National Antimicrobial Resistance Strategy is to implement effective AMS practices across human health settings to ensure appropriate and judicious prescribing, dispensing and administering of antimicrobials.
- The AURA Surveillance System provides support to the implementation of the National Antimicrobial Resistance Strategy.

1.1 Introduction

The ability of antimicrobial agents to control infection is critical, not only for the treatment of infectious diseases, but to support many of the advances and interventions of contemporary health care. Neonatal care, organ transplantation, chemotherapy, surgery and intensive care all rely on effective antimicrobials to prevent and manage infections. However, the increasing use of antimicrobials is contributing to growing rates of antimicrobial resistance (AMR). AMR is a threat to the ability to treat and prevent infections. It increases morbidity and mortality, and healthcare costs. Treatment options are also limited by the decreasing development pipeline for antimicrobials.

Around one-third to half of antimicrobial use in Australian aged care homes and hospitals surveyed in 2015 was considered to be unnecessary or inappropriately prescribed.[1,2] In 2014, NPS MedicineWise found that more than 50% of people in the community with colds and other non-specific upper respiratory tract infections were prescribed an antimicrobial when it was not recommended by national guidelines.[3] Inappropriate or suboptimal antimicrobial use contributes to the development of AMR and medication-related adverse events, and can lead to poorer outcomes for individual patients with infection.[4,5]

Antimicrobial stewardship (AMS) programs have developed as a response to these issues. As a systematic approach to optimising antimicrobial use, AMS aims to minimise the unnecessary use of antimicrobials and promote the appropriateness of antimicrobial prescribing, resulting in improved patient outcomes, cost-effective therapy and reduced adverse consequences of antimicrobial use, including AMR.[6-9] AMS is a key strategy to conserve the effectiveness of antimicrobials, and is carried out by both the public and the private sectors in Australia. Implementing effective AMS practices across human health settings is also an objective of Australia's first National Antimicrobial Resistance Strategy.[10]

Successful management of infections in the future will require a multifaceted approach, including:

- The development of novel antimicrobial agents and therapies
- Coordinated efforts to limit the spread of resistant organisms
- Measures such as AMS to conserve the effectiveness of antimicrobials and contribute to preventing and containing AMR.

This chapter presents the evidence for AMS and outlines a national framework for AMS in Australia. It describes the problem of AMR in human health and the contribution of appropriate antimicrobial use to preventing and containing AMR, and reducing patient harm. The chapter presents the key elements of an effective AMS program, and the evidence for AMS as a means of reducing unnecessary antimicrobial use, improving clinical outcomes and patient safety, and containing healthcare-related costs.

1.2 Challenge and impact of antimicrobial resistance

AMR is a growing global problem. Infections caused by antimicrobial-resistant organisms are becoming increasingly prevalent and more difficult to treat. In some cases, they are untreatable. Antimicrobials that were previously active against infections are becoming less effective. Multi-drug resistance in organisms such as *Mycobacterium tuberculosis*, *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumoniae* and *Neisseria gonorrhoeae* is becoming more common.[11] Resistance is associated with treatment failure, increased mortality, and higher costs for therapy and health care.[12]

To compound the problem, the number of new antimicrobials being developed has decreased, further diminishing the capacity to treat antimicrobial-resistant infections.[13] As a result, there is greater reliance on the effectiveness of currently available agents. One of the major roles of AMS is to preserve the effectiveness of currently available antimicrobial agents.

The causes of the rise in AMR are multi-factorial and include the:

- Selection or amplification of resistant clones through antimicrobial use
- Acquisition of resistance genes from other bacteria in humans, animals and agricultural food sources
- Spread of resistant bacteria and resistance genes through environmental and person-to-person mechanisms.

A key contributor to AMR is unnecessary or inappropriate use of antimicrobials.

1.2.1 Association between antimicrobial use and resistance

Evidence for the association between the use of antimicrobials and the rise in AMR is documented in laboratory, ecological and human studies, and can be seen at both population and individual levels.[14-16]

Association at the population level

In the community, increasing resistance to specific antimicrobials used to treat respiratory tract infections and other infections has been demonstrated.[17] Similar associations between antimicrobial use and AMR in the aged care sector have been seen, especially with extended-spectrum β-lactamase (ESBL)–producing gram-negative organisms and treatment with fluoroquinolones and third-generation cephalosporins.[18] Aged care homes often have high rates of antimicrobial use, and residents with comorbidities require frequent admissions to hospital, which may further contribute to the spread of AMR.

In hospitals, the incidence of resistant organisms has been correlated with the use of broad-spectrum antimicrobials. Examples include increasing fluoroquinolone resistance in *Pseudomonas aeruginosa* in association with increasing use of this antimicrobial class[19,20]; the prevalence of methicillin-resistant *S. aureus* (MRSA) associated with broad-spectrum antimicrobial use[21,22]; and the use of third-generation cephalosporins and the prevalence of ESBL-producing organisms.[23,24] Although use of fluoroquinolones in Australia is low, fluoroquinolone resistance in *E. coli* is slowly increasing, driven by high use of other antimicrobials.[25]

Association at the individual level

Antimicrobial therapy can cause longstanding changes to an individual's resident microorganisms (their microbiome), significantly reducing microbial diversity and promoting overgrowth of antimicrobial-resistant organisms.[17] Longer duration and multiple courses of antimicrobial therapy are associated with higher rates of resistance.[17] For example, in people with recurrent urinary tract infections, causative organisms that are initially susceptible to first-line antimicrobials gradually accumulate resistance to multiple antimicrobials.[26] Therapy with a second- or third-line antimicrobial (if available) is often more expensive, is less well tolerated and, if all oral options have been exhausted, may require intravenous administration, even for less severe infections.[27] In some circumstances, nonresistant populations do not recover, allowing antimicrobial-resistant organisms to amplify.[28]

Persistence of antimicrobial resistance

Once resistant organisms have been introduced into a particular setting, they may persist even if the selective pressure of inappropriate antimicrobial use is removed.[29] This can make it difficult to prove that a reduction in the use of antimicrobials will result in a concomitant decrease in AMR[30], and reflects the complexity of resistance emergence, transmission and persistence.[6]

Resistance may not always reduce the fitness of the microorganism, so the resistance can persist even without antimicrobial selection pressure. Additionally, even if antimicrobial use at one institution is effectively managed, frequent movement of patients between institutions, and lapses in infection prevention and control practices, can reintroduce resistant organisms. The prevalence of observed antimicrobial-resistant organisms in a particular setting will therefore not only reflect antimicrobial use in that setting, but will also be influenced by the types of organisms present, the rate of introduction of new resistant bacterial clones and how readily those clones spread.

This highlights the importance of a multifaceted approach to minimising AMR, including robust infection control management and AMS activities.

1.2.2 Consequences of antimicrobial resistance

Health service organisations and aged care homes are especially vulnerable to problems relating to AMR. These facilities bring together, in close proximity, people who are vulnerable to infections because of their medical comorbidities. The spread of antimicrobial-resistant organisms from person to person is a major contributing factor to AMR in these settings. Antimicrobial use selects for resistant organisms. This increases the prevalence of antimicrobial-resistant clones, which, when they cause infection, require empirical antimicrobial treatment to be broadened. In turn, the use of broad-spectrum antimicrobials selects for more resistant organisms, and promotes the colonisation of patients and their environment with multidrug-resistant organisms and opportunistic pathogens such as *Clostridium difficile*.[24] This creates a cycle of increasing AMR that requires broader-spectrum antimicrobial therapy, until, in some situations, no effective antimicrobial therapy remains.

When multidrug-resistant pathogens are prevalent, clinicians need to use broader-spectrum and (usually) more expensive agents for empirical therapy for seriously ill patients. Patients infected with antimicrobial-resistant organisms spend more time in hospital, and the total cost of their care is higher.[31] Roberts et al. estimated that medical costs attributable to antimicrobial-resistant infections in a United States public teaching hospital were US$18,500 to US$29,000 per patient, and were associated with an excess length of hospital stay of 6.4–12.7 days.[32] The authors also projected substantial medical and societal cost savings by reducing antimicrobial-resistant infection rates.

Because antimicrobials are used to support other areas of health care, AMR also affects those areas. One example is the use of implantable devices. There has been an almost 200% increase in the number of prosthetic hips and knees implanted in Australia over the past 20 years[33], and the number of pacemaker devices implanted increased by 250% between 2000 and 2013.[34] The success of these medical interventions would be significantly reduced if the availability of effective antimicrobials to support these procedures were to become limited.

1.3 Australian framework for antimicrobial stewardship

Responding to the challenge of AMR and preserving the effectiveness of antimicrobials requires a One Health approach, in which all sectors that use antimicrobials – human health, animal health and agriculture – work together to improve appropriate antimicrobial use and reduce AMR. One Health is a coordinated, collaborative, multidisciplinary and cross-sectoral approach to the development and implementation of health strategies for people, animals and the environment.[10] *Responding to the Threat of Antimicrobial Resistance: Australia's first National Antimicrobial Resistance Strategy 2015–2019* outlines the One Health approach to reducing AMR in Australia.[10] This includes implementing AMS practices across all human health and animal care settings. The focus of this chapter, and this publication, is AMS in human health.

A number of arrangements, activities and partnerships in Australia support AMS in human health at the national, state, territory and organisational level, including non-government organisations, professional bodies and research organisations. At the national level, the National Safety and Quality Health Service (NSQHS) Standards have provided the foundation for universal requirements for implementation of AMS in Australia. Effective AMS involves the coordination of a combination of strategies, including regulation, monitoring and surveillance, education and awareness raising, and research.

1.3.1 National standards and guidelines

AMS in Australia is supported by national standards and guidelines, including the:

- National Safety and Quality Health Service Standards
- Antimicrobial Stewardship Clinical Care Standard
- *Australian Guidelines for the Prevention and Control of Infection in Healthcare*.

National Safety and Quality Health Service Standards

The NSQHS Standards (first edition) were released in 2011, and assessment commenced in acute health service organisations from January 2013. The NSQHS Standards (second edition) and supporting resources were released in November 2017.[35] Assessment to the NSQHS Standards (2nd ed.) will commence from 1 January 2019. All public and private acute health service organisations are required to implement the NSQHS Standards and be assessed by an approved accrediting agency to verify their compliance with the NSQHS Standards.

The NSQHS Standards were developed by the Australian Commission on Safety and Quality in Health Care (the Commission) in collaboration with states and territories, clinical experts, patients and carers. The primary aims of the NSQHS Standards are to protect the public from harm and to improve the quality of health service provision. They provide a quality assurance mechanism that tests whether relevant systems are in place to ensure that expected standards of safety and quality are met. The NSQHS Standards describe evidence-based actions to improve health care.[35] They cover key areas relating to governance, partnering with consumers, preventing and controlling healthcare-associated infection, medication safety, comprehensive care, communicating for safety, blood management, and recognising and responding to acute deterioration.

The Preventing and Controlling Healthcare-Associated Infection Standard states:

> *Leaders of a health service organisation describe, implement and monitor systems to prevent, manage or control healthcare-associated infections and antimicrobial resistance, to reduce harm and achieve good health outcomes for patients. The workforce uses these systems.*[35]

The intention of this standard is:

> *To reduce the risk of patients acquiring preventable healthcare-associated infections, effectively manage infections if they occur, and limit the development of antimicrobial resistance through prudent use of antimicrobials as part of antimicrobial stewardship.*[35]

All private and public hospitals, day procedure services, public dental practices, and community health services attached to health service organisations are required to have an AMS program in place (Box 1.1).

The Preventing and Controlling Healthcare-Associated Infection Standard aligns with the criteria and actions of the Clinical Governance Standard, the Partnering with Consumers Standard and the Medication Safety Standard.

The Clinical Governance Standard defines clinical governance as the set of relationships and responsibilities established by a health service organisation between its governing body, executive,

Box 1.1: Preventing and Controlling Healthcare-Associated Infection Standard – criterion and actions for antimicrobial stewardship

Criterion: Antimicrobial stewardship

The health service organisation implements systems for the safe and appropriate prescribing and use of antimicrobials as part of an antimicrobial stewardship program.

Action required

3.15 The health service organisation has an antimicrobial stewardship program that:

a. Includes an antimicrobial stewardship policy

b. Provides access to, and promotes the use of, current evidence-based Australian therapeutic guidelines and resources on antimicrobial prescribing

c. Has an antimicrobial formulary that includes restriction rules and approval processes

d. Incorporates core elements, recommendations and principles from the current Antimicrobial Stewardship Clinical Care Standard

3.16 The antimicrobial stewardship program will:

a. Review antimicrobial prescribing and use

b. Use surveillance data on antimicrobial resistance and use to support appropriate prescribing

c. Evaluate performance of the program, identify areas for improvement, and take action to improve the appropriateness of antimicrobial prescribing and use

d. Report to clinicians and the governing body regarding

- compliance with the antimicrobial stewardship policy
- antimicrobial use and resistance
- appropriateness of prescribing and compliance with current evidence-based Australian therapeutic guidelines or resources on antimicrobial prescribing

clinicians, patients and consumers to deliver safe and high-quality health care. It ensures that the community and health service organisations can be confident that systems are in place to deliver safe and high-quality health care and continuously improve services.

Clinical governance is an integrated component of corporate governance for health service organisations. In relation to AMS, it ensures that everyone – from frontline clinicians to managers and members of governing bodies, such as boards – is accountable to patients and the community for assuring effective AMS.

The NSQHS Standards guide this publication and support implementation of effective AMS through the provision of information and resources for clinicians and health service managers.

AMS is also included as a component of hospital accreditation in other countries. In Canada, AMS was introduced as a Required Organizational Practice for accreditation in 2013. In the United States, health service organisations and aged care homes seeking accreditation through the Joint Commission are required to collect, analyse and report on AMS data.[36] This is done using the measures in *Core Elements of Hospital Antibiotic Stewardship Programs* and *Core Elements of Antibiotic Stewardship for Nursing Homes* produced by the Centers for Disease Control and Prevention.[37,38]

Antimicrobial Stewardship Clinical Care Standard

The clinical care standards developed by the Commission are nationally agreed statements about the care that a patient should be offered by clinicians and organisations for a specific clinical condition, in line with current best evidence. The standards support clinicians' decision-making about appropriate care, and require health services to review the performance of their organisation and make improvements in the care they provide. Clinical care standards aim to improve the appropriateness of health care provided to patients by reducing unwarranted variation in care – that is, variation in care that is not explained by the clinical circumstances or personal choices of the patient. The clinical care standards also help consumers to know what they should expect from their healthcare system and to make informed treatment decisions in partnership with their clinicians.

The Antimicrobial Stewardship Clinical Care Standard contains nine quality statements that describe the key aspects of care that a patient should be offered when antimicrobials are being considered for treatment of a bacterial infection or for prophylaxis.[39] The quality statements relate to high-priority areas for improvement regarding antimicrobial prescribing, based on available evidence (Figure 1.1). The Antimicrobial Stewardship Clinical Care Standard complements the NSQHS Standards and other national efforts that support AMS. It has been developed for use in all healthcare settings, including hospitals, general practice and aged care homes.

Australian Guidelines for the Prevention and Control of Infection in Healthcare

The *Australian Guidelines for the Prevention and Control of Infection in Healthcare*, published in 2010, established the national approach to infection prevention and control. The guidelines provide a basis for healthcare facilities and members of the workforce to develop detailed protocols and processes for infection prevention and control specific to local settings. They incorporate AMS, and outline key requirements of an AMS program and the role of AMS in preventing and managing

Figure 1.1: Antimicrobial Stewardship Clinical Care Standard quality statements

1 A patient with a life-threatening condition due to a suspected bacterial infection receives prompt antibiotic treatment without waiting for the results of investigations.

2 A patient with a suspected bacterial infection has samples taken for microbiology testing as clinically indicated, preferably before starting antibiotic treatment.

3 A patient with a suspected infection, and/or their carer, receives information on their health condition and treatment options in a format and language that they can understand.

4 When a patient is prescribed antibiotics, whether empirical or directed, this is done in accordance with the current version of the Therapeutic Guidelines[42] (or local antibiotic formulary). This is also guided by the patient's clinical condition and/or the results of microbiology testing.

5 When a patient is prescribed antibiotics, information about when, how and for how long to take them, as well as potential side effects and a review plan, is discussed with the patient and/or their carer.

6 When a patient is prescribed antibiotics, the reason, drug name, dose, route of administration, intended duration and review plan is documented in the patient's health record.

7 A patient who is treated with broad-spectrum antibiotics has the treatment reviewed and, if indicated, switched to treatment with a narrow-spectrum antibiotic. This is guided by the patient's clinical condition and the results of microbiology tests.

8 If investigations are conducted for a suspected bacterial infection, the responsible clinician reviews these results in a timely manner (within 24 hours of results being available) and antibiotic therapy is adjusted taking into account the patient's clinical condition and investigation results.

9 If a patient having surgery requires prophylactic antibiotics, the prescription is made in accordance with the current Therapeutic Guidelines[42] (or local antibiotic formulary), and takes into consideration the patient's clinical condition.

Source: Australian Commission on Safety and Quality in Health Care[39] healthcare-associated infections.[40] The Commission has worked with the National Health and Medical Research Council (NHMRC) to review these guidelines, and publication is expected in 2018.

Infection prevention and control standards written specifically for general practices and clinicians in other office-based and community-based settings have been published by the Royal Australian College of General Practitioners (RACGP). The Dental Board of Australia has issued infection control guidelines for dental practitioners.

1.3.2 National Antimicrobial Resistance Strategy

In 2015, Australia's first National Antimicrobial Resistance Strategy was jointly produced by the Australian Government Department of Health and Department of Agriculture.[10] The vision of the National Antimicrobial Resistance Strategy is:

> *a society in which antimicrobials are recognised and managed as a valuable shared resource, maintaining their efficacy so that infections in humans and animals remain treatable and communities continue to benefit from the advances that antimicrobials enable.*[10]

The goal of the National Antimicrobial Resistance Strategy is to minimise the development and spread of AMR in Australia and ensure the continued availability of effective antimicrobials. It aligns with the World Health Organization's Global Action Plan on Antimicrobial Resistance.[41] To achieve this goal, the Australian Government, state and territory governments, non-government organisations, professional bodies and research organisations need to work together on priority areas to achieve the strategy's seven objectives:

1. Increase awareness and understanding of antimicrobial resistance through **communication**, **education** and **training**
2. Implement effective **antimicrobial stewardship** across human and animal care settings
3. Develop nationally coordinated **surveillance** of antimicrobial usage and resistance
4. Improve **infection prevention and control** measures across human and animal care settings
5. Agree a **national research agenda** and promote investment in innovative approaches to containing antimicrobial resistance
6. Strengthen **international partnerships**
7. Establish clear **governance** arrangements.

The Australian Government Department of Health and Department of Agriculture and Water Resources are responsible for the National Antimicrobial Resistance Strategy.[10] The Australian Antimicrobial Resistance Prevention and Containment Steering Group, led by the secretaries of both departments, reports publicly on AMR for the Australian Government.

An implementation plan outlining key areas of focus and specific actions to support the strategy was released in 2016. This outlines the areas of activity that the Australian Government identifies as important to achieving the seven objectives identified in the strategy.[43]

1.3.3 Antimicrobial stewardship in the states and territories

State and territory governments are responsible for planning and implementing AMS and infection prevention and control guidelines in public health service organisations. States and territories have undertaken significant work to support AMS policy and practice, and many have expert advisory processes to provide technical and strategic advice. Several states and territories have also developed jurisdictional antimicrobial formularies, and some conduct training and have produced resources to assist health service organisations to implement AMS programs.

AMS resources available in some states and territories include:

- AMS policies
- AMS committee terms of reference
- Education and training modules
- Information about formulary management and guidelines
- Statewide surveillance data
- Resources for patients
- AMS self-evaluation toolkits.

Examples of state and territory AMS activities and resources are listed in Appendix A.

1.3.4 Therapeutic Guidelines

Evidence-based prescribing guidelines for antimicrobials are a fundamental component of AMS programs because they guide appropriate antimicrobial use. They can also be used to educate prescribers and students on accepted practice for antimicrobial prescribing in the organisation. The NSQHS Standards require that health service organisations provide access to, and promote the use of, current evidence-based Australian therapeutic guidelines.

In Australia, prescribers have access to *Therapeutic Guidelines: Antibiotic*, which provides guidance on optimising the selection, dose, route of administration, duration and timing of initial antimicrobial treatment.[40] These guidelines represent the best available evidence and opinion about treatment and prophylaxis for infections in community and hospital settings in Australia. They are listed in the RACGP *Standards for General Practices* as a resource that supports evidence-based practice, and are available in hard copy and electronically.

Therapeutic Guidelines: Antibiotic are supplemented by *Therapeutic Guidelines: Oral and dental* for dental practitioners, *Therapeutic Guidelines: Dermatology*, *Therapeutic Guidelines: Gastrointestinal* and *Therapeutic Guidelines: Respiratory*, all of which are now incorporated into the *eTG complete* electronic bundle.

1.3.5 Surveillance of antimicrobial use and resistance in Australia

Effective surveillance provides the basis for informed efforts to improve antimicrobial use, and prevent and control AMR, in combination with prescribing guidelines. At the local level, data can be used to provide feedback to clinicians, inform policy and program development, guide formulary listings, and develop other activities to promote appropriate antimicrobial use. At the national level, data can also be used to inform policy and program development – for example, the revision of the list of subsidised medicines, and identification of priorities for public health action to reduce the spread and impact of AMR, such as education campaigns or regulatory measures.[44]

In 2016, the Commission completed the establishment phase of the Antimicrobial Use and Resistance in Australia (AURA) Surveillance System, with funding from the Australian Government. The system enables collection, analysis and reporting of antimicrobial use and AMR surveillance data. The AURA National Coordination Unit at the Commission oversees the strategy for surveillance activities, and implements activities to enhance national surveillance of antimicrobial use and resistance in the acute care and community sectors.

AURA uses a partnership model that has both strengthened support for existing surveillance programs and developed new systems to fill identified gaps (Box 1.2). AURA continues to be enhanced, and broaden its scope of surveillance activities and reporting to inform appropriate prescribing.

AURA program partners include:

- Australian Group on Antimicrobial Resistance
- National Antimicrobial Prescribing Survey (NAPS)
- National Antimicrobial Utilisation Surveillance Program (NAUSP)
- Queensland Health, which enables the use of the OrgTRx System as the IT platform base for the Australian Passive AMR Surveillance System.

Box 1.2: Antimicrobial Use and Resistance in Australia (AURA) Surveillance System

The AURA Surveillance System and the AURA National Coordination Unit:

- Provide the framework for effective planning and coordination of surveillance and reporting of antimicrobial use and antimicrobial resistance (AMR)
- Improve quality, coverage and utility of existing high-quality data collections on antimicrobial use and AMR through improved integration and coordination
- Provide detailed analyses across data collections, including opportunities for analysing relationships between antimicrobial use and AMR, at a system level
- Provide systematic, coordinated and centralised national reporting on antimicrobial use and AMR
- Establish new data collections, if needed, such as for the systematic and timely identification of critical antimicrobial resistances
- Provide a means for rapidly consulting and communicating with stakeholders to further improve the system and its reporting, and to better inform AMR prevention and control strategies.

Source: Australian Commission on Safety and Quality in Health Care[25]

The Commission has also established a national surveillance system for critical antimicrobial resistances, called CARAlert. This has enabled a more timely and effective mechanism to monitor and report on these resistances, which are of vital importance in the development of strategies to prevent and contain AMR and respond appropriately to outbreaks.

To further supplement surveillance and strengthen the value of reporting, the AURA National Coordination Unit works with other important surveillance data programs and organisations to ensure comprehensive reporting on antimicrobial use and AMR, including the:

- Pharmaceutical Benefits Scheme and the Repatriation Pharmaceutical Benefits Scheme
- NPS MedicineWise MedicineInsight program
- National Neisseria Network, on *N. gonorrhoeae* and *N. meningitidis*
- National Notifiable Diseases Surveillance System, on *M. tuberculosis*
- Sullivan Nicolaides Pathology, on AMR rates from the community and private hospital settings.

AURA 2017: Second Australian report on antimicrobial use and resistance in human health provided a comprehensive picture of antimicrobial use, AMR and the appropriateness of antimicrobial prescribing in Australia.[25] Several reports from AURA are now available, including those developed in conjunction with partner programs such as NAPS and NAUSP, and locally developed surveillance reports such as CARAlert. These reports provide extensive data for those responsible for AMS programs to review and consider, alongside local data, to help target AMS efforts. See Chapter 6: 'Measuring performance and evaluating antimicrobial stewardship programs'.

1.3.6 Education and awareness raising

Australians are increasingly recognising that AMR is a problem, but their understanding of how individual behaviours can contribute to the development and spread of AMR is limited. Increasing clinician and consumer awareness and understanding of AMR and the importance of using antimicrobials appropriately is seen as a critical component of AMS. It constitutes the first objective of the National Antimicrobial Resistance Strategy.[10] Priority areas identified for action include:

- Strengthening consumer awareness initiatives
- Supporting clinicians to reinforce messages relating to appropriate antimicrobial use and reducing the spread of infections with patients and consumers
- Strengthening communication and education initiatives for clinicians on AMR, AMS, and infection prevention and control
- Increasing access to reliable sources of information about antimicrobials and AMR.

The implementation plan for the National Antimicrobial Resistance Strategy outlines the activities being undertaken by organisations and health sectors to consider these action items.[43]

Consumer engagement

Consumers, patients and carers can be engaged in AMS through formal and informal education, improved health literacy and shared decision making. Several government and non-government organisations in Australia are involved in developing resources and delivering programs to increase consumer awareness about AMR and change consumer attitudes towards antimicrobial use. Some resources are directed at consumers, and others are directed at clinicians to equip them with the tools and skills to communicate effectively with consumers. These resources are discussed further in Chapter 7: 'Involving consumers in antimicrobial stewardship' and Chapter 10: 'Role of prescribers in antimicrobial stewardship'.

Clinicians

Strengthening communication and education for clinicians on AMR, AMS, and infection prevention and control is another priority area for action. This should start during the clinician's formal training and be regularly reinforced by workplace education and training. A multidisciplinary approach is recommended.[10] A number of online educational resources developed in Australia are available to educators and clinicians. Further information, including information on AMS competency standards, is available in Chapter 5: 'Antimicrobial stewardship education for clinicians' and Chapter 10: 'Role of prescribers in antimicrobial stewardship'.

Antibiotic Awareness Week

Australia has been participating in Antibiotic Awareness Week every November since 2012. The week is jointly organised by the Commission and NPS MedicineWise, and supported by several Australian Government departments and professional societies. The Australian campaign is aligned with international efforts to promote greater understanding of AMR and the responsible use of antibiotics. It takes a One Health approach, and targets consumers and clinicians in human health, as well as prescribers and users in animal health and agriculture.

All health service organisations and clinicians are encouraged to participate in Antibiotic Awareness Week each year. Resources to support Antibiotic Awareness Week are available from the Commission, NPS MedicineWise and professional societies.

1.3.7 Antimicrobial stewardship research

Objective 5 of the National Antimicrobial Resistance Strategy is to agree to a national research agenda, and promote investment in the discovery and development of new products and approaches to prevent, detect and contain AMR.[10] Priority areas for action are to:

- Identify current gaps, and agree to national research and development priorities
- Coordinate national research activities and information sharing
- Explore opportunities to increase support for research and development, including incentives for greater private sector investment
- Explore opportunities to support the translation of promising research findings into new products, policies and approaches.

The NHMRC currently provides funding for four Centres of Research Excellence to research aspects of AMR (Table 1.1). Their focus is on accelerating knowledge translation into changes in policy and practice.

The Australian Medical Research Future Fund has listed AMR as a priority for medical research and innovation for 2016–2018. The research must be consistent with the National Antimicrobial Resistance Strategy. The fund focuses on research that brings point-of-care solutions to market.

1.3.8 Professional societies and organisations

Professional organisations can play an important role in setting professional standards, providing guidelines and educating their members. Several professional organisations in Australia are active in promoting AMS, developing resources, and assisting their members develop the knowledge and skills required to actively participate in AMS activities. Key professional organisations and societies that have provided leadership in AMS in human health are the:

- Australasian Society for Infectious Diseases
- Australian Society of Antimicrobials

Table 1.1: Centres of Research Excellence in antimicrobial resistance

University	Centre of Research Excellence name	Research themes
Bond University	Minimising Antibiotic Resistance for Acute Respiratory Infections (CREMARA)	• Delayed prescribing • Shared decision making and patient decision aids • Diagnostic tests and biomarkers
Queensland University of Technology	Reducing Healthcare Associated Infections (CRE-RHAI)	• Effective infection prevention and control interventions and policy • Modelling transmission dynamics • Cost-effectiveness studies
University of Melbourne	National Centre for Antimicrobial Stewardship (NCAS)	• One Health antimicrobial stewardship • Antimicrobial prescribing studies
University of Queensland	Redefining Antimicrobial Use to Reduce Resistance (CRE REDUCE)	• Development of guidelines • Clinical pharmacokinetics studies • Modelling of novel antimicrobial doses

- Australasian College for Infection Prevention and Control
- Society of Hospital Pharmacists of Australia.

1.4 Antimicrobial use

Antimicrobials that are used inappropriately or unnecessarily not only contribute to AMR but can also lead to patient harm.

1.4.1 Factors contributing to unnecessary and inappropriate antimicrobial use

Antimicrobials continue to be used unnecessarily and inappropriately, despite the availability of well-established evidence-based treatment guidelines.[45] The reasons for this vary. Prescribers may be unaware that guidelines are available or are too busy to consult them. They may be confident that they know the best antimicrobial choice, or unconvinced of the risks of inappropriate use, including the risk of AMR.[45] Many clinicians are unwilling to withhold antimicrobial therapy if the diagnosis is uncertain or to risk treatment failure by using a narrow-spectrum agent. Some prescribers and consumers believe that antimicrobials have few adverse effects, potentially leading to prescribing 'just in case' or for longer than necessary because no negative consequences are perceived. However, it is clear that antimicrobials can cause lasting and detrimental disruptions to the normal flora of individual patients, reducing microbial diversity and promoting overgrowth of antimicrobial-resistant organisms.[46,47]

The knowledge of both consumers and prescribers is a major factor influencing antimicrobial prescribing. In the community, consumer knowledge about antimicrobials and AMR is limited, and preconceptions about the efficacy of antimicrobials and the conditions for which they are of benefit are frequently inaccurate.[48] Prescribers may overestimate consumer expectations for antimicrobials[49], or think that consumers will go to another practitioner if they are not prescribed an antimicrobial[49-51] (see Chapter 7: 'Involving consumers in antimicrobial stewardship').

1.4.2 Antimicrobial use in Australia

Antimicrobial use is high in Australia compared with many other high-income countries, in both hospitals and the community.

Community use

In the community, Australia has the eighth highest rate of antimicrobial prescribing among member countries of the Organisation for Economic Co-operation and Development, and a prescribing rate more than double that of some other countries.[25]

In Australia in 2015, more than 30 million prescriptions were dispensed in the community. Each year, almost half (around 45%) of the Australian population is prescribed at least one course of an antimicrobial. It is estimated that a considerable proportion of those prescriptions are unnecessary[25], especially for respiratory tract infections. In 2015, 60% of people presenting to a general practitioner with colds and other undifferentiated upper respiratory tract infections – conditions for which antimicrobials are generally not recommended – were prescribed an antimicrobial.[25]

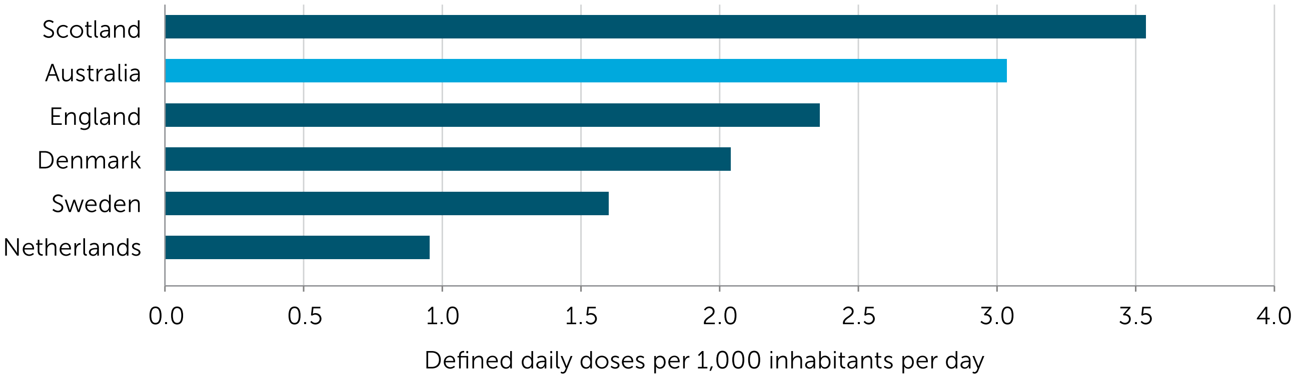
Hospital use

In Australian hospitals, on any given day in 2015, nearly 40% of inpatients were prescribed antimicrobials. Of those prescriptions, almost one-quarter were considered inappropriate, and almost one-quarter were noncompliant with guidelines. The volume of antimicrobial use in Australia is higher than in most comparator countries[25] (Figure 1.2).

1.4.3 Harmful effects of antimicrobial use

In addition to contributing to the development of AMR, antimicrobial use is associated with other risks that may lead to patient harm. Inappropriate antimicrobial use can lead to poor outcomes for individual patients, whether these agents are underused (such as in delayed, omitted or ineffective treatment) or overused (such as starting treatment unnecessarily or continuing treatment for longer than required). Inadequate antimicrobial therapy – such as poor antimicrobial choice, and suboptimal dose, route or duration – is unlikely to be effective against the causative pathogen, and is associated with increased patient morbidity and mortality.[4,5] It is an independent risk factor for death among critically ill patients with severe infection.[5] Other

Figure 1.2: Comparison of hospital antimicrobial use in Australia and similar countries, 2015



Source: Australian Commission on Safety and Quality in Health Care[25]

risks associated with antimicrobial use include increased risk of infection, allergies and other adverse drug reactions, drug interactions, and drug toxicity. These risks can be decreased by reducing unnecessary and inappropriate use.

Increased risk of infection

Broad-spectrum antimicrobials can disrupt an individual's microbiome, leaving the individual susceptible to infection by opportunistic bacterial pathogens such as *C. difficile* and fungal infections such as *Candida*. Patients taking antibiotics are 7–10 times more likely than patients not taking antibiotics to be infected with *C. difficile* while the patient is taking the antibiotic and for one month after discontinuation.[52]

Allergies and other adverse drug reactions, drug interactions, and drug toxicity

All antimicrobials can cause adverse effects. Although many of these are minor or self-limiting, some can be serious, such as anaphylaxis or liver failure. In the United States, antimicrobials have been implicated in around 20% of emergency department visits for drug-related adverse events reported to the National Electronic Injury Surveillance System.[53] Allergic reactions were the most common events in this system. Around 10–15% of hospitalised patients are labelled penicillin allergic. If penicillin is administered to a patient with a true severe allergy, they may experience a fatal anaphylactic reaction. Many patients are labelled as being penicillin allergic based on a vague history and may not have a true allergy. However, because they are labelled 'allergic', they are often prescribed suboptimal reserve agents with less favourable safety profiles, which increases their risk of treatment failure or adverse events.[54-56]

Patients with altered pharmacokinetic profiles (such as older patients, and patients with kidney or liver impairment) are more likely to have an adverse event and are at risk of drug toxicity if the dose or dose frequency is not adjusted.[40] Patients receiving antimicrobials that require therapeutic drug monitoring (such as aminoglycosides and vancomycin) are at risk of poorer clinical outcomes, adverse events and extended length of stay if appropriate systems for monitoring are not in place.[57]

Some antimicrobials interact with other medicines, which can cause adverse events. For example, giving macrolides (erythromycin and clarithromycin) with medicines that prolong the QT interval can increase the risk of cardiac arrhythmias.

1.5 Antimicrobial stewardship

AMS is described as a systematic and coordinated approach to optimising antimicrobial use with the goals of improving patient outcomes, ensuring cost-effective therapy and reducing adverse consequences of antimicrobial use, including AMR.[6-9] It is an integral component of patient safety.

1.5.1 Effective antimicrobial stewardship

Effective AMS requires a suite of coordinated strategies to promote the use of antimicrobials in a way that maximises their benefit, while causing the least harm. The aim is to reduce unnecessary use and improve the appropriate use of antimicrobials by prescribing according to evidence-based guidelines, with medicine choice, dose and duration selected to optimise clinical outcomes and minimise adverse consequences such as drug toxicities, *C. difficile* infection or the selection of resistance.[58] In short, AMS promotes the use of the right antimicrobial, at the right dose, for the right duration, at the right time and by the right route.

AMS requires a systems-based approach that operates with support of the health service organisation executive, within the governance framework of the organisation, using the expertise and resources of a multidisciplinary team to coordinate activities (see 'Structure and governance' in Box 1.3). AMS programs need sustained effort to remain effective; otherwise, antimicrobial consumption patterns can rapidly revert to pre-AMS levels.[59]

AMS programs aim to change antimicrobial prescribing behaviour through different strategies. These include restrictive approaches (such as requiring approval to prescribe a specific antimicrobial) and enabling approaches (such as post-prescription review and feedback).

Strategies considered essential to establishing an effective AMS program are summarised in Box 1.3. Evidence for each of the strategies, and resources and

Box 1.3: Essential elements and strategies for antimicrobial stewardship programs

Structure and governance

Overall accountability for antimicrobial stewardship (AMS) is defined by an organisation's corporate and clinical governance. Managers and senior clinicians are responsible for the AMS program, including:

- Ensuring that AMS resides within the organisation's quality improvement and patient safety governance structure
- Establishing a multidisciplinary AMS team that includes, at least, a lead doctor and pharmacist
- Providing the necessary human, financial and information technology* resources for AMS activities
- Ensuring ongoing education and training for prescribers, pharmacists, nurses, midwives and consumers about AMS, antimicrobial resistance and optimal antimicrobial use.

Essential strategies

The essential strategies that sit within the AMS governance structure are:

- Implementing clinical guidelines† consistent with *Therapeutic Guidelines: Antibiotic* that take into account local microbiology and antimicrobial susceptibility patterns
- Implementing formulary§ restriction and approval systems that include restricting broad-spectrum and later-generation antimicrobials to patients in whom their use is clinically justified
- Reviewing antimicrobial prescribing, with intervention and direct feedback to the prescriber
- Implementing point-of-care interventions (including directed therapy, intravenous-to-oral switching and dose optimisation)
- Ensuring that the clinical microbiology service
  - provides guidance and support for optimal specimen collection
  - targets reporting of clinically meaningful pathogens and their susceptibilities
  - uses selective reporting of susceptibility testing results
  - generates location-specific antimicrobial susceptibility reports (antibiograms) annually
- Monitoring antimicrobial use and outcomes, and reporting to clinicians and management.

* Information technology examples include electronic prescribing with clinical decision support, online approval systems for restricted agents, post-prescription alert systems and antimicrobial use surveillance systems.
† Guidelines include clinical pathways and care bundles.
§ Refers to institutional formularies; in the community, the Pharmaceutical Benefits Scheme and the Repatriation Pharmaceutical Benefits Scheme act as the formulary.

tools to support their implementation in different health settings are described in subsequent chapters.

Most evidence about the effectiveness of AMS initiatives has been generated from public hospitals, including those in Australia, and AMS is maturing in the hospital sector. AMS programs in other settings, such as the community and aged care homes, are in their infancy; however, evidence to support implementation in those settings is growing. Although the principles of AMS are common to all settings, it is recognised that different approaches will be required and interventions will need to be adapted for use in those settings.[60]

1.5.2 Evidence to support the benefits of antimicrobial stewardship

It is sometimes difficult to draw a direct relationship between system interventions and their effects. In the hospital sector, many of the studies of the efficacy of AMS have reported on structural and process measures (such as the presence of guidelines and reduction in antimicrobial use). However, the studies have been limited in their ability to evaluate outcomes, particularly patient outcomes, whether the development of AMR is prevented or minimised, and unintended consequences of AMS.[61] Evidence of positive outcomes associated with AMS is increasing, including reductions in unnecessary antimicrobial use and institutional resistance rates, improved clinical outcomes, improved patient safety, and cost savings.[61-64]

Reduction in unnecessary antimicrobial use

At the community level, there is evidence that media campaigns and specific education programs, in combination with a dedicated workforce to conduct coordinated AMS activities, can lead to broadscale changes in prescribing behaviour and a decrease in antimicrobial use. This has been demonstrated in public campaigns in France and Belgium to improve the use of antimicrobials in outpatients[65,66], which resulted in a 26.5% decrease in antimicrobial prescriptions in France over five years and a 36% decrease in packets of antimicrobials supplied in Belgium over seven years.

In the hospital setting, a 2017 Cochrane review on interventions to improve antibiotic prescribing practices for inpatients showed that AMS interventions can safely reduce unnecessary antimicrobial use in hospitals by improving adherence to guidelines and decreasing the treatment duration.[64]

Reduction in antimicrobial resistance

There is growing evidence that a reduction in antimicrobial use can result in a decrease in AMR in specific settings.

AMS interventions in the community have been associated with a decrease in AMR (Table 1.2).

In the hospital setting, there are many examples of changes in antimicrobial prescribing practices having a significant effect on outbreaks of resistant pathogens. Those changes have often been implemented in times of crisis, such as in response to the emergence of resistance in a unit or across a hospital. However, evidence is growing for the effectiveness of AMS programs in institutions, which show reduced prevalence of resistant organisms over time.[63,72] In a meta-analysis, Beryl et al. found that, overall, AMS activities in hospitalised patients[72]:

- Reduced AMR rates by 34% (incidence rate ratio [IRR] 0.66; 95% confidence interval [CI] 0.47, 0.93; $P = 0.02$)
- Reduced *C. difficile* colonisation by 62% (IRR 0.38; 95% CI 0.23, 0.65; $P < 0.001$)
- Were more effective in reducing AMR among gram-positive bacteria (43% reduction) than gram-negative bacteria (28% reduction); AMS activities were most effective in reducing
  - MRSA (49% reduction; IRR 0.51; 95% CI 0.33, 0.80)
  - carbapenem-resistant gram-negative bacteria (48% reduction; IRR 0.52; 95% CI 0.32, 0.84)
- Did not appear to be effective in reducing vancomycin-resistant enterococci rates.

Another meta-analysis of the clinical outcomes associated with implementating AMS programs showed a reduction in infections due to MRSA, imipenem-resistant *P. aeruginosa* and ESBL-producing *Klebsiella* species.[63] A survey of 448 hospitals in the United States showed that implementing guideline-recommended practices and optimising the duration of empirical therapy were associated with a lower prevalence of resistant organisms.[73] However, the 2017 Cochrane review of interventions to improve antimicrobial prescribing in hospitalised patients reported an inconsistent effect on resistant gram-negative and gram-positive bacteria, citing too few studies and too much variance in microbial outcomes to reliably assess any relationship between microbial outcomes and change in antimicrobial use.[64]

Table 1.2: Community interventions for antimicrobial stewardship

Country	Intervention	Result
Belgium[66,67]	National campaign to reduce unnecessary prescriptions in the community	Reduced penicillin resistance in *Streptococcus pneumoniae* from 17.7% to 10.0% between 2000 and 2007
Iceland[68]	Public media campaign aimed at reducing consumption of antimicrobials	Reduced frequency of penicillin-nonsusceptible *S. pneumoniae* from 20% to 12% between 1993 and 1997
Finland[69]	Community education campaign to reduce macrolide prescribing	Reduced macrolide resistance in *Streptococcus pyogenes* (Group A streptococci) over five years, to 48% of 1991 levels
Scotland[70]	Restriction of the '4C' antimicrobials (cephalosporins, clavulanate, clindamycin and ciprofloxacin) in National Health Service trusts	Around 50% decline in the incidence of *Clostridium difficile*
Australia[11,25,71]	Pharmaceutical Benefits Scheme and Repatriation Pharmaceutical Benefits Scheme subsidies for fluoroquinolones restricted to a limited number of indications and durations	Low rate of fluoroquinolone resistance among gram-negative bacteria compared with other countries with otherwise similar overall antimicrobial use

Some of the most successful AMS programs reported are those aimed at reducing *C. difficile* infection rates. Restricting use of antibiotics deemed high risk for *C. difficile* infection has been associated with significant reductions in targeted antibiotics and *C. difficile* infection rates.[64,74] The 2017 Cochrane review of interventions to improve antimicrobial prescribing in hospitalised patients reported an association of planned AMS interventions with a consistent reduction in *C. difficile* infection (median −48.6%; interquartile range −80.7% to −19.2%).[64] Other studies have demonstrated that reducing the overall use of antimicrobials, combined with improved infection control precautions, reduces the incidence of nosocomial *C. difficile* infection.[75-78] Figure 1.3 is an example of the outcome of a program of improved infection control and targeted antimicrobial consumption on the incidence of *C. difficile* infection in a Canadian hospital.[77]

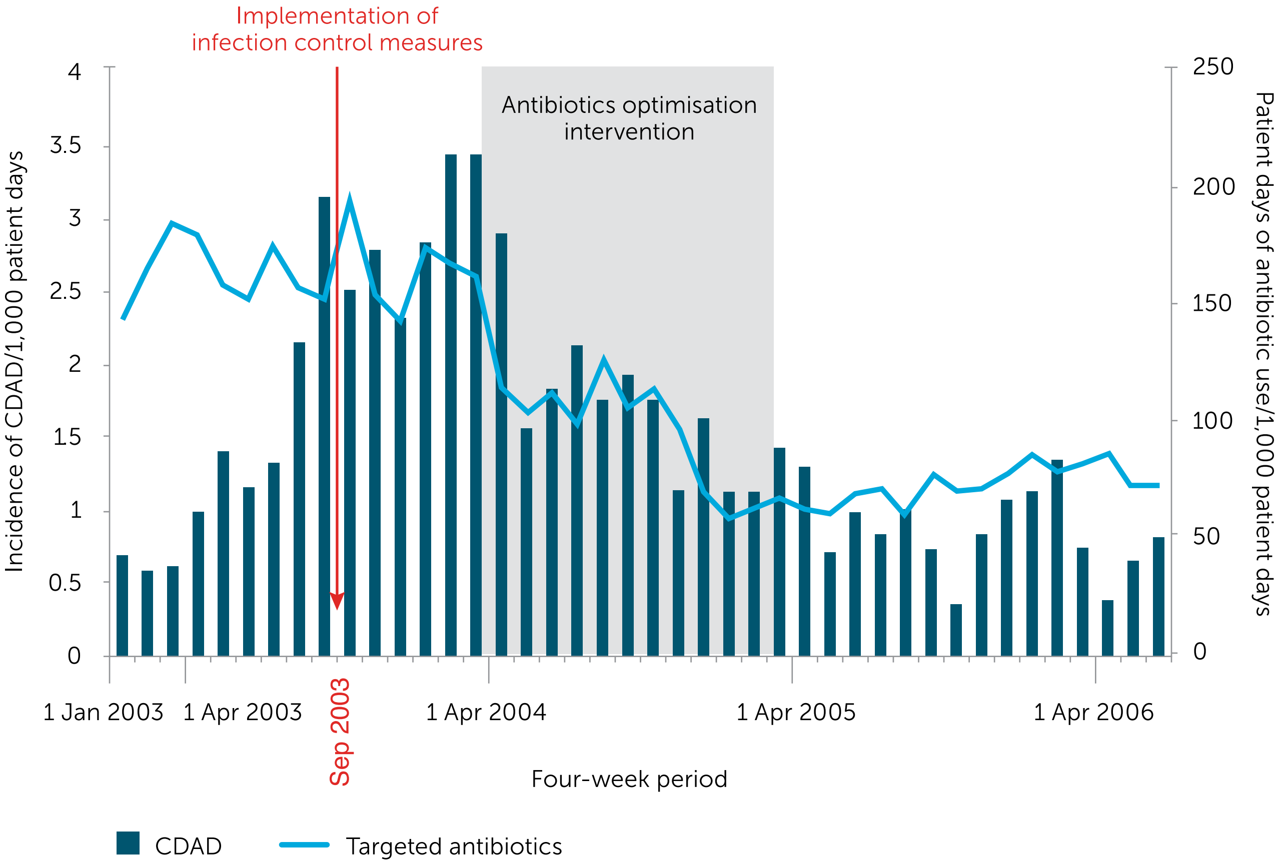
Improved clinical outcomes

Inadequate antimicrobial therapy is associated with increased patient morbidity and mortality due to infection[4,5], and is an independent risk factor for death among critically ill patients with severe infection.[5] Programs that improve antimicrobial prescribing have been shown to increase cure rates, decrease treatment failures[79] and decrease mortality from infection.[61,80] The 2017 Cochrane review concluded that interventions to improve antimicrobial prescribing for hospital inpatients are effective at increasing compliance with antibiotic policies and reducing the duration of antibiotic treatment safely, without increasing mortality.[64] In addition, interventions were associated with reduced length of stay.

A meta-analysis by Schuts et al. examined whether AMS programs in hospitals and long-term care facilities had effects in four predefined patient outcomes: clinical outcomes, adverse events, costs and bacterial resistance.[61] The overall evidence for benefits was assessed against one or more of the four patient outcomes for six AMS objectives:

- Empirical therapy according to guidelines
- De-escalation of therapy
- Intravenous-to-oral treatment switching
- Therapeutic drug monitoring
- Use of a list of restricted antimicrobials
- Bedside consultation.

Figure 1.3: Targeted antibiotic consumption and nosocomial *Clostridium difficile*–associated disease (CDAD) incidence per 1,000 patient days of hospitalisation



Source: Valiquette et al.[77]

The benefits included:

- 35% relative risk (RR) reduction for mortality (RR 0.65; 95% CI 0.54, 0.80; $P < 0.0001$) associated with guideline-adherent therapy
- 56% decrease in mortality (RR 0.44; 95% CI 0.3, 0.66; $P < 0.0001$) associated with de-escalation of therapy
- Improved patient outcomes with infectious diseases physician bedside management of *S. aureus* bacteraemia.

Although many studies in this meta-analysis showed benefit, many were of low quality, and further research is needed in this area. Additionally, no studies regarding predefined outcomes in long-term care facilities were able to be identified; this is also an area for future research.

Improved patient safety

AMS is synonymous with antimicrobial safety and is an integral component of patient safety.[81] In addition to reducing the risk of individual patient harm from AMR and *C. difficile* infection, AMS intervention outcomes include the reduction of medication-related adverse events:

- Over four years (2009–2012), Cao et al. analysed AMS interventions in a hospital in Texas[82]
  - interventions primarily related to inappropriate dosing (39.0% of the AMS interventions), antimicrobial selection (20.5%) and drug allergy (13.0%)
  - serious adverse drug events were potentially avoided in 20.7% of all interventions
- Individualised pharmacokinetic monitoring and adjustment of aminoglycoside dosing have been shown to reduce nephrotoxicity, hospital length of stay and mortality.[57]

Cost savings and cost benefit

Implementation of any new program usually requires some financial investment, through either further resources or reallocation of resources. Published studies indicate that AMS programs produce overall cost savings for organisations and can be financially self-supporting over time.[7,62,83] However, calculation of the health–economic impact of AMS programs is complex because of uncertainties in long-term cost–benefit ratios, attributable costs and effects of avoided infection.

Examples of interventions that have direct cost savings include:

- Ceasing antimicrobial therapy when it is no longer indicated or when the infection has resolved
- Intravenous-to-oral therapy switching
- De-escalating from broad-spectrum or combination therapy to directed therapy
- Implementing evidence-based guidelines that direct the duration of therapy in surgical prophylaxis.

Reports of AMS cost savings in hospitals include a recent review summarising 26 published studies, which indicated that hospital AMS programs reduced antimicrobial costs by an average of 33.9% (95% CI –42%, –25.9%) and length of stay by 8.9% (95% CI –12.8%, –5%).[63] In a 2007 study from the United States, annual savings of between US$200,000 and US$900,000 were reported in large teaching hospitals and small community hospitals with multidisciplinary antimicrobial management programs.[62] Although reports describing the clinical and economic impacts of multidisciplinary antimicrobial management programs were limited to single-centre longitudinal studies, they consistently demonstrated a decrease in antimicrobial use (of between 22% and 36%).[62]

Hospital AMS programs with a narrower focus have also demonstrated cost savings and cost-effectiveness in different settings, and with different targets and strategies (Table 1.3).

Many of the cost savings will be most evident in the first year of introducing AMS, particularly pharmaceutical costs. Measures such as streamlining antimicrobial formularies to optimise purchase price are generally a one-off saving. Presuming that adherence is high, implementing guidelines for surgical prophylaxis will initially bring about antimicrobial cost savings through a decrease in duration of antimicrobial therapy, but is unlikely to provide further reductions. However, cost–benefit is only one consideration in determining economic benefit to support the maintenance of an AMS program. Improved quality of care and patient outcomes are important factors that should also be estimated.

1.5.3 Unintended consequences of antimicrobial stewardship programs

Several meta-analyses have identified no adverse clinical outcomes from AMS in hospitals.[61,63,89,90] To complement the studies showing a benefit in clinical outcomes of AMS, many other studies show that a significant reduction in antimicrobial use, although not showing a change in clinical outcomes, reassuringly does not show adverse clinical effects.[91-95] For example, reducing the duration of intravenous antimicrobial therapy for community-acquired or ventilator-associated pneumonia did not increase mortality or length of hospital stay.[96,97] Studies evaluating shorter duration of surgical prophylaxis also showed no increases in postoperative surgical site infections.[98,99]

Table 1.3: Cost savings from antimicrobial stewardship in hospital settings

Country	Target of program	Outcome
Italy[84]	Perioperative prophylaxis	22.9% reduction in direct drug costs
Singapore[85]	Broad-spectrum antimicrobial use in renal patients	Direct cost savings of S$90,045
United States[86]	Broad-spectrum antibiotics in paediatric critical care	62% reduction in purchase costs of broad-spectrum antibiotics
United States[87]	Optimising treatment of bacteraemia as a single infective syndrome	Maintaining an antimicrobial stewardship team was cost-effective
Germany[88]	Broad-spectrum antibiotic use in an orthopaedic unit	Overall cost savings (including drug cost, infectious diseases consultant time and laboratory costs) over 15 months

However, this does not mean that unintended consequences may not occur in individual programs or strategies. In Scotland, when the national orthopaedic surgical prophylaxis guidelines were changed from cefuroxime to flucloxacillin and gentamicin, there was an associated significant increase in acute kidney injury.[100] Thus, when introducing AMS measures, it is necessary to monitor actual and potential adverse outcomes, as well as positive outcomes such as reduced AMR or *C. difficile* infection. Certain interventions, such as removing broad-spectrum antimicrobials from clinical areas to limit their inappropriate use, may delay antimicrobial delivery if appropriate pathways for antimicrobial supply do not accompany the restrictions. For example, a study in the United Kingdom found that first doses of restricted, non-ward stock antimicrobials were more likely to be delayed than first doses of unrestricted stock antimicrobials. Although the study was not powered to measure whether an adverse clinical outcome was associated with this delay, in the setting of sepsis, delaying antimicrobial prescription has been shown to have adverse consequences.[101,102] More research is needed to understand any unintended consequences of the use of restrictive interventions.[64]

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Appendix A: Examples of antimicrobial stewardship (AMS) activities and resources in Australian states and territories

State	Activities and resources
Australian Capital Territory (ACT)	Healthcare Associated Infections Standards Group based at Canberra Hospital and Health Services, and AMS working group ACT Health Formulary Comprehensive restrictions policies
Northern Territory (NT)	Policies and guidelines available for all hospitals via the policy portal on the intranet homepage Electronic approval systems for Top End hospitals CARPA Standard Treatment Manual (STM) to support remote clinicians
New South Wales (NSW)	State AMS expert advisory committee terms of reference AMS toolkit: sample terms of reference for AMS committees, sample AMS policy, list of antimicrobial restrictions, fact sheets Other resources: hospital-level cumulative antibiograms, e-learning module on AMR, mobile applications
Queensland	Statewide formulary (MedTRx) Statewide AMS program offering a range of educational activities and skills sessions with video conference access available
South Australia	South Australian expert Advisory Group on Antimicrobial Resistance (SAAGAR) Statewide antimicrobial formulary management and surveillance of antimicrobial use AMS self-evaluation toolkit
Tasmania	State Health Service AMS committee Online state medicines formulary with comprehensive antimicrobial component Regional AMS committees reporting to the statewide committee with primary health and GP liaison
Victoria	Support for AMS through Safer Care Victoria, with regular email updates to AMS hospital contact list Annual forum for Antibiotic Awareness Week VICNISS (Victorian Healthcare Associated Infection Surveillance System) activities available to all acute and some non-acute health services in Victoria
Western Australia (WA)	WA Committee for Antimicrobials Statewide medicines formulary

2 Establishing and sustaining an antimicrobial stewardship program

Antimicrobial Stewardship in Australian Health Care

2018

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Acronyms and abbreviations

Abbreviation	Definition
AMR	antimicrobial resistance
AMS	antimicrobial stewardship
AURA	Antimicrobial Use and Resistance in Australia
FTE	full-time equivalent
ID	infectious diseases
IT	information technology
LHD	Local Health District
LHN	Local Hospital Network
NAPS	National Antimicrobial Prescribing Survey
NAUSP	National Antimicrobial Utilisation Surveillance Program
NSQHS Standards	National Safety and Quality Health Service Standards
QI	quality improvement

Key points

- Overall accountability for antimicrobial management lies at the highest level of each health service organisation, and with the clinicians responsible for delivering services efficiently and effectively.
- The National Safety and Quality Health Service Clinical Governance Standard identifies management requirements for ensuring that the antimicrobial stewardship (AMS) program is appropriately supported and implemented, and that outcomes are evaluated.
- The preferred model for AMS in most settings involves a multidisciplinary AMS team that has the responsibility and resources for implementing a program to improve antimicrobial prescribing.
- Effective implementation of an AMS program within a health service organisation requires a good safety culture and uses an appropriate quality improvement process.
- Specific implementation strategies and interventions need to be relevant to the local context and individual circumstances.
- A successful AMS program will incorporate ongoing data collection, analysis and actionable feedback to clinicians, as these elements have been shown to improve prescriber behaviour.
- To be sustainable over time, an AMS program should use a quality improvement framework that incorporates audit and actionable feedback; teams are more likely to be effective if they have access to education and training in AMS, and effective quality improvement processes.

2.1 Introduction

Antimicrobial stewardship (AMS) is a systematic approach by a health service organisation to:

- Promote and optimise appropriate antimicrobial use, and improve patient outcomes
- Reduce and contain antimicrobial resistance (AMR)
- Reduce healthcare costs.

AMS programs contain a range of strategies to reduce unnecessary antimicrobial use and promote the use of appropriate antimicrobials in line with prescribing guidelines.

Changing antimicrobial prescribing behaviour is complex and requires sustained support. No single approach will deliver optimal antimicrobial prescribing in every context. Strategies need to be customised for the individual health service, and consider the local environment and available resources. Using local information and data to better understand the local safety culture and readiness to implement or improve a program will maximise the chance of success.

This chapter suggests approaches to establishing, improving and sustaining an AMS program. It discusses the establishment of appropriate governance for an AMS program and the steps involved in the development of an AMS program plan.

This chapter will be of use to anyone involved in establishing an AMS program: clinicians from all disciplines, health managers and health service executives. Although much of the published experience to date is hospital based, the same principles can be applied to primary health and other settings.

Issues that are especially relevant for certain settings – rural and remote hospitals, private hospitals and aged care – are tagged as R, P and AC, respectively, throughout the text.

R P AC

2.2 Essential elements of antimicrobial stewardship programs

Successful AMS programs comprise a range of strategies, structures and governance, appropriate to local circumstances, to support their implementation. The requirements and strategies considered essential to meet the goals and objectives for AMS in Australian human healthcare settings are summarised in Box 2.1. They are applicable to all healthcare settings: metropolitan, rural and remote hospitals; private hospitals; aged care; community health services; general practice; and dental practice.

Box 2.1: Essential elements and strategies for antimicrobial stewardship programs

Structure and governance

Overall accountability for antimicrobial stewardship (AMS) is defined by an organisation's corporate and clinical governance. Managers and senior clinicians are responsible for the AMS program, including:

- Ensuring that AMS resides within the organisation's quality improvement and patient safety governance structure
- Establishing a multidisciplinary AMS team that includes, at least, a lead doctor and pharmacist
- Providing the necessary human, financial and information technology* resources for AMS activities
- Ensuring ongoing education and training for prescribers, pharmacists, nurses, midwives and consumers about AMS, antimicrobial resistance and optimal antimicrobial use.

Essential strategies

The essential strategies that sit within the AMS governance structure are:

- Implementing clinical guidelines† consistent with *Therapeutic Guidelines: Antibiotic* that take into account local microbiology and antimicrobial susceptibility patterns
- Implementing formulary§ restriction and approval systems that include restricting broad-spectrum and later-generation antimicrobials to patients in whom their use is clinically justified
- Reviewing antimicrobial prescribing, with intervention and direct feedback to the prescriber
- Implementing point-of-care interventions (including directed therapy, intravenous-to-oral switching and dose optimisation)
- Ensuring that the clinical microbiology service
  - provides guidance and support for optimal specimen collection
  - targets reporting of clinically meaningful pathogens and their susceptibilities
  - uses selective reporting of susceptibility testing results
  - generates location-specific antimicrobial susceptibility reports (antibiograms) annually
- Monitoring antimicrobial use and outcomes, and reporting to clinicians and management.

* Information technology examples include electronic prescribing with clinical decision support, online approval systems for restricted agents, post-prescription alert systems and antimicrobial use surveillance systems.

† Guidelines include clinical pathways and care bundles.

§ Refers to institutional formularies; in the community, the Pharmaceutical Benefits Scheme and the Repatriation Pharmaceutical Benefits Scheme act as the formulary.

2.3 Structure and governance

AMS programs should work within the organisation's safety and quality improvement program. Governance requires both executive and clinical leadership.

2.3.1 Safety and quality improvement

Appropriate antimicrobial use is an essential component of patient safety, and requires close oversight and guidance.[1,2] The inclusion of the Preventing and Controlling Healthcare-Associated Infection Standard in the National Safety and Quality Health Service (NSQHS) Standards signifies the importance of AMS in patient safety. This standard requires that 'the health service organisation implements systems for the safe and appropriate prescribing and use of antimicrobials as part of an antimicrobial stewardship program' (see Section 1.3 in Chapter 1: 'Evidence for antimicrobial stewardship').

An organisation's AMS program is most effective and best supported when it resides within the patient safety and quality improvement governance structure, and is incorporated into the organisation's safety and quality strategic plan.[1,3-5] By embedding the program within a safety and quality framework, AMS is framed as an issue of safe and high-quality patient care. Safety is addressed through promoting care that avoids preventable harm, and quality of care is pursued through continuous measurement, evaluation and striving to improve. This moves antimicrobial prescribing and use from an issue that might be considered to be pertinent to only microbiologists and infectious diseases physicians to one that is owned by all involved in the prescribing pathway. Promoting a safe culture can further influence the effectiveness of patient safety practices, such as AMS.[6] Executive and clinical leaders can promote a safety culture by demonstrating their own commitment to safety and providing resources to help teams to improve.[6-8] Regarding AMS, they can help the workforce focus on improved patient safety and outcomes, and best clinical management as the goal of AMS (see also Factors influencing antimicrobial prescribing behaviour).

The Comprehensive Unit-Based Safety Program (CUSP) is an example of a patient safety model that combines best practices and the science of safety, and promotes a safety culture (see Safety culture) as the basis for improving practice.[7,9] Steps in implementing the CUSP model have been included in a CUSP toolkit, developed by the Agency for Healthcare Research and Quality. This framework has been successfully applied to reducing central line–associated bloodstream infections[7,9] and catheter-associated urinary tract infections.[6,10] It could be applied to AMS activities targeted at reducing suboptimal antimicrobial use.

2.3.2 Governance

The NSQHS Clinical Governance Standard describes governance as the set of relationships and responsibilities established by a health service organisation between its governing body, executive, clinicians, patients and consumers to deliver safe and high-quality health care. It aims to ensure that the community and health service organisations can be confident that systems are in place to deliver safe and high-quality health care, and continuously improve services.

Clinical governance is an integrated component of the corporate governance of health service organisations, ensuring that everyone – from frontline clinicians to managers and members of governing bodies, such as boards – is accountable to patients and the community for assuring the delivery of health services that are safe, effective, high quality and continuously improving.

The Clinical Governance Standard requires that accountability for the AMS program must lie with the highest level of corporate and clinical governance and management within the organisation.[11]

Hospital and community health service AMS programs should have clearly defined operational and reporting lines to the health service executive, the director of clinical governance, the patient safety and quality improvement committee, the infection prevention and control committee, and the drug and therapeutics committee.[3,4,12] Figure 2.1 is an example of a governance structure for a hospital AMS program. It is important to consider the specific governance arrangements for a hospital or health service and their effect on local AMS programs, as different governance arrangements may be required depending on local structures and resources.

The structure described in Figure 2.1 could be extended to networked AMS programs organised at the Local Hospital Network (LHN) or Local Health District (LHD) level, or to a private hospital group.[13,14] LHNs and LHDs need to formalise the

R

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workforce members responsible for AMS at the facility and network-wide levels, clarifying where resources are to be shared. These arrangements may also extend to inter- and intra-LHN/LHD networks, providing oversight to rural and remote services. Similarly, arrangements may be extended to include Primary Health Network linkages with LHNs and LHDs.

At the state and territory level, AMS is considered to be best supported within the safety and quality improvement governance arrangements for each state or territory, and should be included within that state's or territory's strategic quality improvement plan. Most state and territory health departments have an established governance structure for AMS. This may include an AMS advisory committee or AMS network, with representation from LHNs and LHDs.

Table 2.1 provides options for governance arrangements for different types of health service organisations (see also Resources).

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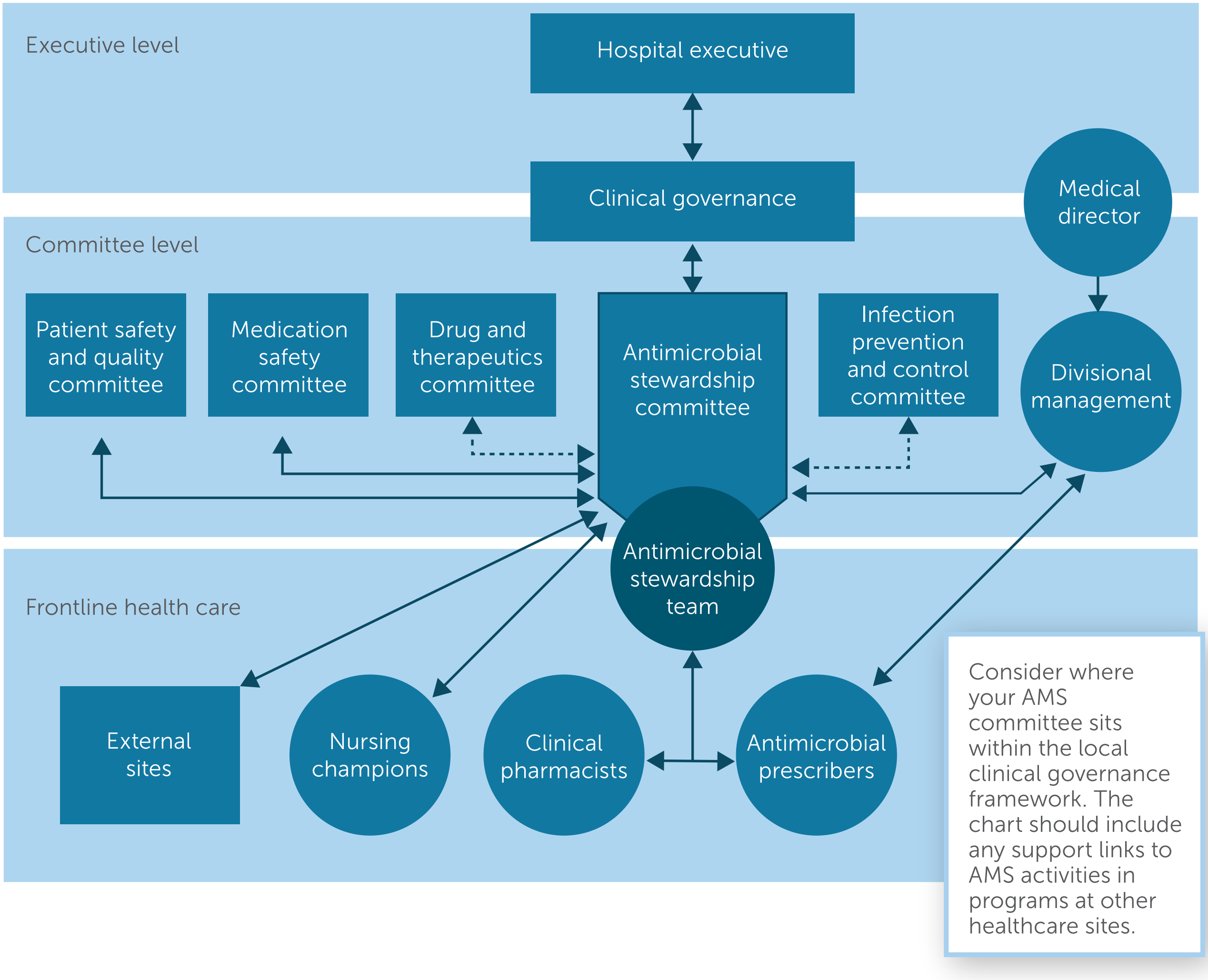
Figure 2.1: Example of a governance structure for a hospital antimicrobial stewardship program



AMS = antimicrobial stewardship
Source: Adapted from Clinical Excellence Commission, 2017[15]

Table 2.1: Options for governance arrangements in different health service organisations

Possible governance arrangements	Program element: Executive leadership	Program element: Governance arrangements, structure and lines of communication
Health service organisation*	Network, district, management group or executive sponsorship and support for AMS program	• Director of AMS program • Multidisciplinary AMS committee • AMS is part of the safety and quality plan • Links to committees responsible for drugs and therapeutics, and infection prevention and control • Reports to chief executive and governance units
Principal Referral Hospital, Acute Group A Hospital, public or private†	Local executive sponsorship and support for AMS program	• Director of AMS program (infectious diseases physician, clinical microbiologist or pharmacist) • Multidisciplinary AMS committee • AMS is part of the safety and quality plan • Links to committees responsible for drugs and therapeutics, and infection prevention and control • Reports to the chief executive and governance units • Multidisciplinary AMS team
Acute Group B Hospital, Acute Group C Hospital, public or private§	Local executive sponsorship and support for AMS program	• AMS program lead is a pharmacist (where possible, may be local or network/district pharmacist), with input from local or network/district infectious diseases physician or clinical microbiologist • If no pharmacist is available, coordinated by a medical clinician or senior nurse with dedicated time for AMS • AMS is part of the safety and quality plan • Links to committees responsible for drugs and therapeutics, and infection prevention and control • Reports to the chief executive and governance units • Multidisciplinary AMS team
Acute Group D Hospital/ multi-purpose service, public or private#	Local executive sponsorship and support for AMS program	• AMS program lead is the facility manager, who coordinates with input from local or network/district pharmacist, infectious diseases physician or clinical microbiologist • AMS is part of the safety and quality plan • Links to committees responsible for drugs and therapeutics, and infection prevention and control • Reports to an organisational governance group • Multidisciplinary AMS team
Same Day Hospital, public or private	Owner and management support for AMS program	• Coordinated by the facility manager, with support from specialist visiting clinicians or pharmacist, where available • AMS is part of the safety and quality plan • Links to committees responsible for drugs and therapeutics, and infection prevention and control • Reports to an organisational governance group

AMS = antimicrobial stewardship
* For example, Local Hospital Network or Local Health District, private hospital group
† For example, large urban hospital or tertiary facility
§ For example, rural/district hospital
# For example, small hospital/multi-purpose service, hospital with fewer than 50 beds

2.3.3 Executive leadership

The success of the AMS program depends on the support and leadership of the executive, senior management and the senior clinical workforce.[1,3,11,16]

An organisation's executive or governing body can show its support and leadership for the AMS program by:

- Prioritising and promoting AMS as a strategic safety and quality goal of the organisation
- Ensuring that the clinical governance framework, and quality improvement systems and processes relating to AMS within the organisation are robust, and that AMS is incorporated into strategic planning
- Identifying an executive sponsor to participate in the AMS committee and program
- Supporting AMS and communicating to the workforce and other leaders why appropriate antimicrobial use is a priority
- Providing appropriate resources for the AMS team and committee, and supporting them to operate within the clinical governance framework
- Scheduling time to review progress and provide advice
- Supporting the AMS team and committee in promoting accountable clinical practice across the organisation
- Ensuring that clinicians (prescribers, pharmacists, nurses and midwives) receive appropriate orientation on the AMS program at the start of their employment in the organisation, and ongoing education and training regarding AMS
- Ensuring that consumers receive appropriate information regarding AMS.

R P AC

Table 2.2 provides examples of how leaders can show commitment to AMS in different healthcare settings. The SA Health Antimicrobial Stewardship Policy Directive provides an example of the roles and responsibilities that are expected of the chief executive and LHN chief executive officers in supporting the implementation of AMS in public hospitals in South Australia.[13]

2.3.4 Clinical leadership

Engaging senior clinicians to champion and support the AMS program is a key factor for successful AMS.[20,21] The aim of developing clinical leadership in AMS is to promote a culture of optimal antimicrobial use within the organisation. Both executive and clinical leadership are needed to champion the AMS effort. Specific change ideas include[22,23]:

- Identifying clinical champions to be thought leaders about AMS
- Enabling clinical champions to work with the executive to ensure that the executive understands the rationale and goals for AMS programs, in order to provide sufficient executive support
- Engaging a clinical champion and central team to improve the focus of AMS in the current process of care
- Using clinical champions to bring disciplines together to improve communication and collaboration about improving antimicrobial use, including (as appropriate to the setting)
  - infectious diseases physicians and clinical microbiologists
  - other specialist clinicians (for example, intensive care, emergency department, respiratory)
  - surgeons
  - junior prescribers
  - pharmacists
  - infection control practitioners
  - nurses and midwives.

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Networked AMS programs often require designated leadership and resources to support rural and remote facilities. If available, an infectious diseases physician or a clinical microbiologist is well placed to lead the AMS program. If these experts are not available, a general practitioner, general physician or surgeon should be supported to lead and manage the program. A pharmacist is a valuable resource to an AMS program and can coordinate hospital AMS programs in settings that have limited access to infectious diseases physicians.[24,25] In hospitals without an on-site pharmacist, this role may be performed by a regional or network pharmacist. Mentorship from a specialist AMS pharmacist (for example, from an established program at a different hospital or the LHN/LHD AMS service) and access to further AMS training are likely to assist a general pharmacist taking on this role. Alternatively, an infection control practitioner, nurse or midwife, with the necessary support and training, could be appointed to coordinate AMS activities (see Chapter 12: 'Role of nurses, midwives and infection control practitioners in antimicrobial stewardship').

Table 2.2: Examples of leadership commitment to antimicrobial stewardship in different health service organisations

Hospital and community health services	Aged care homes	Primary care practice (general, dental)
Leadership support is critical to the success of AMS programs and can include: • **Issuing formal statements** that the facility supports efforts to improve and monitor antimicrobial use • **Including AMS-related duties** in job descriptions and annual performance reviews • **Ensuring that workforce members** from relevant departments are given enough time to contribute to AMS activities • **Supporting** training and education • **Ensuring participation** from the many groups that can support AMS activities. Financial support increases the capacity and impact of a stewardship program. Effective programs will often show savings in both antimicrobial expenditures and indirect costs over time.	Facility leadership, including owners and administrators, as well as regional and national leaders if the facility is part of a larger corporation, can show their support for AMS by: • **Writing statements** in support of improving antimicrobial use, to be shared with the workforce, residents and families • **Including AMS-related duties** in position descriptions for the medical director, clinical nurse leads and consultant pharmacists • **Communicating** to the nursing workforce and prescribing clinicians the facility's expectations about antimicrobial use, and the monitoring and enforcement of AMS policies • **Creating a positive culture**, through messaging, education and celebrating improvement, that promotes AMS.	Community practice leaders can promote appropriate antimicrobial prescribing by: • **Identifying a clear lead** to direct AMS activities within a facility • **Including AMS-related** duties in position descriptions or job evaluation criteria for medical directors, nursing or midwifery leadership positions and practice management personnel • **Communicating** with all workforce members (including administrative, nursing and midwifery, allied health and medical) to set patient expectations by using consistent messages when communicating with patients about the indications for antimicrobials.

AMS = antimicrobial stewardship
Source: Adapted from Centers for Disease Control and Prevention[17-19]

2.4 Antimicrobial stewardship committee and team

Although overall accountability for AMS lies with the highest level of governance in a health service organisation, the responsibility for implementing the program, and effectively and efficiently managing available resources lies with a multidisciplinary AMS committee and the local AMS team.[1,3,26] The terms 'AMS committee' and 'AMS team' are often used interchangeably; however, they describe different entities. The AMS committee provides oversight and advice, whereas the AMS team is concerned with implementation.

The NSW Clinical Excellence Commission's *Antimicrobial Stewardship Teams & Committees fact sheet* informs the establishment of effective AMS committees and teams, including their composition and roles.

2.4.1 Antimicrobial stewardship committee

In the Australian setting, the term 'AMS committee' describes a multidisciplinary committee whose primary role is to direct and support the AMS program within the health service organisation and to oversee the effective implementation and ongoing function of the program. This may be at an individual hospital or practice level, or at an LHN, an LHD or a Primary Health Network level.

The AMS committee should sit within the existing clinical governance structure, and have links with the quality improvement (QI) system. Cross-membership with the drug and therapeutics, medication safety, and infection prevention and control committees is recommended.

Committee membership

Multidisciplinary committees are best suited to guide and advise on the changes required for an effective AMS program.[27] Therefore, although committee membership should include those with professional expertise in the safe use of antimicrobials, different professions and individuals – with diverse perspectives, skills and responsibilities for AMS – should be included. Membership of the committee will vary, depending on the resources available and the practice setting (see Table 2.3). Involving prescribers, pharmacists, nurses, midwives, administrators, infection control practitioners, information systems experts, microbiologists and infectious diseases physicians in a committee that effectively incorporates their views and expertise will support meaningful program interventions.[22]

Organisations should consider including one or more consumers on the AMS committee to help to promote activities that better consider consumer needs (see also Chapter 7: 'Involving consumers in antimicrobial stewardship').

Table 2.3: Suggested antimicrobial stewardship committee and team arrangements for health service organisations

Suggested committee and team arrangements	Program elements	
	AMS committee	**AMS team**
Health service organisation*	Multidisciplinary AMS committee comprising: • The director of the AMS program • A member of the executive • A pharmacist(s) • An infectious diseases physician or a clinical microbiologist • Medical specialists • Surgeons • Infection control practitioners • Nurses and midwives • Representatives from network or district facilities • A consumer representative	Not applicable
Principal Referral Hospital, Acute Group A Hospital, public or private†	Multidisciplinary AMS committee comprising: • The director of the AMS program • A member of the executive • An AMS pharmacist • An infectious diseases physician or a clinical microbiologist • Infection control practitioners • Nurses and midwives • Prescribing clinicians from key departments, including intensive care • Possibly pharmacy manager(s), information systems expert, consumer, other relevant representatives from AMS team	Multidisciplinary AMS team comprising: • An infectious diseases physician or a clinical microbiologist • A pharmacist with allocated time for AMS May also include: • Infection control practitioners • Prescribing clinicians from key departments (e.g. intensive care) • Nurses and midwives

Suggested committee and team arrangements	Program elements	
	AMS committee	AMS team
Acute Group B Hospital, Acute Group C Hospital, public or private[§]	Functions may be performed by an: • AMS committee at level of Local Hospital Network / Local Health District or private hospital group OR • AMS team OR • Existing committee, such as safety and quality, or drug and therapeutics	Multidisciplinary AMS team comprising: • An on-site or a Local Hospital Network / Local Health District pharmacist with allocated time for AMS • A prescribing clinician, nurse or midwife, as appropriate • Input from an infectious diseases physician or a clinical microbiologist
Acute Group D Hospital/multi-purpose service, public or private[#]	Functions may be performed by an: • AMS committee at level of Local Hospital Network / Local Health District or private hospital group OR • AMS team OR • Existing committee, such as safety and quality, or drug and therapeutics	Multidisciplinary AMS team (may be on site or Local Hospital Network / Local Health District) comprising: • A pharmacist with allocated time for AMS • A prescribing clinician, nurse or midwife • Input from an infectious diseases physician or a clinical microbiologist
Same Day Hospital, public or private	Functions performed by: • An AMS team OR • A facility management committee	Facility manager, nurse, midwife, and visiting medical officer (surgeon or anaesthetic representative) or pharmacist (where available)

AMS = antimicrobial stewardship
* For example, Local Hospital Network or Local Health District, private hospital group
† For example, large urban hospital or tertiary facility
§ For example, rural/district hospital
# For example, small hospital/multi-purpose service, hospital with less than 50 beds

Larger health service organisations may have enough resources for a dedicated AMS committee, but this may not be feasible for smaller, and rural and remote organisations. In that case, AMS committee functions could be incorporated into an already functioning committee, such as the drug and therapeutics, infection prevention and control, medication safety, safety and quality, or practice management committee. For smaller health service organisations, membership of the committee will depend on the available workforce and may involve members who have regional roles (for example, an LHN AMS pharmacist) or members from a larger organisation in the LHN/LHD. Off-site AMS specialists may be asked to provide expert advice to meetings by teleconference. As for all organisations, the more members and variety of specialties involved – including infectious diseases physicians, pharmacists, and nurses and midwives – the more robust and sustainable the program will be.

For LHNs or LHDs, the main membership of the networked AMS committee should include representation from executive, medical, surgical, pharmacy, and nursing and midwifery stakeholders, and from different hospitals and multi-purpose services in the network.[13,14]

Committee role

In general, the AMS committee is responsible for:

- Developing, designing and updating the organisation's AMS program
- Overseeing the ongoing implementation and development of the AMS program
- Reviewing local datasets regularly to identify trends, improvements and opportunities for change
- Evaluating and reporting on the progress and effectiveness of the AMS program.

Example terms of reference for AMS committees are available within the NSW Clinical Excellence Commission's AMS Implementation Toolkit.

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LHNs or LHDs may establish an AMS committee responsible for the development and ongoing evaluation of a regional AMS program. Responsibilities of an LHN AMS committee may include[13]:

- Providing governance for the use of antimicrobials, as per the committee terms of reference
- Providing leadership for the LHN to meet the requirements of the NSQHS Preventing and Controlling Healthcare-Associated Infection Standard
- Working collaboratively with other LHN committees – including drug and therapeutics, and infection prevention and control – on formulary management and AMS issues
- Reviewing, approving and promoting LHN guidelines on antimicrobial use or endorsing statewide guidelines for use in LHN facilities
- Coordinating actions in response to reports on antimicrobial use and AMR
- Providing leadership for the education of the LHN clinical workforce and consumers on AMS
- Providing representation on the statewide AMS advisory group and other relevant committees.

2.4.2 Antimicrobial stewardship team

In the Australian setting, the term 'AMS team' describes a group of clinicians who are the 'effector arm' of the AMS program and the 'face of AMS' within the organisation. The composition of this team will depend on local needs.

Team membership

The AMS program model based on a multidisciplinary AMS team approach with a clinical microbiologist or infectious diseases physician and a clinical pharmacist (with infectious diseases training) as main team members is optimal.[1,3,27-29] This approach can be adapted to different healthcare settings, and can be effective in the absence of clinicians with specialist infectious diseases training. See Table 2.3 for the suggested composition of AMS teams in different healthcare facilities.

Where on-site infectious diseases physicians or clinical microbiologists are not available, the AMS team should be led by an interested clinician with a clinical pharmacist, if available. In these circumstances, health service organisations should establish formal mechanisms to access specialist advice to support the local AMS team. This may be achieved through clinical networks within or across LHNs or LHDs, or through arrangements with the private sector. These arrangements should be formalised to ensure continuity of advice and service delivery. Small hospitals and other healthcare settings without an on-site pharmacist needing to seek advice from a clinical pharmacist may be able to do so from another hospital in their LHN/LHD or a community pharmacy service. Innovative programs have been developed in these settings using formalised networks and telehealth facilities.

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The local AMS team may need to recruit support from other workforce members where appropriate (for example, data collectors for audits, or reviewers for guideline development or revision). This can be facilitated by the AMS committee or health service executive and should be considered when planning the program. Teams should also consider involving colleagues from different clinical disciplines when developing AMS interventions. This will help to engage a broader range of prescribers and other clinicians in AMS activities.

It is important that there is sufficient time for the AMS team members to undertake these tasks.

Team roles

To carry out their roles effectively, team members need to be clear about their roles, responsibilities and time commitment. Depending on the setting, AMS team roles and functions may include:

- Providing antimicrobial support to a specific clinical unit or service when guidelines are developed or reviewed

- Implementing guidelines, including auditing prescribers' compliance and providing feedback to them
- Developing, reviewing and maintaining formulary restriction and approval systems (including electronic systems)
- Reviewing patients who have been prescribed restricted antimicrobials
- Monitoring the performance of antimicrobial prescribing by collecting and reporting unit-, ward- or practice-specific data, including appropriateness of antimicrobial use
- Liaising with the clinical microbiology service regarding AMS
- Conducting workforce education and training
- Advising on the design and implementation of information technology (IT) systems to support AMS (for example, electronic clinical decision support systems).

Professional development

AMS professionals engaged in building, leading or evaluating AMS programs require specific knowledge and skills. These include an understanding of the rationale for AMS, the types of stewardship strategies that an AMS program may consider, and the approaches for measuring the processes and outcomes of an AMS program. Guidance on these skills and knowledge has been published and may assist team members.[30] (Links to guidance on skills and knowledge required for AMS professionals are provided in Resources; see also Chapter 5: 'Antimicrobial stewardship education for clinicians'.)

AMS committee and team members are encouraged to learn about, and incorporate findings from, general QI activities in health care, and to seek further information and training in QI and change management processes, as required. It is important to consider involving others who can contribute this expertise, such as workforce members from the organisation's QI and patient safety team, or from state, territory or LHN/LHD safety and quality units.

2.5 Antimicrobial stewardship program plan

When the governance structure (with executive commitment), the AMS committee and the multidisciplinary AMS team have been established, the next step is to plan the AMS program. The program will differ according to the healthcare setting and available resources. Clinician involvement is critical.[31] A QI approach to planning and implementing the program is recommended. QI incorporates behaviour change strategies of sustainable self-measurement by clinicians or clinical teams. It involves ongoing data collection and analysis, together with the provision of actionable feedback, which has been shown to improve prescriber behaviour.[32-34] Evaluating the impact of the intervention helps teams to decide whether implementation strategies are effective or if different approaches are needed, and enables unintended consequences to be identified (see Chapter 6: 'Measuring performance and evaluating antimicrobial stewardship programs'). This approach can be applied to any healthcare setting.

Steps in designing, implementing or improving an AMS program include:

- Assessing readiness to implement an AMS program
- Reviewing existing policies and guidelines
- Reviewing local data on antimicrobial use and AMR
- Determining priority areas for AMS activities
- Identifying effective interventions
- Defining measurable goals and outcomes
- Documenting and implementing the AMS plan
- Educating the workforce
- Developing and implementing a communication plan.

2.5.1 Assessing readiness to implement an antimicrobial stewardship program or intervention

An organisation's readiness to implement an AMS program or specific AMS interventions should consider various factors needed for a successful program, including:

- Structures and processes required for the AMS program
- Resources to support the program
- An understanding of the context in which the AMS program is being implemented, including the organisational culture, safety culture and local influences on prescribing behaviour.

