Part I

Strategies for implementing and sustaining antimicrobial stewardship
Implementing an antimicrobial stewardship program

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1.1 Key points

- Effective antimicrobial stewardship programs have been shown to improve the appropriateness of antimicrobial use, reduce patient morbidity and mortality, and reduce institutional bacterial resistance rates and healthcare costs.

- The overall accountability for antimicrobial management control lies with the hospital administration. They should be responsible for ensuring an antimicrobial stewardship program is developed and implemented, and outcomes are evaluated.

- International literature strongly suggests that the most effective approach to antimicrobial stewardship involves multidisciplinary antimicrobial stewardship teams with the responsibility and resources for implementing a program to improve antimicrobial prescribing.

- The support and collaboration of the hospital executive is essential to the success of antimicrobial stewardship teams, and clear lines of accountability to the hospital executive should be defined.

- Successful stewardship programs include a range of interventions. Two of the most effective strategies are restrictive methods, such as requiring approval to prescribe an antimicrobial, and the proactive strategy of prospective review with direct intervention and feedback to the provider.

- Teams are more likely to be effective in leading and sustaining changes in clinical practice if they have access to, and training in, effective quality improvement methods and knowledge.
1.2 Recommendations

1.2.1 Hospitals have an antimicrobial stewardship program that includes an antimicrobial prescribing and management policy, plan and implementation strategy that are regularly reviewed.

1.2.2 Hospitals have an antimicrobial formulary and guidelines for antimicrobial treatment and prophylaxis that align with *Therapeutic Guidelines: Antibiotic* and are regularly reviewed.

1.2.3 Hospitals establish a multidisciplinary antimicrobial stewardship team that is responsible for implementing the antimicrobial stewardship program. At a minimum, the team should include either an infectious diseases physician, clinical microbiologist or nominated clinician (lead doctor), and a pharmacist.

1.2.4 The antimicrobial stewardship program resides within the hospital’s quality improvement and patient safety governance structure and is included within the hospital’s quality and safety strategic plan.

1.2.5 Antimicrobial stewardship teams have clearly defined links with the drug and therapeutics committee, infection prevention and control committee, and clinical governance or patient safety and quality units.

1.2.6 Team members have clearly defined roles and responsibilities. Team members should be sufficiently supported and trained to enable them to effectively and measurably optimise antimicrobial use by using interventions appropriate to local needs, resources and infrastructure.

1.2.7 Antimicrobial stewardship process and outcome indicators are measured and reported to the hospital executive.
1.3 Antimicrobial management programs

Antimicrobial management programs in hospitals, known as antimicrobial stewardship (AMS) programs, have been developed in response to the emergence of antimicrobial resistance in pathogens encountered in hospitals and — more recently — in the community. Improving the safe and appropriate use of antimicrobials is an important component of patient safety in hospitals\(^1\) and there is extensive evidence for the efficacy of AMS. Together with infection prevention and control, hand hygiene and healthcare associated infections (HAI) surveillance, AMS is considered a key component of a multifaceted, multidisciplinary approach to preventing the emergence of antimicrobial-resistant pathogens and decreasing preventable HAI.

AMS has been defined as ‘an ongoing effort by a health-care institution to optimise antimicrobial use among hospital patients in order to improve patient outcomes, ensure cost-effective therapy and reduce adverse sequelae of antimicrobial use (including antimicrobial resistance)’.\(^2\) Successful AMS programs have been shown to improve the appropriate prescription of antimicrobials and reduce institutional resistance rates, morbidity, mortality and healthcare costs.\(^1,3,12,22,24\) AMS programs are multidisciplinary, using the expertise and resources of infectious diseases (ID) physicians, clinical microbiologists, infection control practitioners and pharmacists. Their aim is to change antimicrobial prescribing to reduce unnecessary use and to promote the use of agents less likely to select resistant bacteria. This is done in line with treatment guidelines and with consideration of the demonstrated local incidence of antimicrobial-resistant pathogens (as shown by antibiograms).\(^25\)

This chapter will focus on how to develop and implement an antimicrobial management program in hospitals and the role of the AMS team in establishing and implementing the program.

1.4 Effective implementation of antimicrobial stewardship programs

A significant percentage of improvement programs in health care do not succeed, fail to be implemented throughout an organisation or are not sustainable. These include interventions that are based on excellent technical evidence and that have been successful in other locations and contexts — such as the AMS strategies described in this book.