Structures and processes required for an antimicrobial stewardship program

An assessment of the key structures and processes required to establish and maintain an AMS program should be completed by the AMS committee or team:

- Before implementing a program, to provide baseline information for a gap analysis
- At regular intervals after implementation, to help AMS teams to measure their progress and identify areas for improvement.

The self-assessment will help to decide the local factors influencing antimicrobial prescribing and use; the level of executive support or commitment to the program; and available human, financial and IT resources. External advice is often helpful in undertaking a comprehensive self-assessment process.

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A number of assessment tools are available for hospitals and community services to decide what structural requirements and processes are in place to support AMS in their organisation (see Box 2.2 for examples and Chapter 6: 'Measuring performance and evaluating antimicrobial stewardship programs').

Resources to support the antimicrobial stewardship program

It is important to assess the resources that are required and currently available or accessible to implement and promote AMS within the organisation. These include the capacity of the workforce to undertake the AMS program, such as access to clinical microbiology, infectious diseases and pharmacy expertise; available policies and guidelines; current audits and data collection processes (that may help support AMS); IT (see Chapter 4: 'Information technology to support antimicrobial stewardship'); and education systems (see Chapter 5: 'Antimicrobial stewardship education for clinicians'). This information can be collected as part of the assessment using the tools listed in Box 2.2.

Resourcing needed for successful AMS programs may include[9,25]:

- Management and workforce
  - dedicated clinician and pharmacist time for participation in AMS activities
  - access to clinical microbiology, infectious diseases and pharmacy expertise
  - resources to provide appropriate orientation to new clinical workforce and ongoing education to the existing workforce regarding the AMS program and AMS strategies
  - a clinical lead for AMS
  - clinical champions
  - an appropriately qualified and trained workforce

Box 2.2: Antimicrobial stewardship self-assessment tools and links

Hospitals

- NSW Clinical Excellence Commission: Antimicrobial Stewardship Progress and Planning Tool[35]
- South Australia (SA) Health Antimicrobial Stewardship Program: Self-evaluation Toolkit[36]
- Centers for Disease Control and Prevention: Checklist for Core Elements of Hospital Antibiotic Stewardship Programs[17]
- Transatlantic Taskforce on Antimicrobial Resistance: Core and supplementary structure indicators for hospital AMS programs[37]

Aged care homes

- Centers for Disease Control and Prevention: Core Elements of Antibiotic Stewardship for Nursing Homes Checklist[19]

Primary care and general practice

- Centers for Disease Control and Prevention: Core Elements of Outpatient Antibiotic Stewardship Checklist[18]
- Royal College of General Practitioners: TARGET Antibiotic Toolkit Self-Assessment Checklist[38]

- IT
  - clinical decision support
  - clinical surveillance systems
- Data analysis and reporting
  - local data collection
  - systems to provide timely data for decision-making.

Few countries have established the human resource requirements for AMS teams but, where they have been established, they are only for hospitals. Several countries have estimated around four full-time equivalent (FTE) workforce members per 1,000 beds for a hospital AMS program. The team should comprise physicians (ideally with infectious diseases training), pharmacists and microbiologists. The European Centre for Disease Prevention and Control recommends two to six FTE workforce members per 1,000 beds.[39] However, comparability of international estimates is limited because of the different methods used to estimate bed capacity, varying primary activities for AMS teams and the way services are delivered in the different healthcare systems.[40]

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Resources should be readily available to the workforce to support appropriate antimicrobial prescribing. Examples include this publication, state and territory guidelines, the latest version of *Therapeutic Guidelines: Antibiotic*[41], relevant websites and information from other groups, information about access to therapeutic advisory groups, and LHN or LHD resources (see Resources). In a community or primary care setting, the material available from NPS MedicineWise will be especially valuable.

AMS program resources may be shared across other safety and quality programs. If more resources are required to establish or improve an AMS program, it may be useful to develop a business case for consideration by the executive. The business case should outline the goals of the program, define the components of the program, qualitatively and quantitatively describe the costs and benefits of the components, and define the indicators that will be used to measure the effects of the program before and after implementation.[42] (See Resources for links to guidance for the development of a business case in hospital settings.)

Establishing and sustaining an AMS program in smaller facilities and in private hospitals where resources may be limited may require more innovative approaches, especially where there are no on-site doctors or pharmacy services, and arrangements for expert consultations vary. In these cases, having formalised networked arrangements in place will promote reliable and sustainable access to AMS essentials. Establishing an LHN/LHD or regional AMS program led by a multidisciplinary AMS committee is a model that has been adopted in some Australian states and territories to oversee, coordinate and support AMS activities across all facilities in the health network. (See also Chapter 4: 'Information technology to support antimicrobial stewardship'.) Rural, remote and private hospitals may be able to access off-site services, such as expert clinical microbiologists from a diagnostic laboratory or infectious diseases physicians from a larger public hospital, through telehealth strategies (see Chapter 4: 'Information technology to support antimicrobial stewardship'). Case study 2.1 provides an example of the resources available through an LHN AMS network to support AMS in a small hospital.

Local context

Understanding the organisational context, culture and workplace norms, including local prescribing rules and behaviours, is critical to successfully establishing an AMS program. A 'one size fits all'

Case study 2.1: Local Hospital Network support for antimicrobial stewardship (AMS) in a small hospital

Hospital A is a 17-bed public hospital that is part of a Local Hospital Network (LHN). The LHN also includes a Principal Referral Hospital in a major city with on-site specialist services, including:

- An infectious diseases unit and a microbiology laboratory
- Four smaller public acute hospitals with on-site general surgeons and general physicians
- Three very small mixed subacute and non-acute hospitals served by visiting general practitioners.

The successful LHN AMS program for Hospital A has seven key features.

Antimicrobial stewardship committee

An LHN AMS committee has been established and holds monthly meetings at the Principal Referral Hospital. Representatives from the networked hospitals attend these meetings, and those at the more remote hospitals attend by videoconference.

Antimicrobial stewardship service

The AMS service at the Principal Referral Hospital is provided by three infectious diseases physicians, who have appointments in AMS and work in the service for a month at a time on a rotating roster. There are also two full-time clinical microbiologists associated with the microbiology laboratory. An AMS pharmacist is employed full time to oversee the program for the LHN.

Expert antimicrobial stewardship clinician support

The network AMS pharmacist visits Hospital A at least quarterly to familiarise themself with the local AMS issues, understand the local environment and build rapport with the workforce. Although the infectious diseases physicians may not be able to attend every meeting, attendance is ensured at least once per year.

Clinical champions

General practitioners at the smaller hospitals have been nominated as local AMS clinical champions and deal with the daily running of the AMS program. A generalist pharmacist also visits Hospital A for four hours twice a week and assists with local issues, including setting up the hospital formulary and some post-prescription reviews. Both the general practitioners and the generalist pharmacist at Hospital A have sought extra training in AMS by attending short courses, and they are supported through a system of mentorship from the networked infectious diseases physicians and AMS pharmacist. They are encouraged to phone the AMS team at the Principal Referral Hospital to discuss any issues and seek antimicrobial prescribing advice.

Antimicrobial policy and guidelines

Guidelines, policies and procedures are developed by the LHN AMS committee. They are available to all hospitals in the LHN and are customised to suit the local context of the individual hospitals.

Education

The AMS team at the Principal Referral Hospital is responsible for delivering education on antimicrobial use to the workforce across the entire network, using online conferencing.

Information technology

Hospitals in the LHN have a common information technology system that allows access to any results or investigations for patients from all sites. The hospitals also have an electronic approval system for pre-prescription approval of restricted medicines, which is on a multi-site platform. The AMS team can view the approvals at each of the sites within the LHN and phone to discuss cases with prescribers, if necessary. They can also recommend formal consultation with the infectious diseases service, if appropriate. This is usually a telephone consult but is sometimes part of a weekly formal infectious diseases ward round conducted using telehealth. Within the LHN, Hospital A had the fastest uptake of the electronic approval system, even though it was one of the least resourced services. This was because Hospital A had a highly enthusiastic and respected local champion and a workforce that was keen to have a successful program. There was also some friendly rivalry among the smaller hospitals within the LHN.

approach is not appropriate and does not sufficiently recognise that each setting has unique elements to be considered, such as enablers and barriers for appropriate antimicrobial prescribing and use. These enablers and barriers can affect the success of the implementation and should be considered when planning the implementation strategy.[43] Information on the effect of context on quality improvement is available from The Health Foundation.

Tools have been developed that can help organisations to assess and better understand the local context and ways in which this will influence improvement efforts. For example, the Model for Understanding Success in Quality (MUSIQ) has helped teams to identify aspects of context that are weak in their setting and consider what can be done to modify those aspects.[44]

Organisational culture

Different cultural factors, encompassing how the organisation operates and communicates, may influence the success of an AMS program. Cultural factors that may support successful AMS include[9,24]:

- Management and workforce
  - endorsement and recognition from management, leading to appropriate leadership and resourcing of the AMS program
  - engagement of clinical leaders
  - institutional buy-in
  - awareness of, or practical access to, antimicrobial prescribing guidelines and resources
- Communication
  - collaborative styles of communication
  - direct styles of communication
  - good organisational networks supporting formal communication processes
- Relationships
  - respectful and trusting
  - collegial and collaborative
  - multidisciplinary engagement
- Conflict management
  - leadership support
  - direct communication with those who resist change.

Safety culture

Establishing and maintaining a safety culture is a specific aspect of organisational culture that can influence the effectiveness of patient safety practices.[6] Increasingly, health service organisations are undertaking safety culture (or safety climate) surveys to inform implementation of improvement strategies. Although a survey is not an essential prerequisite for implementing an AMS program, gaining an understanding of the local safety culture will help teams to identify stewardship strategies that are more likely to succeed.

The AMS team may be able to use recent safety climate surveys or assessments, including surveys that measure workforce perceptions about the organisation's safety culture (see Resources), to assess the local safety culture. Working with patient safety and quality committees or departments within an organisation or network will enable the AMS committee or team to decide what activities may already be occurring regarding assessing, creating and promoting a safe workplace culture. These activities might be able to support implementation of AMS.

Factors influencing antimicrobial prescribing behaviour

Determinants of antimicrobial prescribing behaviour have been identified through Australian and international research.[45,46] An awareness and understanding of these factors, and how they might relate to the local context, can help AMS teams to tailor interventions to change antimicrobial prescribing behaviour in their workplace[45] (see also Chapter 5: 'Antimicrobial stewardship education for clinicians').

Table 2.4 lists the determinants of antimicrobial prescribing behaviour and some practical steps for AMS teams to follow to target some of the determinants, if they are an issue. It is important to consider the drivers behind behaviour, and to target interventions and messages accordingly.

2.5.2 Reviewing existing policies and prescribing guidelines

Local policies and prescribing guidelines, based on evidence-based guidelines, such as *Therapeutic Guidelines: Antibiotic*[41], are the basic structure on which AMS programs are built. It is therefore important to regularly review them, especially as part of the AMS planning process.

Antimicrobial stewardship policy

All health service organisations should have an AMS policy. An AMS policy establishes AMS as a safety and quality priority, gives authority to the AMS team and disseminates the key concepts of AMS. The AMS policy should be:

- Developed by the AMS team and AMS committee, and include a review date
- Approved by the drug and therapeutics or medication management committee
- Endorsed by the health service organisation executive
- Regularly reviewed and audited for compliance
- Readily available to all clinicians
- Used as the basis for AMS education programs.

Table 2.4: Determinants of antimicrobial prescribing behaviour and actions to influence them

Determinants of antimicrobial prescribing behaviour[45-50]	Practical steps for antimicrobial stewardship teams to influence prescribing among hospital clinicians[46]
Decision-making autonomy – clinicians may rely on professional judgement rather than evidence-based guidelines	• Engage senior clinicians in guideline development, with regular microbiological review, to support adherence • Work with senior clinicians to align the evidence base, local guidelines and consultant preferences, considering local resistance patterns • Use effective clinical leadership to influence practice
Limitations of local evidence-based policies – clinicians may deem local policies to be not always applicable to the individual patient	
Etiquette – clinicians may be reluctant to scrutinise and criticise other clinicians' prescribing practices	
Culture of hierarchy – junior clinicians' prescribing decisions are influenced by senior workforce members	• Make guidelines readily available to junior clinicians • Focus on adherence to guidelines and when to deviate when teaching clinicians
Antimicrobial resistance awareness – clinicians may not consider antimicrobial resistance to be relevant to their clinical decisions	• Provide training to all clinicians, including those trained overseas, that increases their awareness about antimicrobial resistance and overuse, the need to prescribe judiciously and current antimicrobial information • Promote prescribing guidelines
Knowledge about antimicrobials, including antimicrobial spectrum and appropriate clinical use – clinicians may not be aware of current antimicrobial information	
Diagnostic uncertainty – clinicians may be afraid of clinical failure or of overlooking something that is of more concern than downstream complications of antimicrobial resistance	• Educate clinicians to perform appropriate diagnostic work-ups before starting treatment – especially the correct use of microbiology and imaging
Expectations of patients, families and carers – clinicians may be influenced by patients' expectations for antimicrobials (perceived and actual)	• Engage with consumers, and use patient information about antimicrobial resistance and shared decision-making tools to change both patients' and clinicians' expectations

At a minimum, the AMS policy should:

- Nominate a person and their position within the organisation who has executive responsibility for the policy's content, and for implementing and monitoring it, and will be involved in future AMS activities
- Incorporate the principles of the Antimicrobial Stewardship Clinical Care Standard[51], including the need for clinicians to prescribe antimicrobials guided by the latest version of *Therapeutic Guidelines: Antibiotic*[41] wherever possible, with specific mention of how evidence-based practice recommendations for antimicrobial prescribing are to be applied locally
- Include a list of restricted antimicrobials, and outline the procedure for obtaining approval for use of those agents and a process for managing unapproved requests
- Provide information on how to access expert advice
- Refer to the health service organisation's policy on liaising with the pharmaceutical industry
- Outline how compliance with the policy will be audited and fed back to prescribers and the AMS committee or governance bodies.

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The AMS policy may be developed and monitored at the LHN, LHD, hospital group, individual facility or practice level, depending on the governance arrangements.

The policy should be regularly reviewed and revised, and this process can be a useful way to gain multidisciplinary input and engagement. However, AMS teams should try to avoid prolonged policy development to the exclusion of other activities. This may slow progress in developing and testing systems to directly influence antimicrobial prescribing.

Examples of Australian AMS policies for hospitals include:

- NSW Clinical Excellence Commission's *Sample Antimicrobial Stewardship Policy: for a Local Health District or Network*[14]
- SA Health's Antimicrobial Stewardship Policy Directive.[13]

Prescribing guidelines

Most healthcare settings will not need to develop local guidelines. However, existing ones will need to be implemented and promoted (for example, *Therapeutic Guidelines: Antibiotic*[41], or guidelines developed or endorsed by the LHN/LHD AMS committee). (See Chapter 3: 'Strategies and tools for antimicrobial stewardship'.) The NPS MedicineWise website provides several resources to help to implement guidelines in primary and community care settings.

As part of the assessment process, AMS teams should ascertain what guidelines are currently available within the organisation and assess whether they:

- Are consistent and evidence based
- Reflect agreed best practice (that is, are consistent with *Therapeutic Guidelines: Antibiotic*[41])
- Reflect the Antimicrobial Stewardship Clinical Care Standard[51]
- Have appropriate engagement and endorsement from units or services
- Have a regular audit and feedback process in place
- Are readily accessible by prescribers
- Have a review date to allow the content to be regularly reviewed.

Guideline development needs to be accompanied by a carefully planned implementation process that includes a program of audit and feedback.

2.5.3 Reviewing local data on antimicrobial use and resistance

AMS programs need to be tailored to the clinical setting. Local factors such as patient characteristics and needs, common indications for antimicrobial therapy, use of particular classes of antimicrobials, use of costly agents, and AMR patterns can be used to guide the focus of the program.

Understanding local antimicrobial use and AMR patterns within the specific clinical setting will help to identify priority areas for improvement. For example, in a primary care setting where the main role for antimicrobials is for urinary tract infections, skin and soft-tissue infections, and selected respiratory tract infections, patterns of use of common first- and second-line oral antimicrobials and resistance rates in *Escherichia coli*, *Staphylococcus aureus*, *Haemophilus influenzae* and *Streptococcus pneumoniae* are of most importance. This situation is different from tertiary cancer care, where a focus on broad-spectrum antimicrobials and antifungals, and resistance patterns in a wider range of pathogens is more relevant. Microbiologists, clinicians, clinical pharmacists, and infection control practitioners can assist in interpreting the data.

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Health service organisations, aged care homes and other health organisations and providers can participate in different programs that can provide baseline and regular data and information to assess AMS performance (see also Chapter 6: 'Measuring performance and evaluating antimicrobial stewardship programs'). Table 2.5 describes data sources for these programs, many of which form part of the Antimicrobial Use and Resistance in Australia (AURA) Surveillance System. In addition to supporting AMS teams to identify areas of focus, baseline data are useful for evaluating improvements in practice.

Table 2.5: Examples of sources of information on antimicrobial use and resistance

Data	Data sources: Hospital sector	Data sources: Aged care homes	Data sources: Community and primary care
Quantity of antimicrobial use	• National Antimicrobial Utilisation Surveillance Program (**A, L+N**) • Hospital pharmacy department dispensing reports (**L**)	• NPS MedicineWise aged care home reports on antimicrobial use in urinary tract infections (**L**)	• NPS MedicineWise feedback on PBS/RPBS prescribing (**L**) • Australian Atlas of Healthcare Variation[52] (**N**)
Prevalence of antimicrobial use	• National Antimicrobial Prescribing Survey (**A, L+N**)	• Aged Care National Antimicrobial Prescribing Survey (**A, L+N**)	• NPS MedicineWise MedicineInsight program (**A, N**)
Quality of antimicrobial use	• National Antimicrobial Prescribing Survey (**A, L+N**)	• Aged Care National Antimicrobial Prescribing Survey (**A, L+N**)	• NPS MedicineWise MedicineInsight program (**A, N**)
Antimicrobial expenditure	• Hospital pharmacy department dispensing reports (**L**)	• None available	• None available
Antimicrobial susceptibility patterns or antibiograms	• Microbiology laboratory • Australian Passive AMR Surveillance System (**A, L+N**)	• Microbiology laboratory • Australian Passive AMR Surveillance System (**A, L+N**)	• Microbiology laboratory (**L**) • Australian Passive AMR Surveillance System (**A, L+N**)
Infection surveillance data	• Infection prevention and control audits (**L**)	• Aged Care National Antimicrobial Prescribing Survey (**A, L+N**)	• None available

AMR = antimicrobial resistance; AURA = Antimicrobial Use and Resistance in Australia; PBS = Pharmaceutical Benefits Scheme; RPBS = Repatriation Pharmaceutical Benefits Scheme
Note: **A** = AURA program participant; **L** = local data; **N** = national data; **L+N** = participation generates local and national data

2.5.4 Determining priority areas for antimicrobial stewardship activities

A gap analysis and risk assessment of the information gathered from the self-assessment, the review of policies and prescribing guidelines, and the data available on antimicrobial use and AMR will help the AMS team to identify:

- Elements of the AMS program that are missing or need improvement
- Areas that should be improved
- Priorities for action.

Risk assessments review the likelihood of occurrence and the size of the likely impact. The AMS risk assessment could consider, for example, whether activities should be focused on particular antimicrobial agents or particular clinical conditions, or whether a broader perspective is needed. In the hospital setting, if existing infrastructure and resources are limited, AMS teams may want to start by targeting specific medicines that have suboptimal local use. Pharmacy costing data, comparative use rates or a baseline audit of the appropriateness of antimicrobial use obtained through AURA, the National Antimicrobial Prescribing Survey (NAPS) and the National Antimicrobial Utilisation Surveillance Program (NAUSP) will guide local priorities. For example, reserve agents such as intravenous quinolones, carbapenems and aztreonam could be targeted, as could third-generation cephalosporins. High-risk agents (for example, aminoglycosides) could be included for safety reasons.

Efforts to improve antimicrobial prescribing for specific clinical conditions (for example, community-acquired pneumonia, asymptomatic bacteriuria, skin and soft-tissue infections) has been shown to be effective, as has targeting patients infected with key pathogens (for example, *S. aureus* bacteraemia, gram-negative bacteraemia, candidaemia).[53,54] This approach relies on the AMS team being able to identify patients whose therapy requires review (for example, febrile neutropenic patients).

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Surgical prophylaxis in hospitals is another area that could be prioritised for attention. Data from the annual NAPS reports show that two out of five prescriptions for surgical prophylaxis are inappropriate.[55] This is of particular importance for private hospitals, which provide around 65% of all elective surgical procedures in Australia, including 75% of orthopaedic knee operations and 70% of major eye operations.[56,57] Results from a study into the appropriateness of antimicrobial prescribing in three large Australian private hospitals in 2013 showed that prescriptions for treatment of infection were generally judged to be appropriate (80% appropriate), whereas the appropriateness of prescribing for surgical prophylaxis was much more problematic (only 40% appropriate).[58] The Australian Commission on Safety and Quality in Health Care (the Commission) has issued guidance regarding surgical prophylaxis and will be working with the Royal Australasian College of Surgeons to further support local AMS programs.

By targeting problem areas, the benefits of the program are likely to be demonstrated quickly, which can help build momentum for future initiatives.

2.5.5 Identifying effective interventions

Essential strategies for successful AMS programs are listed in Box 2.1. The strategies are complementary and some are interdependent – for example, collecting antimicrobial prescribing data to feed back to prescribers in an education session. AMS programs therefore need to comprise a range of interventions and strategies, especially those that have been shown to influence prescribing behaviour, such as restrictive, persuasive and enablement strategies. (See Chapter 3: 'Strategies and tools for antimicrobial stewardship'.)

AMS teams will need to determine which AMS strategies to test, and how they should be implemented in their local context. AMS teams looking to implement or review an AMS program may find it helpful to contact different hospitals or practices to learn how their AMS programs have been developed, what strategies have been selected and what lessons were learned during their implementation. For strategies to be adopted and accepted by prescribers, they need to fit within the clinical workflow, and their implementation should be carefully planned and endorsed by the executive. Different strategies are discussed in Chapter 3: 'Strategies and tools for antimicrobial stewardship', including options for implementation in different settings.

Driver diagrams

A driver diagram is a useful approach to determine which interventions to include in the AMS program.

A driver diagram organises information on proposed activities so the relationships between the aim of the improvement project and the changes to be tested and implemented are clear. A driver diagram is typically set out using columns and comprises:

- An aim statement – the project goal or vision
- Primary drivers – high-level factors that you need to influence to achieve the aim
- Secondary drivers – specific factors or interventions that are needed to achieve the primary drivers; these are targeted areas for specific changes or interventions
- Change ideas – well-defined change concepts or interventions to consider for the secondary drivers, and what exactly will be done and how it will be done.

The Institute of Healthcare Improvement and Centers for Disease Control developed an AMS driver diagram[20] that has been adopted by the NSW Clinical Excellence Commission.[59] The AMS driver diagram in Figure 2.2 describes these processes.

If a driver diagram is considered an appropriate tool, it may be accompanied by a change package that outlines specific interventions that act positively on those drivers. As well as helping teams to identify factors that need to be considered to achieve program goals, the driver diagram can be used to communicate the change strategy and guide the development of a measurement framework.

Driver diagrams can be developed and used for specific AMS problems (for example, to reduce inappropriate antimicrobial use in urinary tract infections) and may be developed for use in other settings.

Once the strategies and specific interventions have been identified in the driver diagram, they should be endorsed by the AMS committee and included in the original and ongoing AMS program plans (see Documenting and implementing the antimicrobial stewardship plan).

2.5.6 Defining measurable goals and outcomes

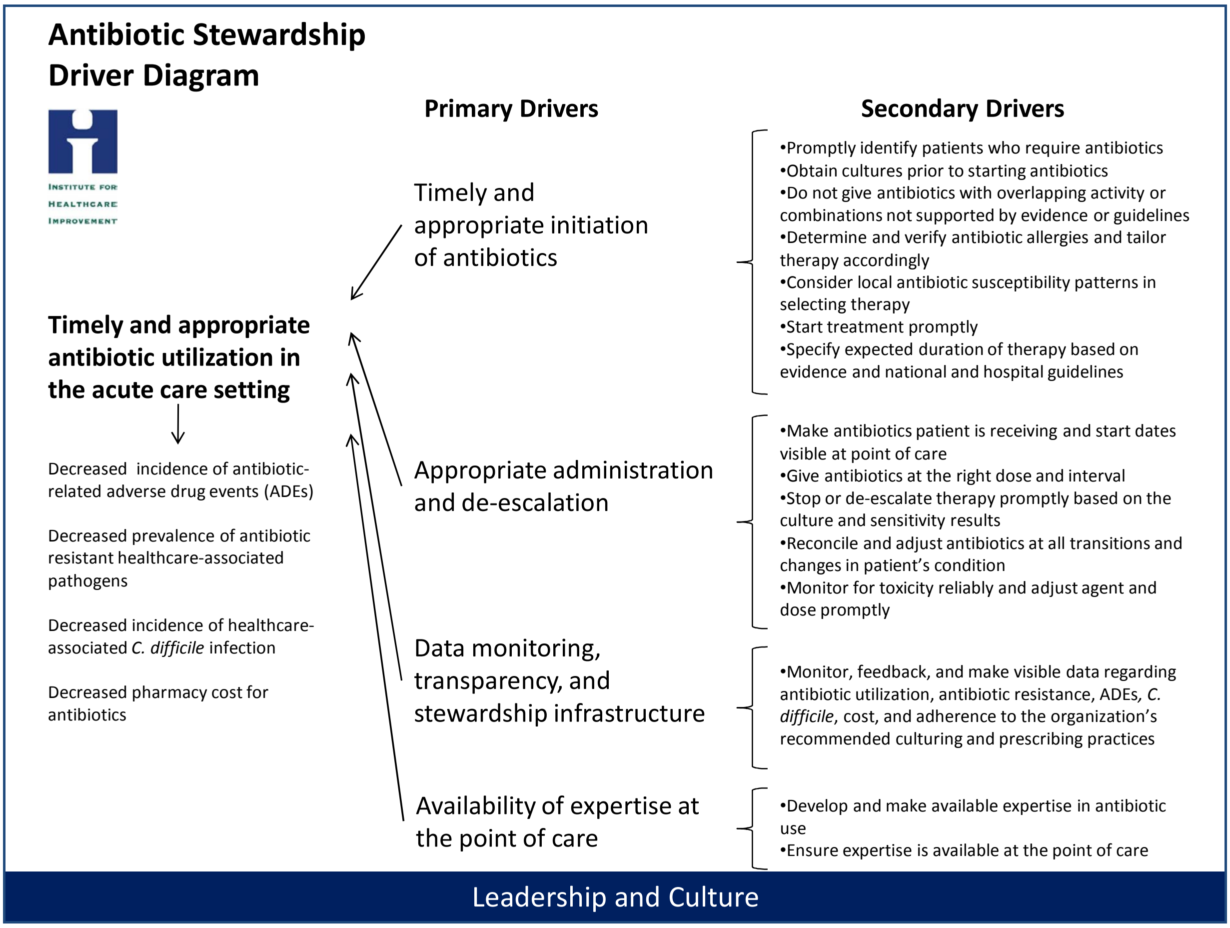
To demonstrate and enable improvements resulting from AMS interventions, the AMS team should ensure that goals and outcomes are measurable and clearly defined. When initiating a program, the goals should be targeted, small and well defined (for example, reduced use of one or a few antimicrobials, rather than a larger goal of decreasing use of all agents or decreasing AMR rates).[60] As the program progresses and achievements accrue, the goals and outcomes can be expanded.

The AMS team should coordinate the collection and analysis of key measures to assess the effectiveness of the AMS strategies implemented, including antimicrobial use and AMR. A balanced set of measures should be agreed and include[12,61]:

- Structural measures – Are the right elements in place?
- Process measures – Are the systems performing as planned?
- Outcome measures – What is the result?
- Balancing measures (to monitor unintended consequences) – Are the changes causing new problems?

The measures need to be sustainable, and the measurement framework should be included in the AMS plan (see Chapter 6: 'Measuring performance and evaluating antimicrobial stewardship programs').

Figure 2.2: Example of a driver diagram for hospital-based antimicrobial stewardship



Source: Centers for Disease Control and Prevention[20]

2.5.7 Documenting and implementing the antimicrobial stewardship plan

Documentation of the plan for the program is important to ensure that everyone – executive, management and clinicians – are 'on the same page'. The documentation should include the results of the assessment and planning steps (local context, resources, policy, and antimicrobial use and AMR); the priority areas for AMS; and the interventions that will be implemented. One way to document the plan is to develop a driver diagram to identify the interventions that will be used, and then add the resources needed and the timing planned for each intervention.

It is important to obtain executive agreement to establish the AMS program and implement it within assigned resources. Documentation of the plan is essential for this step.

In most cases, a period of testing will be needed before the new strategies are introduced or the program is fully implemented, and this should be built into the plan. Testing new processes allows unforeseen problems to be resolved, and interventions evaluated and refined before full implementation into widespread day-to-day operations. Including different individuals and perspectives in both the planning and testing phases will help reduce resistance to change.[62]

In general, testing should follow a QI audit sequence such as plan–do–study–act cycles. Examples of QI models are available from the Institute for Healthcare Improvement's Model for improvement. (See also Resources for examples of AMS toolkits from organisations that use a QI approach to implementation.)

When the AMS team and committee are satisfied that the improved practice or behaviour is established, steps can be taken to spread the intervention to other parts of the organisation (see Resources for tools to support the spread of AMS interventions).

2.5.8 Educating the workforce

Education is an essential component of any AMS program. It should include consumers and clinicians from all healthcare settings who are involved in the antimicrobial medication management pathway. Education provides the foundation of knowledge and understanding that will increase acceptance of AMS strategies, and improve the appropriateness of prescribing and antimicrobial use.

For clinicians, AMS education should start during undergraduate training and continue throughout their careers. Local education programs should include local AMS recommendations. Programs that are multifaceted and include one or more active educational activities are more likely to be successful in changing clinicians' behaviour.

Raising awareness of AMR may be of particular importance for some organisations to overcome workforce perceptions that AMR is not an issue in their facility. For example, a 2014 survey of 330 private hospital visiting medical officers, nurses, midwives and pharmacists revealed a prevalent perception that AMR was more of a problem in other hospitals than in the surveyed private hospital, and only 36% of respondents believed that AMR affected care of their patients.[17] Studies have revealed similar findings in other acute settings and in the community.[63-65] P

Smaller facilities, including rural and remote hospitals, private facilities and aged care homes, may need to draw on communication and education resources available in larger organisations. Advances in technology have made education more accessible to those working outside metropolitan areas. Clinicians can access education on AMS through webinars, online training modules, video lectures, and education activities organised by professional organisations and state or territory AMS networks or committees. Infectious diseases physicians, an AMS pharmacist, or the microbiology workforce from a larger hospital or the LHN/LHD can also be engaged to provide outreach education in person or by online tools. R P AC

Educational activities provided by an organisation need to be assessed, and an evaluation process should be built into the program.[66] Records of AMS education provided, along with records of attendance and certificates of online training modules completed, should be maintained by the organisation. Hospitals, LHNs or LHDs may have existing systems or structures, such as education and QI departments, to assist with this. As well as measures of participation, the evaluation process could also include measures of effectiveness such as pre-knowledge tests and competency assessments. (See Chapter 5: 'Antimicrobial stewardship education for clinicians'.) To encourage uptake among senior clinicians, continuing AMS education could be part of visiting medical officer accreditation for admitting rights at a hospital. Education for consumers is discussed in Chapter 7: 'Involving consumers in antimicrobial stewardship'.

2.5.9 Developing and implementing a communication plan

Robust communication is critical to raise awareness of the AMS program and initiatives, engage stakeholders and disseminate results. Communicating why change is required, providing information on how the change will occur, and reporting ongoing progress to affected individuals and groups will minimise resistance to change. The communication plan should consider:

1. Raising awareness and promoting the AMS program and its specific initiatives or elements
Communication about the AMS program should be clear and concise, outline the goals and benefits of the program, and contain key clinical messages.[66] The Antimicrobial Stewardship Clinical Care Standard[51] and supporting documentation are useful resources for communicating clinical messages (see also Resources).

2. Issuing AMS program updates
Key antimicrobial outcomes should be reported at least quarterly to the executive, directorates and specific clinical areas, and an annual report that summarises data on antimicrobial use and QI initiatives should be published.[37] Organisational laboratory susceptibility data (in the form of antibiograms) should also be reported to the AMS committee at least annually.

3. Providing feedback on antimicrobial prescribing and program outcomes, including improvements over time Communicating and learning from data are important[66], and any unexplained deviation from accepted prescribing practices should be promptly reported back to prescribers. Initially, presenting locally derived, meaningful data to small groups of clinicians in face-to-face meetings (for example, at departmental or practice meetings) is likely to be more successful than emailing out formal reports. However, different strategies are likely to be necessary to disseminate all data. Organisation-wide measures of the quality of prescribing should be regularly reported to prescriber groups, and patient safety and quality groups in the organisation (see Chapter 6: 'Measuring performance and evaluating antimicrobial stewardship programs').

Antibiotic Awareness Week, held each year during the second week of November, is a good time to communicate with clinicians in the organisation or practice about the local AMS program, and provide feedback on local activities and achievements (more information on Antibiotic Awareness Week is available from the Commission and NPS MedicineWise websites; see also Resources).

2.6 Sustaining the antimicrobial stewardship program

The AMS program is expected to evolve over time, depending on the results of QI testing, evaluation and ongoing monitoring, any change in the complexity of service provision, and the availability of new diagnostic tools and IT systems.

Maintaining an AMS program can be challenging, but continuous planning and evaluation with feedback to clinicians will support sustained improvements (see Chapter 6: 'Measuring performance and evaluating antimicrobial stewardship programs'). Ongoing education is critical to the engagement of clinicians and others involved in AMS initiatives (see Chapter 5: 'Antimicrobial stewardship education for clinicians'). Programs need to communicate successes with the use of process and outcome data, and be ready to respond to changing circumstances. It is likely that programs will need to change as new challenges are identified, and goals and achievements are realised.

Using a QI framework will support sustainability. Once a practice has become established or behaviour change has occurred, attention needs to be refocused on consolidating improved prescribing practices and behaviours. Several measurement cycles might be needed to identify whether changes to clinical practice have been embedded in the organisation. If it becomes evident that practice change has not been sustained, strategies may need to be refined or retested.

Examples of how different health service organisations have approached implementing and sustaining an AMS program are provided in Resources.

Examples of successful and sustained AMS programs that have incorporated some of the above strategies are provided in Appendix A.

Resources

Governance of antimicrobial stewardship

- An example of the roles and responsibilities that are expected of the chief executive and LHN/LHD chief executive officers: SA Health Antimicrobial Stewardship Policy Directive

Antimicrobial stewardship committee and team

- Advice on establishing effective AMS committees and teams, including their composition and roles: NSW Clinical Excellence Commission's *Antimicrobial Stewardship Teams & Committees: Fact sheet*
- Example terms of reference for AMS committees: NSW Clinical Excellence Commission's AMS Implementation Toolkit
- Cosgrove SE, Hermsen ED, Rybak MJ, File TM, Parker SK, Barlam TF. Guidance for the knowledge and skills required for antimicrobial stewardship leaders. Infec Control Hosp Epidemiol 2014;35:1444–51.

Antimicrobial stewardship program plan

- Information on the effect of context on QI: The Health Foundation
- A tool to identify weak aspects of context and consider what can be done to modify those aspects: Model for Understanding Success in Quality (MUSIQ)
- AMS self-assessment tools and links
  - NSW Clinical Excellence Commission: Antimicrobial Stewardship Progress & Planning Tool
  - SA Health: Antimicrobial Stewardship Program Self-evaluation Toolkit
  - Centers for Disease Control and Prevention: Checklist for Core Elements of Hospital Antibiotic Stewardship Programs
  - Centers for Disease Control and Prevention: Core Elements of Antibiotic Stewardship for Nursing Homes Checklist
  - Centers for Disease Control and Prevention: Core Elements of Outpatient Antibiotic Stewardship Checklist
  - Core and supplementary structure indicators for hospital AMS programs: Transatlantic Taskforce on Antimicrobial Resistance
  - National Institute for Health and Care Excellence: Antimicrobial stewardship: systems and processes for effective antimicrobial medicine use
  - Royal College of General Practitioners: TARGET Antibiotics Toolkit Self-Assessment Checklist
- Agency for Healthcare Research and Quality: examples of patient safety culture surveys for different healthcare settings
- Examples of Australian AMS policies
  - NSW Clinical Excellence Commission: *Sample Antimicrobial Stewardship Policy: for a Local Health District or Network*
  - SA Health: Antimicrobial Stewardship Policy Directive
- Resources to support AMS: NPS MedicineWise
- Public Health Ontario: selecting antimicrobial stewardship strategies
- Barlam TF, Cosgrove SE, Abbo LM, MacDougall C, Schuetz AN, Septimus EJ, 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;62:1197–202.
- Resources for Antibiotic Awareness Week: the Commission and NPS MedicineWise

Business case resources

- Public Health Ontario: *How to Make a Business Case for an Antimicrobial Stewardship Program*
- Society for Healthcare Epidemiology of America: *Antimicrobial Stewardship Program Proposal Sample*
- Sinai Health System – University Health Network: spreadsheet for start-up costs and projections
- Making a business case for antimicrobial stewardship: Tamma PD, Cosgrove SE. Antimicrobial stewardship. Infect Dis Clin North Am 2011;25:245–60.

Implementation toolkits

- NSW Clinical Excellence Commission: AMS Implementation Toolkit
- Nathwani D, Sneddon J: *A Practical Guide to Antimicrobial Stewardship in Hospitals*
- EQuIP Program (Education, Quality, Infection Prevention, Training, and Professional Development): *Jump Start Stewardship: Implementing antimicrobial stewardship in a small, rural hospital*
- National Quality Forum: *National Quality Partners Playbook: Antimicrobial stewardship in acute care*
- Agency for Health Research and Quality: Toolkit for Reduction of *Clostridium difficile* through Antimicrobial Stewardship
- Agency for Health Research and Quality: Toolkits for AMS interventions in aged care homes – Implement, monitor, and sustain an antimicrobial stewardship program

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Appendix A: Examples of successful and sustained antimicrobial stewardship programs

Case study A1: A successful and sustained Australian antimicrobial stewardship program in one Australian hospital, 2012–2016

Setting

Large metropolitan hospital of 380 beds.

Team

- Dedicated infectious diseases (ID) physician, increasing from 0.2 full-time equivalent (FTE) to 0.5 FTE over time as program expanded
- ID team with registrar
- Dedicated pharmacist (0.2 FTE)
- Considerable input from pharmacy dispensary and clinical teams (for example, education, prescribing and formulary reviews, safety and quality).

Resources

Supportive ID team; pharmacy service, including clinical pharmacists; clinical microbiology service, and infection prevention and control service; executive support; and access to advice and essential electronic prescribing guidelines (local or *Therapeutic Guidelines: Antibiotic*).

Strategies

The core strategies developed to implement the antimicrobial stewardship (AMS) program are listed below.

2012

- Implemented a formal antimicrobial restrictions procedure and ID approval system, incorporating phone-based ID approval codes
- Developed and implemented a local antimicrobial formulary and restriction policy, and a gentamicin procedure.

2013

- Established an AMS advisory committee, chaired by the Executive Director of Medical Services, to help establish the AMS program and show support from the hospital executive
- Established an annual quality improvement plan for AMS
- Started contributing data to the National Antimicrobial Utilisation Surveillance Program, with review of those data by the AMS committee
- Developed and implemented local guidelines, starting with a febrile neutropenia guideline
- Started annual point prevalence surveys, with feedback to clinicians, using the National Antimicrobial Prescribing Survey (NAPS) method (see Figures A1–A3)
- Started participating in annual Antibiotic Awareness Week, using national presentation from the Australian Commission on Safety and Quality in Health Care as a basis, and incorporating local data that highlighted areas that were doing well and those requiring attention (including annual NAPS data and key improvement areas); data discussed at medical grand rounds
- AMS committee developed and started annual review of local antibiograms
- Initiated regular clinical reviews of guidelines and prescribing to validate processes
- Started clinical education using multiple modalities, including structured education from the ID, AMS and clinical pharmacy teams, as well as on-the-spot ward education from ward pharmacists.

2014

- Started accreditation against the National Safety and Quality Health Service (NSQHS) Preventing and Controlling Healthcare-Associated Infection Standard
- Developed and implemented local AMS clinical procedures, as well as more widespread guidelines, such as
  - community-acquired pneumonia guideline
  - paediatric empirical quick reference guide
  - *Staphylococcus aureus* bacteraemia guideline
  - vancomycin guideline
  - intravenous-to-oral switching guideline
  - hospital-acquired pneumonia guideline

  (These guidelines are maintained locally based on usage and risk; some are informed and updated based on available statewide policy, such as for vancomycin)
- Expanded program to incorporate medical AMS education during orientation and developed an AMS intranet page
- Following a review of Hospital in the Home services, established improved procedures for antibiotic infusor devices for those services, incorporating
  - specific ID approval codes
  - implementation of a discharge approval sheet
  - initiation of active ID review at weekly Hospital in the Home infusor clinics
  - improved ordering and review processes in pharmacy.

2015

- Marked the launch of the statewide formulary, incorporating a comprehensive anti-infective formulary with local implementation
- Developed a procedure for post-exposure prophylaxis after non-occupational exposure to HIV
- Consolidated and further refined processes (for example, responding to antimicrobial shortages and reviewing antimicrobials stored in clinical areas)
- Provided letters to the Division of Surgery, highlighting improvements in surgical prophylaxis.

2016

- Tabled reports on antimicrobial incidents, infection control and antimicrobial resistances at meetings of the AMS committee for review.

Review of AMS committee membership

The AMS committee was firmly established in the organisational structure, enabling a change in the committee chair from executive leader to ID/clinical microbiology consultant. The AMS committee receives oversight from, and reports to, the relevant drug and therapeutics committee (DTC), which in turn reports to the Local Hospital Network (LHN) Clinical Governance Committee. The AMS committee makes recommendations to the DTC, and sends updates to the LHN committee about the NSQHS Preventing and Controlling Healthcare-Associated Infection Standard regarding AMS actions.

Executive leadership for the Preventing and Controlling Healthcare-Associated Infection Standard was determined to be no longer essential, although links are maintained.

AMS committee members include:

- ID/clinical microbiology consultant (chair)
- DTC chairperson or representative
- ID physicians and clinical microbiologists
- Consultant physicians from other LHN campuses
- Pharmacy directors and senior pharmacists from different campuses and departments
- Infection prevention and control representative.

The AMS program has been expanded into other areas of the LHN, where it contributes to statewide processes and policy development, such as the review of antimicrobial formulary applications and guidelines.

Monitoring, review and feedback

Based on surveillance, intervention and feedback, the following improvements in prescribing were seen:

- Reduced duration of ciprofloxacin for procedural prophylaxis during prostatic biopsy following correspondence from pharmacy (2014)
- Audit and review of ceftriaxone use in the intensive care unit following National Antimicrobial Utilisation Surveillance Program (NAUSP) data review (2014)
- Intervention and reduction in inappropriate norfloxacin use following NAUSP data review (2014)
- Vancomycin use and education to clinicians (2015)
- Gentamicin audit showed ID approval requirement at 72 hours is working and improving patient safety with input from ID (2016).

Results of AMS activities

- AMS committee activities: appropriateness of antimicrobial prescribing improved from 69% in 2013 to 87% in 2015, and this was sustained in 2016 (Figure A1)
- The percentage of surgical prophylaxis given for more than 24 hours decreased from more than 30% in 2014 to less than 20% in 2016 (Figure A2)
- Targeted intervention (management of chronic obstructive pulmonary disease): appropriateness increased from 14% in 2015 to 90% in 2016 using education and awareness strategies (Figure A3)
- Improved governance and procedures relating to antimicrobial infusors: significant reductions in antimicrobial use and post-implementation cost savings of around $45,000.

Figure A1: Appropriateness of antimicrobial prescribing at the hospital, using National Antimicrobial Prescribing Survey methods, 2013–2016

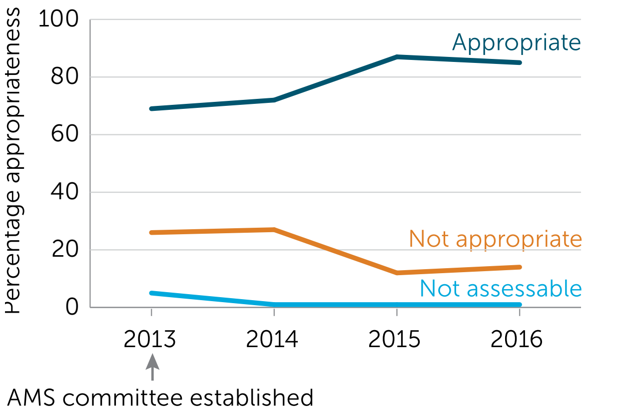


Figure A2: Percentage of surgical prophylaxis given for more than 24 hours, 2013–2016

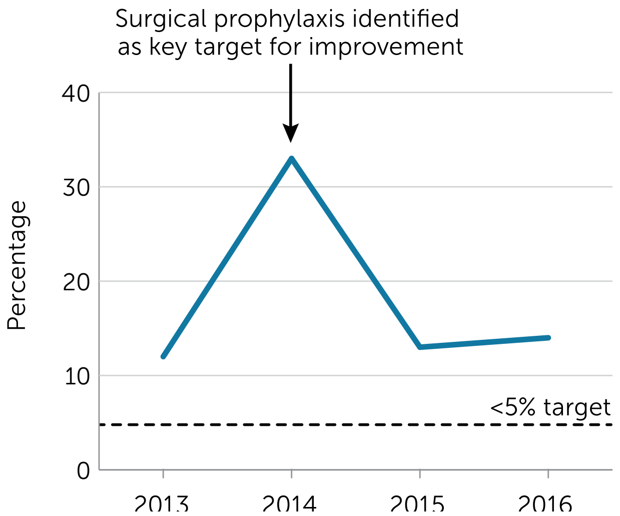
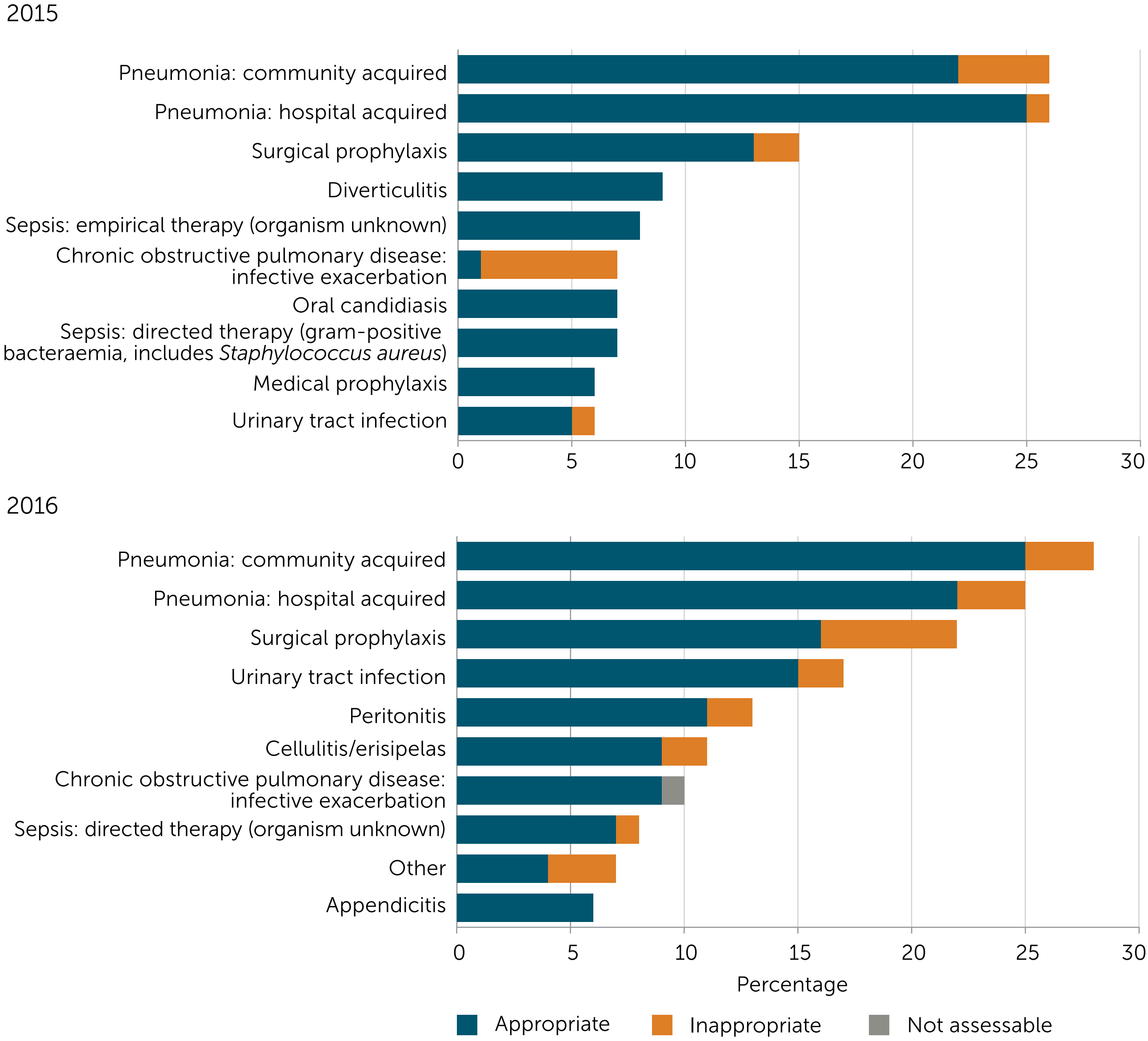


Figure A3: Most common indications for antimicrobial prescribing in the hospital, using National Antimicrobial Prescribing Survey methods, 2015 and 2016



Note: The total numbers of antimicrobial prescriptions were 199 in 2015 and 208 in 2016.

Case study A2: Implementation and sustainability of an Australian antimicrobial stewardship program in one Australian hospital, 2003–2017

Setting

Tertiary referral hospital with approximately 500 beds.

Team

Dedicated 1.0 full-time equivalent (FTE) infectious diseases (ID) pharmacist with 0.2 FTE ID physician.

Resources

Supportive ID team, pharmacy service, clinical microbiology service, and infection prevention and control service.

Strategies

The core strategies developed to implement the antimicrobial stewardship (AMS) program are listed below.

2003

- Introduced a paper-based 'monitored antibiotic authority form' for all third-generation cephalosporins and intravenous β-lactam/β-lactam inhibitors prescribed.

2005

- Started contributing data to the National Antimicrobial Utilisation Surveillance Program.

2007

- Established hospital antibiotic stewardship group to develop a formal AMS program
- Started formal ID–adult intensive care unit (ICU) clinical liaison (including twice-weekly clinical liaison rounds).

2008

- Started formal ID–haematology clinical liaison (including weekly clinical liaison rounds)
- Developed successful business case for a dedicated ID pharmacist (1.0 FTE) position on basis of escalating antimicrobial use and costs, and concerns about antimicrobial resistance because of a hospital outbreak of vancomycin-resistant enterococci
- Established hospital AMS committee
- Endorsed antimicrobial restriction policy with three categories of antimicrobials: category A (unrestricted), category B (restricted) and category C (highly restricted).

2009

- Formally launched the AMS program
- Implemented electronic clinical decision support system to enable implementation of the antimicrobial restriction policy
- Started daily AMS rounds (weekdays only) to review selected patients taking restricted antimicrobials.

2010

- Started formal ID–neonatal/paediatric ICU clinical liaison (including weekly clinical liaison rounds)
- Developed guidelines for aminoglycosides and vancomycin
- Started collaborative work with surgical units and anaesthetists to develop local surgical antibiotic prophylaxis guidelines consistent with *Therapeutic Guidelines: Antibiotic* to assist with local implementation, together with auditing and feedback processes

- Conducted first whole-of-hospital point prevalence antimicrobial use survey (pilot site using the European Surveillance of Antimicrobial Consumption Network methodology); since 2010, these surveys have been conducted at least annually, targeting clinical syndromes or clinical units/services, with participation in the National Antimicrobial Prescribing Survey and with feedback provided to the relevant units/services.

2011

- Developed guidelines relating to antimicrobial use to assist local implementation, including for febrile neutropenia in haematology–oncology patients, and management of *Staphylococcus aureus* bacteraemia, endocarditis and prosthetic joint infection.

2012

- Engaged with stakeholders (including the emergency department) in response to inappropriate antimicrobial use in the treatment of community-acquired pneumonia to develop and implement a local community-acquired pneumonia guideline with an associated clinical pathway, together with an agreed audit and feedback process.

2013

- Joined a statewide AMS network that was established to support AMS programs across the state
- Provided support to regional acute hospitals without a dedicated ID service to help establish their AMS programs, and provided ongoing clinical support and AMS committee membership
- Replaced the antimicrobial restriction policy with an antimicrobial use protocol that specifies that antimicrobials are to be prescribed in line with *Therapeutic Guidelines: Antibiotic*, as well as prescribing criteria and antimicrobial restrictions
- Developed an online state medicines formulary for the state health service with a comprehensive antimicrobial component
- Formally launched the adult sepsis pathway in the emergency department with an accompanying empirical antibiotic therapy guideline
- Started reporting an annual cumulative antibiogram.

2014

- Changed the hospital AMS committee to a regional AMS committee, expanded to involve primary health, oral health and mental health services
- Engaged with the general surgical unit in response to inappropriate antimicrobial use in the treatment of intra-abdominal infections to develop and implement a local antibiotic therapy guideline for intra-abdominal infections, and engaged with the general surgical clinical pharmacist to provide ongoing support to the junior clinical workforce to ensure adherence to the guideline.

2015

- Aligned auditing of surgical antibiotic prophylaxis with surgical site surveillance for key surgical procedures, with reporting to surgical units and external reporting to the Australian Council on Healthcare Services (Figure A4)
- Started annual antimicrobial use surveys in the rural inpatient facilities in the state, facilitated through the state infection prevention and control unit
- Started formal engagement of general practitioner liaison officers and general practitioner prescribers within the rural inpatient facilities.

2016

- Started formal ID–renal clinical liaison (including weekly clinic and regular meetings).

2017

- Helped establish an overarching state health service AMS committee to provide formal governance for AMS across the health service, which includes acute public hospitals, rural inpatient facilities, oral health services and mental health services
- Started planning statewide consistency for guideline development, and auditing/feedback and reporting processes
- Started planning a proposed relaunch of the AMS program for 2018.

Examples of AMS program outcome measurements

AMS outcome measurements are shown in Table A1 and Figures A4 and A5.

Figure A4: Surgical antimicrobial prophylaxis (SAP) data for coronary artery bypass graft procedures according to Australian Council on Healthcare Service criteria

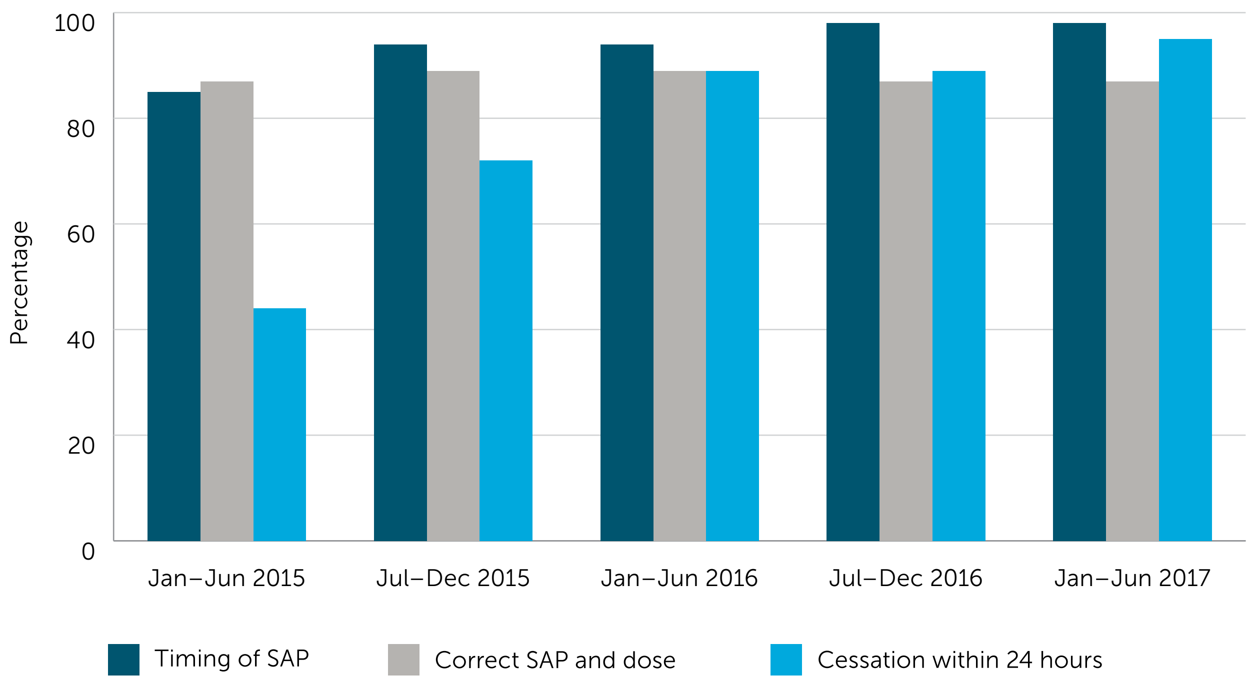


Figure A5: Total combined cost of antibacterial agents per occupied bed day (OBD)

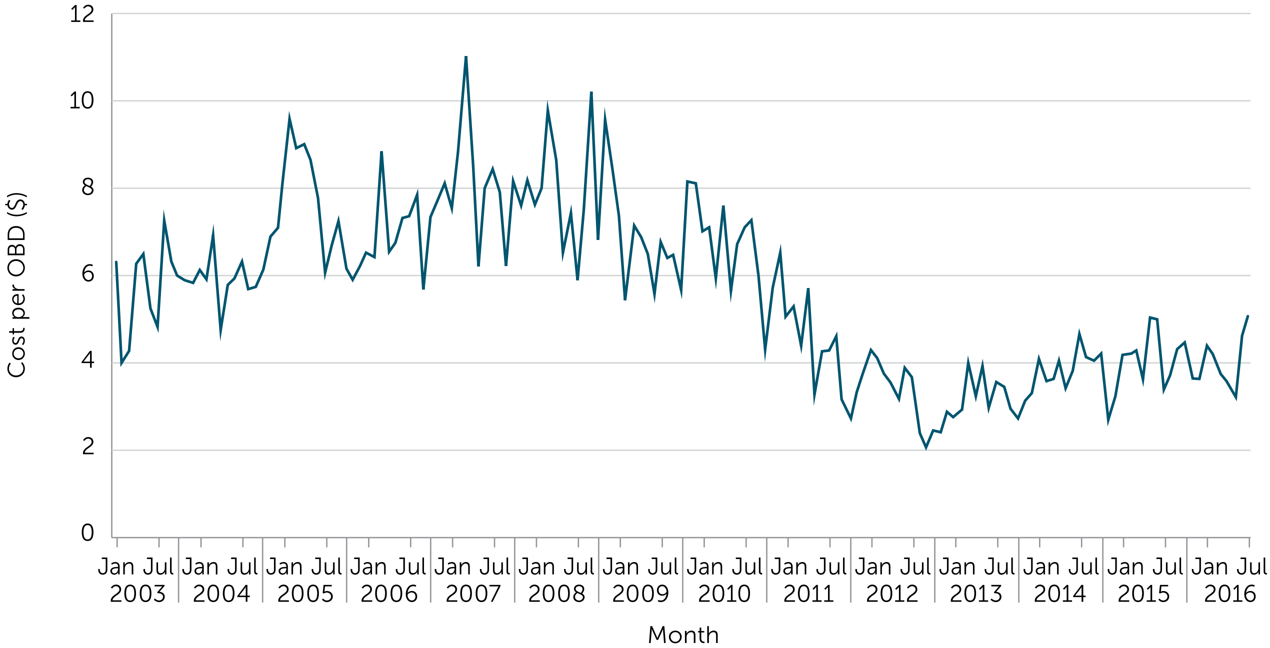


Table A1: Appropriateness of antimicrobial use: whole-of-hospital antimicrobial use data from the National Antimicrobial Prescribing Survey, 2015

Criteria	Percentage
Percentage of inpatients on antimicrobials	38
Percentage appropriateness (where appropriateness was assessable)	82
Percentage documented indication	80

AUSTRALIAN COMMISSION
ON SAFETY AND QUALITY IN HEALTH CARE

3 Strategies and tools for antimicrobial stewardship

Antimicrobial Stewardship in Australian Health Care

2018

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Acronyms and abbreviations

Abbreviation	Definition
AMR	antimicrobial resistance
AMS	antimicrobial stewardship
Commission	Australian Commission on Safety and Quality in Health Care
DTC	drug and therapeutics committee
ICU	intensive care unit
ID	infectious diseases
LHD	Local Health District
LHN	Local Hospital Network
NAPS	National Antimicrobial Prescribing Survey
NSQHS Standards	National Safety and Quality Health Service Standards
PBS	Pharmaceutical Benefits Scheme
PCR	polymerase chain reaction
POCI	point-of-care intervention
TGA	Therapeutic Goods Administration

Key points

- The use of evidence-based guidelines has been shown to be effective in improving prescribing practice.
- Involving clinicians in the development and implementation of guidelines and tailoring implementation strategies to suit the local context can increase guideline uptake.
- Care bundles can be a useful way to package a group of simple evidence-based steps that can help promote evidence-based care.
- A formulary for antimicrobials, with restrictions on use, and an approval system for antimicrobials are effective in changing prescribing practices.
- Timely review of antimicrobial prescriptions, ideally by an antimicrobial stewardship (AMS) team comprising an infectious diseases (ID) physician and clinical pharmacist, is a useful strategy to optimise antimicrobial use.
- Point-of-care interventions, based on reviews or data, can improve patient management and patient outcomes.
- It is important that hospitals have access to ID physicians or AMS pharmacists to provide AMS support when needed. Strategies to include expert advice in AMS programs may include networking and using telehealth.

3.1 Introduction

This chapter discusses four of the essential strategies for an antimicrobial stewardship (AMS) program outlined in Chapter 2: 'Establishing and sustaining an antimicrobial stewardship program':

- Implementing clinical guidelines consistent with *Therapeutic Guidelines: Antibiotic*[1] that take into account local microbiology and antimicrobial susceptibility patterns
- Implementing formulary restriction and approval systems that include restricting broad-spectrum and later-generation antimicrobials to patients in whom their use is clinically justified
- Reviewing antimicrobial prescribing, with intervention and direct feedback to the prescriber
- Implementing point-of-care interventions (POCIs), including directed therapy, intravenous-to-oral switching and dose optimisation.

The chapter provides information about practical methods to bring the principles of AMS to the point of prescribing. These represent a mix of strategies – restrictive, persuasive and enablement – that influence prescribing behaviour[2]:

- Restrictive strategies require prescribers to adhere to a set of rules (for example, as decided by a formulary), and prevent prescribers from gaining access to certain antimicrobial agents unless criteria are met and formal approval is granted. This may occur before the prescription is written or at a decided time after the prescription has been filled as part of the post-prescription review
- Persuasive strategies aim to improve prescriber knowledge, and change attitudes and beliefs about prescribing through review and feedback
- Enablement strategies make it easier for prescribers to gain access to the information they need to prescribe appropriately.

Persuasive strategies are more widely practised and more readily accepted by clinicians, and provide greater opportunity to educate prescribers than restrictive strategies.[3] Several leading guidelines on AMS endorse the use of a mix of restrictive, persuasive and enablement strategies to enable comprehensive stewardship in hospital settings. A Cochrane systematic review in 2013 suggested that restrictive strategies have the greatest immediate effect on prescribing behaviour, whereas persuasive strategies may have a slower but more sustained effect.[4] A later review reported that enablement strategies – such as prospective review, audit and feedback, academic detailing, and electronic clinical decision support – increased the effect of other AMS interventions, including those with restrictive elements.[2]

Table 3.1 summarises these strategies, the guidance to support them and the practical tools that enable their implementation. Each of these is discussed in more detail in subsequent sections of this chapter.

Issues that are especially relevant for certain settings – rural and remote hospitals, private hospitals and aged care – are tagged as R, P and AC, respectively, throughout the text.

R P AC

Table 3.1: Strategies, rules and tools for antimicrobial stewardship programs

Strategy	Rules	Tools
Implementing clinical guidelines consistent with *Therapeutic Guidelines: Antibiotic* that take into account local microbiology and antimicrobial susceptibility patterns	• Prescribers prescribe according to current evidence-based guidelines • Prescribers are encouraged to follow care bundles	• Easy access to the current versions of guidelines, including *Therapeutic Guidelines: Antibiotic* • Endorsement of evidence-based guidelines by clinical champions • Barriers to guideline uptake analysed and minimised • Leadership support for new guidelines • Awareness raising and communication activities about guidelines and care bundles • Monitoring and evaluation of AMS over time
Implementing formulary restriction and approval systems that include restricting broad-spectrum and later-generation antimicrobials to patients in whom their use is clinically justified	• Prescribers prescribe according to the formulary • Approval is required for all highly restricted antimicrobials before use; an approval system must be used to register the indication for use of all restricted antimicrobials, and further approval sought if use exceeds three days	• Posters and web pages that make the formulary rules explicit to all prescribers • A formalised approval system should be in place (fax, phone or electronic)
Reviewing antimicrobial prescribing, with intervention and direct feedback to the prescriber	• AMS teams are expected to review all patients receiving highly restricted antimicrobials, or courses of restricted antimicrobials for more than three days	• AMS team to provide regular individualised prescription review • Electronic tools may help prompt review and triage patients
Implementing POCIs (including directed therapy, intravenous-to-oral switching and dose optimisation)	• AMS teams, microbiology services initiate/advise on specific interventions to optimise therapy	• AMS team provides advice on de-escalation, empirical to directed therapy, duration, cessation of therapy and management • Some standard POCIs may be able to be implemented as part of pathways or care bundles (e.g. intravenous-to-oral switching)

AMS = antimicrobial stewardship; POCI = point-of-care intervention

3.2 Prescribing guidelines

Appropriate antimicrobial use happens when antimicrobials are prescribed according to evidence-based guidelines, with choice, dose and duration selected to optimise clinical outcomes and minimise adverse consequences.[5] Prescribing guidelines are an essential requirement for AMS programs. They describe evidence-based best practice and provide a standard for prescribing behaviour for other clinical situations that are not explicitly described in the guidelines.

The involvement of clinicians in the development and implementation of evidence-based practice guidelines can improve antimicrobial prescribing behaviour and thereby influence patient outcomes. The use of practice guidelines has been demonstrated to be effective. For example:

- Implementation of a multidisciplinary practice guideline in a surgical intensive care unit led to a 77% reduction in antimicrobial use, a 30% reduction in overall cost of care, decreased mortality and shorter length of stay[6]
- Implementation of guidelines for managing patients with pneumonia was associated with earlier antimicrobial therapy, which in turn was associated with faster clinical stability, lower inpatient mortality at 48 hours and lower 30-day mortality when care was compliant with recommendations[7]
- The use of guidelines for managing paediatric surgical conditions such as appendicitis was associated with shorter durations of antimicrobial therapy, reduced costs and shorter lengths of hospital stay, without compromising clinical outcomes.[8]

3.2.1 National guidelines

The National Safety and Quality Health Service (NSQHS) Standards require all hospitals and health service organisations to provide ready access to current, evidence-based guidelines for prescribers.[9] In Australia, *Therapeutic Guidelines: Antibiotic*[1] is recognised as the national best-practice guide for antimicrobial prescribing. These guidelines are developed using a rigorous process of consultation with experts from different disciplines, and states and territories. They cover prescribing in the hospital and the community, for adult and paediatric patients, and in urban and rural settings.

3.2.2 Local guidelines

Therapeutic Guidelines: Antibiotic[1] provides treatment recommendations for most infections seen in hospital and community settings. If local prescribing guidelines are necessary, they should reflect the nationally agreed practice described in *Therapeutic Guidelines: Antibiotic*. This also applies to antimicrobial treatment recommendations in clinical guidelines, local care pathways and algorithms. If local guidelines are already in place, they should be reviewed against *Therapeutic Guidelines: Antibiotic*. Where differences are warranted – for example, in response to local antimicrobial resistance (AMR) patterns or an outbreak of a new resistant bacterial strain – an evidence-based rationale should be provided for any variation in practice.

For conditions not covered by *Therapeutic Guidelines: Antibiotic*[1], organisations should refer to the best available evidence to develop guidelines appropriate to the local context. Local guideline development should involve expert guidance from infectious diseases (ID) physicians, microbiologists and pharmacists, and the guidelines should be reviewed and endorsed by the AMS committee.

Existing prescribing guidelines relevant to rural and remote practice, such as the Centre for Remote Health's *CARPA Standard Treatment Manual*[10], can be customised to suit the local conditions and may be useful for nurse-run facilities. R

Health service organisations that do not have on-site access to ID physicians should have antimicrobial prescribing guidelines that are tailored to the local situation, but based on the principles stated above. In the public sector, the Local Hospital Network (LHN) or Local Health District (LHD) should be consulted to ensure that local guidelines are consistent with LHN/LHD policy. The guidelines should describe situations that require discussion with an ID physician or clinical microbiologist, or escalation to larger hospitals, and the relevant referral processes. R P AC

Local guidelines should be regularly reviewed and updated in consultation with key clinicians to ensure that evidence-based best practice is upheld. An important part of the review process is ensuring that only the latest versions of guidelines are available for use. The frequency of review may be routinely over a two-year cycle, or sooner if there have been major changes in protocols or information about emergent antimicrobial resistance. An update at least once per year has been recommended if changes are in response to local pathogen variations.[11]

3.2.3 Promoting guideline uptake

Effort is required to promote prescribing according to guidelines and to ensure appropriate care – this is the key to translating evidence into practice. The existence of a guideline is usually not enough to achieve change, and adherence varies among the workforce, clinical areas and organisations. The 2015 National Antimicrobial Prescribing Survey (NAPS) found that, overall, 23.3% of antimicrobial prescriptions in hospitals were noncompliant with guidelines.[12] Prescriptions for surgical prophylaxis and bronchitis had the highest rate of noncompliance – 41% of prescriptions for these indications did not comply with guidelines. In the community, data from the NPS MedicineInsight program for 2015 showed that a large proportion of the antimicrobials prescribed were not consistent with the first recommendation in Australian guidelines.[13] Concordance with guidelines varied from 27% for sinusitis to 67% for pneumonia.[13]

Guideline development needs to be accompanied by a carefully planned implementation process that includes a program of audit and feedback. To inform implementation planning and promote uptake, it is essential to understand the existing culture and prescribing practices, the drivers affecting them and any barriers to change (see Section 2.5.1 in Chapter 2: 'Establishing and sustaining an antimicrobial stewardship program'). Each of these needs to be considered as part of a local guideline implementation plan.

Guidelines should be considered and endorsed by clinical champions; absence of support can adversely affect effective implementation. During the development phase, concerns raised should be identified and addressed. In Principal Referral Hospitals, where senior medical clinicians influence trainees' prescribing, it is especially important to engage these senior clinicians in the development or promotion of local guidelines. A study in the Netherlands reported increased compliance with guidelines (from 67% to 86%) when clinicians were widely consulted in the revision of guidelines for antimicrobial therapy; active dissemination was also important.[14]

Importantly, the workflow of the workforce involved also needs to be understood so that opportunities to guide change are identified. The AMS team may need to visit relevant hospital departments and attend unit meetings to discuss the guidelines, to promote awareness and to ensure that they are appropriate for the local context. In general, the aim is to make it easier for the workforce to do the right thing. Advice should be readily available, and prompts should be visible during a prescriber's everyday work (see Tools and resources to support guideline implementation).

Ideally, prescribing guidelines should be implemented within a quality improvement framework. The guidelines serve as the starting point for a quality improvement cycle that leads to ongoing refinement of the guidelines, continual guideline implementation, and ongoing improvement in patient outcomes. The process requires ongoing data collection, analysis and feedback to clinicians to ensure awareness of improvements and ongoing compliance with the guidelines. Evaluating the use of prescribing guidelines can help to identify whether implementation strategies are effective and whether alternative approaches are needed, and enables unintended consequences to be identified and addressed (see Section 6.8.3 in Chapter 6: 'Measuring performance and evaluating antimicrobial stewardship programs').

3.2.4 Tools and resources to support guideline implementation

Resources such as posters, checklists, clinical pathways, visual prompts and aids, that are available at the point of care and specific to the local context, can promote guideline uptake. Posters can raise awareness of AMR, and influence attitudes of both prescribers and their patients towards careful antimicrobial prescribing.[15] Other tools – such as laminated cards, booklets and phone apps – may simplify guidelines and make recommendations easily available for prescribers.[16] Links to such tools are provided in Resources.

Checklists, algorithms and clinical pathways have been used by clinicians in hospital and community settings to help to standardise care and promote optimal prescribing.[17] They help promote guideline-concordant practice in everyday care. They can be especially useful in a busy environment (such as those with a high volume of elective procedures that follow fairly predictable clinical courses), because the pathway can prompt decisions in a stepwise, structured fashion. For example, in one hospital, a clinical pathway to manage perforated appendicitis in paediatric patients helped to standardise antimicrobial prescribing, resulting in decreased use of postoperative antimicrobials without an increase in adverse outcomes.[18] Similarly, clinical pathways for the management of pneumonia have been used to promote appropriate empirical antimicrobial choices and investigations, prompt routine daily consideration of de-escalation and intravenous-to-oral switching, and ensure the appropriate duration of antimicrobials.[19]

Public Health England's Start Smart – Then Focus toolkit for antimicrobial treatment and surgical prophylaxis is one algorithm that can be used as a reminder of the principles of good antimicrobial prescribing.[20] Visual prompts on medication charts, such as brightly coloured stickers, have been used with some success in settings such as intensive care units (ICUs), where multiple carers can be involved in clinical decision-making over a few days.[21] They help to make intentions explicit, especially by clearly documenting the indication for starting the antimicrobial, and the intended duration or a planned review date to prompt consideration of cessation when microbiological results are available. They can be especially useful in communicating antimicrobial plans on discharge of patients from the ICU to the ward.

Electronic tools can also promote guideline-concordant prescribing by incorporating alerts, sidebars with icons to enable ready access to information, or more structured decision support algorithms (see Chapter 4: 'Information technology to support antimicrobial stewardship'). Smartphone apps can also be used to access guidelines and prescribing information.

3.2.5 Education and feedback

Guideline implementation and adherence can be facilitated through education (see Chapter 5: 'Antimicrobial stewardship education for clinicians'). Making prescribers aware of local and national guidelines and resources is important in all healthcare settings.[22] Education about the available resources and antimicrobial prescribing should be an ongoing part of continuing education and professional development for all clinicians. Guidelines can form the basis for educating prescribers and other clinicians on accepted practice for antimicrobial prescribing in the organisation. This includes the importance of documenting in the patient's healthcare record the indication for the prescribing decision and, where the prescriber varies from guideline-concordant practice, the rationale for the decision.

General education can be coupled with feedback and local information. Topics addressed should include local antimicrobial prescribing patterns, local AMR patterns for common pathogens, local patterns of infection and, where possible, patient outcomes. Workforce rotations are common in many settings, so effort should be made to repeat communication regularly. Review, feedback and reflection are critical components of any efforts to improve practice (see Post-prescription reviews).

3.2.6 Antimicrobial stewardship care bundles

Care bundles are increasingly used in healthcare quality improvement as a structured way of improving the processes of care and patient outcomes. A bundle may comprise a set of three to five evidence-based practices that, when performed collectively and reliably, have been proven to improve patient outcomes.[23]

Cooke et al.proposed the use of care bundles to improve appropriate antimicrobial prescribing in acute care and surgical prophylaxis (Box 3.1).[24,25] The bundles were broken down into individual measurable practices, and compliance with each element was monitored and used as a target for improving practice.[25] This approach requires routine documentation of the reason for starting the antimicrobial, along with a stop date or review date (see Quality Statement 6 of the Antimicrobial Stewardship Clinical Care Standard[26]).

The two care bundles (treatment and surgical prophylaxis) can be implemented separately or in combination, and AMS teams can adapt the focus of the proposed bundles to their local context. These bundles may be of particular value for smaller services where AMS resources are accessed remotely. Clinical teams could take ownership of the bundle and incorporate it into the existing quality improvement framework.

3.3 Formularies and approval systems

In its simplest form, a formulary is a list of medicines, including antimicrobial agents, that has been approved by an authority (within an organisation or network, or nationally) for use. Formulary systems establish rules governing medicine use.

3.3.1 National formulary

The Therapeutic Goods Administration (TGA) and the Pharmaceutical Benefits Scheme (PBS) form the regulatory system that produces the formulary of

Box 3.1: Antimicrobial care bundles

Treatment bundle

At initiation of treatment, the prescriber:

- Provides a clinical rationale for antimicrobial initiation
- Sends the appropriate specimens to a diagnostic microbiology laboratory (according to local policy)
- Selects the antimicrobial according to local policy and having considered the patient risk group (including drug allergy profile)
- Considers removal of any foreign body, drainage of pus or other surgical intervention, as appropriate.

During continuation of treatment, there is:

- Daily consideration of de-escalation, intravenous-to-oral switching or stopping antimicrobials (based on the clinical picture and laboratory results)
- Monitoring of antimicrobial levels, as required by local policy.

Surgical prophylaxis bundle

- Select antimicrobials that match local guidelines (having considered patient allergies)
- Time the first dose to be within 60 minutes pre-incision
- Stop antimicrobial administration within 24 hours of the preoperative dose or the first dose after post-prescription review.

medicines for Australia. This is done by requiring medicines to be registered before they are allowed onto the market (TGA) and determining which medicines will be subsidised (PBS).

The PBS provides the mechanism whereby access to subsidised antimicrobials can be restricted to approved indications. This acts as a financial disincentive to use those antimicrobials outside the approved indications. A phone-based approval system with documentation of the indication is used, and audits can be conducted to check compliance. Phone-based authorisation and documentation of the indication are also required for antimicrobials that are prescribed beyond the standard durations (for example, for several weeks), which helps to minimise prescriptions for extended durations of therapy. This system has been thought to be responsible for the relatively low consumption of ciprofloxacin in Australia and consequently the low incidence of fluoroquinolone resistance among community-acquired bacterial pathogens in Australia compared with other countries.[27]

3.3.2 State and territory formularies

Several states in Australia, including Queensland, South Australia, Tasmania and Western Australia, have developed statewide antimicrobial formularies. This promotes consistency of prescribing in hospitals, and means that clinicians have clear, common expectations about the availability of broad-spectrum antimicrobials.

3.3.3 Hospital formularies

A formulary that includes a list of restricted antimicrobials is an essential component of a hospital AMS program. The antimicrobial formulary should be appropriate to the needs of the hospital and should consider the range of antimicrobials required, the clinical orientation of the hospital and local AMR. It should be updated periodically, and compliance should be audited.

Responsibility for creating and maintaining a formulary usually lies with a hospital's drug and therapeutics committee (DTC). The DTC evaluates the evidence regarding the efficacy, safety and cost of new agents before deciding whether to endorse their use in the hospital and list them on the formulary. The DTC may have an antimicrobial subcommittee or may use the AMS team to evaluate requests for new antimicrobial agents or new indications for use, and to make recommendations for formulary listing.

It is important that antimicrobial formulary decisions are informed by local microbiological data. For example, if resistance to one antimicrobial class has been emerging locally, the DTC may respond by directing prescribing towards alternative agents or making alternatives available. This may require a change in criteria for approval to use the alternative agents. It is therefore important for microbiologists and ID physicians to provide continuous expert advice to DTCs (through membership of the committee or liaison with the AMS team). Hospitals participating in national passive AMR surveillance, NAPS and the National Antimicrobial Utilisation Surveillance Program will have access to data to inform this decision-making.

In many circumstances, medicines on the formulary have conditions attached to their approval – for example, use may be approved only for a particular unit, for patients with a particular condition, or when other options are contraindicated because of intolerance or demonstrated failure. In the case of antimicrobials, certain medicines may be restricted for use only with approval by nominated expert prescribers, such as ID physicians or microbiologists. When the use of an agent is confined to particular situations, this may guide the way in which stock is made available in the hospital. For example, the hospital might store only selected antimicrobials in theatre and may withdraw antimicrobials from the operating suites if their use is not approved for surgical prophylaxis. Highly restricted antimicrobials might be removed from ward imprest cupboards so that pharmacists are involved in their dispensing, to improve oversight and ensure that their use meets formulary conditions.

It has been well demonstrated that restrictive formularies can direct prescribing patterns in hospitals. Many studies have described changes in formulary restrictions that led to changes in prescribing patterns and, in some cases, changes in local rates of antimicrobial-resistant pathogens.[28-39] However, studies involving multiple centres over longer periods are needed.

Although a restricted antimicrobial list is often used in public hospitals, restrictive formularies have not been common in the private sector.[40] However, the NSQHS Standards include the requirement for AMS programs to have a restrictive formulary and approval system. Therefore, private hospitals and small public hospitals staffed by visiting medical officers will need to consider how best to establish prescribing restrictions, given their resources and prescribing workflow. This may be achieved by using an off-site expert who can provide approval by telephone or an electronic decision support system.

Rural and remote hospitals may be able to access formularies developed at the LHN/LHD level, or at the state or territory level. Restricting access to some antimicrobials[40] may be the most efficient and direct method of monitoring and limiting antimicrobial use in hospitals with limited resources (see the NSW Clinical Excellence Commission's *Antimicrobial Restrictions in Small to Medium-Sized Hospitals fact sheet*). Interested local physicians or pharmacists with access to an ID physician or clinical microbiologist can be used as stewards of the approval system. Smaller hospitals without on-site physicians or pharmacists may use other models.

3.3.4 Antimicrobial approval systems

Approval to use an antimicrobial that the DTC has labelled 'restricted' may occur before the medicine is prescribed (pre-prescription), at a certain time after therapy has started (post-prescription) or at both these times. A 2017 Cochrane review of AMS strategies[2] noted that several studies suggest that antimicrobial approval systems can reduce the volume of broad-spectrum antimicrobials prescribed, thereby reducing medicine expenditure.[41-44] A reduction in adverse drug reactions for patients has also been described.[45] Effects on patient outcomes are less well described, although reduced lengths of hospital stay have been reported after an antimicrobial approval system was deployed and after improvements were made in the appropriateness of empirical antimicrobial therapy.

Many hospitals use a graded approach to classify restrictions, sometimes known as a traffic-light approach, which categorises antimicrobials as unrestricted (green), restricted (orange) or highly restricted (red) (Table 3.2).

Internationally, the World Health Organization Essential Medicines Group is taking action regarding antimicrobial restrictions.[46] The AWARE listing divides antimicrobials into three groups:

- ACCESS – those that should be accessible in all countries to treat common infections
- WATCH – medicines that should be conserved for situations in which use is clearly justifiable, and not freely available to all
- RESTRICT – last-line agents that should be reserved for use only when narrower-spectrum agents will not be effective, and generally only used with some degree of expert supervision.

P

Pre-prescription approval processes should clearly document the prescriber, the patient, the medicine and the indication for use. This allows a nominated expert or the AMS team to triage such patients for post-prescription review at 48–72 hours.

R

Table 3.2: Categories of antimicrobial restrictions

Antimicrobial category	Details and examples
Unrestricted	• Can be prescribed without an approval • Examples include benzylpenicillin and doxycycline
Restricted or 'protected'	• Require an approval within a nominated time of the medicine being prescribed (e.g. within 24 hours) • Individual prescription review is required for prolonged use (beyond 48–72 hours) • Examples include broad-spectrum antimicrobials with potential to promote resistance – such as ceftriaxone, vancomycin, ciprofloxacin and meropenem – and those that are common targets for antimicrobial stewardship programs
Highly restricted	• Require discussion with a nominated expert to obtain approval before the medicine can be initiated, to ensure that use is appropriate and to enable ongoing patient follow-up • Often, a full, formal, specialist clinical consultation for these patients is also recommended • Examples include antimicrobials viewed as last-line agents and reserved for highly resistant pathogens, or medicines with high potential toxicity or high cost, such as echinocandins, colistin and linezolid

A requirement for post-prescription review and approval for prolonged antimicrobial use can help to encourage de-escalation or cessation of these medicines wherever possible. In some sites, a 'no approval, no drug' policy that forces the prescriber to seek approval before the medicine is dispensed may be used. In other centres, the hospital policy may allow the medicine to be dispensed for 24 hours, during which approval should be obtained or dispensing will stop. Some sites with electronic approval programs also use an alert system in which dispensing continues, but an electronic alert is raised to the AMS team to request review of the non-approved prescription.

Approvals may be administered by several mechanisms, including paper-based order forms[37], fax- or telephone-based[41] systems, or electronic systems.[47-49] The choice of system largely depends on the resources available to the site and processes for auditing or following up approvals. Telephone-based approval systems may be onerous because of workflow interruptions, the systems needed to support appropriate record keeping, and communication with the clinical workforce to reduce variation in advice between approvers. However, even the antimicrobial approval systems that are personnel intensive have been shown to be cost-effective in hospitals.[50]

Many hospitals in Australia have successfully introduced electronic antimicrobial approval systems to streamline the workflow for AMS programs (see Section 4.2.2 in Chapter 4: 'Information technology to support antimicrobial stewardship'). The advantages of electronic systems are that they can be accessed 24 hours a day and provide consistent information regarding approved indications for antimicrobial use. The institution may nominate certain standard indications and durations for which approval may be obtained via the computer, and then require individual approval for more complex indications or prolonged durations. This process focuses the AMS team's attention on the complex cases and does not burden the team with routine indications. However, it ensures that the prescriber is still aware of hospital policy and prescribing guidelines at the time of prescribing. Electronic approval systems also support audit and feedback processes.[51]

In the published literature, the use of electronic approval systems for individual antimicrobial agents and larger numbers of antimicrobials is generally reported as resulting in reduced consumption of the restricted agents.[48]

3.4 Post-prescription reviews

Regular ward rounds for post-prescription antimicrobial review, often called AMS ward rounds, have been adopted at many Australian hospitals. They can provide insight into many aspects of antimicrobial prescribing that may not be recognised through more passive mechanisms of audit. Importantly, regular AMS rounds provide teaching opportunities for the junior and senior workforce, and can help to increase awareness of AMS within health service organisations.[2]

Post-prescription review has been associated with a reduction in the volume of prescribing of several key classes of antimicrobial agents at some hospitals, and significant cost savings.[52,53] These reviews provide a valuable opportunity to change the original prescription by using information that was not available at the time the antimicrobials were prescribed (such as from radiological and microbiological tests).[54]

A key strength of programs that use individual prescription review is that they can assess the individual patient's clinical situation. Clinical guidelines cannot encompass all situations, and many important patient-specific factors require consideration, such as long-term care goals for the patient.

The options of de-escalation, streamlining, switching from intravenous to oral delivery or ceasing antimicrobial therapy may not show an immediate improvement in patient outcomes compared with continuation of broad-spectrum therapy. However, it is important to show that there are no new harms or adverse events when optimising antimicrobial therapy, in addition to showing any cost savings that may be realised. If available, evidence showing patient safety outcomes (such as reduced length of stay) should be included as part of the feedback and education process when rationalising antimicrobial therapy.