Successfully influencing clinical practices, such as antimicrobial prescribing in hospitals, is complex. To maximise the chance of success, AMS teams are urged to learn about and incorporate findings from other quality improvement work in health care.

Boaden et al.\(^26\) recently summarised the factors associated with successful improvement of clinical processes and outcomes in health care:

- participation of a nucleus of physicians
- feedback to individual practitioners
• supportive organisational culture
• conducive external environment
• phased and coordinated approach to spreading interventions where management monitors progress, coordinates team efforts and allocates resources
• bottom-up activities supported by top-down policies that are consistent with the improvement objectives.

There are also principles of improvement that should guide the process of AMS program development and implementation. They are:

• knowing what needs to be improved and having a clear aim that will guide the effort and motivate participants
• making sure there is a process to get feedback to let participants know if improvement is happening and if changes are being made that are taking them closer to their aim
• developing changes that are likely to make improvements
• testing a change before any attempts are made to implement it permanently by using some form of experiential learning method, such as the Plan-Do-Study-Act cycle
• knowing when and how to implement a permanent change.

These principles are integrated into relevant sections of this and other chapters of this book as appropriate. Readers are urged to seek further information and training in quality improvement if they do not have access to relevant expertise. There are many useful resources, including the NSW Health publication, *Easy guide to clinical practice improvement* and the Institute for Healthcare Improvement.

### 1.5 The evidence for antimicrobial stewardship programs

The Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America collaboratively reviewed AMS strategies. The review showed that comprehensive AMS programs consistently demonstrated a decrease in antimicrobial use (in the order of 22–36% reduction) and significant cost savings. Similarly, authors systematically reviewed 66 studies on AMS interventions for the Cochrane Collaboration. They reported improved drug use in 81% of the studies that examined optimising antimicrobial use.

Reducing unnecessary antimicrobial use and optimising treatment minimises the potential for selecting resistant organisms. There are many examples where changes in antimicrobial prescribing practices have had a significant effect on outbreaks of resistant pathogens. However, these programs are often implemented in times of crisis, such as in response to the emergence of resistance in a unit or hospital. There are few studies examining the effect of an established AMS program on the emergence of resistant organisms over long time periods.

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[a](www.ihi.org)
One large study of 448 hospitals in the United States found an inverse relationship between the presence of AMS programs and local antimicrobial resistance rates. This study showed high implementation rates of guideline-recommended practices, and optimising the duration of empirical therapy were associated with a lower prevalence of resistant organisms. Some of the most successful AMS programs reported have been those that aimed to reduce *Clostridium difficile* infection (CDI) rates. A number of studies have demonstrated that reducing the overall use of antimicrobials, combined with improved infection control precautions, reduces the incidence of nosocomial CDI. Figure 1.1 provides an example of the outcome of a program of improved infection control and targeted antimicrobial consumption on CDI incidence in a Canadian hospital.

![Figure 1.1](image-url)

**Figure 1.1**  Targeted antibiotic (Abx) consumption and nosocomial *Clostridium difficile*-associated disease (CDAD) incidence per 1000 patient days of hospitalisation

Inadequate antimicrobial therapy is associated with increased patient morbidity and mortality due to infection, and is an independent risk factor for death among critically ill patients with severe infection. In addition to improving patient care by reducing the risk of HAI, programs that improve antimicrobial prescribing have been shown to increase cure rates, decrease treatment failures and decrease mortality from infection. In the Cochrane Collaboration’s systematic review, 26% of the studies reported microbiological outcomes and, of these, 75% reported significant improvements in the local bacterial resistance rates. A smaller number of studies (nine) also reported on clinical outcomes (length of hospital stay, mortality) and the majority reported improvement. The authors concluded that interventions to improve antimicrobial prescribing to hospital inpatients are successful in reducing...
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antimicrobial resistance in local pathogens, and decreasing the incidence of HAI, death, illness and length of hospital stay.

Implementation of any new program requires some financial investment; however, published studies indicate that AMS programs at least cover their costs and can be financially self-supporting.\(^1,12\) Examples of interventions that have direct cost savings include:\(^15\)

- stopping antimicrobial administration when patients are no longer infected
- switching from intravenous to oral therapy
- de-escalating from broad-spectrum combination therapy to directed therapy.

Maintaining an AMS team with the focused objective of optimising treatment of bacteraemia as a single infective syndrome has been shown to be cost-effective.\(^13\) Dellit et al. describe annual savings of US$200 000–900 000 in large teaching hospitals and small community hospitals with multidisciplinary antimicrobial management programs.\(^1\) Similar savings have been reported in Australia (see Box 4 in this chapter and Case study 2 in Appendix 1).

1.6 Governance of antimicrobial stewardship programs

The appropriate use of antimicrobials is considered an essential part of patient safety, thus requiring careful oversight and guidance.\(^1,11\) ACSQHC supports recommendations that the AMS program should reside within the hospital quality improvement and patient safety governance structure,\(^1,17\) and be included within the hospital’s quality and safety strategic plan.\(^3\)

As AMS is an important component of patient safety, its performance indicators should be safety and quality parameters that can be measured, and for which hospital and hospital executives should be accountable.

The responsibility for implementing and managing the program should reside with a multidisciplinary AMS team or committee.\(^1,17-18\) Formal links should be established between the:

- AMS team
- hospital executive
- director of clinical governance
- drug and therapeutics committee
- infection prevention and control committee.\(^1,17\)

The AMS team should be represented on the last two committees.\(^1\)
Figure 1.2 is an example of a reporting framework for an AMS team established for Scottish hospitals.\(^\text{17}\) The structure emphasises that AMS is an important component of patient safety that must be integrated into the local clinical governance and patient safety framework. This model could be adapted to the varying Australian hospital structures in place.

![Model for antimicrobial prescribing pathways in acute hospitals (Scotland)](image)

**APP&P** = antimicrobial prescribing policy and practice

*Source: Nathwani (2006)\(^\text{17}\)*

**Figure 1.2**  Model for antimicrobial prescribing pathways in acute hospitals (Scotland)

### 1.6.1 The role of hospital executives in antimicrobial stewardship

Like any change and improvement activity, the success of the AMS program is dependent on the support and leadership of hospital management and senior medical staff.\(^1, 16-17\) Without support from hospital leadership, funding may be inadequate and prescribers may thwart attempts to improve antimicrobial use.\(^12\)
Hospital leaders can demonstrate their explicit support for improvements such as AMS programs by:

- allocating an executive sponsor
- making AMS a strategic goal of the organisation
- communicating why change is needed to staff and other leaders
- scheduling time to review progress and provide advice
- assigning high-performing staff to the team and resourcing them adequately.\(^{37}\)

### 1.7 The antimicrobial stewardship team

Multidisciplinary teams are better suited to implement the kind of improvement and change required for effective AMS.\(^{34}\) There are a range of professions and individuals that have an interest in and responsibility for AMS, each with different perspectives and skills. Involving prescribers, pharmacists, administrators, infection control experts, information systems experts, microbiologists and ID physicians into a well-managed team effectively incorporates their views and expertise.

As a minimum, a multidisciplinary AMS team or committee should include an appropriate clinician (a microbiologist or ID physician, if available) and a clinical pharmacist (with ID training, if possible) as core team members.\(^{1, 16-17, 34}\)

Where on-site ID physicians or clinical microbiologists are not available, the AMS team should be lead by an interested clinician with a clinical pharmacist. In these circumstances, hospitals should negotiate appropriate external specialist advice to support the local AMS team. Small hospitals without an on-site pharmacist should be able to seek advice from a clinical pharmacist (e.g. from a regional hospital).

Core team members should have dedicated time for AMS tasks. One group from the United States suggested that in hospitals with more than 150 beds, a full-time pharmacist and part-time physician are required, with less staffing for institutions with 100–150 beds.\(^{35}\) There is no consensus on staffing recommendations in Australia. However, clinicians in hospitals with existing programs suggest that for every 100 acute beds, at least 10 hours (0.3 full-time equivalent) of senior pharmacist and 3.5 hours (0.1 full-time equivalent) of lead clinician time per week should be dedicated to AMS activities (K Buising, Infectious Diseases Physician, St Vincent’s Hospital, Melbourne, Clinical Research Physician Victorian Infectious Diseases Service, Royal Melbourne Hospital, pers comm, 2010).