3.4.1 Who should perform reviews in hospitals?

Post-prescription review of antimicrobials in hospitals may be undertaken by a single clinician – for example, an ID physician or a clinical pharmacist – or by a multidisciplinary team with two or more members representing specialties such as infectious diseases, pharmacy, infection control and microbiology.

Both the individual approach and the team approach have been found to improve antimicrobial prescribing. However, international peak bodies recommend a team approach because it is more likely to have a positive effect.[20,55] AMS teams play a key role in this process and are supported by the Australian Commission on Safety and Quality in Health Care (the Commission). The composition of the expert team will depend on the availability of local resources. Increasingly, nurses, midwives, infection control practitioners, pharmacists, and doctors who are not necessarily ID physicians but who have additional training in AMS are able to participate very effectively in these teams (see Chapter 2: 'Establishing and sustaining an antimicrobial stewardship program').

In Australia, clinical pharmacists are generally available in larger hospitals to review medication charts, identify prescribing errors and identify antimicrobial prescribing that requires review. They can also refer cases to the nominated AMS clinician or team as needed. Establishing systems that support referral to the AMS team by other members of the clinical workforce will enable workforce members to feel that concerns about antimicrobials will be promptly addressed (see Chapter 11: 'Role of the pharmacist and pharmacy services in antimicrobial stewardship').

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Some hospitals do not employ ID physicians directly, and other approaches are used to ensure that visiting medical officers and other contracted workforce members receive the guidance they need. Some hospitals use clinician networks for referrals and consultations – for example, surgeons may involve one of a small group of general physicians to assist in perioperative care of their patients. It may be useful to involve these groups of physicians in AMS initiatives such as post-prescription review. (See also Chapter 4: 'Information technology to support antimicrobial stewardship' and Chapter 8: 'Role of the infectious diseases service in antimicrobial stewardship'.)

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In organisations with no on-site ID physicians or pharmacists, nurses, midwives, infection control practitioners or other doctors with appropriate training can assist with post-prescription review by identifying high-risk patients, or patients from a predetermined list of key indications or antimicrobials (see Chapter 12: 'Role of nurses, midwives and infection control practitioners in antimicrobial stewardship'). Action regarding these patients might include:

- Scanning copies of charts and forwarding them to an off-site pharmacy department for review

- Having regular teleconferences with off-site pharmacists, ID physicians or clinical microbiologists to review patients' prescriptions and discuss cases
- Using telehealth to include off-site experts in ward rounds of high-risk or high-use areas.

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In rural, remote and private hospitals, effective networked models of service delivery, involving off-site ID experts to discuss more complex cases with the local pharmacists, can be established with formalised protocols and with the support of telehealth. Several studies have shown that targeted AMS interventions can be effective in hospitals with few ID resources. Yam et al. describe an AMS program at a rural hospital without an ID physician and pharmacist.[56] There, six antimicrobials with high potential for misuse were targeted for interventions that included prospective review with streamlining of therapy, discontinuation, antimicrobial change and dose optimisation. The streamlining rate doubled from 44% to more than 90%, and antimicrobial purchase costs per 1,000 patient days decreased by 51% over a two-year period.[56] Prescription review efforts in facilities with limited resources should target areas in which AMS interventions will achieve the most significant return. This could include conditions that account for the majority of the antimicrobial prescriptions and those with the most inappropriate antimicrobial prescriptions. Audits such as NAPS can help to identify these conditions, as well as the units, services and prescribers responsible for significant proportions of inappropriate antimicrobial use in the facility.

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Telehealth provides opportunities for the on-site workforce to be supported in a number of settings, including rural and remote hospitals, and also for post-prescription review in small hospitals with no on-site pharmacist (see Case study 3.1 and Chapter 4: 'Information technology to support antimicrobial stewardship').

Case study 3.1: Post-prescription review in small rural facilities using telehealth

A pharmacist-led antimicrobial stewardship telehealth model has been established in far north Queensland to help smaller rural facilities with no on-site pharmacist to meet the National Safety and Quality Health Service Preventing and Controlling Healthcare-Associated Infection Standard.

A regional hospital, which is part of a Local Hospital Network (LHN), initiated a telehealth case conference service to review all inpatients receiving antimicrobial agents in two small rural hospitals with no on-site pharmacist or infectious diseases (ID) physician. A multidisciplinary team, comprising senior medical and nursing personnel, was formed at each site, and weekly case review conferences were established. Patient clinical information was supplied to the pharmacist before the case conference, and service-wide data systems were used for relevant pathology. Pharmacist recommendations were made according to the LHN's antimicrobial stewardship formulary, and included recommendations to contact the ID physician at the regional hospital for the use of restricted antimicrobials or when further advice was required.

Over 24 months, in a total of 112 case conferences, 260 patient cases were reviewed and 212 pharmacist recommendations were made. Recommendations included choice of antimicrobial, dose (including adjustment for decreased renal function), allergy advice, length of treatment and advice for ID consultation as per the LHN formulary.

3.4.2 Which patients should be reviewed?

A review of a patient's antimicrobial therapy may be triggered by a referral from another clinician, the prescription of a particular antimicrobial, a laboratory result, or a clinical condition such as meningitis or sepsis. In many hospitals, electronic tools are being used to identify patients for clinical review by the AMS team, and to prospectively collect data on the types of patients being seen, the advice given and the interventions required so that these data may be audited and considered (see Chapter 4: 'Information technology to support antimicrobial stewardship' and Chapter 6: 'Measuring performance and evaluating antimicrobial stewardship programs').

Routine AMS ward rounds should be done in clinical areas with high antimicrobial use – for example, ICUs, transplant wards and haematology units. This can ensure that the AMS team's expertise and advice are readily available to prescribers. Generally, a consultant or senior fellow from the treating unit attends the AMS ward round to discuss issues directly. The AMS team should also review the use of highly restricted antimicrobials across the whole hospital and episodes of prolonged use of other restricted antimicrobials (this often requires at least twice-weekly ward rounds to capture cases in a timely way).

The frequency of AMS ward rounds depends on the size and resources of the hospital, and the casemix of patients. Generally, an AMS team should aim to do AMS ward rounds at least twice per week in areas of greatest need (for example, the ICU).

3.4.3 What should be included in the feedback?

The review should start by stating the documented indication for antimicrobial use, and then move to discuss any relevant clinical factors or investigation results to date that might influence the antimicrobial prescription. It may be useful to compare the prescription with prescribing guidelines and comment on the appropriateness of the prescription, if possible.

One or more of the following might be used in an assessment of appropriateness:

- The decision to prescribe an antimicrobial
- Choice of antimicrobial
- Whether use was in accordance with local or national prescribing guidelines
- Route of administration (intravenous or oral)
- Appropriateness for treatment for the suspected or confirmed pathogen
- Dosage and frequency
- Clarification of allergy status
- Duration of therapy to date.

The post-prescription review should ensure that the prescription aligns with the Antimicrobial Stewardship Clinical Care Standard.[26] A range of point-of-care stewardship interventions can be used to provide direct and timely feedback to the prescriber at the time of prescription review or laboratory diagnosis (see Point-of-care interventions). This feedback may include recommendations for streamlining or de-escalating therapy, which can help treating teams to plan ahead.

3.4.4 How should feedback be provided?

Feedback, when required, can be communicated in person (such as during a round in the ICU) or discussed during a phone call with the treating team. This feedback should always be included in the patient's healthcare record. If the advice is not urgent and simply provides confirmation that antimicrobial use is appropriate or assistance for planning ahead, it can be communicated solely via the healthcare record. The written documentation should follow an appropriate structure – for example:

> **AMS ward round**
>
> **Review: day 2 of ceftriaxone**
>
> *Admitted with community-acquired pneumonia, chest X-ray changes left base, positive pneumococcal antigen in urine. No allergies.*
>
> *Clinically improved, eating, afebrile, white cell count normalised, oxygen saturations now normal on room air. Sputum and blood cultures no growth.*
>
> *The patient does not have severe pneumonia and thus does not likely need ceftriaxone. Suggest switch to oral amoxicillin 1 g tds with a plan for a further 5 days, as 7 days total antibiotic is usually adequate for mild–moderate pneumonia.*
>
> *Name, date, signature*

Note that the above example follows the recommendations for medical communications known as ISBAR (introduction, situation, background, assessment and recommendation;

see Resources). This approach can be applied to both written and verbal forms of communication.[57]

Given that most AMS teams do not directly take a history or examine the patient, care should be taken with the scope of advice given. It is important to understand that the treating clinician ultimately makes the decision about whether to accept the recommendation of the AMS team and change the prescription. The notes by the AMS team should document its rationale for advice. If the clinical situation is complex, it is recommended that the treating team be called or an ID physician be consulted. This is especially important if it has not been possible to discern the rationale for the current antimicrobial choice or regimen.

Different methods of feedback after post-prescription review were compared by Cosgrove et al. in a large United States hospital.[58] The study looked at feedback provided by a telephone call, a note in the healthcare record or a text message sent to the clinician's pager. The text messages and notes left in the healthcare record included detailed information on the recommended change, including the dose of the new agent and a rationale for the change. There was no statistical difference in the uptake of recommendations between the groups, and the authors suggested that clinicians may be willing to implement changes regardless of how feedback is provided. In Australia, documentation in the healthcare record has usually been the more accepted method of communication, often accompanied by a phone call if any clarification is needed.

AMS teams should keep records of their interventions to help them identify existing or emerging prescribing issues. This may also help to inform future communication or education campaigns. The team may create summaries of information and feed them back to the units involved to trigger opportunities for discussion.

3.4.5 Prescription review at transitions of care

Specific prescription review should occur at transitions of care (when patients are admitted to or discharged from a facility, or transferred within the facility), and especially for end-of-life care decisions in all healthcare settings. The appropriateness of ongoing prophylactic antimicrobials, in particular, should be questioned. Frequently, such prescriptions can be safely ceased; however, this often requires an intervention to ask why the medicine is being given and whether it is necessary. At the end of life, when comfort is paramount, it is important to determine whether antimicrobials are appropriate and whether they may be causing increased discomfort, such as anorexia, nausea or diarrhoea. It is essential to ensure that the risks and benefits of prescribing antimicrobials are reassessed in the context of the patient's current general health status (see Chapter 10: 'Role of prescribers in antimicrobial stewardship').

3.4.6 Post-prescription reviews in the community setting

Post-prescription review is an endorsed practice in the Antimicrobial Stewardship Clinical Care Standard. In some community medical practices, the general practitioner may schedule a clinical review of a patient who has been prescribed empirical antimicrobial therapy after a given time (for example, at 48 hours), to monitor their clinical progress and review any investigation results; this may be done by telephone. This provides an opportunity to optimise antimicrobial therapy and set a planned cessation date for the antimicrobial in the light of additional clinical information. Clinical review of patients who are not prescribed antimicrobials is also useful to reassure both the patient and the clinician, and to ensure that any deterioration is identified and acted on promptly.

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In aged care homes, local policies should require clinical review of residents by a clinician if the resident was prescribed antimicrobials over the phone after hours. Ideally, this should be done within 24 hours of the prescription. This is especially important for locum services or other situations in which the covering doctor may not be familiar with the patient. This type of review can promote appropriate prescribing and set in place processes to cease antimicrobials after defined time periods.

Individual prescription review may also be prompted by a particular laboratory investigation result. Many laboratories will initiate contact with prescribers to discuss antimicrobial therapy when an unusual or potentially serious isolate or test result is identified.

Clinicians may also want to discuss antimicrobial prescriptions with nominated experts based on clinical concerns. Pathways for prescribers in community settings to access such specialist advice should be clearly identified. This may occur through links with ID or pharmacy services at local hospitals, or with clinical microbiologists at laboratory service providers.

3.5 Point-of-care interventions

POCIs are one of the most effective aspects of AMS in hospitals. They can improve patient management and patient outcomes, and provide excellent opportunities to educate the clinical workforce on optimal prescribing. Recommendations from post-prescription review (see Post-prescription reviews) are likely to include one or more POCIs.

Examples of POCIs include advice or actions on:

- Directed therapy based on microscopy and other rapid tests
- Directed therapy based on culture and susceptibility test results
- Dose optimisation
- Limiting toxicity
- Duration of therapy
- Route of administration (intravenous-to-oral switching)
- Escalation to formal expert clinical review.

Which interventions are selected, how they are delivered and by whom will be determined by local resources and the expertise available. POCIs can be delivered by a clinical pharmacist, by an AMS team or during an ID consultation.

3.5.1 Directing therapy based on results from microscopy and other rapid tests

For a small number of conditions, the choice of empirical therapy can be improved using microbiology test results that are available minutes or hours after specimen collection, such as:

- Fast specimen processing of cerebrospinal fluid, which might include the use of on-call workforce members to conduct cell counts, Gram stains and antigen tests for suspected meningitis
- Microscopy for vaginitis, which readily distinguishes between candidiasis, trichomoniasis and bacterial vaginosis
- Polymerase chain reaction (PCR) testing, which can allow earlier diagnoses of conditions such as influenza, or may be used to help differentiate methicillin-susceptible from methicillin-resistant *Staphylococcus aureus* in blood cultures
- Mass spectrometry, which may enable earlier identification of bacterial species from critical sites such as blood cultures
- Rapid procalcitonin tests, which can lead to earlier cessation of antimicrobials in patients whose procalcitonin levels remain low
- Point-of-care tests for C-reactive protein, which may be used to help decide about antimicrobial treatment in respiratory tract infections, primarily in the community setting.[59]

3.5.2 Directing therapy based on culture and susceptibility test results

Bacterial culture results, including identification and susceptibility test results, are usually available 48–72 hours after specimen collection. Results of these tests should be used to improve antimicrobial choices and optimise therapy by streamlining or de-escalating therapy.[55,60-62] Encouraging the treating team to modify therapy (if necessary) can reduce antimicrobial exposure and costs. Typical interventions in this category are:

- Changing the antimicrobial agent (for example, changing from a broad-spectrum agent to one with a narrower spectrum that targets the infecting organism)
- Ceasing additional antimicrobials that will not improve outcomes (for example, stopping dual anaerobic antibacterial therapy)
- Ceasing antimicrobial therapy altogether if the diagnosis is a non-bacterial infection (for example, positive viral PCR) or non-infective condition (for example, cardiac failure rather than pneumonia).

3.5.3 Optimising dosing

When reviewing medication orders and dispensing prescriptions, pharmacists play an important role in identifying variation from recommended dosing schedules and recommending optimal dosing regimens. The pharmacokinetic and pharmacodynamic features of the antimicrobial need to be taken into account in this process.

Antimicrobial dosing schedules can be optimised by:

- Checking and adjusting doses to suit patient size and renal function
- Looking for drug–drug interactions (for example, between linezolid and some antidepressants)
- Adjusting the dosing interval, where appropriate – for example, considering extended infusions, or continuous infusion of short half-life β-lactams such as piperacillin–tazobactam, cefepime or meropenem[63,64]

- Monitoring antimicrobial levels in an individual patient, and adjusting dosing to maximise efficacy and minimise toxicity (therapeutic drug monitoring – for example, with aminoglycosides, vancomycin and azole antifungals)
- Guiding antimicrobial selection towards the most appropriate agents (for example, agents with higher cerebrospinal fluid penetration, if required).

3.5.4 Limiting toxicity

Specific advice may be provided to reduce the harm from antimicrobial use. This may include:

- Limiting gentamicin use to less than 48 hours
- Ceasing other drugs that might interact with the antimicrobial agent
- Monitoring renal or hepatic function
- Identifying potential side effects early.

3.5.6 Changing the duration of therapy

Incorrect duration of antimicrobial therapy is a frequent problem in hospital prescribing; surgical prophylaxis that is administered beyond one dose or one day is a common example. In the 2015 NAPS, the proportion of surgical prophylaxis prescriptions extending for more than 24 hours was 27.4% – best practice is less than 5%.[12] Hospitals should have policies for the prophylactic use of antimicrobials that state that a single dose is the preferred option.[20,65] The Commission is working with the Royal Australasian College of Surgeons to develop resources to promote improved surgical prophylaxis.

Almost all infections have standard treatment durations. However, the duration of therapy may need to be tailored to individual responses to treatment. It is important to promote and sustain a prescribing culture that includes daily review and setting a maximum duration of treatment unless there is a clear indication in the healthcare record that therapy should be continued. Planned review dates may also prompt treating teams; review and/or stop dates should be clearly documented in the patient's healthcare record and on their medication chart.[20,26]

3.5.7 Switching from intravenous to oral delivery

Oral therapy is often in the best interests of the patient because continued hospitalisation can be associated with the risk of acquiring a new multidrug-resistant infection (by direct transmission) or a preventable adverse event such as an infection from the intravenous line. Oral therapy allows patients to be discharged to their home environment once they are clinically stable.

Encouraging a switch to oral therapy once the patient has shown significant clinical response to treatment is a well-studied strategy with proven value.[53] Benefits of intravenous-to-oral switching include[55]:

- Lower treatment costs
- Reduced morbidity from intravenous lines
- Reduced length of stay
- Higher patient satisfaction.[66]

Certain antimicrobials – for example, fluoroquinolones, linezolid, fluconazole and voriconazole[63] – have near-complete bioavailability. Patients receiving these therapies are often excellent candidates for early intravenous-to-oral switching.

Defined criteria that allow the AMS team to expedite the change to oral therapy can be established. *Therapeutic Guidelines: Antibiotic*[1] provides guidance on when oral therapy should be used in preference to parenteral therapy. Several states and territories have also developed specific guidance (see Resources).

In the United Kingdom, the National Institute for Health and Care Excellence AMS guidelines recommend that intravenous antimicrobials be reviewed at 48–72 hours to determine whether the antimicrobial needs to be continued and, if appropriate, the patient switched to oral therapy.[67] Public Health England's Start Smart – Then Focus toolkit also promotes daily consideration of opportunities to streamline therapy, including intravenous-to-oral switching.[20]

3.5.8 Escalating to formal expert clinical review

Post-prescription review services often identify patients who have complex problems and are likely to benefit from early clinical review by ID physicians. In Australian tertiary hospitals, escalation to review by ID physicians has been observed to account for 5–10% of reviews; it is noted that this pattern may be very different in other hospitals in Australia and overseas.[68] It is likely that many of these patients would eventually have been referred, but the post-prescription AMS review often facilitates earlier identification. In some cases, critically important clinical problems that were previously overlooked by the treating team have been identified by AMS teams. For some infections, an ID consultation has been demonstrated to reduce mortality through diagnostic precision and the optimisation of antimicrobial management.[69-71] Patients with serious antimicrobial allergies may also be referred to immunologists for specialised advice (see Section 8.3.1 in Chapter 8: 'Role of the infectious diseases service in antimicrobial stewardship').

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It is important that all hospitals have access to advice from ID physicians or specialised pharmacists, to provide support when needed. Options for accessing expert advice when it is not available on site may include:

- Using LHN/LHD clinical networks or other formalised clinical networks
- Using clinical microbiology networks from laboratories that provide diagnostic services
- Using an AMS pharmacist or physician in an LHN/LHD regional or hospital group role
- Using telehealth networks to support formalised networks with specialists (see Section 4.4 in Chapter 4: 'Information technology to support antimicrobial stewardship').
- Contracting ID and clinical microbiology services.

Resources

Prescribing guidelines

- *Therapeutic Guidelines: Antibiotic*
- Public Health England: Antimicrobial Stewardship: Start Smart – Then Focus
- NSW Clinical Excellence Commission: *Sample Antimicrobial Stewardship Policy: for a Local Health District or Network*
- Centre for Remote Health: *CARPA Standard Treatment Manual*

Restricted antimicrobials policies

- NSW Clinical Excellence Commission: *Antimicrobial Restrictions in Small to Medium-Sized Hospitals: Fact sheet*

Post-prescription review

- National Institute for Health and Care Excellence (UK): AMS guidelines
- Hunter New England Area Health Service: ISBAR tools

Point-of-care interventions – intravenous-to-oral switching

- SA Health, South Australian expert Advisory Group on Antimicrobial Resistance: *IV to Oral Switch Guideline for Adults Patients: can antibiotics S.T.O.P.*
- ANZPID–ASAP Group: *Guidelines for Antibiotic Duration and IV–Oral Switch in Children*
- Children's Health Queensland: Intravenous (IV) to oral antimicrobial switch
- Sydney Children's Hospitals Network: *Intravenous to Oral Antimicrobial Switch: Practice guideline*
- Sydney Children's Hospitals Network: *Making the Switch: Changing from intravenous to oral antibiotics* [Information for parents]

Other

- Barlam TF, Cosgrove SE, Abbo LM, MacDougall C, Schuetz AN, Septimus EJ, 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;62:1197–202.

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AUSTRALIAN COMMISSION ON SAFETY AND QUALITY IN HEALTH CARE

4 Information technology to support antimicrobial stewardship

Antimicrobial Stewardship in Australian Health Care

2018

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Acronyms and abbreviations

Acronym	Abbreviation
AMR	antimicrobial resistance
AMS	antimicrobial stewardship
AURA	Antimicrobial Use and Resistance in Australia
eCDSS	electronic clinical decision support system
EMM	electronic medication management
HL7	Health Level 7
ID	infectious diseases
IT	information technology

Key points

- Although primary care has had digital prescribing for some time, the digital transformation of Australian hospitals is now occurring rapidly. Digital prescribing allows sophisticated prescribing, digital decision support and digital transparency, where potentially all pathology results and prescriptions are available for review and curation in real time.
- Information technology (IT) systems can support the development and delivery of antimicrobial stewardship (AMS) programs in areas such as decision support and review, data management and reporting, and telehealth.
- Electronic clinical decision support systems (eCDSSs), in particular, can be useful tools in AMS programs. A range of eCDSS options are available, including mobile applications, approval systems, surveillance programs, and electronic medication prescription and management. eCDSSs complement the clinical, pharmacy and technical members of the AMS team, but are not able to replace their expertise.
- eCDSSs and other IT systems can be important data sources to identify patients who require post-prescription review, and to provide institutional data for audit and reporting. Data systems should be able to interface across the health service organisation and the Local Hospital Network or Local Health District, and enable input into national data surveillance programs.
- The future of AMS in an integrated digital healthcare system may involve redefining the role and remit of the antimicrobial steward.
- Telehealth can support improved access to clinical services, specialist advice, diagnostic information and education, over distance, as part of formalised service networks. Telehealth may include the use of the telephone, video, voice over internet applications (such as Skype), digital images, electronic diagnostic test results and remote monitoring links.

4.1 Introduction

Antimicrobial prescribing and antimicrobial stewardship (AMS) involve a range of complex tasks that can be supported and improved by using information technology (IT).

At the AMS program level, the AMS team requires relevant and timely information and data to review patients and optimise their care, as well as to support AMS initiatives and quality improvement. IT systems can be used to support AMS programs by enabling a range of strategies, including (see also Chapter 3: 'Strategies and tools for antimicrobial stewardship'):

- Restrictive strategies – for example, formularies, restricted indications and antimicrobial approval systems
- Persuasive strategies – for example, clinical guidelines, pathways and post-prescription review.

At the patient level, antimicrobial prescribing requires a complex sequence of decisions, often based on information from different sources. Clinicians need to consider the diagnostic criteria, the likely pathogens, the clinical significance of microbiology isolates and susceptibility data, and then select the appropriate antimicrobial at the optimal dose and duration. Potential drug interactions, contraindications and adverse reactions must also be considered. IT systems, such as electronic clinical decision support systems (eCDSSs), can enable this process by bringing together patient-specific data (for example, pathology, medicines) and knowledge bases that support the judicious use of antimicrobials (for example, rule-based alerts and approved indications for use).

IT systems can also be used in AMS programs to facilitate data collection and reporting on quantity and quality of antimicrobial use.

Figure 4.1 shows the IT systems associated with AMS and how they link with data sources from existing legacy IT systems.

This chapter considers the role of IT in supporting AMS activities, including eCDSSs, data collection and reporting, and telehealth.

Issues that are especially relevant for certain settings – rural and remote hospitals, private hospitals and aged care – are tagged as R, P and AC, respectively, throughout the text.

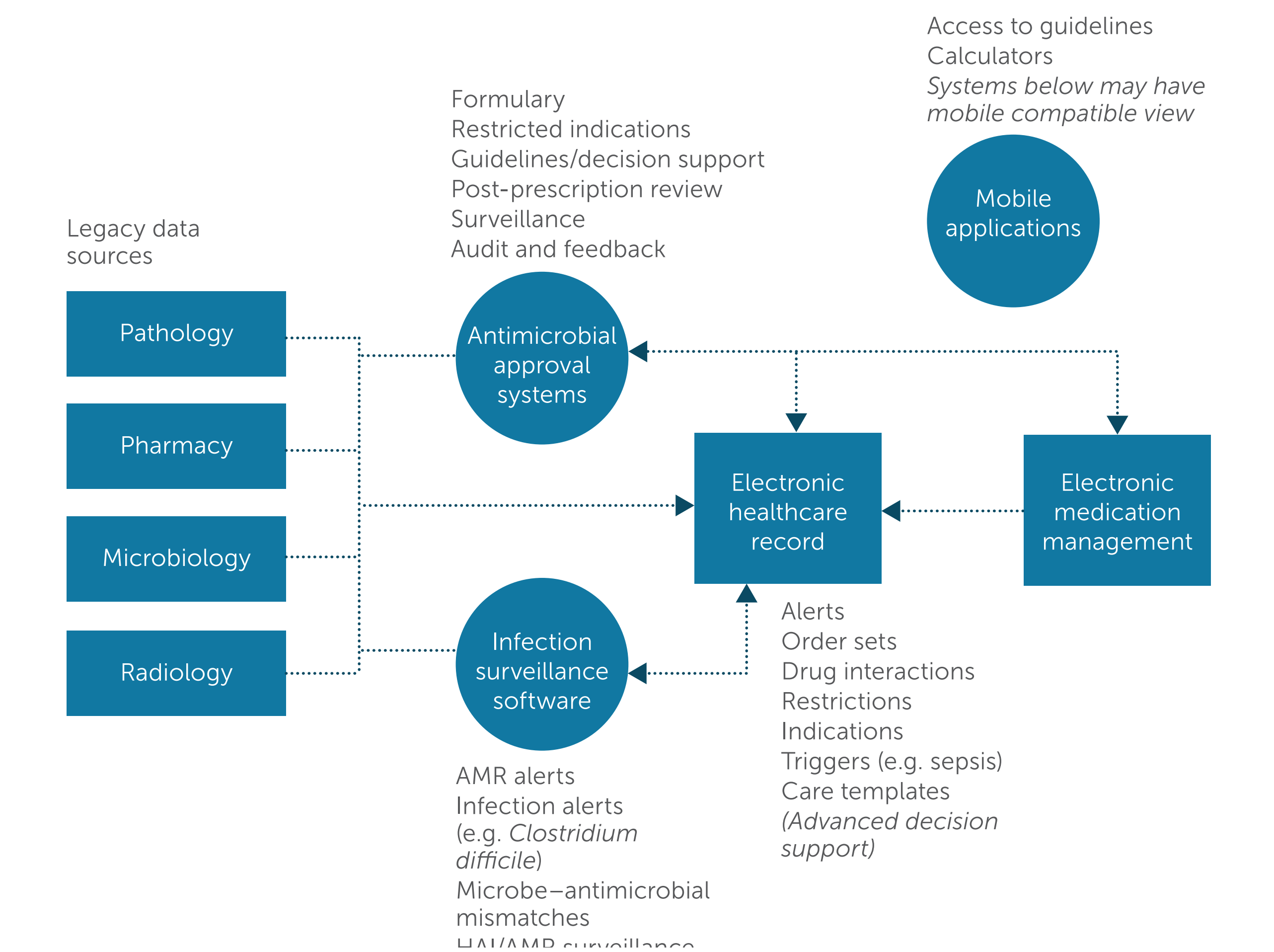
R P AC

4.2 Electronic clinical decision support systems

eCDSSs provide access to information that is stored electronically to enable prescribers to make decisions about health care. eCDSSs can organise and present appropriate information to the user in a way that supports them to make clinical decisions with increased accuracy and reduced error.

eCDSSs can assist clinicians to make more accurate and timely diagnosis, and aid in the decision to prescribe antimicrobials for a patient. Key infectious diseases (ID) bodies support the use of eCDSSs as potentially useful tools in AMS programs, especially for providing access to data that can support quality improvement initiatives.[1] eCDSSs can improve the quality and reduce the costs of antimicrobial prescribing. Many studies report cost avoidance or cost minimisation as a result of implementing an eCDSS, although rigorous cost-effectiveness or

Figure 4.1: Information technology systems and antimicrobial stewardship



AMR = antimicrobial resistance; HAI = healthcare-associated infection cost–benefit analyses are lacking. Reported savings include reduction in antimicrobial expenditure per patient or for the institution, reduction in the proportion of total medicine expenditure, reduction in length of stay, reduction in hospitalisation costs, and reduction in resistant organisms.[2-5]

eCDSSs do not need to be complex to be effective; they may include online access to documents such as formulary restrictions, local antimicrobial prescribing guidelines and *Therapeutic Guidelines: Antibiotic*[6] through the internet or an intranet. Providing an engaging and accurate presentation of information to prescribers or the AMS team (for example, using dashboards[7]) can influence prescribing, even in the absence of complex decision support. More complex systems can integrate eCDSSs within other applications (such as pharmacy dispensing systems or medication management systems) and advanced decision support (see Advanced decision support systems).

Because many systems are available, it is important for health service organisations to plan and implement an appropriate system that responds to current and future local requirements. The assessment of those requirements should involve the local multidisciplinary AMS team, and others with clinical, planning and IT expertise, and ensure that there is an effective interface with other corporate systems in the hospital, and in the Local Hospital Network or Local Health District. No single system is likely to meet all requirements, and a combination system may be required. Some systems have been developed by individual institutions, and are therefore adapted to the environment and culture of the institution. This means that these systems are not always readily transferable to other organisations. Systems may require substantial customisation to integrate with existing infrastructure and align with the organisation's workflow. The comparative cost, risk and benefit of bespoke and commercial systems need to be assessed, along with ongoing maintenance and support for these systems.

eCDSSs that effectively support the AMS clinical team incorporate alerts, prompts and restrictions, and allow integration with pharmacy and microbiology laboratory systems. Several of these elements may be asynchronous – that is, they do not provide decision support at the time of prescribing, but use knowledge-based expert systems to issue clinical alerts to the AMS team after the antimicrobial is ordered.

R

P

eCDSSs for AMS can also be useful in private and rural and remote hospitals, especially where AMS expertise is provided remotely. As well as supporting the local workforce by streamlining the workflow for AMS interventions, they provide a valuable clinical resource and support the involvement of off-site experts, such as ID physicians. For example, an online approval system may be more effective and feasible to implement than a telephone approval system.

Although eCDSSs are a valuable support for AMS, expert advice is needed to improve the quality of decision-making, and support safe and appropriate prescribing. eCDSSs are not effective in isolation. The health service organisation needs to ensure that AMS is appropriately directed through the advice of ID physicians and other experts. To ensure that eCDSSs remain relevant to clinical practice and are sustainable, they need to continue to receive ongoing support from expert advisors.

The most common uses of IT systems to provide decision support for AMS include:

- Passive decision support through electronic access to guidelines and mobile applications
- Electronic antimicrobial approval systems
- Electronic infection prevention surveillance systems
- Electronic prescribing (e-prescribing) and electronic medication management (EMM)
- Advanced decision support.

The following sections discuss each of these systems, and Table 4.1 shows the opportunities, potential advantages and issues in the application of different types of eCDSS.

4.2.1 Passive decision support systems and smartphone apps

Passive decision support includes electronic access to guidelines and mobile applications. This can occur at many entry points in hospital systems, such as within pathology reports.

Clinical systems are increasingly becoming mobile device compatible to support ready access to data, and passive decision support for prescribing can be made available at the point of care using smartphone apps. Clinicians are likely to have ready access to a mobile phone, in contrast to pocket guides, desktop computers and reference handbooks. Information available on a smartphone might be accessed more often at the patient bedside than other forms of information. It will also be easy to update remotely without needing to issue new physical copies.[8]

Table 4.1: Antimicrobial stewardship information technology systems with electronic clinical decision support system functionality

IT option	Intervention opportunities	Benefits	Considerations during implementation
Smartphone applications	• Dissemination of disease- or medication-based guidelines • Dosing calculators • Antibiograms	• Allow rapid dissemination • Useful for hospitals with poor IT infrastructure	• May not be able to be integrated with hospital systems • Need to ensure a system for version control and a process for timely uptake of revisions • May not influence prescribing of senior clinicians
Approval systems (standalone or integrated with e-prescribing systems)	• Enforcing a formulary • May be pre-prescription or post-prescription • Enforcing approved indications by medicine • Educational opportunity for the prescriber • Can include clinical decision support • Reports and feedback	• Can work well in the absence of electronic health records or e-prescribing • Support an organisational approach to AMS • Should trigger post-prescription review • Best combined with an antimicrobial team to review patients 24–48 hours after approval	• Consider appropriate human resources to perform post-prescription review
Computerised physician order entry (e-prescribing)	• Alerts • Drug–drug interactions • Dosing • Restriction prompts • Automated stop orders (e.g. surgical prophylaxis) • Order sets (community-acquired pneumonia, sepsis)	• Will reduce transcription errors, but not incorrect choice or indication (unless combined with decision support) • Best combined with decision support	• Require more resources to develop customised AMS reports
Infection prevention surveillance systems, including data-mining tools	• Pharmacy ± laboratory integration • Microbe–antimicrobial mismatches • Double coverage • Restricted medicine use • Surveillance and real-time alerts for poor practice	• Support an organisational approach • Can be integrated with an electronic healthcare record	• Require substantial resources to review reports and determine clinically relevant alerts that need action • Require dedicated pharmacist time • Commercial systems can be expensive

IT option	Intervention opportunities	Benefits	Considerations during implementation
Electronic healthcare records, including those that include a medication record	• Error alerts, such as allergy, dosing, drug–drug interactions • Chart abstraction tools to screen and identify patients at risk for sepsis, or collate information for AMS (medicines, results) • Pre-prescription restriction rules • Record AMS recommendations and interventions • Support order sets for syndromes (e.g. community-acquired pneumonia) • Alerts and triggers identify patients suitable for intravenous-to-oral switching, or AMS review • Care protocols (templates or phased order sets)	• Eliminate the cost of external vendor • Allow real-time interventions and alerts • Allow retrieval of data for research	• Require substantial institutional investment up front • Require considerable hospital IT time to create the tools • Templates must be incorporated into electronic healthcare records at each site • Local adaptation still required for each build • Less responsive to change
Advanced electronic clinical decision support systems	• Interventions based on the development of a causal probabilistic network of pathogens, by specimen type or underlying condition of patient • Case-based probability • Pathogen prediction	• Sophisticated decision support based on predictive capabilities and machine-learning algorithms • Highly patient specific	• Complex, usually bespoke, systems • Currently in early phase of adoption • Ability to be translated to other sites is unclear

AMS = antimicrobial stewardsip; IT = information technology

A range of smartphone apps have been developed for use in health care, including for AMS[9] (see Resources) and ID.[10] Some studies suggest that the medical workforce may prefer these to traditional intranet guidelines.[11] In the United States, UpToDate was identified as the most commonly used resource for learning about antimicrobial prescribing in a survey of medical students[12]; this app is also used in Australia. Another common use of mobile technology is to provide access to guidelines available through mobile-enabled web pages.

However, the knowledge bases for third-party mobile apps may not support local practices, guidelines, formularies, restrictions or antibiograms (although some apps, such as MicroGuide, support local customisation). Another consideration is that the user must initiate updates on their own device, which may lead to the potential for multiple versions to be in use in the same health service organisation.

The impact of mobile apps on prescribing appropriateness is uncertain, because prescribing decisions are often made by senior doctors, who might not use the apps while on ward rounds.[13] Another consideration is that limited wi-fi access may affect the types of smartphone apps that can be used in hospitals. However, this situation is likely to evolve quickly. Unintended consequences of the use of smartphones for antimicrobial use or infections have not been studied. One example of the use of a smartphone app is in Case study 4.1.

Case study 4.1: A smartphone application for delivering antimicrobial policy

A free smartphone application – the Imperial Antibiotic Prescribing Policy (IAPP) app – was developed and made available across five teaching hospitals associated with the Imperial College Healthcare NHS Trust. The app was developed using an iterative clinician-led approach supported by mixed methods research. It included guidelines based on medicines or infections, calculators, intravenous-to-oral switching recommendations, allergy guidelines and therapeutic medication monitoring. A pre-implementation questionnaire found that more than 75% of doctors and pharmacists used their own mobile device at work, and 50% used commercial applications. There was 100% uptake by junior doctors at 12 months.

However, several issues were encountered. Poor wi-fi in the hospitals meant that the app was developed as 'native' software to allow use offline. This meant that the app was not automatically updated and much of the workforce did not update the app until 12 months later, which led to different versions being in use. A post-intervention structured questionnaire was designed and disseminated at one month and at 12 months after the launch of the app. There was a 20% response rate by doctors, 70% of whom reported that the IAPP improved their knowledge and 81% of whom reported that it improved their compliance with the policy. However, 20% of doctors reported that they did not feel comfortable using the app in front of patients.[13]

4.2.2 Electronic approval systems

R

P

Authorisation or approval systems for antimicrobials are an essential strategy for AMS (see Section 3.3 in Chapter 3: 'Strategies and tools for antimicrobial stewardship'), and are very effective in reducing consumption of targeted antimicrobials and reducing medication costs.[14] They act as a restrictive strategy for prescribing and support the post-prescription review process.

Electronic approval systems support the formulary system and streamline the approvals process for general prescribers and pharmacists. The systems can direct attention towards antimicrobial prescriptions that should be reviewed by the AMS team. Importantly, electronic approvals support antimicrobial use auditing, which enables feedback to individual prescribers, units and committees. Successful implementation of electronic approval systems requires close collaboration with the pharmacy, the clinical microbiology and ID workforce, and individual hospital units. This includes customising the system content to support the local formulary and indications for use, as determined by the AMS committee or drug and therapeutics committee.

Electronic antimicrobial approval systems have had high uptake in some Australian states. These locally developed, third-party systems (see Electronic prescribing and medication management systems and Case study 4.2) have usually been implemented in sites without electronic healthcare records or e-prescribing systems and have streamlined the workflow for AMS programs.[15,16] For example, one web-based approval system has been adopted at more than 60 sites, including public, private and regional hospitals. The program supports a bundle of AMS interventions, including formulary support, restricted indications for target antimicrobials, access to national guidelines, administration alerts by pharmacists if medicines are given without approval, targeted post-prescription review, feedback and reporting. The system has been associated with:

- Improved appropriateness of antimicrobial use[17]
- Improved resistance patterns in some gram-negative isolates in intensive care units[4]
- Reduction in hospital-acquired *Clostridium difficile* infections[17]
- No observed increase in length of stay or mortality in serious infections[17]
- Acceptable usability for clinicians.[18]

Case study 4.2: Electronic antimicrobial approval systems in Victoria

Eight networks in Victoria implemented a third-party electronic antimicrobial approval system from 2009 to 2011. All but two hospitals introduced an antimicrobial stewardship team at different times (ranging from immediately to three years) after the system was implemented.

Implementation of the electronic system was associated with a significant reversal in the consumption of antipseudomonal penicillins, azithromycin, ceftriaxone and vancomycin, and a trend towards reduced consumption of broad-spectrum antibiotics (4.53% reduction per year; $P = 0.027$). Data from the 2014 National Antimicrobial Prescribing Survey also showed a mean appropriateness of use of all antimicrobials in the study group of 82.2% ($n = 1{,}518$) compared with the national average in Peer Group A hospitals of 74.4% ($n = 10{,}955$).

Source: Australian Commission on Safety and Quality in Health Care[19]

Pre-prescription approval processes are being introduced in most EMM systems as a key component of AMS. In some cases, these processes will interface with a third-party electronic antimicrobial approval system or be a part of the EMM system. However, electronic systems (including computerised physician order entry) do not prevent inappropriate antimicrobial prescribing. Just as for traditional prescribing, prescribers can select an erroneous indication that will provide access to the antimicrobial agent of their choice.

4.2.3 Electronic surveillance and infection prevention systems

Antimicrobial prescribing can be optimised with effective communication between pharmacy and laboratory systems. These systems can:

- Direct antimicrobial choice based on microbiology results
- Identify opportunities for de-escalation
- Improve antimicrobial dosing and monitoring (based on pathology results)
- Shorten clinician response time
- Contribute to broader quality improvement issues (such as surveillance of antimicrobial resistance and simultaneous microbiology).[20]

Both locally developed and commercial infection prevention systems are available to integrate the electronic patient record with the pharmacy system, and with microbiology, pathology and sometimes radiology results. These systems help to identify patients at high risk of nosocomial infection or with suboptimal antimicrobial therapy. They also assist with monitoring antimicrobial resistance (AMR) and with routine surveillance activities, including reporting and generating antibiograms. In Australia, these systems have not yet been fully integrated because there are still interoperability barriers with legacy pathology and pharmacy systems, or because there are other priorities for local funding or support.

In Australia, surveillance programs such as the National Antimicrobial Prescribing Survey and the National Antimicrobial Utilisation Surveillance Program, which are part of the Antimicrobial Use and Resistance in Australia (AURA) Surveillance System, may be used in future eCDSSs.

Electronic surveillance and infection prevention systems can help to guide appropriate antimicrobial prescribing (see Box 4.1). However, such systems, like antimicrobial approval systems, require processes and a clinical workforce to monitor and act on the alerts, and generate reports and feedback. Systems that are able to mine large amounts of data and provide real-time alerts for infection prevention or patients requiring review do not necessarily save time.[21] A number of studies have shown that the increased information flow needs to be supported by increased resources for interpretation and triaging of information.[22] The human resources required to achieve this may be a barrier to success (Box 4.1). The licensing costs of these systems are also a consideration for organisations already dealing with other e-health strategies. However, as these systems are purpose designed to support infection prevention activities, they are likely to continue to have an important role in AMS.

Box 4.1: Use of surveillance systems to generate alerts for prospective review

A study in Texas found that the addition of a data-mining tool to an antimicrobial stewardship program decreased inappropriate antimicrobial use, provided a greater reduction in overall antimicrobial use and provided increased cost savings without negatively affecting patient outcomes.

Rules and alerts were built into the data-mining tool to aid in identifying inappropriate antimicrobial use. During 2012, 2,003 antimicrobial interventions were made in response to alerts such as restricted antimicrobials, duration of therapy or intravenous-to-oral switching, with a 90% acceptance rate. Targeted broad-spectrum antimicrobial use decreased by 15% in 2012 compared with 2010, which represented a cost saving of US$1,621,730. No adverse patient outcomes were noted.[23]

In Nebraska, a third-party electronic clinical decision support system was evaluated in a 624-bed medical centre. The system triggered prospective alerts for the following rules: eligibility for influenza or pneumococcal vaccine; polyantimicrobials; microbe–antimicrobial mismatches; redundant anaerobic coverage; vancomycin use; and positive blood cultures for coagulase-negative staphylococci or methicillin-sensitive *Staphylococcus aureus*, or no positive cultures in the previous seven days.[22]

A total of 8,571 alerts were generated in 791 patients over five months, and 284 interventions were made. Coupled with review and feedback, the system resulted in an increase in interventions and recommendation acceptance.

However, only 30% of alerts were actionable. The system required 2–3 hours per day for review and 1–2 hours per day for intervention and documentation. This was associated with alert fatigue.[22]

4.2.4 Electronic prescribing and medication management systems

E-prescribing systems are computer applications that allow clinicians to generate paper or electronic medication prescriptions. E-prescribing is often delivered as part of an electronic health record. EMM systems are information systems that manage each phase of the medication management process, including:

- Computerised entry of physician orders (e-prescribing)
- Medication review
- Medication reconciliation
- Dispensing
- Recording medication administration
- Decision support (optional).

These systems can support more appropriate prescribing and more efficient medication management.

The use of systems for e-prescribing and EMM has substantially increased around the world in recent years, after government-sponsored initiatives to modernise healthcare technology infrastructure in Europe, the United States and Australia. In the United States, more than 70% of prescriptions are now written electronically[24], and the United States Government has offered financial incentives for deploying these systems. In 2014, approximately 35% of English hospitals had begun implementation of eCDSS functionality within their EMM systems in at least one ward or hospital department; in the United States, this figure was more than 60%.[25]

In Australia, the uptake and implementation of e-prescribing and EMM systems in public hospitals have been slower. Each state and territory now has an implementation program for EMM in place and is progressively rolling out systems. All prescribing in Northern Territory hospitals is electronic, and New South Wales, Queensland, South Australia, Tasmania and Victoria already have e-prescribing in place. Several private hospitals have also implemented EMM.

Cost-effectiveness studies have demonstrated that e-prescribing systems – particularly those with decision support – are likely to lead to long-term savings due to reductions in adverse drug events, readmissions and healthcare costs.[26-30]

EMM and e-prescribing can be harnessed to support AMS. Almost all commercial e-prescribing systems are associated with front-end decision support that can be used in AMS, such as default values, routes of administration, doses and frequencies; they may also include allergy alerts and drug–drug interaction alerts. These systems can support a bundled approach to AMS, including antimicrobial restriction, dosing recommendations, rule-based alerts and order sets for disease conditions. One study has demonstrated reductions in mortality, length of stay and readmissions for patients admitted with community-acquired pneumonia using an evidence-based order set.[28] The systems have the capacity to include automated stop orders or review prompts for medicines. Electronic order systems for pathology can also integrate decision support prompts.

Poorly implemented e-prescribing without associated decision support (for example, error checking) may be associated with patient harm.[31-33] Many resources are usually required to modify eCDSS content provided by commercial vendors for local implementation.[34] In a study of 10 e-prescribing systems in the United States, aspects of system safety that would negatively affect antimicrobial prescribing included[35-37]:

- Large numbers of medicines and dosing combinations
- Dangerous autocomplete directions that displaced or contradicted the original intended orders
- Failure to transmit medication discontinuation orders from computerised physician order entry to outpatient pharmacies
- Inconsistent design, implementation and firing of the clinical decision support, leading to very high rates of override (more than 90%) for many alerts
- Off-the-shelf commercial medication databases that were poorly designed to meet the needs of sites, leading to extensive local customisation that was difficult to maintain with software releases.

Sophisticated EMM environments can incorporate algorithms to force or prevent any aspect of the electronic workflow, and to customise alerts and reporting functions for the AMS team. However, such modifications or customisations require considerable time investments from the health service organisation in terms of IT and content expertise. The extra time might not be factored in at the time of the original implementation.

In Australia, where third-party antimicrobial approval systems are already embedded within AMS programs, AMS is conducted within the EMM environment to generate the workflow to support these systems. This might include forcing an approved indication and approval number for restricted antimicrobials. Other teams have developed custom-made solutions – such as post-prescription review tools that interface with the hospital e-prescribing system – to support their AMS service.

4.2.5 Advanced decision support systems

Advanced decision support systems use complex logic, mathematical modelling and case-based probabilities to provide patient-specific recommendations. There are very few reports of advanced decision support systems that support antimicrobial prescribing and that have been successfully implemented outside the originating institution.

The Antimicrobial Assistant, developed by the informatics group at the Latter Day Saints hospital in Utah, was an early leader in antimicrobial decision support.[38] The system used predictive models, and its impact was described in several publications relating to AMS, infection control surveillance, surgical prophylaxis and adverse drug events.

Another eCDSS for empirical antimicrobial therapy uses a causal probabilistic network. The system uses the available data within the first few hours of infection presentation to predict sites of infection and specific pathogens. In a cluster-randomised trial across three wards in three countries (Israel, Denmark and Germany), the system was shown to improve appropriateness of empirical antimicrobial therapy and improve patient outcomes.[39-41]

Machine learning, natural language processing and text mining are promising technologies to support AMS; they allow the use of free text in electronic healthcare records, pathology or radiology reports, and prescriptions. These systems use supervised learning to establish a knowledge base of classification rules. A text-mining tool for predicting pulmonary invasive fungal infection from computed tomography chest reports was more effective than traditional manual methods and led to earlier detection in the validation dataset.[42] A Canadian eCDSS was augmented with machine-learning capabilities to identify inappropriate prescriptions, such as dose and dosing frequency adjustments, discontinuation of therapy, early intravenous-to-oral switching, and a redundant antimicrobial spectrum.[43]

eCDSSs have a potential role in the detection and management of sepsis in hospitals with fully implemented electronic healthcare records (including patient observations). An automated, real-time surveillance algorithm was developed that aggregated, normalised and analysed patient data from disparate clinical systems and delivered early sepsis alerts to nurses and midwives, and treatment advice to clinicians, using mobile devices and portals. Implementation of the algorithm was associated with a significant reduction in mortality.[44] A recent systematic review of eight studies found that automated sepsis alerts derived from electronic health data may improve care processes, but tend to have poor positive predictive value (ranging from 20.5% to 53.8%; negative predictive value 76.5% to 99.7%), and do not improve mortality or length of stay.[45] However, a systematic review does not capture the important qualitative evaluation required to fully understand the impact of an eCDSS, and why some systems were not associated with improved outcomes despite improved care processes.

4.2.6 Implementing electronic clinical decision support systems for antimicrobial stewardship

Implementing eCDSSs requires an assessment of the organisation's needs and capacity, compared with the capabilities of the new system. It is also vital to recognise that IT systems for AMS are not standalone systems and that AMS activities should be integrated with other IT systems.

Although few studies have looked at the reasons that eCDSSs may or may not be effective[46,47], the features of an eCDSS that are likely to improve effectiveness include speed, simplicity of use, integration with workflow, monitoring and feedback.[48] There are also many barriers and facilitators for implementation and uptake of these systems.[25,49]

Ensuring effective integration of eCDSSs with clinical workflow requires consideration of organisational, cultural and technological factors. For example, an evaluation of an Australian web-based AMS management tool identified differences in uptake and adoption of the tool between the junior and senior medical workforce, and this was correlated with awareness of AMS.[18,50]

Readiness assessment

Organisations implementing eCDSSs need to consider a broad range of local issues, and different users need to be involved in making informed decisions.

Five system planning and design processes are essential before procuring and implementing a new system:

1. Technical readiness – understanding the integration requirements, and access to IT infrastructure; this includes availability of IT workforce members to support
   - data extraction and processing (for example, Health Level 7 [HL7])
   - databases and servers
   - local security requirements.

   Data security is essential, particularly with the increasing use of wireless, mobile and cloud technologies, and appropriate data governance policies need to be established in advance of system implementation
2. Financial and human resources – including appropriate project support (often an AMS pharmacist or ID specialist) with allocated time for AMS activities
3. Skills training – considering training needs and previous experience of the project team and end users.

   Training of the project leads in the new system, followed by a train-the-trainer approach, may be appropriate. Visits to demonstration sites that have a particular system in place are also recommended
4. Process readiness – including project planning, system implementation and evaluation planning
5. Administrative readiness – including executive support and high-level clinical champions.

Effective system planning will ensure that AMS team members are formally engaged in the scoping, functional specification and implementation of an eCDSS, including approval systems, electronic surveillance systems, e-prescribing systems and electronic healthcare record implementation. All elements of the system that are relevant to AMS should be reviewed to ensure that they meet the needs of the AMS program and end users, and the hospital more generally.

Cultural factors

Cultural factors can have a marked effect on the successful implementation of new IT systems. In a hospital where ID physicians or microbiologists have not previously played a prominent consultative role, the workforce will face more barriers than in hospitals with existing telephone- or paper-based approval systems. Any barriers to acceptance need to be identified during the planning phase of the project and managed during implementation. Importantly, management of the change process – including local champions or project leaders, and an organisation that supports innovation, incentives and participation – is a key determinant in system uptake.[51]

Sites with successful eCDSSs report a common set of factors:

- Strong leadership with a clear long-term commitment
- A commitment to improving clinical processes by enlisting clinician support
- Involving the clinicians in all stages of the development process.

A well-planned and well-timed communication strategy using the intranet, grand rounds, unit meetings and posters in preparation for the go-live date is important. The strategies used need to meet the institution's particular needs, goals and culture.[52]

4.2.7 Electronic clinical decision support in primary care

The use of general practice prescribing software is almost universal in Australia: 80–90% of general practitioners and 65% of community pharmacists use one of six prescribing systems, and one of three dispensing systems. The National Prescribing Service evaluated general practitioner prescribing systems to establish which features were available to support safety and quality in prescribing.[53] A panel of 12 experts in medicine, informatics or pharmacy identified 114 features across several domains that were tested in each of the systems. The decision support features were the most variable and, on average, the most poorly implemented. Features relating to recording patient data and selecting medicines were better implemented.

The report was published in 2011, but remains highly relevant for the key safety and quality issues relating to AMS. In particular, it found the following[54]:

1. The systems had limited access to evidence-based medicine and therapeutic information.

   No system provided access to independent (that is, not developed by the pharmaceutical industry) resources such as *Therapeutic Guidelines: Antibiotic*[6] and the *Australian Medicines Handbook*.[55] Many medication prompts contained information sponsored by pharmaceutical companies, which may not be immediately apparent to the prescriber

2. There was variable decision support for prescribing.

   Drug–drug interactions, medicines in pregnancy and allergy alerts were the most commonly implemented eCDSS features. All but one system relied on commercial medication databases, with limited opportunity for modification

3. Linking the prescription with the indication was optional.

   Mandatory indication documentation is required for quality improvement activities such as comparing individuals' prescribing with best-practice guidelines.

4. Clinical reporting was variable.

   The ability to report back to the clinician was limited.

General practices can, however, set up their practice systems to maximise the opportunity for improved antimicrobial prescribing, by:

- Subscribing to the electronic version of *Therapeutic Guidelines: Antibiotic*[6]
- Turning off automatic repeats
- Ensuring that indications and allergies are captured in the healthcare record for future patient visits.

Most published reports of eCDSSs in general practice relate to conventional algorithms integrated into electronic healthcare records or on an electronic device, which support antimicrobial prescribing for specific syndromes such as urinary tract and respiratory tract infections.[56-63] A systematic review of these systems found that eCDSSs that provided automatic decision support were more effective than those that required information to be initiated by the provider.[64]

The My Health Record system in Australia is an electronic summary of an individual's key health information drawn from their existing healthcare records and is designed to be integrated into existing local clinical systems. The system aims to give healthcare organisations access to patient information such as medication records, test results, discharge summaries, allergies and immunisations. Once it is widely rolled out, this program should provide increased opportunities for clinical decision support. Although the adoption of the My Health Record system has been slow (4.78 million users as of July 2017), a move to an opt-out clause and the introduction of the e-health Practice Incentives Program will increase its use. The ability for the system to interface with hospital electronic healthcare record systems would further improve communication between the community and hospital sectors.

4.3 Data collection and reporting

Antimicrobial approval systems, infection surveillance and EMM systems are all important data sources that can help to identify patients who require post-prescription review. They are also sources of data about antimicrobial use that can be used for institutional auditing and reporting purposes (see Chapter 6: 'Measuring performance and evaluating antimicrobial stewardship programs').

Approved linkages between institutional datasets are important to enable the monitoring and surveillance of both intended (improved patient outcomes and reduced AMR) and unintended consequences of AMS programs. Many hospitals' pathology or pharmacy databases do not allow for the data aggregation required to support such activities. Data from pathology systems can, however, contribute to local, state, territory and national data collections, as well as produce local antibiograms. Hospital pharmacy systems can generate reports on antimicrobial use and costs for monitoring and evaluation purposes.

A major barrier to effective reporting and surveillance of AMS interventions is the functionality of systems interoperability and the heterogeneity of messaging standards (especially HL7). National approaches to AMS will be improved by the standardisation of clinical data systems, semantic interoperability, the use of standard terminologies, messaging standards (such as HL7, particularly for microbiology data) and the use of unified patient healthcare record numbers.

There have been several improvements to the systems that support local, state, territory and national hospital data collection for the National Antimicrobial Prescribing Survey and the National Antimicrobial Utilisation Surveillance Program. The AURA project has established a coordinated approach to national surveillance and reporting for AMS, AMR and patient outcomes. This work will continue to improve data quality and consistency through the alignment of data definitions, the ability to improve the interoperability of systems and the potential for appropriate data linkage.

Table 4.2: Situations in which telehealth can be used to support antimicrobial stewardship strategies

AMS strategy	Telehealth options
Pre-authorisation (individual patient ID consultations, AMS ward rounds)	• Videoconferencing, Skype • Remote access to electronic healthcare records; electronic medication management systems; and pathology, microbiology, teleradiology results • Remote access to AMS electronic decision support systems
Post-prescription review (AMS ward rounds)	• Videoconferencing, Skype • Remote access to electronic healthcare records; electronic medication management systems; and pathology, microbiology, teleradiology, telepathology results • Scanning medication charts and sending to an off-site pharmacy for review
Education	• Online education programs • Webinars

AMS = antimicrobial stewardship; ID = infectious diseases

4.4 Telehealth

The International Organization for Standardization defines telehealth as the 'use of telecommunication techniques for the purpose of providing telemedicine, medical education and health education over a distance'.[65] Telehealth involves using different telecommunication technologies to support a model of service delivery in which not all clinical input is available on site. All telehealth must be underpinned by an appropriate service model and may include:

- Live, audio and video interactive links for clinical consultations and education
- Storage of digital images, video, audio and clinical data for secure transmission and use in remote clinics
- Teleradiology and telepathology for remote reporting and clinical advice for diagnostic tests
- Telehealth services and equipment to monitor people's health in their homes.

R

Telehealth can improve access to services and specialty care, especially for people living in rural and remote areas. Rural and remote health services are often leaders in the use of telehealth across a range of clinical areas, including support for AMS activities – for example, the use of low-cost videoconferencing systems to conduct individual patient reviews with an ID specialist, or virtual AMS ward rounds with a remote ID physician, clinical microbiologist or pharmacist. Examples of the types of telehealth that can be used to support AMS activities are listed in Table 4.2.

Health service planning needs to incorporate telehealth into AMS program delivery, and consider the following questions:

- What is the scope of services to be provided through telehealth, and what workforce is required to support these services?
- What key antimicrobials, indications or microbiology results will require consultation?
- Have formal arrangements been established for when and how advice on prescribing is to be sought and documented?
- Have ongoing arrangements been established to ensure continuity of service provision – for example, for leave?
- Have protocols been established for documenting consultations and decisions?
- How will external access be provided to on-site IT systems such as electronic healthcare records, AMS clinical decision support, and pathology, microbiology and radiology systems?
- What processes and systems are required to ensure the confidentiality and security of patient records?
- Will education form part of the telehealth service? How will clinicians be involved in educating and upskilling the local workforce?
- How will other technology, such as clinical decision support software or electronic healthcare records, be used and supported at both sites?

Models for providing AMS by telehealth include regular weekly AMS case conferences and virtual AMS bedside rounds, and prescriptions being reviewed remotely before being dispensed. Australian models have included an ID physician or clinical microbiologist who has remote access to the hospital computer system and teleconferencing, with an on-site AMS pharmacist who attends the bedside and reviews the patient's paper medication chart. The pharmacist then documents the agreed recommendation about antimicrobial use in the patient's notes. See Case study 4.3 for an Australian example.

Case study 4.3: Using telehealth for antimicrobial stewardship

Hospital B is a 250-bed public hospital in a regional town. It has an electronic antimicrobial approval system that was designed in-house and facilitates pre-prescription authorisation of restricted antimicrobials according to nominated indications, but does not have on-site infectious diseases (ID) physicians or a microbiology service. It had no system for escalating concerns about prescribing and no opportunities for post-prescription review. The AMS program was overseen by the infection control service; however, they did not feel equipped to manage the AMS program without more support, especially in the intensive care unit.

A successful business case was developed for contracting AMS services from a large major-city teaching hospital to support the local program. A comprehensive service agreement was achieved that included:

- Monthly visits by an ID physician
- Attendance by the ID physician at the AMS committee and infection prevention meetings (using teleconference facilities or on site)
- Access to policies and guidelines developed at the Principal Referral Hospital that could be customised for local use
- Involvement in audit activities, including analysis of data and preparation of reports
- Monthly on-site ID outpatient service, funded under a Medicare fee-for-service arrangement.

The AMS team developed a new model of care in which the ID physician conducts weekly AMS ward rounds using teleconference facilities. The AMS pharmacist triages a list of patients for post-prescription review, based on the pre-prescription approval list. The ID physician has remote access to the hospital's information technology (IT) system, and can view investigations and results, as well as nursing or midwifery handover notes. If required, they can phone to discuss patients with the resident doctors. The local clinicians discuss the cases with the AMS pharmacist at the bedside, with the ID physician joining through teleconference facilities. The resulting advice is documented electronically using an IT product that enables the AMS pharmacist to view the ID physician's typed recommendations and send them to the electronic healthcare record. The AMS ward rounds also involve regular contact with intensive care clinicians, using teleconference facilities, to provide advice about their patients.

The local AMS pharmacist and infection control practitioner felt better supported when they were able to discuss concerns with the ID physician first. Consistent advice was delivered by the ID physician, and the local team gained valuable knowledge. The pharmacist and infection prevention practitioners attended training courses in AMS to develop their skills. The program has been very well received by the workforce, and preliminary data suggest an immediate increase in the appropriateness of antimicrobial prescribing.

Resources

- Third-party antimicrobial approval systems: The Guidance Group, eASY medication stewardship, IDEA^{3}S
- Third-party eCDSSs: TheraDoc, TREAT

Mobile apps providing prescribing information and guidelines

Australian

- Therapeutic Guidelines Limited: e-TG complete (Therapeutic Guidelines complete)

International

- Imperial College London: Imperial Antibiotic Prescribing Policy app
- Sanford Guide: Sanford Guide online
- Johns Hopkins Medicine: Johns Hopkins antibiotics guide
- Horizon Strategic Partners (UK): MicroGuide (supports local customisation)
- Emergency Medicine Residents Association (US): 2017 EMRA Antibiotic Guide
- Wolters Kluwer Health (US): UpToDate online
- Börm Bruckmeier Publishing, LLC Medica: Antibiotics pocket
- Spectrum Mobile Health Inc: Spectrum – localized antimicrobial stewardship
- Infection Control Branch, Centre for Health Protection, Department Of Health (Hong Kong): Impact

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AUSTRALIAN COMMISSION
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5 Antimicrobial stewardship education for clinicians

Antimicrobial Stewardship in Australian Health Care

2018

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Acronyms and abbreviations

Acronym	Abbreviation
AMR	antimicrobial resistance
AMS	antimicrobial stewardship
ID	infectious diseases

Key points

- All clinicians caring for patients (including medical, dental and other non-medical prescribers, such as pharmacists, nurses and midwives) need to be educated about antimicrobial resistance (AMR), optimal antimicrobial use and principles of antimicrobial stewardship (AMS).
- Education on appropriate antimicrobial prescribing and use, AMR and the principles of AMS is an essential element of any AMS program.
- The goal of education in AMS is not only to reduce the total use of antimicrobials by an individual but to ensure that, when an antimicrobial is indicated, it is the right medicine at the right dose, via the right route and for the right duration.
- Education of all clinicians involved in prescribing, dispensing or administering antimicrobials should begin at undergraduate level, and be refreshed and consolidated with further training throughout their careers.
- Multifaceted interventions that combine clinician, patient and public education in several formats have been found to be the most successful approach to reducing unnecessary and inappropriate prescribing.
- Education strategies that incorporate behaviour change principles such as audit and feedback, along with more active strategies including academic detailing, consensus-building sessions and educational workshops, are more effective in changing behaviour than the passive dissemination of information alone.
- Pharmaceutical industry–sponsored activities have been shown to negatively influence the prescribing behaviour of clinicians, and AMS education should raise awareness of this issue.
- Evaluation of education should monitor not only the number of courses and participants but also the impact of education on knowledge and behaviour.
- A wide range of resources are available to assist with AMS training, and the use of website information and online training materials can be especially cost- and time-effective for many organisations.
- There are a number of key enablers for effective AMS education that should be considered when planning and implementing education programs.

5.1 Introduction

All clinicians caring for patients (including medical, dental and other non-medical prescribers, such as pharmacists, nurses and midwives) need to be educated about antimicrobial resistance (AMR), optimal antimicrobial use and principles of antimicrobial stewardship (AMS). They also need to be able to communicate effectively with patients to inform them, and manage their concerns and expectations about the supply (or non-supply) of an antimicrobial prescription.

Education can provide the foundation of knowledge to improve the implementation and acceptance of AMS strategies.[1] Its aim is to improve clinicians' knowledge, and to change attitudes and beliefs about antimicrobial prescribing and use. Education has therefore been described as a cornerstone of AMS programs and integral to their success.[1-3]

Teaching and education can be:

- **Passive** – such as didactic lectures or tutorials, the distribution of printed material and some online learning programs.
  Although passive learning alone has little effect on antimicrobial use[4,5], recent data indicate that passive education can increase the effectiveness of other interventions[6,5,7]
- **Active** – such as interactive small-group or one-on-one sessions, interactive online learning programs, audit and feedback, and reminders.[2,6,8,9]
  Although resource intensive[6], active education has been shown to be more effective and to have greater and more lasting effects on prescribing behaviour than passive techniques[1,2,5,10]

- **Combined and multifaceted** — including passive and active strategies tailored to different audiences. Several systematic reviews have examined the effectiveness of education in supporting improvements in antimicrobial prescribing and conclude that highly interactive learning methods are the most effective.[5,11,12] Multifaceted interventions that combine clinician, patient and consumer education in different venues and formats have been found to be the most successful approach to reducing inappropriate prescribing.[11]

This chapter focuses on the education of clinicians, which should begin at the undergraduate level and continue throughout their careers. The chapter is relevant to all health service organisations; private, and rural and remote hospitals may find the section on Websites and online learning resources especially useful. The education of consumers is addressed in Chapter 7: 'Involving consumers in antimicrobial stewardship'.

Issues that are especially relevant for certain settings – rural and remote hospitals, private hospitals and aged care – are tagged as R, P and AC, respectively, throughout the text.

R P AC

5.2 Key elements of antimicrobial stewardship education

Effective AMS education should be targeted to its audiences, and should consider the learning needs of the organisation and the local context. Evaluation of educational activities and their impact will be an important way to measure and drive ongoing change.

5.2.1 Audiences

Education for clinicians should include information about microorganisms and usual susceptibilities, antimicrobials and their mechanism of action, and the prevalence of AMR. Clinicians should also have an understanding of the benefits of using antimicrobials to treat different conditions, the principles of AMS, symptom management and the use of microbiology test results. They also need training in effective communication to equip them to inform patients and manage their expectations relating to the supply of an antimicrobial prescription.[9,13] Providing regular education throughout the clinician's career will help them to safely and appropriately use antimicrobials in their practice, and also contribute more fully to AMS. All clinicians who prescribe antimicrobials within their scope of practice require ongoing AMS education and support.

R P

In Australia, most antimicrobial prescribing (97%) is by medical practitioners.[14,15] Because prescribing by junior doctors is influenced by senior doctors[16,17], it is important that both senior and junior doctors are educated about optimal prescribing and are made aware of the local AMS program, including the relevant policies and guidelines. They should also be informed of the availability of AMS team members, and the processes for obtaining expert infectious diseases (ID), microbiology or pharmacist advice, whether on site or remotely.

AC

Management of antimicrobials requires teamwork between clinicians. Pharmacists working in the community, hospital and aged care settings play an important role in the process by reviewing and supplying antimicrobials, providing medication information and advising patients about their medicines.[8] Similarly, nurses and midwives are responsible for several patient management activities that incorporate and support safe and effective antimicrobial use. This highlights the importance of including pharmacists, nurses and midwives in continuing education about antimicrobial use and AMS strategies.[8] They need to develop an understanding of their role in prescribing and know that prescribing is also their business. Importantly, they need the knowledge to enable them to speak up and question orders for antimicrobials they believe are not in line with local policies and guidelines. (See Chapter 11: 'Role of the pharmacist and pharmacy services in antimicrobial stewardship' and Chapter 12: 'Role of nurses, midwives and infection control practitioners in antimicrobial stewardship'.)

Patients and consumers also have an important role in appropriate and safe antimicrobial use, and in addressing AMR for the safety of themselves, their families, other patients and health care in the future. Clinicians need to develop the skills to communicate effectively with patients to manage their concerns and expectations, and discuss why an antimicrobial prescription may not be appropriate for their condition. If an antimicrobial is prescribed, they need to educate consumers about how, when and for how long to take the antimicrobial.[18] Shared decision-making tools may support patient education. General practitioners trained in communication skills – and specifically in shared decision making – have been shown to prescribe significantly fewer antimicrobials than general practitioners without this training.[19] (See Chapter 7: 'Involving consumers in antimicrobial stewardship'.)

5.2.2 Principles of education on antimicrobial stewardship

> *The goal of education in antimicrobial stewardship is not only to reduce the total use of antibiotics by an individual, but to ensure that, when an antibiotic is truly indicated, it is the right drug and the right dose, via the right route, and for the proper duration.*[6]

Considering the objectives, potential approaches and content of education can help to ensure that educational activities are appropriately targeted and effective.

Education objectives

The purpose of AMS education is not only to improve knowledge but to change clinicians' attitudes towards the management of infection and their antimicrobial prescribing behaviour.[6]

Prescribing behaviour is affected by different factors, including attitudes, beliefs and experience (see Section 10.2 in Chapter 10: 'Role of prescribers in antimicrobial stewardship'). Improving knowledge alone does not necessarily lead to improved clinician behaviour.[6] An education program that considers the local determinants of prescribing and uses one or more of the active (behaviour-changing) educational activities is more likely to be successful in shifting attitudes and beliefs, and changing antimicrobial prescribing practices.[5,6,20,21]

Education approaches

Combined or multifaceted education strategies tailored to the target audience, and organised to complement and support other strategies in the AMS program have been shown to be more effective than single interventions (see Introduction). Studies combining educational activities with audit and feedback or prescribing guidelines have demonstrated improvements in antimicrobial prescribing in community, dental and hospital settings.[9,11,22] In a systematic review, Lee et al. reported that multiple interventions were more often effective in reducing the rate of antimicrobial prescribing than interventions using education alone.[9] Clinical education combined with audit and feedback was the most effective, achieving a 72% reduction in antimicrobial prescriptions. Education combined with clinical reminder and decision support systems achieved a 57% reduction. Least effective was patient education (a 14% reduction).[9] Many AMS guidelines for hospitals advocate combining multifaceted education interventions with other effective AMS strategies.[4]

Education content

The content of an AMS education program will depend on the audience, their place of practice and their professional development status. Required elements for educating clinicians about prudent antimicrobial use have been described (Table 5.1).[8] These elements can be used to determine topics, principles and learning outcomes to include in an undergraduate core curriculum, intern and clinical training, and specialty and professional training. They can also be used to derive competencies required for appropriate antimicrobial prescribing.

5.2.3 Antimicrobial stewardship competencies and standards

Competency standards describe the skills, attitudes and other attributes (including values and beliefs) attained by an individual based on knowledge (gained through study at university) and experience (gained through subsequent practice), which together enable the individual to practise effectively in their profession.[23]

Australia has a generic prescribing competency framework for all prescribers. The framework has seven competency areas and attributes that are essential for judicious and appropriate prescribing of medicines, including antimicrobials.[24]

In the United Kingdom, generic prescribing competencies are complemented by specific competencies for AMS, designed to be used by any individual prescriber to develop their antimicrobial prescribing practice.[25] There are five competency areas:

- Competency 1 – infection prevention and control
- Competency 2 – antimicrobial resistance and antimicrobials
- Competency 3 – prescribing antimicrobials
- Competency 4 – antimicrobial stewardship
- Competency 5 – monitoring and learning.

These competencies can be used by education providers and professional bodies to inform standards, guidance, the development of training

Table 5.1: Elements of education for antimicrobial prescribing

Topic	Concepts	Principles, learning outcomes and competencies
Antimicrobial resistance	Selection, mutation	• Extent and causes of resistance in pathogens (low antimicrobial concentration and prolonged exposure of microorganisms to antimicrobials is driving resistance) • Extent and causes of resistance in commensals, and the phenomenon of overgrowth (e.g. *Clostridium difficile* infection, yeast infection) • Epidemiology of resistance, accounting for local variations and importance of surveillance (e.g. differences between wards, countries)
	Infection prevention and control	• Spread of resistant organisms
Antimicrobials	Mechanisms of action of antimicrobials and antimicrobial resistance, toxicity, costs	• Broad-spectrum versus narrow-spectrum antimicrobials; preferred choice of narrow-spectrum agents • Combination therapy (synergy, limiting emergence of resistance; broaden the spectrum) • Collateral damage of antimicrobial use (toxicity, cost) • Consequences of bacterial resistance • Lack of development of new antimicrobials (limited arsenal)
Diagnosing infection	Infection, inflammation	• Interpretation of clinical and laboratory biological markers • Fever and C-reactive protein elevation are signs of inflammation, not necessarily indicative of an infection
	Isolation and identification of bacteria, viruses and fungi	• Practical use of point-of-care tests • Importance of taking microbiological samples for culture before starting antimicrobial therapy
	Susceptibility to antimicrobials	• Interpretation of basic microbiological investigations (e.g. Gram stain, culture, polymerase chain reaction, serology)
Treating infection	Indication for antimicrobials	• Definitions of, and indications for, empirical/directed therapy versus prophylaxis • Clinical situations when an antimicrobial should not be prescribed • Colonisation versus infection (e.g. asymptomatic bacteriuria) • Viral infections (e.g. acute bronchitis) • Inflammation versus infection (e.g. fever without a definite diagnosis in a patient with no severity criteria)
Preventing infection	Indication for antimicrobials	• Surgical antibiotic prophylaxis: indication, choice, duration (<24 hours), timing

Topic	Concepts	Principles, learning outcomes and competencies
Medical record keeping	Choice, duration, timing	• Documentation of antimicrobial indication in clinical notes • Recording (planned) duration or stop date
Prescribing antimicrobials: initially	Empirical therapy (local guide, antimicrobial booklet), diagnostic uncertainty	• Best bacteriological guess for empirical therapy • Choice of empirical therapy in patients with previous antimicrobial treatment • Managing penicillin allergy • Choosing the dose and interval of administration (basic principles of pharmacokinetics and pharmacodynamics) • Estimating the shortest possible adequate duration
Prescribing antimicrobials: targeted therapy	Communication with the microbiology laboratory, value of specialist consultation in infectious diseases or microbiology	• Reassessment of intravenous antimicrobial prescription after 48–72 hours • Streamlining or de-escalation once microbiological results are known • Intravenous-to-oral switching (bioavailability of antimicrobials) • Therapeutic drug monitoring to ensure adequate medicine levels (e.g. vancomycin)
Prescribing antimicrobials: standard of care	Importance of guidelines in clinical practice	• Prescribing antimicrobial therapy according to national or local practice guidelines • Using *Therapeutic Guidelines: Antibiotic*
	Quality indicators of antimicrobial use	• Audit and feedback to assess prescribing practice using quality indicators
Communication skills	Discussion techniques	• Explaining to the patient the absence of an antimicrobial prescription • Education of patients regarding appropriate antimicrobial use (e.g. comply with the clinician's prescription, no self-medication)

Source: Adapted from Pulcini and Gyssens[8]

(such as through curriculum development, or designing education and training courses and other materials) and the assessment of competency.[3]

In addition to meeting professional competency standards, all registered clinicians in Australia must undertake continuing professional development. For most clinicians, a continuing education record or portfolio must be maintained. This record generally needs to show participation in different activities to maintain, improve and broaden knowledge, skills and performance to help clinicians deliver appropriate and safe care.[26] Participation in any of the AMS educational activities described in this chapter could be documented in the clinician's record.

5.2.4 Influence of the pharmaceutical industry

As commercial entities, pharmaceutical companies employ a range of strategies to market their products to clinicians. These may include sponsorship to attend educational events, production of educational materials and free samples, speaker and consulting fees, participation in advisory board meetings, food and beverages, and small gifts.

Literature indicates that interactions between the pharmaceutical industry and medical practitioners can influence prescribing practices, leading to increased medicine costs, prescribing that is not concordant with guidelines, a preference for new medicines, and decreased prescribing of generic medicines.[27,28]

In Australia, the relationship between medical practitioners and pharmaceutical companies is self-regulated through industry codes. The Medical Board of Australia Code of Conduct requires medical practitioners to recognise that pharmaceutical and other medical marketing may influence clinicians, and to be aware of ways in which their practice may be influenced.[29] Medicines Australia, the representative body of the pharmaceutical industry, requires member companies to report fees and support paid to Australian clinicians. These reports are published on the Medicines Australia website.

It is important that all clinicians who care for patients receiving antimicrobials are educated about unbiased sources of information, and that local policies on interactions with the pharmaceutical industry are applied to all clinicians. Medical schools and teaching hospitals have an important role to play in preparing future medical practitioners to recognise potential bias and appropriately manage conflicts of interest.[30] Policies regulating interaction with the pharmaceutical industry can assist students to maintain a level of independence from industry bias and may promote better educational outcomes.[31,32] Guidelines for managing conflict of interest, including interactions with the pharmaceutical industry, have been developed by professional societies and colleges, some academic institutions, and state and territory health departments (see Appendix A). Issues of influence by the pharmaceutical industry also need to be considered for other members of the health workforce.

5.2.5 Evaluation of educational activities

Good governance requires organisations to monitor both the type and the frequency of education provided, and the extent of participation, to confirm that all clinicians are provided with education and training that will enable them to deliver safe care.[33] For this reason, organisations should keep appropriate records of AMS education provided and, if mandatory, records of attendance. If individual clinicians are required to complete online training modules, certificates of completion may be submitted; existing systems or structures within a hospital or across a network may assist with this. For example, many hospitals have education and quality improvement systems in place for monitoring attendance; in Primary Health Networks or practices, there may be individuals who are responsible for monitoring education provided, and who can assist with maintaining records and sources of data for evaluation.

A comprehensive approach to evaluating educational activities is encouraged. Surveying clinicians about their knowledge of antimicrobial management, and about their perceptions before and after an education intervention can also be a useful way to evaluate educational activities.[34]

Knowledge assessments alone are not enough to evaluate the effectiveness of education interventions.[35] Teams can undertake impact (immediate reaction to education) and outcome (resulting changes in practice) evaluations by following up participants, if resources allow. Counting the hits on the organisation's website resources will provide information on how often guidelines and other resources are accessed. Other sources of evaluation might include results of audits, and more qualitative observations of increased attendance or engagement in learning activities, or in the number of teams or individuals seeking advice from the AMS team.

5.3 Antimicrobial stewardship education for different groups and stages

A firm educational grounding for undergraduates, consolidated with further training throughout their careers, has been recommended to achieve optimal prescribing and use of antimicrobials (Figure 5.1).[8,9] During the undergraduate and intern (foundation) years – when knowledge, attitudes and behaviours of clinicians are being shaped – education should focus on building a solid knowledge base for future practice. For example, a surgeon who is taught the principles of guideline development and antimicrobial prophylaxis will be more likely to follow the organisation's prophylaxis guidelines.[8] Because attitudes and behaviours can change over time, it is important that educational messages are regularly repeated.[9,36]

5.3.1 Undergraduate training

AMS is likely to be more successful if education begins early in the undergraduate curriculum.[8] For professions such as pharmacy, a strong foundation in the undergraduate curriculum is especially important, as many pharmacy graduates will not have the opportunity to obtain formal postgraduate training.[37]

International studies show that many undergraduate healthcare students do not receive the level of education required to safely and effectively prescribe, review, dispense or administer antimicrobials; understand AMR; and understand the principles of AMS.[38,39] Most students surveyed in the studies wanted more education on choosing antimicrobial treatments and appropriate prescribing, and many felt ill-equipped to manage patients requesting unnecessary antimicrobials and to prescribe in cases of diagnostic uncertainty.[37,40] The results of a survey on knowledge and attitudes of Australian doctors at three Australian hospitals indicate that medical interns have gaps in antimicrobial prescribing knowledge.[17]

Topics for inclusion in undergraduate education programs for clinicians include principles of microbiology, ID and clinical pharmacology, with emphasis on appropriate antimicrobial prescribing and use.[41] Dyar et al. suggest including more cases of diagnostic uncertainty in medical undergraduate education and using successes such as prevention of methicillin-resistant *Staphylococcus aureus* as evidence for the importance of AMS interventions.[42] Managing the demands of patients can be included in communication skills sessions.[8]

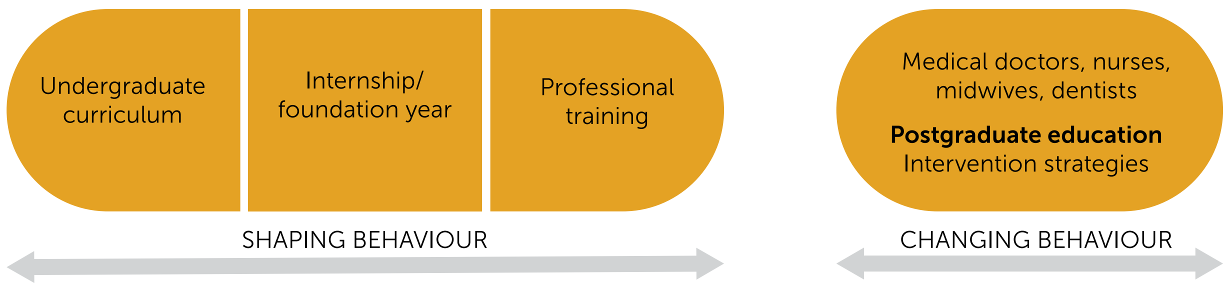
Because AMS relies on the expertise and engagement of all team members, it is well suited to being taught within a multidisciplinary learning environment.[37] A United States study reported a better understanding of, and attitude to, the different clinicians' roles and collaborative approaches to AMS when pharmacy and medical students learned about AMS together.[43] Problem-based learning that allows interactive learning in small groups is recommended for teaching AMS concepts.[8] (See also Resources.)

5.3.2 Early-career development

Prescribers often acquire their antimicrobial prescribing habits from the practice of colleagues and senior workforce members, recommendations in antimicrobial handbooks, and information from representatives of the pharmaceutical industry.[2] Learning about the purpose of AMS and the importance of appropriate antimicrobial prescribing early in career development may help to shape attitudes and behaviours of future prescribers and other clinicians, and better equip them with the knowledge and skills needed to incorporate AMS principles in their practice.

Education should be provided early in employment and continue at regular intervals. An annual cycle of learning and development is suggested, although sessions may need to be repeated more often to take into account workforce changes and rotations. In addition to an introductory session on AMS provided during orientation, essential training in prudent antimicrobial use is mandatory for doctors, nurses, midwives and pharmacists working in United Kingdom hospitals, and must be repeated every three years.[13,44] This approach is supported by international studies showing that education sessions are one of the most helpful interventions for improving prescribing among junior doctors.[13] Box 5.1 lists topics for inclusion in an AMS training program. Such a program will cover some of the common causes of inappropriate prescribing among medical interns, such as gaps in antimicrobial prescribing knowledge and lack of awareness about which antimicrobials are restricted.[17]

Figure 5.1: Time line for educating clinicians on optimal antimicrobial use and principles of antimicrobial stewardship



Source: Adapted from Pulcini and Gyssens[8]

AMS messages can also be incorporated into other early-career training activities – for example, highlighting the importance of reviewing and documenting decisions about antimicrobial therapy at transitions of care (between wards and facilities, and at the community–hospital interface), as part of clinical handover and medication reconciliation training. The importance of documenting arrangements for contacting patients for follow-up after discharge if changes to antimicrobial treatment are needed in the light of microbiology results could also be discussed.

Involving students and early-career professionals in team-based quality improvement projects for AMS can improve clinical care and build the capability and capacity of the workforce in both quality improvement and AMS. It can also help people understand the complexity of health systems and appreciate the roles of different clinicians and teams in patient care.[45] Davey suggests that there is a:

> *need to rethink professional education to embrace complexity and enable teams to learn in practice. Workplace-based learning of improvement science will enable students and early-career professionals to become change agents and transform training from a burden on clinical teams into a driver for improvement.*[45]

5.3.3 Continuing education and professional development

AMS education needs to be available for clinicians to access on an ongoing basis throughout their careers to ensure that antimicrobial use is based on current evidence, and is safe and effective, and that patients are not harmed by unnecessary or inappropriate prescribing.

Continuing education for AMS should build on the knowledge and skills gained during undergraduate and early-career training. AMS continuing education may be provided in a number of different formats, and organisations may select a mix of passive and active educational activities relevant to their situation and resources (see Introduction). Some practical examples of engaging clinicians in educational activities are provided below.

Lectures, tutorials, in-service and grand rounds sessions

Demonstrating the relevance of AMS to clinical practice by using case studies, and focusing education on complications of antimicrobial management and implications for patient care can help to engage clinicians. For tutorials or workshops, interactive sessions using problem-based learning with case vignettes are recommended.

AC

Using local data can be a powerful way to convince clinicians about problems with resistance and inappropriate use. For example, national, state and territory surveillance data from sources such as the Antimicrobial Use and Resistance in Australia Surveillance System can be used to show the extent of problems with AMR and to inform local AMS programs.[14,15] Local data on antimicrobial use and the appropriateness of prescribing (from sources such as the National Antimicrobial Prescribing Survey, the Aged Care National Antimicrobial Prescribing Survey and the National Antimicrobial Utilisation Surveillance Program) are useful for showing variations in volume and appropriateness of use compared with peer health services, and for clinicians working in aged care services. In general practice, local data sources could include MedicineInsight practice reports from NPS MedicineWise, and information on variation in prescribing across local areas, states and territories from the *Australian Atlas of Healthcare Variation*.[46] Understanding the audience is helpful in determining what type of data to use and how to present them. For example, some groups may be motivated by evidence, whereas others may be more influenced by case studies.

Department or practice meetings, morbidity and mortality meetings

Discussions during morbidity and mortality meetings, or unit, department or practice meetings, where the management of individual patients can be discussed within clinical teams or with peers, can help to engage clinicians from different disciplines by making AMS relevant to patient management.[45] Department meetings are also a good forum for providing feedback on the results of audits, with recommendations for improving prescribing behaviour. These activities can be supplemented with electronic messages, posters and online resources (see Case study 5.1).

Academic detailing

Academic detailing or education outreach involves one-on-one educational sessions between a clinician educator (usual a pharmacist or clinician) and a prescriber. Such sessions have been shown to have greater and more lasting effects on changing prescriber behaviour than printed materials or group interactions.[10] A systematic review of interventions to improve antimicrobial prescribing in hospital inpatients reported that 20 of 21 studies

Box 5.1: Topics for inclusion in antimicrobial stewardship training programs

- Extent and causes of antimicrobial resistance, including the role of antimicrobials in driving resistance
- Role of infection prevention and control
- General principles of antimicrobial therapy
- Interpretation of antimicrobial susceptibility reports and local antibiograms
- Allergies to antimicrobials
- Therapeutic drug monitoring
- Antimicrobial stewardship (AMS) prescribing principles and the Antimicrobial Stewardship Clinical Care Standard
- Purpose of AMS and details about the functions of the local AMS program, including:
  - availability of national and local diagnostic and treatment guidelines
  - organisational policies on antimicrobial prescribing
  - clinical decision support systems
  - local restrictions and approval systems
  - who to go to for advice
- Factors influencing the behaviour of prescribers and other healthcare professionals regarding antimicrobial use, including the effect of promotional activities conducted by the pharmaceutical industry.