The support and collaboration of hospital administration, medical staff leadership, and local providers in the development and maintenance of antimicrobials stewardship programs is essential.\(^{1}\)
The core team members should recruit others as appropriate. Colleagues from a range of clinical disciplines may assist in developing strategies that are more acceptable to prescribers. This may also help to engage a broad range of prescribers in AMS activities. Team members should be clear about their roles and their time commitment. An example of an AMS program team terms of reference is provided in Appendix 2, Section A.2.1.

Team membership should not be confined to those with professional expertise in antimicrobial usage. Evidence from quality improvement work suggests that effective improvement teams include members with three broad kinds of expertise and authority:

- a system leader who has the authority to institute change and overcome barriers (e.g. a senior member of clinical administration)
- an individual with technical expertise, such as an ID physician, pharmacist or microbiologist
- someone to provide day-to-day leadership with dedicated time allocation. This is the driver of the project who ensures implementation and performance measurement. An AMS team comprised solely of technical experts is less likely to be able to effect change and improvement. In an AMS team, this person could have one of a variety of professional backgrounds, including a pharmacist with training in quality improvement, or a member of the safety and quality team.

The AMS team should establish links with existing committees or groups, have representation on the drug and therapeutics committee, and the infection prevention and control committee, and seek endorsement of the hospital executive for formal structural alignment (see Figure 1.2).

### 1.8 The antimicrobial stewardship program plan

Once executive support, the AMS team and a governance structure are established, the next step is to plan the AMS program.

The AMS team will have to develop clear aims and metrics that allow monitoring of improvements, and select changes to consider and test for implementation. An AMS policy will need to be developed or updated to underpin these activities. The AMS team should consider whether to develop this policy as their first activity, or in parallel with investigating and testing changes aimed at improved prescribing. As the policy development process can be a useful way to gain multidisciplinary input and engagement, initially focusing on this activity is likely to be particularly important if there has been little progress in AMS to date. However, AMS teams should try to avoid extremely prolonged policy development to the exclusion of other activities, as this will slow progress in developing and testing systems to directly influence antimicrobial prescribing. AMS policy is discussed further in Section 1.9.

Gathering information to better understand the local organisational culture is essential to maximising a new AMS program’s chances of success. This information
Implementing an antimicrobial stewardship program should be used to inform testing and implementation, and to build a business case for resourcing, if required. An approach to setting up an AMS program is outlined below, and it is highly recommended that any hospital introducing or strengthening AMS in their institution consider following these steps:

1. Collect baseline information relevant to the institution
   - antimicrobial use and trends over time
   - antimicrobial expenditure and trends over time
   - the institution’s microbial susceptibility patterns.

2. Assess organisational culture regarding AMS — readiness survey, what the local ‘drivers’ are (e.g. financial savings, antimicrobial resistance), and the level of executive support or commitment to the program.

3. Assess what assets are available (e.g. interested personnel, trained personnel, information technology support and willingness to look at new systems, microbiology, ID physician and pharmacy availability and support). Assess what resources are accessible (e.g. this book, jurisdictional guidelines, latest version of *Therapeutic Guidelines: Antibiotic*, web sites, other groups, state therapeutic advisory group resources). Appendix 2 provides information on resources and useful web sites.

4. Review existing antimicrobial prescribing and management policies. Assess if they are current, comprehensive, and whether they have been audited and cover all the necessary issues or not (see Section 1.9). Ensure that the policy nominates a person and their position within the hospital who has executive responsibility for the policy content, implementation and monitoring, and that this person will be involved in future AMS activities. Ensure the policy is readily available to all healthcare professionals in hard copy or online.

5. Review the existence, accessibility and acceptance of the organisation’s antimicrobial treatment and surgical prophylaxis guidelines. Assess whether or not the guidelines
   - are consistent and evidence based
   - reflect agreed best practice (e.g. as stated in *Therapeutic Guidelines: Antibiotic*)
   - specify recommended agent, dose, route and duration of empirical antimicrobial treatment for the major infection categories.

6. Review existing groups or committees with an interest in AMS (e.g. safety and quality, drug and therapeutics, infection prevention and control, postgraduate medical education committees). Their responsibilities and reporting structures should be understood, as well as how they might impact or interact with AMS work.