Source: Nathwani et al.[3]

on academic detailing were associated with an improvement in prescribing, with median effect sizes of between 20% and 46.3%.[5]

Academic detailing is often combined with audit and feedback, and guideline promotion in hospitals and community settings. Maxwell et al. describe a set of interventions that included academic detailing, feedback of audit results and point-of-prescribing prompts to improve antimicrobial prescribing in the management of community-acquired pneumonia in Australian emergency departments. An overall 1.5-fold improvement in guideline-concordant prescribing was reported.[47]

One-on-one patient-directed education

There are many opportunities for informal one-on-one education at the individual patient level in the workplace, especially in teaching hospitals – for example, during the approval process, as feedback following reviews of prescribing by the AMS team, or during an ID consultation. Petrak et al. describe an ID consultation that is 'written, verbally discussed, supported by literature and refocused as the case evolves' as the perfect model for educating the clinical workforce.[48] The medical workforce in an Australian teaching hospital reported that the patient-level advice provided by a telephone-approval system managed by the ID unit was educational and useful.[49]

Online learning

Online learning modules with an interactive component are an effective mechanism for learning (see Resources). For example, an internet-based training program for general practitioners on improving patient communication skills and using C-reactive protein testing improved prescribing for acute respiratory tract infections in a multinational trial.[50]

This mode of delivery can occur at a time convenient to the workforce, and may suit senior prescribers, general practitioners and junior clinicians. Ideally, such education includes questions during or on completion of the module that enable the clinician to reflect on and measure their learning.

Repeated education to reinforce the message is very important. Time-spaced learning, in which education is provided regularly in short bursts but spaced over time, reduces the need for clinicians to spend large blocks of time away from the workplace. Relearning the material at spaced intervals has also been shown to help learners remember over time. An example of a time-spaced learning program is

Case study 5.1: Antimicrobial stewardship continuing professional education in hospitals

Clinicians were surveyed at a large tertiary referral hospital to assess their knowledge and explore their attitudes to antimicrobial use. The results indicated that basic information was required, because clinicians had forgotten what they had learned in undergraduate training. Education was therefore pitched at a level that assumed only minimal knowledge.

Once or twice a month, a 'did you know?' email is sent to junior medical officers and registrars, as well as nurse educators, nurses and pharmacists. These usually cover one topic that the AMS team has come across during ward rounds. They are short, sharp and clinically focused (see Appendix B). People can read them in their own time and are encouraged to email questions back if the advice is not clear. They have been well received.

The emails are saved on the hospital intranet page for future access. Topics are recycled each year to catch new doctors and reinforce repeated problem areas. The emails are complemented by posters, online resources, and talks at unit meetings (although the talks may happen only once every few years).

the AMS Massive Open Online Course developed by Scottish medical schools and the British Society for Antimicrobial Chemotherapy (see Websites and online learning resources).

Education combined with other antimicrobial stewardship activities

Combining education with other AMS activities can increase the effectiveness of the intervention. For example, feedback of individual prescribing data combined with educational messages, or as part of an academic detailing session, has been shown to be effective in reducing antimicrobial prescribing in general and dental practices. In Australia, NPS MedicineWise provides feedback to general practitioners on their own prescribing relative to their peers, including points of reflection for the prescriber. Antibiotic Awareness Week can be a good time to focus on continuing education activities.

Another strategy used to promote guideline-concordant antimicrobial prescribing is 'nudging'. Meeker et al. reported a 19.7% reduction in inappropriate antimicrobial prescribing by using a behavioural nudge based on a public commitment to avoiding inappropriate prescribing of antibiotics for acute respiratory tract infections.[51]

5.3.4 Education and training for antimicrobial stewardship teams

Leading an AMS program requires a range of skills and knowledge beyond ID and microbiology[52], and clinicians interested in leading AMS programs should be encouraged to develop these skills (see Continuing education and professional development). In addition to the skills required for improving the prescribing and use of antimicrobials, members of AMS teams need to be knowledgeable about quality improvement techniques and measuring the success of a program. Skills in quality improvement methods will help the team work together to determine areas for improvement, identify barriers, and select and evaluate interventions that are more likely to change prescribing behaviour.

The Society for Healthcare Epidemiology of America has partnered with the Infectious Diseases Society of America and other organisations to develop a summary description of the core knowledge and skills required for AMS professionals engaged with building, leading and evaluating AMS programs.[52] These requirements can be used by AMS teams or organisations to identify gaps in training, to assess education needs when developing AMS courses and curriculums, and as a framework for determining knowledge and skills needed for developing AMS programs.

Some states and territories conduct training days for AMS teams in hospitals. The training days provide team members with skills in AMS principles, and practical advice on implementing and evaluating AMS programs. They also provide a good forum for discussing difficult issues, such as dealing with prescribers who are resistant to change. Pulcini and Gyssens have published a set of learning outcomes that can be used as a basis to design AMS workshops for AMS team members.[8]

Several professional organisations host online forums that provide opportunities for clinicians

Box 5.2: Australian antimicrobial stewardship online networking forums

- Infexion Connexion Discussion List, facilitated by the Australasian College for Infection Prevention and Control
- Antimicrobial stewardship online monthly journal club meeting, facilitated by the National Centre for Antimicrobial Stewardship
- Infectious Diseases Specialty Practice Stream, facilitated by the Society of Hospital Pharmacists of Australia
- Ozbug network, facilitated by the Australasian Society for Infectious Diseases

working in AMS to network and canvass specific AMS issues (Box 5.2).

5.3.5 Specialist training

Postgraduate specialist education can consolidate learning gained during undergraduate education and postgraduate clinical experience. Specialist programs should include education on the implications of AMR for specific patient groups, the types of infections commonly seen, and the antimicrobials that are used more often in specialist settings relevant to the professional group.

Professional colleges and associations can take a proactive role in supporting AMS – for example, by updating their members about changes to guidelines and providing continuing education or discussion forums. This is especially important for specialist groups that are responsible for prescribing antimicrobials as an adjunct to their roles (for example, surgeons, anaesthetists, dentists).

Postgraduate training of ID physicians, clinical microbiologists and AMS pharmacists should incorporate specific, detailed education on AMS to enable trainees to develop the knowledge and skills necessary to actively contribute to AMS efforts. The requirements detailed by Cosgrove et al.[52] can be used by trainees to assess their own education needs, and by colleges and professional organisations to develop AMS courses and curriculums. A number of online education programs and external training courses are available for trainees (see Resources).

Some details of profession-specific training are provided in Chapter 8: 'Role of the infectious diseases service in antimicrobial stewardship', Chapter 11: 'Role of the pharmacist and pharmacy services in antimicrobial stewardship' and Chapter 12: 'Role of nurses, midwives and infection control practitioners in antimicrobial stewardship'.

5.4 Education resources

A range of Australian and international resources are available to assist with AMS training. Australian resources on antimicrobial prescribing and resistance are preferred because they are based on national guidelines, Australian susceptibility data and antimicrobials available in Australia.

5.4.1 Guidelines

Evidence-based clinical guidelines are a popular educational tool for clinicians and have become a major feature of health care.[53] They can form the basis for educating prescribers and other clinicians on accepted practice for antimicrobial prescribing in the organisation (see Section 3.2 in Chapter 3: 'Strategies and tools for antimicrobial stewardship'). *Therapeutic Guidelines: Antibiotic*[54] is recognised as the national best-practice guideline for antimicrobial prescribing in Australia, and is considered by doctors and other clinicians to be an enabler of appropriate prescribing.[17]

Educational activities are often used to improve the uptake of guidelines. They include awareness-raising activities and audits of compliance with guidelines, with feedback to prescribers and clinical departments.

5.4.2 Websites and online learning resources

In recent years, technology has enabled education to be delivered in a range of different formats, such as online learning modules and video- and web-supported continuing education programs. Online learning offers access to learning materials developed by experts that may not otherwise be readily accessible to all clinicians, especially those working in smaller, rural or remote centres.

R
P

Mobile technology, such as smartphones, is also increasingly being used to access resources on antimicrobial prescribing, including antimicrobial guidelines.[37,55] In a study of emergency department doctors, 89% were found to use mobile technology for antimicrobial prescribing decisions.[56] The rapid uptake in the use of smartphones to access information to aid antimicrobial decision-making provides an opportunity for health service organisations to improve access to national and local antimicrobial prescribing guidelines and other relevant antimicrobial prescribing information.[37,55]

Online Australian resources that are available for use in hospital and community practice include videos, online learning courses, the electronic version of *Therapeutic Guidelines: Antibiotic*[54], case studies, and many publications, including MedicineWise News, with a focus on specific antimicrobial topics. The antimicrobial online learning modules developed by NPS MedicineWise and the Australian Commission on Safety and Quality in Health Care provide an introduction to prescribing antimicrobials and case-based scenarios on prescribing for common hospital infections. All medical interns and overseas-trained doctors should finish these modules early in their training.

A range of resources are also available from overseas websites, including:

- Future Learn online course on AMS in hospitals, which provides the opportunity to learn in a novel way with participants from around the world[57]
- Training materials developed by the Scottish Antimicrobial Prescribing Group with NHS Education for Scotland to support continuing professional development in both hospital and community settings.

However, not all resources available electronically are appropriate to Australian practice. The source of resources should be considered when searching the internet for treatment guidelines or dosage regimens, or when accessing material via social media. International guidelines may not be relevant to the Australian context or consistent with recommended Australian treatment guidelines.

Prescribers must be educated to use credible sources of information and supported to use appropriate resources. This can be achieved by establishing an up-to-date website on the internet or organisational intranet that provides easy access to:

- Information on the local AMS program and current strategies[58]
- Local prescribing guidelines and *Therapeutic Guidelines: Antibiotic*[54]
- Links to appropriate websites and apps that have been endorsed by the local AMS committee.

In the hospital sector, making such websites publicly available facilitates the sharing of ideas and may assist other hospitals to implement similar programs.[58,59] Many AMS websites provide useful information and educational resources for designing and implementing AMS programs and for educating clinicians (see Resources).

5.4.3 Educators

It is important that education is from a credible source and is tailored to the audience; the prescriber needs to have confidence in the advice. The person or group providing education needs to be respected by the clinician – that is, someone who is viewed as a peer, understands the clinical situation that they are talking about, knows the evidence and can justify the advice. This is especially important when convincing senior doctors to change their prescribing habits.

A multidisciplinary group that includes ID physicians, clinical microbiologists, clinical pharmacists, nurses, midwives and infection control practitioners, or the AMS team, should be responsible for planning, developing and delivering a local education program. This will help to ensure that the approach to education is suitable for the intended audience and relevant to the local practice context.[8,60] Consideration should be given to providing education sessions in multidisciplinary team environments and to clinician-specific groups, given the multidisciplinary nature of AMS activities.

Members of the AMS team can also provide AMS education (see Chapter 8: 'Role of the infectious diseases service in antimicrobial stewardship', Chapter 9: 'Role of the clinical microbiology service in antimicrobial stewardship', Chapter 11: 'Role of the pharmacist and pharmacy services in antimicrobial stewardship' and Chapter 12: 'Role of nurses, midwives and infection control practitioners in antimicrobial stewardship'). In the community, NPS MedicineWise provides multifaceted, nationally coordinated education programs (including academic detailing) to general practitioners.

Resources

Online education resources include:

- NPS MedicineWise
  - Antimicrobial online learning modules (antimicrobial prescribing courses, management of urinary tract infections in aged care)
  - Case studies
  - Clinical e-audits
  - Medicines use reviews
- Online course on AMS in hospitals: Future Learn
- Scottish Antimicrobial Prescribing Group: training materials to support continuing professional development
- Australian Commission on Safety and Quality in Health Care
  - video presentations on antimicrobials and AMS in hospitals
  - materials to promote Antibiotic Awareness Week
- British Society for Antimicrobial Chemotherapy: *Antimicrobial Stewardship: From principles to practice*
- Australian AMS online networking forums
  - Infexion Connexion Discussion List, facilitated by the Australasian College for Infection Prevention and Control
  - AMS online monthly journal club, facilitated by the National Centre for Antimicrobial Stewardship
  - Infectious Diseases Specialty Practice Stream, facilitated by the Society of Hospital Pharmacists of Australia
  - Ozbug network, facilitated by the Australasian Society for Infectious Diseases
- Prescribing curriculums and competencies
  - NPS MedicineWise National Prescribing Curriculum
  - NPS MedicineWise Prescribing Competencies Framework
  - Department of Health and Public Health England Antimicrobial Prescribing and Stewardship Competencies

Other resources:

- Tools and resources from the General Practitioner Antimicrobial Stewardship Programme Study
- Conflict of interest guidelines, codes of conduct and position statements (Appendix A)
- Example of a 'Did you know' email for clinicians (Appendix B).

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Appendix A: Managing conflicts of interest and relationships with the pharmaceutical industry – further reading and links

National guidance

Australian Government Department of Health

- Therapeutic Goods Advertising Code (2015)
- National Medicines Policy (2000)

State and territory guidance

- **ACT Government:** Gifts, Benefits & Hospitality Policy (2016)
- **NSW Therapeutic Advisory Group Inc.:** *Pharmaceutical Industry and Hospital Staff Liaison in Public Hospitals*
- **SA Health:** Gifts and Benefits Policy Directive (2016)
- **VicHealth:** Gifts, Benefits and Hospitality Policy (2017)
- **Western Australian Therapeutic Advisory Group:** *Guidance Document for Western Australian Public Hospitals and Health Services and their Staff on Liaison with the Pharmaceutical Industry* (2010)

Professional association codes, guidance and policies

- **Medicines Australia:** Code of Conduct (2015)
- **Pharmaceutical Society of Australia:** Code of Ethics for Pharmacists (2017)
- **Medical Board of Australia:** *Good Medical Practice: A code of conduct for doctors in Australia* (2014)
- **Nursing and Midwifery Board of Australia:** Professional standards web page
- **Royal Australasian College of Physicians:** Code of Conduct (2013)
- **Royal Australasian College of Surgeons:** Conflict of Interest Policy (2016)
- **Royal Australian College of General Practitioners:** Conflict of Interest Policy (2015)
- **Australian Medical Association:** Medical Practitioners' Relationships with Industry [position statement] (2012) (currently under review)
- **Australian Dental Association:** Policy Statement 5.12 – The Relationship between Dentists and the Pharmaceutical Industry (2014)

Further reading

- NPS MedicineWise. Identifying and managing competing interests (panel discussion). In: Phillips S, Komesaroff P, Kerridge I, Hemming M. Independent therapeutic advice: how achievable is it? Aust Prescr 2013;36(Suppl 2):S1–48.
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Appendix B: Example of a 'Did you know' email for clinicians

Source: Antimicrobial Stewardship Pharmacist, The Royal Melbourne Hospital – City Campus, Pharmacy Department, Grattan Street, Parkville Victoria 3050

These emails usually cover one topic identified by the AMS team during ward rounds. They are short, sharp and clinically focused. People can read them in their own time and are encouraged to email questions back if the advice is not clear. Other topics that have been included in these emails are intravenous-to-oral switching and vancomycin.

DID YOU KNOW?

Management of *Enterococcus* urinary tract infections

General tips

- Only request urine cultures if the patient **has clinical signs of a urinary infection**
- **Catheter urine samples** almost always have *white blood cells* present and are colonised by bacteria; these do NOT need to be treated with antibiotics if the patient is otherwise well. If treatment is necessary, infection will not clear without changing the catheter (*in many cases this is all that is required*).

Enterococcus susceptibility and treatment options

- Enterococci are gram-positive cocci that are common commensal organisms of the gastrointestinal tract
- *Enterococcus faecalis* isolates are almost always SUSCEPTIBLE to amoxycillin
- *Enterococcus faecium* isolates are almost always RESISTANT to amoxycillin
- Note that amoxycillin-resistant isolates will be resistant to amoxycillin/clavulanate also
- Both *E. faecalis* and *E. faecium* are usually susceptible to vancomycin, which must be administered intravenously
- If the enterococci are resistant to vancomycin (VRE) in a patient with a true infection, contact VIDS for advice.

Oral options for penicillin-intolerant patients (check that the patient is TRULY penicillin intolerant by asking details of 'allergy' first).

Nitrofurantoin:

- is a reasonable option for uncomplicated cystitis due to *E. faecalis*, and some *E. faecium* isolates
- should NOT be used for systemic infection or prostatitis
- should NOT be used if the patient has renal impairment.

Fosfomycin:

- is an oral antibiotic option that may be prescribed only after consultation with VIDS
- has fewer toxicity issues compared with nitrofurantoin
- is also NOT suitable for systemic infection in general
- can have susceptibility testing performed by our Microbiology team on request.

Why is ciprofloxacin not a good option?

- Quinolones (including ciprofloxacin) have intrinsically *reduced activity* against enterococci, compared with gram-negative organisms, e.g. members of the Enterobacteriaceae
- Quinolones are generally **not recommended** for infections due to *Enterococcus* spp.
- Quinolones have a BROAD spectrum of activity, and so the potential for adverse consequences of using these agents is substantial – e.g. *Clostridium difficile* risk or subsequent infection with multidrug-resistant bacteria.

Always remember to chase up susceptibility results to determine the most appropriate narrowest-spectrum agent.

Remember that the Microbiology registrars are always available and will be delighted to discuss testing/treatment options!

AUSTRALIAN COMMISSION ON SAFETY AND QUALITY IN HEALTH CARE

6 Measuring performance and evaluating antimicrobial stewardship programs

Antimicrobial Stewardship in Australian Health Care

2018

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Acronyms and abbreviations

Abbreviation	Definition
acNAPS	Aged Care National Antimicrobial Prescribing Survey
AMR	antimicrobial resistance
AMS	antimicrobial stewardship
AURA	Antimicrobial Use and Resistance in Australia
DDD	defined daily dose
DOT	days of therapy
LOT	length of therapy
NAPS	National Antimicrobial Prescribing Survey
NAUSP	National Antimicrobial Utilisation Surveillance Program
NSQHS	National Safety and Quality Health Service
OBD	occupied bed day
PBS	Pharmaceutical Benefits Scheme
QI	quality improvement
RPBS	Repatriation Pharmaceutical Benefits Scheme
SNAPS	Surgical National Antimicrobial Prescribing Survey

Key points

- Antimicrobial stewardship (AMS) measurement and assessment systems should be part of existing monitoring systems and linked to the measurement of performance in the health service organisation.
- Measuring the effectiveness of AMS program activities in health service organisations is a requirement for meeting the National Safety and Quality Health Service Preventing and Controlling Healthcare-Associated Infection Standard.
- AMS measurement should be embedded into the AMS program and should include structure, process, outcome and balancing measures that are sustainable and appropriate to the healthcare setting.
  - Structure measures assess whether the essential elements of an AMS program are established and maintained.
  - Process measures determine whether policies and processes are being followed correctly; they can be used to evaluate initiatives to improve the quality of prescribing.
  - Outcome measures aim to assess the effect of AMS in terms of whether patient outcomes have improved, adverse events have decreased, and infections caused by resistant pathogens have decreased.
  - Balancing measures relate to whether changes might cause new problems.
- Ongoing surveillance of antimicrobial use is essential to measure the effect of stewardship interventions.
- Regular, small quality improvement audits can help to drive changes in prescribing.
- The measurement and evaluation of AMS initiatives is facilitated by the use of standardised formats for collecting and reporting data, and information technology systems to collect, analyse and report data.
- Timely feedback and reporting to clinicians and health service managers is a key component of effective AMS.

6.1 Introduction

Tracking and reporting antimicrobial use and outcomes are recognised as key components of antimicrobial stewardship (AMS) programs.[1-4]

> *Measurement is considered to be critical to identify opportunities for improvement and assess the effect of improvement efforts.*[5]
>
> *Measurement for improvement is not focused on judging whether data meet a compliance threshold or target, but as a means to determine whether the changes made to improve practice are effective and to what degree.*[6]

Measurement includes:

- Collecting and monitoring of data for quality indicators, encompassing structure, process, outcome and balancing measures
- Surveillance of antimicrobial use
- Auditing of the quality of prescribing.

This information should be used to provide feedback to prescribers to influence prescribing behaviour; inform those accountable for the AMS program of the effect of AMS initiatives on patient outcomes, antimicrobial use and resistance patterns; and assist in better targeting initiatives to improve prescribing.

A range of tools and resources are available in Australia to measure antimicrobial use, and to audit the appropriateness and quality of use in hospital and community settings. It is important that the routine measurement of antimicrobial use, regular assessments of quality and appropriateness of use, and reporting of process and outcome measures are built into the design, development and implementation of AMS programs. Effective measurement and assessment systems are an integral part of existing monitoring systems and linked to the measurement of performance in health systems overall.

Issues that are especially relevant for certain settings – rural and remote hospitals, private hospitals and aged care – are tagged as R, P and AC, respectively, throughout the text.

R P AC

6.2 Key elements of antimicrobial stewardship measurement

Determining what to measure and how to measure it is a key step in developing a suitable performance measurement plan.

6.2.1 What should be measured?

Data collection for key measures, or indicators, of the performance of the AMS program should be planned as an integral component of the AMS program from the outset. In the acute care setting, the measures can be built into general reporting in the health service organisation's performance framework, against the AMS criterion in the National Safety and Quality Health Service (NSQHS) Preventing and Controlling Healthcare-Associated Infection Standard. A range of measures is recommended, including[1,6]:

- Structure measures
- Process measures
- Outcome measures
- Balancing measures.

Examples of these measures are summarised in Table 6.1 and discussed in this chapter. The measures should be selected according to the specific context of the AMS program.

Collecting qualitative data is also important for evaluating program performance (see Qualitative and other related measures of program activity).

6.2.2 Measurement approaches

The AMS team may be able to use existing measurement systems, or it may have to develop operational definitions for AMS measures. Similarly, data collection and feedback processes may already exist or may need to be developed. Many existing resources can be used to design and use measurement for clinical practice improvement, including the New South Wales (NSW) Health publication *Easy Guide to Clinical Practice Improvement*[7] and online resources from the Institute for Healthcare Improvement.

Measurement to support process improvement (in this case, antimicrobial prescribing practice) differs from measurement to evaluate performance or measurement for research purposes. Improvement measures aim to bring new knowledge into daily practice. Therefore, frequent, small samples during the process of testing and implementation will be more useful than infrequent, large surveys. These will allow the team to see whether changes are resulting in improvement. For example, Figure 6.1 shows the results of weekly audits of five hospitals' inpatient records for documentation of the indication for the antimicrobials prescribed.

Any measurement also needs to be sustainable (Box 6.1) to ensure that assessments can be conducted and compared across time. When indicators are used for public reporting, their validity, reliability, impact and costs should be assessed within 1–2 years of implementing quality measurements and reporting programs.[9]

6.3 Structure measures

Structure measures for AMS programs ask 'Are the right elements in place?' and 'Are the resources, lines of reporting and policies available?'

6.3.1 Hospitals

The NSQHS Standards require hospitals to provide evidence of developing, implementing and regularly reviewing the effectiveness of their AMS systems. However, the NSQHS Standards do not prescribe how this is to be done.[11]

Structure measures for AMS can support health service organisations to determine whether the appropriate governance, workforce and processes, such as formularies and guidelines, are in place.[12,13] These measures have been used to measure progress in AMS development in Scotland[6,14] and the United States.[2]

A number of resources are available to help organisations assess the elements of their AMS program, identify areas for improvement and

Table 6.1: Measures to evaluate antimicrobial stewardship programs

Type of measure	Questions answered by the measures	Examples
Structure	• Are the right elements in place? • Are the resources, lines of reporting and policies available?	• Self-assessment of the program using a structured tool
Process	• Are our systems performing as planned? • Are they effective?	• Rates and volume of antimicrobial prescribing over time • Rates of general practice visits, emergency visits or admissions for specific conditions • Compliance with prescribing guidelines • Compliance with antimicrobial restriction conditions • Assessment of surgical prophylaxis given for >24 hours • Assessment of appropriateness of prescribing • Assessment of adequacy of documentation of indication for antimicrobial therapy • Assessment of adequacy of prescription details for antimicrobial therapy
Outcome	• What is the result?	• Patient outcomes (e.g. infection-related mortality, length of stay, time to respond to treatment) • Surveillance of antimicrobial resistance (e.g. using cumulative antibiogram) • Changes in cost, length of stay, antimicrobial acquisition costs, cost-effective use of pathology services
Balancing	• Are the changes causing new problems?	• Incidence of adverse drug events (e.g. cardiac toxicity, renal impairment) • Incidence of allergic reactions • Infection-related mortality • Infection-related readmission in 28 days • Rates of surgical site infection

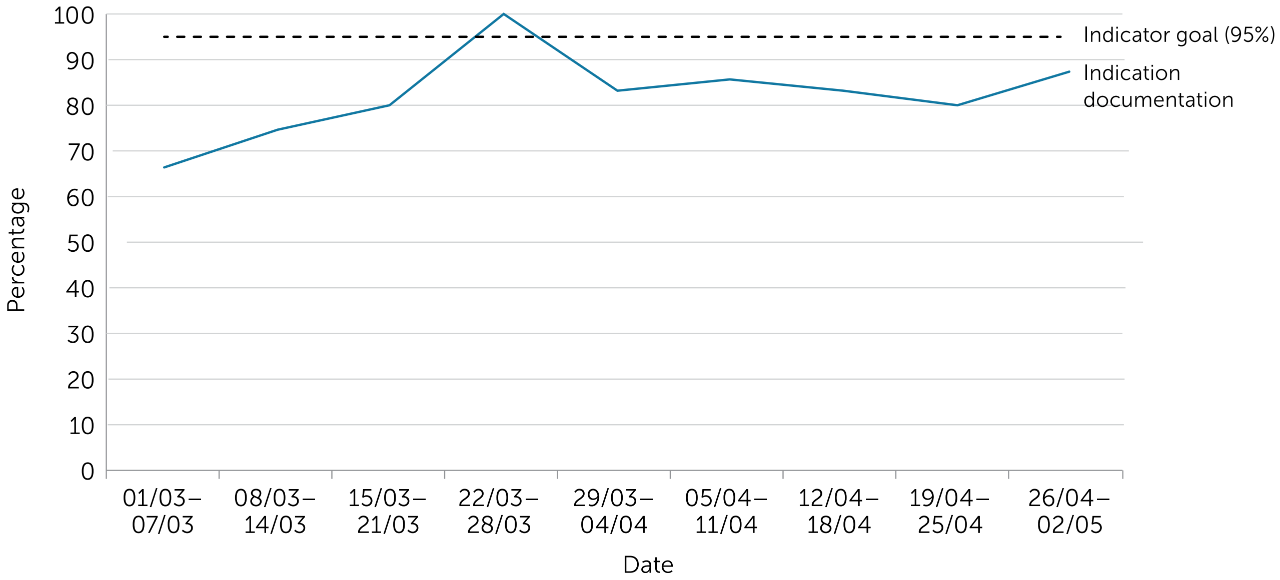
Source: Adapted from Nathwani and Sneddon[1]

Box 6.1: Eight principles of sustainable measurement

- Seek usefulness, not perfection, in the measurement
- Use a balanced set of process, outcome and cost measures
- Keep measurements simple; think strategically, but in smaller measurable interventions
- Use both qualitative and quantitative data that are 'fit for purpose'
- Be clear about operational definitions of the measures
- Measure small, representative samples
- Build measurement into daily work
- Set up a measurement team.

Source: Davey[10]

Figure 6.1: Documentation of antimicrobial indication in inpatient records



Source: NSW Clinical Excellence Commission[8]

measure improvements over time (see Resources). They include the Antimicrobial Stewardship Progress & Planning Tool developed by the NSW Clinical Excellence Commission[15] and the South Australia (SA) Health Antimicrobial Stewardship Program Self-evaluation Toolkit. In 2016, the Transatlantic Taskforce on Antimicrobial Resistance published a set of core and supplementary structure and process indicators for hospital AMS programs[16], which can also be used by health service organisations to assess whether they have the infrastructure and activities to support AMS.

6.3.2 Community

No structure indicators specific to AMS have been published for aged care homes in Australia. Internationally, the Centers for Disease Control and Prevention's Core Elements of Antibiotic Stewardship for Nursing Homes[17] and Core Elements of Outpatient Antibiotic Stewardship[18,19] include checklists of requirements for AMS in aged care homes and primary care. In the United Kingdom, the Royal College of General Practitioners has produced an AMS self-assessment toolkit[20] that enables general practitioners to assess their practice and receive advice on strategies to optimise antimicrobial prescribing in primary care. These tools could be adapted for use in aged care settings in Australia.

6.4 Process measures

Process measures play a role in answering questions such as 'Are our systems performing as planned?' and 'Are they effective?'. These measures include rates of adherence to guidelines, appropriateness and timeliness of therapy for a given infection, and rates of prescribing concordant with susceptibility reporting.

Process measures may be used regularly:

- As part of a quality improvement (QI) cycle
- On an intermittent basis as part of the evaluation of an AMS intervention
- As an annual point prevalence survey, such as the National Antimicrobial Prescribing Survey (NAPS) for hospitals or the Aged Care National Antimicrobial Prescribing Survey (acNAPS) for aged care homes
- As part of continuous surveillance, such as the National Antimicrobial Utilisation Surveillance Program (NAUSP).

When instituted as regular audits and reported back to prescribers, process measures can be useful instruments to help maintain prescribing performance at an appropriately high level.

Examples of process measures relating to the quality of antimicrobial prescribing developed for use in Australian health settings are in Table 6.2. Data collection tools are available for many of these

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Table 6.2: Examples of process measures relating to quality of antimicrobial use developed for Australian healthcare settings

Setting	Source	Description of specific process measure
Hospital	National Quality Use of Medicines Indicators for Australian hospitals[25]	• Percentage of patients undergoing specified surgical procedures who receive an appropriate prophylactic antimicrobial regimen • Percentage of prescriptions for restricted antimicrobials that are concordant with drug and therapeutics committee–approved criteria • Percentage of patients in whom doses of empirical aminoglycoside therapy are continued beyond 48 hours • Percentage of adult patients with community-acquired pneumonia who are assessed using an appropriate validated objective measurement of pneumonia severity • Percentage of patients presenting with community-acquired pneumonia who are prescribed guideline-concordant antimicrobial therapy
	National Antimicrobial Prescribing Survey[26]	• Indication documented in medical notes (best practice >95%) • Surgical prophylaxis given for >24 hours (best practice <5%) • Compliance with guidelines • Appropriateness
All healthcare settings	Antimicrobial Stewardship Clinical Care Standard[27,28]	• Median time to first dose of antibiotics for patients with suspected bacterial meningitis, or for actual or suspected severe sepsis • Antibiotic prescribing in accordance with current and peer-reviewed clinical guidelines • Antibiotic allergy mismatch in prescribing • Documentation of reason for prescribing antibiotics • Review of patients prescribed broad-spectrum antibiotics • Surgical antimicrobial prophylaxis in accordance with guidelines • Timely administration of prophylactic antibiotics before surgery • Cessation of prophylactic antibiotics after surgery

process measures (see Resources). Internationally, quality indicators for antimicrobial use in primary care and disease-specific indicators to assess the quality of antimicrobial prescribing have been developed by the European Surveillance of Antimicrobial Consumption Network.[21] The latter indicators have been adapted and used to determine acceptable rates of prescribing in general practices participating in the NPS MedicineWise MedicineInsight program.[22,23]

The development of process measures should involve multidisciplinary teams to ensure ownership by relevant clinical groups.[24] Reporting and feedback on process measures should be in a format that can be readily interpreted and used by clinicians for QI.[10] Results should be presented dynamically in the form of control charts (with control limits) to allow clinicians and the AMS team to see whether the process is responsive and to identify improvement over time.[25]

6.5 Outcome measures

Outcome measures ask 'What is the result?'

Although reduction in antimicrobial use is usually the most easily measured outcome, by itself it may not indicate improvements in patient outcomes – a range of safety and quality outcome measures also need to be monitored. It is also important to measure economic outcomes, to ensure continued support for AMS initiatives from the organisation's executive.[29,30] McGowan proposes using the four main goals of AMS as a basis for categorising outcomes for AMS programs[29]:

- Improved patient outcomes
- Improved patient safety
- Reduced antimicrobial resistance (AMR)
- Reduced costs.

Table 6.1 provides examples of outcome measures.

6.5.1 Improved patient outcomes

Improvements in patient care are implicit in the goals of an AMS program. Indicators of clinical success associated with AMS programs include reduced infection-related mortality, length of stay and time to respond to treatment. Until recently, little has been reported in the literature to indicate that the introduction of AMS programs has led to improvements in these parameters. However, three recent systematic reviews and meta-analyses of hospital-based AMS programs have demonstrated that AMS activities can reduce mortality and length of stay.[31-33] Programs that have shown improvement in clinical outcomes are those that aim to optimise treatment, not just reduce antimicrobial use.[33]

Given that there are a number of factors that can contribute to patient outcomes, it is not possible to ascribe changes in these parameters solely to AMS programs. However, process measures that can reliably be related to improvements in outcomes may be more readily measured by health service organisations and may be used as surrogates for outcome measures.

6.5.2 Improved patient safety

Improvements in safety can be measured by surveillance of adverse events associated with antimicrobial use. For example, a reduction in *Clostridium difficile* infection has been a notable outcome of some AMS programs in hospitals because this infection is directly related to overall antimicrobial use and the use of certain broad-spectrum agents (such as third-generation cephalosporins, amoxicillin–clavulanate, clindamycin and fluoroquinolones).[34] *C. difficile* infection rates can also be reduced by implementing stricter infection control strategies; a number of studies have demonstrated that a combination of improving infection control precautions and reducing overall antimicrobial use can reduce the incidence of nosocomial *C. difficile* infections.[35,36] Qualitative analysis of individual cases of *C. difficile* can be used for feedback to clinicians on antimicrobial prescribing that may have contributed to the development of these infections.

Other indicators of improved patient safety are lower mortality associated with appropriate administration of empirical antimicrobial therapy and fewer antimicrobial adverse events.[29,32] An example of the latter may be fewer cases of vancomycin-induced nephrotoxicity if appropriate dosing and therapeutic drug monitoring are used within an AMS program. Similarly, fewer episodes of hypersensitivity reactions to penicillin given to patients with documented penicillin allergies may be expected if the workforce is appropriately educated to recognise those antimicrobials that are classified as penicillins.

6.5.3 Reduced resistance

AMS programs aim to improve antimicrobial prescribing and address the increase in AMR in health care and the community. Improvements in resistance rates have been difficult to measure and ascribe directly to an AMS program because the causes of resistance are complex and often outside the control of hospital or community programs. However, there is increasing evidence indicating that AMS activities can contribute to a decrease in AMR.[30-33,37]

The NSQHS Preventing and Controlling Healthcare-Associated Infection Standard requires health service organisations to monitor AMR as an outcome of the AMS program. Monitoring changes through an annual cumulative antibiogram is a useful mechanism for this (see Section 9.6.2 in Chapter 9: 'Role of the clinical microbiology service in antimicrobial stewardship'). Participation in the national passive Antimicrobial Use and Resistance in Australia (AURA) Surveillance System offers the opportunity for ready access to data reports and antibiograms. As antibiograms can be difficult to interpret, the involvement of clinical microbiologists and infectious diseases physicians in the analysis and use of these data is recommended.

At the national level, the AURA Surveillance System has been established to provide a comprehensive and integrated picture of patterns and trends in AMR, and to improve the understanding of AMR across Australia. AURA 2016 and AURA 2017 have reported on antimicrobial use and AMR in human health in Australia, and provided clinicians and health service organisations with detailed national information on AMR rates and antimicrobial use to guide improvements in infection control, AMS and antimicrobial prescribing practices.[22,23]

6.5.4 Reduced costs

Economic outcomes are also important to measure. A baseline measurement at the outset of a new program will allow changes to be monitored over time. If reduced system costs can be demonstrated following the introduction of an AMS program, managers are able to see the tangible benefits of investment and may be prepared to resource further improvements. Comparability of data on the costs of antimicrobials will be affected by factors such as changes in procurement contracts, formulary changes and variations in ordering patterns. These factors need to be considered when determining antimicrobial expenditure. Despite this limitation, this information can be helpful to identify where dollars are being spent[38] and to track any savings from AMS activities.

The simplest measure is a reduction in medicine acquisition costs as a result of reduced antimicrobial use or a switch from an expensive agent to a cheaper one. This may be a useful argument in favour of an AMS program with regard to the use of expensive agents such as antifungal therapies, but is often a difficult argument to mount for common antimicrobials because they are generally relatively inexpensive.

Demonstrating the cost-effectiveness of an AMS program may be challenging. Savings may be demonstrated through measures such as early intravenous-to-oral switching, reduced length of stay and reduced adverse events. Those savings can sometimes be extrapolated to the costs of related downstream events, such as reduced resistance among local bacterial pathogens, better cure rates for patients with infections, and fewer infections as a result of more appropriate prophylactic antimicrobial use. Measuring cost-effectiveness requires health economic analyses, and reports in the literature are mixed in terms of finding consistent cost savings from AMS program implementation.[39-41]

6.5.5 Qualitative and other related measures of program activity

A qualitative evaluation of the AMS program can be used to inform the AMS team about how well the program is operating and to identify further areas for improvement. User acceptance can be measured directly through surveys or questionnaires for clinicians; questions might cover awareness of the program, effectiveness of the interface with the AMS team and the degree to which the AMS team's advice was considered useful. Surveys and questionnaires can also provide opportunities for the AMS team to get feedback that can be used to improve the program. This feedback can also be helpful to assess the perceptions and attitudes of prescribers to AMR in order to assess changes in local culture that may have been influenced by the AMS program.[42,43]

In conjunction with this feedback, activity of the AMS program can also be reviewed by assessing the number of guidelines written or reviewed, the number of education sessions delivered, the number of patients reviewed by the AMS team, the rate of acceptance of advice within 24 hours, and the number of audits conducted under the AMS program each year.

6.6 Balancing measures

As well as measuring improvements in patient safety, AMS teams should be alert to potential unintended consequences of AMS interventions. Balancing measures provide insight into the question of whether changes might cause new problems. For example, an implicit goal of AMS programs is an overall reduction in the volume of prescribed antimicrobials, because overprescribing is the most common form of inappropriate use. However, there may be some concern that this may result in under-treatment of infection and poorer clinical outcomes.

Changes in prescribing guidelines can have unexpected outcomes. For example, Bell et al. described an increase in the rate of acute kidney injury following a change in prophylactic guidelines from cephalosporins to gentamicin in orthopaedic surgery.[44] Additionally, changes in prescribing as a result of an AMS intervention may create new selective pressures on microbial flora, causing potential new clinical problems, such as the emergence of new multidrug-resistant strains or the re-emergence of infections that were previously uncommon.[6] When one antimicrobial is restricted and replaced with another, the reduction in resistance to the first class of antimicrobial may be 'balanced out' by increasing resistance to the second class (known as the 'squeezing the balloon' effect).[45,46]

Therefore, it is important to ensure that AMS interventions do not cause unintended consequences such as increased mortality and morbidity – for example, higher complication rates, adverse drug events and higher rates of infection-related readmission. This can be monitored by collecting data on balancing measures such as those listed in Table 6.1.[6]

6.7 Surveillance of antimicrobial use

Research indicates that antimicrobial overuse (that is, antimicrobials being prescribed when not indicated or being used for longer durations than required) is common when AMS programs are absent. Reductions in the volume of prescribing may be the most immediate effect of an AMS program.[35] Conversely, there are situations in which an increase in the use of specific antimicrobials may indicate an improvement in the appropriateness of prescribing and may be linked to improved patient outcomes. An example of this is fewer surgical site infections associated with appropriate prescribing of surgical prophylaxis.

Ongoing monitoring of antimicrobial use across a facility, practice, Local Hospital Network or Local Health District will provide the AMS team with data to identify issues and effect changes in prescribing. Surveillance needs to be carried out consistently, using standard definitions and data-gathering methods, and ideally analysed in a statistically valid manner to ensure integrity of the results and their interpretation. Any significant change should be investigated to ensure that it is not a result of inappropriate prescribing. Participation in NAUSP provides hospitals with information on antimicrobials prescribed and changes in use over time.

6.7.1 Measuring the volume of antimicrobial use in hospitals

To standardise the quantification of antimicrobial use and allow comparisons over time within and between units and hospitals, it is recommended that medicine-use data are expressed as a standard unit of measure. In Australia, defined daily doses per 1,000 occupied bed days (DDD/1,000 OBDs) is used. The DDD represents the average daily maintenance dose of an antimicrobial for its main indication in adults.[47] DDD/1,000 OBDs is the measure used by NAUSP[48], which is part of the AURA Surveillance System. By participating in NAUSP, public and private hospitals contribute data on inpatient use of antimicrobials and receive valuable analyses of these data in response. NAUSP provides comparative data by hospital peer group and enables business reports for local use.

The DDD/1,000 OBDs measure does not account for patient variability, actual dose administered or individual patient exposure. And, because DDDs are based on adult dosing, these measures are not suitable for determining antimicrobial use in paediatric units. Other limitations to DDDs are that they do not take into account the casemix or infection rates for OBDs in hospitals, and World Health Organization–defined DDDs often differ from doses used in Australian clinical practice.

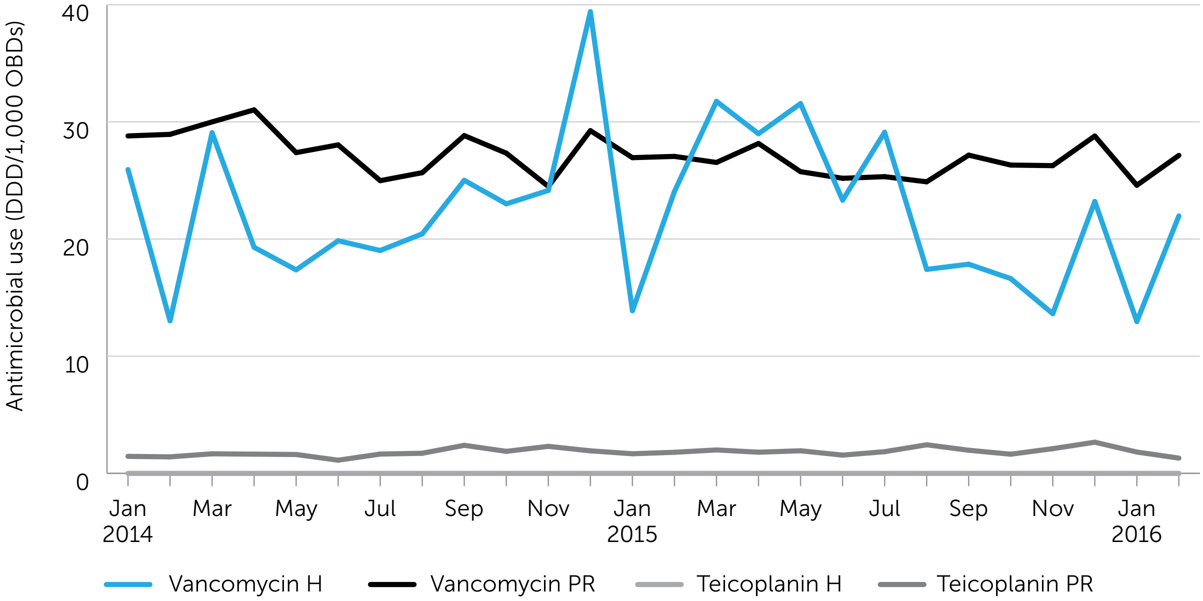
Hospitals choosing to calculate their total or ward-level antimicrobial consumption figures can use the AMC Tool: the antimicrobial consumption tool, which converts numbers of packages or vials into numbers of DDDs.

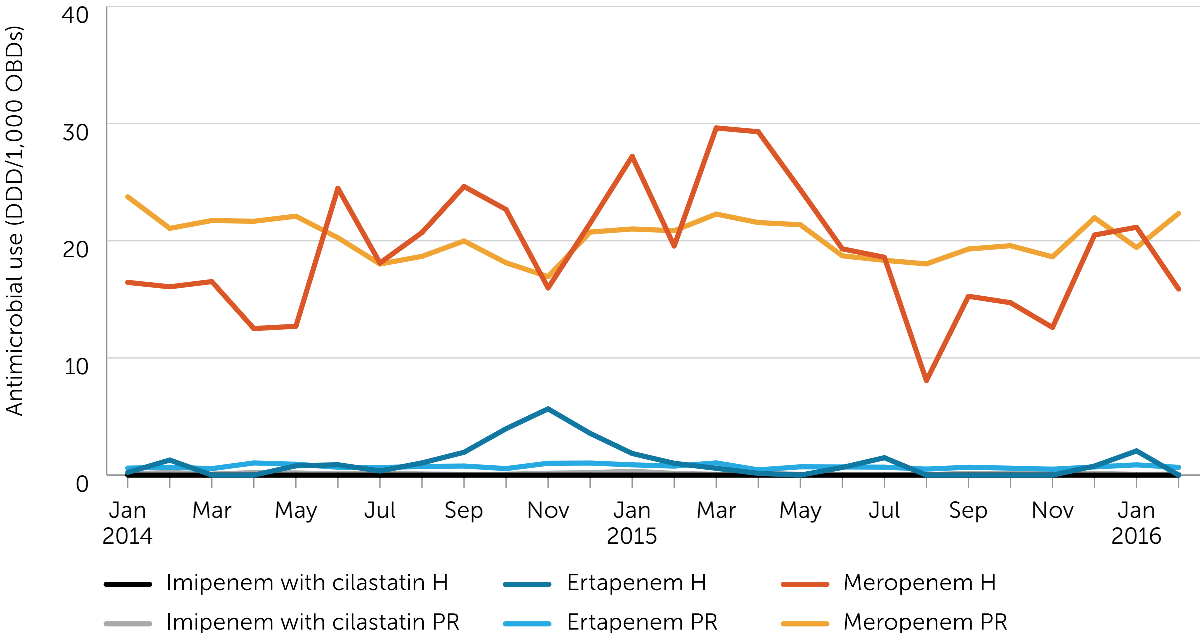
National Antimicrobial Utilisation Surveillance Program

Participation in NAUSP is voluntary. In 2015, 159 acute care hospitals participated (138 public and 21 private hospitals), representing 100% of Principal Referral Hospitals, 86% of Public Acute Group A and B Hospitals and 8% of Public Acute Group C Hospitals.[48] In Private Acute Hospitals, 28% of Group A and B Hospitals, and 10% of Group C Hospitals contributed data.

NAUSP reports on the volume of antimicrobial use in hospitals as DDD/1,000 OBDs in the form of time-series graphs, including usage rates for specific antimicrobial classes (using the World Health Organization Anatomical Therapeutic Chemical classification system).[48] Contributing hospitals receive bimonthly reports of their antimicrobial use and comparisons with the average use in hospitals in the same peer group (Figure 6.2). For some contributors, usage rates are also reported for intensive care units. Individual contributors are able to generate their own reports at any time. Specialty unit reporting capacity commenced in 2016 for haematology/oncology and respiratory units.

Figure 6.2: Examples of graphs of usage rates of glycopeptides and carbapenems for a reporting hospital and peer group hospitals (three-month moving average)



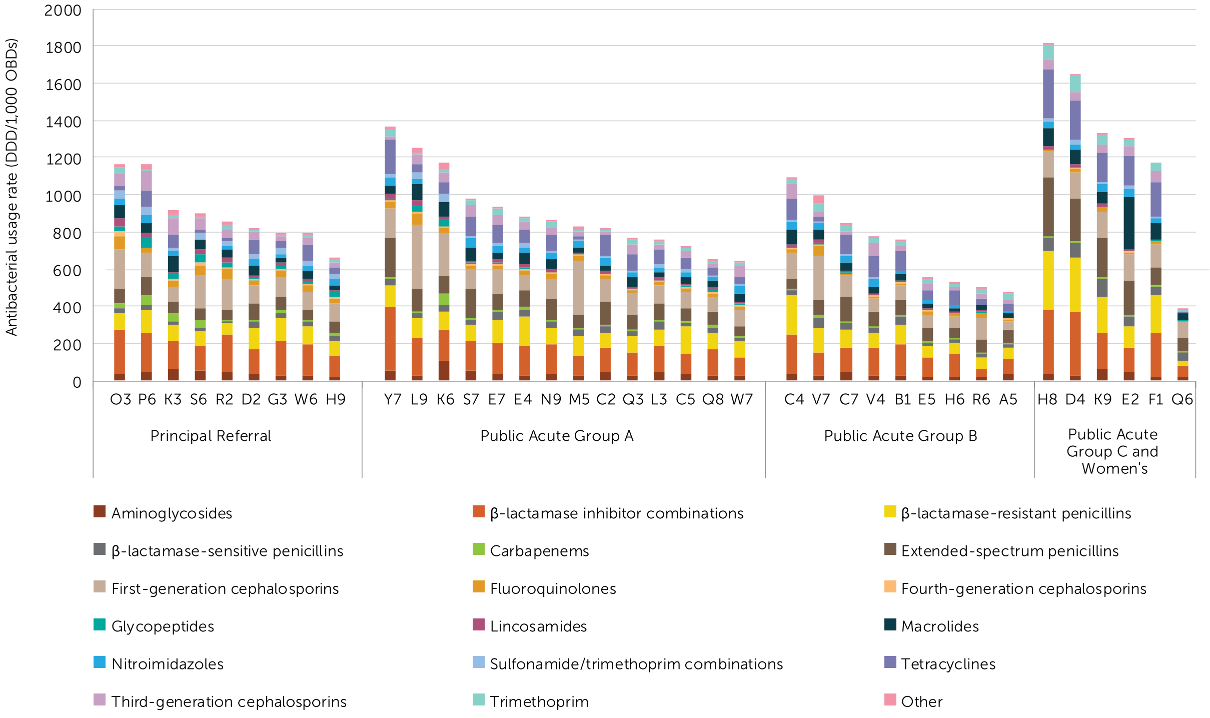


DDD = defined daily dose; H = reporting hospital; OBD = occupied bed day; PR = peer group hospitals

The NAUSP annual report includes graphs that hospitals can use to compare their total hospital and intensive care unit use with other hospitals.[49,50] It also includes analyses of use by state and peer group. Figure 6.3 shows combined peer group data for hospitals in two jurisdictions. Relevant data from NAUSP are also incorporated into AURA reports, which include comparative data on antimicrobial use in Australia and other countries, as well as case studies on the use of NAUSP data to guide AMS activities in hospitals.[22,23]

At the local level, data from NAUSP can be used to monitor the effect of AMS activities on antimicrobial use and to benchmark use against peer groupings. This type of surveillance is useful for monitoring trends over time. Statistically significant increases or decreases in antimicrobial use can be investigated to determine whether they indicate inappropriate prescribing. However, peer group data should also consider variations in casemix between hospitals, as direct comparisons may not be appropriate (see Use of data for benchmarking). The data are useful for tracking changes in antimicrobial use over time

Figure 6.3: Total antibacterial use in 38 hospitals in 2015, by peer group



DDD = defined daily dose; OBD = occupied bed day
Note: Private hospitals are included in the Principal Referral, Public Acute Group A and Public Acute Group B Hospital peer groups.
Source: Australian Commission on Safety and Quality in Health Care[50]

within one organisation to identify trends, with the potential to consider whether common changes are also occurring elsewhere. For example, a change to a national guideline that recommends higher doses of vancomycin might result in increased vancomycin use at a number of hospitals.

Other measures of antimicrobial use

Days of therapy (DOTs) is another method of collecting data on antimicrobial use.[51] DOTs can be most readily obtained when electronic systems are used for prescribing. If a patient receives any dose of the given antimicrobial on a given day, it is counted as 1 DOT. For example, benzylpenicillin and gentamicin administered on the first day of therapy contribute 1 DOT for each medicine (a total of 2 DOTs). This method is more robust when dealing with combined adult and paediatric populations, because the dose administered is not considered.

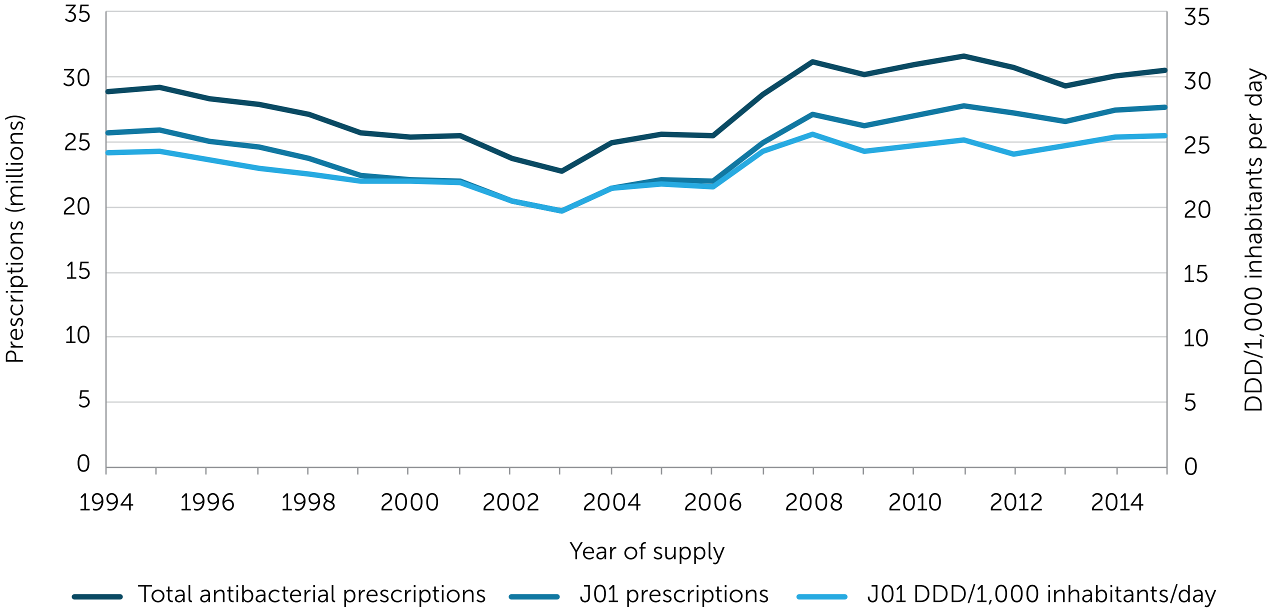
Length of therapy (LOT) – the number of days a patient receives systemic antimicrobials – can also be used as a measure. It measures the number of days of treatment a patient receives, regardless of the number of antimicrobials or doses administered. Treatment with two different antimicrobials for one day will equate to 1 LOT. Both DOTs and LOTs can be standardised to 1,000 patient days.[51-53]

6.7.2 Measuring the volume of antimicrobial use in the community

Efforts to measure and compare the volumes of antimicrobials prescribed in the community have been described by several countries in their annual reports on surveillance of AMR and antimicrobial use.[54-58] Standardised measures are used to enable comparisons within and between countries. They include DDDs per 1,000 inhabitants per day and numbers of prescriptions or packages supplied per 1,000 inhabitants per day.

Community antimicrobial use in Australia is published in AURA reports.[22,23] The data are derived from the Australian Government Department of Human Services pharmacy claim records of prescriptions dispensed under the Pharmaceutical Benefits Scheme (PBS) and Repatriation Pharmaceutical Benefits Scheme (RPBS), and the Drug Utilisation Sub Committee database, and are presented in time-series graphs (for example,

Figure 6.4: Volume of antimicrobials dispensed under the Pharmaceutical Benefits Scheme and Repatriation Pharmaceutical Benefits Scheme, 1994–2015



DDD = defined daily dose

Notes:

1. J01 is the Anatomical Therapeutic Chemical code for antibacterials for systemic use.
2. Data relating to the number of prescriptions dispensed before April 2012 include estimates of under co-payment and private dispensing. Data relating to the number of prescriptions dispensed after April 2012 include actual under co-payment data, but no estimate for private dispensing. The data on DDD/1,000 inhabitants/day leave out some items for which there is no DDD.

Source: Drug Utilisation Sub Committee database, 2017

Figure 6.4). Information on variation in prescribing across local areas, states and territories, and socioeconomic status has been published in the *Australian Atlas of Healthcare Variation*.[59]

6.7.3 Reporting and monitoring use data at the local level

Antimicrobial use data collected locally, or as part of state or national data collections, can be used to monitor use at a local level.

Hospitals

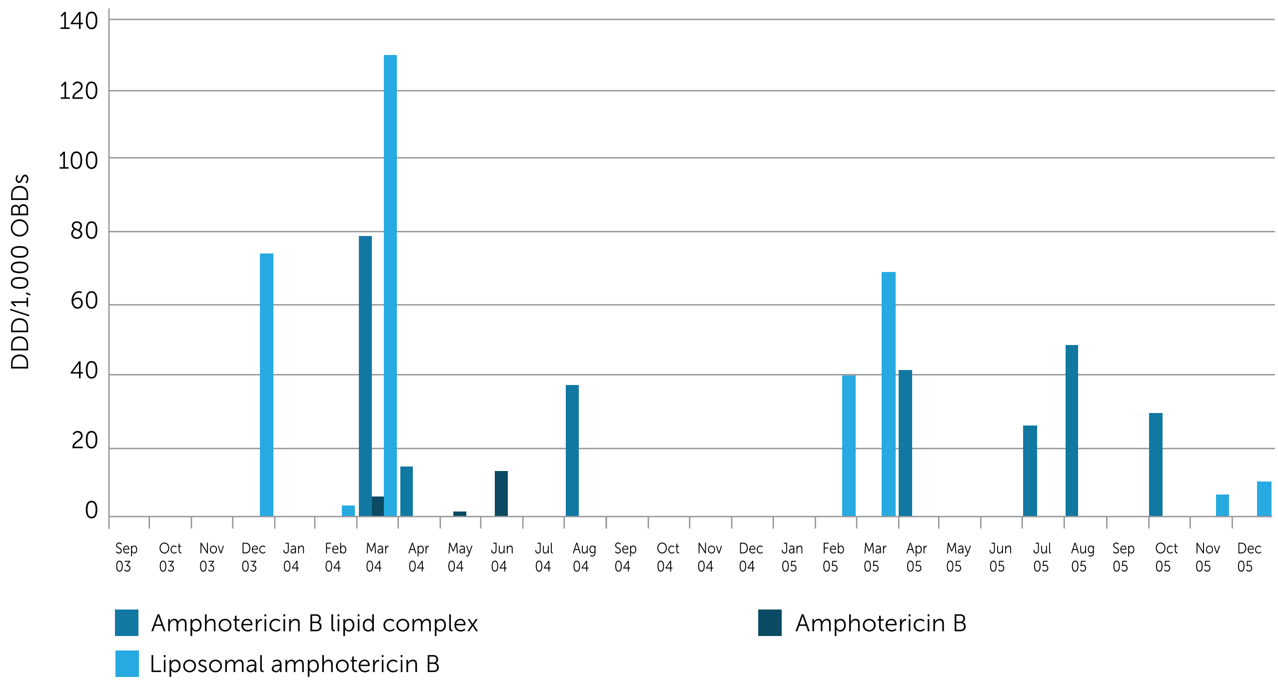
Information on antimicrobial use is generally available from hospital pharmacy information systems. Data on inpatient use are obtained from the volume of ward stock issued, combined with individual patient issues. They may be reported monthly, quarterly or annually, preferably as DDDs. Ward stock use is not generally linked to individual prescribers, so the data are purely a measurement of the volume of medicines prescribed in a given time. Data can be reported for the whole hospital or broken down into individual ward or division information. Data can also be reported by total antibiotic consumption or by specific antimicrobials or antimicrobial classes.

Because much of the consumption data cannot be linked to individual patients, and many agents are used for a narrow band of indications, large fluctuations can appear in data for ward populations. An example of surveillance of antifungal agents at the ward level is shown in Figure 6.5, which illustrates monthly amphotericin B use in a large intensive care unit.

Another limitation to using ward-based data is that the data are only directly relevant to individual prescribers if the ward corresponds closely to a medical or surgical specialty unit (for example, an intensive care, oncology or haematology unit).

However, with the increasing use of electronic healthcare records and electronic prescribing systems, antimicrobial dispensing or administration data can be linked to prescribers, and more precise surveillance and feedback are possible. Third-party AMS software programs are able to collect and analyse these individualised data and report them to the AMS team, individual prescribers, units

Figure 6.5: Amphotericin B use in an intensive care unit



DDD = defined daily dose; OBD = occupied bed day
Source: D Looke, Princess Alexandra Hospital, Queensland

and relevant committees as an accurate reflection of antimicrobial use (see Chapter 4: 'Information technology to support antimicrobial stewardship').[60]

Despite the limitations, broad-scale surveillance of antimicrobial use data obtained from hospital pharmacy information systems can be useful on many levels. It currently provides the most accurate indication of which antimicrobials are being used. Where it brings prescribing trends into focus, it may allow more time-efficient use of drug use evaluation resources, so that they are directed towards real changes in prescribing volumes.

Analysis of ward data over time is especially useful. Continuous monitoring of facility or ward data using methods such as time-series charts can help to identify trends in prescribing, and may signal that inappropriate prescribing of specific antimicrobials is occurring. This can act as a trigger for further investigation, such as drug use evaluation audits of the antimicrobials used in a ward or unit. Time-series charts can also be used to identify real improvements over time. Such charts should ideally have control limits.

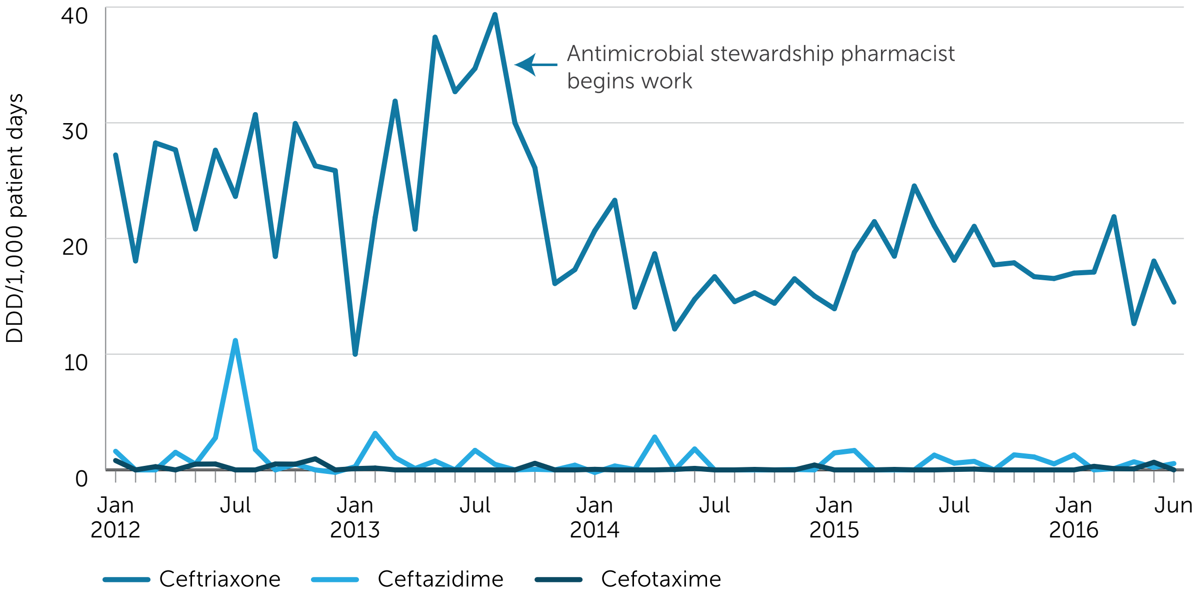
Continuous monitoring of a single facility is of value in identifying unexpected changes or evaluating the effect of interventions. Figure 6.6 shows that employing a dedicated AMS pharmacist had an immediate effect on the volume of third-generation cephalosporins dispensed, as a result of the AMS pharmacist enforcing compliance with hospital restrictions.

Time-series charts using generalised additive models can be useful for monitoring antimicrobial use data because they can account for a proportion of the random variation seen in prescribing.[61] This is important because interventions for random variations waste resources and may affect the credibility of the AMS program

Community

In Scotland, a strategy of feedback to general practitioners has been initiated, in which doctors are made aware of their own prescribing behaviour relative to that of their peers.[62] A similar feedback strategy is used in Australia by NPS MedicineWise, using data obtained from the PBS and RPBS, and from NPS MedicineInsight for general practitioners who have agreed to participate in the program.[63] Figure 6.7 shows an example of the feedback provided to prescribers. NPS MedicineWise has also worked with Webstercare to enable community pharmacists to create reports on the volumes of antimicrobials that are typically used for urinary tract infections in particular aged care homes, and to compare their use with volumes used in similar homes.

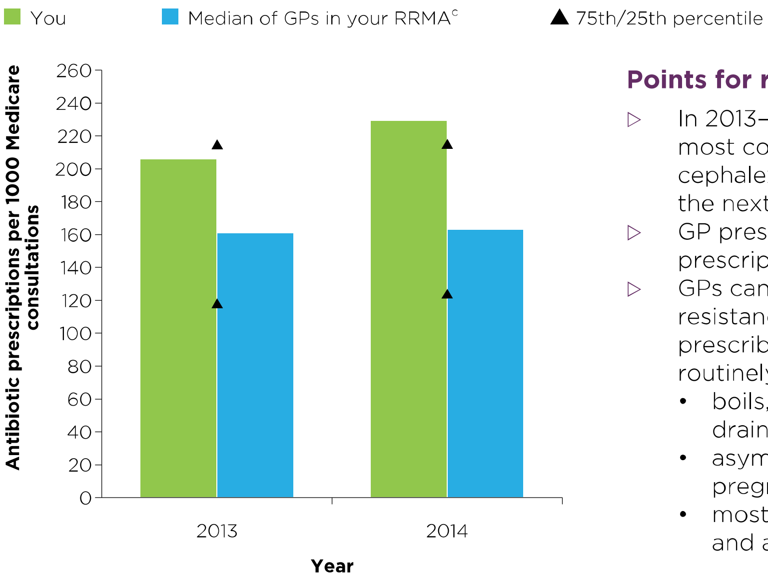
Figure 6.6: Use of third-generation cephalosporins in a 150-bed hospital before and after the appointment of an antimicrobial stewardship pharmacist, January 2012 to June 2016



DDD = defined daily dose
Source: L Davis, Communicable Diseases Unit, Queensland Health; D Looke, Princess Alexandra Hospital, Queensland

Figure 6.7: Example of individual prescriber feedback in the MedicineInsight program

Your prescribing of oral antibiotics[b] in 2013 and 2014



Points for reflection

- In 2013–14 Australian BEACH GP data, the most commonly prescribed medicines were cephalexin and amoxycillin. Paracetamol was the next most commonly prescribed medicine.[8]
- GP prescribing accounts for 75% of antibiotic prescriptions in the community.[9]
- GPs can contribute to minimising antibiotic resistance by avoiding unnecessary antibiotic prescribing. For example, antibiotics are not routinely indicated in the following conditions:[2]
  - boils, most will require only incision and drainage
  - asymptomatic bacteriuria, except in pregnancy
  - most upper respiratory tract infections and acute bronchitis.

BEACH = Bettering the Evaluation and Care of Health; RRMA = Rural, Remote and Metropolitan Areas classification
Source: NPS MedicineWise

6.8 Auditing the quality of antimicrobial prescribing

Auditing the quality of prescribing can provide assurances that the most effective therapy is being given and that the risk of poor outcomes (including antimicrobial-related adverse events) is being reduced.

6.8.1 Auditing prescribing in hospitals

Dumartin et al. report that hospitals that carry out practice audits are more likely to achieve a decrease in total antimicrobial use.[64]

In the absence of electronic systems to efficiently report data in real time, the appropriateness of prescribing can be measured by reviewing patient notes or using prevalence surveys such as NAPS, clinical audits as part of a drug use evaluation program or audits of prescribing indicators.[25,26,65] Data from these surveys can be used by the AMS team and the AMS committee or the drug and therapeutics committee to:

- Identify the appropriateness of prescribing
- Monitor the effectiveness of an intervention
- Provide feedback to prescribers in individual or group education sessions.

Prevalence surveys

Prevalence surveys are an effective tool to improve the quality of antimicrobial prescribing. They allow problem areas to be targeted and enable more intensive audits, leading to further interventions to improve prescribing. They are also useful for measuring the effects of interventions. Such surveys are most useful when repeated at regular intervals. Some organisations use prevalence surveys as the basis of regular antimicrobial rounds, where an expert group reviews either all patients who have been prescribed antimicrobials or, more commonly, patients who have been prescribed restricted agents.

Point prevalence surveys

Point prevalence or 'snapshot' surveys have the advantage of being resource efficient. However, they can only provide feedback on limited elements of prescribing in the health service organisation and may not consistently reflect practice within a unit or hospital.[66] Point prevalence surveys are usually carried out at a single site on a single day. The data are often collected from one data source – the medication chart. The type of information provided by these surveys may include the percentage of patients prescribed antimicrobials, range and volume of agents prescribed, percentage of restricted antimicrobials prescribed, number of antimicrobials per patient, duration of therapy, dosing and dosage intervals, and time of intravenous-to-oral switching.[67,68] Prophylactic use can be assessed by reviewing surgical patients who were prescribed antimicrobials in the previous 24 hours.

Linking survey information with clinical data gathered from other sources (such as indication, prophylaxis or treatment; nature and severity of the infection; and details of antimicrobial therapy received) can enable a better assessment of the appropriateness of prescribing, including prescribing in accordance with clinical guidelines.[68] However, this type of survey is more resource intensive and requires input by experienced clinicians to assess appropriateness.

Serial point prevalence studies conducted at regular intervals are a practical method for studying hospital antimicrobial use in the absence of electronic prescribing. They provide hospitals with baseline information on current antimicrobial use, from which specific targets for intervention can be identified and evaluated in subsequent audits. One or two point prevalence studies per year has been suggested as sufficient to provide ongoing monitoring of antimicrobial use.[69] (See National Antimicrobial Prescribing Survey.)

Clinical pharmacists are ideal personnel to collect data, with an AMS pharmacist coordinating data collection[68] and infectious diseases physicians or clinical microbiologists involved in assessing appropriateness.[66]

In smaller hospitals and private hospitals, data may be collected by nurses, midwives or infection control practitioners.

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Inviting a unit's resident medical officer or consultant to participate in the audit process can be useful. They can contribute information that may not be readily available from patients' healthcare records, and this process provides opportunities for them to directly communicate with the AMS team.

Point prevalence surveys can be used to measure and compare antimicrobial use at multiple sites. The data can be used to inform local and national audits, and support prescribing initiatives.[66]

National Antimicrobial Prescribing Survey

The Hospital NAPS is part of the AURA Surveillance System. The Hospital NAPS involves a nationwide point prevalence study that is conducted each year during the spring months; the results are published each year.[70-72]

NAPS gathers nationwide data on the quality of hospital antimicrobial prescribing and gives feedback, including benchmark values, to contributors.[70-72] The survey uses standard methods and standard definitions to enable health service organisations to compare findings on key indicators against similar facilities. Table 6.3 shows the NAPS results for key indicators for all contributors in 2013, 2014 and 2015.

In Australia, hospitals can compare their prescribing data with recommendations in *Therapeutic Guidelines: Antibiotic*.[73] NAPS allows comparison with evidence-based local guidelines, if they vary from national guidelines, and collects data on microbiology isolates to allow assessments of directed therapy. The assessments are judged as:

- Optimal therapy (as per guidelines)
- Adequate therapy (not as per guidelines but a reasonable alternative)
- Suboptimal therapy (for example, an error with the prescription, such as a wrong dose)
- Inadequate therapy (it is likely that the pathogen is not being treated)
- Not assessable (small numbers).

Table 6.3: Results for key antimicrobial prescribing indicators for all contributing hospitals, 2013–2015

Key indicator		Percentage of total prescriptions 2013	2014	2015	Percentage change from 2014 to 2015: Absolute change*	Relative change†
Indication documented in medical notes (best practice >95%)		70.9	74.0	72.5	−1.5	−2.0
Review or stop date documented (best practice >95%)		n/a	n/a	35.5	n/a	n/a
Surgical prophylaxis given for >24 hours (best practice <5%)§		41.8	35.9	27.4	−8.5	−24.0
Compliance with guidelines	Compliant with *Therapeutic Guidelines: Antibiotic* or local guidelines#	59.7 (72.2)	56.2 (73.7)	55.9 (70.6)	−0.3	−1.0
	Noncompliant#	23.0 (27.8)	24.3 (26.3)	23.3 (29.4)	−1.0	−4.0
	Directed therapy	n/a	10.4	12.4	2.0	19.0
	No guideline available	11.0	4.6	3.8	−0.8	−17.0
	Not assessable	6.3	4.5	4.7	0.2	4.0
Appropriateness	Appropriate (optimal and adequate)**	70.8 (75.6)	72.3 (75.9)	73.2 (77.0)	0.9	1.0
	Inappropriate (suboptimal and inadequate)**	22.9 (24.4)	23.0 (24.1)	21.9 (23.0)	−1.1	−5.0
	Not assessable	6.3	4.7	5.0	0.3	6.0

Source: Australian Commission on Safety and Quality in Health Care, National Centre for Antimicrobial Stewardship[72]
n/a = not applicable
* Figures represent the change between 2014 and 2015 (2015 percentage minus 2014 percentage).
† Figures represent the percentage change between 2014 and 2015 expressed as a percentage of the 2014 base year.
§ Where surgical prophylaxis was selected as the indication (3,404 prescriptions in 2015).
\# Figures in brackets refer to prescriptions for which compliance was assessable (17,429 prescriptions in 2015). The denominator excludes antimicrobial prescriptions marked as 'directed therapy', 'not available' or 'not assessable'.
** Figures in brackets refer to prescriptions for which appropriateness was assessable (20,929 prescriptions in 2015). The denominator excludes antimicrobial prescriptions marked as 'not assessable'.

NAPS is designed as a comprehensive point prevalence study that can be used to gauge the broad patterns of prescribing within a health service organisation. This may help identify prescribing practices that warrant a more in-depth audit. A carefully considered analysis of the data submitted to NAPS is presented to participating organisations in a manner that highlights major issues that are immediately actionable for that site. A critical role of NAPS is to focus on useful indicators to help AMS teams interpret the large volumes of data generated.

In 2015, data were submitted to NAPS by 281 hospitals (213 public, 68 private).[72] Data from the NAPS reports are also published in AURA reports, providing national data on the appropriateness of antimicrobial prescribing and compliance with guidelines in hospitals.[22,23]

6.8.2 Auditing prescribing in the community

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Community organisations can also collect data on the quality of antimicrobial prescribing. Two programs have been specifically developed for use in general practices and aged care homes.

MedicineInsight program

The MedicineInsight program, developed by NPS MedicineWise, collects detailed patient-level data on antimicrobial prescribing behaviour from more than 400 general practices across Australia. The program automatically extracts antimicrobial prescribing and clinical data from electronic healthcare records and prescribing software in volunteer practices recruited to the program. MedicineInsight links prescriptions to the indication for which the antimicrobial was prescribed, which enables broad assessments of consistency with guidelines. Participating general practitioners receive reports comparing their prescribing with other MedicineInsight practices in terms of overall rate of prescribing, prescribing for specific indications, recorded reason for prescribing and percentage of repeat prescriptions. Figure 6.8 shows an example of feedback provided to general practitioners.

The MedicineInsight program also provides information on patterns of systemic antimicrobial use, as well as the demographic characteristics and risk factors of patients prescribed systemic antimicrobials. It also assesses the appropriateness of prescribing for specific indications, including upper respiratory tract infections and urinary tract infections. These data are published in the AURA reports.[22,23]

Aged Care National Antimicrobial Prescribing Survey

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The Aged Care National Antimicrobial Prescribing Survey (acNAPS) has been developed for Australian aged care homes to monitor the prevalence of infections and antimicrobial use, and to identify inappropriate antimicrobial prescribing. It forms part of the AURA Surveillance System.[74] This prevalence survey is open to aged care homes throughout Australia and can be accessed via the NAPS website. Facilities can also enter data at other times, and produce their own facility and regional reports.

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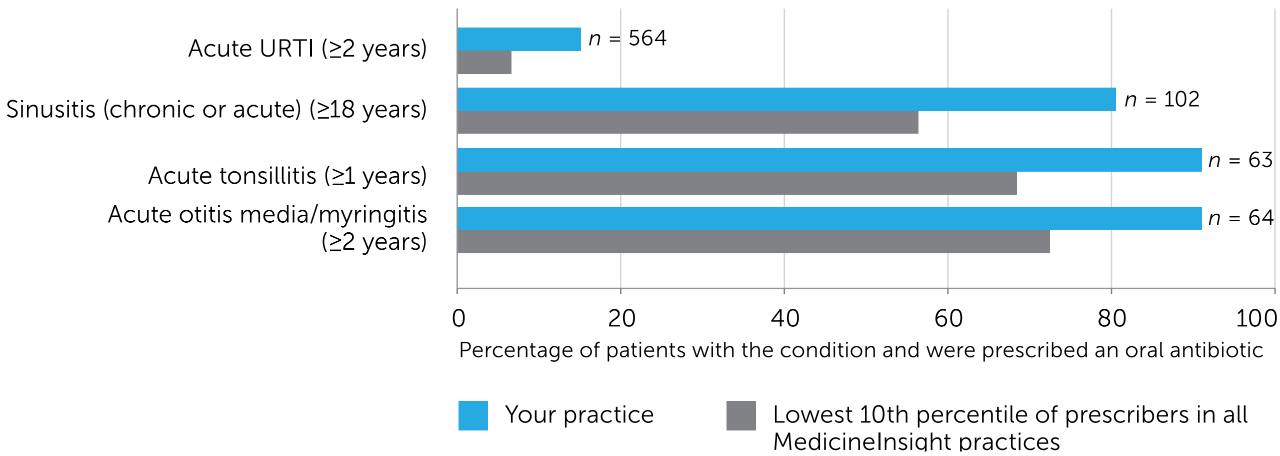
The survey is based on the same survey approach as NAPS, but uses modified questions that are more suitable for aged care homes and the McGeer

Figure 6.8: Example of prescriber feedback in the MedicineInsight program



URTI = upper respiratory tract infection
Source: NPS MedicineWise[63]

infection criteria as a measure of appropriateness of prescribing. acNAPS was piloted in 2015 with 186 multi-purpose services and aged care homes participating.[74] In 2016, participation had increased to 251 facilities.[75]

6.8.3 Quality improvement audits

A QI audit collects data on a small number of subjects, focusing on key measures of quality of prescribing. QI audits are usually designed to be simple so that they are easy to repeat periodically, to document improvement in practices over time and feed into the plan–do–study–act model of QI. Examples of QI audit tools are provided in Resources.

Hospitals

The NSW Clinical Excellence Commission's 5x5 Antimicrobial Audit and the QI-NAPS audit are examples of simple audits designed for the hospital context. They both assess key markers of a safe antimicrobial prescription, such as documentation of the indication, whether the use matches recommendations in guidelines, and the intended duration or a review date. Some of these audits encourage a clinical intervention at the time of auditing to deal with any problems discovered.

The Surgical NAPS (SNAPS) audit tool focuses on surgical antimicrobial prophylaxis, which is a common indication for prescribing in hospitals. Prescribing for this indication is often inappropriate.[72] SNAPS assesses antimicrobial choice, dose, timing and duration; key patient risk factors; and outcomes. The main purpose is to periodically assess the appropriateness of surgical antimicrobial prophylaxis within an organisation to look for areas that require improvement. In addition, by collating data from several sites that use a consistent tool, SNAPS enables a broader description of prescribing behaviour to be developed across larger groups of patients and allows some comparisons to be made.

Similarly, dedicated antimicrobial audits can be used to examine actual prescribing behaviour relative to antimicrobial dosing guidelines. They may be done once per year, or before and after interventions, such as the introduction of new guidelines. A specific antimicrobial audit may be triggered in response to a change in surveillance data, such as data from NAUSP showing increasing antimicrobial consumption. The antimicrobial audit allows the AMS committee to examine in detail why consumption may have changed – for example, whether use is high in a specific unit or for a specific indication, or whether dosing has changed.

Infective syndromes such as community-acquired pneumonia and cellulitis can also be the subject of dedicated antimicrobial audits. Syndromes may be chosen because they are frequent indications for antimicrobial use or because unusual practice has been reported anecdotally. A QI audit, which may uncover aberrant practices, generally involves a small number of patients and focuses on assessing key issues, such as the selection of therapies suggested by guidelines, duration of intravenous therapy or length of stay.

It is important that the data are analysed carefully and that clinically relevant concerns are explored. Common problems need to be identified so that actions can be targeted to correct these issues and meaningful findings can be fed back to prescribers. For example, it is not enough to report that 30% of cellulitis prescriptions are inappropriate. Prescribers also need to know:

- Which unit or prescriber is responsible
- Whether the choice of antimicrobial, the dose or the duration was inappropriate
- What type of patient was involved – for example, whether they were older or had vascular pathology.

It is critical that the results of any audit are fed back to the prescribers. Clinicians need ward- or unit-level feedback on their performance, ideally relative to other units and wards, or relative to other hospitals. Feedback should be actionable. Auditors need to identify the two or three key messages to feed back to prescribers that would improve prescribing and include those messages in their report. The findings of the audits should prompt discussion and follow-up actions as soon after the audit as possible.

Guideline evaluation

When local guidelines are developed for the management of specific conditions or the use of particular antimicrobials, their development should follow a close review of the evidence and the need for a local approach. It is important to ensure that the uptake of the guideline is assessed. QI audit tools are one method for periodically auditing the quality of patient management relative to guidelines and monitoring changes in behaviour over time. The results of these audits should then be fed back to the guideline authors to inform updates or revisions to the guideline. The audits may help to identify situations that are not being addressed by the guideline, or possible misinterpretations where clarity is needed. Audits may also help to identify situations in which practice does not match the guideline, and a review of the evidence and broader discussion is required, including identifying the reasons that the guideline is not being followed. This feedback helps to 'close the loop' between writing guidelines and finding out what is actually happening to patients.

Community

In the community, there are examples of audit activities that assess the quality of antimicrobial prescriptions. NPS MedicineWise administers online self-audits, in which general practitioners review the management of the last 10 patients assessed for a particular condition (for example, upper respiratory tract infection). This encourages general practitioners to reflect on their prescribing behaviour relative to current best-practice guidelines. A similar tool is available for pharmacists and nurses to assess the management of residents with urinary tract infections in aged care.[76] Table 6.4 shows the NPS MedicineWise clinical indicators relevant to antimicrobial use that are used in the clinical audits of general practitioner prescribing.[77]

6.9 Reporting, feedback and use of data

Data collected on antimicrobial use can be invaluable to individual organisations, and can also contribute to network, state and territory, and national reporting and understanding of AMR and AMS.

6.9.1 Health service organisation reports

In hospitals, key antimicrobial use data at the hospital level, or broken into ward or division information, should be reported at least quarterly to the executive, divisions or directorates, and specific clinical units (for example, intensive care, transplant, oncology, haematology). The data, along with results of prevalence surveys and QI audits, should also be tabled for discussion at meetings of the drug and therapeutics committee, the infection prevention and control committee and the AMS committee. These data, along with information on practice improvement initiatives, should be summarised and published in the form of an AMS annual report.

Antimicrobial prescribing data, infection control data and AMR data should be interpreted together to identify and prioritise areas for improvement, and to measure the success of AMS interventions and infection prevention and control strategies.

Measurement of the quality of prescribing should be regularly reported to prescriber groups, and patient safety and quality groups in the organisation. Unexplained deviation from accepted prescribing practices should be promptly fed back to prescribers. The clinical workforce needs feedback on its performance, ideally relative to other units and wards or to other hospitals. Presenting locally derived, meaningful data to small groups of clinicians (for example, at departmental meetings) is likely to be more successful than emailing formal reports. The use of dashboards and control charts to display information can be useful; however, several strategies are likely to be necessary to disseminate all the data.

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6.9.2 State and territory reports

The Queensland and South Australian health departments routinely collect and report on hospital inpatient antimicrobial use data from hospital pharmacy dispensing data. The South Australian data are collected and managed as part of NAUSP, which, since 2008, has also collected and analysed data from hospitals that participate voluntarily in all other states and territories (see National Antimicrobial Utilisation Surveillance Program). NAUSP provides regular reports on a publicly accessible website, including reports by peer group, antimicrobial class, and intensive care unit versus whole-of-hospital use.

Queensland data on public hospital inpatient dispensing are collated using MedTRx data collation and analysis software. These data are fed back monthly to AMS teams across the state and can be further interrogated to give ward-level data for most facilities. The data are not publicly available; they are sent in summary form for inclusion in NAUSP.

6.9.3 National reports

The AURA Surveillance System reports on AMR, antimicrobial use and the appropriateness of prescribing in hospitals and the community at the national level.[22,23] Antimicrobial use data are contributed by NAUSP and NAPS for the hospital sector, and by the PBS and RPBS, acNAPS and NPS MedicineInsight program for the community sector.

Table 6.4: NPS MedicineWise clinical indicators used in clinical audits of general practitioner prescribing

Area of care	Indicator
Patient education	• Discussion of beliefs and expectations regarding treatment • Provision of advice on symptomatic management
Antimicrobial use	• Use of a recommended antimicrobial, dose, frequency and duration where antimicrobial therapy is recommended • Use of an antimicrobial where there is no recommendation for antimicrobial therapy
Common cold / acute viral rhinitis (non-specific upper respiratory tract infection)	• Use of an antimicrobial (not recommended)
Acute bronchitis	• Use of an antimicrobial (not recommended)
Acute bacterial rhinosinusitis	• Use of a recommended antimicrobial where an antimicrobial is recommended • Use of a recommended dose and frequency where a recommended antimicrobial is prescribed • Use of the recommended duration of therapy where a recommended antimicrobial is prescribed • Use of an antimicrobial where there is no recommendation for antimicrobial use
Acute sore throat / pharyngitis / tonsillitis	• Use of a recommended antimicrobial where an antimicrobial is recommended • Use of a recommended dose and frequency where a recommended antimicrobial is prescribed • Use of the recommended duration of therapy where a recommended antimicrobial is prescribed • Use of an antimicrobial where there is no recommendation for antimicrobial use
Acute otitis media	• Use of a recommended antimicrobial where an antimicrobial is recommended • Use of a recommended dose and frequency where a recommended antimicrobial is prescribed • Use of the recommended duration of therapy where a recommended antimicrobial is prescribed • Use of an antimicrobial where there is no recommendation for antimicrobial use
Imaging in acute bacterial rhinosinusitis	• Recommendation for a sinus CT scan when a CT scan is ordered

CT = computed tomography
Source: Australian Commission on Safety and Quality in Health Care[77]

Table 6.5 lists uses and outcomes from national surveillance of antimicrobial use and AMR at different health system levels.

6.9.4 Use of data for benchmarking

Using larger-scale reporting systems to make comparisons across hospitals, Local Hospital Networks, Local Health Districts, states and territories, or even countries, can have potential problems. In hospitals, differences in casemix and

Table 6.5: Uses and outcomes of national surveillance of antimicrobial use and resistance at different health system levels

Level	Use of surveillance data	Impact or outcome
Global	• Inform strategies to prevent and contain antimicrobial resistance, including the response to the Global Action Plan on Antimicrobial Resistance[78]	• Coordinated efforts internationally: avoidance of duplication of effort and inefficient use of resources
National	• Inform policy and program development • Develop and revise guidelines • Inform public health priorities • Inform regulatory decisions • Coordinate, where necessary, the response to critical antimicrobial resistances	• Coordinated and integrated efforts across Australia • Increased awareness of antimicrobial resistance and the One Health approach*
State and territory	• Inform policy and program development • Develop and revise guidelines • Inform public health priorities • Inform regulatory decisions • Detect and respond to critical antimicrobial resistances and outbreaks	• Improved knowledge of local antimicrobial resistance profiles • Timely response to emerging resistance • Appropriate and effective use of antimicrobials
Healthcare services	• Inform clinical practice • Inform policy development • Develop local strategies to improve antimicrobial stewardship • Detect and respond to outbreaks of resistant organisms	• Appropriate and effective use of antimicrobials • Improved capacity for timely response to emerging resistance
Individual	• Raise awareness of appropriate use in the community	• Appropriate use of antimicrobials as prescribed • Decreased complications from unnecessary or inappropriate antimicrobial therapy

* The One Health approach encourages collaboration between clinicians, veterinarians, farmers, food safety specialists and other experts.

regional variations in the incidence of particular infectious diseases or AMRs can confound the results. Ideally, for antimicrobial use data to be valid for benchmarking purposes, they should be risk adjusted for casemix, severity of illness and other relevant variables.[79] Kuster et al. attempted to correlate antimicrobial consumption with a casemix index across a group of hospitals in Switzerland.[80] They found a significant correlation and suggested that casemix distribution should be considered when analysing large antimicrobial use datasets. Kritsotakis and Gikas attempted the stratification of surveillance data by ward type to reduce confounding by casemix.[81] Although this was useful to the individual facility in indicating trends, there were major problems with comparisons between facilities. Ibrahim and Polk describe the use of indirect standardisation to risk adjust antimicrobial use data. They also describe the use of the ratio of observed to expected use in DOTs and LOTs to reflect use, and as a potential measure for benchmarking across teaching hospitals.[79] This method identifies hospitals where use deviates from the predicted use, and the clinical services responsible. However, it relies on hospitals having electronic systems that link individual patient antimicrobial use data with the patient's diagnosis.

Resources

Measurement for improvement

- Australian Commission on Safety and Quality in Health Care: Measurement for Improvement Toolkit 2006
- Using measurement to improve clinical practice
  - NSW Health: *Easy Guide to Clinical Practice Improvement*
  - Institute for Healthcare Improvement: online resources
- AMS measurement frameworks
  - Centers for Disease Control and Prevention: Antimicrobial Stewardship Measurement Framework
  - Be SMART with Resistance: *Practical Guide to Antimicrobial Stewardship in Hospitals*
  - National Quality Forum: *National Quality Partners Playbook: Antibiotic stewardship in acute care*
  - Royal College of General Practitioners: TARGET Antibiotic Toolkit

Structure measures

- Tools and checklists to help health service organisations to assess the structure of their AMS programs
  - NSW Clinical Excellence Commission: Antimicrobial Stewardship Progress & Planning Tool
  - SA Health: Antimicrobial Stewardship Program Self-evaluation Toolkit
  - Transatlantic Taskforce on Antimicrobial Resistance: core and supplementary structure indicators for hospital AMS programs
  - Centers for Disease Control and Prevention: Checklist for Core Elements of Hospital Antimicrobial Stewardship Programs
  - Ontario Public Health: AMS Gap Analysis Checklist
  - National Institute for Health and Care Excellence: baseline assessment tool for antimicrobial stewardship
- Checklists of requirements for AMS in residential aged care settings and primary care
  - Centers for Disease Control and Prevention: Core Elements of Antibiotic Stewardship for Nursing Homes
  - Centers for Disease Control and Prevention: Core Elements of Outpatient Antibiotic Stewardship

Process measures

- Quality indicators
  - National Quality Use of Medicines Indicators for Australian Hospitals
  - Indicator specification – Antimicrobial Stewardship Clinical Care Standard

Surveillance tools

- Antimicrobial consumption tool to convert numbers of packages or vials into numbers of DDDs: AMC Tool: the antimicrobial consumption tool
- National Antimicrobial Utilisation Surveillance Program

Audits of quality of prescribing

- NAPS
  - Hospital NAPS
  - acNAPS
  - SNAPS
  - QI NAPS
- NPS MedicineWise
  - MedicineInsight program
  - Clinical e-Audits
  - RACF/Webstercare report on antibiotics for urinary tract infections
- QI audit tools
  - NSW Clinical Excellence Commission: The 5x5 Antimicrobial Audit
  - NPS MedicineWise: Clinical e-Audits for general practitioners
  - Public Health England: Dental antimicrobial stewardship: toolkit
  - Royal College of General Practitioners, TARGET Antibiotic Toolkit: audit toolkits and action planning

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AUSTRALIAN COMMISSION ON SAFETY AND QUALITY IN HEALTH CARE

7 Involving consumers in antimicrobial stewardship

Antimicrobial Stewardship in Australian Health Care

2018

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Acronyms and abbreviations

Abbreviation	Definition
AMR	antimicrobial resistance
AMS	antimicrobial stewardship
Commission	Australian Commission on Safety and Quality in Health Care
NSQHS	National Safety and Quality Health Service
RACGP	Royal Australian College of General Practitioners

Key points

- Many consumers are aware that antimicrobial resistance (AMR) is a problem, but their understanding of the nature of the problem and the role that consumers can play in preventing AMR is limited.
- Consumers may overestimate the benefits and underestimate the risk of harm from the use of antimicrobials.
- Many consumers believe antimicrobials are effective against the common cold and other viral upper respiratory tract infections, and parents are twice as likely to request antimicrobials to treat their child's cold or cough than for themselves.
- Clinicians have a central role in supporting consumers to better understand appropriate antimicrobial use and AMR.
- Clinicians need to consider consumer concerns, preferences and expectations about antimicrobial use and AMR.
- Accessible tools and resources need to be available to support consumer awareness of antimicrobial use and AMR.
- Many prescribers think that consumers expect to receive a prescription for antimicrobials, when that may not be the case.
- When discussing antimicrobial use and AMR with consumers, it is important that the messages are clear, concise and consistent.
- Consumers need support and information to help them manage symptoms associated with infections and better understand when they should seek further medical attention.
- Providing consumers with information on treatment options, including evidence of effectiveness, and likely benefits and risks of harm can support consumer engagement and shared decision making.
- Consumer representation on antimicrobial stewardship committees is suggested to enable effective communication.

7.1 Introduction

Informing consumers about antimicrobial use and antimicrobial resistance (AMR), and involving consumers in decisions about appropriate antimicrobial use are important elements of antimicrobial stewardship (AMS). A consumer is someone who has used, or may potentially use, health services (in hospital and in primary care) or is a carer for a patient using health services. Consumers also include residents of aged care homes, and their carers and families.

Effective consumer partnerships contribute to efficient use of resources, improved safety and quality of care, improved patient outcomes and experience, and improved performance of health service organisations.

Action 1.1 of the National Antimicrobial Resistance Strategy specifies the need to 'strengthen consumer awareness initiatives to improve understanding of AMR and the importance of using antibiotics appropriately'. AMS messages should be reinforced during all interactions between consumers and clinicians in all settings.

Quality statements 3, 4 and 5 of the Antimicrobial Stewardship Clinical Care Standard aim to ensure that consumers are informed about their possible clinical condition so that they can participate in decisions about their treatment. If an antimicrobial is prescribed or recommended by a clinician, it is important to ensure that an antimicrobial is warranted; the most appropriate antimicrobial is selected; consumers receive information about when and how to take the antimicrobial, for how long, and any potential side effects; and a review of the care plan is arranged.[1]

A healthcare consumer may also act as a consumer representative on an AMS committee, to provide a consumer perspective, contribute experiences, advocate for the interests of current and potential health service users, and take part in decision-making processes. Ensuring that consumers are partners in the planning, design, delivery and evaluation of healthcare systems and services is the aim of the National Safety and Quality Health Service (NSQHS) Partnering with Consumers Standard. This is especially relevant when considered in conjunction with the Preventing and Controlling Healthcare-Associated Infection Standard, which requires safe and appropriate antimicrobial prescribing as a strategic goal of the clinical governance system.

This chapter aims to help clinicians and health service organisations understand the knowledge, attitudes and behaviours of consumers, and to equip them to engage effectively with consumers in efforts to promote AMS.

Issues that are especially relevant for certain settings – rural and remote hospitals, private hospitals and aged care – are tagged as R, P and AC, respectively, throughout the text.

R P AC

7.2 Consumer awareness and expectations

Understanding the knowledge, attitudes and behaviours that influence consumer decision-making about antimicrobials is important to effectively engage with consumers. A range of factors influence consumers' decision-making, including their awareness and understanding of antimicrobial use and AMR, and their previous experience with antimicrobials.

7.2.1 Consumer understanding of when antimicrobials are needed

Many consumers mistakenly believe that antimicrobials are effective against the common cold and other viral infections. An Australian study undertaken by NPS MedicineWise revealed that only 37% of respondents knew that antibiotics are effective against bacteria and not viral infections.[2] Similar findings have been described overseas.[3-5] The NPS MedicineWise study also found that one in five Australians expect their doctor to prescribe antimicrobials for themselves or their child when they have a cough or cold.[2] Mothers with young children expected, and at times demanded, antibiotics for their children. This was especially the case if their child was sick for longer than they expected.[2]

Consumers visit their general practitioners when their symptoms are prolonged or severe enough to cause pain, or interfere with daily activities or sleep.[3] Certain symptoms (for example, green or yellow nasal discharge) are perceived by consumers as a compelling reason to take antimicrobials.[4,6-9] Consumers also report that it is not what you have (that is, a viral or bacterial infection) but how you feel that can influence antimicrobial-seeking behaviour.[10]

Consumers are also concerned about the possibility of the illness developing into a severe infection. For example, parents of children with otitis media were concerned about their child developing septicaemia or requiring hospitalisation, and the possibility of hearing loss.[11]

The desire of the consumer or parent to return to normal activity (such as work, school or day care) after an illness is another significant driver for antimicrobial requests.[8] Consumers tend to overestimate the effects of antimicrobials on upper respiratory tract infections, especially the effect on recovery time, duration of illness and prevention of serious complications.[6] Side effects and AMR are generally underestimated relative to the benefits.[3,8]

However, although general practitioners often perceive that consumers want an antimicrobial for acute respiratory tract infections[12], research has shown that prescribers may overestimate consumer expectations for antimicrobials.[13] Some general practitioners also perceive that consumers will go to another practitioner if they are not prescribed an antimicrobial.[13-15] Therefore, it is important for clinicians not to pre-empt the consumer's actual expectations during a consultation, as it may be that those expectations are overestimated.

7.2.2 Consumer awareness and understanding of antimicrobial resistance

Consumers vary widely in their understanding of the cause, meaning and impact of AMR. The NPS MedicineWise study found that:

- 70% of more than 1,000 respondents reported having heard of the term 'antibiotic resistance'
- 84% agreed that bacteria can become resistant to antibiotics
- 74% were aware that taking antibiotics when you do not need them means they are less likely to work in the future.[2]

Some consumers believe that taking antimicrobials may cause them – not bacteria – to become resistant to antimicrobials.[4,8,16]

Many consumers do not understand how AMR can affect them personally. Consumers perceive resistance as a problem in hospitals, and few recognise resistant infections as a problem in the community. Most believe that there is little they can do to positively influence the situation.[10,17,18] There is little understanding that the misuse of antimicrobials affects the individual taking the antimicrobial, as well as promoting the development of resistant organisms that can be transmitted to others.[19] This is especially important in close living conditions, such as in the family home, aged care homes and hospitals.

7.2.3 Previous experience of antimicrobials

Consumers who have received antimicrobials in the past will often expect antimicrobials again for the same symptoms (for example, cough, sinus pain or sore throat).[8,11,20,21] The prescription of an antimicrobial can validate the illness for the consumer and suggest that something is being done about it.[10]

Conversely, when a consumer has been persuaded that antimicrobials are not required, this gives them confidence to avoid antimicrobials in the future for the same symptoms.[8]

7.3 Key messages and communication

Consumers should be provided with information about the risks and benefits of the most effective and appropriate treatment options for them. This includes information about specific antimicrobials (if appropriate) and the risks associated with AMR.

When discussing the use of antimicrobials and AMR with consumers, it is important that the messages are clear, simple and consistent. Information may need to be provided in different formats and styles, tailored to the needs and preferences of the consumer.

Programs for engaging with consumers should consider using key messages that are consistent with national programs, such as those implemented by NPS MedicineWise (Box 7.1). It is noted that most consumers more readily understand the term 'antibiotics' rather than 'antimicrobials'.

When explaining AMR to consumers, it should be recognised that the actual term means little to many.[10] Using language that focuses on the illness or bacteria – such as antimicrobial-resistant bacteria or illness – is more specific. Further, referring to actual bacteria (e.g. *E. coli* or 'golden staph') feels more 'real' to many consumers.[10] Discussion of the bacteria can also avoid the misunderstanding that it is the body becoming resistant, rather than the microbes.[10] Other messages that have demonstrated effectiveness are those about bacteria becoming stronger and medicines not working against these stronger organisms.[10]

Box 7.2 shows some tips for talking with consumers about AMR.

7.3.1 Reassurance

It is important for clinicians to consider that consumers often visit their general practitioner for advice about their health condition, and not necessarily to receive a prescription. For parents, this may mean ensuring that their child does not have a serious illness and having the opportunity to discuss their concerns about complications.[3,6,9] Providing easy-to-understand information to consumers about the expected duration of symptoms, and how to identify signs and symptoms of more serious illness, may help to manage their expectations about antimicrobials.

7.3.2 Health literacy

Health literacy is the way in which people understand and use information about health. If people cannot find, understand and use health-related information and services, it is difficult for them to make good decisions about their health. Almost 60% of Australians have low individual health literacy and may not be able to effectively exercise their choice or voice when making healthcare decisions.[22]

Clinicians and health service organisations have a responsibility to make it as easy as possible for consumers to obtain, understand, appraise and apply information, including about antimicrobials. This means providing information about AMR and antimicrobial use in clear and simple language in formats that meet the needs and preferences of a diverse range of consumers. For example, NPS MedicineWise has translated information

Box 7.1: Key consumer messages

Antibiotic-resistant bacteria are a personal threat to you and the wider community

- Many bacteria are now resistant to treatment with antibiotics.
- Infections caused by antibiotic-resistant bacteria can be difficult to treat and last for a long time.
- Antibiotics are losing their effectiveness at a faster rate than new antibiotics are being developed.
- It is the bacteria that become resistant, not the person.
- Antibiotic-resistant bacteria that cause infections can spread to family and friends.

Antibiotics do not work for all infections

- Antibiotics do not treat colds and flu.
- Most coughs, earaches, sinus congestion and sore throats can get better without antibiotics.

Using antibiotics when they are not needed or in the wrong way increases the resistance of bacteria to antibiotics

- Do not always expect an antibiotic. They do not work for all infections.
- If you are prescribed an antibiotic, take it for as long as you are advised to by your clinician.
- Antibiotics can have side effects, and some are serious.
- Never save antibiotics for another illness or share them with other people.
- Dispose of any remaining antibiotics by returning them to a pharmacy.

Discuss with your clinician the best way to manage your or your child's illness

- You or your child may feel very unwell with an infection like a cold or the flu. But you can manage many symptoms without antibiotics.
- Ask your clinician for advice.
- You may need an antibiotic in some circumstances.

Source: Adapted from the NPS MedicineWise program information implemented in 2015–16. Current program information is available at: www.nps.org.au/medical-info/clinical-topics/reducing-antibiotic-resistance and www.nps.org.au/medical-info/consumer-info/antibiotic-resistance-the-facts

Box 7.2: Tips for explaining antimicrobial resistance to consumers

- Explain that antibiotic resistance is when antibiotics no longer work against the (bacterial) infection that they previously worked against
- Ask what they understand about antimicrobial resistance and use resources to assist the discussion
- Use diagrams, videos and other graphics to explain how resistance works
- Use consumer resources from the Australian Commission on Safety and Quality in Health Care (including a consumer summary of the Antimicrobial Use and Resistance in Australia 2016 report) and NPS MedicineWise.

about antimicrobials to support culturally and linguistically diverse communities (see Resources). Table 7.1 summarises some actions that support consumers' individual health literacy, which can be applied within AMS programs.[23]

7.3.3 Communication with consumers in different settings and circumstances

There are a number of specific settings and circumstances in which effective communication with consumers about antimicrobials is especially important.

Travellers

With increasing numbers of people travelling internationally, there is the possibility of greater contact with antimicrobial-resistant organisms that can be brought home and spread to others.[24] Infections caused by multidrug-resistant bacteria are increasing in healthcare settings in low- and middle-income countries.[25] Australian consumers may be susceptible not only to resistant organisms emerging here but also to resistant organisms from other countries.

Travellers should be made aware that they should take routine steps to avoid infection, such as seeing their general practitioner to receive any recommended vaccines before travelling, practising good hand hygiene and safe sex, and being careful about what they eat and drink. The use of prophylactic antimicrobials (for example, for malaria prevention) should be discussed with the consumer, including benefits and harms. Clinicians should also ask consumers about any recent travel or medical procedures performed overseas.

Hospitals

Admission to hospital results in increased risk of harm from healthcare-associated infections. Patients are at risk of acquiring a resistant organism and transmitting resistant organisms to others. Consumers should have the opportunity to ask questions about their antimicrobials while in hospital and be able to obtain information about

Table 7.1: Actions that consumers, clinicians and health service organisations can take to improve health literacy

Role	Possible actions
Consumers	• Discuss with clinicians any difficulties in understanding health information and services • Ask family, friends or support services (such as translating services) for help with communication difficulties • Ask for more information about any part of care that is unclear • Be open and honest with clinicians about medical history and medicines.
Clinicians	• Recognise the needs and preferences of individual patients and consumers, and tailor the communication style to the person's situation • Assume that most people will have difficulty understanding and applying complex health information and concepts • Use different interpersonal communication strategies to confirm that information has been delivered and received effectively • Encourage people to speak up if they have difficulty understanding the information provided • Use ways of communicating about treatment risks that are known to be effective.
Health service organisations	• Develop and implement health literacy policies and processes that aim to reduce the health literacy demands of information materials, the physical environment and local care pathways • Provide and support access to health literacy and interpersonal communication training for clinicians, including training in methods for communicating risk • Provide education programs for consumers aimed at developing health knowledge and skills.

appropriate antimicrobial use, AMR and the antimicrobials they have been prescribed.

Fact sheets and other short resources can be helpful in informing consumers about what they can do to prevent infections (see Resources). The Australian Commission on Safety and Quality in Health Care (the Commission) has published Top Tips for Safe Health Care, which supports consumers, their families and carers by providing information about medicines and care in hospital to assist when they are speaking with their doctor and other health professionals. Encouraging the involvement of parents, families and carers in the process of antimicrobial prescribing can better support the individual patient to ask questions and better understand the implications of their medicines.

Consumers at transitions of care

At transitions of care – such as transfers between wards in hospital, or from hospital to the community – the consumer needs to have the information to support them to appropriately manage their medicines, including continuing and ceasing treatment, as directed by the clinical workforce. They should also be empowered to pass on information to other clinicians in the community, such as their general practitioner.

Residents in aged care homes

AC

Consumers in aged care homes include the residents and their families. As in other settings, consumers' understanding about AMR varies. Consumers often do not recognise that organisms become resistant and can transfer to another person, even if that person has never received the antimicrobial. It is important to educate consumers about the transfer of resistant organisms between people in aged care homes.

Aged care homes can raise awareness of AMR and appropriate antimicrobial use, and involve consumers in decision-making about their care, including the need for a regular medication review.

End-of-life antimicrobial prescribing

The decision on whether to prescribe antimicrobials to patients at the end of life can be challenging (see Section 10.3.2 in Chapter 10: 'Role of prescribers in antimicrobial stewardship'). The possible benefits versus harms of antimicrobial therapy, as well as the beliefs and expectations of the patient and their family, may be unclear. Similarly to other end-of-life treatment choices, the decision to prescribe an antimicrobial should be shared between the clinician, patient, carer and family, and should be based on how the treatment will affect the patient's quality of life – especially in the final stages. Discussions and decision-making about antimicrobial use can be considered as part of advance care planning processes.

Consumer engagement in system-wide AMS

Consumer engagement in system-wide AMS can be achieved through a range of activities, which might include surveying consumers about AMS experiences, working with consumer organisations to consult on and analyse AMS issues, undertaking focus groups or consumer interviews to explore strategies for improving antimicrobial use, and encouraging management and consumer representation on AMS committees.

In health service organisations, there is an opportunity to include consumers in decisions about antimicrobials by having consumer representation on the organisation's AMS committee. Involving consumers in the governance of the health service organisation through an AMS committee will help the health service to meet the aim of the NSQHS Partnering with Consumers Standard, which is to ensure that consumers are partners in the planning, design, delivery and evaluation of healthcare systems and services.

7.4 Consumer resources and tools

Consumer resources and information should be available to meet consumer needs along the continuum of care. For the consumer, the desire for an antimicrobial is often decided before going to the doctor[11]; therefore, the timing of messages about AMR is important. This issue is also important in terms of the resources and time available to clinicians. If high-quality information is available before a consultation, it can help to frame the discussions between the clinician and the consumer during the consultation, and can be reinforced after the consultation.

7.4.1 Before the consultation

Consumer information should give the consumer greater confidence in knowing when to seek a clinician's advice, asking questions of their clinician, and trusting the answers and advice provided. To address the reasons that consumers request or expect a prescription for an antimicrobial, further information is needed on symptoms and their seriousness, when to take a child to a doctor, the management of symptoms, and treatments other than antimicrobials.[7] Studies indicate that consumers generally seek information from multiple sources before making a decision.[7] These sources include social networks (family, friends and childcare workers), television, newspapers, websites, books and leaflets, as well as information from clinicians such as doctors and pharmacists.[7,26]

Resources such as posters and videos in waiting rooms on topics such as immunisation, hand hygiene and AMR can raise awareness and prepare consumers before a consultation. The NPS MedicineWise website and the Better Health Channel have a wide range of information available for consumers, and the General Practitioner Antimicrobial Stewardship Programme Study has also developed a range of resources for practitioners and consumers. The Commission's Question Builder helps consumers think about the questions they want to ask their doctor before an appointment.

Education on AMR can start in schools, including information about bacteria, antibacterials, hygiene (hand and respiratory) and vaccinations. Examples of school education programs are e-Bug in Europe and Do Bugs Need Drugs? in Canada.

7.4.2 During the consultation

During the consultation, the consumer and their clinician should discuss the treatment options available, and the consumer's expectations and beliefs before deciding whether antimicrobials are an appropriate treatment option. Information such as the likely duration and course of symptoms of the illness, the period of infectivity and which conditions require antimicrobials are important components of the discussion that can help the consumer understand when antimicrobials may or may not be beneficial.

Shared decision making

Shared decision making can be an effective strategy for engaging with consumers and reducing the overuse of antimicrobials.[27-29] Most consumers would like to be more actively involved in making healthcare decisions. However, low levels of individual health literacy may affect their ability to effectively exercise choice when making such decisions.[22] Sharing decisions with consumers supports them to be partners in their care to the extent that they choose or are able to participate.

Shared decision making occurs when a clinician and a consumer jointly make a decision about health care after discussing the different options for care, the likely benefits and harms of each option, and the consumer's values, preferences and circumstances.[30] It can be helpful when there is more than one reasonable treatment option, when no option has a clear advantage, and when the consumer has different views from the clinician on the benefits and harms. It provides an opportunity for consumers to partner with clinicians to make more informed decisions.[29]

Using a communication model for shared decision making within a consultation guides a two-way information exchange. This may be implemented using a three-step model[31]:

1. Introduce choice
2. Describe options, often by integrating the use of consumer decision support
3. Help the consumer explore preferences and make decisions.

Questions that clinicians can use to guide shared decision making are listed in Box 7.3.

The Commission, in collaboration with the Royal Australian College of General Practitioners (RACGP), has produced an online module for clinicians on shared decision making and risk communication.[32] The module, *Helping Patients Make Informed Decisions: Communicating risks and benefits*, is available through the Commission's website.[33] Versions of the online module will be developed for specialist colleges.[33]

Box 7.3: Five questions that clinicians can use with consumers to guide shared decision making

- What will happen if we watch and wait?
- What are your test or treatment options?
- What are the benefits and harms of each option?
- How do the benefits and harms weigh up for you?
- Do you have enough information to make a choice?

Source: Hoffmann et al.[30]

The process may include the use of decision aid tools, although the use of these alone does not equate to shared decision making.[30] Patient decision aids on antimicrobial use, including for sore throat, acute bronchitis and middle ear infection in children, have been developed for use in the Australian primary care setting.[34]

The Choosing Wisely Australia program is led by Australia's medical colleges and professional societies, and facilitated by NPS MedicineWise. The program encourages clinicians and consumers to have a conversation about what care is needed. The medical colleges and societies have developed recommendations, based on the best available evidence, about the tests, treatments and procedures that clinicians and consumers should question. A number of those recommendations refer to the appropriate use of antibiotics.

Tools and techniques for engaging the consumer

A number of resources are available to assist prescribers in engaging consumers.

Action plan: respiratory tract infections

General practitioners can use an action plan to help consumers to self-manage coughs and colds, and avoid antimicrobials. The NPS MedicineWise action plan for respiratory tract infections (Figure 7.1) helps general practitioners to establish patients' beliefs, engage them in discussion about the benefits and harms of antibiotic therapy, and outline a symptomatic management plan.

Online commentary

Online commentary is a technique whereby clinicians describe their clinical findings to the patient as they perform the physical examination. The commentary can include simple observations during the examination while conveying to patients what the likely diagnosis and treatment plan will be. An example of this is rejecting the need for antibiotic treatment in favour of symptomatic, non-prescription medicines. A 'problem' commentary is strongly related to inappropriate prescribing compared with a 'no problem' commentary, and makes it more likely that parents will question the treatment plan.[35,36]

If clinicians offer specific, positively formulated treatment plans, it is more likely that parents will accept the advice and follow recommendations. Similarly, recommendations against a treatment are less likely to be problematic.[37]

7.4.3 After the consultation

If the decision has been made to prescribe antimicrobials, the consumer should be given information about how to take the medicine and for how long, the expected benefits of taking the medicine, possible side effects of the medicine, and what to do if they are not getting better or are getting worse.

Delayed antimicrobials strategies

Strategies that delay the use of antimicrobials for upper respiratory tract infections can reduce antimicrobial use without adversely affecting clinical outcomes.[38] One such strategy is a delayed prescription. This involves offering consumers a prescription to be used at a later time if symptoms do not improve or get worse. Appropriate information should be given to the consumer so that they understand if and when antimicrobials should be started, or if it is appropriate to return to the clinician.[38-40] For example, What Every parent should know about coughs, colds, earaches and sore throats is a resource that provides information for parents about the management of respiratory tract infections in children, designed to be used in primary care consultations.

Infection prevention and control in the home and elsewhere

Preventing the spread of infections reduces the need for antimicrobials[41] and reduces the likelihood of resistance developing.[25] Infections can be prevented by immunisation, safe food preparation, hand hygiene, and using antimicrobials only when necessary and for the appropriate duration. Consumers should be informed about how they can avoid transmitting their infection to others – for example, handwashing can reduce the spread of respiratory viruses.[42]

7.4.4 Reaching and engaging consumers nationally

In Australia, consumer education has been a key component of the approach taken by NPS MedicineWise since the first Common Colds Need Common Sense campaign was launched in 2000. This campaign was repeated annually during the winter months until 2009.

In 2012, NPS MedicineWise launched a five-year educational program for clinicians and consumers, which included a mass audience campaign to raise awareness of, and combat, AMR. The campaign

Figure 7.1: NPS MedicineWise action plan for respiratory tract infections

Name: **ACTION**PLAN

RESPIRATORY TRACT INFECTIONS

Manage your symptoms

You have an infection of the ear, nose, throat, sinuses and/or chest, most likely caused by a virus. Antibiotics don't work against viral infections. Antibiotics won't make you feel better or recover faster.

What is a respiratory tract infection?

A respiratory tract infection is an infection anywhere in the respiratory tract (ie, the nose, throat and lungs). Your respiratory tract infection is most likely caused by a virus; antibiotics kill bacteria, not viruses.

How can I treat a viral respiratory tract infection?

Most coughs, earaches, sinus congestion problems and sore throats get better without antibiotics. Colds rarely cause serious harm, but they can still make you feel unwell. The good news is that colds usually get better in 7 to 10 days, although a cough can last up to 3 weeks and there are things you can do to feel better.

Contact your doctor

Contact your doctor if you don't begin to feel better after a few days, your symptoms worsen, new symptoms develop or you get side effects.

A respiratory tract infection can make an ongoing medical condition — such as asthma or diabetes — worse. Contact your doctor if this happens.

Additional advice and actions

What can you do?

Rest

- [ ] Allow your immune system to fight off the virus.

Use home remedies

- [ ] Gargle warm salty water.
- [ ] Suck on an ice cube or lozenge as needed.
- [ ] Have a soothing drink (eg, honey & lemon).
- [ ] Apply moisturiser to soothe dry skin of the nose.
- [ ] Inhale steam from the shower. Don't inhale steam from a bowl of hot water because of the risk of burns.

Use symptom-relieving medicines

- [ ] Use a decongestant nasal spray or drops.*
- [ ] Use saline nasal spray or drops.
- [ ] Take a decongestant tablet or mixture.*
- [ ] Take a non-prescription pain reliever medicine.

*Should not be given to children < 6 years of age & should only be given to children aged 6 to 11 years on the advice of a doctor, pharmacist or nurse practitioner.

Prevent the spread of infection

- [ ] Cover your mouth when sneezing or coughing.
- [ ] Clean your hands after blowing your nose.

For more information

Visit the NPS MedicineWise website:
www.nps.org.au/rtis

NPS MEDICINEWISE

was timed to coincide with the start of winter, and focused on misconceptions about colds and flu in the context of antimicrobial use. The primary target audience for the original campaign was mothers with children under 15 years old. The two key components for the strategy were making people aware of the problem and educating them about it, and empowering them to be part of social media activities. The campaign has contributed to improving consumer understanding that bacteria can become resistant to antimicrobials. By 2014, 74% of consumers understood that taking antimicrobials when they are not needed means that the antimicrobials are less likely to work in the future for themselves and others.[2]

7.4.5 Antibiotic Awareness Week

For some years, antibiotic awareness campaigns have been conducted in a number of countries each November, including the United States, Canada and some European countries. In Australia, Antibiotic Awareness Week has been observed nationally each November since 2012. Aligning the Australian campaign with international efforts demonstrates the global significance of AMR.

Antibiotic Awareness Week in Australia is jointly organised by the Commission and NPS MedicineWise, and is supported by several Australian Government departments, states and territories, and professional organisations. All health service organisations are encouraged to participate in Antibiotic Awareness Week.

The campaign targets both consumers and clinicians, as well as prescribers in animal health and agriculture, through collaboration between key government departments. Participating in activities during Antibiotic Awareness Week can help focus clinicians' awareness on local patterns of AMR and antimicrobial use, enable the promotion and uptake of local AMS strategies and resources, and highlight progress and opportunities for ongoing AMS activities.

Raising awareness and educating consumers about AMR aims to empower them to be part of the solution. Consumers can commit to changing behaviour by making a pledge on social media to use antibiotics appropriately (Box 7.4).

Box 7.4: The Antibiotic Resistance Fighter pledge

1. I will not ask for antibiotics for colds and the flu as they have no effect on viruses.
2. I understand that antibiotics will not help me recover faster from a viral infection.
3. I will only take antibiotics in the way they have been prescribed.
4. I understand that it is possible to pass on antibiotic-resistant bacteria to others.
5. I will make a greater effort to prevent the spread of germs by practising good hygiene.

Resources

General consumer information

- NPS MedicineWise website
- Australian Commission on Safety and Quality in Health Care: AURA
- Better Health Channel
- General Practitioner Antimicrobial Stewardship Programme Study

School resources and programs

- Europe: e-Bug
- Canada: Do Bugs Need Drugs?

Resources and information for primary health care

- *Helping Patients Make Informed Decisions: Communicating risks and benefits* (produced by the Commission in collaboration with the RACGP, Royal Australian and New Zealand College of Obstetricians and Gynaecologists, Australian and New Zealand College of Anaesthetists and Royal Australasian College of Surgeons, available on the Commission's website)
- Australian Commission on Safety and Quality in Health Care: patient decision aids on antibiotic use, including for sore throat, acute bronchitis and middle ear infections
- Choosing Wisely Australia program and recommendations about the tests, treatments and procedures that healthcare providers and consumers should question
- Choosing Wisely Australia video for consumers about antibiotics losing their power through misuse and overuse
- NPS MedicineWise
  - action plan for symptom management for respiratory tract infections
  - Antibiotic resistance: the facts
  - Antibiotics, explained
  - Antibiotics, antibiotic resistance and childhood respiratory tract infections
  - Consumer pledge to help prevent antibiotic resistance
  - *What Every Parent Should Know About Coughs, Colds, Earaches and Sore Throats*
  - Translated information about antimicrobials for culturally and linguistically diverse communities

Resources and information for hospital inpatients

- NSW Clinical Excellence Commission: information about antibiotic therapy for inpatients
- NSW Clinical Excellence Commission and Sydney Children's Hospitals Network: *Making the Switch: Changing from intravenous to oral antibiotics* parent information leaflet
- The Royal Melbourne Hospital: patient safety campaign What Matters to You – Matters to Us

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AUSTRALIAN COMMISSION ON SAFETY AND QUALITY IN HEALTH CARE

8 Role of the infectious diseases service in antimicrobial stewardship

Antimicrobial Stewardship in Australian Health Care

2018

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Acronyms and abbreviations

Abbreviation	Definition
AMR	antimicrobial resistance
AMS	antimicrobial stewardship
ICU	intensive care unit
ID	infectious diseases
LHD	Local Health District
LHN	Local Hospital Network
IT	information technology
QI	quality improvement

Key points

- Infectious diseases (ID) physicians play an essential role in antimicrobial stewardship (AMS), which needs to be considered when planning the AMS program and the composition of hospital and network AMS teams.
- Depending on activity, the involvement of at least one ID physician to contribute effectively to the development, implementation and functions of the AMS program is important to the success of the program.
- The roles of ID physicians include providing advice on the appropriate use of antimicrobials; developing and implementing evidence-based guidelines for antimicrobial treatment and prophylaxis; and contributing to formulary decision-making, antimicrobial restriction policies, and the establishment and operation of antimicrobial approval systems.
- ID physicians are able to make a considerable contribution to the development and delivery of education to the workforce through formal education programs, through feedback provided at forums such as grand rounds, or as part of an AMS intervention.

8.1 Introduction

The effectiveness of many of the strategies to improve antimicrobial prescribing discussed in other chapters depends on a formalised multidisciplinary approach, including the involvement of infectious diseases (ID) physicians. Their expertise in the management of infectious disease and support for antimicrobial stewardship (AMS) activities is considered essential to the success of hospital AMS programs.[1-3] There is good evidence that the involvement of ID physicians in AMS programs improves antimicrobial use and clinical outcomes, and reduces the overall costs of antimicrobial therapy.[4-6]

ID physicians contribute to AMS in many ways, including by providing expert advice and educating clinicians. They have a major role in the development of antimicrobial policy and prescribing guidelines, formulary decision-making, and the establishment and operation of antimicrobial approval systems. The AMS committee and the AMS team should include an ID physician, if one is available.[7]

Issues that are especially relevant for certain settings – rural and remote hospitals, private hospitals and aged care – are tagged as R, P and AC, respectively, throughout the text.

R P AC

8.2 Leadership

The involvement of ID physicians in the development, implementation and function of the AMS program, and collaboration with local specialists to ensure that the AMS team's goals are understood and met, is essential to effective AMS.[1] Clinicians caring for critically ill patients are more likely to follow an antimicrobial policy that is supported by their ID colleagues[6], and ID physicians can gain prescriber acceptance of antimicrobial interventions by ensuring that there is no perceived loss of autonomy in clinical decision-making.[8]

Although guidelines recommend that the hospital AMS program be led by an ID physician[1,3], that is not always feasible. Increasing numbers of programs are successfully led by clinicians without specialist ID training.[9-11] AMS programs require leaders with knowledge of quality improvement, organisational change, the measurement of improvement and the conduct of effective programs. ID physicians with responsibility for leading programs are encouraged to develop skills in these areas. Typical responsibilities of ID physicians who lead AMS programs are shown in Box 8.1.

Principal Referral Hospitals and Acute Group A Hospitals should consider having at least one ID physician (or clinical microbiologist) on site to participate in AMS activities.

Box 8.1: Responsibilities of a lead infectious diseases physician

The infectious diseases physician's responsibilities in leading an antimicrobial stewardship (AMS) program include:

- Coordinating the development of an implementation plan for the AMS program that
  - responds to the requirements for AMS of the National Safety and Quality Health Service Preventing and Controlling Healthcare-Associated Infection Standard*
  - incorporates the Antimicrobial Stewardship Clinical Care Standard
- Working with the AMS committee to set up and evaluate program goals
- Establishing and maintaining the AMS committee and/or team
- Integrating the functions of the AMS committee and/or team with those of the drug and therapeutics committee, and the infection prevention and control committee
- Coordinating the analysis and reporting of antimicrobial use data
- Recommending audits of prescribing and clinical indicators
- Ensuring the availability of a process of feedback on antimicrobial prescribing to prescribers and the AMS committee and/or team
- Advising on workforce education programs on AMS and antimicrobial prescribing
- Identifying responsibility for
  - developing, implementing and maintaining prescribing policies (including antimicrobial formulary and restrictions), guidelines and clinical pathways
  - collecting and reporting data on antimicrobial use and quality improvement measures
  - resourcing the above activities
- Reporting on the effectiveness of the AMS program to the organisation's clinical governance unit.

* For relevant health service organisations
Source: Adapted from Nathwani et al.[2]

Smaller hospitals employing a part-time ID physician can achieve improved antimicrobial prescribing and significant antimicrobial cost savings when the ID physician works alongside a clinical pharmacist to review prescribing and provide feedback.[3,12-14] In addition to a 42% decrease in antimicrobial expenditure, Day et al. reported improved susceptibility in *Pseudomonas aeruginosa* over three years following the introduction of a weekly review with feedback.[13]

8.2.1 Participating in the antimicrobial stewardship team and committees

International guidelines recommend that an ID physician be a core member of the hospital multidisciplinary AMS team, along with a clinical pharmacist with ID training.[1,3,15,16] (See also Chapter 2: 'Establishing and sustaining an antimicrobial stewardship program'.)

ID physicians play key roles in AMS team reviews of patients who are prescribed highly restricted antimicrobials and in AMS ward rounds (see Section 2.4 in Chapter 2: 'Establishing and sustaining an antimicrobial stewardship program').

Large health service organisations may also have an AMS committee to oversee the implementation and ongoing function of the AMS program. The committee may be organised at the hospital level or at the Local Hospital Network (LHN)/Local Health District (LHD) level, and include at least one ID physician or a clinical microbiologist who may also act as the chair of the committee. ID physicians may also be involved in state, territory or national AMS committees.

8.2.2 Implementing and maintaining antimicrobial policies and guidelines

ID physicians have an important role in the development, implementation, review and audit of antimicrobial policies, prescribing guidelines, clinical pathways and bundles of care. This input is necessary to ensure that prescribing guidelines, restriction policies and other activities are based on the best evidence, and that patients are not placed at risk.[1]

Clinical guidelines developed for local use should accord with national guidelines, such as *Therapeutic Guidelines: Antibiotic*.[17] In conjunction with the AMS team, an ID physician should establish whether there is enough evidence to vary from national guidelines and advise on any changes, taking into account local antibiograms and antimicrobial resistance (AMR) patterns. ID physicians should take an active role in developing and reviewing antimicrobial policy and guidelines.

Noncompliance with prescribing guidelines is common. Barriers to appropriate guideline use by prescribers have been identified and need to be considered as part of the local implementation plan for introducing prescribing guidelines.[18] The collaboration of prescribers with ID and microbiology departments as part of AMS programs has been cited as a facilitator of compliance with AMS policy.[19]

Successful policy and guideline implementation requires the support of motivated individuals to enable change[20], and research has shown that clinicians are more likely to follow a policy that is supported by their ID colleagues.[6,21] ID physicians should take an active role in planning and executing the guideline implementation plan. Buy-in from senior clinicians is critical, and the ID physician should actively engage with senior clinicians to gain support for new guidelines, clinical pathways and treatment algorithms. Along with other members of the AMS team, the ID physician should promote the antimicrobial prescribing guidelines and educate the workforce about them (see Section 3.2 in Chapter 3: 'Strategies and tools for antimicrobial stewardship'). Guidelines and clinical pathways need to be regularly reviewed by the AMS team. The frequency of review may be routinely over a two-year cycle, or sooner if there have been major changes in protocols or new information about emergent antimicrobial resistance becomes available.[2] If local guidelines are developed, they need to be consistent with the latest version of *Therapeutic Guidelines: Antibiotic*[17], and local microbiology and AMR patterns. This requires the input of ID physicians and/or clinical microbiologists.

8.3 Expert advice

Many studies highlight the contribution of ID physician consultations to improved patient outcomes, including reduced mortality, morbidity and cost of care for patients.[4,22-27] The literature suggests that, when an ID physician is involved in patient care, there are improvements in diagnosis and treatment, and fewer relapses.[22,23,25] Improvements in patient outcomes associated with ID physician interventions have been reported for a broad ranges of ID diagnoses.[25] For example, ID intervention has reduced the 28-day mortality rate for *Staphylococcus aureus* bacteraemia.[4,22-24,27] Filice and Abraham concluded that treatment outcomes would be substantially improved if ID physicians were involved in all cases of *S. aureus* bacteraemia.[23]

ID consultations often result in changes to antimicrobial therapy, such as de-escalation to less expensive or narrow-spectrum agents, or the cessation of all antimicrobials.[27-29] In one point prevalence survey of antimicrobials used in Australian paediatric hospitals, Osowicki et al. found that inappropriate prescribing was significantly more common when there was no ID consultation. This was especially true for overprescribing, and for inappropriate choice of agent and application (dose, frequency or route of administration).[30]

The advice of an ID physician should be sought about:

- The initiation, de-escalation and cessation of antimicrobial therapy for individual patients (this can occur during AMS rounds)
- The need for therapeutic drug monitoring to maximise clinical activity and minimise adverse events caused by antimicrobial therapy
- Adjustment in the dose, frequency and route of antimicrobial administration in specific clinical situations (for example, management of sepsis and neutropenia) and specific patient groups (for example, neonates).

ID physicians can also play an important role in interpreting antibiograms and trends in AMR at local and national levels.

8.3.1 Specific situations requiring infectious diseases physician expertise

Specific situations in which the expertise of ID physicians may be required have been identified.

Specific infections

Early involvement of the ID physician can improve antimicrobial management (including choice of antimicrobial, dose, duration and assessment of response) for a range of infections. Examples of infections commonly recommended for ID consultation include infective spinal discitis or osteomyelitis, infected joint replacements, bacterial meningitis, infective endocarditis, *Staphylococcus aureus* bacteraemia, candidaemia, fever of unknown origin, febrile neutropenia in immunocompromised patients, and severe sepsis or septic shock.

Antimicrobial allergies

Penicillin allergy is the most common drug allergy and is reported in 5–10% of patients admitted to hospital.

Only 10–20% of patients labelled as having a penicillin allergy have a positive reaction to penicillin skin testing.[31] Patients labelled as having a penicillin allergy receive broader-spectrum, suboptimal and more toxic antimicrobial agents, and this is associated with increased AMR, cost, length of stay and mortality.[32-35]

Structured allergy assessments that include penicillin skin testing and oral challenge can be used to accurately de-label those patients who do not have a true penicillin allergy.[31,36,37]

An ID physician can advise on a procedure for improving the management of patients who report an antimicrobial allergy. This should include[38]:

- Obtaining and documenting an accurate and detailed history of the antimicrobial allergy by the AMS team (to differentiate immunological and non-immunological adverse drug reactions)
- Consulting with a provider experienced in performing and interpreting penicillin skin testing, unless the patient has a history of severe non–IgE mediated reaction (for example, toxic epidermal necrolysis or Stevens–Johnson syndrome)[37]
- Recommending antimicrobial rechallenge when allergy documentation reflects pharmacologically predictable side effects or mild non–IgE mediated drug reactions[39]
- Advising on appropriate alternative therapy for the management of infections in patients with true β-lactam allergy[40]
- Advising on desensitisation regimens to induce temporary tolerance in patients with true IgE-mediated reactions when no acceptable alternative antimicrobial is available.[41]

Using structured allergy assessments with penicillin skin testing to accurately de-label patients without a true penicillin allergy has been shown to decrease the use of certain antimicrobials (including vancomycin and fluoroquinolones) with no significant adverse reactions in patients, as well as to reduce the length of hospital stay and the costs associated with patient care.[31,38,42] Rimawi et al. reported an annual saving of US$82,000 using skin testing to guide antimicrobial therapy.[43] Such testing should be undertaken by experienced clinicians. In the absence of immunology support, available personnel (including physicians and pharmacists, when adequately trained) can implement penicillin skin testing.

The Infectious Diseases Society of America recommends incorporating antimicrobial allergy testing of patients into AMS programs to increase the use of first-line agents.[37] A partnership between ID physicians, pharmacists and allergists/clinical immunologists is proposed as a preferred approach for antimicrobial allergy care that would enable antimicrobial allergy testing to be targeted to those requiring it.[36] A model for an integrated AMS and antimicrobial allergy de-labelling program has been described.[31]

Intensive care

AMR has emerged as one of the most important problems affecting the care and outcomes of patients in intensive care units (ICUs).[44]

The management of antimicrobial therapy in ICUs is challenging, and this area should be a focus for AMS in hospitals. ICU patients are highly susceptible to infections due to a number of factors, including their underlying illness, the use of diagnostic and therapeutic procedures that may be immunosuppressive, and the insertion of devices such as central venous catheters and endotracheal tubes for mechanical ventilation. Life-threatening infections such as bacteraemia and pneumonia predominate, and may be the reason for the ICU admission.[45] ICUs have the heaviest burden of antimicrobial use in the hospital[46] and, because of the need for early treatment of sepsis, use is often empirical. A further challenge is the complexity of the pharmacokinetics of antimicrobials in ICU patients with altered volumes of distribution and clearance (for example, those with sepsis, on dialysis or receiving extracorporeal membrane oxygenation).

Infections in ICU patients are increasingly caused by multidrug-resistant and extensively drug-resistant organisms, and the management of these infections requires a good knowledge of the local epidemiology. Effective treatment requires an understanding of the likely effect of critical illness and sepsis on pharmacokinetics in order to determine appropriate dosing, especially for β-lactam antibiotics, for which continuous infusion may be employed.[47]

ID physicians have expert knowledge of the local epidemiology. They can contribute to the management of severely septic patients by using known susceptibility data for the causative organism, in combination with the patient's clinical status, to advise on the most appropriate agent, dose and dosing schedule. They can also advise on when to cease treatment or de-escalate therapy.[48] This advice can be provided as part of a consultation on an individual patient or during a regular AMS round. Box 8.2 provides some examples of outcomes achieved when ID physicians participate in ICU rounds.

8.3.2 Support for external organisations

ID physicians may have roles specific to individual hospitals, or may perform network-wide roles.

Hospitals

Smaller metropolitan hospitals, private hospitals, and rural and remote hospitals may engage ID physician support to:

- Provide clinical advice for the management of individual patients or specific issues
- Assist with setting up AMS programs
- Act as the administrators of an antimicrobial approval system.

This expertise may be provided through formalised arrangements such as contracting or networked arrangements, outreach arrangements from an established ID department, or other LHN/LHD arrangements. This may be part of a telehealth service model (see also Chapter 3: 'Strategies and tools for antimicrobial stewardship' and Chapter 4: 'Information technology to support antimicrobial stewardship').

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Box 8.2: Examples of outcomes when infectious diseases physicians participate in intensive care rounds

Rimawi et al. described an intervention in a large tertiary university teaching hospital where, in addition to an existing antimicrobial stewardship (AMS) pharmacist, an infectious diseases (ID) fellow commenced daily AMS rounds with the intensivist and critical care fellows.[49] Recommendations included antimicrobial cessation, directed therapy based on culture results, conversion to oral therapy and alteration of duration; 81% of recommendations made were followed. Outcomes included a significant decrease in overall antimicrobial use, a decrease in broad-spectrum agent use, an increase in narrow-spectrum agent use, and cost savings with no associated change in all-cause intensive care unit (ICU) mortality. The authors concluded that daily communication between ID and critical care clinicians on an AMS round provides further benefits to those provided by a dedicated AMS pharmacist.

DiazGranados also described the impact of an ID physician participating in multidisciplinary ICU rounds three times a week to provide feedback on infection management and antimicrobial use.[50] Emergence of antimicrobial resistances was significantly less frequent during the intervention (17% versus 31% at baseline), and rates of selection of appropriate antimicrobials were significantly higher during the intervention than at baseline (82% versus 70%).

Formalised lines of reporting and accountability for advice given by the ID physician are required. This might be achieved through contracts, protocols, policies and other formal agreements. These arrangements should cover:

- ID physician oversight of the patient's progress
- Online access to pathology and radiology results, and other resources required to optimise advice
- Method of communication, including access to documentation, such as emails, and other information technology (IT) tools, to ensure that recommendations are clear and misinterpretation is avoided
- Requirements for appropriate documentation and secure communication systems to ensure patient confidentiality.

Primary Health Networks

Objective 2 of the National Antimicrobial Resistance Strategy calls for effective AMS practices to be implemented across human health and animal care settings. Primary Health Networks are well placed to support the implementation of AMS in general practice.[51] Such initiatives may seek the involvement of ID physicians to advise on AMS strategies and provide expert advice.

Dental services

As AMS becomes more established in dental practices, professional collaboration will be needed between dental practitioners, pharmacists, medical practitioners and ID specialists to improve prescriber knowledge, understand antimicrobial usage patterns and provide pathways to seek advice in difficult situations.

8.4 Support for formularies and approval systems

Restricting the use of antimicrobials through a formulary system with pre- or post-prescription approval is considered an essential component of any hospital AMS program (see Section 3.3 in Chapter 3: 'Strategies and tools for antimicrobial stewardship'). ID physicians have an important role to play in developing a restricted formulary and managing the approval process. Health service organisations without an on-site ID physician need to consider arrangements for these services.

8.4.1 Formularies

ID physicians play an important role in developing and maintaining the antimicrobial section of the organisation's formulary and the list of restricted antimicrobials (see Section 3.3 in Chapter 3: 'Strategies and tools for antimicrobial stewardship'). It is important that formulary decisions are informed by local microbiology and resistance data. ID physicians should participate in hospital drug and therapeutics committee procedures for listing antimicrobials on the formulary, including:

- Evaluating requests for new antimicrobials
- Extending indications for existing products
- Recommending products that should be restricted
- Defining the criteria for prescribing restricted products.

This involvement can be achieved through either direct membership of the drug and therapeutics committee or liaison between the committee and the ID department or AMS team. An ID physician should also participate in a regular review of the antimicrobial formulary using facility-specific data on antimicrobial susceptibility to guide decisions.

8.4.2 Approval systems

To be effective, antimicrobial approval systems require close collaboration across the multidisciplinary AMS team, especially between the ID physicians (or clinical microbiologists) and the pharmacy service.

It is well accepted that ID physicians (or clinical microbiologists) should be directly involved in the approval process (see Section 3.3 in Chapter 3: 'Strategies and tools for antimicrobial stewardship').[5] However, barriers to involvement have been identified, including the time involved in the approval process. To assist in these processes, electronic approval systems may be used, or the approval process may be delegated to ID fellows or clinical pharmacists (with referral to an ID physician for expert advice).[1,52,53]

Requests for antimicrobial approvals provide opportunities to educate prescribers.[5] For example, when a verbal approval is sought by a prescriber, the ID physician has the opportunity to provide management advice and guidance about antimicrobial prescribing.[21,54] This includes advising on what is best for the patient, providing antimicrobial advice that reflects known or predicted antimicrobial susceptibilities, and considering the future need for antimicrobials. Importantly, ID physician advice does not need to be limited to antimicrobials – it may include suggestions for other appropriate investigations or debulking of infection, or recommending no antimicrobial therapy.

Medical staff in an Australian teaching hospital reported that the advice provided by an approval system managed by the ID department was useful and educational.[21] Sunenshine et al. reported similar findings in their survey of ID physicians in the United States.[5] Most prescribers in the Australian study believed that the advice improved patient outcomes.[21] Concerns that electronic antimicrobial approval systems, such as web-based systems, would reduce personal communication and educational opportunities have been unfounded, and these systems have been shown to enable communication and education while saving ID physicians' time.[52,53] (See Section 4.2.2 in Chapter 4: 'Information technology to support antimicrobial stewardship'.)

8.5 Prescription review with feedback

A key role for ID physicians is reviewing local prescribing practices and providing feedback. Review and feedback strategies are especially important in streamlining antimicrobial therapy.[1] ID physicians have an important role in delivering this and other point-of-care interventions (see Section 3.5 in Chapter 3: 'Strategies and tools for antimicrobial stewardship').

8.5.1 Antimicrobial stewardship team rounds

AMS team rounds provide the opportunity for ID physicians to discuss therapeutic options and promote optimal antimicrobial prescribing with the treating clinician at the bedside.[55-57] This may include advice about:

- The appropriateness, dose and frequency, route of administration, and duration of the antimicrobial therapy
- Recommendations for further investigations
- Interpretation of results
- The need to seek further advice from other specialties.

(See Section 3.4 in Chapter 3: 'Strategies and tools for antimicrobial stewardship'.)

Electronic clinical surveillance systems and other technologies are increasingly being used to identify patients requiring review by the AMS team through techniques such as data mining of healthcare records and automatic electronic alerts (see also Section 4.2.3 in Chapter 4: 'Information technology to support antimicrobial stewardship').[57-59] These systems can support the ID physician to prioritise patients for review. Smith et al.[57] described the institution of daily (Monday–Friday) AMS rounds in a community hospital at which identification of inappropriate prescribing was done through data mining of a newly introduced electronic healthcare record. The program demonstrated a return on investment of 7:1 despite a marked investment in software and the recruitment of one full-time equivalent (FTE) pharmacist and a 0.3 FTE ID physician.

ICUs, dialysis units, oncology wards and bone marrow transplant wards are some of the main areas associated with inappropriate antimicrobial treatment[60], which AMS team rounds could focus on. At a minimum, ICU patients should have their therapy reviewed by an AMS team that includes an ID physician (see Intensive care). The NSW Clinical Excellence Commission has published an information sheet on establishing an antimicrobial liaison round in ICUs.

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In rural and remote hospitals, ICU rounds can be supported by telehealth services with the on-duty intensivist and an off-site ID physician. A pharmacist can assist in these rounds by assembling a list of the antimicrobials, doses and start dates for each patient before the round. (See Section 3.4 in Chapter 3: 'Strategies and tools for antimicrobial stewardship'.)

8.5.2 Conflicting advice

Antimicrobial prescribing practices may vary among ID physicians, which can lead to treatment recommendations for individual patients that differ from that of the AMS team, potentially causing professional friction and confusion for the primary clinician.[7] Three options have been described for the AMS team in hospitals with an ID department[9]:

- Patients who have received an ID physician consultation are not reassessed
- Review these patients, discuss any recommendations that differ from the AMS team's view with the ID physician, and come to an agreement
- Review these patients and submit an independent AMS team recommendation.

Yeo et al. described the outcomes of differing treatment recommendations in a large tertiary university hospital where ID physicians and the AMS team provided independent assessments and recommendations.[7] Nineteen per cent of patients had differing recommendations. In most of those cases, ID physicians generally recommended continuation of broad-spectrum antibiotics rather than de-escalation, longer duration of antibiotics or combination antibiotics (particularly for *Pseudomonas aeruginosa* infections). Acceptance of either ID physician or AMS team recommendations was not associated with differences in 30-day mortality or readmission rates, although clinical deterioration rates were lower in patients for whom AMS team recommendations were accepted. The authors of the study noted that the approach of an independent AMS team review of patients who have received an ID physician consultation could be complementary and not result in professional conflict between the two groups, provided there is good communication. Early discussion between ID physicians and AMS teams in circumstances where prescribing advice varies may reduce the number of conflicting recommendations.

8.6 Monitoring antimicrobial use and evaluating interventions

Continuous surveillance of antimicrobial use is an essential component of AMS programs. ID physicians have an important role in establishing and evaluating systems for monitoring the overall volume and quality of antimicrobial use in their organisation, and in the collection and use of data for quality improvement (QI). This includes participating in or advising the AMS committee or team about the measures to include in the AMS program (see Chapter 6: 'Measuring performance and evaluating antimicrobial stewardship programs'). Box 8.3 shows the role of ID physicians in monitoring and evaluating antimicrobial use.

The data produced can be used to assess trends in use, such as areas of high use, and identify areas for more in-depth review of use (for example, a drug use evaluation study). This analysis can assist in scoping activities to include in the AMS program and evaluating whether there is any improvement.

ID physicians should also liaise with the AMS pharmacist to coordinate the participation of the hospital in state or national antimicrobial surveillance systems, such as the National Antimicrobial Utilisation Surveillance Program. ID physicians can help interpret the data and advise on local use. When analysing the data, ID physicians need to be aware of some of the limitations of using defined daily dose per occupied bed day as a measure of use. These limitations include a bias against combination therapy, failure to account for situations in which larger or smaller individual doses may be required, and unsuitability of the measure for paediatric settings[61] (also see Section 6.7.1 in

Box 8.3: Role of infectious diseases physicians in monitoring and evaluating antimicrobial use

The role of infectious diseases physicians in monitoring and evaluating antimicrobial use includes:

- Advising the antimicrobial stewardship (AMS) committee or team about which indicators to monitor (including structure, process, outcome and balancing measures)
- Monitoring data on quantity and quality of antimicrobial use provided through surveillance programs such as the National Antimicrobial Utilisation Surveillance Program, the National Antimicrobial Prescribing Survey (NAPS) and the Surgical NAPS
- Advising the AMS committee or team about the areas to target for review, or studies to evaluate antimicrobial use
- Assisting in analysing results
- Participating in determining the appropriateness of antimicrobial prescribing – for example, through quality audits or point prevalence surveys
- Helping to produce reports and recommendations for drug and therapeutics, infection control and prevention, medication safety, and health service safety and quality committees.

Chapter 6: 'Measuring performance and evaluating antimicrobial stewardship programs').

Auditing the quality of prescribing and compliance with prescribing guidelines, and providing feedback to prescribers are important steps in the QI cycle. They are also an important strategy for promoting the use of guidelines and clinical pathways, and influencing prescribing.[2,3,62] QI audits can also identify whether implementation strategies are effective or whether different approaches are needed (see Section 6.8.3 in Chapter 6: 'Measuring performance and evaluating antimicrobial stewardship programs'). ID physicians should be involved in audits of the appropriateness of prescribing, such as the various National Antimicrobial Prescribing Survey audits, including the prescribing of surgical prophylaxis.

8.7 Liaison

ID physicians are required to liaise within and between different groups in the organisation, and with external providers such as pharmaceutical companies.

8.7.1 Liaison within hospitals

Effective AMS programs require collaboration between the ID department and other departments and committees, including:

- Clinical departments – developing and implementing policies and guidelines, and providing education and feedback on results of audits and drug usage evaluation studies
- Pharmacy workforce – managing restricted formulary and approval systems, and providing expert advice and support for other AMS interventions; this may include consultation when a conflict arises[1], but should also include regular and free communication and cooperation[16]
- Infection prevention and control workforce – taking a leadership role in the management of the hospital's infection control and prevention program; this provides the ideal opportunity for AMS activities to enhance infection control practices in the control of outbreaks of resistant organisms
- Immunology workforce – working with the immunology workforce to set up a referral system for diagnosing, skin testing or desensitising patients with a history of antimicrobial allergy
- IT workforce (see also Section 4.2 in Chapter 4: 'Information technology to support antimicrobial stewardship') – working with the IT workforce tasked with implementing electronic clinical decision support systems for AMS activities; this could include advising on
  - alerts within electronic healthcare records or clinical decision support software systems to target inappropriate prescribing (such as microbe–antimicrobial mismatch, infection unlikely, inappropriate double coverage, inappropriate dosage), and to identify opportunities to improve antimicrobial use (such as de-escalation and intravenous-to-oral switching)
  - content of order sets
  - electronic surveillance and infection prevention systems
  - access to, and content of, guideline recommendations and treatment algorithms
  - development of electronic approval systems, ensuring that they link to local and national therapeutic guidelines.

8.7.2 Interacting with the pharmaceutical industry

Studies of interactions between the clinical workforce and the pharmaceutical industry confirm that those interactions can increase requests for additions to formularies (even when the proposed addition has no therapeutic advantage over existing formulary drugs) and can affect prescribing practices.[63-65] These findings highlight the importance of educating prescribers about the influence of pharmaceutical industry relationships and sponsorship on prescribing behaviour.

ID physicians should be involved in providing this education at undergraduate and postgraduate levels. ID physicians themselves need to exercise caution in their interactions with pharmaceutical companies and their representatives. They should actively support the development and implementation of hospital policies that restrict workforce access to pharmaceutical representatives, and support the adoption of conflict-of-interest guidelines developed by professional societies or colleges. These guidelines should be incorporated into hospital policy and training programs. (See also Section 5.2.4 in Chapter 5: 'Antimicrobial stewardship education for clinicians'.)

8.8 Role in education

One of the primary roles of the ID physician is that of educator. This can be performed as part of a multidisciplinary program in hospitals[2] through presentations at grand rounds, or as part of an intervention (for example, during the approval process, or as feedback following a review of antimicrobial prescribing) (see also Chapter 5: 'Antimicrobial stewardship education for clinicians').[4]

ID physicians, especially ID registrars, can make a major contribution to the development of education and its delivery to the workforce. ID registrars are often primarily responsible for providing advice and antimicrobial approvals to other specialties, sometimes to more senior clinicians. They need to have the training to understand the rationale for AMS, and to prescribe and recommend treatment according to guidelines. Early in ID registrars' training, it is useful for an ID physician to review the antimicrobial approvals provided by the registrar and discuss possible choices. Basic skills that should be developed during training include:

- Knowledge of local and national guidelines
- Provision of evidence-based advice
- Interpersonal skills and appropriate delivery of advice
- Involvement of, and escalation to, consultant level to diffuse conflict situations.

ID physicians who are interested in leading AMS programs are encouraged to develop the knowledge and skills required to build, lead and evaluate an AMS program.

Antibiotic Awareness Week, held in November each year, provides a good opportunity for ID physicians to be at the forefront of activities to promote AMS, and educate the workforce and the community about AMR and AMS.

Resources

- NSW Clinical Excellence Commission: information sheet on establishing an antimicrobial liaison round in ICUs
- NSW Clinical Excellence Commission: antibiotic communication tool

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AUSTRALIAN COMMISSION ON SAFETY AND QUALITY IN HEALTH CARE

9 Role of the clinical microbiology service in antimicrobial stewardship

Antimicrobial Stewardship in Australian Health Care

2018

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Acronyms and abbreviations

Abbreviation	Definition
AMR	antimicrobial resistance
AMS	antimicrobial stewardship
AURA	Antimicrobial Use and Resistance in Australia
CAR	critical antimicrobial resistance
CLSI	Clinical and Laboratory Standards Institute
CMS	clinical microbiology service
CPE	carbapenemase-producing Enterobacteriaceae
EUCAST	European Committee on Antimicrobial Susceptibility Testing
ID	infectious diseases

Key points

- The clinical microbiology service (CMS) provides a vital function in laboratory diagnosis of infections, which supports effective patient management.
- The laboratory diagnostic process involves test ordering, specimen collection, laboratory testing, and interpretation and communication of the result. The systematic application of best practice is needed at each of these stages to optimise patient care and antimicrobial use.
- Formalised processes should be in place to ensure appropriate clinical specimen collection and testing, to ensure the accuracy and quality of diagnostic testing, and timely reporting with comments that assist in interpretation.
- The CMS also plays system-wide roles in antimicrobial stewardship, including in the surveillance of antimicrobial resistance (AMR), advice on infection control issues, therapeutic drug monitoring and workforce education.
- The CMS provides input to the reporting of AMR through surveillance programs such as Antimicrobial Use and Resistance in Australia and the National Alert System for Critical Antimicrobial Resistances.

9.1 Introduction

Microbiology testing is a key component of antimicrobial stewardship (AMS).[1] The clinical microbiology service (CMS) performs the combined role of patient-specific diagnostic testing to guide direct patient care, and system-wide diagnostic stewardship, surveillance of resistant organisms and outbreak investigation.

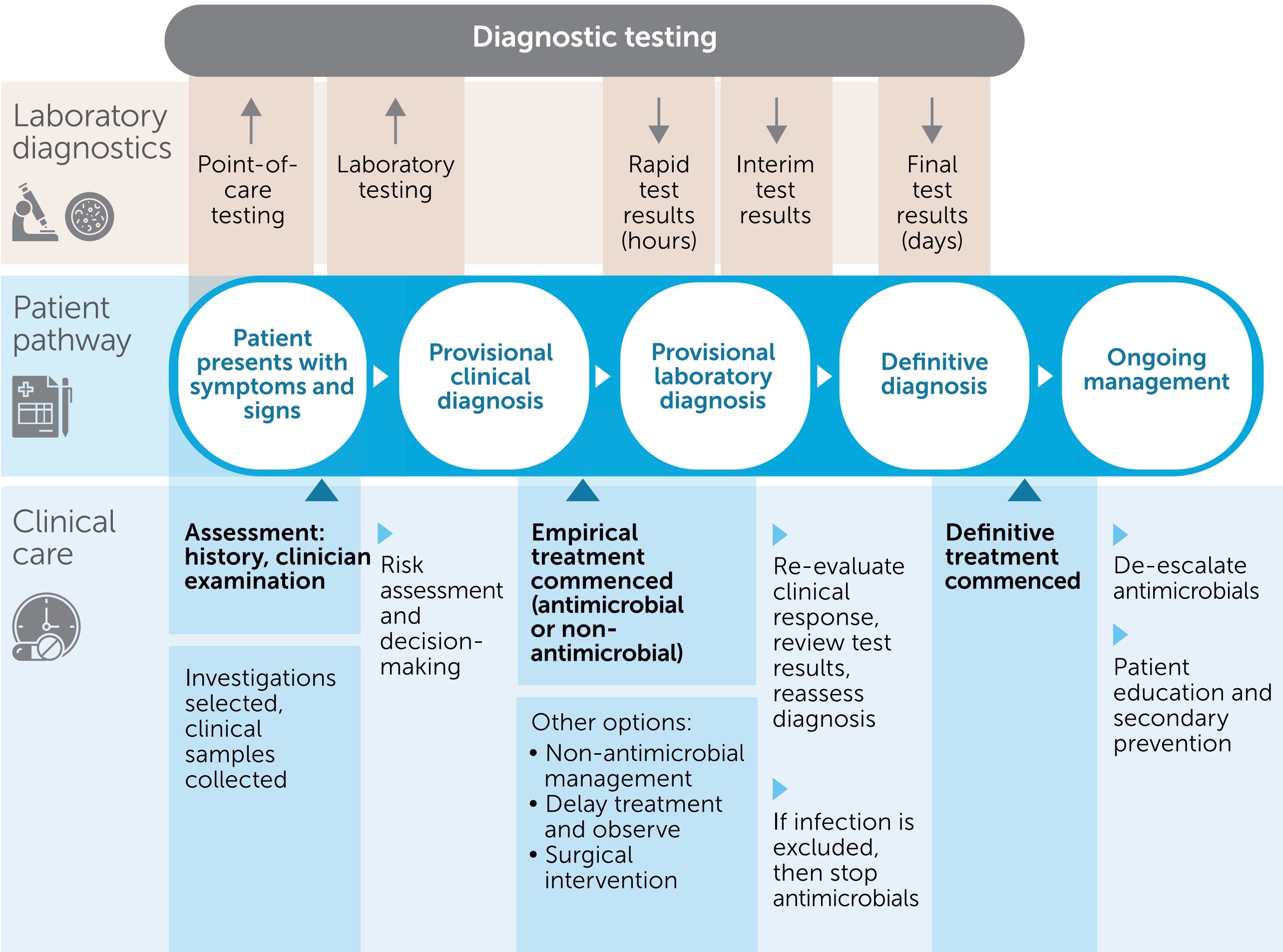
9.2 Overview of the diagnostic testing process

The CMS provides laboratory testing to support a provisional clinical diagnosis of infection, and to guide empirical and directed antimicrobial therapy. Diagnostic error is a contributor to suboptimal antimicrobial prescribing[2], and improved use of microbiology laboratory tests has been associated with better prescribing.[3] The 2015 Australian National Antimicrobial Prescribing Survey found that 12.4% of all antimicrobials were prescribed based on laboratory evidence of infection.[4] The CMS is able to contribute to AMS as part of the multidisciplinary team working to improve the use of testing to better inform treatment.

Figure 9.1 shows the process of laboratory testing as part of an episode of care. Microbiology testing involves different elements that are available sequentially as they are completed. Results from direct examination of a specimen are typically available within hours, the preliminary culture result within 24–48 hours, and the final result that includes the antimicrobial susceptibility information afterwards.[5] The timing of the result release is not always predictable, which may complicate diagnosis and antimicrobial treatment decisions.[3,6]

Figure 9.1 shows that diagnosis and management are dynamic processes that are complemented by an understanding of the time course of the disease and testing.[7] When there is a strong clinical indication to start treatment early, empirical treatment is started based on a provisional diagnosis and immediately after collecting appropriate specimens. Treatment is later modified depending on the patient's progress and the results of investigations. This can occur, for example, in patients with suspected sepsis who may not necessarily present as being acutely unwell but need urgent management.[6] If the clinical problem is subacute or chronic, treatment can be deferred until after a microbiological diagnosis has been established, although it is usually not. This is especially important for conditions that may require prolonged therapy, such as chronic osteomyelitis, septic arthritis or infected prosthetic material. AMS best practice for hospitalised patients requires that there is at least a daily review of clinical progress,

Figure 9.1: Role of diagnostic testing across the diagnostic continuum



new results of investigations and antimicrobial treatment plans.

The laboratory diagnostic process has three phases[8]:

- Pre-analytical phase – comprising test selection and ordering, and specimen collection and transport
- Analytical phase – comprising specimen processing and analysis
- Post-analytical phase – ensuring that results are delivered and read, and that the appropriate action is taken based on correct interpretation of the results; the post-analytical components of diagnostic testing are often overlooked, but their neglect can contribute to suboptimal clinical care[9] and antimicrobial misuse.

9.3 Pre-analytical phase: microbiology process

In the pre-analytical phase of diagnosis, the CMS supports practices that ensure that the right tests are performed on appropriately collected clinical samples. The CMS also helps to ensure that communication with, and delivery to, the laboratory is optimised to influence clinical care. This role also includes efforts to avoid testing when it is not clinically appropriate.

9.3.1 Selecting diagnostic tests

Culture-based tests are the principal investigations used to diagnose and guide treatment for most bacterial infections that are treated with antimicrobials. Midstream urine culture is the most frequently used microbiology test in Australia (see Box 9.1); Medicare data from 2017 indicated that more than 4.7 million tests were undertaken.[10]

Box 9.1: Urine examination and antimicrobial stewardship

Midstream urine (MSU) microscopy, culture and susceptibility (m/c/s) tests enable effective targeting of antimicrobial treatment for urinary tract infections, or may provide negative diagnostic evidence that prompts consideration of alternative diagnoses. Urine is not intrinsically sterile – the prevalence of asymptomatic bacteriuria in the healthy population ranges from 1% to 15%.[11] Requesting MSU m/c/s testing without a clear clinical indication is strongly discouraged, as it may lead to overdiagnosis and misuse of antibiotics. Failure to correctly interpret the result and correlate it to the clinical situation contributes significantly to antimicrobial misuse.[12-14]

In the absence of urinary tract symptoms, the MSU m/c/s result should not be used to diagnose urinary tract infection. MSU m/c/s testing is recommended in all cases of upper or complicated urinary tract infections.[15]

MSU m/c/s testing should consider pre-analytical factors that can affect urine culture results, including collection methods, time from collection to processing, and methods to reduce overgrowth associated with delays in transport and processing (such as boric acid or refrigeration).[16] The clinical microbiology service, in collaboration with the clinical workforce, can play a key role in ensuring that urine cultures are ordered only when appropriate, collection is optimised, and results are reported clearly to aid interpretation.

All elements of the test report, especially the white cell and epithelial cell counts, and the patient's clinical signs are used when making patient management decisions. The final result is a combination of results from biochemical tests, cell counts, quantitative culture and antimicrobial susceptibility testing. Antimicrobial susceptibilities should be reported in keeping with prescribing guidelines.[12,15,17]

Potential antimicrobial stewardship strategies relating to urinary tract infections include:

- Not performing urine cultures unless there are signs or symptoms of infection[18]
- Recommending non-antibiotic management of urinary tract infection in women with mild to moderate symptoms, or when testing is performed on patients with urinary catheters[16,19-23]
- Withholding antimicrobial susceptibility results for culture-positive urine samples from non-catheterised patients as a default, with an explanation that most of these results represent asymptomatic bacteriuria.[24]

The other commonly ordered tests are cultures of blood, wound, genital and sputum samples. Additional information about blood cultures and AMS is in Box 9.2.

Non-culture-based tests using molecular and immunology methods make up the remaining suite of microbiology tests used in clinical care. Such tests are commonplace for detecting sexually transmissible infection.

Irrespective of the test method, a positive microbiology diagnostic test is used to confirm a provisional clinical diagnosis, and the antimicrobial susceptibility results guide targeted antimicrobial management. Negative tests, from optimally collected clinical samples, may suggest that a diagnosis can be excluded and provide evidence that antimicrobial therapy is not indicated.

Tests for acute-phase reactants (for example, C-reactive protein and procalcitonin) may be used in a complementary role. They can indicate the possibility of an infectious aetiology in acute clinical syndromes before microbiological results are available or when culture-based tests are not feasible. It should be appreciated that these tests are non-specific, and their value is limited in guiding decision-making. Despite widespread use, the published evidence for their effectiveness has been limited to a range of specific scenarios. For example, these tests have been demonstrated to be useful in suggesting a bacterial aetiology in adults with acute respiratory disease presenting to emergency departments.[25,26] Serial procalcitonin measurements

Box 9.2: Sepsis and detection of bacteraemia or fungaemia, and antimicrobacterial stewardship

The detection of pathogens involved in bloodstream infection is one of the most important diagnostic tests performed by the clinical microbiology service.[5,27] Microbiological diagnosis of bloodstream infection may confirm or alter the provisional clinical diagnosis and guide definitive antimicrobial treatment, with potential impacts on mortality, morbidity, antimicrobial use, length of stay in hospital and healthcare expenses. With regard to antimicrobial stewardship (AMS), blood culture results may determine whether empirical therapy is appropriate by detecting unsuspected antimicrobial resistance, or enable switching from broad-spectrum agents to targeted choices. Negative results for optimally collected specimens can guide cessation of empirical therapy.[3,28] In the case of positive blood cultures, the organism identified may indicate the source of infection, and that information can guide non-antimicrobial treatment and overall management.

Indications for the collection of blood cultures require careful consideration.[29-31] Poorly collected blood cultures can lead to false positive or false negative results that may compound diagnostic uncertainty. This may prompt unnecessary empirical therapy and prolonged hospitalisation.[32] The collection process should ensure appropriate asepsis to reduce contamination, adequate sample volumes, and multiple sets to provide adequate sensitivity.[33-35]

Rapid blood culture analytical methods, both phenotypic and molecular, have been demonstrated to reduce the time to targeted antimicrobial therapy and to reduce mortality. This is especially true if the results are directly communicated to the clinician or via the AMS team.[36,37]

in intensive care patients treated with antimicrobials may also provide a useful guide to the timing of de-escalation or cessation of antimicrobial therapy. In essence, tests for acute-phase reactants should be used sparingly and interpreted with caution when managing infectious diseases.[38-40]

Optimal selection of diagnostic microbiology tests is critical to providing reliable guidance to clinicians who are managing patients with possible infection.[41] The type of test selected depends on the timing of presentation and the type of organisms suspected to be causing the infection. The decision to order a diagnostic test should be based on the pre-test probability of suspected infection, taking into consideration that potential pathogens may be present as part of the normal flora. Syndrome-specific diagnostic algorithms – for example, the United Kingdom Standards for Microbiology Investigations[42] – and integrated clinical pathways[6] may be useful for guiding test selection. Computerised pathology ordering systems that require better specimen description, structured clinical notes or nominated indications for testing are recommended.[43] Applications for mobile devices to guide test selection are also available[1,44] (see Chapter 4: 'Information technology to support antimicrobial stewardship').

The following general principles apply to selecting diagnostic tests:

- Avoid diagnostic testing of patients who are asymptomatic or where the likelihood of infection is low (for example, cultures of wounds without signs of infection[45])
- Provide guidelines and specifications of minimum requirements for microbiological investigations for common syndromes that require hospital admission (for example, complicated urinary tract infection, severe skin and soft tissue infection, pneumonia, acute osteomyelitis, septic arthritis and endocarditis).[46]

9.3.2 Collecting and transporting samples

Optimal specimen collection and transport are critical elements of the testing process.[5,47,48] Most samples submitted for testing are collected by the frontline clinical workforce, but the patient may self-collect urine, sputum and faeces samples. Packaged collection kits and training collection staff to optimise blood culture collection have been shown to reduce contamination and provide better samples.[44,45,49]

Samples from non-sterile sites such as urine, wounds and sputum are easily contaminated during collection. It is important that efforts are made during the collection process to increase the chance that test results reflect the organisms that are present at the site of infection. Collection of the sample after antimicrobial therapy has started may lead to false negative culture results.[50,51] Test results may also be adversely affected by suboptimal specimen labelling, an inadequate volume of material provided, incorrect specimen containers, and delays between specimen collection and performing the test.[47]

The following general principles apply to optimal sample collection and transport:

- Set up best-practice systems for sample collection to avoid contamination and maximise diagnostic accuracy
- Follow clinical guidelines on microbiology specimen collection that incorporate laboratory requirements, and are current and readily accessible
- Collect clinical samples for culture before antibiotics are commenced, whenever possible
- Provide consumer guides for self-collected samples
- Label clinical samples correctly and include relevant clinical information in the request order
- Minimise transport time to the laboratory; this is especially important when laboratory testing is performed at a distant location.

9.3.3 Commenting on specimen quality

The CMS should have in place systems to manage poor-quality specimens submitted for testing. Macroscopic and microscopic analyses are used to determine whether the sample submitted is unlikely to yield useful clinical information. Poor samples should be rejected or re-collected, or, at a minimum, a comment should be added to the laboratory report. A suggested approach for commenting on specimen quality is in Table 9.1.

9.4 Analytical phase: microbiological analytical practice

The analytical phase of diagnostic testing, from specimen processing to final result, is often complex. It can involve a range of methods, from traditional Gram-stain microscopy to whole-genome sequencing. Some elements of testing are predominantly manual, whereas others are automated. Diagnostic testing technology is rapidly evolving, with the goal of optimising negative and positive predictive values, and reducing the time to produce results.[52,53] The menu of laboratory diagnostic tests is likely to change markedly over the next decade as culture-based and traditional phenotypic methods are replaced by molecular and other methods.[1] An example is the introduction of mass spectrometry for faster species identification of colonies of bacterial and fungal organisms in culture-based testing. Similarly, testing methods for the detection of emerging antimicrobial resistances (AMRs) demand that the CMS have in place processes to ensure the timely adoption of newer laboratory processes.

9.4.1 Rapid diagnostics and testing

Early availability of diagnostic test results is critically important for the management of patients with infection. Rapid diagnostics and the enhancement of laboratory processes can have a significant effect on

Table 9.1: Examples of comments on specimen quality

Criterion for adding comment	Comment text
Sputum with profuse squamous epithelial cells	The presence of abundant squamous cells indicates probable contamination of this specimen by oropharyngeal flora.
Urine with squamous epithelial cells >50 × 10^6/L	The presence of squamous cells indicates probable contamination of this specimen by perineal flora.
Formed or soft stool submitted for viral detection, bacterial culture or *C. difficile* detection	Formed or soft stool is unsuitable for detection of enteric pathogens.

patient outcomes and optimise the use of antibiotics, by reducing the time required to confirm or exclude a diagnosis and guiding the switch from empirical to directed antimicrobial treatment.[53,54] Point-of-care testing is an example of rapid diagnostic testing. Point-of-care tests include the detection of influenza antigens from respiratory samples[55], the use of immunochromographic or latex agglutination tests for meningitis[56], and rapid tests for pneunomoccal urinary antigen to predict pneumococcal infection.[57]

Increasingly, results of molecular and advanced phenotypic methods (for example, MALDI-TOF MS[58] for the detection of pathogens and specific antimicrobial-resistant organisms direct from clinical samples) can be provided within hours, which significantly improves early treatment decisions. Direct susceptibility testing may be performed on urine and positive blood culture samples, providing preliminary information to guide management 24–48 hours earlier than the final result.[59-63]

All of the laboratory processes, from specimen transport and analytical workflow to result reporting, should be optimised to reduce the time taken for the information to be available to influence clinical care. This may require moving away from traditional laboratory practice towards a full 24-hour-a-day service with flexible processes to enable multiple runs of plate rounds, assays and on-demand result reporting.[64,65]

9.4.2 Antimicrobial susceptibility testing

Traditionally, the antimicrobial susceptibility of organisms detected in clinical samples is determined using culture-based phenotypic testing. All laboratories should test in line with requirements and interpretations specified by one or more standards organisations (see Resources).

Genotypic testing for AMR genes is now widely used for different organisms harbouring certain resistance genes. An example of this is direct detection of *Staphylococcus aureus* genes and methicillin resistance from a positive blood culture broth.

9.5 Post-analytical phase: microbiology reporting

The CMS should provide timely and accurate results and advice to support clinical management decisions and optimal antimicrobial prescribing. Results should be readily available and easy to interpret.

9.5.1 Timeliness of test reporting and integration with antimicrobial stewardship programs

Susceptibility and culture results should be reported to clinicians as soon as possible to allow them to streamline or stop antimicrobial therapy, as appropriate. AMS interventions that are prompted by susceptibility testing results have a greater impact on timely therapy change than those that are not.[37,66,67]

9.5.2 Reporting and interpreting results

Microbiology results may be qualitative or quantitative, and often include a combination of result elements. These factors can contribute to the risk of incorrect interpretation of the information. Microscopy or cell count results may be overlooked, even when they are important as indicators of colonisation, contamination or an inflammatory response to infection. Single or multiple organisms can grow in cultures, each with different susceptibility and potentially different clinical relevance. Report design is paramount in supporting the safe interpretation of the results.[68,69] Summarising or grouping results to improve visual display can improve data interpretation.[70,71] Another challenge in the comprehension of results is dealing with unfamiliar terminology related to newer diagnostic technology and changes in organism nomenclature.[1]

The addition of laboratory comments in result reports has been proven to assist clinicians with the interpretation of the information.[72,73] Report comments can prompt clinicians to consider the possibility of false negative or false positive results, or other features that suggest that the result reflects contamination or colonisation (see Table 9.2).[47]

Table 9.2: Examples of comments that interpret results, and provide clinical and infection control advice

Specimen type	Indication	Suggested reporting comment
Blood	*Staphylococcus aureus* isolated	*Staphylococcus aureus* isolated from blood is rarely a contaminant. 30-day all-cause mortality of *S. aureus* bacteraemia is approx. 21%.[78] Formal consultation with infectious diseases physician or clinical microbiologist is strongly recommended. The Staphylococcus Bacteraemia Management Guideline can be found at [location/URL]. Relapse of *S. aureus* bacteraemia occurs in up to 5% and may present up to 3 months after the event. Patients should receive a written note to this effect [reference information sheet].
Blood	Isolate of coagulase-negative *Staphylococcus* (CoNS) from an intensive care patient – mixed or isolated after prolonged incubation (>1 day), only one set taken	For optimal sensitivity and specificity, at least two separate blood culture sets (adult, 20 mL each) should be collected from separate venepuncture sites before starting antimicrobial treatment. This patient had one set collected, which has isolated CoNS. This result could indicate either infection or contamination – clinical correlation is required.
Blood	Isolate of potential contaminant organism(s) from non–intensive care unit patient – mixed or isolated after prolonged incubation (>1 day), not present in multiple sets	This isolate most likely represents contamination. To avoid contamination during blood culture collection: • Do not collect sample through pre-existing or new intravascular lines • Perform hand hygiene before the procedure • Disinfect the skin site and blood culture bottle caps with [alcohol/other preferred agent] (applied for at least 1 minute) • Use sterile gloves and no-touch technique for venepuncture • Avoid needle exchange before inoculation of bottle(s).
Faeces	Isolate of *Campylobacter*	*Campylobacter* gastroenteritis does not normally require antimicrobial treatment. However, in severe or prolonged cases, and during pregnancy, treatment is indicated – refer to *Therapeutic Guidelines: Antibiotic*.
Isolate from non-sterile site	Antimicrobial susceptibility reported for information rather than to recommend treatment	The reporting of antimicrobial susceptibility does not imply that treatment with antimicrobials is necessary. Colonisation (as opposed to infection) does not require antimicrobial treatment.
Any specimen	Isolate of carbapenemase-producing Enterobacteriaceae (CPE)	CPE detected. Treatment options are limited – consult [insert preferred reference here]. Manage CPE-colonised inpatients with standard and contact precautions. [An alert is placed on the patient record.] (For further information, see Resources.)

Antimicrobial susceptibility results should be withheld for isolates that reflect colonisation rather than infection, to avoid prompting unnecessary antimicrobial treatment.[68] Examples of circumstances in which results could be withheld include:

- Selected urine culture results[24] (see Box 9.1)
- Screening specimens, other than those for multidrug-resistant organisms
- *Candida* isolation from sputum.[74]

If results are reported in these circumstances, their significance should be discounted by providing a comment (see Table 9.2). Comments can also be used to provide treatment advice for both antimicrobial and non-antimicrobial measures.[47,75] Reports can refer to management guidelines, such as *Therapeutic Guidelines: Antibiotic*[76], or infection control recommendations.[77] Comments that assist in the interpretation of antimicrobial susceptibility results should also be included to ensure that the most appropriate treatment is selected. Examples of this type of comment are shown in Table 9.3.

9.5.3 Cascade reporting

Cascade (selective) reporting of antimicrobial susceptibilities has been shown to markedly improve the appropriateness of prescribing of antibiotics in a randomised case-vignette study.[79] A recent quasi-experimental retrospective study demonstrated a significant and sustained reduction in the use of, and resistance to, ciprofloxacin after the implementation of routine suppression of ciprofloxacin susceptibility results.[80]

The process involves withholding antimicrobial susceptibility test results for second-line agents (that is, generally those that are more broad spectrum) unless an organism is resistant to first-line agents within a particular antimicrobial class (see Table 9.4 for examples).[79] Routine reporting of susceptibility to non-formulary or restricted antimicrobial agents should be avoided.

Table 9.3: Examples of comments that interpret antimicrobial susceptibility results

Specimen type and indication	Reporting comment
Pus or skin swab with methicillin-susceptible *Staphylococcus aureus*	*S. aureus* susceptible to flucloxacillin/dicloxacillin is also susceptible to cefazolin, cefalexin and amoxicillin–clavulanate. (Flucloxacillin/dicloxacillin result reported as susceptible based on cefoxitin test.)
Any site where *Pasteurella* species is isolated	*Pasteurella* species are always resistant to dicloxacillin/flucloxacillin.
Respiratory tract or blood isolate (meningitis absent) where *Streptococcus pneumoniae* is isolated	In pneumonia, benzylpenicillin 1.2 g IV every 6 hours is enough treatment for isolates with MIC ≤0.5 mg/L. Use 1.2 g every 4 hours for isolates with MIC ≤1 mg/L. Use 2.4 g every 4 hours for isolates with MIC ≤2 mg/L. Alternative therapy should be selected for isolates with MIC ≥4 mg/L – please discuss with the on-call clinical microbiologist. (Comment derived from EUCAST.)
Pus or sterile-site aspirate, or tissue culture, where anaerobic (gram-negative) species is isolated	Agents that are generally active against gram-negative anaerobes (such as *Bacteroides* and *Prevotella* spp.) include metronidazole (use 12-hourly dosage), clindamycin and piperacillin–tazobactam. (Modify as per local formulary.)
Pus/skin swab with methicillin-resistant *S. aureus* (MRSA)	MRSA is NOT susceptible to any β-lactam antibiotic except ceftaroline. For severe infection, collect blood culture sets from different sites, use vancomycin IV (loading dose required) and consider infectious diseases or clinical microbiologist consultation. For simple cutaneous abscess, surgical drainage is usually curative. For oral therapy, use one antibiotic that has tested susceptible (NOT oral vancomycin). For advice on recurrent skin infection, refer to [url of reference site].

EUCAST = European Committee on Antimicrobial Susceptibility Testing; IV = intravenous; MIC = minimum inhibitory concentration

Table 9.4: Examples of cascade reporting of antimicrobial susceptibility results

Situation	Reporting approach
Staphylococcus aureus from blood culture	• First-line report (methicillin-susceptible *S. aureus*): flucloxacillin and cefazolin • Second-line report (methicillin-resistant *S. aureus*): vancomycin
Escherichia coli from urine culture	• First-line report: ampicillin, cefazolin/cefalexin, trimethoprim, gentamicin, nitrofurantoin • Second-line report – add amoxicillin–clavulanate if resistant to ampicillin or cefazolin – add ceftriaxone if resistant to cefazolin – add ciprofloxacin if resistant to all of ampicillin, cefazolin and amoxicillin–clavulanate • Third-line report – add tobramycin/amikacin if resistant to gentamicin – add piperacillin–tazobactam if resistant to ceftriaxone – add meropenem if resistant to piperacillin–tazobactam and ceftriaxone – test and add fosfomycin if resistant to norfloxacin

9.5.4 Communicating critical results

Critical microbiology results such as positive blood cultures should be urgently discussed with the clinician so that appropriate treatment is not delayed. For sterile-site (including blood) specimen results, contacting the clinician at the time of a positive Gram stain often leads to treatment change. For example, in a study of 123 patients with clinically important positive blood cultures, 36% of patients had their treatment changed after a Gram stain.[81] Further liaison between the CMS and the clinician after culture and susceptibility results were available led to treatment change in another 50% of patients, usually a change to a narrower-spectrum antimicrobial. Barenfanger et al. demonstrated that patient mortality was halved if Gram stains from blood cultures were performed and results communicated within one hour of the culture becoming positive.[82]

A structured approach to discussing sentinel results is useful to ensure clear communication and documentation of the discussion and recommendations. An approach adopted from the ISBAR (identify, situation, background, assessment, recommendation) clinical handover process is recommended.[83] It can also be helpful to request a read-back of the result to confirm accurate understanding. Barenfanger et al. detected a 3.5% error rate in outgoing laboratory phone calls, which was corrected by introducing a read-back policy.[84]

Automated communication of critical results to clinicians is another valuable method that improves the timeliness of notification and avoids the potential errors that can occur in verbal communication.[85] AMS ward rounds provide another opportunity for the discussion of sentinel results with clinicians.

9.6 Specific situations that need clinical microbiology service expertise

As well as influencing individual patient care, the CMS can support different specific AMS initiatives at the local and national levels.

9.6.1 Support for high-risk units

Intensive care, transplantation, haematology and oncology units have high rates of antimicrobial use and warrant particular attention from the CMS. High antimicrobial use exerts selection pressure for AMR, and this may have a spillover effect on patients managed by other services because of cross-infection.

Clinicians and managers in high-risk units should regularly consult with the CMS to review antimicrobial use, changes in cumulative antibiograms and reports on multidrug-resistant organisms for the unit. This can provide the impetus to change local antimicrobial recommendations, with reference to *Therapeutic Guidelines: Antibiotic*[76], and promotes adherence to relevant infection prevention and control measures.

A CMS representative should attend AMS team rounds, which may be on a daily, twice-weekly or weekly basis, depending on the size and case load of the particular unit. These rounds are often conducted with the infectious diseases (ID) service. AMS liaison rounds generally involve:

- Appraising the clinical presentation, previous treatment and current status of each patient
- Considering the function of antimicrobial treatment (prophylaxis, empirical or directed treatment)
- Interpreting existing microbiological results and, if required, recommending other relevant investigations
- Recommending changes (in the light of patient situation, microbiology and guidelines) to the documented diagnosis; the choice of medicine(s) and the route of administration or dosage; and the defined or agreed duration of treatment, or a date for further review.

9.6.2 Cumulative antibiogram analysis

The CMS should provide annual analyses of cumulative AMR to groups with responsibility for local antimicrobial therapy guidelines to inform recommendations for local empirical therapy and formulary management.[86]

Caution should be exercised if clinicians are provided with cumulative antibiograms. Interpretation by a clinical microbiologist or ID physician is needed, so that clinicians recognise at which point an antimicrobial is no longer a reliable empirical agent against an organism or group of organisms. Commentary should accompany the cumulative antibiogram to indicate whether the local resistance patterns show that a variation from *Therapeutic Guidelines: Antibiotic*[76] is needed locally. Examples of such commentaries are available from the AIMED website.[87]

The Clinical and Laboratory Standards Institute (CLSI) guideline M39-A2 is the accepted international standard for the analysis and presentation of antibiograms. It is recommended to use the Australian standard approach to analysing and reporting cumulative antibiograms, based on the CLSI standard.[86] The Australian standard specifies a number of 'sentinel organisms' for which local epidemiology should be examined and recommends a format for presenting the cumulative antibiogram (Figure 9.2).

Currently available software for antibiogram analyses includes OrgTRx (part of the national Antimicrobial Use and Resistance in Australia [AURA] Surveillance System), WHONET software, and various in-house and commercial options.

Locally generated antibiograms may be compared with national AMR data published by the AURA program. The AURA 2017 report provides a selected array of information about rates of resistance by specimen type and by state and territory.[89]

9.6.3 Signal and critical antimicrobial resistances (CARs)

The Australian standard antibiogram format recommends separate consideration of six important 'signal resistances' (S), which have been supplemented by a variety of other isolates with resistances that need to be reported to the National Alert System for Critical Antimicrobial Resistances (CARAlert):

- Vancomycin-resistant enterococci (S), linezolid-non-susceptible *Enterococcus* species (CAR)
- Methicillin-resistant *S. aureus* (S), and vancomycin-, linezolid- or daptomycin-resistant *S. aureus* (CAR)
- Vancomycin-intermediate and vancomycin-resistant *S. aureus* (S)
- Carbapenemase-producing Enterobacteriaceae (CPE) and other carbapenemase-producing gram-negative organisms (S), carbapenemase-producing or ribosomal methylase–producing Enterobacteriaceae (CAR)
- *Streptococcus pneumoniae* with a penicillin minimum inhibitory concentration ≥0.06 mg/L (S)
- Enterobacteriaceae that are resistant to third- or later-generation cephalosporins (S)
- Multidrug-resistant *Mycobacterium tuberculosis* (CAR)
- Ceftriaxone- or azithromycin-non-susceptible *Neisseria gonorrhoeae* (CAR)

Figure 9.2: Example of a hospital urinary isolate antibiogram, taken from John Hunter Hospital

	Organism type	Isolates	Percentage of total	Unrestricted antibiotics						Restricted antibiotics	
				Ampicillin	Amoxicillin–clavulanate	Cefazolin/cefalexin	Nitrofurantoin	Trimethoprim	Gentamicin (aminoglycoside)	Ceftriaxone	Norfloxacin
All isolates		5,645	Some miscellaneous/contaminant species excluded								
Gram-negative isolates	*Escherichia coli*	3,197	57%	58%	86%	86%	99%	78%	96%	96%	93%
	Klebsiella species	522	9%	R	92%	82%	n/a	87%	99%	97%	96%
	Enterobacter-like species*	316	6%	R	R	R	n/a	76%	95%	†	94%
	Proteus mirabilis	195	3%	88%	98%	92%	R	79%	96%	99%	97%
	Pseudomonas aeruginosa	290	5%	R	R	R	R	R	98%	R	95%
Gram-positive isolates	*Staphylococcus saprophyticus*	150	3%	95%	S	S	100%	94%	n/a	S	n/a
	Streptococcus agalactiae (group B strep)	300	5%	S	S	S	S	n/a	R	S	n/a
	Enterococcus faecalis	675	12%	S	S	R	S	R	R	R	R

R — Intrinsically resistant

45% — <70% of isolates susceptible

75% — 70–89% of isolates susceptible

93% — >90% of isolates susceptible

S — Susceptible by extrapolation or intrinsically susceptible

n/a — Not available – not routinely tested in this laboratory or no testing standard available

* — *Enterobacter, Serratia, Citrobacter, Providencia, Morganella* species (excludes *C. diversus*)

† — Resistance may emerge during therapy, and agent NOT recommended for these species

Refer to www.aimed.net.au for the Hunter New England Local Health District restricted anti-infective indications

Source: Pathology North[88]

- Ceftriaxone-non-susceptible *Salmonella* species (CAR)
- Multidrug-resistant *Shigella* species (CAR)
- *Streptococcus pyogenes* with reduced susceptibility to (benzyl)penicillin (CAR).

The CMS should actively monitor and report on these exceptional phenotypes. For a broader discussion of exceptional resistance phenotypes across all major pathogenic bacterial species, see the EUCAST expert rules, updated in 2016.[90]

Extra information about the epidemiology of important endemic or emerging resistant pathogens can be obtained by analysis and reporting of:

- Relevant molecular resistance mechanisms (for example, the presence of specific carbapenemase or extended-spectrum β-lactamase genes in gram-negative organisms)
- Epidemiological markers (for example, by using one of many typing methods that imply clonality).

These data can further inform AMS, and infection prevention and control strategies by identifying outbreaks and the epidemiology of pathogen transmission.

CMSs are encouraged to participate in the AURA Surveillance System[91] and its component programs, such as the Australian Group on Antimicrobial Resistance[92] and the Australian Passive AMR Surveillance system.[93]

9.6.4 Therapeutic drug monitoring and review

The CMS should collaborate with clinical chemistry and pharmacy departments to:

- Monitor blood antimicrobial levels for results that are either above or below targets (for example, for aminoglycosides, vancomycin, antifungal agents)
- Provide appropriate interpretive comments consistent with *Therapeutic Guidelines: Antibiotic*.[76]

The CMS should enable access to therapeutic drug-monitoring data by pharmacy and other auditors to enable assessments of indicators of the quality of antimicrobial use (see Chapter 6: 'Measuring performance and evaluating antimicrobial stewardship programs').

9.6.5 Linking microbiology results with electronic prescribing

Linkage of patient microbiology and antimicrobial susceptibility results with electronic prescribing system data can help to improve antimicrobial prescribing (see Chapter 4: 'Information technology to support antimicrobial stewardship').[94] In-house and proprietary systems are effective in targeting patient-level AMS interventions.[95-97] These systems may prompt review when organisms are resistant to the antimicrobial being prescribed, when prescriptions are ordered where no organisms have been isolated, and when broad-spectrum agents could be switched to narrower-spectrum[98] or less expensive antimicrobials.

9.6.6 Measuring performance of the clinical microbiology service as part of the antimicrobial stewardship program

Performance measures for CMS activities with potential impacts on AMS may include the following.

Pre-analytical phase:

- Compliance with test recommendations for the specific clinical presentation
- Proportion of patients for whom a microbiological diagnosis is obtained for the specific clinical syndrome
- Analyses of repeat specimen submission and compliance with rejection criteria
- Specimen quality measures
  - urine contamination[99]
  - blood cultures – collection of more than one set, sample volume and contamination rates[33,100-103]
  - rates of suboptimal sputum and wound samples, based on evaluation of microscopic findings (relative presence of polymorphonuclear cells and squamous cells)[104]
- Time from sample collection to arrival in the laboratory for processing.

Analytical phase:

- Laboratory external quality assurance performance
- Monitoring of turnaround times for negative and positive results of major tests.

Post-analytical phase:

- Accuracy and completeness of documentation, and actioning of critical results
- Monitoring of time to reporting urgent tests
- Compliance with cascade reporting requirements
- Clinician satisfaction surveys.

9.7 Role in education

The CMS should educate the nursing, midwifery, medical and pharmacy workforce, and pathology specimen collection personnel about clinical indications for testing, correct specimen collection, available laboratory testing procedures and optimal use of these procedures.[1,105,106] The workforce should be updated when collection or testing methods change.

The CMS can also contribute to local AMS education efforts by educating about the interpretation of, clinical significance of, and appropriate responses to, significant microbiology test results. This approach has been shown to be effective in changing clinicians' prescribing behaviour[68,81], especially if it is combined with selective reporting of antimicrobial susceptibility results that also contains interpretive comments.

Resources

International testing standards

- Public Health England: UK Standards for Microbiology Investigations
- EUCAST: Clinical breakpoints
- EUCAST: Guidance documents in susceptibility testing
- CLSI: testing standards

Reporting standards

- Australian Commission on Safety and Quality in Health Care: Structured microbiology requests and reports for healthcare-associated infections

Antibiotigram specifications and tools

- Australian Commission on Safety and Quality in Health Care: specification for hospital-level cumulative antibiogram
- AIMED: antibiogram commentaries and other microbiology resources
- Software for antibiogram analyses: OrgTRx and WHONET software

Signal and critical antimicrobials resistances

- Australian Commission on Safety and Quality in Health Care: Information specific to carbapenemase-producing Enterobacteriaceae
  - *Recommendations for the Control of Carbapenemase-Producing Enterobacteriaceae (CPE): A guide for acute care health facilities*
  - information for patients
  - information for ward staff and after-hours managers
  - information for clinicians and health service managers
  - information for clinicians
- Exceptional resistance phenotypes: EUCAST expert rules
- National surveillance programs
  - AURA
  - Australian Group on Antimicrobial Resistance
  - CARAlert
- AURA 2017: national AMR data

Education

- For a detailed discussion of CMS education topics and resources, see Morgan DJ, Croft LD, Deloney V, Popovich KJ, Crnich C, Srinivasan A, et al. Choosing wisely in healthcare epidemiology and antimicrobial stewardship. Infect Control Hosp Epidemiol 2016;37(3):755–60.

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AUSTRALIAN COMMISSION ON SAFETY AND QUALITY IN HEALTH CARE

10 Role of prescribers in antimicrobial stewardship

Antimicrobial Stewardship in Australian Health Care

2018

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Acronyms and abbreviations

Abbreviation	Definition
ADR	adverse drug reaction
AMR	antimicrobial resistance
AMS	antimicrobial stewardship

Key points

- Understanding the process and culture of prescribing, and pressures on prescribers, is an important factor in devising antimicrobial stewardship (AMS) programs and strategies.
- Prescribers are aware of and concerned about antimicrobial resistance; however, they often do not perceive this as a problem or a priority for individual prescribing in their own practice.
- AMS prescribing principles should be incorporated into programs of study and continuing education for all prescribers.
- Processes that help to address diagnostic uncertainty and the risk of complications can reduce unnecessary and inappropriate antimicrobial prescribing.
- The Antimicrobial Stewardship Clinical Care Standard, *Therapeutic Guidelines: Antibiotic*, the National Prescribing Curriculum and the Prescribing Competencies Framework are essential resources to inform the education of antimicrobial prescribers.
- A clear understanding of AMS prescribing principles underpins optimal prescribing, which can be strengthened by ready access to information and resources to support good decision-making, including formulary information, prescribing guidelines, local resistance patterns and specialist advice.
- Systems should be established to enable prescribers to receive feedback about their prescribing and how their practice compares with guidelines, indicators and their peers.
- The early diagnosis and management of sepsis is a priority for good patient outcomes
  - In hospital settings, the use of protocols for sepsis has the potential to influence prescribing of early broad-spectrum antimicrobial therapy
  - Prescribers must ensure that treatment for suspected sepsis is commenced without delay and, although treatment may start broad, it should be reassessed when the patient's condition is better understood
  - As sepsis is increasingly being diagnosed, the importance of judicious use of antimicrobials and the involvement of multidisciplinary teams in the development of protocols needs to be highlighted and acted on.

10.1 Introduction

Prescribers, including doctors, dentists and non-medical prescribers, work across different settings where they need to diagnose and treat infections, and prescribe antimicrobials.[1] It is the responsibility of all prescribers to follow good prescribing and antimicrobial stewardship (AMS) principles, and to use guidelines and resources in their practice to ensure that they are contributing to AMS. The prescriber takes into account multiple factors when prescribing an antimicrobial, and understanding those factors is important when devising AMS programs and strategies.

Understanding differences in prescribing environments across primary, secondary and tertiary care is important to achieving effective AMS. Hospital prescribers are more likely to be team based, with the opportunity to work collaboratively with other clinicians in the workplace, and their prescribing decisions are more likely to be subject to review by infectious diseases physicians, pharmacists or other members of the healthcare team. Prescribers in general practice tend to work more independently and have greater autonomy in making diagnostic and management decisions.[2]

Non-medical prescribers in Australia include nurse practitioners, midwives, podiatrists and optometrists; in other countries, they also include pharmacists and physiotherapists. Non-medical prescribers have varied levels of pharmacological training, and their prescribing is restricted, depending on their practice and state or territory legislation.

This chapter describes the influences on prescriber decision-making with regard to antimicrobial prescribing, appropriate prescriber strategies, and guidance and support that are available to prescribers.

Issues that are especially relevant for certain settings – rural and remote hospitals, private hospitals and aged care – are tagged as R, P and AC, respectively, throughout the text.

R P AC

10.2 Prescriber concerns and influences

Access to information and knowledge alone is insufficient to achieve good antimicrobial prescribing practice. Consideration needs to be given to the factors that affect prescribing practices, such as time, motivation or skills to apply information, and knowledge to change practice.[3] Understanding the cultural, contextual and behavioural aspects of antimicrobial use is necessary to identify, develop and implement directed interventions to optimise antimicrobial prescribing (see Section 2.5.1 in Chapter 2: 'Establishing and sustaining an antimicrobial stewardship program').[3,4]

Numerous studies have investigated factors that influence prescribers in their antimicrobial decision-making (see Chapter 2: 'Establishing and sustaining an antimicrobial stewardship program').[3,5-10] They have identified both pharmacological (medical or clinical) factors and non-pharmacological factors that influence behaviour. Multiple factors are considered when deciding to prescribe antimicrobials for individual patients.[7,11]

10.2.1 Prescriber perspectives on antimicrobial resistance

Prescribers are aware of and concerned about antimicrobial resistance (AMR); however, they often do not perceive it as a problem or a priority in everyday practice (see Chapter 2: 'Establishing and sustaining an antimicrobial stewardship program').[7,11-18] In some studies, participants have considered AMR more as a public health issue[12,13,19] caused by 'other doctors' and the responsibility of 'other people'.[10]

Clinicians widely agree that AMR is an important healthcare issue in hospitals, but they are much less likely to perceive it as a problem in their own institution or practice.[16-18] For example, junior doctors in France and Scotland perceive that resistance occurs in the community setting and is transported into hospitals by patients.[16,17] Prescribers identify causes of AMR as the prescription of too many antimicrobials, too many broad-spectrum antimicrobials or subtherapeutic doses of an antimicrobial, and poor infection control practices.[17,18]

Similar findings have been indicated among hospital prescribers in Australia.[14] Perspectives on the importance of AMR and its relevance to everyday clinical decisions are mixed. Some prescribers believe that AMR issues, especially methicillin-resistant *Staphylococcus aureus* and vancomycin-resistant enterococci, should be discussed and have a direct effect on clinical decisions. However, other prescribers believe that communication about AMR is not necessarily practical and that other day-to-day clinical matters are more important.[14]

10.2.2 Policies and guidelines

Policies and guidelines are standard tools that support AMS programs and drive the achievement of their goals (see Section 3.2 in Chapter 3: 'Strategies and tools for antimicrobial stewardship'). Prescribers report that evidence-based antimicrobial prescribing guidelines are necessary[9] and enable appropriate prescribing.[20] However, adherence is variable and influenced by several factors, including acceptance of the guidelines (which is highest among junior prescribers[20-22]), awareness of and familiarity with the guidelines, and the availability of the guidelines or policy.[9,23,24] Organisational culture, and an understanding of the roles of hierarchy and prescriber autonomy need to be considered when developing and implementing policies and guidelines, as they can influence compliance.[14,21,23]

In Australia, reasons for noncompliance with hospital AMS policy include lack of familiarity or agreement with the policy, prescriber autonomy, and structural issues. The involvement of infectious diseases and microbiology departments can facilitate compliance with policy.[23]

10.2.3 Diagnostic uncertainty

Clinical signs and symptoms often leave prescribers with diagnostic uncertainty, and this influences prescribing in all settings. In the face of uncertainty, general practitioners could be inclined to prescribe an antimicrobial, depending on their experience and patient-related factors such as patient expectations.[2] This is despite most viral and bacterial infections in primary care being self-limiting and not needing antimicrobial therapy.[25]

Diagnostic uncertainty is a predictor for antimicrobial prescribing that is inconsistent with best-practice recommendations.[26] A United States hospital study demonstrated that an accurate diagnosis was linked to optimal antimicrobial therapy, whereas an inaccurate diagnosis was linked to inappropriate antimicrobial therapy. The most common diagnoses for which diagnostic accuracy was relatively poor were pneumonia, cystitis, pyelonephritis and urosepsis.[26]

Processes to help reduce uncertainty (such as point-of-care testing for group A *Streptococcus* or C-reactive protein) as part of a multifaceted intervention can reduce inappropriate antimicrobial prescribing.[27-30] However, point-of-care testing is not widely used in Australia.

The 2015 National Antimicrobial Prescribing Survey showed that only about 12% of antimicrobial therapy is given on a directed basis in hospitals.[31] This indicates that many patients receive empirical treatment, implying either high levels of diagnostic uncertainty or a delay in appropriate diagnostic testing, post-empirical intervention or de-escalation. It is important to ensure appropriate diagnostic work-ups, including the correct use of microbiology (see Chapter 9: 'Role of the clinical microbiology service in antimicrobial stewardship').

General practitioners may prescribe antimicrobials for respiratory tract infections because of concern about overlooking something more serious or fear of the disease progressing.[10,11] The consequences of not prescribing antimicrobials, especially in situations in which patients might develop more serious problems, appear to worry some prescribers more than the possible downstream complication of AMR[12,32], and have been reported by general practitioners in several studies.[11,13,33,34] This concern also exists for hospital prescribers.

One study describes prescriber tendencies to use broader therapies to ensure that everything is covered and nothing has been missed.[14] Other areas of uncertainty include when to initiate antimicrobials, what type to use and how long to prescribe them for.

The early diagnosis and management of sepsis is a priority for good patient outcomes. In hospital settings, the use of protocols for sepsis has been widely promoted and may influence prescribing of early broad-spectrum antimicrobial therapy (see Section 8.3 in Chapter 8: 'Role of the infectious diseases service in antimicrobial stewardship'). Given the significance of sepsis as a leading cause of death, there have been widespread efforts to inform clinicians of the importance of these events and, as a result, there has been increasing recognition of, and intervention for, sepsis. One example of these programs is the NSW Clinical Excellence Commission's Sepsis Kills program. In May 2017, the World Health Assembly and the World Health Organization made sepsis a global health priority by adopting a resolution to improve, prevent, diagnose and manage sepsis. As sepsis is increasingly being diagnosed, the importance of judicious antimicrobial use and the involvement of multidisciplinary teams in developing protocols need to be highlighted and acted on.[35] In one study, diagnosis of sepsis increased almost three-fold over nine years.[35] Although prescribing for sepsis may start broad, it should narrow when the patient's condition is better understood.

10.2.4 Influence of others

Prescribing practice in hospitals is influenced not only by the expertise and experience of the practitioner but also by the medical hierarchy and professional relationships.[1] Junior clinicians are influenced by senior clinicians, such that junior medical staff may be reluctant to alter or challenge prescriptions written or suggested by senior medical staff. This influence, described as 'prescribing etiquette'[36], involves:

- Decision-making autonomy, in which senior doctors rely on their own professional judgement rather than guidelines or policies in antimicrobial decision-making, especially if the guidelines are not endorsed by peers[36]; this is accompanied by a lack of questioning by peers
- A culture of hierarchy, which is especially relevant to junior clinicians[36]; although junior doctors write the prescription, their decision is either under the direction of a senior doctor or influenced by the previous choices of that senior doctor.

Senior doctors have a dominant influence on hospital trainees, who learn their prescribing behaviours from the senior doctors.[37] This influence is more profound among less experienced doctors. Senior clinicians therefore have an opportunity to provide leadership in AMS for junior medical staff; they should ensure that support is provided for an environment that uses evidence-based interventions, and that they maintain currency in their own prescribing practice (see Section 2.3.4 in Chapter 2: 'Establishing and sustaining an antimicrobial stewardship program').[38]

Consumer expectations also influence the behaviour of prescribers, and communication with consumers about AMS is an important management tool (see Chapter 7: 'Involving consumers in antimicrobial stewardship').

10.2.5 Prescribers in aged care

AC

In aged care homes, factors that influence antimicrobial prescribing can be direct – for example, the influence of others, such as colleagues, the resident, the resident's family and nurses (that is, a lack of direct clinician involvement with client assessment). Factors can also be indirect – for example, the influence of the environment, such as covering for another clinician on a weekend and being unfamiliar with the resident.[39]

Other factors may include:

- The environment and communication, such as impaired communication with residents, or a lack of typical clinical signs and symptoms
- Advance care plans that may or may not include the use of antimicrobials
- The use of diagnostic resources that may be limited or too burdensome for frail or older residents, contributing to diagnostic uncertainty
- Perceived risks of prescribing, or not prescribing, an antimicrobial.

10.2.6 Non-medical prescribers

The knowledge, attitudes and behaviours of non-medical prescribers with respect to AMR and AMS have mainly been studied overseas among nurse practitioners. There is little information about other non-medical prescribers, such as midwives, podiatrists, optometrists, pharmacists and physiotherapists.

Australian nurse practitioners can prescribe certain medicines under the Pharmaceutical Benefits Scheme (PBS). However, their prescribing is limited by the nurse practitioner's scope of practice, and state and territory prescribing rights, and accounts for less than 1% of the antimicrobial prescriptions dispensed through the PBS. Although the level of prescribing of antimicrobials by nurse practitioners in Australia is low relative to the total volume, antimicrobial agents account for a significant component (29%) of their prescribing.[40] (Also see Chapter 12: 'Role of nurses, midwives and infection control practitioners in antimicrobial stewardship'.)

Little is known about Australian nurse practitioners' current attitudes to, perceptions of, and knowledge about, antimicrobial prescribing. The nurse practitioner role in Australia varies from the role in other countries, including the United States and the United Kingdom, where there are more nurse practitioners and the role is more established.[41] It is therefore difficult to draw direct comparisons about attitudes and experiences. Aspects highlighted in international studies have been related to nurse practitioners' perceptions about AMS, and nurse prescribing generally, and prescribing confidence, diagnostic uncertainty and patient expectations are often cited as factors that influence nurse practitioners' prescribing behaviour.[42-44] For example, results of a 2009 study suggested that nurse practitioners in the United States see AMR as a national or global problem, rather than a local problem.[43] In that study, nurses agreed that antimicrobials were overused nationally, but agreed less strongly that antimicrobials were overused locally.[43] The study indicated that knowledge of antimicrobials is important, and surveyed nurses indicated that they would like more education and feedback about their antimicrobial selections.

Non-medical prescribers also need to deal with prescribing confidence, patient expectations and diagnostic uncertainty. Non-medical prescribers in the United Kingdom stated that patients with self-limiting respiratory tract infections needed reassurance and wanted their symptoms 'fixed', and that previous prescriptions often drove the consultation (see Chapter 7: 'Involving consumers in antimicrobial stewardship').[42] Non-medical prescribers were aware that they did not have the same experience as general practitioners and were concerned about the possibility of making mistakes. As a result, they needed to justify their prescribing decisions.

10.3 Prescriber strategies

Prescribers should follow AMS prescribing principles when prescribing antimicrobials.

10.3.1 Antimicrobial stewardship prescribing principles

The following prescribing principles underpin AMS. They have been adapted from *Therapeutic Guidelines: Antibiotic*[25], the Antimicrobial Stewardship Clinical Care Standard[45] and the United Kingdom National Institute for Health and Care Excellence AMS guidelines.[46]

Before prescribing:

- Assess the patient, and document the symptoms and indication for use of the antimicrobial
- Consider the clinical need for microbiology testing
  - For patients in hospital with a suspected bacterial infection, take microbiological samples, if possible, before starting antimicrobial therapy; review and, if necessary, modify the prescription when the results are available
  - For patients in primary care, consider microbiology testing, and review the prescription when the results are available, modifying treatment if necessary
- For patients with non-severe infections, consider waiting for the results of microbiology testing before deciding to prescribe an antimicrobial, provided it is safe to do so
- Consider the risk of AMR for the individual patient and the population as a whole
- Assess the allergy status of the patient – elicit the nature and seriousness of any allergy to an antimicrobial, and document it in the patient's healthcare record
- Where appropriate, discuss with the patient, and their family or carers
  - the likely cause and progression of the condition
  - any self-management strategies
  - their concerns and expectations of management, including whether they want an antimicrobial
  - the benefits and harms of providing an antimicrobial
  - any symptoms that require a return visit (advise to re-consult if symptoms persist or worsen, or if they are worried)
  - whether they need information about their medicines and illness in another format.

If prescribing:

- Select an antimicrobial for the specified indication that is consistent with national (*Therapeutic Guidelines: Antibiotic*[25]) or local endorsed clinical guideline recommendations, taking into account
  - the required spectrum of activity
  - potential adverse effects, drug interactions and cost
  - patient factors such as recent antimicrobial use, allergy status, and other diseases and conditions (such as renal impairment, pregnancy and breastfeeding)
- Select an appropriate dose, frequency and route for the antimicrobial, taking into account the severity of infection, the site of infection and any factors that may alter the patient's pharmacokinetics
- Prescribe the antimicrobial for an appropriate duration according to guidelines and indicate a review or stop date; give a repeat antimicrobial prescription only if that is indicated for a particular clinical condition to ensure an appropriate duration of treatment
- Clearly document all antimicrobial therapy – including the indication and the duration of therapy before the stop or review date – in the patient's healthcare record or medication chart
- Provide information to the patient about the antimicrobial, including when and how to take it, how long to take it for, and potential adverse effects.

The MIND ME antimicrobial creed[25] is a useful reminder for prescribers about issues to consider when prescribing antimicrobials (Box 10.1).

Box 10.1: MIND ME

Microbiology guides therapy, wherever possible

Indications should be evidence based

Narrowest spectrum required

Dosage individualised to the patient, and appropriate to the site and type of infection

Minimise duration of therapy

Ensure oral therapy is used, where clinically appropriate

After prescribing:

- Review the clinical evolution and microbiological results at 48–72 hours to determine whether antimicrobial treatment should continue; if continuing, consider the possibility of switching to oral therapy (if receiving parenteral therapy) or the need for modifying the prescription to a narrower-spectrum parenteral antimicrobial
- Participate in quality improvement audits for antimicrobials (see Section 6.8.3 in Chapter 6: 'Measuring performance and evaluating antimicrobial stewardship programs')
- Provide information (including on the duration of the intended therapy) to patients, families and carers, and to the next clinician or team at transitions of care
- Follow local policies when interacting with representatives from pharmaceutical companies.

10.3.2 Prescribing in specific situations

Prescribers should also be aware of particular patient needs in specific situations, such as for patients with suspected sepsis or antimicrobial allergies, during transitions of care, and at the end of life.

Patients with antimicrobial allergies

Up to 20% of patients report allergies to one or more antimicrobials.[47-49] Most of the allergies were reported to be to β-lactam agents (83% in a recent Australian study)[48], and most of those were to penicillin. However, only 10–20% of patients labelled penicillin allergic may have a true allergy (see Section 8.3.1 in Chapter 8: 'Role of the infectious diseases service in antimicrobial stewardship').[50] Allergies and adverse drug reactions (ADRs) are often poorly assessed and documented in patient healthcare records or medication charts, without due consideration of whether the allergy or ADR should preclude the administration of one or more antimicrobials recommended as first-line treatments. These patients are more often prescribed suboptimal reserve agents with less favourable safety profiles, increasing their risk of treatment failure or adverse events.[51,52] The presence of an antimicrobial allergy label in the healthcare record has been associated with poorer clinical outcomes, such as increased length of hospital stays, higher intensive care admission rates, the development of resistance and *Clostridium difficile* infection, and higher mortality rates.[53-55]

Thorough allergy assessments that include penicillin skin testing and oral challenge have been shown to reduce the use of alternative antimicrobials, the length of hospital stay, costs and adverse events from the use of antimicrobials (see Section 8.3.1 in Chapter 8: 'Role of the infectious diseases service in antimicrobial stewardship').[56] Researchers suggest that almost 90% of β-lactam allergy labels can be safely removed.[50,55] Optimal allergy management relies on detailed ADR reporting to differentiate immunological from non-immunological ADRs. Those patients with plausible allergy histories (especially to β-lactams) should be referred to an infectious diseases physician for management advice, especially for more serious infections when β-lactams are being considered as the best treatment choice. This may include further assessment by a drug allergy specialist to confirm true allergies and remove invalid labels.[48] For patients with confirmed allergies, the true nature of the ADR needs to be clearly documented in the patient's healthcare record, and the information needs to be readily available to other clinicians at the point of prescribing, dispensing and administration.

Antimicrobial prescribing at transitions of care

AC

Antimicrobials have been cited as a common cause of medication error when care is transferred, such as when people are transferred between hospitals and aged care homes, or between hospitals and the community.[52] Patients admitted to a health service organisation or aged care home who are taking an antimicrobial and patients who need to continue antimicrobials on discharge should have their prescriptions reviewed and reconciled.[52] At the time of discharge from hospital, the appropriateness of ongoing prophylactic antimicrobials, in particular, should be questioned and decisions documented. Similarly, when patients are transferred from intensive care units to other wards, antimicrobial therapy should be reviewed, and treatment decisions documented and communicated to the next clinician or team.

Antimicrobial prescribing at the end of life

AC

Overseas studies report that up to 90% of hospitalised patients with advanced cancer receive antimicrobials during the week before death[57], and as many as 42% of aged care home residents with advanced dementia are prescribed antimicrobials during the last two weeks of life.[58] In the hospice setting, around one-quarter of recipients, for whom the intended goal of care is comfort, receive antimicrobials during the final weeks of life.[59] Research suggests that antimicrobials are often prescribed to dying patients in the absence of clinical symptoms of a bacterial infection.[58,59]

The decision on whether to prescribe antimicrobials to patients at the end of life can be challenging. The possible benefits versus harms of antimicrobial therapy, as well as the beliefs and expectations of the patient and their family, may be unclear. Ideally, decision-making about antimicrobial use should be done as part of advance care planning, and treatment preferences should be documented in advance care directives.

Similarly to other end-of-life treatment choices, the decision to prescribe an antimicrobial should be approached using shared decision making (see Section 7.4.2 in Chapter 7: 'Involving consumers in antimicrobial stewardship').[60] Patients and families should be told that infections are expected near the end of life, and are commonly a terminal event. Individuals should understand that, even if the infection were cured, the underlying illness (for example, metastatic cancer or advanced dementia) would remain. The risks and burdens of evaluating and treating an infection should be presented, as well as the possible benefits. Sometimes antimicrobials given in the last days of life prolong dying, rather than restore good health. If antimicrobial therapy is indicated, a time-limited trial of therapy may be appropriate (for example, 48 hours), and patients and families should be informed of the signs and symptoms that show that the antimicrobials are or are not effective, in what circumstances antimicrobial treatment would be ceased, and in what circumstances it would be appropriate for it to continue.

If the preference is only for treatments that optimise comfort, it is reasonable to recommend that no investigations be initiated for a suspected bacterial infection and that palliative care be provided. If the evidence to support a bacterial infection is suitable and the use of antimicrobials is thought to be of some benefit, they should be administered by the least invasive route and should not increase patient discomfort.

10.4 Prescriber resources and tools

Several guidelines, standards and principles are available to support prescribers in antimicrobial prescribing.

10.4.1 Guidelines and antimicrobial information

All prescribers should have access to relevant evidence-based prescribing guidelines. In hospitals, local guidelines may be implemented to take into account local resistance patterns and local environments (for example, there may be separate prescribing guidelines for the emergency department). In primary care, it is critical for general practitioners to have access to, and follow, the latest version of *Therapeutic Guidelines: Antibiotic*.[25]

Other sources of information about antimicrobials and prescribing include the *Australian Medicines Handbook*[61], and the Centre for Remote Health's *CARPA Standard Treatment Manual*.[62]

10.4.2 Antimicrobial Stewardship Clinical Care Standard

The Antimicrobial Stewardship Clinical Care Standard[45] provides guidance to clinicians, health service managers and consumers on the delivery of appropriate care when prescribing antimicrobials. The standard aims to ensure that a patient with a bacterial infection receives optimal treatment with antimicrobials, which includes avoiding antimicrobial use when it is not indicated. A set of suggested indicators is available as part of the standard to assist local implementation of AMS programs. Prescribers can use the indicators to monitor AMS implementation and support improvement (see Chapter 6: 'Measuring performance and evaluating antimicrobial stewardship programs').

10.4.3 Education and professional development

AMS needs to be supported by competent prescribers practising good prescribing principles. All prescribers have a responsibility to participate in continuing education activities throughout their careers to ensure that their prescribing is based on current evidence and guidelines. See Chapter 5: 'Antimicrobial stewardship education for clinicians' for resources to support professional development.

Resources

- *Therapeutic Guidelines: Antibiotic*
- Antimicrobial Stewardship Clinical Care Standard
- United Kingdom National Institute for Health and Care Excellence: AMS guidelines

Other sources of information about antimicrobials and prescribing:

- *Australian Medicines Handbook*
- *CARPA Standard Treatment Manual*
- NPS MedicineWise and Australian Commission on Safety and Quality in Health Care: National Prescribing Curriculum and online modules on antimicrobial prescribing.

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AUSTRALIAN COMMISSION ON SAFETY AND QUALITY IN HEALTH CARE

11 Role of the pharmacist and pharmacy services in antimicrobial stewardship

Antimicrobial Stewardship in Australian Health Care

2018

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Acronyms and abbreviations

Abbreviation	Definition
AMR	antimicrobial resistance
AMS	antimicrobial stewardship
DUE	drug use evaluation
ID	infectious diseases
LHD	Local Health District
LHN	Local Hospital Network
NSQHS	National Safety and Quality Health Service

Key points

- Pharmacists play a key role in antimicrobial stewardship (AMS) in hospitals, aged care homes and the community.
- A pharmacist with experience and training in AMS performs an important leadership role and is an important resource for the AMS team. In some health service organisations, the AMS pharmacist may lead the AMS program.
- Ideally, the AMS pharmacist should be an experienced clinical pharmacist with expertise in antimicrobials and the therapeutic management of infectious diseases.
- The AMS pharmacist is in a position to promote the uptake and implementation of the National Safety and Quality Health Service Preventing and Controlling Healthcare-Associated Infection Standard and the Antimicrobial Stewardship Clinical Care Standard as part of routine patient care.
- Studies in hospitals have shown that pharmacists' interventions, including routine reviews of antimicrobial prescriptions, can improve the appropriate use of antimicrobials and reduce costs.
- In addition to clinically reviewing and dispensing antimicrobial prescriptions, community pharmacists should educate patients and carers about the appropriate use of antimicrobials.
- Pharmacists providing home medication reviews or residential medication management reviews can also contribute to AMS activities.

11.1 Introduction

All pharmacists have a role in antimicrobial stewardship (AMS), whether they work in hospitals, aged care homes or the community. This input is essential to the success of AMS programs (see Section 2.3 in Chapter 2: 'Establishing and sustaining an antimicrobial stewardship program').[1-4] The pharmacist's roles and responsibilities can encompass activities at the individual patient level and at the system level.[2,3,5-12] At the patient level, the pharmacist's role may include:

- Optimising antimicrobial therapy by recommending an appropriate antimicrobial, dose regimen and duration of therapy
- Recommending intravenous-to-oral switching
- Therapeutic drug monitoring
- Instructing patients and their families and carers on appropriate use of antimicrobials.

At the system level, the pharmacist's role may include planning and implementing AMS programs and other initiatives that encourage appropriate antimicrobial use.

This chapter outlines the role of pharmacists providing clinical or dispensary services to people in the community, hospital and aged care homes. It also describes the roles of designated AMS pharmacists and pharmacy managers.

Issues that are especially relevant for certain settings – rural and remote hospitals, private hospitals and aged care – are tagged as R, P and AC, respectively, throughout the text.

R P AC

11.2 Pharmacists and antimicrobial stewardship

Pharmacists providing clinical or dispensary services to patients have an important role in supporting AMS activities, regardless of the setting they work in (see Activities in different settings). This includes responding to the requirements of the National Safety and Quality Health Service (NSQHS) Preventing and Controlling Healthcare-Associated Infection Standard and promoting the uptake of the Antimicrobial Stewardship Clinical Care Standard as part of routine patient care.[13] Reviewing antimicrobial therapy, and providing information and feedback to prescribers about optimal antimicrobial prescribing are key roles, and all pharmacists need to have the skills to perform these tasks.[14]

11.2.1 Activities in different settings

Studies in hospitals have shown that pharmacists' interventions improve appropriate antimicrobial use and reduce costs.[15-17] Typical interventions are patient-specific recommendations on therapy; the implementation of policies, education and therapeutic drug monitoring; and participation in AMS ward rounds. Hospitals with pharmacist-managed aminoglycoside or vancomycin therapy had 6.7% lower death rates and 12.3% shorter length of stay than hospitals that did not have such a program.[18] A study in the United States demonstrated that pharmacists can provide cost-saving interventions and can implement AMS programs in hospitals that have limited infectious diseases (ID) resources. Two years after implementing a pharmacist-driven antimicrobial program without the support of an ID physician, one organisation had saved an estimated US$355,000.[15] The implementation of a 24-hour pharmacist-coordinated AMS service in a community hospital reduced antimicrobial expenditure from US$14.46 per adjusted patient day to US$11.22 per adjusted patient day after 12 months.[19]

The roles of community pharmacists in AMS and the opportunity for them to contribute to AMS have recently been articulated by the International Pharmaceutical Federation.[9] In addition to clinically reviewing and dispensing antimicrobial prescriptions, community pharmacists can educate patients and carers about using antimicrobials appropriately. Pharmacists providing medication management reviews can also contribute to AMS activities. In Scotland, specialist AMS pharmacists work across hospital and community care, and have a role in activities designed to influence the prescribing behaviour of general practitioners.[20] AMS pharmacists in England are considered leaders in implementing AMS interventions across the primary care and hospital sectors.[21] In Australia, Local Hospital Networks (LHNs) or Local Health Districts (LHDs), and Primary Health Networks may be able to identify opportunities through integrated care programs to implement strategies similar to those overseas.

The following sections include examples of how pharmacists can support AMS in different healthcare settings. For further details on the roles of pharmacy managers and AMS pharmacists, see Pharmacy managers and Roles of antimicrobial stewardship pharmacists.

Hospitals

Pharmacists can support AMS in hospitals in the following ways.

Review and assessment:

- Review prescribed antimicrobials for their appropriateness (for example, choice, dose, route, frequency, duration; history of allergies and adverse drug reactions to antimicrobials; drug interactions) and, if necessary, refer or intervene (for example, contact prescriber to discuss)
- Conduct subsequent reviews at 48 hours, on the documented review date, on transfer to another ward and on discharge
- Where applicable
  - recommend switch from intravenous to oral therapy, or appropriate therapeutic substitution(s)
  - review antimicrobial susceptibility results and provide advice (for example, streamlining therapy to narrow-spectrum agents, changing therapy if the microorganism is resistant)
  - notify prescriber if multiple antimicrobials that have overlapping spectrums of activity are prescribed
  - review therapeutic drug monitoring results for antimicrobials and provide advice
- Regularly review antimicrobials that are kept on ward imprest and in the pharmacy to limit access to restricted antimicrobials.

Supply and access:

- Ensure the adequate supply of, and timely access to, antimicrobials.

Counselling and advice:

- Counsel patients and their families or carers on the appropriate use of antimicrobials
- If appropriate, provide advice to prescribers of antimicrobials
- Act as liaison between the AMS team or AMS pharmacist and clinicians to advise on optimising the use of some antimicrobials (for example, colistin, fosfomycin).

Monitoring and feedback:

- Contribute to surveillance activities (for example, the National Antimicrobial Prescribing Survey and National Antimicrobial Utilisation Surveillance Program)
- Support or lead drug use evaluation studies, or quality audits, and provide feedback on antimicrobial use
- Provide relevant feedback to the AMS pharmacist and team.

Participation:

- Participate in health promotion and infection prevention measures (for example, Antibiotic Awareness Week)
- Participate in relevant committees (for example, drug and therapeutics, medication safety, infection control) and advise on the use of antimicrobials at the facility
- Contribute, where appropriate, to the development of antimicrobial prescribing guidelines and algorithms
- Lead or participate in AMS research.

Promotion and advocacy:

- Promote the use of the Antimicrobial Stewardship Clinical Care Standard
- Advocate appropriate documentation relating to antimicrobial prescribing (for example, start dates, stop or review dates, indications)
- Promote hand hygiene and other relevant infection prevention measures
- Advocate that formulary restrictions and practice guidelines are followed.

Education:

- Educate prescribers and others about the optimal use of antimicrobials.

This list was compiled from statements published by the Society of Hospital Pharmacists of Australia[2] and the American Society of Health System Pharmacists Council on Pharmacy Practice.[6]

Aged care homes

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Pharmacists can support AMS in aged care homes in the following ways.

Review and assessment:

- Review prescribed antimicrobials for their appropriateness (for example, choice, dose, route, frequency, duration; history of allergies and adverse drug reactions to antimicrobials; drug interactions) and, if necessary, refer or intervene (for example, contact prescriber to discuss)
- Conduct subsequent reviews at a documented review date
- Question the need for antimicrobial prescriptions that are for long-term or chronic use (for example, for several months).

Supply and access:

- Ensure the adequate supply of, and timely access to, antimicrobials.

Counselling and advice:

- Counsel patients and their families or carers on the appropriate use of antimicrobials
- If appropriate, provide advice to prescribers of antimicrobials.

Monitoring and feedback:

- Contribute to surveillance activities (for example, the Aged Care National Antimicrobial Prescribing Survey)
- Monitor antimicrobial use within the facility, and provide feedback and reporting to facility executives (for example, on antimicrobial use for urinary tract infections).

Participation:

- Participate in health promotion and infection prevention measures (for example, Antibiotic Awareness Week)
- Participate in relevant committees (for example, medication advisory committee) and advise on antimicrobial use at the facility
- Develop, support and maintain antimicrobial guidelines, algorithms, formularies and policies for the facility.

Promotion and advocacy:

- Promote the use of the Antimicrobial Stewardship Clinical Care Standard
- Advocate appropriate documentation relating to antimicrobial prescribing (for example, start dates, stop or review dates, indications)
- Promote the safe disposal of unwanted antimicrobials (for example, through the National Return and Disposal of Unwanted Medicines [NatRUM] program)
- Promote hand hygiene and other relevant infection prevention measures
- Promote and advise on immunisation (for example, influenza vaccination).

Education:

- Educate prescribers and others about the optimal use of antimicrobials.

Community

Pharmacists can support AMS in the community in the following ways.

Review and assessment:

- Review prescribed antimicrobials for their appropriateness (for example, choice, dose, route, frequency, duration; history of allergies and adverse drug reactions to antimicrobials; drug interactions) and, if necessary, refer or intervene (for example, contact prescriber to discuss)

- Question or investigate the need for antimicrobials that are for long-term or chronic use (for example, for several months)
- Question individuals who return with a repeat prescription after a long period, at which point the original infection would be expected to be resolved
- Assess the need for over-the-counter products containing antimicrobials when providing primary care advice to consumers and, if appropriate, refer them to their general practitioners
- Recommend alternatives to antimicrobials when antimicrobials are not indicated (for example, analgesics or decongestants for viral infections).

Supply and access:

- Ensure the adequate supply of, and timely access to, antimicrobials.

Counselling and advice:

- Counsel patients and their families or carers on the appropriate use of antimicrobials
- If appropriate, provide advice to prescribers of antimicrobials
- Advise patients to correctly dispose of unused antimicrobials
- Advise patients on the symptomatic management of coughs, colds and influenza.

Monitoring and feedback:

- If possible, monitor antimicrobial use and provide feedback to prescribers.

Participation:

- Participate in health promotion and infection prevention measures (for example, Antibiotic Awareness Week).

Promotion and advocacy:

- Promote the use of the Antimicrobial Stewardship Clinical Care Standard
- Promote the safe disposal of unwanted antimicrobials (for example, through the NatRUM program)
- Promote hand hygiene and other relevant infection prevention measures
- Promote and advise on immunisation (for example, influenza vaccination) and access to vaccination services.

Education:

- Educate prescribers and others about the optimal use of antimicrobials.

Home medicines reviews and residential medication management reviews

Pharmacists can support AMS in medication management reviews in the community sector in the following ways.

Review and assessment:

- Review prescribed antimicrobials for their appropriateness (for example, choice, dose, route, frequency, duration; history of allergies and adverse drug reactions to antimicrobials; drug interactions) and, if necessary, refer or intervene (for example, contact prescriber to discuss)
- Question or investigate the need for antimicrobials that are for long-term or chronic use (for example, for several months) and take action if use is inappropriate.

Supply and access:

- Ensure the adequate supply of, and timely access to, antimicrobials.

Counselling and advice:

- Counsel patients, and their families or carers about the appropriate use of antimicrobials
- If appropriate, provide advice to prescribers of antimicrobials.

Monitoring and feedback:

- If applicable, monitor antimicrobial use and provide feedback to the facility's executive.

Participation:

- Participate in health promotion and infection prevention measures (for example, Antibiotic Awareness Week).

Promotion and advocacy:

- Promote the use of the Antimicrobial Stewardship Clinical Care Standard
- Promote the safe disposal of unwanted antimicrobials (for example, through the NatRUM program)
- Promote hand hygiene and other relevant infection prevention measures
- Promote and advise on immunisation (for example, influenza vaccination) and access to vaccination services.

Education:

- Educate prescribers and others about the optimal use of antimicrobials.

11.2.2 Pharmacy managers

Pharmacy managers in hospital and community pharmacy practice have an important part to play in supporting AMS activities.

Hospitals

In the hospital setting, the pharmacy manager or their nominee has an important role in:

- Establishing communication and collaboration between the pharmacy workforce, microbiology and ID services, and the infection prevention and control service
- Maintaining the health service organisation's formulary
- Supporting the activities of relevant committees (for example, drug and therapeutics committee, medication advisory committee) in evaluating antimicrobials for inclusion in the organisation's formulary
- Ensuring the effective implementation of antimicrobial restriction systems
- Monitoring and reporting on antimicrobial use
- Ensuring that enough priority is given to the AMS program, including a suitable pharmacy workforce.

Different organisational models for AMS programs are in place in Australian hospitals. The AMS pharmacist generally has multiple lines of direct and indirect reporting and communication. These may include reporting to the heads of the departments of pharmacy, ID or infection prevention and microbiology, or to the chair of the AMS committee. Leadership responsibility for AMS generally resides with the pharmacy, ID or clinical microbiology department.

Community and aged care homes

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Pharmacy managers in community pharmacy and those responsible for the provision of services to aged care homes can set up processes to ensure that:

- Antimicrobial prescriptions are reviewed for appropriateness (that is, the most appropriate agent, dose, frequency, duration and indication), and checked for drug interactions, allergies and previous adverse drug reactions
- Antimicrobial prescriptions are written in line with prescribing policy (for example, the requirements of the Pharmaceutical Benefits Scheme and the Repatriation Pharmaceutical Benefits Scheme, or health service organisation policy)
- Antimicrobial prescriptions are correctly documented in the patient's dispensing history[13]
- Antimicrobial use is regularly monitored, and feedback is provided to prescribers and the management of aged care homes.

Pharmacists should consider whether there is still a clinical need to fill all prescriptions presented – for example, original and repeat prescriptions that are presented for dispensing several months after they were written (when it would be expected that the original infection would have resolved), or prescriptions for long-term use (for example, for several months). Such prescriptions should only be dispensed if the pharmacist is satisfied that the use is appropriate. If not, there should be discussion with the prescriber.

Community pharmacy is an important site of community education and activities for AMS in primary care because of the ease and frequency of the public's access to community pharmacists compared with other clinicians.[9] Community pharmacy managers are ideally placed to educate – or set up processes to educate – patients, carers and the pharmacy workforce about appropriate antimicrobial use, the problem of antimicrobial resistance (AMR), and infection prevention strategies.

It should be routine practice that consumers who have been dispensed antimicrobials, or their carers, are[22]:

- Counselled on the correct administration and storage of antimicrobials and the duration of therapy
- Informed of any potential adverse reactions or drug interactions – for example, between rifampicin and hormone contraceptives – and how to manage them
- Offered access to consumer medicines information and other written information (if appropriate), with the opportunity to ask questions
- Advised not to keep any unused antimicrobials, but to return them to a pharmacy for disposal.

In the pharmacy, processes should also be in place to ensure that antimicrobials are dispensed safely and in a timely manner, and stored and disposed of appropriately (for example, through the NatRUM program).

In Australia, pharmacy services to aged care homes are mostly provided by community pharmacies and pharmacists providing residential medication management reviews. Managers of those services should foster good communication and collaboration between pharmacy staff, the general practitioner, and the facility's executive and workforce to ensure optimal antimicrobial use. They can also lead or enable processes to:

- Set up and maintain an antimicrobial prescribing policy or formulary
- Review antimicrobial prescribing and antimicrobial use regularly
- Educate the workforce, residents, and their families and carers about using antimicrobials appropriately.

Pharmacists who pack dose administration aids for aged care homes can also identify inappropriate use, such as long-term continuation of therapy, and follow such use up with the prescriber.[23]

11.2.3 Roles of antimicrobial stewardship pharmacists

The main roles of an AMS pharmacist are to lead the AMS program or collaborate with the AMS program leader and others to coordinate the activities of the health service organisation's AMS program. More and more pharmacists are taking the lead role in hospital and community AMS programs, especially where there is no on-site ID physician or clinical microbiologist.[15,21,24]

Most of the evidence for the roles of AMS pharmacists is from the hospital sector, and the roles described relate mainly to hospitals with an on-site pharmacy service. However, these roles can be adapted by health service organisations that do not have an on-site pharmacy (for example, small hospitals, community health services and aged care homes), and by LHNs/LHDs or hospital groups establishing an AMS program across several sites.

Depending on demand, the AMS pharmacist may be full time or part time, and may have a role across the LHN or LHD. In the latter situation, the AMS pharmacist may be responsible for supporting a range of AMS activities across several hospitals and community services (see Case study 2.1 in Chapter 2: 'Establishing and sustaining an antimicrobial stewardship program'). At the individual hospital level, AMS pharmacists may provide clinical services to patients in addition to contributing to AMS program activities.[25] Other models include incorporating AMS activities into the roles and responsibilities of the pharmacist responsible for drug use evaluation (DUE) studies or the quality use of medicines.

In small hospitals or aged care homes, the pharmacist providing services may also be responsible for AMS. Where there is no pharmacist on site, AMS support may be provided by the LHN/LHD AMS pharmacist or the AMS pharmacist at the regional hospital (see Case study 2.1 in Chapter 2: 'Establishing and sustaining an antimicrobial stewardship program' and Case study 3.1 in Chapter 3: 'Strategies and tools for antimicrobial stewardship'). Regardless of the various roles and responsibilities, it is important that enough time and resources are provided for pharmacists to support AMS activities.[1,26]

Other roles and responsibilities of pharmacists with direct responsibility for AMS activities are discussed in Sections 11.3–11.8. These may provide a basis for a position description for an AMS pharmacist working across various settings.

11.3 Leadership

AMS pharmacists should show leadership in the AMS program, and advocate the implementation of activities that aim to improve the prescribing and quality use of antimicrobials. This may include being involved in health promotion and awareness campaigns (such as Antibiotic Awareness Week) and representing the health service organisation in forums relating to AMS.

Leadership may also include leading the AMS program in community-based health services or small hospitals, and providing leadership or expertise at the LHN/LHD, state or territory, or national level. AMS pharmacists should also support the pharmacy workforce and other clinicians on issues related to the local AMS program – for example, by resolving differences of opinion about antimicrobial prescribing practices or when there is a failure to comply with restrictions.[27]

AMS pharmacists should keep abreast of the current literature on AMS and new or revised prescribing guidelines, and advise the AMS committee on new interventions and guideline revisions.

11.3.1 Promoting uptake and compliance with national standards for antimicrobial stewardship

The AMS pharmacist can promote the uptake or implementation of the Antimicrobial Stewardship Clinical Care Standard as part of routine patient care.[13]

The AMS pharmacist should play a key role in the health service organisation's efforts to implement and evaluate an AMS program that meets the AMS criterion in the NSQHS Preventing and Controlling Healthcare-Associated Infection Standard.[28] They should be familiar with the requirements for AMS in the standard, and work with the AMS committee to ensure that evidence demonstrating compliance is available and that its currency is maintained. A number of Resources are available to assist health service organisations to implement the NSQHS Standards.

11.3.2 Developing and maintaining antimicrobial guidelines

The AMS pharmacist should work with the microbiology, ID and other departments to develop and maintain:

- Antimicrobial prescribing guidelines, including unit protocols (for example, guidelines for antimicrobial use for febrile neutropenia)[2,6,11] (see Section 3.2 in Chapter 3: 'Strategies and tools for antimicrobial stewardship')
- Policies for therapeutic drug monitoring of antimicrobials (for example, aminoglycosides, glycopeptides, azole antifungals), and training for clinicians about safe and effective dosing practices[27]
- Access to the latest versions of *Therapeutic Guidelines: Antibiotic*[29] and endorsed local prescribing guidelines, both hard copy and electronic.

11.4 Expert advice

AMS pharmacists can provide expert advice to assist in individual patient care or for AMS more generally.

11.4.1 Providing expert advice to clinicians, patients and carers

AMS pharmacists can advise other pharmacists and prescribers on the management of antimicrobial therapy in individual patients. The advice may be on the choice, dose, route and duration of antimicrobial therapy.[1,2,6] Dose optimisation – based on individual patient characteristics, causative organisms, the site of infection, pharmacokinetic and pharmacodynamic characteristics of the antimicrobial, and therapeutic drug monitoring – has been cited as an important part of AMS[1] and one that AMS pharmacists are well placed to advise on. Prospective review of antimicrobial orders and timely follow-up with the prescriber by an AMS pharmacist can reduce inappropriate antimicrobial prescribing and improve clinical outcomes.[1,7] AMS pharmacists can also assess those cases that require input from clinical microbiologists or (AMS) ID physicians.[27]

Providing expert advice includes informing senior management and relevant medical units about the AMS program and activities within the organisation and, where applicable, counselling patients or their carers on the appropriate use of antimicrobials (see Community and aged care homes).

11.4.2 Participating in antimicrobial stewardship ward rounds

AMS pharmacists in hospitals should actively participate in ward rounds with the AMS team. Their inclusion has been shown to decrease antimicrobial consumption and expenditure.[17,30,31] This may include regular rounds in units with complex antimicrobial management issues, such as intensive care or haematology units[27], as well as reviews of individual patients referred to the AMS team or identified by the AMS pharmacist. The latter may include patients who have been prescribed specific antimicrobials, who are receiving therapy not supported by microbiological tests or who have documented treatment failure.[30] Where information technology systems are available, patients may be identified through electronic clinical decision support systems and electronic healthcare records (see Section 4.2.3 in Chapter 4: 'Information technology tools to support antimicrobial stewardship').[32-35]

During the ward round, the pharmacist and the AMS team should review the patient's microbiological, pathology and diagnostic imaging results, and the medicines prescribed (see Section 3.4 in Chapter 3: 'Strategies and tools for antimicrobial stewardship'). The AMS pharmacist can provide expert advice relating to the ongoing management of the patient's antimicrobial therapy.

11.4.3 Initiating point-of-care interventions

AMS pharmacists can play a leading role in implementing policies and activities that promote safe and appropriate antimicrobial use at the point of care at the bedside or in the community pharmacy (see Section 3.5 in Chapter 3: 'Strategies and tools for antimicrobial stewardship'). These interventions are able to be performed in health service organisations where there are no on-site ID or clinical microbiology services.[24,36] Interventions include:

- Streamlining therapy to narrow-spectrum agents when culture and sensitivity results are available[1,25]
- Identifying therapy to which the targeted microorganism is resistant[24,36]
- Therapeutic substitution of antimicrobials[25]
- Dose optimisation
- Antimicrobial stop orders[25]
- Promoting switching from intravenous to oral antimicrobials, when this is safe and appropriate for the patient[1,27,37]
- Supporting systems for obtaining and recording approvals for restricted antimicrobials, such as mandatory order forms, or telephone or online approval systems[1,38]
- Notifying prescribers of multiple antimicrobials with overlapping spectrums of activity
- Developing and disseminating clinical decision support tools, such as antimicrobial dosing cards for common infections, or facilitating their uptake into electronic systems.

An appropriately trained AMS pharmacist, working within their scope of practice, may be involved in ordering laboratory diagnostic tests relating to the management of infection in a patient (for example, therapeutic drug monitoring for vancomycin, aminoglycosides and azole antifungals), or may have the authority to approve the use of restricted antimicrobials. The pharmacist may also use, or provide input into the application of, tests for acute-phase reactants such as C-reactive protein and procalcitonin in monitoring and potentially decreasing the duration of antimicrobial therapy.

11.5 Formularies and approval systems

Restricted formularies and antimicrobial approval systems are effective in improving antimicrobial use (see Section 3.3 in Chapter 3: 'Strategies and tools for antimicrobial stewardship'). AMS pharmacists can support and help to maintain the organisation's antimicrobial restriction systems by:

- Participating in the management of the antimicrobial formulary (for example, reviewing the evidence for the inclusion of new antimicrobials in, or the deletion of existing antimicrobials from, the formulary)
- Reviewing and approving or declining requests for restricted antimicrobials; where an ID physician is available, the pharmacist may refer more complex or non-standard requests to the physician, thereby performing a 'triage' process for requests for restricted antimicrobials
- Updating the medicines formulary and antimicrobial prescribing guidelines in line with decisions of the drug and therapeutics committee or medication advisory committee (for example, updating information and alerts within clinical decision support systems for electronic prescribing, dispensing and antimicrobial approval systems; see Chapter 4: 'Information technology to support antimicrobial stewardship')
- Educating and supporting other pharmacists who provide the clinical and dispensary services to enforce antimicrobial prescribing programs and policies, and to encourage compliance with prescribing guidelines[2,6] (for example, providing advice, with support from the AMS team, if clinicians wish to prescribe outside the guidelines[25])
- Monitoring compliance with the organisation's antimicrobial prescribing policies (see Chapter 6: 'Measuring performance and evaluating antimicrobial stewardship programs'), and liaising (where appropriate) with clinical microbiologists, ID physicians and other relevant individuals.

11.6 Monitoring antimicrobial use and evaluating interventions

Pharmacy data can inform local and national AMS programs (see Chapter 6: 'Measuring performance and evaluating antimicrobial stewardship programs').

AMS pharmacists should generate and collate reports on antimicrobial use for the AMS team; the drug and therapeutics, medication advisory and infection control committees; health service organisation executives or administrators; and the heads of clinical units. The reports may include:

- Regular reports of antimicrobial use and expenditure from pharmacy records, such as total use, use of restricted antimicrobials, or use of specific antimicrobial groups at the hospital or clinical unit level
- Hospital antimicrobial use rates (for example, in defined daily doses per 1,000 occupied bed days) compared with relevant peer group averages for hospitals participating in the National Antimicrobial Utilisation Surveillance Program, or state or territory surveillance programs.

AMS pharmacists may also be involved in activities to assess and improve the quality of antimicrobial use, such as:

- Point prevalence or quality improvement surveys – the National Antimicrobial Prescribing Survey (NAPS), the Surgical NAPS or the Aged Care NAPS
- DUE studies and audits of a specific antimicrobial or group of antimicrobials against *Therapeutic Guidelines: Antibiotic*[29] or endorsed local prescribing guidelines – for example, indications for prescribing, sensitivity to the antimicrobial, use as empirical therapy versus treatment, doses prescribed, duration of therapy
- Measuring and monitoring indicators, including structure, process, outcome and balancing measures
- Local or collaborative projects, such as those organised by states, territories or the National Centre for Antimicrobial Stewardship.

If possible, the AMS pharmacist should also be actively involved in leading, coordinating or participating in research and practice development activities relating to AMS.[27] The AMS pharmacist should be encouraged and supported to publish the results of AMS initiatives in peer-reviewed publications and to present at conferences.[27]

11.7 Liaison

AMS pharmacists can facilitate interaction between the pharmacy and the microbiology or ID departments.[27] Liaising with other departments and committees on behalf of the pharmacy department or AMS service is an important role for AMS pharmacists (Table 11.1).[2,6]

Pharmacists responsible for AMS can liaise with colleagues and AMS experts through professional organisations (see Section 1.5 in Chapter 1: 'Evidence for antimicrobial stewardship').

11.8 Education

Pharmacists with AMS roles will need specific training, and can also train other clinicians.

11.8.1 Antimicrobial stewardship education for pharmacists

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Pharmacists working in the community, aged care homes and hospitals are encouraged to complete continuing professional education on managing common infections, using antimicrobials appropriately and reducing the risk of AMR. NPS MedicineWise provides a range of tools and resources for pharmacists to develop and maintain these skills, such as national case studies and pharmacy practice reviews (see Appendix A).

Specialist AMS pharmacists should be experienced clinical pharmacists with expertise in antimicrobials and the therapeutic management of infectious diseases.[25,27] Postgraduate training in ID or AMS and the ability to effectively interact with senior clinicians are highly desirable attributes for an AMS pharmacist.[25,39] Skills or knowledge in quality improvement and interventions that influence prescriber behaviour are also desirable.

Formalised training programs and courses for pharmacists to specialise in AMS in Australia are limited. Most AMS pharmacists have gained their knowledge and expertise through on-the-job training with ID physicians and clinical microbiologists, or with pharmacist mentors. However, educational opportunities – from seminars and university units to online courses – are increasingly becoming available to help Australian pharmacists to improve their knowledge and skills in ID and AMS (see Appendix A). Guidance on knowledge and skills required for AMS leaders has been published and can be used by individual pharmacists to identify gaps in their knowledge and practice (see Chapter 5: 'Antimicrobial stewardship education for clinicians').[40]

Table 11.1: Pharmacy liaison with departments and committees within a health service organisation

Department or committee	Liaison activity
Microbiology, infectious diseases and other departments	• Maintaining antimicrobial formularies • Introducing new antimicrobials • Monitoring for unexpected changes in antimicrobial use patterns • Developing policies related to AMS activities[11,25] • Managing antimicrobial shortages and out-of-stock occurrences • Managing the supply of unregistered antimicrobials • Updating hospital antimicrobial prescribing guidelines • Describing changes in antimicrobial sensitivities • Developing antibiograms
Committees and management	• Reporting on antimicrobial use • Communicating results from prescribing audits and DUE studies • Ensuring compliance with national standards • Communicating outcomes of specific AMS intervention strategies • Participating in relevant committees, such as the – AMS committee or the antimicrobial subcommittee of the drug and therapeutics committee[25], for which the AMS pharmacist may provide secretarial support – infection prevention and control committee[25] – medication safety committee
Information technology	• Being involved in advising on the functional specifications and implementation of electronic decision support systems for AMS • Developing standard reports on antimicrobial use • Developing alerts/reports from EHR systems that identify patients for review[33] • Developing and maintaining alerts within EHRs or clinical decision support software systems to target inappropriate prescribing[32] • Developing and maintaining order sets, order forms and dose-checking alerts in electronic medication management systems[32] • Developing tools to communicate and record AMS recommendations and interventions[32]

AMS = antimicrobial stewardship; DUE = drug use evaluation; EHR = electronic healthcare record

11.8.2 Pharmacists' role in education

The AMS pharmacist's role in educating clinicians and consumers may involve:

- Educating clinical staff and students on the principles of appropriate antimicrobial prescribing and AMS, the AMS criterion in the NSQHS Preventing and Controlling Healthcare-Associated Infection Standard, the quality statements in the Antimicrobial Stewardship Clinical Care Standard, and the concept of AMR[2,27]
- Informing prescribers about antimicrobial prescribing guidelines and policies, including educating junior doctors during their orientation, reinforcing information at roster changes, and presenting results of clinical audits and DUE studies in forums such as medical teaching rounds[27]
- Using active educational techniques, such as academic detailing, which uses one-on-one education sessions with clinicians[7,41](see Chapter 5: 'Antimicrobial stewardship education for clinicians')
- Providing feedback to clinicians and hospital executives on the results of prescribing audits and measurement of indicators (see Chapter 6: 'Measuring performance and evaluating antimicrobial stewardship programs')
- Educating and providing information to consumers, patients and carers (see Chapter 7: 'Involving consumers in antimicrobial stewardship').

Resources

Pharmacists and antimicrobial stewardship

- Society of Hospital Pharmacists of Australia: *Antimicrobial Stewardship – Prevent and reduce infections and antimicrobial resistance* fact sheet
- International Pharmaceutical Federation: *Fighting Antimicrobial Resistance: The contribution of pharmacists*
- Royal Pharmaceutical Society: *The Pharmacy Contribution to Antimicrobial Stewardship*
- Royal Pharmaceutical Society: Antimicrobial resistance and stewardship
- Society of Infectious Diseases Pharmacists: Resources
- American Society of Health-System Pharmacists: *ASHP Statement on the Pharmacist's Role in Antimicrobial Stewardship and Infection Prevention and Control*

Education

- Training and educational resources for pharmacists: see Appendix A
- Royal Pharmaceutical Society: *Infection and Antimicrobial Stewardship: Expert professional practice curriculum*

Other resources

- Infectious Diseases Specialty Practice Stream, facilitated by the Society of Hospital Pharmacists of Australia
- National Return and Disposal of Unwanted Medicines program

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Appendix A: Examples of training and educational opportunities for AMS pharmacists

Setting	Institution	Course type
Australian	National Centre for Antimicrobial Stewardship	AMS seminars for specific professionals
	Society of Hospital Pharmacists of Australia	Introduction to Infectious Diseases Clinical Seminar
	NPS MedicineWise	Online learning modules relating to antimicrobial use, case studies and pharmacy practice review audits
	Monash University	Accredited unit in Infectious Diseases Pharmacotherapy
International	Society of Infectious Diseases Pharmacists, USA	Antimicrobial Stewardship Certificate programs for: • Acute care • Long-term care
	Stanford University, USA	Antimicrobial Stewardship: Optimization of Antibiotic Practices
	European Society of Clinical Microbiology and Infectious Diseases	Various AMS training courses
	British Society for Antimicrobial Chemotherapy, University of Dundee and Future Learn	Massive Open Online Course (MOOC) – Antimicrobial Stewardship: Managing Antibiotic Resistance

AUSTRALIAN COMMISSION ON SAFETY AND QUALITY IN HEALTH CARE

12 Role of nurses, midwives and infection control practitioners in antimicrobial stewardship

Antimicrobial Stewardship in Australian Health Care

2018

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Acronyms and abbreviations

Abbreviation	Definition
AMR	antimicrobial resistance
AMS	antimicrobial stewardship
ICP	infection control practitioner
ID	infectious diseases

Key points

- Successful implementation of antimicrobial stewardship (AMS) programs requires collaboration between all members of the healthcare team.
- Nursing and midwifery practice activities that support the goals of AMS include
  - assessment, care planning and patient monitoring
  - medication management
  - collaborating with multidisciplinary team members
  - coordinating care.
- Support for nurse and midwife involvement in AMS activities should be promoted across health service organisations.
- Nurses and midwives in leadership positions have specific roles in facilitating the engagement of this important workforce.
- The involvement of nurses and midwives in AMS should be supported and enabled through
  - AMS policies that include the role of nurses and midwives in AMS
  - explicit executive, and AMS committee and team support
  - AMS educational strategies and resources specific to the nursing and midwifery role and scope of practice.

12.1 Introduction

Antimicrobial resistance (AMR) can affect patients in all healthcare settings and, as a result, antimicrobial stewardship (AMS) concerns all clinicians.[1] AMS requires the expertise and resources of all team members to ensure the safe and appropriate use of antimicrobials. It extends beyond prescribing to encompass antimicrobial administration, patient monitoring and review, patient and carer education, and infection prevention and control.

To date, AMS programs have primarily targeted the practices of doctors, microbiologists and pharmacists, and few studies have explored the role of nurses and midwives.[1-4] However, professional associations and experts, internationally and in Australia, highlight that nurses, midwives and infection control practitioners (ICPs) play key roles in preventing and controlling AMR.[4-10] They can help to safeguard the effectiveness of antimicrobials through infection prevention and control, education, and involvement in AMS activities. This applies in all settings, especially those with no infectious diseases (ID), microbiology or pharmacy services on site.

This chapter explores the role of nurses, midwives and ICPs in AMS; the ways in which AMS can be integrated into routine nursing and midwifery practice; and key areas of influence. Options are provided for strengthening engagement. The specific role of specialist and advanced practice nurses and midwives is also considered.

The chapter is a useful guide for AMS teams looking to improve the involvement of nurses and midwives in AMS programs, and for nurses and midwives who want to be more formally involved in AMS programs and better understand their potential contribution.

Issues that are especially relevant for certain settings – rural and remote hospitals, private hospitals and aged care – are tagged as R, P and AC, respectively, throughout the text.

R P AC

12.2 Nursing and midwifery practice and antimicrobial stewardship

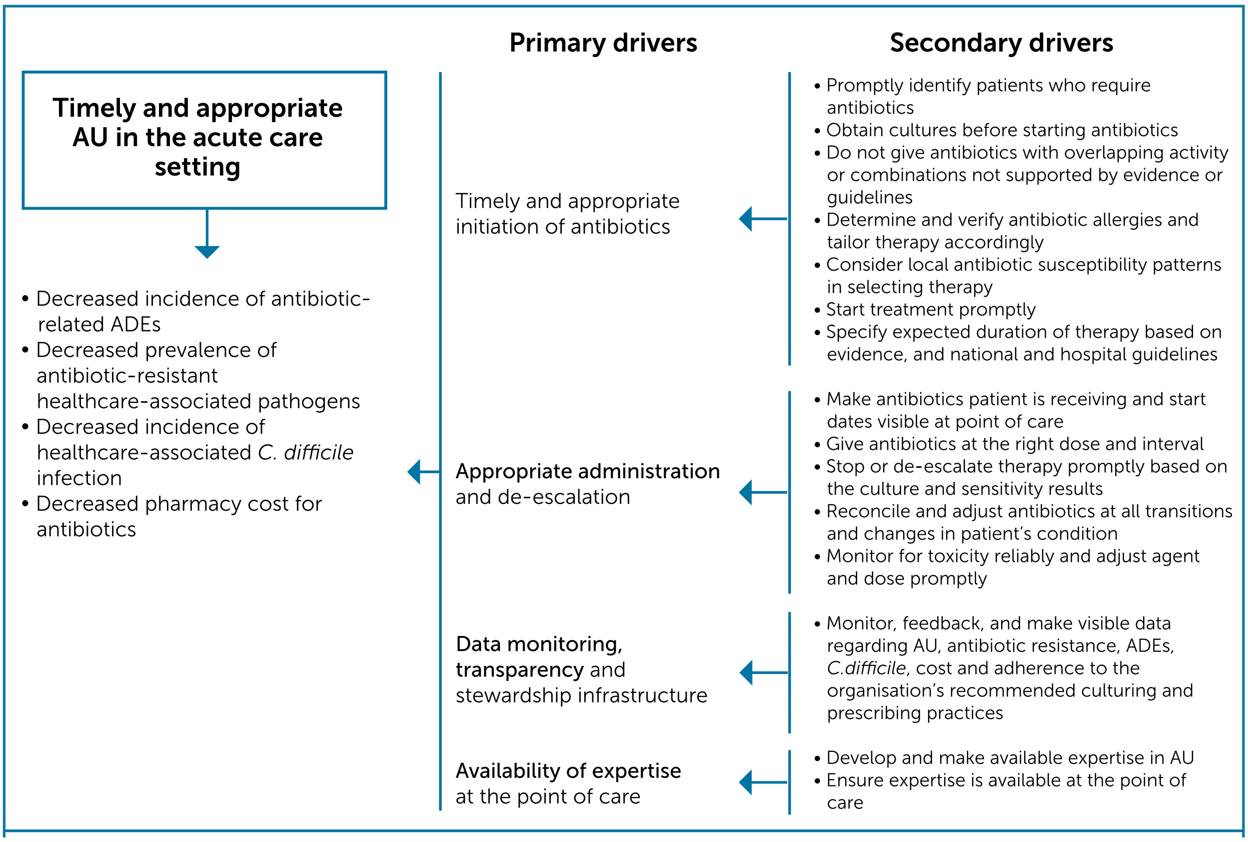
Nurses and midwives make up more than half of the Australian health workforce and are involved in all aspects of patient care.[2,4] Nurses and midwives apply a person-centred and holistic approach to their practice.[10,11] They are a constant in the patient journey and advocate for patients, and their contribution to patient safety and quality of care is acknowledged.[12]

The key drivers for successful AMS in acute care settings are described in the United States Centers for Disease Control and Prevention's AMS driver diagram (Figure 12.1) Both the primary and secondary drivers of AMS depend on nursing and midwifery participation and action, highlighting the importance of nurse and midwife involvement.[4] See also the driver diagrams in Section 2.5.5 of Chapter 2: 'Establishing and sustaining an antimicrobial stewardship program').

Nursing and midwifery practice involves patient assessment, the development and implementation of patient care plans, and evaluation of outcomes.[14] Many of these activities overlap with AMS functions[6] and are consistent with the goals of AMS: to improve patient safety and outcomes, reduce AMR, and minimise healthcare costs. Examples include recognising signs of sepsis, assessing infection risk and making decisions about precautions to be put in place, implementing standard and transmission-based precautions and practices to prevent infections associated with invasive medical devices, administering antimicrobials safely, monitoring patient responses, and educating patients and their carers about safe and appropriate medication use. Nurses and midwives can therefore play a significant role in AMS by embedding AMS principles into routine practice.[6] Table 12.1 summarises nursing and midwifery practice activities that support AMS; many of them align with the quality statements of the Antimicrobial Stewardship Clinical Care Standard.[15]

There are specific aspects of AMS that would benefit from formalising nursing and midwifery involvement. For example, nurses and midwives in all settings could be empowered to initiate discussion of antimicrobial indication and duration of therapy to ensure that medicines are ceased or reviewed in line with clinical need.[16] In hospital settings, this could include antimicrobials for surgical prophylaxis, for which high rates of inappropriate prescribing have been reported.[17,18] Also in hospital settings, nurses[19] and midwives can be supported to promote changing from intravenous

Figure 12.1: Driver diagram for acute care



ADE = adverse drug event; AU = antibiotic use
Source: Adapted from US Centers for Disease Control and Prevention[13]

Table 12.1: Nursing and midwifery practice activities that support and influence antimicrobial stewardship

Practice area	Specific activities
Assessment, monitoring and early response	• Conduct nursing and midwifery assessment and care planning, incorporating history of allergies, adverse events and risk of infection • Identify and escalate patients with signs of acute deterioration or serious infection • Document and communicate assessment findings to healthcare team members • Implement nurse- and midwife-led clinical pathways and protocols for acute deterioration, including sepsis pathways
Infection prevention and control	• Assess the risk of acquiring and transmitting an infection • Identify patients who are likely to be colonised or infected with multidrug-resistant organisms • Instigate and promote compliance with standard and transmission-based precautions (e.g. hand hygiene) • Detail infection signs and symptoms in care plans or healthcare records
Microbiological specimen collection	• Correctly collect microbiological specimens when indicated • Ensure timely transfer of microbiological specimens to laboratories to maintain specimen quality
Medication management and safety	• Review and recognise when treatment is not in line with microbiological results, and highlight this to prescribers • Follow medication safety principles, incorporating the nine 'rights'[20] to prevent errors – five rights of medication administration: patient, drug, route, time and dose – four other rights: documentation, action, form and response • Speak up about or question antimicrobial management that is not in line with policy and guidelines • Ensure timely administration of antimicrobials, including the first dose for sepsis • Check the patient's allergy status before administration[21] • Administer antimicrobials via the correct route, and recognise when patients are able to tolerate oral intake and could switch from intravenous to oral antimicrobials • Support appropriate documentation for prescribed antimicrobials: generic name, dose, time, route, indication, and review and stop date • Reduce the incidence of missed antimicrobial doses • Administer intravenous antimicrobials at the right rate and dilution • Monitor duration of treatment and promote timely patient review • Support timely therapeutic drug monitoring to ensure that antimicrobials that perform optimally within a specific therapeutic level are in line with recommended guidance • Monitor the patient to assess whether the antimicrobial has the intended effect, and to identify allergic responses and unwanted effects • Support the timely cessation of antimicrobial therapy • Correctly dispose of unused antimicrobials

Practice area	Specific activities
Transitions of care (including end-of-life care)	• Assess the patient's suitability for discharge or transfer • Include infection risks or issues in clinical handover communications when care is transferred (e.g. on admission, discharge, transfer of care to another practice or clinician) • Identify patients suitable for, and support safe transitions to, outpatient antimicrobial therapy • Ensure appropriate documentation • Arrange or coordinate a follow-up for review of antimicrobial therapy, if required • Discuss issues concerning antimicrobial therapy at the end of life with patients, carers and other members of the healthcare team as part of planning for end-of-life care
Patient education	• Educate patients and carers about – infection prevention and control, including the importance of hand hygiene – safe and appropriate antimicrobial use, including the importance of timely administration and review when concerned • Advocate for patients to be involved in decision-making about management and care
Collaboration	• Contribute to the development of policies and guidelines • Participate in committees and teams responsible for developing AMS resources • Participate in AMS quality improvement projects and initiatives

AMS = antimicrobial stewardship

to oral medicines, which reduces the risk of infection due to indwelling devices and enables earlier discharge (see Section 3.5 in Chapter 3: 'Strategies and tools for antimicrobial stewardship').

The extent of nurses' and midwives' participation in AMS will depend on the context, and their level of practice and competence. Experienced nurses and midwives have considerable knowledge, understanding and skills acquired through practice, which are often complemented by postgraduate education. These individuals can apply their nursing and midwifery experience and knowledge to contribute to AMS in specific settings; to the development of AMS policies, quality improvement initiatives and education; or to participation in the AMS committee or team. More experienced nurses and midwives are often in clinical leadership roles, and are well placed to champion nursing and midwifery involvement in AMS.

R P In settings that have reduced access to pharmacy and ID services, such as private or small hospitals, nurses or midwives may also be required to coordinate local AMS activities. However, nurses and midwives complement rather than replace the specialist pharmacy and medical expertise. Nurses coordinating AMS programs require specialist support, resources and education. See Chapter 2: 'Establishing and sustaining an antimicrobial stewardship program'.[22,23]

12.3 Facilitating nursing and midwifery involvement

The involvement of nurses and midwives in AMS can be supported and enabled through explicit engagement strategies, and by providing relevant education and resources. The focus should be on enabling and empowering them to use their specific knowledge and skills to influence AMS, and on ensuring that appropriate infrastructure, education and resources are available to support their participation.

12.3.1 Planning for nursing and midwifery involvement

An approach to planning, implementing and sustaining AMS programs has been outlined in Chapter 2: 'Establishing and sustaining an antimicrobial stewardship program'.

In planning for nursing and midwifery involvement in AMS, it is essential that nurses and midwives collaborate with the local AMS team to ensure that activities are consistent with the broader AMS program goals. A suggested starting point for nurses and midwives is to meet with members of the AMS team (whether on site or as part of a network or group) to gain an understanding of the local AMS program, including program goals, priorities and strategies, and the roles of different team members.

There is literature indicating that nurses and midwives may be unsure about their role in AMS, citing competing workload priorities as a factor that limits their involvement in AMS programs.[24,25] Planning should incorporate discussion with nurses and midwives about their perceptions of their role and contribution, and factors seen to be barriers or enablers to their participation (see Chapter 2: 'Establishing and sustaining an antimicrobial stewardship program'). Understanding this viewpoint will enable a tailored approach to increasing nurse and midwife involvement that is achievable within the local context. The nursing or midwifery team can then assess the current situation in terms of their existing involvement in AMS, using the advice and information from the AMS team to identify any gaps in knowledge or skills, opportunities for involvement or improvement, and resources or support needed. It may be helpful to consider the activities listed in Table 12.1 and use them to inform a baseline assessment to identify priorities for improvement.

In hospitals, planning and priority setting may be conducted within a ward or unit; in smaller hospitals, it may involve nurses and midwives from across the hospital. In general practice settings, practice nurses and midwives could discuss issues with the practice team, or a single practice nurse or midwife could do a self-assessment or arrange to meet with others within the primary care network.

When establishing priorities, it may be helpful to consider the quality statements of the Antimicrobial Stewardship Clinical Care Standard[15], which promote timely treatment, documentation, optimal collection and transportation of specimens for culture to enable targeted therapy, and patient and carer education. The standard could be used as the basis of a gap analysis to identify where nurses and midwives could maximise their contribution to AMS. Priorities could include[3,4,6,22]:

- Prompting prescribers to
  - obtain cultures before starting therapy
  - obtain approval for prescribing restricted antimicrobials
  - use *Therapeutic Guidelines: Antibiotic*[26] or local guidelines based on it
  - review antibiotics after 48 hours or a documented review date
- Communicating microbiology results to prescribers in a timely way, to enable treatment to be targeted to a narrow-spectrum agent or ceased, if appropriate[4]
- Promoting documentation of indication, drug name, dose, route of administration, duration and review plan[9]
- Educating patients and their carers about taking antimicrobials as prescribed, how long to take them for, any potential side effects, and whether treatment will need to be reviewed
- Implementing nursing and midwifery clinical pathways; for example
  - switching from intravenous to oral delivery
  - sepsis pathways.

Handover communication is another important area in which nurses and midwives can implement AMS principles. Nurses and midwives are routinely responsible for handover of care within a hospital, between health services or when patients are discharged from care. Nurses and midwives can ensure that medicines are considered at each transition of care, and that clear information is provided to the patient, carer and receiving clinician (see Section 10.3.2 in Chapter 10: 'Role of prescribers in antimicrobial stewardship'). This also applies to end-of-life care, in which there is some evidence that patients receive antimicrobial therapy inappropriately (see Chapter 10: 'Role of prescribers in antimicrobial stewardship'). Nurses' understanding of patient needs at this time has been described.[27]

Engaging nursing and midwifery managerial leaders, including nursing or midwifery managers and the executive, and clinical leaders, such as clinical nurse and midwife consultants, practitioners, educators and ICPs, in discussions is important. Nurse and midwife leaders are often in a position to empower other nurses and midwives to consider the 'bigger picture' of the workplace, and help to ensure that any changes are adequately supported, and are within the scope of nursing and midwifery practice and existing resources (see Box 12.1). This may be more applicable in the hospital setting, but the primary care sector could also promote such leadership opportunities for practice nurses and midwives. Another part of a nurse's or midwife's leadership role is to work with other organisational and clinical leaders to promote engagement and encourage collaborative work environments to support AMS.[28]

Box 12.1: Nurse and midwife leadership and engagement

Nursing and midwifery leadership and engagement may involve:

- Promoting antimicrobial stewardship (AMS) as a patient safety activity[2]
- Working with nurses and midwives to help them appreciate and understand the significance of their role in AMS
- Facilitating nurse and midwife participation in formalised education programs[2]
- Ensuring that members of the multidisciplinary team and executive are clear about how nurses and midwives will be involved in AMS efforts in the local context
- Promoting nurse and midwife representation on relevant teams and committees responsible for developing antimicrobial policies and guidelines
- Advocating nurses' and midwives' involvement in AMS rounds and other care activities in which individual patient progress and antimicrobial therapy are discussed
- Supporting nurses and midwives in quality improvement activities and projects that aim to improve infection prevention and control or AMS
- Reviewing clinical pathways to include nurse- or midwife-initiated actions (e.g. prompt for intravenous-to-oral switching, flag patients for review by the AMS team)
- Identifying and supporting AMS nurse and midwife champions
- Encouraging nurses and midwives to participate or take the lead in activities for Antibiotic Awareness Week
- Ensuring that audit results are shared with nurses and midwives.

12.3.2 Promoting a safety culture

A positive safety culture is an important factor in successful AMS. Collaboration and effective teamwork are characteristics of a positive safety culture. As part of this, healthcare team members are enabled to speak up freely and question antimicrobial management if there are concerns about patient safety.

It has been argued that the capacity for nurses to discuss or question antimicrobial management choices is closely connected to the construct of power and knowledge, especially within the acute care context.[3] For example, they may be uncertain about questioning antimicrobial management if they perceive that local hierarchies and working relationships do not support this.[3] Also, nurses and midwives may rely on guidelines and local policy to influence prescribing, but this contribution may be undermined when junior prescribers consider the prescribing preferences of senior clinicians to be more important than evidence-based guidelines or policy.[3,23,29-31] Acknowledging and promoting AMS as an organisation-wide patient safety program that is multidisciplinary, and including nurses and midwives as key team members and participants in AMS, will help to confirm their position. Such acknowledgement should come from both managerial and clinical leaders from all disciplines and, importantly, the AMS committee and team. Including nurses and midwives on multidisciplinary committees and teams responsible for AMS further formalises recognition of their contribution. Supporting nursing and midwifery participation in AMS or team rounds can also help to ensure that their role is acknowledged, enable a shared understanding of the nursing and midwifery role, and promote improved communication and cooperation between team members.[3] Internationally, professional societies and government policies recommend having nurses and midwives on AMS committees.[16]

Establishing processes that formally encourage and support nurses and midwives to speak up without criticism may also help to involve nurses and midwives in AMS. This approach has been adopted in many patient safety initiatives aimed at improving teamwork, including the Comprehensive Unit-Based Safety Program (see Section 2.3.1 in Chapter 2: 'Establishing and sustaining an antimicrobial stewardship program').[32,33]

Strategies to enable nurse and midwife involvement in AMS are summarised in Table 12.2.

Table 12.2: Summary of strategies to support the involvement of nurses and midwives in antimicrobial stewardship

Role	Action
Executive, managers, and nurse and midwife leaders	• Promote a positive workplace culture, including promoting AMS as an organisation-wide multidisciplinary patient safety program • Formally acknowledge the role of nurses and midwives in AMS • Establish rules and procedures that empower nurses and midwives to speak up about antimicrobial management • Ensure that nurses and midwives have access to antimicrobial prescribing policies and guidelines at the point of care • Ensure that nurses and midwives know how to access – expert advice on antimicrobial management – pathways to escalate if there are serious concerns • Provide access to education on AMS, including face-to-face sessions and online learning modules • Support quality improvement activities and projects that focus on improved practice in infection prevention and control, and AMS
AMS committee and team (in collaboration with nursing and midwifery teams)	• Include nurses and midwives on AMS committees and teams (relevant to the facility) • Engage nurses and midwives in development, review and implementation of AMS strategies, tools and resources • Advocate for nurses and midwives to be included in AMS strategies, and publicly support rules and procedures to empower them in their role • Make antimicrobial prescribing policies, and formulary restrictions and guidelines accessible at the point of care • Include nurses and midwives in audit and feedback activities, and in AMS team rounds • Support nursing and midwifery education on AMS

AMS = antimicrobial stewardship

12.3.3 Education

If nurses and midwives are to be engaged in, and contribute to, AMS, they need to be included in AMS education activities (see Chapter 5: 'Antimicrobial stewardship education for clinicians').

Some nurses and midwives may lack an understanding of AMR and AMS strategies, or may not view AMS as part of their scope of practice or be aware that they can influence prescribing behaviour.[16,22,25,34] They may be unclear about antimicrobial therapy that patients in their care are receiving, patients' allergy status, the expected duration of therapy, or the importance of timely administration to ensure optimal therapy and limit adverse effects (including AMR).[21,22,25] Increasing nurses' and midwives' knowledge of antimicrobial management may improve their capacity to influence more appropriate use.[22,23]

Mandatory education and training in AMS for all clinicians, including nurses and midwives, has been recommended by the National Health Service (NHS) in Scotland and England.[16,35,36] Nurses and midwives also require education specific to their role.[3,4,37] Targeting education to focus on aspects of nursing and midwifery practice linked to AMS[3,4,38] can help nurses and midwives to better understand the ways their practice integrates with AMS, and the significance of their role in influencing antimicrobial prescribing and antimicrobial use. Further, this may empower decision-making and enable them to take action when antimicrobial or clinical management is not in line with recommended practice outlined in local guidelines and policies. Continuing education should incorporate and consider the principles and quality statements outlined in the Antimicrobial Stewardship Clinical Care Standard.[15] Topics that could be considered in nursing and midwifery education include AMR, classes of antimicrobials, aminoglycoside monitoring, allergy management and early recognition of sepsis. Several of these topics have been included in nurse education programs in Scotland.[35] Suggested topic areas for nurse and midwife education are listed in Box 12.2.

Education can be formal or informal, and can be comprehensive or more focused. For example, a formal AMS education program coordinated by ICPs at a large Australian tertiary health service focused on intravenous-to-oral switching and the potential to change practice. Interviews with each of the 79 participating senior nurses before and after the intervention showed that the intervention resulted in an increase in AMS knowledge and the potential to influence antimicrobial use. For example, when asked if they had previously questioned a patient's antimicrobial order, the results were significantly different ($P < 0.0001$) before (71%) and after (91%) the education.[22]

Informal education can happen by including nurses and midwives as part of AMS team rounds, patient case reviews, audit and feedback, or other quality improvement initiatives. Participating in these activities in day-to-day practice can help nurses and midwives to consolidate and apply the knowledge gained through more formalised educational activities, providing opportunities to discuss antimicrobial treatment, indication and the duration of therapy with other clinicians and the AMS team.

See Chapter 5: 'Antimicrobial stewardship education for clinicians' for recommendations on educating clinicians, specific education strategies and approaches to education, and links to education resources.

12.3.4 Resources and tools

Tools and resources such as standardised medication charts, clinical pathways, screening tools and checklists that are available at the point of care and specific to the local context can help to embed AMS in routine nursing and midwifery practice. Resources that support safe and effective nursing and midwifery practice have been shown to improve patient care in different areas, including for sepsis. Nurse-initiated sepsis protocols (for early assessment and recognition) have been developed to support the implementation of sepsis guidelines in emergency department and ward settings, and have significantly reduced the time to first-dose antimicrobials.[4,39]

Box 12.2: Topic areas for nurse and midwife education about antimicrobial resistance and antimicrobial stewardship

- What antimicrobial resistance (AMR) is and how it can be contained
- Infection management and control, including differences between infection and colonisation, and their link to addressing AMR
- Role of antimicrobial stewardship (AMS) in preventing and containing AMR, including the link with patient safety
- Antimicrobial pharmacotherapy
- Medication safety – timeliness of administration, safe administration (correct dose, duration of therapy), allergies, the differences between antimicrobial adverse reactions and true antimicrobial allergies, patient response
- Microbiology, including the timing, collection and quality of microbiology specimens; prioritisation of laboratory result communication; distinction between positive test results (e.g. urine culture and chest X-ray reports) and active infection
- Role of clinical practice guidelines, local guidelines and policies
- How to access resources
- AMS strategies, such as antimicrobial de-escalation linked to patient response, switching from intravenous to oral delivery, and changing the duration of therapy
- How to educate patients and carers about antimicrobials

Source: Adapted from recommendations from Pulcini and Gyssens[36], Scottish Antimicrobial Group[35] and Public Health England[16]

It has been suggested that the most effective resources may be those that are tailored to practical nursing and midwifery tasks such as preparing and administering antimicrobials[40], including readily accessible information about intravenous therapy such as dilution rates, compatible fluids and rates of administration. Such information should be available at the point of care. One example of such a resource in Australia is the *Australian Injectable Drugs Handbook*.[41] Checklists, clinical pathways and other point-of-care guidance can include a prompt for nurses and midwives to consider the potential for reviewing microbiology results, intravenous-to-oral switching or initiating patient education.

Information technology (IT) can support education and information sharing among nurses and midwives, and provide ready access to guidelines and pathways. Examples of IT tools are electronic clinical decision support systems, electronic healthcare records, online medication references, calculators, handheld devices and mobile device applications (see Chapter 4: 'Information technology to support antimicrobial stewardship').

Nurses and midwives should be included on relevant teams and committees responsible for developing, piloting and implementing guidelines, pathways and other resources for AMS. This will help to ensure that day-to-day nursing and midwifery practices and workflow are considered in the development of these tools, and will also help to encourage their uptake and use in practice. The OSSIE Toolkit[42] guides those looking to implement improvement activities in infection prevention and control practice in conjunction with their AMS program.

12.4 Advanced and specialist practice roles

Nurse practitioners and ICPs have specific roles to play in AMS.

12.4.1 Nurse practitioners

Nurse practitioners are registered nurses with the education and experience needed to work autonomously and collaboratively in an advanced clinical role. This role is grounded in a set of nursing values, knowledge, theories and practice that is qualitatively different from that of medical practitioners.[43]

In 2016, around 1,400 nurse practitioners were registered to work across Australia in many different clinical settings, from primary to tertiary care.[44] Nurse practitioners may perform advanced physical assessments, order and interpret investigations, prescribe medicines and independently refer patients to other clinicians,[43] subject to regulation in individual states and territories regarding the scope of prescribing practice. These are important responsibilities in AMS.[45]

Recent data show that nurse practitioners account for less than 1% of antimicrobial prescribing in the Australian community.[46] Although the overall contribution of nurse practitioner prescribing to antimicrobial use appears to be small, antimicrobials account for around a third of nurse practitioner prescriptions in Australia.[47]

Because nurse practitioners prescribe antimicrobials and can initiate and plan treatments, they should participate in AMS education activities and ensure that they adopt AMS principles into their clinical practice (see Chapter 10: 'Role of prescribers in antimicrobial stewardship'). Studies of nurse prescriber attitudes to antimicrobial prescribing have shown similar findings to studies of general prescriber attitudes, with prescribing confidence, diagnostic uncertainty and patient expectations often cited as factors that influence nurse practitioner prescribing behaviour.[48-50]

Nurse practitioners, like all prescribers, require ready access to evidence-based prescribing guidelines (*Therapeutic Guidelines: Antibiotic*)[26] and to standards and tools to support good prescribing practice (see Chapter 3: 'Strategies and tools for antimicrobial stewardship'). Nurse practitioners should also be informed about local AMS teams and processes for obtaining expert ID, microbiology or pharmacist advice, whether on site or remotely.

Similarly, AMS principles can also be incorporated into the nurse practitioners' diagnostic role. This includes ensuring that optimal collection methods are used, and that laboratory results are immediately followed up so that therapy can be optimised. Key principles that apply to the selection of diagnostic tests, and to optimal sample collection and transport are discussed in Chapter 9: 'Role of the clinical microbiology service in antimicrobial stewardship'.

The combination of advanced and extended practice skills and leadership skills means that, depending on the context, nurse practitioners are well placed to lead AMS efforts in their respective practice settings, and champion nursing and midwifery involvement in AMS. Establishing or accessing existing professional networks may help nurse practitioners to develop a community of practice for AMS.[45]

Table 12.3 summarises suggested strategies for nurse practitioners to consider as part of their role.

12.4.2 Infection control practitioners

In 2017, the Australasian College for Infection Prevention and Control published an updated position statement on the role of ICPs in AMS.[7] Endorsed by both the Australian Society for Antimicrobials and the Australasian Society for Infectious Diseases, the statement noted that ICPs should be part of a multidisciplinary AMS team that includes ID physicians, general practitioners, pharmacists and microbiologists, and that ICPs play a role in:

- Contributing to the governance of AMS programs by participating in the AMS committee or a similar body
- Educating healthcare workers on infection prevention and control strategies to minimise the risk and transmission of AMR, including safe and appropriate antibiotic use
- Promoting access to current endorsed therapeutic guidelines on antimicrobial prescribing
- Surveillance of resistant organisms, healthcare-associated infections, antimicrobial use, and adherence to antibiotic and treatment guidelines.

Most Australian hospitals employ ICPs, and the scope of practice for ICPs is diverse and expanding.[51-53] Many ICPs have extensive experience and expertise in infection prevention and control practices and – given that their role is often organisation-wide – a good understanding of the local organisational culture and systems, and have established links with multiple professional groups. Although there are differences between the responsibilities of AMS programs and infection control programs, it is important that there is collaboration between the two programs if they are to improve clinical outcomes, reduce AMR and prevent the spread of infection.[54]

Areas in which ICPs may influence AMS are summarised in Table 12.4.

Table 12.3: Examples of antimicrobial stewardship strategies for nurse practitioners

Practice	AMS strategies
Diagnosis	• Adopt the key principles that apply to the selection of diagnostic tests and optimal sample collection and transport (see Chapter 9: 'Role of the clinical microbiology service in antimicrobial stewardship') • Follow up on results within 48 hours to enable review and changes to therapy
Prescribing	• Follow AMS prescribing principles before, during and after the consultation • Prescribe according to *Therapeutic Guidelines: Antibiotic* and the Antimicrobial Stewardship Clinical Care Standard • Consider the use of shared decision-making resources when discussing antimicrobial decisions with consumers • Be aware of local resistance patterns, local prescribing guidelines and recommended antimicrobial treatment regimens • Participate in audit and feedback activities, and evaluate antimicrobial use
Patient education	• Educate patients and carers during consultations, and provide written information to them • Promote infection prevention and control, including hand hygiene • Promote immunisation
Professional activities	• Participate in continuing professional education, including by completing online learning modules on antimicrobial prescribing • Establish or participate in an AMS interest group or a network for nurse practitioners (i.e. a community of practice) • Promote AMS through education, information resources and tools • Promote and participate in Antibiotic Awareness Week

AMS = antimicrobial stewardship

Table 12.4: Areas of influence for infection control practitioners

Participating roles	Leading roles, in collaboration with other experts (on site or remote)
• Promoting compliance with standard and transmission-based precautions, including hand hygiene • Educating and providing information to clinicians, students, consumers and others • Undertaking surveillance and providing information to incorporate feedback on – local infection patterns – local pathogen antimicrobial resistance patterns – local infection patterns – local antimicrobial prescribing patterns • Translating information about patient outcomes into educational opportunities • Facilitating the implementation of clinical care bundles to reduce infection in high-risk situations (e.g. CAUTI, CLABSI, PIVC, VAP) • Providing expert advice to clinicians, patients and carers • Promoting uptake of, and compliance with, national standards for AMS • Participating in AMS committees or AMS team rounds • Supporting nurses and midwives in resolving disagreements about adherence to antimicrobial prescribing guidelines	• Triaging patients for post-prescription review at 48–72 hours • Coordinating Antibiotic Awareness Week activities • Informing senior management and relevant committees about the AMS program • Coordinating, or actively participating in, AMS ward rounds • Implementing intravenous-to-oral switching programs • Auditing, evaluating and reporting on antimicrobial use, including quality indicators • Conducting AMS research

AMS = antimicrobial stewardship; CAUTI = catheter-associated urinary tract infection; CLABSI = central line–associated bloodstream infection; PIVC = peripheral intravenous cannula; VAP = ventilator-associated pneumonia
Source: Nagel et al.[54]

A recent multi-centred cross-sectional study found that ICPs spend about 36% of their time on surveillance activities, such as surveillance of multidrug-resistant organisms and surgical site infections.[55] ICPs can use surveillance data to support early identification of resistant organisms and infections.[56] Communication about this to the AMS team and prescribers can support appropriate antimicrobial therapy for individual patients.[54] ICPs can apply their knowledge and understanding of surveillance principles to the surveillance of antimicrobial use and appropriateness. In the 2015 National Antimicrobial Prescribing Survey, close to 20% of the auditors were nurses and ICPs; in private hospitals, the percentage was higher, at close to 50%.[18]

ICPs can show leadership within the AMS program and champion AMS efforts by being involved in relevant committees and education[16], quality improvement and research programs. ICPs are often responsible for educating the workforce on the importance of infection prevention and control to prevent the spread of infection. The ICP can work with the AMS team to incorporate AMS into the infection control education program. Incorporating feedback on local infection patterns, local pathogen AMR patterns and local antimicrobial prescribing patterns and, if possible, information about patient outcomes into education sessions can bring an extra perspective to infection prevention and control. This will increase awareness and understanding of the importance of infection prevention and control activities to successful AMS programs.

ICPs may be required to coordinate or lead AMS programs in public and private hospitals, and aged care homes.[23] This can be achieved with support from executive leaders and input from a local pharmacist. If pharmacists, ID physicians or clinical microbiologists are not available on site, input from the Local Hospital Network, Local Health District or a community pharmacist may be possible.[57] In those circumstances, the focus should be on how best to apply the skills and knowledge of the ICP to develop a tailored program. As with nurses and midwives, ICPs cannot replace

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the specialist expertise brought to AMS by other experts. For example, post-prescription review in hospitals requires that the pharmacokinetic and pharmacodynamic features of the antimicrobial be considered, which is outside the ICP scope of practice. Published examples of successful ICP-led AMS interventions have highlighted the role of support and input from specialist colleagues in supporting implementation[22,23] (see Case study 12.1).

Case study 12.1: Infection control practitioner–led program in aged care homes

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An antimicrobial stewardship program led by infection control practitioners (ICPs) at two aged care homes demonstrated successful post-intervention results. ICPs were involved in the education of general practitioners, nurses and midwives; data collection; monitoring of pathology results; and discussions between general practitioners and an infectious diseases physician. Pre- and post-intervention results showed a significant reduction in total days of antimicrobials prescribed ($P < 0.0001$).[23]

Resources

- Position statements
  - International Confederation of Midwives: Midwives and prevention of antimicrobial resistance
  - International Council of Nurses: Antimicrobial resistance
  - Australasian College for Infection Prevention and Control: The role of the ICP in antimicrobial stewardship
  - American Nurses Association: white paper on the role of nurses in hospital antibiotic stewardship practices
- NSW Clinical Excellence Commission: Antibiotics in-service for nursing staff
- Australian Commission on Safety and Quality in Health Care: Antimicrobial stewardship video presentations
- NPS MedicineWise: Reducing antibiotic resistance – information and continuing professional development options
- NHS Education for Scotland: *Antimicrobial Stewardship Workbook* for nurses and midwives
- NSW Clinical Excellence Commission: Sepsis Kills program
- Information about preparing and administering antimicrobials: *Australian Injectable Drugs Handbook*
- Australian Commission on Safety and Quality in Health Care: The OSSIE Toolkit – guidance on implementing improvement activities in infection prevention and control practice

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AUSTRALIAN COMMISSION ON SAFETY AND QUALITY IN HEALTH CARE

13 Role of general practice in antimicrobial stewardship

Antimicrobial Stewardship in Australian Health Care

2020

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Acronyms and abbreviations

Abbreviation	Definition
ACSQHC	Australian Commission on Safety and Quality in Health Care
AMR	antimicrobial resistance
AMS	antimicrobial stewardship
AURA	Antimicrobial Use and Resistan
COPD	chronic obstructive pulmonary disease
eTG	Therapeutic Guidelines
GAPS	General practitioners Antimicrobial Stewardship Programme Study
GP	general practitioner
MRSA	Methicillin-resistant *Staphylococcus* aureus
NAPS	National Antimicrobial Prescribing Survey
NSQHS	National Safety and Quality Health Service
OECD	Organisation for Economic Co-operation and Development
PBAC	Pharmaceutical Benefits Advisory Committee
PBS	Pharmaceutical Benefits Scheme
PHN	Primary Health Network
RACF	residential aged care facility
RACGP	Royal Australian College of General Practitioners
RPBS	Repatriation Pharmaceutical Benefits Scheme

Key points

- Antimicrobial resistance is increasingly evident in our community. Organisms of particular concern in the community include methicillin-resistant *Staphylococcus aureus* (MRSA) and extended-spectrum β-lactamase-producing *Escherichia coli*.
- In 2017, 41.5% of the Australian population had at least one systemic antibiotic dispensed under the Pharmaceutical Benefits Scheme or Repatriation Pharmaceutical Benefits Scheme.
- The development of new antimicrobials has slowed significantly.
- Rates of antimicrobial use in Australia are high compared with data for international usage.
- The most commonly supplied antibiotics under the Pharmaceutical Benefits Scheme and Repatriation Pharmaceutical Benefits Scheme are cefalexin, amoxicillin, and amoxicillin with clavulanic acid. This represents heavy reliance on broad-spectrum β-lactam antibiotics in the community setting, which have greater potential to select for resistance to multiple drug classes.
- General practice has a crucial role in reducing antimicrobial use and antimicrobial resistance in the community.
- Effective antimicrobial stewardship in general practice encompasses interventions across three periods: before, during and after the consultation.
    - **Before** a consultation, strategies include increasing GP awareness of their antibiotic prescribing behaviours in comparison with their peers; providing antimicrobial stewardship education; demonstrating antimicrobial stewardship commitment to patients; promoting antimicrobial stewardship to consumers; and implementing the quality statements of the Antimicrobial Stewardship Clinical Care Standard within general practice.
    - **During** the consultation, strategies include optimising antimicrobial prescription; embedding antimicrobial guidelines into practice workflows; shared decision-making with consumers; and delaying prescribing.
    - **After** the consultation, strategies include supporting patient self-management; and, antimicrobial audit and feedback in general practice.
- Leadership for antimicrobial stewardship within primary care occurs at the national, regional and practice levels. Each is important for a nationally- coordinated, effective response to reduce antimicrobial prescribing and antimicrobial resistance.
- The Royal Australian College of General Practitioners Standards for General Practice (5th Edition) describe the role of antimicrobial stewardship in general practice to maintain the effectiveness of antimicrobials and decrease preventable healthcare associated infections.

13.1 Introduction

Antimicrobial resistance (AMR) is a global healthcare issue that has been described as one of the principal health concerns of this century.[1] Australia is contributing to the global problem of AMR, with Australian antibiotic consumption in primary care above the OECD (Organisation for Economic Co-operation and Development) average.[2] Australia's National Antimicrobial Resistance Strategy 2020 and Beyond describes national priority actions to address this growing public health threat.[1]

The Antimicrobial Stewardship in Australian Health Care book (the AMS Book) was published in 2018 to provide an overarching resource for antimicrobial stewardship programs in Australia. The AMS Book is available at www.safetyandquality.gov.au/our-work/healthcare-associated-infection/antimicrobial-stewardship/book/.

Additional chapters of the AMS Book are planned to further support antimicrobial stewardship (AMS) in Australia. As additional chapters are completed, they will be published to supplement the AMS Book.

The role of general practice in antimicrobial stewardship is the latest addition to the Book. This chapter discusses AMS in general practice and:

- describes the factors that influence general practitioner decisions to prescribe antimicrobials;
- identifies resources to support appropriate prescribing of antimicrobials;
- provides practical strategies that can be implemented in general practice to improve AMS; and
- discusses the role of clinical governance and leadership in AMS.

This chapter supports general practice to implement AMS components of the Royal Australian College of General Practitioners (RACGP) Standards for General Practice (5th Edition).[3]

13.1.1 Antimicrobial resistance in the community

Antimicrobial overuse and misuse, including in general practice, is a key driver of AMR. AMR is a risk to patient safety because it reduces the range of antimicrobials available to treat infections. AMR increases morbidity and mortality associated with infections caused by multidrug-resistant organisms.[4]

The AURA (Antimicrobial Use and Resistance in Australia) Surveillance System monitors AMR and antimicrobial use in Australia.[4] This system is coordinated by the Australian Commission on Safety and Quality in Health Care (the Commission) and provides national data on antimicrobial use across a range of Australian healthcare settings, including general practice.

AURA data show AMR is increasingly evident in the community in Australia. Organisms of concern in the community include methicillin-resistant *Staphylococcus aureus* and extended- spectrum β-lactamase-producing *Escherichia coli*.[5] Also of concern is the non-susceptibility of organisms more broadly to fluoroquinolones, third generation cephalosporins, aminoglycosides and carbapenems.[5]

Rates of methicillin-resistance in *S. aureus* were stable at around 20% in New South Wales, Queensland and South Australia for the decade 2006–2015. However, resistance rates have slowly increased nationally since then, with rates of 21.6% in 2015 and 22.5% in 2017.[6]

Rates of *E. coli* not susceptible to fluoroquinolones increased from 2% in 2006 to 11.8% in 2017, despite significant restriction of fluoroquinolones in hospitals and the community. This trend is most apparent in major cities and rates of resistance have risen in all regions of Australia.[6]

AMR also occurs at an individual level. Individuals treated with antibiotics for respiratory tract and urinary tract infections have been shown to carry antimicrobial-resistant organisms at one month, two months and 12 months after antimicrobial treatment.[7]

13.1.2 Antimicrobial use in the community

In 2017, 41.5% of the Australian population had at least one systemic antibiotic dispensed under the Pharmaceutical Benefits Scheme (PBS) and the Repatriation Pharmaceutical Benefits Scheme (RPBS).[4] A large proportion are prescribed in general practice.[4]

The 2019 AURA report revealed that the rate of antibiotic dispensing under the PBS and the RPBS declined in 2016 and 2017. This is the first decline since the late 1990s. Despite this recent improvement, rates of antimicrobial use in Australia remain high.

Available data show substantial geographical variation in antimicrobial use. In Australia, geographical variation in healthcare use is reported in the Australian Atlas of Healthcare Variation series. According to the Australian Atlas of Healthcare Variation, in 2016–17, the dispensing rate of antimicrobial prescriptions varied substantially across Australia. There was a 4.8-fold difference in antimicrobial dispensing across geographical areas.[8]

Antimicrobials are overprescribed in general practice compared with guideline recommendations. For example, antibiotics are prescribed for acute respiratory infections in Australian general practice at rates four to nine times higher than current clinical practice guidelines recommend.[9] Antibiotics continue to be prescribed in general practice to patients with health problems for which there is no clinical benefit, including for influenza (52.2% of patients) and acute bronchitis (92.4% of patients).[4]

The most commonly dispensed antibiotics under the PBS and RPBS are cefalexin, amoxicillin, and amoxicillin with clavulanic acid. These antimicrobials accounted for more than half of all prescriptions dispensed in 2017.[4] This represents a heavy reliance on broad-spectrum β-lactams in the community setting, which have greater potential to select for resistance to multiple drug classes.[4]

Use of antimicrobials in general practice is more common in the youngest and oldest age groups. In patients aged less than 65 years, the highest rate of dispensing is in children aged 2–4 years.

Antimicrobial use in children in Australia is high compared with international usage rates.[8]

13.1.3 Antimicrobial stewardship and general practice

AMS programs are evidence-based multicomponent strategies that aim to increase judicious use of antimicrobials in order to improve patient outcomes and decrease AMR.[1]

AMS is a core component of the National Safety and Quality Health Service (NSQHS) Standards.[10] The Standards are used by hospitals and other health facilities. The Preventing and Controlling Healthcare-associated Infection NSQHS Standard aims to improve the measures designed to help prevent infections and the spread of antimicrobial resistance, through appropriate prescribing and use of antimicrobials.

AMS in general practice is different to hospitals, for which the Standards were primarily developed. Hospital AMS involves a multidisciplinary team of infectious diseases physicians, clinical pharmacists and clinical microbiologists working in collaboration with hospital administrators and other clinicians. The purpose of collaboration is to improve decision-making about antimicrobial use and to monitor antimicrobial use and resistance.[11]

AMS in general practice needs to consider the different context within which antimicrobial prescribing decisions are made, the nature of patient encounters and presentations and the different support and infrastructure available in general practice compared with hospitals. The AMS team in general practice is different to that in hospitals. Team members include GPs, practice nurses and practice administrative personnel. Allied health providers including pharmacists may also participate in AMS in general practice. Pharmacists also have an important role in supporting team-based AMS in residential aged care. Pathology providers support AMS in general practice by supporting GPs in the appropriate ordering of pathology specimens and in providing AMS information in reporting results.

Each team member has a different role in reducing antimicrobial use and AMR in the community through continued improvements in antimicrobial prescribing practices.[3] Members of the AMS team can also have a positive influence on the beliefs of individual patients and the broader community regarding antimicrobial use and AMR.

Within general practice, the RACGP Standards for General Practice (5th Edition) describe the role of general practice-based AMS programs to maintain the effectiveness of antimicrobials and decrease preventable infection associated with healthcare.[3] AMS in general practice is also an important component of Australia's National Antimicrobial Resistance Strategy - 2020 and Beyond.[1]

An estimated 85 percent of the Australian population visit a general practice each year. Most people visit the general practice more than once. General practice play an important role in influencing the general practice through information about the appropriate use of antimicrobials, antimicrobial resistance, and supporting antimicrobial stewardship practice.

13.2 Factors that influence antimicrobial prescribing in general practice

The main factors that influence general practitioner decisions to prescribe antimicrobials for individual patients are general practice characteristics, patient characteristics, patient expectations and diagnostic uncertainty. Each factor is described below. In addition, hospital antimicrobial prescribing practices influence GP's prescribing patterns.

13.2.1 General practice characteristics

Both individual general practitioner (GP) characteristics and the general practice work environment influence GP decisions to prescribe antimicrobials. GP characteristics associated with higher levels of antimicrobial prescribing include: being older than 45 years, more years in practice, and being an international medical graduate.[12-15] Factors that may contribute to higher antimicrobial prescribing by international medical graduates include: differences in training environments, continuing to prescribe antibiotics in accordance with cultural expectations, or the probability of bacterial infections in their country of training.[12]

Time constraints within patient consultations appear to influence antimicrobial prescribing. The GP workday is divided into 'sessions' of 3.5 to 4.5 hours' duration. The likelihood that a GP will prescribe antimicrobials increases as the session progresses.[16] Further, in some studies, shorter appointment times are associated with higher rates of antimicrobial prescribing. This is attributed to the GP having less time to discuss with the patient whether or not antimicrobials are needed.[13,15-18]

13.2.2 Patient characteristics

Rates of antimicrobial dispensing are higher in some populations, including in patients with specific chronic diseases, who are immunosuppressed, in remote Indigenous populations, in communities with lower socio-economic status, and in residential aged care facilities.[4,8] Antimicrobial dispensing rates are generally lower in rural areas compared with urban areas.[8]

13.2.3 Indigenous populations

Prescribing rates may be higher in some Indigenous populations because of differences in the epidemiology and microbiology of infectious diseases and the consequences of infections.[19] In remote Australian Indigenous communities there are different patterns of infectious disease and bacterial infections are very common.[20] At any one time in some remote Indigenous populations, 45% of children will have impetigo, up to 80% of infants aged under one year will be hospitalised for a lower respiratory tract infection, 66% of children will present with otitis media before five years of age and 75% of all community members present with skin and soft tissue infections each year.[20] In adults, resistant skin infections and sexually transmitted infections remain highly prevalent in some communities. Sepsis rates resulting in hospitalisation and intensive care admission are four- fold higher in Indigenous than in non-Indigenous Australians in northern Australia.[20]

Due to this infective illness burden, high frequency but appropriate antimicrobial use often occurs in remote Australian Indigenous communities.[19,20] By their first birthday, an estimated 95% of children in some communities receive at least one antibiotic prescription and 47% receive at least six antibiotic prescriptions.[21] Antimicrobials are also used more often for sore throat treatment to prevent serious complications such as rheumatic heart disease.[19] However, other factors may contribute to inappropriate antimicrobial use including the absence of senior clinical staff, high staff turnover rates, lack of diagnostic capability, and living in remote areas, where lack of treatment may precipitate the need for retrieval to a distant hospital.[20]

As a result of the complex interplay of these factors, AMR is a growing problem in some remote Australian Indigenous communities. Rising rates of MRSA, azithromycin resistance in Streptococcus pneumonia and emerging gram-negative resistance in urinary tract pathogens have been observed.[20]

13.2.4 Residential aged care facilities

Residential aged care facilities (RACFs) are an important setting for AMS. Residents of RACFs are vulnerable to infections because of frailty, poor functional status, multiple comorbidities and compromised immune systems.[22] The close living proximity and frequent nurse-to-resident and resident-to-resident contact can facilitate the spread of organisms in the RACF setting.[22]

Widespread antibiotic prescribing, including use of topical antimicrobial preparations, is observed in RACFs.[22,23] Nationally, the annual Aged Care National Antimicrobial Prescribing Survey demonstrates exposure to at least one course of antimicrobials occurs in 50–75% of RACF residents annually and more than one in 10 residents are in receipt of an antimicrobial at any given time.[24] Antimicrobials may be prescribed through telephone-based orders, without the resident being reviewed by the treating doctor or investigations being ordered.[22,23]

Between 40% and 75% of antibiotic use in RACFs is considered inappropriate i.e. not consistent with clinical practice guidelines.[22] Inappropriate prescribing is associated with increased harm to residents, including serious drug-related adverse events, Clostridium difficile colonisation and the development of AMR among residents.[25] An estimated 30.6% of Australian RACFs have infection-control trained staff on site. Few facilities have AMS policies and approximately 14% have antimicrobial prescribing restrictions.[26]

AMS interventions are needed to improve antibiotic use in RACFs. Interventions require GPs, pharmacists and RACF nursing staff to work together to identify strategies to improve AMS.[22] The RACGP Aged Care Clinical Guide (Silver Book) provides guidelines for general practice for AMS in infection and sepsis care in RACFs.

13.2.5 Patient expectations

In general, patients tend to overestimate the benefits of medical treatment and underestimate the harm.[27] Patients may not understand that antibiotics don't help viral illnesses or that the net benefit of antimicrobials on symptom resolution is less than 24 hours for common bacterial respiratory infections.

Patients may expect to receive a prescription for antimicrobials to treat their infection. This influences the antimicrobial prescribing decisions of many GPs in treating upper and lower respiratory infections in particular,[28-31] and for infections in general.[32,33]

Shared decision-making regarding antimicrobial prescribing is therefore essential to ensure patients are fully informed about the pros and cons of antimicrobial use.[34] Chapter 7 of Antimicrobial Stewardship in Australian Health Care (2018) has more information about shared decision-making and consumer understanding of when antimicrobials are needed.

Evidence also shows that the provider's perceptions about patient expectations are a stronger determinant of prescribing than actual patient expectation.[35] Patients who expect medication to be prescribed are nearly three times more likely to receive a prescription than patients who do not.

However, when the GP thinks that the patient expects medication (regardless of whether they actually do or not), the patient is 10 times more likely to receive a prescription.[29,31,35,36]

Prescribers tend to overestimate patient expectations for antimicrobials. Approximately 75% of the time GPs correctly identify when parents do not expect antimicrobials for their child.

However, they are only correct about 50% of the time about when parents do expect antimicrobials.[37]

13.2.6 Diagnositc uncertainty

Diagnostic uncertainty influences clinical decisions to prescribe antibiotics, particularly for respiratory tract infections. It is difficult for clinicians to differentiate between a bacterial and a viral infection, particularly in the early stages.[38] Diagnostic uncertainty is more common in some patient groups, including older people, patients with complex comorbidities and patients who are immunosuppressed. In the face of diagnostic uncertainty, GPs weigh up different clinical factors to determine whether to prescribe.[20,29,39-42]

Antimicrobials offer little to reduce symptoms and complications for most acute respiratory tract infections in primary care. Evidence shows that if a general practice with 7,000 patients reduced prescribing antimicrobials for respiratory tract infections by 10%, the practice might see just 1.1 more cases of pneumonia each year and 0.9 more cases of peritonsillar abscess each decade. There is no evidence that the complications of mastoiditis, empyema, meningitis, intracranial abscess or Lemierre's syndrome are more frequent with low antibiotic prescribing practices.[43]

For patients with chronic obstructive pulmonary disease (COPD), diagnostic uncertainty is common. Current clinical practice guidelines recommend early management of infective exacerbations of COPD that are characterised by increased volume and change in colour of sputum or fever with antibiotics.[44] This is because infective exacerbations of COPD due to bacterial infection are associated with adverse impacts on illness trajectory. However, exacerbations can also be caused by common viral pathogens or urban air pollutants.[44]

Availability of testing for timely identification of the underlying cause of exacerbations is limited in general practice. Treatment of exacerbations therefore commonly occurs without determining the underlying cause.[44]

13.3 Antimicrobial stewardship strategies for general practice

Antimicrobial stewardship (AMS) strategies for general practice need to consider the practice workflow and professional responsibilities of individual general practice staff.

Chapter 10 of Antimicrobial Stewardship in Australian Health Care (2018) contains general information about AMS prescribing principles for prescribers. AMS strategies in general practice can be allocated into three time periods – before the consultation occurs, during the consultation and after the consultation.

13.3.1 Before the consultation

AMS strategies that may be effective in general practice in the period before a consultation occurs include:

a. increasing provider awareness of antibiotic prescribing behaviours in comparison with peers
b. providing AMS education
c. health care professionals demonstrating AMS commitment to patients
d. promoting AMS to consumers
e. demonstrating practice consistent with the Antimicrobial Stewardship Clinical Care Standard

a. Increasing provider awareness of antibiotic prescribing behaviours in comparison with peers

Providing GPs with data comparing their antibiotic prescribing rates with the prescribing rates of their peers is an effective strategy to reduce antibiotic use. The NPS MedicineWise has previously provided GPs with data comparing their antimicrobial prescribing with their peers. In addition, a letter from the Australian Chief Medical Officer sent in 2017 to the top 30% of antibiotic prescribers in general practice and containing peer comparisons was associated with a reduction in antibiotic prescribing of 12.3% within six months.[45]

b. Providing antimicrobial stewardship education

Education can influence antibiotic prescribing in general practice. However, education alone has limited impact on antibiotic prescribing behaviours of GPs.[43] Education is most effective when incorporated into a multicomponent AMS strategy within general practice.

Education interventions that have been demonstrated to be effective

include:[46,47]

and infective exacerbations of chronic obstructive pulmonary disease;

- facilitated multidisciplinary case-based meetings;
- case-based learning;
- online learning modules, including antimicrobial prescribing courses; and
- including AMS education in publications with a broad GP readership.

c. Demonstrating antimicrobial stewardship commitment to patients

Individuals who make public commitments to specific behaviours are more likely to follow through with these expressed intentions.[48] Demonstrating commitment is effective in improving appropriate prescribing of antimicrobials.[48]

Resources to use in general practice to raise awareness and demonstrate professional commitment to reducing AMR are available to download and use within general practice. Links are included in the Resources section at the end of this chapter.

d. Promoting antimicrobial stewardship to consumers

Consumer expectations play a major role in antimicrobial prescribing in general practice. Resources such as posters, leaflets and videos in waiting rooms on topics such as immunisation, hand hygiene and AMR can raise awareness and prepare consumers to discuss AMS before a consultation.

Chapter 7 of Antimicrobial Stewardship in Australian Health Care (2018) has more information about shared decision-making and consumer understanding of when antimicrobials are needed.

e. Demonstrating practice consistent with the Antimicrobial Stewardship Clinical Care Standard

The Antimicrobial Stewardship Clinical Care Standard aims to ensure that a patient with an infection receives optimal treatment.[49] This means the right antibiotic, at the right dose, by the right route, for the right duration based on accurate assessment and timely review.

Elements of the Antimicrobial Stewardship Clinical Care Standard that are of particular relevance to GPs include:

- When a patient is prescribed antibiotics, whether empirical or directed, this occurs in accordance with the current version of the Therapeutic Guidelines (or local antibiotic formulary).
- When a patient is prescribed antibiotics, information about when, how and for how long to take them, potential side effects and a review plan, are discussed with the patient or their carer.
- When a patient is prescribed antibiotics, the reason, drug name, dose, route of administration,

intended duration and review plan are documented in the patient's health record.

13.3.2 During the consultation

> AMS strategies that have been demonstrated to be effective in general practice during the consultation include:
>
> a. optimising antimicrobial prescription
>
> b. embedding antimicrobial guidelines into practice workflows
>
> c. shared decision-making with consumers
>
> d. delaying prescribing
>
> e. multicomponent approaches.

a. Optimising antimicrobial prescription

Antimicrobial prescribing in Australian general practice is strongly influenced by the availability of antimicrobials on the PBS / RPBS. Clinical decision support functions embedded in clinical practice software also influence prescribing. Prescribers should document the reason for prescribing antimicrobials, dates of commencement and planned cessation in the patient record. This should include topical antimicrobials.

Prescriptions for commonly prescribed antimicrobials often include repeat prescriptions. However, common infections almost never require repeat prescriptions, and in many cases, shorter antibiotic courses can be used safely for common bacterial infections.[50] PBS data show most repeat prescriptions are not dispensed. Of those that are dispensed, some are dispensed long after the date of the original prescription.[51]

The Australian Pharmaceutical Benefits Advisory Committee (PBAC) has reviewed the PBS listing for high-volume antibiotics prescribed with repeats. The PBAC has recommended the removal of repeat options in line with Australian Therapeutic Guidelines to improve AMS and to assist in the reduction of AMR. This came into effect on 1 April 2020. See the PBS website for full details.

There are sometimes significant differences between what may be recommended in clinical practice guidelines and the pack sizes that are dispensed on the PBS/RPBS.[52] Prescribers should be encouraged to specify the duration of use on the prescription rather than prescribing according to available pack sizes.

Computer-based point-of-care reminders have been shown to improve appropriate prescribing for otitis media, sore throat and urinary tract infections.[53-55] Chapter 4 of Antimicrobial Stewardship in Australian Health Care (2018) has more information about information technology to support AMS.

Where pathology tests are ordered, general practice staff should review sensitivities and confirm appropriate antibiotic selection.

b. Embedding antimicrobial guidelines into practice workflows

Clinical practice guidelines for antimicrobial use are readily accepted and widely available in Australia. The Antimicrobial Stewardship Clinical Care Standard specifies that all antimicrobials should be prescribed in accordance with *Therapeutic guidelines: Antibiotic* (eTG).[38]

Automated clinical decision support is more likely to improve prescribing than systems that have to be actively initiated by the GP.[56] Clinical practice guidelines can be embedded within computer-aided clinical decision support systems to improve antibiotic prescribing in general practice.

In addition, Therapeutic Guidelines has produced a summary table *Antibiotic prescribing in primary care: Therapeutic Guidelines summary table 2019* that provides a desktop reference for GPs and summarises recommendations within eTG regarding managing common infections in primary care.

c. Sharing decision-making with consumers

Shared decision-making involves clinicians and patients jointly participating in making a health decision. It means discussing the options, the benefits and harms of each option, and considering the patient's values, preferences and circumstances.[57] For most infections encountered in general practice, the choice about whether or not to treat with antibiotics involves weighing the benefits of antibiotics against potential harms.[57] This makes consultations for antibiotic prescribing ideally-suited to shared decision-making.

Shared decision-making helps address consumer expectations and concerns. Written decision aids used by the GP in consultation with the patient to share decisions about antibiotic prescribing have been shown to enable more effective shared decision-making.[57]

Chapter 7 of Antimicrobial Stewardship in Australian Health Care (2018) has more information about shared decision-making and consumer understanding of when antimicrobials are needed.

> Prescriber resources and more information are included at the end of this chapter, including the Commission's

d. Delaying prescribing

Delayed prescribing has been shown to reduce antimicrobial use without adversely affecting clinical outcomes or patient satisfaction.[58] Delayed use of antimicrobials is recommended as a means of demonstrating to consumers that antimicrobials are not always necessary.

If the GP does not think antibiotics are necessary at the time of the consultation, they can discuss with the patient when they may be needed. The GP can provide the patient with an antibiotic prescription with advice to only have prescription filled after a few days if symptoms do not improve, or if they get worse. Appropriate information should be given to the consumer so they understand if and when antimicrobials are needed, or if it is more appropriate to return to the healthcare provider.[58,59]

The *General practitioners Antimicrobial Stewardship Programme Study* (GAPS) has booklets which can be used to support discussion with patients about delayed antibiotic prescribing for acute respiratory infections.[60] Links are included in the Resources section at the end of this chapter.

Where pathology tests are ordered, prescribers may choose to delay antibiotic prescribing until results are received. Laboratories may provide providers with advice regarding the most appropriate prescribing of antimicrobials for the pathogen identified.

Prescribers can also annotate antimicrobial prescriptions to state the prescription is only valid for a specified time – for example, one month from the date of issue. This can prevent the consumer keeping the prescription for use at a later time for a different problem.

Another strategy for delayed prescribing is making the prescription available at the clinic reception at an agreed time (to be picked up if symptoms do not improve or get worse). However, this option may be considered less satisfactory by patients as the patient has to make another visit to the practice.[58,59]

Regardless of the approach, practices with multiple GPs should discuss their approach to AMS to ensure uniformity for patients regarding antibiotic prescribing.

e. Multicomponent approaches

Multicomponent approaches have been associated with decreased antimicrobial dispensing to patients.[60]

Multicomponent AMS interventions provide GPs with a suite of tools they can select from and tailor to each consultation. Tools may include:

- delayed prescribing protocol
- access to point-of-care testing for common infections
- patient decision aids to support shared decision-making
- GP education and training in communication within the consultation
- promotional materials describing the general practice policy for prescribing antimicrobials.

> AMS strategies that have been demonstrated to be effective in the period after the consultation include:
>
> a. supporting patient self-management
>
> b. antimicrobial audit and feedback in general practice.

13.3.3 After the consultation

a. Supporting patient self-management

Self-management is about patients managing their own health. Patients need to be supported with information that can assist them in self-management and decision-making after the consultation.

Patients should receive relevant advice including:[61]

- Prevent infections by regularly washing your hands and keeping up to date with vaccinations.

- Prevent food-borne infections by washing fruits and vegetables, and cooking food properly.
- Understand that antibiotics only work against bacteria. They do not work for colds and flus which are caused by viruses.
- Do not insist on antibiotics from your health professional if they say you do not need them. Ask about other ways to relieve your symptoms.
- Only take antibiotics when they are prescribed for you. Do not use or share leftover antibiotics.

A plain English infographic for consumers is available at https://www.amr.gov.au/resources/infographic-what-you-can-do that explains how to prevent antibiotic resistance (Figure 1).

- Follow your health professional's instructions when you are prescribed antibiotics.

GPs should also provide self-care instructions, information on when people should stay home from school or work, and correct cough and sneeze etiquette.[62]

General practice has a key role in achieving high rates of immunisation.

Uptake of pneumococcal and influenza vaccines in the community influences disease patterns and helps reduce overall antibiotic use, particularly for people with chronic diseases.[62,63]

Childhood immunisations is associated with a decrease in the prevalence of childhood diseases such as otitis media, which may also help to decrease antimicrobial use.[64-66]

Figure 1: Australian Government Infographic: What you can do

b. Antimicrobial audit and feedback in general practice

General practices should monitor and review their antimicrobial prescribing on an ongoing basis as part of their broader continuous quality improvement activities.[67] Audit and feedback is a method that allows for target patient populations to be defined and monitored for enhanced AMS efforts. Comparisons need to be localised to the setting within which the GP works.

There are tools available to support general practice audit and feedback activities. Links to available tools are included in the Resources section at the end of this chapter.

Strategies may include reviewing the use of intravenous antibiotics, with the view to change to the oral route of administration as soon clinically appropriate or to an agent with high oral bioavailability. Areas where this could apply include in residential aged care facilities and in regional and remote hospitals where GPs are the primary prescribing clinician.

Box 1: Antimicrobial stewardship strategies for general practice

Practice	AMS strategies
Before the consultation	• Provide GPs with data comparing their antibiotic prescribing rates • Promote AMS to patients with posters, leaflets and videos in waiting rooms. • Demonstrate to patients a commitment to antimicrobial stewardship • Use a multicomponent AMS strategy into general practice.
During the consultation	• Optimise antimicrobial use by specifying the duration of use on the prescription rather than prescribing according to available pack sizes. • Embed the Clinical Practice Guidelines into computer-aided clinical decision support systems. • Share the decision-making with patients by discussing the options, the benefits and harms of each option. • Use delayed prescribing to demonstrate to consumers that antimicrobials are not always necessary
After the consultation	• Support patient self-management by providing advice and information about managing infections. • Monitor and review antimicrobial prescribing on an ongoing basis as part of continuous quality improvement activities

Reviewing long term antimicrobial use, including topical antimicrobial, should be regularly considered after the initial consultation. Primary Health Networks (PHNs), through their provider support role, facilitate quality improvement within general practices in topic areas of the GP's choosing. GPs may choose AMS as an area for improvement. GPs may find resources customised to their prescribing patterns and targeting local issues of value. Formal programs such as the NPS MedicineWise general practice MedicineInsight program can also provide helpful data to prescribers.[a]

[a] In the most recent NPS MedicineWise national primary care data program, MedicineInsight, report (2017-18), data were available from 474 general practice sites, incorporating 532 general practices. This represents 6.6% of general practices nationally. There is significant variation in the proportion of practices by location. Approximately 26% of practices in Tasmania participate, compared with participation by general practices in South Australia (1.8% coverage) and Victoria (4.9% coverage).

13.4 Clinical governance and leadership for antimicrobial stewardship

13.4.1 Professional leadership

The RACGP advocates for a collaborative multi-sectoral approach to support appropriate antimicrobial use and reduce AMR in Australia. The RACGP endorses interventions which prevent AMR while minimising harm, morbidity and mortality from infectious disease.

The RACGP *Response* to *antimicrobial resistance in primary care* (November 2017) outlines the RACGP response to the threat of AMR in accordance with the Australian Government's National Antimicrobial Resistance Strategy 2015–2019.[68]

Key areas of focus for the RACGP are community education, clinical governance, GP education, infection control, outcome monitoring and research.

13.4.2 National leadership

The Australian Commission on Safety and Quality in Health Care (the Commission) provides national leadership in AMS. The aim of the Commission's work on AMS is to improve the safe and appropriate use of antimicrobials, reduce patient harm and decrease the incidence of AMR in Australia.

The Commission provides many resources for health services that support antimicrobial stewardship including:

- the *Preventing and Controlling Healthcare-Associated Infection Standard*
- maintaining the *Antimicrobial Stewardship in Australian Health Care* publication
- providing antimicrobial prescribing e-learning modules and videos for clinicians
- conducting surveillance of antimicrobial use through the Antimicrobial Use and Resistance in Australia (AURA) surveillance system
- supporting the National Antimicrobial Prescribing Survey (NAPS)
- funding and supporting the National Antimicrobial Utilisation Surveillance Program (NAUSP).

13.4.3 Regional leadership

PHNs were established with the aim of increasing the efficiency and effectiveness of medical services provided to patients by supporting general practice in achieving optimal safety and quality in health care.

PHNs play a significant role in supporting quality improvement in general practice and in facilitating audit activities within general practice.

GPs can call upon PHNs for support in quality improvement, including AMS. PHNs can provide GP education and training in AMS, infection control and immunisation, and maintaining health pathways that guide appropriate use of antibiotics.

13.4.4 Practice leadership

Clinician leaders in general practices have an important role in promoting and implementing AMS strategies that will help their practice workforce reduce unnecessary use of antimicrobials.[1,68]

This leadership can:

- encourage the general practice workforce to be accountable for the appropriate use of antimicrobials
- identify multicomponent AMS strategies to implement and maintain within the practice
- monitor antimicrobial use over time.

Chapter 2 of Antimicrobial Stewardship in Australian Health Care (2018) has more information about approaches to clinical leadership to establish and sustain an antimicrobial stewardship program in clinical practice.

Resources

- AMR – Antimicrobial stewardship for GPs: https://www.amr.gov.au/what-you-can- do/general-practice/prescribing-antibiotics
- Australia's National Antimicrobial Resistance Strategy - 2020 and Beyond - https://www.amr.gov.au/resources/australias-national-antimicrobial-resistance-strategy-2020-and-beyond
- RACGP Aged Care Clinical Guide (silver book): https://www.racgp.org.au/clinical- resources/clinical-guidelines/key-racgp-guidelines/view-all-racgp-guidelines/silver- book/part-a/infection-and-sepsis
- RACGP Standards for General Practices. 5th Edition: https://www.racgp.org.au/running-a-practice/practice-standards/standards-5th-edition

Consultation resources

- Australian Government. Infographic – What you can do: https://www.amr.gov.au/resources/infographic-what-you-can-do
- General Practitioners Antimicrobial Stewardship Programme study (GAPS) resources: https://public-health.uq.edu.au/gaps
- NPS MedicineWise antibiotic resistance resources: https://www.nps.org.au/professionals/reducing-antibiotic- resistance
- NPS MedicineWise patient resource: Respiratory Tract Infection Action Plan. https://www.nps.org.au/professionals/reducing-antibiotic-resistance#resources
- Therapeutic Guidelines: Antibiotic – Antibiotic prescribing in primary care: Therapeutic Guidelines summary table 2019: https://www.tg.org.au/news/antibiotic-summary-table/
- University of Queensland Managing your Respiratory Tract Infection resource: https://public-health.uq.edu.au/files/5609/Managing-your-respiratory-tract-infection.pdf

Australian Commission on Safety and Quality in Health Care resources

- AMS resources: https://www.safetyandquality.gov.au/our-work/healthcare-associated-infection/ams-and-hai-resources-and-links/
- Antimicrobial Stewardship Clinical Care Standard: https://www.safetyandquality.gov.au/publications/antimicrobial-stewardship-clinical-care-standard/
- Preventing and Controlling Healthcare-Associated Infection Standard: https://www.safetyandquality.gov.au/standards/nsqhs-standards/preventing-and- controlling-healthcare-associated-infection-standard
- Primary Care resources: https://www.safetyandquality.gov.au/our-work/antimicrobial-stewardship/antimicrobial-stewardship-primary-care
- Shared decision-making: https://www.safetyandquality.gov.au/our-work/shared-decision- making/

International resources

- Core Elements of Outpatient Antibiotic Stewardship: https://www.cdc.gov/antibiotic-use/community/improving-prescribing/core-elements/core-outpatient-stewardship.html
- Health Improvement Scotland. Optimising antibiotic use: https://www.sapg.scot/quality-improvement/primary-care/optimising-antibiotic-use/
- TARGET Antibiotic Toolkit: http://www.rcgp.org.uk/clinical-and- research/resources/toolkits/target-antibiotic-toolkit.aspx

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AUSTRALIAN COMMISSION ON SAFETY AND QUALITY IN HEALTH CARE

14 Antimicrobial stewardship in the care of children

Antimicrobial Stewardship in Australian Health Care

2020

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Acronyms and Abbreviations

Abbreviation	***Definition***
ACSQHC	Australian Commission on Safety and Quality in Health Care
AMR	antimicrobial resistance
AMS	antimicrobial stewardship
ANZPID-ASAP	Australia and New Zealand Paediatric Infectious Diseases Group - Australasian Stewardship of Antimicrobials in Paediatrics
AURA	Antimicrobial Use and Resistance in Australia
CAR	critical antimicrobial resistance
CARAlert	National Alert System for Critical Antimicrobial Resistances
CPE	Carbapenemase-producing Enterobacterales
DDD	defined daily dose
DOT	days of therapy
GP	general practitioner
MRSA	Methicillin-resistant *Staphylococcus aureus*
NAPS	National Antimicrobial Prescribing Survey
NSQHS Standards	National Safety and Quality Health Service Standards
OECD	Organisation for Economic Co-operation and Development
OPAT	outpatient parenteral antimicrobial therapy
PBS	Pharmaceutical Benefits Scheme
PCT	procalcitonin
POC	point of care
RACGP	Royal Australian College of General Practitioners
TDM	therapeutic drug monitoring

Key Points

- Antimicrobial resistance affecting children is a growing health problem, resulting in increasing duration and severity of infective illness and limiting the therapeutic options available to treat these infections.
- Antimicrobial resistance patterns for children are different to those of adults. Organisms of particular concern for children are carbapenemase-producing Enterobacterales (CPE) and ceftriaxone non-susceptible *Salmonella* species.
- Antimicrobial use promotes bacterial resistance in children.
- Pharmaceutical Benefits Scheme (PBS) data show that in all patients aged less than 65 years, the highest rate of antibiotic dispensing is for children aged 2 to 4 years.
- Antibiotic use in children is often unnecessary. Many childhood infections are caused by viruses, and some uncomplicated bacterial infections do not require treatment with antibiotics. Determining if antibiotic therapy is indicated is an important initial step in the appropriate prescribing of antimicrobials in children.
- Antimicrobials are over-prescribed for children that receive care in Australian hospital, outpatient and general practice settings.
- There is a growing body of evidence that antibiotic exposure in very young children disrupts the developing gut microbiota, which is associated with increased risk of necrotising enterocolitis, fungal infections, childhood asthma, allergy, dermatitis and obesity later in life.
- Paediatric antimicrobial stewardship (AMS) programs have been found to:
  - decrease antimicrobial use
  - reduce antimicrobial resistance
  - decrease prescribing errors
  - improve patient outcomes
  - decrease medication costs.
- When prescribing antimicrobials for children, it is important to recognise their unique needs with respect to age, size, weight, development, pattern of antimicrobial resistance, antimicrobial risk of harm, suitability of formulations and dose effectiveness.
- Key paediatric AMS strategies include:
  - improved focus on appropriateness of antimicrobial prescribing
  - reduced duration of treatment
  - use of oral therapy where clinically feasible (including intravenous to oral switch)
  - dose optimisation.
- Antimicrobial stewardship programs in health care settings that provide paediatric care should include:
  - a multidisciplinary team that specifically comprise members with a range of paediatric expertise
  - access to evidence-based prescribing guidance that is appropriate for children (including neonates and infants)
  - systems that facilitate and audit adherence to evidence-based treatment
  - approaches that target areas of inappropriate antimicrobial use in children
  - paediatric specific education for staff
  - education support for parents and carers.
- Smaller services that provide paediatric care, including those located in rural and remote areas, should consider entering into a formalised network arrangement with tertiary paediatric care providers to access additional AMS program support and expertise specific to the care of children.
- General practice has a critical role in reducing childhood antimicrobial use and preventing antimicrobial resistance by:
  - achieving high rates of childhood immunisation
  - continuous improvement in appropriateness of antimicrobial prescribing
  - educating parents and carers in appropriate antimicrobial use
  - providing advice on alternative treatment options when antibiotic use is not indicated.
- Paediatric AMS programs measure performance differently to adult AMS programs. The standard measurement of rate of antimicrobial use in adults (defined daily dose [DDD] per 1,000 occupied-bed days) is not suitable for paediatric settings because of weight differences with age. Increased uptake of electronic medicines management systems in Australian paediatric hospitals in the future should facilitate the collection of data required to monitor paediatric antimicrobial usage using the preferred method of days of therapy (DOT).
- Other methods of monitoring AMS programs may include alternative antimicrobial usage measures, appropriateness of use measures and outcome measure such as infection rates.

14.1 Introduction

Antimicrobial resistance (AMR) is a global health priority and antimicrobial stewardship (AMS) is recognised as key in the global action plan to combat this issue.[1]

Antimicrobial stewardship programs are evidence-based multi-component strategies that aim to increase judicious use of antimicrobials to improve patient outcomes and decrease AMR.[2] Initially AMS programs were largely focussed on the care of adults. Recently, AMS programs for paediatric patients have been developed to meet the needs of children, respond to high rates of antimicrobial use in children, and recognise the unique AMR patterns in children compared with adult populations.[3]

Antimicrobial Stewardship in Australian Health Care (the AMS Book) was revised in 2018 to provide an overarching resource for AMS programs in Australia. The AMS Book is available at www.safetyandquality.gov.au/our-work/healthcare-associated-infection/antimicrobialstewardship/book/.

Additional chapters of the AMS Book are added as they are completed to further support AMS in Australia.; Chapter 13: 'Role of general practice in antimicrobial stewardship' was added in 2020.

This chapter discusses AMS in the care of children, and:

- Describes the factors that influence antimicrobial prescribing for children
- Identifies key strategies to improve antimicrobial use in children
- Provides practical strategies for the implementation and evaluation of paediatric AMS programs in all healthcare settings
- Identifies approaches to measuring paediatric AMS performance.

This chapter supports implementation of an AMS program in paediatric care settings including paediatric tertiary hospitals, other hospitals that provide care to paediatric patients, and primary care providers of paediatric care such as general practice.

14.1.1 Antimicrobial use in children

Use of antimicrobial medicines in the Australian community is decreasing. However, usage continues to be higher in Australia than other comparable OECD countries.[4]

In 2017, 45% of Australian children aged 9 years and younger had at least one prescription for an antibiotic dispensed per year under the Pharmaceutical Benefits Scheme (PBS). In all patients aged less than 65 years, the highest rate of antibiotic dispensing under the PBS was for children aged 2 to 4 years.[5]

Available data show substantial geographical variation in antimicrobial use. In Australia, geographical variation in healthcare use is reported in the *Australian Atlas of Healthcare Variation* series. According to the *Australian Atlas of Healthcare Variation*, in 2016–17 there was a 16-fold difference in antimicrobial dispensing across geographical areas nationally.[6] Substantial variation prompts investigation into why this may be occurring and the potential for improvement.

Antibiotic use in children is often unnecessary. Many childhood infections are caused by viruses, and some uncomplicated bacterial infections may not require treatment with antibiotics.[7] Antibiotics should be reserved for cases in which a bacterial cause is suspected and antimicrobial treatment is recommended; this is a key area to target to reduce antibiotic prescribing.

Antimicrobials are frequently over-prescribed in Australia. A recent study of antibiotic use in children in public hospital and primary care settings found that almost 40% of antimicrobials are not prescribed in accordance with clinical practice guidelines. In some conditions, such as acute otitis media, 86% of prescribed antimicrobials are not appropriate.[8] Australian studies have also identified over-prescribing of antimicrobials in children for a range conditions including upper respiratory tract infections, bronchitis and bronchiolitis, and tonsillitis.[9]

Inappropriate use of antimicrobials also occurs in children admitted to public and private hospitals in Australia. Data from the National Antimicrobial Prescribing Survey (NAPS) identified almost 20% of antimicrobial prescriptions for admitted children were inappropriate, and 59% of prescriptions for surgical prophylaxis in children were inappropriate in NAPS contributor hospitals. The most frequently inappropriately prescribed antimicrobials in children admitted to hospital were amoxicillin and the broad-spectrum agents cefazolin and ceftriaxone.[10]

Antibiotic overuse has also been identified in very young children. A large Victorian study found half of all infants are exposed to at least one antibiotic before one year of age. The number of antibiotic prescriptions and the cumulative antibiotic exposure of infants in this Australian study was markedly higher than other high-income countries. Amoxicillin–clavulanic acid was identified as the most commonly prescribed antibiotic, despite clinical guideline recommendations that amoxicillin alone is the first-line agent for most common early childhood infections in Australia.[11]

Overuse of antimicrobials in neonatal intensive care units is an issue of significant concern. Antimicrobial medicine consumption in intensive care settings can be almost ten times general hospital wards.[12] International and Australian data indicates a lack of consistency in antimicrobial use across neonatal intensive care units.[13,14] A recent Australian study identified only 4% of antimicrobial prescriptions for the treatment of sepsis in neonates were for microbiologically confirmed infections. Further, more than 20% of antibiotics were prescribed for greater than 48 hours, despite identification of most potential pathogens in neonatal sepsis occurring within 36 to 48 hours. Due to the unique risks associated with serious bacterial infection, risk of sepsis in neonates generally requires commencement of antibiotic therapy, despite the fact that most will not have culture-confirmed infection.[15]

Most antimicrobial prescribing for children occurs in the outpatient setting, predominantly in primary care and, to a lesser extent, in hospital clinics and emergency departments. There is also increasing use of outpatient parenteral antimicrobial therapy (OPAT) for home-based systemic treatment of serious infections in children.[16] The 2017 Australian OPAT NAPS pilot study evaluated the appropriateness of antimicrobial use in OPAT in children and adults. This study found that less than half of antimicrobial prescriptions were compliant with guidelines.[17]

14.1.2 Antimicrobial resistance and children

The overuse and misuse of antimicrobials, particularly broad-spectrum antibiotics in healthcare settings, is a key contributor to AMR. Antimicrobial resistance reduces the number of therapeutic options for treating infection; this is of particular concern in paediatric care, as therapeutic options in children are already limited compared to options available for adult patients. For children, AMR may increase the duration and severity of infective illness. Children infected with extended spectrum β-lactamase-producing organisms have, on average, a longer length of hospital stay, require more intensive care unit days and have a higher risk of death than those without such infection.[18]

The Antimicrobial Use and Resistance in Australia (AURA) Surveillance System monitors AMR and antimicrobial use in Australia.[19] This system, which is coordinated by the Australian Commission on Safety and Quality in Health Care (the Commission), provides national data on antimicrobial use across a range of Australian healthcare settings. Data collected through the National Alert System for Critical Antimicrobial Resistances (CARAlert) show critical antimicrobial resistances (CARs) have been isolated in patients of all ages in Australia. The CARs more frequently isolated from Australian children include carbapenemase-producing Enterobacterales (CPE) and ceftriaxone non-susceptible *Salmonella* species.[20]

Antimicrobial use promotes bacterial resistance through direct selection pressure that is advantageous to bacteria expressing resistance genes.[21] Longer duration of antibiotic use and multiple courses are associated with higher rates of bacterial resistance in an individual.[22] Antibiotic resistance genes have also been identified without antimicrobial exposure.[23] This finding suggests community transmission of AMR may occur and children may be important recipients and transmitters of resistant bacteria in the community.[24]

14.1.3 Antimicrobial stewardship in paediatric care

Antimicrobial stewardship is a core component of the National Safety and Quality Health Service (NSQHS) Standards. The NSQHS Standards support hospitals and health services to ensure nationally expected levels of quality and safety are met. The NSQHS Preventing and Controlling Healthcare-Associated Infection Standard aims to improve the measures designed to help prevent infections and the spread of AMR, through appropriate prescribing and use of antimicrobials.[25] Antimicrobial stewardship components are also included in the Royal Australian College of General Practitioners (RACGP) Standards for General Practice[26] and the Aged Care Quality and Safety Commission (ACQSC) Aged Care Quality Standards.[27]

Whilst much of the evidence for AMS is based on research pertaining to adult care, there is a growing evidence base for paediatric AMS programs. Studies of AMS programs for paediatric inpatient care in high-income countries demonstrate paediatric AMS programs:

- Decrease antimicrobial use
- Decrease prescribing errors
- Improve patient outcomes
- Decrease medication costs.[28, 29]

Recent research has also identified that paediatric AMS programs reduce AMR in inpatient and outpatient settings.[30]

A small number of studies provide evidence on the effectiveness of paediatric AMS interventions in the primary care setting. Interventions aimed at changing prescriber behaviour and educating caregivers have been found to improve prescribing in accordance with guidelines, decrease the number of antibiotics dispensed per-child per-year and decrease the prescribing of broad-spectrum agents.[31] For example, antibiotic consumption in children aged 0-6 years was halved in Sweden from the years 2000 to 2014 supported by the development, public dissemination, and health professional uptake of new guidelines for the treatment of childhood illnesses such as otitis media.[32] These significant reductions in antimicrobial use that can be achieved in primary care are an important component of comprehensive, whole of system responses to AMR.

14.2 Factors that influence antimicrobial prescribing in children

Although many of the core principles of AMS apply to both adults and children, there are some aspects of AMS that are unique to children.

14.2.1 Anatomical and physiological factors

Children differ anatomically and physiologically from adults. Babies are born with an immature immune system, which matures and acquires memory as they grow. Early protection is provided by transplacental transfer of immunoglobulin, and also from breastmilk.[33] Despite this early protection, children have high rates of infection. It is understood that viral infections and nonspecific syndromic presentations are more common in paediatrics than in adult medicine.[34]

Different microorganisms from those often seen in adult patients may cause infectious diseases in children. For example, group B streptococci and *Escherichia coli* are the most common bacterial causes of meningitis in neonates, but *Streptococcus pneumoniae* and *Neisseria meningitidis* are the predominant causes in infants and older children. This influences empirical and targeted antimicrobial choices.[35] Patterns of AMR in children also vary significantly by age, requiring age-specific antimicrobial guidance for selected infections.[36]

Age- and development-appropriate dosing can be challenging when prescribing antimicrobials for children. An accurate body weight, and sometimes height (to determine body surface area), is required to calculate dosage. This may not always be possible (for example in critically ill children). Although age-based weight estimation formulas exist, the accuracy of these formulas is variable, which can increase the risk of inaccurate dosing.[37] Inappropriately low dosing of antimicrobials can contribute to AMR.[38]

As children grow, body composition changes (for example water, fat, protein) and the absorption, distribution, metabolism and excretion of medications change. As a result, the pharmacokinetic and pharmacodynamic properties of medications such as antimicrobials can be variable during childhood.[39] This precludes the use of a one-dose-fits-all approach to dosing. Evidence of the pharmacokinetic and pharmacodynamic properties of many antimicrobials in children is lacking; often data from *in vitro* or animal models, confirmed in adult patients have not been corroborated in paediatric patients. Where evidence exists, the appropriate duration of antimicrobial therapy is often shorter than for the same infection in adults.[40]

In addition, standard dosing schedules may not be appropriate in specific populations with altered pharmacokinetics such as neonates and children with: burns, cystic fibrosis; immunocompromise; or obesity.[41,42] Almost one-quarter of Australian children are overweight (17%) or obese (7.7%).[43] Obese children differ in body composition and physiology from children who are not obese. Dosing by actual body weight may result in either sub-therapeutic levels or drug toxicity. For example, aminoglycoside doses are usually calculated based on ideal body weight rather than actual total body weight to prevent toxicity, whilst doses for other medications are based on adjusted body weight. Little data is available to guide antibiotic dosing in obese children.[44]

Children can respond differently to antimicrobials compared to adults. The likelihood of adverse reactions to antimicrobials can increase or decrease with age and development. Lower toxicity for some antimicrobials in children (for example aminoglycoside nephrotoxicity) may mean that these antimicrobials have greater usefulness in children. Conversely, some irreversible side effects that might be tolerated in an elderly patient (for example significant ototoxicity) could be unacceptable in an infant. [45] These different side effect profiles could necessitate the use of alternative antimicrobials that would not be commonly used in adults, for example the preferential use of cefotaxime rather than ceftriaxone to avoid ceftriaxone-related cholelithiasis, which is more prevalent in infants than adults.[46]

Difficulties associated with AMR can affect risk-benefit considerations when selecting antimicrobials. Historically, use of antimicrobials such as tetracyclines and fluoroquinolones has been contraindicated due to concerns about adverse effects in children. Despite this, there is increasing use of these agents in the treatment of multidrug-resistant pathogens, where there is no safe or effective alternative, and where the benefit is considered to exceed the risk.[47]

14.2.2 Antimicrobial access and safety factors

Fewer antimicrobials are available for use in children than in adults, which may limit the ability of clinicians to treat resistant organisms. Formulations suitable for use in neonates, infants and children are often unavailable, or have not been sufficiently assessed for safety or efficacy in children. Although formal evaluation of new antimicrobials in children is now an international regulatory requirement, the lack of clinical studies for older products means many antimicrobials are used off-label in children.[48,49] Off-label use of medications in children can limit affordable access to antimicrobials as this type of use is not subsidised under the PBS.[50]

When selecting an antimicrobial product, formulation factors are important. Considerations such as the taste of a liquid formulation, the volume of liquid required, or the ability of the child to swallow tablets can affect adherence. Modifying adult formulations such as crushing a tablet or opening a capsule is not always appropriate.[51] Small errors in volume or dose can result in underdosing or overdosing, leading to adverse outcomes, particularly in neonates.[52] The excipients present within adult formulations also require consideration. Some formulations include excipients that can be potentially harmful to neonates and children.[53] Solvents such as ethanol and propylene glycol can cause toxicity. Further, some preservatives can cause adverse effects in children; for example, benzyl alcohol can cause potentially fatal gasping syndrome in neonates, and benzoic acid is associated with increased rates of jaundice in neonates, which can result in brain dysfunction (kernicterus).[54]

Increasingly, evidence suggests antimicrobial use in very young children may cause long term harm through alteration of the microbiome of the gut.[55] The microbiota acquired by infants, mainly at birth, mature in early childhood up to the age of approximately 3 years, by which time the microbiota are mostly adult-like.[56] Microbiota have an important role in immune system development in infants. There is a growing body of evidence that antibiotic exposure early in life can change the microbiota temporarily or permanently.[57] Changes to the microbiome due to early exposure to antibiotics are associated with an increased risk of early adverse outcomes such as necrotising enterocolitis and fungal infections. Studies indicate certain probiotic strains appear to reduce the prevalence of necrotising enterocolitis in premature infants, although further research is required to determine the optimal formulation, dosage and treatment duration.[58] In addition, early antibiotic exposure is associated with increased risk of chronic disease later in life such as allergy, atopic dermatitis, celiac disease, diabetes and obesity. [59,60,61]

The potential short-term and long-term risks of neonatal antimicrobial exposure have caused Australian researchers to question the risk-benefit considerations of intrapartum antibiotic prophylaxis to prevent early-onset group B *Streptococcus* infection in neonates.[62] National Health Service clinical guidelines used in England and Wales, do not recommend routine antenatal screening for group B *Streptococcus* because evidence of its clinical and cost-effectiveness remains uncertain.[63] Further research into the clinical risks and benefits of intrapartum antibiotic prophylaxis for the prevention of early-onset group B streptococcal infection is required.

14.2.3 Other factors

Prescribers may have a lower threshold for prescribing antibiotics in children due to their perceptions of uncertainty and risk. Non-specific syndromic and viral presentations can cause diagnostic uncertainty and drive antimicrobial prescribing, especially when there are no positive microbiology results to guide therapy.[64] Children may have difficulty in communicating their symptoms, which can make assessment difficult.

Clinical uncertainty and concerns regarding risk of serious bacterial infection, particularly in neonates can also affect decisions to commence and continue antimicrobial therapy.[65] Perinatal infection remains the highest cause of Australian neonatal death and clinical signs of neonatal sepsis can be non-specific.[66] As such, empiric antibiotic therapy is commonly commenced in hospitalised neonates as prescribers seek to balance the unique risks and benefits of antimicrobial treatment associated with this vulnerable patient group. Tools to assist clinicians in determining the probability of a neonatal early-onset sepsis[67] can safely reduce neonatal blood culture screening, empirical antibiotic exposure and hospital length of stay.[68,69]

Antibiotic allergy labels are usually acquired by children because of rash presentation after antibiotic use; however, many never have a formal allergy evaluation. When formal evaluation is performed the majority are found not to have antibiotic allergy.[70]

Unevaluated childhood antibiotic allergy labels can perpetuate into adulthood, drive the use of broad-spectrum antibiotics and subsequently AMR, and lead to poorer health outcomes.[71] A recent study conducted in Western Australia identified more than 5% of children admitted to a major paediatric tertiary hospital had an antibiotic allergy label. Those with an antibiotic allergy label were treated with more broad-spectrum antimicrobials than those without an antibiotic allergy label, and had longer lengths of hospital stays.[72] Testing to prove or disprove antibiotic allergy labels can increase access to appropriate antibiotic therapy, reduce AMR and improve health outcomes.[73]

Aboriginal and Torres Strait Islander children experience a greater infectious disease burden, higher rates of invasive infections, and are more likely to be hospitalised for infectious diseases than non-Indigenous children.[74,75] Acute rheumatic fever, caused by an immunological response to group A *Streptococcus* infection predominantly affects Aboriginal and Torres Strait Islander children aged 5-14 years. Antibiotic use in the treatment and secondary prophylaxis of acute rheumatic fever is important to minimise heart valve damage and progression to rheumatic heart disease. Prompt assessment and antibiotic treatment of superficial infections often caused by group A *Streptococcus* (such as sore throats and skin sores) is also important for the prevention of acute rheumatic fever in Aboriginal and Torres Strait Islander children.[76] See Chapter 15 of the AMS Book for additional information regarding AMS and Aboriginal and Torres Strait Islander people.

14.3 Antimicrobial Stewardship strategies for paediatric Care

Many of the strategies and tools for AMS, as described in Chapter 3 of the AMS Book, are also applicable to the paediatric care setting. In this section five key strategies are discussed that are specifically used in the care of children.

14.3.1 Reduce antimicrobial prescribing in primary care

Chapter 13: 'Role of general practice in antimicrobial stewardship', of the AMS Book contains general information about strategies to reduce antimicrobial prescribing in the general practice setting. In addition to the information provided in Chapter 13, AMS strategies for general practice also need to consider issues that are specific to children and their carers.

A meta-review of studies to reduce antibiotic prescriptions for children presenting to primary care with respiratory tract infections, identified evidence that interventions reducing clinical uncertainty, reducing clinician/parent miscommunication, eliciting parent concerns, making clear delayed or no-antibiotic recommendations and providing clinicians with alternate treatment actions have the best chance of success.[77]

Although childhood infections are often due to viral pathogens and can be managed with watchful waiting, GPs are often faced with diagnostic uncertainty, as the causative pathogen is often unknown. Fears of failing to identify a serious bacterial infection often drive a cautious approach that may include the precautionary use of antibiotics. Increasing use of point-of-care (POC) testing for biomarkers of bacterial infection and some common childhood pathogens is evident in Europe in an effort to reduce clinical uncertainty and improve targeted therapy.[78,79] Point-of-care testing uptake in Australia has been slow due to the costs associated with POC testing and regulation of POC testing.[80]

Parents often expect that antibiotics are required for mild childhood infections. In 2017, an NPS MedicineWise survey identified almost one-third of Australian parents visit their GP expecting to receive antibiotics for their child's sore throat, cough or cold.[81] Health professionals' perceptions of parental expectation can also influence prescribing practices. A systematic review of qualitative studies identified primary care clinicians may misinterpret parent requests for information as requests for antibiotic prescriptions.[82] In order to elicit patient concerns and reduce clinician-perceived pressure to prescribe antibiotics, GPs should explicitly ask parents or carers about their concerns and expectations early in the consultation.[83]

When antibiotic use is not warranted, prescribers should take time to discuss with parents: the likely nature of the condition; why prescribing an antimicrobial may not be the best option, and alternative options to prescribing an antimicrobial.[84] This information needs to be conveyed confidently and unambiguously. A recent Australian survey identified most consumers would accept the GP's decision not to prescribe an antibiotic if it was clearly explained.[85]

Parents also require clear guidance on the usual time to recovery and what they should do if their child's clinical condition deteriorates. The NPS survey found that parents generally expect mild respiratory tract infection symptoms to last for a shorter time than they actually do.[86] Many people presenting to a general practice simply want reassurance that the illness is not serious and does not require treatment.[87]

The decision not to prescribe an antibiotic can be perceived as creating a 'treatment vacuum.' Explicit advice regarding alternative treatment options such as over-the-counter symptomatic relief products, home care and standard safety-net advice is important to provide parents with the advice and assurance they need to appropriately care for their child.[88]

Figure 1 provides a series of evidence-based statements to change antibiotic prescribing for childhood respiratory tract infection (RTI), ordered from the strongest to weakest evidence.

Figure 1: Recommendations for interventions to change antimicrobial prescribing behaviour in childhood respiratory tract infections (RTI) [89]

An intervention to change clinician prescribing behaviour should:

1. **Give explicit antibiotic prescription recommendations**
2. **Give alternative treatment options (including for parents e.g. home care advice, and clinicians e.g. delayed scripts)**
3. **Address the treatment/no treatment distinction made by clinicians**
4. **Give information on specific symptoms**
5. **Address both clinicians and parents**
6. **Provide information on prognosis that is tailored to the child and addresses the common and/or stated (not implied) concerns of parents**
7. **Address known environmental pressures (e.g. external pressures to prescribe/consult)**
8. **Make clinicians feel more confident/experienced**
9. **Acknowledge treatment decisions in care of childhood RTIs are usually made in the absence of definitive diagnosis.**
10. **Be designed in consultation with clinicians and parents**

An intervention to change clinician prescribing behaviour should not:

1. **Work against the environment in which clinician operates**
2. **Be generic**
3. **Patronise or undermine parental or clinician decision making**
4. **Be passive (e.g. posters)**
5. **Increase anxiety or perception of risk for either party**

General practice has a key role in achieving high rates of childhood immunisation. Vaccines can reduce AMR through direct reduction of specific organisms and strains carrying resistant genes or by reduction in febrile illness, which reduces antibiotic use. Evidence shows immunisation of children with the pneumococcal conjugate vaccine reduces the number of AMR episodes in children and reduces antibiotic use. Further, children who receive influenza vaccination have fewer antibiotics prescribed compared to those that are not immunised. A large cluster-randomised trial also identified influenza vaccination of children is associated with reduced antibiotic consumption for vaccinated children, their families and community contacts.[90,91]

14.3.2 Limit duration of antimicrobial therapy

Limiting the duration of antimicrobial therapy is an important means of reducing unnecessary antimicrobial exposure in children. Prolonged exposure has been associated with the emergence of antimicrobial resistance, *Clostridioides (Clostridium) difficile* (CDI) infection and fungal infection. Evidence suggests the appropriate duration of therapy for some common infections is shorter in children than in adults. For example, in a study of community-acquired pneumonia in children aged less than five years, five days of high-dose oral amoxicillin resulted in equivalent outcomes to a 10-day course, with no treatment failures, although a three-day course had a 40% treatment failure rate.[92] A study of uncomplicated gram-negative bacteraemia in children found 10 days of intravenous antimicrobial therapy was as effective as 14 to17 days of therapy in preventing relapse.[93]

The Australia and New Zealand Paediatric Infectious Diseases Group - Australasian Stewardship of Antimicrobials in Paediatrics (ANZPID-ASAP) has developed evidence-based recommendations for duration of antibiotic treatment and intravenous to oral step down for a variety of bacterial infections in children. See the Resources section of this chapter for a link to the full table of recommendations.

In outpatient and primary care settings, the quantity of antimicrobial therapy prescribed should be limited according to clinical guidance, rather than PBS pack size. Repeat prescriptions should not be prescribed unless clinically indicated. Prescribing software should have the default repeat setting on antimicrobials set to no repeats.[94] Pharmacists should clarify clinical appropriateness before dispensing repeat prescriptions for antimicrobials when significant time has elapsed between the original dispensing and the repeat dispense request.[95] Routine issue of repeat prescriptions for antimicrobials creates a reservoir of antimicrobials that can be accessed by consumers. Survey results indicate many Australian consumers retain antimicrobial repeat prescriptions for future use.[96] Parents require clear instructions about the prescribed duration of therapy to prevent truncated or excessive use. Pharmacists should also advise parents of the potential harms associated with using repeat prescriptions for antimicrobials later without further assessment by a doctor.

14.3.3 Intravenous to oral switch

Where possible, the use of oral antimicrobials is preferred in children. Treatment using the oral route avoids the use of vascular access devices, and associated risk of catheter related-infection. Oral therapy often has less serious adverse effects than parenteral therapy, facilitates early discharge, improves drug administration efficiency and reduces financial burden on the family and healthcare system.[97]

Oral antimicrobials alone may be sufficient where intravenous antimicrobials have traditionally been used. A Cochrane review of antibiotics for acute pyelonephritis in children found no difference in duration of fever, treatment failure or long-term renal damage in children treated with oral antibiotic therapy for 10 to 14 days compared with children treated with three days of intravenous antibiotic therapy followed by 10 days of oral antibiotic therapy.[98] Further, a systematic review of pneumonia in children under five years of age found oral amoxicillin to be as effective as intravenous ampicillin in severe and non-severe pneumonia.[99]

When intravenous antibiotics are necessary, optimising the duration of intravenous and oral antibiotics aims to provide the shortest safe duration of antibiotics to treat infection. A randomised controlled trial on acute haematogenous osteomyelitis in children showed that only three to four days of intravenous antibiotics were necessary, with the remainder of the course by the oral route; this finding has substantially changed practice.[100] The ANZPID-ASAP have developed evidence-based guidance for the duration and timing of intravenous to oral switch for 36 paediatric infectious diseases.[101] See Figure 2 for general principles to guide clinical decisions for intravenous to oral switch of antimicrobials.

Figure 2: General principles guiding intravenous to oral switch of antimicrobials[102]

Clinical condition

- **Clinically stable without signs of severe sepsis (fever alone need not prevent switch)**

Ability to absorb oral antimicrobials

- **Able to tolerate oral medication (not vomiting or nil by mouth)**
- **No impairment to absorption (e.g. mucositis)**
- **Older than 28 days (under 28 days is not an absolute contraindication, but absorption is variable)**

Availability of an appropriate antimicrobial

- **Antimicrobial treats the infecting or expected organism**
- **Antimicrobial is available in appropriate or palatable paediatric formulation**
- **Antimicrobial has sufficient penetration of affected tissues**

Practical issues

- **Adherence to oral antimicrobials**
- **Family agreement to the plan**

Factors that prevent intravenous to oral switch can include: perceived pressure from patient (or parent) expectation regarding treatment; hierarchy of the medical team structure not facilitating opportunities for de-escalation of antibiotics, or the perception that intravenous antibiotics are more potent.[103]

Intravenous to oral switch can be supported by:[104, 105]

- Shared decision making between prescribers and parents or carers about therapy, including intravenous to oral switch
- Education about the benefits and risks associated with differing routes of antimicrobial therapy
- Access to prescribing guidelines for infections that can be treated with oral agents
- Promotion of clinical criteria for considering intravenous to oral switch, with clear inclusion and exclusion criteria that describe when switch is safe and appropriate, for example flow charts
- A multidisciplinary approach, with nursing and pharmacy staff to prompt reviews of intravenous therapy
- Multimodal communication resources to promote intravenous to oral switch, for example lanyard cards, posters and pamphlets

14.3.4 Antimicrobial dose optimisation

Children exhibit age-related pharmacokinetic and pharmacodynamic variability. For example, the average clearance of linezolid in children aged 2 to 11 years is 2.3 times higher than that of adolescents and adults.[106] There is a lack of pharmacokinetic and pharmacodymanic evidence for many antimicrobials used in children. Many of the current dosing guidelines for antimicrobial treatment in children are extrapolated from adult studies. This can lead to sub-optimal dosing, with associated issues of lower efficacy and increased AMR, or over-dosing and antimicrobial toxicity.[107]

In addition to the dose optimisation strategies discussed in Section 1.2.2. of this chapter, therapeutic drug monitoring (TDM) is an important tool used in paediatric dose optimisation to support personalised dosing of antibiotics in order to increase antimicrobial effectiveness, reduce AMR and minimise toxicity.[108] Understanding the link between antimicrobial exposure (pharmacokinetics) and microbiological response (pharmacodynamics) is important to enable dosing optimisation of the limited number of antibiotics available for paediatric use. Using area under the curve and minimum inhibitory concentration approaches may improve outcomes for some paediatric patients, especially those with life-threatening infections such as sepsis where studies have shown standard dosing rates can be sub-optimal.[109,110] Dosing informed by TDM can also facilitate the continued use of narrower-spectrum antibiotics when treating multidrug-resistant organisms.[111] Therapeutic drug monitoring can be essential when using antimicrobials that are not licensed for use in children. For example, posaconazole is not approved for use in children under 13 years of age; despite this, it is often used off-label in specialist paediatric hospitals. Therapeutic drug monitoring is required to ensure target plasma concentrations of posaconazole are achieved to avoid breakthrough invasive fungal disease.[112]

Therapeutic drug monitoring requires collaboration between paediatricians, pharmacists, pathologists and clinical pharmacologists. Some practical limitations to the use of TDM for dose optimisation in infants and children include: difficulties with venous access and a reluctance to use frequent blood tests to optimise dose or monitor toxicity; the need for large sample volumes compared to circulating blood volumes, particularly in neonates; and lack of access to sufficiently rapid diagnostic testing.[113]

14.3.5 Rapid diagnostics

Recent advances in rapid diagnostics are assisting the earlier identification of pathogens and detection of select antibiotic-resistance genes. Rapid diagnostic tests are associated with reduced time to targeted therapy, reduced mortality, early discharge, and decreased hospital costs.[114] Rapid diagnostics may assist in reducing diagnostic uncertainty. Procalcitonin (PCT) is a diagnostic test used to distinguish bacterial infections from other infectious and inflammatory conditions. There is growing evidence of the value of the infection biomarker PCT to improve diagnosis of bacterial infections, reduce initiation of antibiotic treatment in low risk presentations and guide judicious antibiotic prescribing for children with more severe infections.[115]

14.4 Implementing and leading antimicrobial stewardship in paediatric care

General requirements for implementing and sustaining an AMS program, as described in Chapters 2, 4 and 5 of the AMS Book, are also applicable to the paediatric setting. However, some modification for the paediatric setting is required.

14.4.1 A team approach to AMS

In healthcare settings that provide paediatric care, the AMS team should consist of clinical staff with paediatric-specific knowledge, experience and expertise.

In specialist paediatric hospitals the AMS team may be paediatric specific. In other generalist hospitals that provide care for children, a clinician with paediatric AMS expertise should be involved in the development of the hospital's AMS program and be a member of the AMS team to provide guidance on paediatric-specific issues. In the absence of a specialist paediatrician, advice should be sought from the AMS team from a specialist paediatric hospital. Alternatively, the hospital could enter into a collaborative arrangement with a statewide specialist paediatric network, if available, for advice and support in selecting and developing paediatric AMS strategies.

The NSW Agency for Clinical Innovation's Paediatric Network is an example of a collaborative arrangement. The Paediatric Network links local paediatric units within NSW to support quality care close to home for paediatric patients. The Network supports local paediatric units with activities and resources such as shared clinical guidance documents and education and training opportunities.[116]

Other core members of the AMS team include infectious diseases physicians, clinical pharmacists, infectious diseases nurses, clinical nurse consultants, educators and clinical microbiologists with paediatric expertise. Team members could be included on AMS team rounds in paediatric wards, work with members of the AMS team to develop local paediatric AMS resources, provide paediatric-specific AMS education, and participate in audit and feedback activities. Paediatric specialist nurses and paediatric nurse practitioners can support programs, act as AMS champions (especially where there is no on-site paediatrician), and liaise with specialist paediatricians from established networks.

A survey of 14 tertiary paediatric hospitals located in Australia and New Zealand, identified only half of the surveyed hospitals had a dedicated AMS team or AMS team with a paediatric representative. Staff have identified a lack of dedicated staff with paediatric expertise, particularly in the areas of infectious diseases medicine and pharmacy as an important barrier to paediatric AMS implementation.[117]

The AMS team in general practice has different characteristics, and needs, to that of hospitals. Team members may include GPs, practice nurses, practice managers, as well as pharmacists and pathology providers. The AMS team is required to develop an AMS program that maintains the effectiveness of antimicrobials and decrease preventable infection associated with healthcare.[118] The team should consist of clinical staff with paediatric-specific knowledge and expertise and the program should address the effective use of antimicrobials in patients of all ages including neonates, infants, and children. Further information about implementing and leading antimicrobial stewardship in general practice is provided in Chapter 13 of the AMS Book.

14.4.2 Plans and strategies for AMS programs

All health service organisations are required to implement an AMS program to meet the requirements of the National Safety and Quality Health Service (NSQHS) Standards.[119] Health service organisations that provide paediatric care should ensure that the organisation's AMS program also addresses the unique requirements of children.

Prescribing guidance

Paediatric-specific prescribing guidelines (either national or locally developed) should be available to prescribers to guide empirical therapy, including duration of therapy and intravenous to oral switching in children. Health service organisations are required to provide prescribers access to appropriate guidelines for antimicrobial prescribing, this includes access to the national antibiotic guidelines, Therapeutic Guidelines: Antibiotic.[120] National paediatric-specific prescribing guidelines have also been developed by the ANZPID-ASAP.[121] Where national guidance is not available, guidelines may need to be sourced from a local tertiary paediatric service or locally developed. Local evidence-based guidelines should be developed in collaboration with experts and draw from quality evidence (where available). The guideline development process should also include input from a multidisciplinary team with paediatric expertise.

Health service organisations should develop an antimicrobial policy (see Chapter 2 of the AMS Book) that includes recommendations that are specific to paediatrics, such as:

- The need to document the patient's weight on prescriptions and medication charts, and regularly review this throughout the duration of care. The National Inpatient Medication Chart Paediatric promotes safe prescribing of medicines in hospitalised children (see resources).
- Guidance on conditions for which paediatric-specific advice should be sought, and when to seek the advice of paediatric infectious diseases experts.
- How to access paediatric infectious diseases or microbiology advice in the absence of on-site services.

As uptake of electronic healthcare records and electronic medication management increases over time, further opportunities will arise to embed prescribing guidance and principles of antimicrobial policy within prescribing, dispensing and medicines administration functions. See Chapter 4 of the AMS Book for further detail on information technology to support antimicrobial stewardship.

Adherence to evidence-based treatment

Facilitating or encouraging adherence to evidence-based treatment is a core component of paediatric AMS programs. The two main strategies used are audit of antibiotic use with feedback (persuasive strategy) and antimicrobial pre-authorisation prior to use (restrictive strategy).[122]

In the first strategy prescriptions provided for antimicrobials are reviewed in the context of the patient's medical record, compared with prescribing guidelines and feedback is provided to the prescriber or clinical unit. Whilst this strategy is largely used in general practice and other non-admitted settings, persuasive AMS strategies have also been demonstrated to be effective in the hospital setting.

'Handshake Stewardship' created and implemented in a United States children's hospital involves shared review of all prescribed antimicrobials by a pharmacist and a physician, and in-person feedback to prescribers at daily rounds to support appropriate use of antimicrobials. This method has demonstrated a reduction in overall antimicrobial use, reductions in broad spectrum antimicrobial use in the first year of implementation,[123] and a sustained reduction in antimicrobial use over five years.[124] The approach also demonstrated high rates of acceptance amongst medical staff.[125]

The second strategy is an antimicrobial restriction system that involves the review and approval of antimicrobial prescriptions prior to commencing treatment. These systems are often used in hospitals. Electronic decision support and restricted prescribing systems are effective in reducing total and broad-spectrum antimicrobial use and reducing antimicrobial costs.[126,127,128]

There is also some evidence of reduced healthcare-associated infection rates associated with the implementation of electronic AMS support systems.[129,130] The context of the facility providing care to the paediatric population is an important consideration as to what is feasible and effective.

A Cochrane review found that restrictive strategies have a more immediate effect and persuasive strategies have a more sustainable effect, such that six months after implementation persuasive and restrictive strategies are equally effective in reducing inappropriate prescribing of antimicrobials.[131] A possible explanation for the reduced effect of restrictive practices over time is the development of workarounds to avoid access restrictions.

A study of after-hours access to antimicrobials in an Australian paediatric hospital with an electronic antimicrobial restriction system identified over two-thirds of the antimicrobials accessed after-hours were not AMS adherent, and half of the restricted antimicrobials accessed were not approved. The most common restricted antimicrobials accessed after hours were ceftriaxone, azithromycin, and clindamycin [132]

Interventions to improve adherence to evidence-based treatment guidelines consist of both persuasive strategies that facilitate appropriate treatment selection (including treatment without antimicrobial use) and restrictive measures that limit the opportunity to select inappropriate antimicrobial treatment. A combination of both these options are more effective than persuasive or restrictive strategies use alone.[133]

14.4.3 Targeted approaches

AMS programs in the hospital setting have largely targeted specific antimicrobials using pre-prescription approval processes or post-prescription audit and feedback. As AMS programs evolve, and with increasing focus on AMS in primary care, there has been a growing interest in targeting specific infective diseases.[134]

Specific strategies should be developed for targeted approaches to AMS that are more likely to be effective in children. Priority areas for targeting could be those where high rates of inappropriate prescribing in children have been identified (such as surgical prophylaxis in the hospital setting and otitis media in primary care).

Antimicrobial stewardship programs may also include targeting of sub-populations in which a small percentage of children receive a disproportionally high percentage of antimicrobials. Examples may include children with a diagnosis of cystic fibrosis, neonates, children with malignancy and children presenting to emergency departments. An Australian AMS program that targets paediatric patients receiving outpatient parenteral antimicrobial therapy as part of a hospital-in-the-home program, has achieved: high rates of appropriate antimicrobial prescribing; reductions in inappropriately long durations of antimicrobial therapy; and reductions in the median number of days patients received broad-spectrum antimicrobial treatment, whilst retaining low rates of infection and antimicrobial-associated complications.[135]

When developing a targeted strategy, it is important to consider what type of measures to use, for example process, outcome or balancing measures. It is important to choose measures that are relevant and achievable. Measuring AMS performance is discussed further in section 14.5.

14.4.4 Education

Educational programs that include the unique needs of children are important for the successful implementation of AMS in the paediatric setting. Education of healthcare providers on appropriate antibiotic prescribing has been shown to enhance other AMS interventions.[136]

Education of staff (medical, pharmacy, nursing, pathology) on orientation and repeatedly as part of ongoing professional development is required. Where possible, inter-professional learning opportunities should be provided. Key education program components include:

- Common paediatric infections
- Local resistance patterns
- Different microbiology of infections between children and adults

- Developmental and physiological aspects relating to prescribing antimicrobials in paediatric patients
- The pharmacokinetics and pharmacodynamics of antimicrobials in neonates and children
- Therapeutic drug monitoring in paediatric patients
- Duration of therapy
- Principles of intravenous-to-oral switch
- Managing diagnostic uncertainty
- Discontinuing therapy.[137,138]

Passive educational techniques such as didactic presentations are modestly effective for increasing health professional knowledge. Interactive or dynamic techniques such as case-based learning, interactive small group sessions, e-learning, retrospective audit with feedback and academic detailing are more effective in influencing prescribing behaviour.[139] A lack of education was identified as the most common perceived barrier to successful paediatric AMS in hospitals in Australasia and in other high-income countries.[140,141]

Education interventions aimed at parents and carers can assist in addressing misperceptions about antibiotic use in childhood infections, and reduce parental expectation of antimicrobial treatment for children. Most parents want to be more involved in shared decision making about antimicrobial treatment.[142] Whilst education materials such posters, brochures and informational videos can be effective, evidence indicates communication between prescribers and parents or carers is the most effective education intervention. In addition, interventions that target both prescribers and parents or carers are more effective than those that only target prescribers or parents/carers alone.[143]

Parents and carers also require education on the correct administration of antimicrobials to their children. Children as young as four years can be taught to swallow tablets, and parents and families should be assisted in teaching the child how to do this. A number of organisations have produced resources to support education of parents, families and staff in administering oral medicines to children (see resources).

14.5 Measuring AMS performance

One of the key differences between AMS programs for children and AMS programs for adults is outcome measurement. Approaches to measuring the performance of AMS programs are discussed in Chapter 5 of the AMS Book. The targeted use of audit and feedback is an important component of an AMS strategy.

14.5.1 Rate of antimicrobial use

The standard measurement of rate of antimicrobial use in adults is defined daily dose (DDD) per 1,000 occupied bed days. Because dosing for children is largely based on body weight or body surface area, the DDD measurement of antimicrobial consumption is not appropriate. Modification of the DDD method to include standardised weight bands for different paediatric age groups has been proposed as a strategy to enable comparison between adults and children benchmarking between hospitals.[144,]

Most Australian paediatric hospitals monitor use by unit of use (for example, number of vials) or cost or both.[145] These approaches do not provide an accurate measure of consumption, but they do have some utility in monitoring trends. This difference in measurement approach also precludes comparison of paediatric and adult rates of antimicrobial use. Variation in measures can also prevent benchmarking between hospitals providing paediatric care.

In North America the most commonly used measure for adults and children is days of therapy (DOT).[146,147] Days of therapy is measured as days of therapy over a total number of days such as per 1,000 patient days. To improve the usefulness of DOT, a length of therapy (LOT) measure can also be used. The DOT/LOT ratio provides a measure of the mean number of antibiotics received per person per day.[148] Use of DOT in Australia is limited, as data collation is laborious. Increased uptake of electronic medicines management systems in Australian paediatric hospitals in the future should facilitate the collection of data required to monitor paediatric antimicrobial usage using DOT.[149]

14.5.2 Appropriateness of use

A limitation of antimicrobial usage metrics is that they cannot account for the appropriateness of antimicrobial use. The overuse of broad-spectrum antimicrobials could result in a reduced usage rate compared with the appropriate use of a multidrug narrow-spectrum targeted therapy. Monitoring patterns of antimicrobial prescribing is important in order to understand current practice, evaluate

AMS program performance and identify priority areas for improvement.

Point prevalence surveys can also be used to measure the appropriateness of paediatric antimicrobial prescribing. Many of the measures discussed in Chapter 5 also apply to paediatric settings or can be adapted for paediatric use. For example, proportion of patients with documented indication, duration of therapy, surgical prophylaxis beyond 24 hours, allergy mismatch, compliance with guidelines, and appropriateness of use. More specific paediatric measures could include documentation of weight with regular review in very young patients, and specifying the dose calculation on the prescription. Issues of poor or incomplete documentation can be a limitation to assessing appropriateness from a point prevalence survey in paediatric populations. For example, it will not be possible to determine appropriateness of dose if an accurate weight has not been obtained or documented.

Audit teams in general hospitals should include a paediatrician when assessing appropriateness of prescribing in children.

Other measures to determine appropriateness of antimicrobial use in children may include: time to optimal therapy for patients with an invasive infection; percent of peripherally inserted central catheters potentially avoided; and time to conversion from intravenous to oral administration of antibiotics, where intravenous to oral switch is indicated. These measures are also helpful in identifying areas to target AMS efforts.[150]

14.5.3 Outcome measures

When measuring AMS performance in paediatric care it is important to choose outcome measures that are relevant and achievable in children. AMS outcome measures that are often used or recommended in adult settings are not necessarily suitable for use in paediatrics. For example, it is common to measure rates of *Clostridioides (Clostridium) difficile* infection (CDI) in the adult setting. However, this is a poor marker in paediatric settings because of the high carriage rate of this organism in children under two years of age.[151]

Changes in the prevalence of resistant organisms has been described as a better measure, although baseline rates of methicillin-resistant *Staphylococcus aureus*, vancomycin-resistant enterococci and extended-spectrum beta-lactamase-producing organisms are often low in children. Lack of change may not reflect lack of improvement in prescribing; other factors, such as community prevalence of resistance can influence outcomes. There may be more value in communicating changes in other outcomes measures such as length of stay or readmission rates. For example, a reduced duration of therapy for patients with community-acquired pneumonia (five days) does not increase hospital readmissions.[152]

Antimicrobial stewardship in paediatric sepsis

Sepsis results from a dysregulated host response to infection leading to organ dysfunction. Major improvements in patient outcomes can be achieved by institutional pathways that improve the timely recognition and treatment of sepsis in adults and children. However, there is concern regarding the potential adverse impact of sepsis pathways on appropriate antimicrobial use.

In 2017, the Queensland Statewide Sepsis Collaborative incorporated expertise from AMS pharmacists and infectious disease specialists when designing and implementing a new statewide sepsis pathway.[153] The evaluation of the Collaborative includes AMS at the core of a range of balancing measures. Given a limited evidence base upon which to evaluate the impact of the pathway on AMS, a range of internationally recognised AMS interventions (such as antimicrobial review, and intravenous to oral switch) and metrics (of appropriateness and consumption) were adapted for use in children evaluated on the sepsis pathway.

These interventions are now being incorporated into a digital sepsis pathway, which will incorporate AMS metrics into performance dashboards for clinician feedback and benchmarking.

Resources

- Australasian Neonatal Medicines Formulary: https://www.anmfonline.org/
- Australia and New Zealand Paediatric Infectious Diseases Group - Australasian Stewardship of Antimicrobials in Paediatrics - antimicrobial stewardship resources including antibiotic duration and IV-oral switch: https://www.asid.net.au/groups/antimicrobial-stewardship
- Australian Government. Australia's National Antimicrobial Resistance Strategy - 2020 and beyond
- https://www.amr.gov.au/resources/australias-national-antimicrobial-resistance-strategy-2020-and-beyond
- Children's Healthcare Australasia: https://children.wcha.asn.au/
- Children's Health Queensland Hospital and Health Service: https://www.childrens.health.qld.gov.au/
- Children's Health Queensland Hospital and Health Service - Antimicrobial Treatment: Early Intravenous to Oral Switch - Paediatric Guideline: https://www.childrens.health.qld.gov.au/wp-content/uploads/PDF/ams/DUG-Early-Intra.pdf
- Clinical Excellence Commission - parent and carer information about antibiotics and IV-to-oral switch: http://www.cec.health.nsw.gov.au/keep-patients-safe/medication-safety-and-quality/antimicrobial-stewardship/information-for-patients
- Clinical Excellence Commission - supporting intravenous to oral switch: cec.health.nsw.gov.au/__data/assets/pdf_file/0004/383089/Using-a-QI-approach-to-support-timely-oral-antibiotic-switch-Evette-Buono.pdf
- Don't Forget the Bubbles - paediatric information for clinicians: https://dontforgetthebubbles.com/the-dftb-team/
- IDStewardship - educational resources to teach children about antimicrobial stewardship: https://www.idstewardship.com/antimicrobial-stewardship-kids-tools-teach-children-hygiene-microbes-science/
- Kaiser Permanente. Neonatal early-onset sepsis calculator: https://neonatalsepsiscalculator.kaiserpermanente.org/
- Monash Children's Hospital: https://monashchildrenshospital.org/
- NPS antibiotic resistance resources: https://www.nps.org.au/professionals/reducing-antibiotic-resistance
- NPS MedicineWise Fact Sheet - What every parent should know about coughs, colds, earaches and sore throats: https://www.nps.org.au/consumers/what-every-parent-should-know-about-coughs-colds-earaches-and-sore-throats
- National Inpatient Medication Chart Paediatric - promotes safe prescribing in hospitalised children: https://www.safetyandquality.gov.au/publications-and-resources/resource-library/national-inpatient-medication-chart-nimc-paediatric
- NSW Health - Guidelines for Networking Paediatric Services: https://www.health.nsw.gov.au/kidsfamilies/paediatric/Publications/guidelines-paediatric-networking.pdf
- Pediatric Infectious Diseases Society (American Academy of Pediatrics) – Pediatric Antibiotic Stewardship Program Toolkit: https://www.pids.org/asp-toolkit.html
- Paediatric Improvement Collaborative Clinical Practice Guidelines: https://www.rch.org.au/clinicalguide/
- Pediatric Infectious Diseases Society: https://www.pids.org/
- Perth Children's Hospital: https://pch.health.wa.gov.au/
- Perth Children's Hospital - Children's Antimicrobial Management Program (ChAMP): https://pch.health.wa.gov.au/For-health-professionals/Childrens-Antimicrobial-Management-Program
- Preventing and Controlling Healthcare-Associated Infection Standard: https://www.safetyandquality.gov.au/standards/nsqhs-standards/preventing-and-controlling-healthcare-associated-infection-standard

- RACGP Standards for General Practices. 5th Edition: https://www.racgp.org.au/running-a-practice/practice-standards/standards-5th-edition
- SA Health – Paediatric Clinical Practice Guidelines: https://www.sahealth.sa.gov.au/wps/wcm/connect/public+content/sa+health+internet/clinical+resources/clinical+programs+and+practice+guidelines/children+and+youth/paediatric+clinical+practice+guidelines
- SA Health – Neonatal Medication Guidelines: https://www.sahealth.sa.gov.au/wps/wcm/connect/public+content/sa+health+internet/clinical+resources/clinical+programs+and+practice+guidelines/womens+and+babies+health/neonatal+medication+guidelines/neonatal+medication+guidelines
- Sharing Antimicrobial Reports for Pediatric Stewardship (SHARPS) http://pediatrics.wustl.edu/sharps
- Telethon Kids Institute: https://www.telethonkids.org.au/
- Telethon Kids Institute - Infectious Diseases Research: https://infectiousdiseases.telethonkids.org.au/about-the-wesfarmers-centre/
- Therapeutic Guidelines - Antibiotic: www.tg.org.au
- The Royal Children's Hospital Melbourne - teaching children how to swallow tablets and capsules: https://www.rch.org.au/pharmacy/medicinesinformation/Teaching_children_how_to_swallow_tablets_and_capsules/
- The Sydney Children's Hospitals Network: https://www.schn.health.nsw.gov.au/#

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AUSTRALIAN COMMISSION ON SAFETY AND QUALITY IN HEALTH CARE

15 Antimicrobial stewardship in the Aboriginal and Torres Strait Islander population

Antimicrobial Stewardship in Australian Health Care

2020

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Acronyms and abbreviations

Abbreviation	Definition
ACCHO	Aboriginal Community Controlled Health Organisation
ACSQHC	Australian Commission on Safety and Quality in Health Care
AHP	Aboriginal Health Practitioner
AHW	Aboriginal Health Worker
AMR	antimicrobial resistance
APSGN	acute post-streptococcal glomerulonephritis
AURA	Antimicrobial Use and Resistance in Australia
CARPA	Central Australian Rural Practitioners Association
COPD	chronic obstructive pulmonary disease
CSOM	chronic suppurative otitis media
GAS	group A *streptococcus*
GP	general practitioner
Hib	*Haemophilus influenzae* type b
MRSA	methicillin-resistant *Staphylococcus aureus*
NAPS	National Antimicrobial Prescribing Survey
NPS	National Prescribing Service
NSQHS	National Safety and Quality Health Service
PBS	Pharmaceutical Benefits Scheme
PCV	pneumococcal conjugate vaccine
PHN	Primary Health Network
QI-NAPS	Quality Improvement National Prescribing Service
RAAHS	Remote Area Aboriginal Health Services
RPBS	Repatriation Pharmaceutical Benefits Scheme

Key points

- **The burden of infections experienced by Aboriginal and Torres Strait Islander peoples contributes to higher overall rates of antimicrobial use compared with non-Indigenous populations.**
- **Antimicrobials are under-used in some Aboriginal and Torres Strait Islander populations. This increases the risk of serious complications from infectious diseases.**
- **Rates of antimicrobial resistance are increasing in some Aboriginal and Torres Strait Islander populations.**
- **Antimicrobial stewardship is important to reduce antimicrobial resistance (AMR) and improve infectious disease outcomes.**
- **Effective antimicrobial stewardship initiatives are community driven, culturally safe and address social determinants of health that contribute to the infectious diseases burden.**
- **Aboriginal and Torres Strait Islander Community Controlled Health Organisations (ACCHOs) have a crucial role in reducing AMR in Aboriginal and Torres Strait Islander communities.**
- **ACCHOs and other health services may draw upon a range of antimicrobial stewardship initiatives include developing and implementing localised prescribing guidelines, establishing and maintaining a corresponding antimicrobial formulary, monitoring antimicrobial use and resistance patterns, providing feedback and education to staff and delivering community and patient education in an accessible and targeted way.**
- **Antimicrobial guidelines may need to be adapted to local circumstances, depending on the local microbiology of infectious diseases and availability of health services.**
- **Most Aboriginal and Torres Strait Islander peoples live in urban and regional areas, however most published studies on antimicrobial stewardship and AMR have been conducted in rural and remote communities. Further research is needed on antimicrobial stewardship, especially in urban and regional settings.**

15.1 Introduction

Australia's National Antimicrobial Resistance Strategy describes national priority actions to address the growing public health threat of antimicrobial resistance (AMR), a global public health problem.[1] Antimicrobial stewardship is a key component of the national strategy.

The Antimicrobial Stewardship in Australian Health Care book (the Antimicrobial Stewardship Book) was published in 2018 to provide an overarching resource for antimicrobial stewardship programs in Australia. The Antimicrobial Stewardship Book is available at www.safetyandquality.gov.au/our-work/healthcare-associated-infection/antimicrobial-stewardship/book/.

Additional chapters of the Antimicrobial Stewardship Book are being developed on specific topics to further support antimicrobial stewardship in Australia; as these are completed, they will be published to supplement the Antimicrobial Stewardship Book.

Antimicrobial Stewardship in the Aboriginal and Torres Strait Islander Population is the latest addition to the Antimicrobial Stewardship Book. This chapter:

- describes antimicrobial use and resistance in Aboriginal and Torres Strait Islander populations;
- identifies resources to support appropriate prescribing of antimicrobials;
- provides practical strategies that can be implemented to improve antimicrobial stewardship in Aboriginal and Torres Strait Islander communities; and
- discusses the critical role of Aboriginal Community Controlled Health Organisations (ACCHOs) in antimicrobial stewardship.

15.1.1 Aboriginal and Torres Strait Islander demographic characteristics

In 2016 there were an estimated 798,365 Aboriginal and Torres Strait Islander peoples in Australia, representing 3.3% of the total Australian population.[2] The Aboriginal and Torres Strait Islander population is projected to reach about 1.1 million people by 2031.[3]

This population has a relatively young age structure with a median age of 23 years compared with 37.8 years for non-Indigenous Australians.[3]

Although 81% of Aboriginal and Torres Strait Islander peoples live in major cities, inner regional and outer regional areas, in remote Australia 18% of the population is Aboriginal or Torres Strait Islander and in very remote Australia 47% of the population is Aboriginal and Torres Strait Islander.[3,4]

Aboriginal and Torres Strait Islander peoples speak about 150 languages and belong to many cultural groups. Aboriginal and Torres Strait Islander languages play an important role in maintaining and passing on cultural knowledge and practices and contributing to a stronger sense of identity and belonging.[5]

15.1.2 Infectious diseases and Aboriginal and Torres Strait Islander peoples

Aboriginal and Torres Strait Islander peoples experience a greater infectious disease burden than non-Indigenous Australians, regardless of where they live. Aboriginal and Torres Strait Islander peoples who live in rural and remote areas experience disproportionately higher rates of some infectious diseases than their urban counterparts. Antimicrobial stewardship is therefore important to ensure antimicrobials are used appropriately in Aboriginal and Torres Strait Islander peoples and contribute to improved health outcomes.

In Australia, children of Aboriginal and Torres Strait Islander background have higher rates of infectious diseases including skin, ear, respiratory and gastrointestinal infections, invasive infections, including bloodstream infections, pneumonia and bronchiectasis, and are more likely to be hospitalised for infectious diseases than non-Indigenous children.[6,7] Acute and chronic otitis media and associated conductive hearing loss are more prevalent in remote communities compared with urban communities.[8]

Group A streptococcal (GAS) infections cause skin, soft tissue and throat infections, invasive disease and the autoimmune sequelae of acute rheumatic fever and acute post-streptococcal glomerulonephritis (APSGN).[9] APSGN can lead to chronic renal failure and a requirement for renal dialysis. Mortality from rheumatic heart disease in Aboriginal and Torres Strait Islander Australians is the highest reported in the world.[10]

Skin infections are a major contributor to the burden of GAS. In remote communities, impetigo is predominantly caused by GAS and affects 45% of Aboriginal and Torres Strait Islander children at any one time. A high burden of scabies, affecting 50% of Aboriginal and Torres Strait Islander children, increases rates of impetigo.[9] Adults in some remote communities also experience high rates of skin and soft tissue infections, up to 75% each year.[11]

Notifications of sexually transmissible infections, including chlamydia, gonorrhoea and syphilis are higher in some Aboriginal and Torres Strait Islander teenage and adult populations.[12]

Some chronic diseases increase risk of severe infections. Rates of type 2 diabetes are high in some remote communities. Diabetes contributes to respiratory tract infections, urinary tract infections, skin and soft tissue infections, ear infections and cholecystitis.[13] Bronchiectasis and chronic obstructive pulmonary disease (COPD) are also common in some adult Aboriginal and Torres Strait Islander populations and contribute to increased hospitalisations and mortality.[7]

Serious infections resulting in sepsis are more common in some Aboriginal and Torres Strait Islander populations; rates of sepsis resulting in hospitalisation and intensive care admission are four-fold higher in Aboriginal and Torres Strait Islander than in non-Indigenous Australians.[14]

15.2 Antimicrobial use

Although most of Australia's Aboriginal and Torres Strait Islander population live in urban and regional areas[15], studies of antimicrobial prescribing in Aboriginal and Torres Strait Islander populations have largely been conducted in rural and remote areas, leaving gaps in our understanding about antimicrobial stewardship in urban populations.

Available evidence suggests rates of antimicrobial use are appropriately higher in urban, rural and remote Aboriginal and Torres Strait Islander patients because infectious disease burden is greater.[16] However, other factors contribute to high rates of antimicrobial use, including:[16]

- a lack of diagnostic capability in some care settings especially the remote health care sector and
- a lack of availability of treatment which may precipitate increased prescribing by the health care provider to mitigate the risk of worsening infection for which the patient cannot later access timely health care.

High workforce turnover and a lack of availability of senior clinical staff may also contribute to higher rates of antimicrobial prescribing due to lack of familiarity with some of the infections that are rarely seen elsewhere in Australia.[16]

Prescribing practices differ between remote Aboriginal and Torres Strait Islander communities and non-remote communities, largely due to differences in infectious disease burden. [17,18] The s100 Remote Area Aboriginal Health Services program measure (RAAHS) accounts for 1% of antimicrobials supplied through the Pharmaceutical Benefits Scheme (PBS). Amoxicillin is the most common antimicrobial supplied; azithromycin is the second most common. Azithromycin is used for the treatment of trachoma and uncomplicated urethritis which have higher rates in rural and remote Aboriginal and Torres Strait Islander communities.[19] In comparison, the most commonly supplied antimicrobials through the PBS / RPBS are amoxicillin, cefalexin and amoxicillin-clavulanic acid.

Rural and remote Aboriginal and Torres Strait Islander children are prescribed antimicrobials more frequently than non-Indigenous children. According to the results of one study, by their first birthday an estimated 95% of Aboriginal and Torres Strait Islander children in some rural communities receive at least one antimicrobial prescription and 47% receive at least six antimicrobial prescriptions.[20] In another study of Aboriginal and Torres Strait Islander children aged less than two years in remote communities, the children received a median of five antimicrobial prescriptions in both their first and second years of life.[21]

Medical practitioners treat acute otitis media in Aboriginal children more frequently with antimicrobials and for longer periods than in non-Aboriginal children.[22] Prescribing practices are generally consistent with clinical practice guidelines, with an estimated 8% of prescriptions for treatment of infections not aligned with relevant otitis media treatment guidelines.[20]

Topical antimicrobials are prescribed in Aboriginal and Torres Strait Islander populations for the treatment of ear infections. [21] Treatment with oral antimicrobials is not recommended and is usually less effective than topical antimicrobial treatment for chronic suppurative otitis media (CSOM). However, up to 75% of children with CSOM are prescribed oral amoxicillin.[23]

Harm from acute rheumatic fever is reduced through secondary prophylaxis with antimicrobials, whereby people at risk of recurrent acute rheumatic fever (i.e. those who have previously been diagnosed with acute rheumatic fever or rheumatic heart disease) receive regular intramuscular injections of benzathine penicillin.[24] This strategy is important in reducing the burden of rheumatic heart disease. However, it only prevents the worsening of rheumatic heart disease in established cases. To prevent acute rheumatic fever, evidence supports providing prompt assessment and antimicrobial treatment of skin sores and sore throats as well as reducing crowding and socio-economic disadvantage.[24] Unfortunately, population efforts to rationalise the use of antimicrobials for sore throat may inadvertently be contributing to the inability to prevent acute rheumatic fever through early treatment of sore throats.[24]

Antimicrobials may be under-utilised for treatment of sore throat in some Aboriginal and Torres Strait Islander patient groups. Antimicrobials are indicated for the treatment of Aboriginal and Torres Strait Islander paediatric patients with upper respiratory tract infections (URTIs) due to a higher risk of developing non-suppurative (i.e. non-pus producing) complications. In remote Aboriginal and Torres Strait Islander populations higher rates of antimicrobial prescribing for URTIs are observed.[20] However, available data from urban general practice shows no significant difference in antimicrobial prescribing for Aboriginal and Torres Strait Islander and non-Indigenous patients with URTIs.[25,26] Further, data from MedicineInsight (a large general practice dataset managed by NPS MedicineWise) show that in 2017, 29.2 per 100 Aboriginal and Torres Strait Islander patients were prescribed an antimicrobial in general practice compared with 27.7 per 100 non-Indigenous patients.[27] Aboriginal and Torres Strait Islander patients are under-identified in primary care data which may influence the reported rates of prescribing in general practice.[28]

Appropriate use of antimicrobials is of the utmost importance in the management of skin and soft tissue infections in Aboriginal and Torres Strait Islander patients. Some studies show high antimicrobial prescribing rates for skin infections.[29] Available data from remote Aboriginal and Torres Strait Islander communities suggests that, by their first birthday, 51% of Aboriginal and Torres Strait Islander children had received one antimicrobial prescription where skin sores were the sole presenting condition.[20] Another study of children in their first two years of life found 63% of children with scabies infections are prescribed antimicrobials.[21]

The treatment of intestinal worm infection in some Aboriginal and Torres Strait Islander populations requires administration of, commonly, oral ivermectin. Mass drug administration of ivermectin for scabies has been trialled in remote, tropical Aboriginal communities where *Strongyloides stercoralis* is hyper-endemic. This resulted in a sustained and significant reduction in *Strongyloides* seroprevalence over 18 months.[30] Annual ivermectin prescription volume correlates negatively with *Strongyloides* seropositivity.[31]

15.2.1 Impact of vaccination on antimicrobial use

Vaccination is an important public health intervention to reduce the burden of infectious diseases in the Australian community. There have been significant decreases in the burden of viral hepatitis, rotavirus, varicella, meningococcal disease, invasive pneumococcal disease and *Haemophilus influenzae* type b in the Australian population as a result of immunisation programs.[32] Vaccination against *Streptococcus pneumoniae* and *Haemophilus influenzae* type b has been associated with changes in rates of infection and in antimicrobial use.[33,34]

Pneumococcal conjugate vaccination (PCV) of infants at two, four and six months of age has been associated with an 80% vaccine effectiveness for all-cause invasive pneumococcal disease in Australian children and a 61% reduction in all-cause invasive pneumococcal disease in unvaccinated children, mainly due to strong herd immunity.[34] Paediatric hospitalisations for pneumonia have also decreased. Both bacterial and viral pneumonia hospitalisation rates declined in the general population, suggesting pneumococcus may also play a role in viral pneumonia.[35]

Since the introduction of the *Haemophilus influenzae* type b (Hib) vaccine, invasive Hib disease notification rates have decreased by more than 99% in both Aboriginal and Torres Strait Islander and other Australian children aged <5 years.[32] Rates of infection with non-B-encapsulated serotypes have not increased significantly since widespread immunisation against Hib. However, invasive Hib disease rates in Aboriginal and Torres Strait Islander children aged <5 years remain around 10 times higher than in non-Indigenous children, partly due to lower vaccination coverage rates.[32] This highlights the continuing importance of ensuring adequate vaccine coverage in the paediatric population.[36]

Both *S. pneumoniae* and *H. influenzae* are pathogens associated with otitis media infection. They may densely co-colonise the nasopharynx and infect the middle ear of Aboriginal and Torres Strait Islander infants from very early in life.[37] Early and dense colonisation of the nasopharynx increases the risk of acute otitis media substantially.[38]

The administration of PCV may reduce or eliminate nasopharyngeal colonisation by *S. pneumoniae*, and subsequently reduce incidence of acute otitis media. In turn, PCV may also disrupt the progression from pneumococcal-associated otitis media to chronic, recurrent otitis media and thereby reduce subsequent and more complex disease caused by non-vaccine serotypes of *S. pneumoniae* and non-typeable *Haemophilus influenzae*.[33]

Although there has been a reduced prevalence of severe otitis media attributed to introduction of PCV, incidence has not reduced in all vaccinated Aboriginal and Torres Strait Islander populations.[39] After the introduction of the first 7-valent pneumococcal conjugate vaccine (7vPCV), the overall incidence of invasive pneumococcal disease decreased by 74% in all Australian children under 2 years of age.[24] However, similar reductions in common ear and respiratory diseases were not observed in Aboriginal and Torres Strait Islander children and invasive pneumococcal disease due to non-vaccine serotypes increased.[40] Serotype replacement was observed. The most common serotypes colonising infants at 2 months (serotypes 16F and 19A) were not serotypes covered by 7vPCV and were more likely to cause otitis media and lung disease as the infants matured. These serotypes were also more likely to be associated with β-lactam antimicrobial resistance.[41]

The later introduction of 13-valent pneumococcal conjugate vaccine was associated with further reductions in invasive pneumococcal disease in the general population but not in improvements in ear health or substantial improvement in invasive pneumococcal disease in vaccinated Aboriginal and Torres Strait Islander children.[42,43]

Aboriginal and Torres Strait Islander pregnant women and infants less than 6 months old have a high baseline risk for pneumococcal disease compared with the general population, particularly in low resource settings.[44] To reduce the burden of respiratory disease in infants, pneumococcal vaccination given in pregnancy has been trialled. Available data suggest this approach is not effective. Increased risk of acute otitis media in the first six months of life and increased risk of premature birth with pneumococcal vaccination have been observed in published studies.[45,46]

15.2.2 Antimicrobial resistance

High levels of infectious disease and resultant high levels of antimicrobial use contribute to increased rates of AMR in Aboriginal and Torres Strait Islander populations. AMR reduces the range of antimicrobials available to treat infections and increases morbidity and mortality associated with infections caused by multidrug-resistant organisms.[27]

AMR is problematic and rising in remote Aboriginal and Torres Strait Islander communities.[16] Examples include tuberculosis, methicillin-resistant *Staphylococcus aureus* (MRSA) rates of around 50% in some communities, azithromycin resistance in *S. pneumoniae* and emerging resistance in gram-negative urinary tract pathogens.[47,48,49]

Emerging AMR is not isolated to remote Australia. In the past 20 years, the virulent ST93-MRSA clone has emerged from remote northern Australia and is now the most prominent community-associated MRSA throughout Australia.[50]

Antimicrobial use has caused changing resistance and carriage patterns in organisms implicated in high rates of ear and lung diseases, including *S. pneumoniae*, non-typeable *H. influenzae* and *Moraxella catarrhalis*.[20,21,29,48,51]

AMR in *Neisseria gonorrhoeae* is recognised as a public health problem of importance in Australia. Rates of azithromycin resistance have increased significantly since 2015, and 9.3% of isolates were resistant in 2017. The total number of notifiable cases also continues to increase.[27] However, in Aboriginal and Torres Strait Islander populations, gonorrhoea is concentrated primarily in Aboriginal heterosexual persons living in remote areas of central and northern Australia.[52] The most recent Australian Gonococcal Surveillance Program Annual Report indicates gonococcal AMR in these regions remains low in infections acquired locally.[53]

Scabies disease, caused by *Sarcoptes scabiei*, affects up to one in five remote living Aboriginal children and adults. Effective treatments that are tolerable without the risk of emerging resistance are needed.[54]

AMR is therefore a priority for action in Aboriginal and Torres Strait Islander populations due to its serious and growing impact on health.

15.3 Antimicrobial stewardship

Antimicrobial stewardship is a set of coordinated strategies to improve antimicrobial use, enhance patient outcomes, reduce AMR and decrease unnecessary costs.

Effective antimicrobial stewardship in Aboriginal and Torres Strait Islander populations is complex and must balance the need for timely antimicrobial treatments to address the substantial infectious disease burden with judicious use of antimicrobials.

Holistic, culturally tailored approaches to reducing the infectious disease burden are essential.

15.3.1 Social determinants of health and infectious diseases

The conditions in which people live, work, and play shape people's opportunities for health. These are social determinants of health and include factors such as housing, employment conditions, education, social relationships, income, poverty and the distribution of power and resources.[55]

Access to health care is a significant determinant of health in its own right. Barriers to access relate to availability, affordability, acceptability and appropriateness. Poor access to health care is associated with presentations with more advanced infections and comorbid diseases.[56]

Aboriginal and Torres Strait Islander peoples living in remote areas may face distinct challenges that contribute to excess infectious disease burden such as housing conditions, environmental health issues and food costs. Living in an overcrowded household increases the likelihood of health problems such as skin, ear and eye infections.[57]

There is compelling evidence that improving the social determinants of health, including access to health services, reduces the incidence of some infectious diseases. For example, specific strategies for the treatment and prevention of bacterial skin infections in Aboriginal and Torres Strait Islander children that have reduced infections include: management of active infections and lesions; improving environmental and personal hygiene; the installation of swimming pools; screening and treatment.[58]

Affordability of medicines may reduce compliance with treatment for infectious diseases. Improving access to affordable medicines is an important strategy to improve health. The PBS Closing the Gap co-payment measure reduces the cost of PBS medicines for eligible Aboriginal and Torres Strait Islander peoples living with, or at risk of, chronic disease.[59] When obtaining PBS medicines at their local pharmacy, eligible general patients who would normally pay the full PBS co-payment pay the concessional rate. Those who would normally pay the concessional price can receive their PBS medicines without being required to pay a PBS co-payment.

The burden of infectious disease among Aboriginal and Torres Strait Islander peoples can be reduced through improved housing conditions, adequate and timely housing repair and maintenance and the ability to perform healthy behaviours such as showering, toileting and safe food preparation.[60]

Poorly maintained housing and the condition of food preparation and storage areas are associated with gastrointestinal infections. Skin infections and viral conditions such as influenza are associated with crowding. The excess burden of gastrointestinal, skin, ear, eye, and respiratory illnesses, are all related in various ways to poorly functioning health hardware (showers, toilets, electrical systems, taps and stoves), removal and treatment of sewage, crowding, presence of pests and vermin and the growth of mould and mildew.[60]

Box 15.1 shows examples of successful holistic programs to improve overall health and wellbeing, along with reduced incidence of infection

Box 15.1: Holistic approaches to reduce infectious disease burden

New South Wales Housing for Health

The New South Wales Housing for Health program aims to assess, repair and replace health services to improve living conditions in Aboriginal communities. The program first ensures that houses are safe from life-threatening faults, then addresses the following nine healthy living practices in order of priority:[61]

- washing people
- washing clothes and bedding
- removing waste safely
- improving nutrition
- reducing overcrowding
- reducing the impact of animals, vermin and insects
- reducing dust
- controlling temperature
- reducing trauma.

The program trains and employs local Aboriginal and Torres Strait Islander peoples, and partners with health and environmental health teams to deliver comprehensive community-wide education campaigns. The program resulted in a 38% reduction in hospital separation rates for infectious diseases compared with the rural New South Wales Aboriginal population without Housing for Health interventions.

Linking health and environmental health in the Kimberley

In the Kimberley region of Western Australian, links between the health and environmental health services were strengthened by simple but timely referrals of infective conditions to environmental health teams. The changes resulted in resolution of issues in a timely manner, opportunities for Aboriginal environmental health workers to provide education about household maintenance and hygiene practices, and prevention of further infections.[62]

15.3.2 Cultural considerations in antimicrobial stewardship

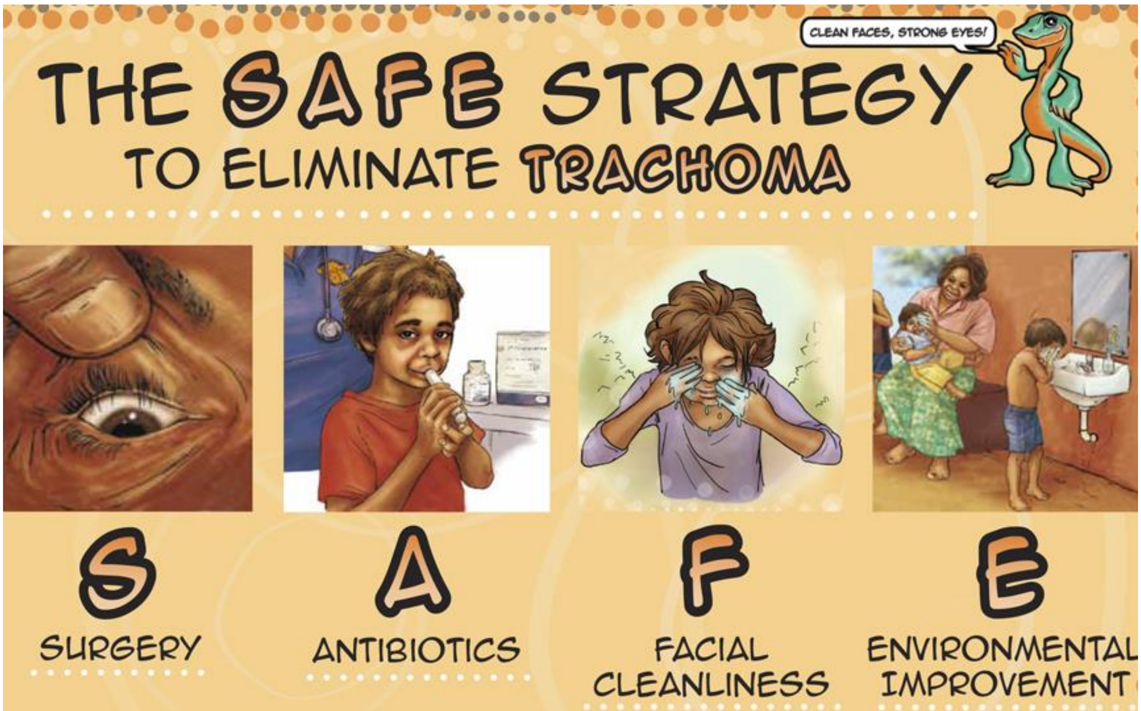
Connectedness to culture and caring for country are positive determinants of Aboriginal and Torres Strait Islander health.[63] Initiatives to improve antimicrobial stewardship within Aboriginal and Torres Strait Islander communities need to be culturally appropriate, community-developed and community-driven.[64] For example, housing programs where Aboriginal and Torres Strait Islander communities lead the design, construction and maintenance of housing have improved housing-related health outcomes, including infectious disease outcomes.[65]

Culturally informed initiatives can better promote antimicrobial adherence, especially when combined with resources proven to support decisions by Aboriginal and Torres Strait Islander peoples. Some specific considerations include the following:

- There is a need to improve culturally tailored communication developed in partnership with Aboriginal and Torres Strait Islander peoples for Aboriginal and Torres Strait Islander peoples about antimicrobial stewardship. Many Aboriginal and Torres Strait Islander peoples favour oral and visual communication.[66] However, availability of culturally specific resources to explain antimicrobials or antimicrobial resistance is limited.[67]
- Drug formulations and dosing schedules can be modified to be more acceptable to Aboriginal and Torres Strait Islander patients. For example, a short course of oral co-trimoxazole for impetigo[68] or more patient-centred approaches to penicillin use and changes in penicillin formulations can improve adherence with secondary prophylaxis for rheumatic fever.[69]
- Working with communities to understand data about antimicrobial resistance can facilitate community responses to AMR.67
- Health services need to improve Aboriginal and Torres Strait islander identification of patients. This improves individual patient management and the quality of community data about AMR.

Figure 1 below shows an example of culturally tailored communication about infections and antimicrobial use for trachoma.

Figure 1: University of Melbourne SAFE Strategy to eliminate trachoma



Improving access to primary health care for Aboriginal and Torres Strait Islander peoples is vital to making significant gains and closing the gap in health outcomes. Securing access to primary health care services requires close physical proximity, and ensuring health care without additional barriers including discrimination, racism and cultural inappropriateness.[4] The role of ACCHOs in achieving this is discussed later in this chapter.

Culturally safe, responsive and flexible health care delivery needs to be the basis of any health service training and implementation. This encourages health professionals to effectively partner with Aboriginal and Torres Strait Islander patients, their carers and family, including responding to differing perceptions of health, wellbeing, illness, and the body.[70] All health care providers working with Aboriginal and Torres Strait Islander peoples should develop cultural responsiveness skills to allow them to provide care in a manner that is respectful of a person's culture and beliefs, and free from discrimination.[71]

Cultural safety is about overcoming the cultural power imbalances of places, people and policies to contribute to improvements in Aboriginal and Torres Strait Islander health.[72] Health consumers are safest when clinicians have considered power relations, cultural differences and patients' rights. Part of this process requires clinicians to examine their own beliefs and attitudes.[73]

Recognising that culture is a source of strength, resilience, happiness, identity and confidence for Aboriginal and Torres Strait Islander peoples, and that the protection of culture is linked to health and wellbeing, is essential for reducing the disparities in health experienced by Aboriginal and Torres Strait Islander peoples.[72] Health care has been provided traditionally for millenia. Incorporating traditional knowledge and understanding into treatment of infections may also help in adherence to recommendations.

The NSQHS (National Safety and Quality Health Service Standards) specifically require organisations and governing bodies to:

- have strategies to improve the cultural awareness and cultural competency and cultural safety of the workforce to meet the needs of its Aboriginal and Torres Strait Islander patients
- demonstrate a welcoming environment that recognises the importance of the cultural beliefs and practices of Aboriginal and Torres Strait Islander patients
- ensure that the organisation's safety and quality priorities address the specific health needs of Aboriginal and Torres Strait Islander patients
- implement and monitor strategies to meet the organisation's safety and quality priorities for Aboriginal and Torres Strait Islander patients
- work in partnership with Aboriginal and Torres Strait Islander communities to meet their health care needs
- use communication mechanisms that are tailored to the diversity of the consumers who use its services and, where relevant, the diversity of the local community
- support clinicians to communicate with patients, carers, families and consumers about health and health care so that information is provided in a way that meets the needs of patients, carers, families and consumers
- discuss available treatment options with family members. [74]

Antimicrobial stewardship initiatives must be tailored to the health literacy of the target population. Health literacy is 'the cognitive ability to understand and interpret the meaning of health information in the written, spoken and digital form as well as the ability to navigate through the health system' (see also Chapter 7).[75] Health literate antimicrobial stewardship initiatives should also give consideration to the context of history, language and culture of Aboriginal and Torres Strait Islander peoples.[76]

15.4 Antimicrobial stewardship and Aboriginal Community Controlled Health Organisations

Government-funded ACCHOs are located across all Australian jurisdictions and provide primary health care and associated wellbeing services to Aboriginal and Torres Strait Islander peoples.[77] ACCHOs also provide access to a range of advocacy and support services in relation to the social determinants of health and accountability of mainstream services to provide culturally safe services and incorporate Aboriginal representation in health service governance.[77] ACCHOs have an important role to play in addressing the infectious disease burden experienced by Aboriginal and Torres Strait Islander peoples.

The evolution of Aboriginal primary health care services arose from mainstream health services being unable to adequately meet the needs of Aboriginal and Torres Strait Islander communities. Aboriginal and Torres Strait Islander peoples have often been excluded and marginalised from mainstream health services.[78] In 2017–18, 6.1 million client contacts were delivered by ACCHOs from 383 sites across Australia. One-third (32%)

provide services in very remote areas, 13% in remote areas, 23% in outer regional areas, 20% in inner regional areas and 12% in major cities.[77]

ACCHOs work to improve the health of Aboriginal and Torres Strait Islander communities through comprehensive programs that incorporate treatment and management, prevention and health promotion.[78] They also play a significant role in training the medical workforce and employing Aboriginal and Torres Strait peoples.[79]

ACCHOs address social determinants of health. In particular, ACCHO staff provide advocacy and support for housing for individual clients and the community as a whole.[78] When coupled with community-level hygiene programs, the burden of infectious diseases can be reduced.[60]

Care delivered by ACCHOs is more likely to involve a range of health professionals. ACCHOs employ a wide variety of staff, including Aboriginal and Torres Strait Islander health workers, doctors, nurses, allied health professionals, social and emotional wellbeing staff, and medical specialists; just over half (54%) of employed staff are Aboriginal and Torres Strait Islander peoples.[77]

There are different types of Aboriginal and Torres Strait islander health workers and practitioners, each with a different role. Broadly, Aboriginal Health Practitioners (AHPs) provide direct clinical services to the Aboriginal and Torres Strait Islander community and are registered with the Aboriginal and Torres Strait Islander Health Practice Board of Australia supported by the Australian Health Practitioner Regulation Agency.[80] Aboriginal Health Workers (AHWs) have different roles and position titles across jurisdictions and organisations. Roles of AHWs may include to:[81]

- facilitate better access and liaison, and provide health promotion and preventive health services;
- provide advocacy, support and liaison within an acute-care health setting, such as hospitals and multipurpose services;
- promote hygiene behaviours in culturally and socially appropriate ways; provide internal and external maintenance services, promote home maintenance skills, and provide education on active lifestyles, healthy nutrition, cooking and safe food storage.

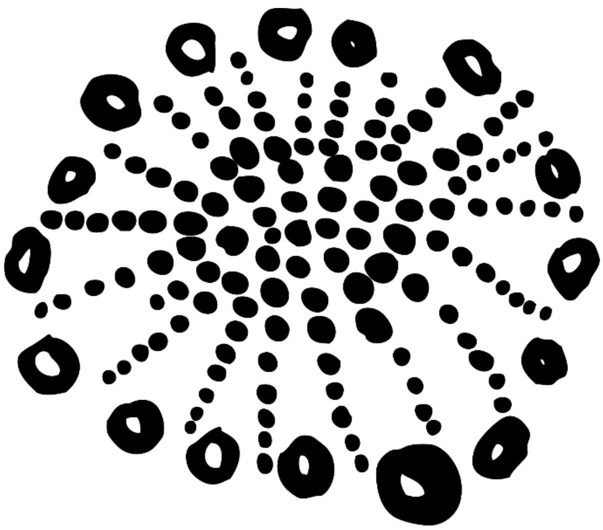
Aboriginal and Torres Strait Islander health workers and practitioners have health care training and facilitate effective communication. They perform a clear cultural brokerage role and should be embedded in all health care teams that provide services to Aboriginal and Torres Strait Islander peoples, particularly where other Aboriginal health practitioners do not identify themselves as Aboriginal and Torres Strait Islander.[76] AHWs play an essential role in improving access to antimicrobials for Aboriginal and Torres Strait Islander peoples and in improving medication compliance.[82]

Nurses and AHWs deliver the majority of care in regional, remote and very remote areas. Various state and territory laws in Australia allow certain health practitioners to possess, administer and supply certain scheduled substances and antimicrobials without a medical officer's order.[83] These arrangements allow people to access care and treatment for some common infectious diseases in a timely manner or if the medical condition of the person requires administration of antimicrobials without delay.

15.4.1 Establishing Aboriginal Community Controlled Health Organisation antimicrobial stewardship programs

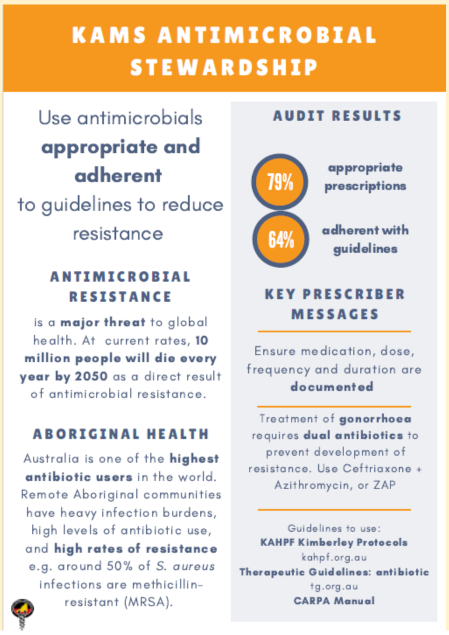
Although strategies for antimicrobial stewardship have been successfully applied in a range of settings (see Chapter 3 of this book), evidence is lacking about strategies in ACCHOs. It is therefore suggested that the same principles for implementing the key elements of antimicrobial stewardship discussed in other chapters be considered by ACCHOs, but specific factors and issues affecting Aboriginal and Torres Strait Islander peoples must be carefully considered if the program is to be successful. Each ACCHO will need to analyse the barriers and enablers for establishing an antimicrobial stewardship program based on their local environment.

Box 15.2 provides an example of an antimicrobial stewardship program in the Kimberley.



Box 15.2 An antimicrobial stewardship program in the Kimberley

Kimberley Aboriginal Medical Services (KAMS) has an evolving program of localised strategies to reduce antimicrobial resistance within the remote communities to whom primary health care is provided. Key pillars of the program include a regional formulary (the Kimberley Standard Drug List) which determines clinic imprest, and locally developed clinical protocols, through the Kimberley Aboriginal Health Planning Forum (KAHPF). Resources guide the management of conditions prevalent in the region. For example, [the skin infections in children protocol]() provides treatment recommendations that address the high rates of MRSA in the Kimberley region.



A new feature of the program for KAMS is the antimicrobial stewardship audit tool. This tool has been developed to enable regular feedback to be provided to clinicians regarding adherence of prescriptions to KAHPF and other relevant guidelines.

Feedback is provided to each clinic at team meetings and via email, with an infographic poster containing three actionable key messages.

Clinic level feedback, rather than individual feedback, was chosen to foster a team approach to stewardship. Clinicians have reported that the quality improvement process has raised the profile of antimicrobial stewardship and promoted a sense of responsibility and accountability in their prescribing decisions.

15.4.2 Community development

A successful antimicrobial stewardship program takes a community development approach, providing advocacy and ensuring collaboration to improve the social determinants of health in the local community. Community development requires working in an environment that advocates the full and active participation of all community members, to assist the community to find solutions to the problems they have identified.[62,64]

ACCHOs will have systems in place to identify the specific health problems and needs of the community they serve, and how these needs can be met. Needs specific to infectious disease and antimicrobial resistance may be considered by the ACCHO in identifying community priorities.

Population-based approaches to infection prevention and hygiene promotion often require activity across and beyond the health system. Communities can identify solutions to promote hand hygiene, personal hygiene and immunisation and to address priority social determinants of health.[63]

15.4.3 Governance

The role of the governance and executive leaders in antimicrobial stewardship programs is discussed in Chapter 2. The best outcomes are achieved when accountability for antimicrobial use sits at the highest level of management, which takes responsibility for ensuring that an antimicrobial stewardship program is developed and implemented, and its outcomes are evaluated.[58]

The governance body may consider whether antimicrobial stewardship should be integrated with the ACCHO's quality and patient safety functions. Dedicated resources could be required for antimicrobial stewardship activities, education and measuring and monitoring antimicrobial use.

15.4.4 Standards, policies and guidelines

The inclusion of antimicrobial stewardship requirements in the NSQHS Standards has been a driver for establishing antimicrobial stewardship programs across health settings. Guidance for organisations establishing antimicrobial stewardship programs to meet the NSQHS Standards is available on the Commission's website.

ACCHOs may choose to develop an overall antimicrobial stewardship policy (see Chapter 2) or draw upon other organisations or peak body resources. In addition, prescribing policies, guidelines and clinical pathways can be developed and implemented that are consistent with evidence-based guidelines and adapted to the ACCHO practice setting and local microbiology of infectious diseases.

Many evidence-based treatment guidelines in Australia have a lower threshold for antimicrobial use in Aboriginal and Torres Strait Islander peoples. National treatment guidelines limiting the use of antimicrobials in certain conditions (such as pharyngitis and tonsillitis) may need to be localised to accommodate the additional risk factors experienced by Aboriginal and Torres Strait Islander peoples.

15.4.5 The antimicrobial stewardship team

The antimicrobial stewardship team provides clinical leadership for implementing antimicrobial stewardship activities within the organisation and monitoring success. Team membership is broad and can comprise medical, nursing, pharmacy, microbiologists and AHP/AHW members. Pharmacists have been essential to the success of antimicrobial stewardship programs in other settings because they have a positive effect on improving appropriate antimicrobial use, and patient care and safety.[84] The antimicrobial stewardship team may also need access to an infectious diseases physician to provide specialist advice (see Chapters 8 and 15).

There are 31 Primary Health Networks (PHNs) throughout Australia the role of which is to increase the efficiency and effectiveness of medical services for patients, particularly those at risk of poor health outcomes, and improve the coordination of care to ensure patients receive the right care in the right place at the right time. Aboriginal and Torres Strait Islander health is one of the seven priority areas established for PHNs by the Australian Government.[85] PHNs and State and Territory Governments may provide programs and services that support ACCHOs to implement antimicrobial stewardship strategies.

15.4.6 Antimicrobial stewardship program strategies

As with all antimicrobial stewardship programs, ACCHOs can select the antimicrobial stewardship strategies that will best help them to meet their goals. At a minimum, these might include prescribing guidelines, an antimicrobial formulary, surveillance of antimicrobial use and resistance, evaluation of the antimicrobial stewardship program, audit and prescriber feedback and education of staff and consumers.

15.4.7 Prescribing guidelines

ACCHOs may wish to consider providing easy access for clinicians to diagnosis and treatment protocols that have been adapted to the local microbiology of infectious diseases. Relevant guidelines from which local protocols may be adapted include *Therapeutic Guidelines: Antibiotic*, the *Queensland Primary Clinical Care Manual* and the *Central Australian Rural Practitioners Association (CARPA) Standard treatment manual.*[86,87,88] Guidelines differ, which is reflective of the target populations to which each guideline is relevant.

15.4.8 Antimicrobial formulary

ACCHOs can consider developing a standard impress list of antimicrobials to be stocked for the management of acute infectious conditions. The list should be based on local susceptibility patterns and align with localised treatment protocols used by staff within the ACCHO. Staff may need to be made aware of the antimicrobials that are available.

For the rural/remote setting, it is important to consider the distance to an acute care facility in cases of severe infection and sepsis when considering which antimicrobials should be available locally.

15.4.9 Monitoring of antimicrobial use and evaluation of the antimicrobial stewardship program

Approaches to monitoring the volume and quality of antimicrobial use and measuring the effectiveness of antimicrobial stewardship programs are outlined in Chapter 5. The (Antimicrobial Use and Resistance in Australia) AURA surveillance system coordinates data from a range of sources to provide a comprehensive picture of patterns and trends of AMR and antimicrobial use in human health across Australia.[89]

ACCHOs may choose to select a range of measures that will help them monitor targeted interventions and determine whether their antimicrobial stewardship efforts are successful. This will be influenced by available resources to support monitoring and the feasibility of monitoring in the ACCHO’s practice setting. Organisations may need to monitor for potential unintended consequences of the interventions, such as making sure antimicrobial stewardship initiatives do not result in reduced appropriate treatment for infectious diseases.

15.4.10 Surveillance of antimicrobial resistance and antibiograms

Collection and distribution of surveillance data on resistant organisms and production of annual cumulative antibiograms to indicate susceptibility patterns for key pathogens can help clinicians make more appropriate empirical antimicrobial choices.[84] Access to diagnostic and laboratory testing may be limited in some settings. Point of care testing may be used, which increases diagnostic accuracy, but does not provide information about antimicrobial resistance.

ACCHOs may need to review diagnosis and treatment protocols regularly to ensure guidance to staff regarding antimicrobial use remains consistent with current patterns of susceptibility and resistance. Collaboration with microbiologists can be important to ensure data are interpreted correctly.

State and Territory governments and private pathology providers may be able to support ACCHOs to receive timely information regarding antibiograms that describe sensitivity and resistance patterns.[1] The use of cascade reporting of antimicrobial susceptibility by pathology providers is encouraged as this has been shown to reduce the use of broad-spectrum antimicrobials (see Chapter 9).

The AURA Surveillance System includes Australian Passive AMR surveillance (APAS) which collects, analyses and reports on de-identified patient-level AMR data across Australia. AMR in isolates referred for testing from public and private hospitals, aged care homes and community settings. The Commission is working to expand participation in APAS in rural and remote settings.

Hot North provides data from surveillance of AMR in northern Australia. HOTspots, which is part of this project aims to support healthcare professionals to make empirical antibiotic therapy choices and to provide local and timely data to support the activities of antimicrobial stewardship programs, pathology providers (in the development of local antibiograms) and those updating therapeutic guidelines.

15.4.11 Audit and feedback

Clinicians rely on audit and feedback to monitor whether their prescribing patterns are consistent with their peers and with evidence-based guidelines and protocols. Audit and feedback of prescribing practices have been shown to reduce inappropriate antimicrobial prescribing in other settings.[90]

Personalised prescriber feedback should be available to doctors, nurses, AHPs and any other clinicians who prescribe antimicrobials. Depending on available resources, ACCHOs may wish to support their staff to participate in national audit and feedback programs, such as the National Antimicrobial Prescribing Survey (NAPS) available at naps.org.au.

Audit and feedback within ACCHOs should compare clinician prescribing practices with protocols and treatment guidelines that are relevant to the local setting.[91] The quality improvement NAPS (QI-NAPS) is an appropriate tool for ACCHOs to use should they wish to consider this.

15.4.12 Staff education

Strategies to support antimicrobial stewardship education are described in Chapter 6, and information on resources and tools are described throughout this Chapter. ACCHO staff should be aware of infectious diseases relevant to their local community and associated diagnosis, treatment and referral pathways. Public health services can provide information to ACCHOs about local communicable disease epidemiology and trends.

ACCHOs may consider incorporating the recognition and management of infective conditions that are prevalent in the local area (e.g. acute streptococcal throat and skin infections where rheumatic heart disease is prevalent), and appropriate antimicrobial use for specific types of common infections (e.g. skin infections, otitis media, pneumonia, urinary tract infections, helminth and parasitic infections) into staff education and training. The potential complications of antimicrobial management and implications for care could also be included in staff education initiatives. PHN health pathways may also be used by staff to guide evidence-based decision making for patient assessment and management of infectious diseases.

15.4.13 Community and patient education

Community and patient education are essential elements of local antimicrobial stewardship programs. Educational resources and tools for consumer education are described in Chapter 7. To date, educational materials on the use and misuse of antimicrobials has been largely targeted at the general population, with only a few specific messages or materials for Aboriginal and Torres Strait Islander patients.

ACCHOs may need to adapt and/or translate education resources to meet local needs and circumstances as community and patient education should be aligned with local infectious disease burden, health literacy and cultural needs. Education materials may need to include messages that address causes of infections, the role of antimicrobials and other treatments such as hand hygiene and environmental interventions.

ACCHOs may wish to participate in national awareness campaigns for reducing the overuse of antimicrobials (such as Antimicrobial Awareness Week). However, organisations may need to develop materials that suit the specific needs of their community as local antimicrobial stewardship messages may differ from those in mainstream materials due to differences in infectious diseases and their treatment.

Box 15.33 below provides an example of educational resources adapted to meet local needs.

Box 15.3 Consumer education about germ theory

The infectious diseases program of the Aboriginal Resource and Development Service in the Northern Territory aims to improve health literacy and people's understanding of germ theory.

The program uses microscopes to teach people about bacteria and viruses and uses this as a platform to talk about the causes, symptoms and treatment of bacterial infections of the skin and respiratory tract, bloodborne viruses and sexually transmissible infections.

The programs are delivered in Yolngu language, and a series of programs was also broadcast on Yolngu Radio. The Nyumurrku' buwayak warrakan' mala-Small invisible animals/Germs-DVD is available here.

There is also Antibiotics-puy Dhäwu - Antibiotics Story DVD which will benefit Aboriginal people particularly in northeast Arnhem Land

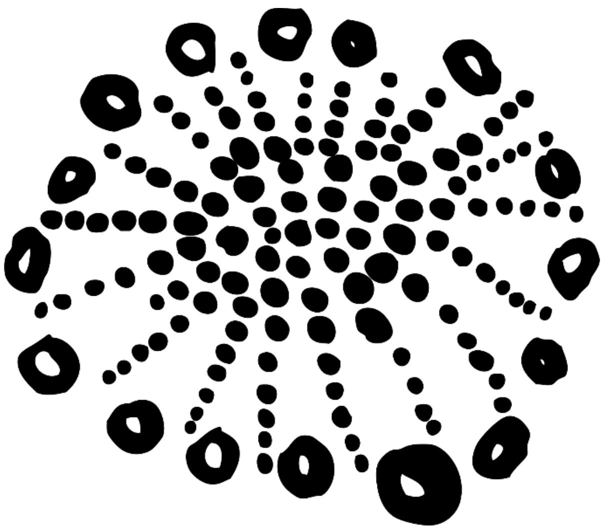
Social marketing and mass media campaigns targeting the overuse of antimicrobials and antimicrobial resistance in the general population have been effective in increasing consumer awareness (see Chapter 7). The effectiveness of these campaigns in Aboriginal and Torres Strait Islander populations has not been specifically evaluated.

15.5 Conclusions

The recommendations for antimicrobial stewardship programs described in other chapters of this book are also relevant to antimicrobial stewardship in Aboriginal and Torres Strait Islander communities. Antimicrobial stewardship initiatives should identify and address social and cultural factors that influence infectious diseases burden and antimicrobial use. Aboriginal and Torres Strait Islander leadership at local community level generating solutions led by Aboriginal and Torres Strait Islander people, is required to have a longer-term effect on reducing the infectious disease burden and reducing AMR.

ACCHOs play an important role in improving antimicrobial stewardship and reducing infectious diseases burden in Aboriginal and Torres Strait Islander communities. A range of antimicrobial stewardship strategies have been described that ACCHOs may consider in developing antimicrobial stewardship programs. In addition, ACCHOs should strongly consider adopting a community development approach to antimicrobial stewardship with strong organisational governance and accountability to ensure antimicrobial stewardship program success.

There are many evidence gaps that limit our understanding of effective antimicrobial stewardship approaches in Aboriginal and Torres Strait Islander populations. Further work led by Aboriginal and Torres Strait Islander peoples is required to better understand the infectious diseases burden and use of antimicrobials in Aboriginal and Torres Strait Islander populations, including areas where antimicrobials are being overused or misused, or where practice needs improvement. Research to inform our understanding of barriers and enablers to antimicrobial stewardship in Aboriginal and Torres Strait Islander populations and evaluation of the success of antimicrobial stewardship strategies is also required.



This logo that has been used throughout the chapter is a sea urchin design developed by a Worimi artist from the mid-north coast of NSW for use by the Commission.

Resources

- RACGP Cultural awareness and cultural safety training https://www.racgp.org.au/the-racgp/faculties/atsi/education/post-fellowship/cultural-awareness-and-cultural-safety-training
- National Agreement on Closing the Gap https://www.closingthegap.gov.au/national-agreement-closing-gap-glance
- NSQHS Standards Actions to meet the needs of Aboriginal and Torres Strait Islander peoples https://www.safetyandquality.gov.au/our-work/aboriginal-and-torres-strait-islander-peoples
- Kimberley Aboriginal Medical Services https://kams.org.au/resources/health-promotion/
- RHD Australia ARF RHD Guideline https://www.rhdaustralia.org.au/arf-rhd-guideline
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AUSTRALIAN COMMISSION ON SAFETY AND QUALITY IN HEALTH CARE

Glossary

Antimicrobial Stewardship in Australian Health Care

2018

Glossary

Term	Definition
acquired resistance (in bacteria)	A reduction in susceptibility to antimicrobials. This may be through the bacterium's own genes mutating, or by acquiring genes that encode resistance from other bacteria.[1]
advance care plan	A plan that states preferences about health and personal care, and preferred health outcomes. An advance care planning discussion will often result in an advance care plan. Plans should be made on the person's behalf and use a person-centred approach to guide decisions about care.[2]
adverse drug reaction	A response to a medicine that is noxious and unintended, and occurs at doses normally used or tested in humans for the prophylaxis, diagnosis or therapy of disease, or for the modification of physiological function. An allergy is a type of adverse drug reaction.[2]
adverse event	An incident that results, or could have resulted, in harm to a patient or consumer. A near miss is a type of adverse event.[2]
aged care home	A special-purpose facility that provides accommodation and other types of support – including assistance with day-to-day living, intensive forms of care and assistance towards independent living – to frail and aged residents.[1]
algorithm (as in clinical or treatment algorithm)	A flow chart that outlines a sequence of clinical decisions that can be used for guiding patient care and for teaching clinical decision-making.[3]
allergen	A substance that causes an allergic reaction. Typical allergens include some medicines, some foods and latex.[4] An allergen may be encountered through inhalation, ingestion, injection or contact with skin.[2] See also *allergy or allergic reaction*
allergy or allergic reaction	Allergy occurs when a person's immune system reacts to substances in the environment that are harmless for most people. These substances are known as allergens and are found in dust mites, pets, pollen, insects, ticks, moulds, foods and some medicines.[4]
antibiogram	Table of antimicrobial susceptibilities. These are used to inform local empirical antimicrobial recommendations and formulary management.[5]
antibiotic	A substance that kills or inhibits the growth of bacteria.[6]
antimicrobial	A substance that inhibits or destroys bacteria, parasites, viruses or fungi, and can be safely administered to humans or animals. Used when broadly referring to agents used to treat or prevent infections caused by microorganisms, the term embraces antibacterial, antifungal, antiviral and antiparasitic agents.[1]
antimicrobial resistance (AMR)	The failure of an antimicrobial to inhibit a microorganism at the antimicrobial concentrations usually achieved over time with standard dosing regimens.[2]
audit (clinical)	A systematic review of clinical care, assessed against a predetermined set of criteria.[2]
AURA	Antimicrobial Use and Resistance in Australia
bacteraemia	A bacterial infection of the blood or the lymph system.[6]
bloodstream infection	The presence of live pathogens in the blood, causing an infection.[6]

Term	Definition
broad-spectrum antimicrobial	An antimicrobial that kills or inhibits a wide range of organisms.
care bundle	A set of evidence-based practices that have been shown to improve outcomes when performed collectively. The Institute for Healthcare Improvement in the United States developed the concept to improve the care process and patient outcomes.[6]
care pathway	A complex intervention that supports mutual decision-making and organisation of care processes for a well-defined group of patients during a well-defined period.[2]
carer	A person who provides personal care, support and assistance to another individual who needs it because they have a disability, medical condition (such as a terminal or chronic illness) or mental illness, or they are frail or aged. An individual is not a carer merely because they are a spouse, a de facto partner, a parent, a child, or a relative or guardian of an individual, or live with an individual who requires care. A person is not considered a carer if they are paid, a volunteer for an organisation, or caring as part of a training or education program.[2]
clinical care standards	A series of quality statements that describe the care patients should be offered by clinicians and health services for a specific clinical condition or defined clinical pathway in line with current best evidence.[7] The clinical care standards were developed by the Australian Commission on Safety and Quality in Health Care.
clinical guideline	Evidence-based statement that includes recommendations intended to optimise patient care and help clinicians to make decisions about the appropriate health care for specific clinical circumstances. In this publication, clinical guidelines may also be referred to as clinical practice guidelines.[8]
clinical handover	The transfer of professional responsibility and accountability for some or all aspects of care for a patient, or group of patients, to another person or professional group on a temporary or permanent basis.[2]
clinical pathway	A document outlining a standardised, evidence-based multidisciplinary management plan, which identifies the appropriate sequence of clinical interventions, time frames, milestones and expected outcomes for a homogenous patient group.[9]
clinical procedure	For the purposes of this publication, a clinical procedure is an act of care for a patient where there is a risk of direct introduction of a pathogen to the patient.[10]
clinician	For the purposes of this publication, the term clinician includes nurses, midwives, medical practitioners, allied health professionals, scientists and other individuals delivering health care, including students who provide health care under supervision.
colonisation	The sustained presence of replicating infectious microorganisms on or in the body, without producing an immune response or disease.[10]
consumer	A person who has used, or may potentially use, health services, or is a carer for a patient using health services. A healthcare consumer may act as a consumer representative to provide a consumer perspective, contribute consumer experiences, advocate for the interests of current and potential consumers, and take part in decision-making processes.[2]
context	The influences that may be external (such as the prevailing economic, social, political environment) or internal to the organisation under study. Examples are the organisation's resources, capabilities, structure, culture and politics.[11]

Term	Definition
credentialing	The formal process used by a health service organisation to verify the qualifications, experience, professional standing, competencies and other relevant professional attributes of clinicians. Credentialing is used so that an organisation can form a view about the clinician's competence, performance and professional suitability to provide safe, high-quality healthcare services within specific organisational environments.[2]
data mining	The analysis of large datasets to discover patterns and use those patterns to forecast or predict the likelihood of future events.[12]
decision support tools	Tools that can help clinicians and consumers to draw on available evidence when making clinical decisions. The tools may be designed to, for example: • Enable shared decision making (for example, decision aids) • Provide some of the information needed for some components of the shared decision-making process (for example, risk calculators, evidence summaries) • Provide ways of initiating and structuring conversations about health decisions (for example, communication frameworks, question prompt lists).[2] See also *shared decision making*
defined daily dose (DDD)	The average dose per day of a medicine to treat the main indication for an average adult patient, as defined by the World Health Organization.[1]
drug use evaluation	A system of continuous, systematic, criteria-based drug evaluation that ensures the appropriate use of drugs. It is a method of obtaining information to identify problems related to drug use. If properly developed, it also provides a means of correcting the problem and thereby contributes to rational drug therapy. Drug use evaluation can assess the actual process of administration or dispensing of a medication (including appropriate indications, drug selection, dose, route of administration, duration of treatment and drug interactions) and also the outcomes of treatment (for example, cured disease conditions or decreased levels of a clinical parameter). The objectives of drug use evaluation include: • Ensuring that drug therapy meets current standards of care • Controlling drug cost • Preventing problems related to medication • Evaluating the effectiveness of drug therapy • Identifying areas of practice that require further education of practitioners.[13]
end of life	The period when a patient is living with, and impaired by, a fatal condition, even if the trajectory is ambiguous or unknown. This period may be years in the case of patients with chronic or malignant disease, or very brief in the case of patients who suffer acute and unexpected illnesses or events, such as sepsis, stroke or trauma.[2]
e-prescribing	Prescriptions that are issued and dispensed in an electronic system, without the use of a paper-based document at any point.[14]
hand hygiene	A general term referring to any action of hand cleansing, including: • Washing hands with water and soap or a soap solution, either non-antimicrobial or antimicrobial OR • Applying a waterless antimicrobial hand rub to the surface of the hands (for example, alcohol-based hand rub). When performed correctly, hand hygiene results in a reduction of microorganisms on hands.[15]

Term	Definition
healthcare-associated infections (HAIs)	Infections acquired in health service organisations (nosocomial infections) and that occur from healthcare interventions (iatrogenic infections). HAIs may manifest after people leave the organisation.[10]
health service organisation	A separately constituted health service that is responsible for implementing clinical governance, administration and financial management of a service unit(s) that provides health care at the direction of the governing body. A service unit involves a group of clinicians and others working in a systematic way to deliver health care to patients. It can be in any location or setting, including pharmacies, clinics, outpatient facilities, hospitals, patients' homes, community settings, general practices and clinicians' rooms.[2]
hospital peer group	A group of Australian public and private hospitals according to a classification system developed by the Australian Institute of Health and Welfare. Hospitals are assigned to peer groups based on the type and nature of the services they provide. Peer grouping of hospitals supports valid comparisons that reflect the purpose, resources and role of each hospital.[1]
immunocompromised	Having an immune system that has been impaired by disease or treatment.[6]
infection	The invasion and reproduction of pathogenic organisms inside the body, which may cause tissue injury and disease.[2] See also *pathogen*
infection prevention and control (IPC)	Measures that aim to prevent the spread of pathogens between people in a healthcare setting. Examples of IPC measures include using hand hygiene, protective clothing and isolation procedures, and auditing compliance with hygiene measures.[6] See also *hand hygiene*, *pathogen*
intravenous	Within or into a vein (for example, an intravenous catheter is a catheter that is inserted into a vein).[6]
invasive medical devices	Devices inserted through the skin, a mucosal barrier or internal cavity, including central lines, peripheral lines, urinary catheters, chest drains, peripherally inserted central catheters and endotracheal tubes.[2]
invasive procedure	A procedure that involves entry into tissues, cavities or organs, or repair of traumatic injuries.[10]
Local Health District (LHD)	A legal term used to describe public hospitals and health institutions, and the provision of health services for residents of the geographic areas that constitute the district.
Local Hospital Network (LHN)	An organisation that provides public hospital services in accordance with the National Health Reform Agreement. An LHN can contain one or more hospitals, and may include other health services. It is usually defined as a business group, geographical area or community. Every Australian public hospital is administered by an LHN or LHD.[16] Several states and territories may apply other terminologies to describe an LHN. These include 'Local Health District', 'Local Health Network', 'Hospital and Health Service' or 'Health Service'.
medication management	Practices used to manage the provision of medicines. Medication management has also been described as a cycle, pathway or system, which is complex and involves many different clinicians. Medication management includes manufacturing, compounding, procuring, dispensing, prescribing, storing, administering and supplying medicines, and monitoring their effects. It also includes decision-making, and rules, guidelines, support tools, policies and procedures that are in place to direct the use of medicines.[2]

Term	Definition
medicine	A chemical substance given with the intention of preventing, diagnosing, curing, controlling or alleviating disease, or otherwise improving the physical or mental wellbeing of people. These include prescription, non-prescription, investigational, clinical trial and complementary medicines, regardless of how they are administered.[2]
morbidity	The state of being ill, diseased or injured.[6]
mortality	Death, or the frequency or number of deaths. For example, 'infections are a major cause of mortality worldwide', and 'the mortality rate of this type of infection is 30%'.[6]
multidisciplinary team	A team that includes clinicians from different disciplines who work together to deliver comprehensive care (that is, care that deals with as many of the patient's health and other needs as possible). The team may operate under one organisational umbrella or may be from several organisations brought together as a unique team. As a patient's condition changes, the composition of the team may change to reflect the changing clinical and psychosocial needs of the patient. Multidisciplinary care includes interdisciplinary care. (A discipline is a branch of knowledge within the health system.)[2]
My Health Record (formerly known as a personally controlled electronic health record)	The secure online summary of a consumer's health information. Clinicians are able to share clinical documents to a consumer's My Health Record, according to the consumer's access controls. A My Health Record may include a consumer's medical history, and treatments, diagnoses, medicines and allergies.[2] My Health Record is managed by the System Operator of the national My Health Record system (the Australian Digital Health Agency).
National Antimicrobial Prescribing Survey (NAPS)	A voluntary annual audit of antimicrobial use by health services. It provides a snapshot of medication charts and patient records that have been assessed for appropriateness of antimicrobial prescribing and compliance with guidelines. The results from NAPS can be used as evidence to support the antimicrobial stewardship criterion of the National Safety and Quality Health Service Preventing and Controlling Healthcare-Associated Infection Standard. NAPS is part of the AURA Surveillance System.
National Antimicrobial Utilisation Surveillance Program (NAUSP)	A national surveillance program focusing on standardised measurement of antimicrobial usage in Australian adult public and private hospitals. Hospitals contribute monthly data on a voluntary basis. NAUSP provides a range of reports on usage rates of selected antimicrobials and therapeutic groups. NAUSP is part of the AURA Surveillance System.
National Centre for Antimicrobial Stewardship (NCAS)	A national body for antimicrobial stewardship in Australia. NCAS undertakes research relating to antimicrobial consumption, inappropriate use, interventions to change prescribing behaviour and measuring the effectiveness of these interventions. This research informs policy and practice around antimicrobial prescribing for both humans and animals. NCAS conducts NAPS.
National Safety and Quality Health Service (NSQHS) Standards	The Australian Commission on Safety and Quality in Health Care developed the NSQHS Standards to improve the quality of health service provision in Australia. The NSQHS Standards provide a nationally consistent statement about the level of care consumers can expect from health service organisations.[2] There are eight standards in the second edition of the NSQHS Standards. See also *standard*
occupied bed days (OBDs)	The total number of bed days of all admitted patients accommodated during a reporting period, taken from a count of the number of inpatients at about midnight each day.[1]

Term	Definition
outbreak	A classification used in epidemiology to describe a localised group of people affected by an infectious disease.[6]
passive surveillance	Data collection designed for a broader purpose, but where a subset of the data is used for specific analysis. In this publication, it refers to broader datasets from which data on antimicrobial use and resistance are extracted.
pathogen	A disease-causing agent. The term is often used to refer to infectious microorganisms, such as bacteria, viruses or fungi.[6]
patient	A person who is receiving care in a health service organisation.[2] It is acknowledged that some people receiving care are referred to as 'clients'. However, the term 'patient' is commonly used in healthcare delivery, research and literature related to antimicrobial stewardship.
Pharmaceutical Benefits Scheme (PBS)	An Australian Government program that subsidises medicines.[1]
point of care	The time and location of an interaction between a patient and a clinician for the purpose of delivering care.
policy	A set of principles that reflect an organisation's mission and direction. All procedures and protocols are linked to a policy statement.[2]
prescribers	A health professional authorised to undertake prescribing within the scope of their practice.[17]
prescribing guidelines	Guidelines that describe evidence-based best prescribing practice, and provide a standard against which prescribing behaviour can be compared.
prevalence	The number of events (for example, cases of disease) present in a defined population at one point in time.[10]
procedure	The set of instructions, specific to an organisation, to make policies and protocols operational.[2]
program	An initiative, or series of initiatives, designed to deal with a particular issue, with resources, a time frame, objectives and deliverables allocated to it.[2]
prophylactic	Medicines or other treatments used to prevent disease or illness. For example, antimicrobials are sometimes given prophylactically before surgery to prevent infection.[6]
protocol	An established set of rules used to complete a task or a set of tasks.[2]
quality improvement (QI)	The combined efforts of the clinical workforce and others – including consumers, patients and their families, researchers, planners, and educators – to make changes that will lead to better: • Patient outcomes (health) • System performance (care) • Professional development. QI activities may be undertaken in sequence, intermittently or continually.[2]
Repatriation Pharmaceutical Benefits Scheme (RPBS)	An Australian Government program that subsidises medicines for veterans.[1]
risk assessment	A review of the likelihood of risks occurring and the size of their likely effects.
risk management	The design and implementation of a program to identify, and avoid or minimise, risks to an organisation's consumers, workforce, volunteers and visitors, and to the organisation itself.[2]

Term	Definition
safety culture	A commitment to safety that permeates all levels of an organisation, from the clinical workforce to executive management. Features commonly include: • Acknowledgement of the high-risk, error-prone nature of an organisation's activities • A blame-free environment in which individuals are able to report errors or near misses without fear of reprimand or punishment • An expectation of collaboration across all areas and levels of an organisation to seek solutions to vulnerabilities • A willingness of the organisation to direct resources to deal with safety concerns.[2]
scope of clinical practice	The extent of an individual clinician's approved clinical practice within a particular organisation. A clinician's scope of clinical practice is based on the clinician's skills, knowledge, performance and professional suitability, and the needs and service capability of the organisation.[2]
sepsis	A life-threatening condition that arises when the body's response to infection injures its own tissues and organs. Sepsis can present in any patient and in any clinical setting, and is a medical emergency. It is one of the leading causes of inpatient death worldwide.[18]
shared decision making	A consultation process in which a clinician and a patient jointly participate in making a health decision. It involves discussing intervention options, and their benefits and harms, and considers the patient's values, preferences and circumstances.[2]
standard	Agreed attributes and processes designed to ensure that a product, service or method will perform consistently at a designated level.[2] See also *National Safety and Quality Health Service (NSQHS) Standards, clinical care standards*
state and territory requirements	Systematically developed statements from state and territory governments about appropriate healthcare or service delivery for specific circumstances. State and territory requirements encompass a range of documents including legislation, regulations, guidelines, policies, directives and circulars. Terms used for each document may vary by state and territory.[2]
surgical site infection	An infection that occurs at the site of a surgical operation that is caused by the operation[7] and occurs within 30 days of the surgery.[19] Infections can occur in: • Skin and subcutaneous tissue of the incision (superficial incisional) • Deep soft tissue (for example, fascia, muscle) of the incision (deep incisional) • Any part of the anatomy (for example, organs and internal spaces) other than the incision that was opened or manipulated during an operation (organ/space).[19]
surveillance	In the context of this publication, surveillance refers to data collection, analysis and reporting of factors that affect disease, resistance and healthcare delivery, such as antimicrobial use and appropriateness of use.
targeted surveillance	Data collection designed for a specific and targeted purpose. In this publication, it predominantly refers to data collected for the surveillance of antimicrobial-resistant organisms.[1]
therapeutic group or class	A category of medicines that have similar chemical structure and spectrum.[1]

Term	Definition
transitions of care	Situations when all or part of a patient's care is transferred between health service organisations or individuals, or levels of care within the same location, as the patient's condition and care needs change.[2]
VICNISS	Victorian Healthcare Associated Infection Surveillance System. VICNISS has been previously known as the Victorian Hospital Acquired Infection Surveillance System and the Victorian Nosocomial Infection Surveillance System.
workforce	All people working in a health service organisation, including clinicians, and any other employed or contracted, locum, agency, student, volunteer or peer workers. The workforce includes: • Members of the health service organisation • Medical company representatives providing technical support who have assigned roles and responsibilities for the care of, administration of, support of or involvement with patients in the health service organisation.[2]

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