7. Review the organisation’s existing communication strategies, particularly those aimed at prescribers (e.g. access and use of email, newsletters, departmental meetings, mobile phones).
An institution’s readiness to adopt an AMS program is discussed in Chapter 2, including how to implement electronic decision-support and approval systems.

1.9 Antimicrobial prescribing and management policy

An antimicrobial prescribing and management policy should be in place and used as a base for education programs. It should have an expiry date and be regularly reviewed and audited. As mentioned in Section 1.8, policy development is likely to be particularly important in sites just beginning an AMS program. The policy should be developed by the AMS team and approved by the drug and therapeutics committee. Prescribers should have easy access to it, including electronically (preferably) and a printed version. As a minimum, the policy should include:

- the requirement for clinicians to prescribe antimicrobials guided by the latest version of the *Therapeutic Guidelines: Antibiotic* wherever possible, with specific mention of how evidenced-based practice recommendations for antimicrobial prescribing are to be applied locally
- a list of restricted antimicrobials and the procedures for obtaining approval for these
- guidelines for prescribing, including local clinical guidelines
- reference to the hospital’s policy on liaising with the pharmaceutical industry.

An example template for a hospital antimicrobial policy prepared by the Specialist Advisory Committee on Antimicrobial Resistance (SACAR) in the United Kingdom is provided in Appendix 2. Appendix 2 also includes examples of Australian policies. A summary of the SACAR template contents is provided in Box 1.

Prescribing policies should accord with *Therapeutic Guidelines: Antibiotic* and incorporate messages such as the antimicrobial creed, MINDME (see Box 2).

The United Kingdom Department of Health’s *Antimicrobial prescribing: summary of best practice* also provides recommendations that could be incorporated into prescribing policy:

- **Decision to prescribe.** The decision to prescribe an antimicrobial should always be clinically justified and the reason(s) recorded in the patient’s medical record. It is important not to prescribe antimicrobials on a ‘just in case’ basis. Antimicrobials prescribed empirically in life-threatening situations should be reviewed early in light of factors such as microbiological results and clinical progress, and, where necessary, changed or discontinued as soon as is reasonable.

- **Intravenous (IV) or oral therapy.** Unless there are not suitable alternatives, IV therapy should only be used for those patients with severe infections or who are unable to take oral antimicrobials. As a general rule, IV antimicrobials should only be prescribed for two days, after which the prescription should be reviewed and, if appropriate, the patient switched to an oral equivalent.
Box 1  Summary of contents of the SACAR template for hospital antimicrobial policy

Title page
• name of policy, date, version, review date, and contact details for normal hours and out-of-hours enquiries

Introduction section
• statement as to whether the guideline is mandatory or for guidance only, contents, and a local procedure for microbiological samples

Summary list of available antimicrobials
• unrestricted, restricted (approval of a specialist is required) or permitted for specific conditions

Regimens for treatment of common infections
• treatment, prophylaxis and rules for switching from intravenous to oral administration

Source:  Specialist Advisory Committee on Antimicrobial Resistance

Box 2  The antimicrobial creed, MINDME
M microbiology guides therapy wherever possible
I indications should be evidence based
N narrowest spectrum required
D dosage appropriate to the site and type of infection
M minimise duration of therapy
E ensure monotherapy in most cases

Source: Therapeutic Guidelines: Antibiotic

• Review of antimicrobial treatment. It is important to establish a culture that includes daily review and de-escalation from IV to oral therapy. It should set maximum durations for treatment without repeat prescription, unless there is a clear indication in the medical record that antimicrobials should be continued (e.g. a specific infection that requires extended therapy). The patient's microbiology results should be reviewed regularly and antimicrobial therapy rationalised accordingly. In a critical care environment, for example, a joint daily round between intensivist, microbiologist and pharmacist should be considered.

• Minimising use of broad-spectrum antimicrobials. The use of broad-spectrum antimicrobial agents is a major factor in inducing CDI. Therefore, clinicians should
avoid the widespread use of cephalosporins, quinolones, broad-spectrum penicillins and clindamycin unless there are clear indications for their use. Broad-spectrum antimicrobials should be restricted to the treatment of serious infections when the pathogen is not known or when other effective agents are unavailable. Restricted antimicrobials should not be held in main ward stocks and should only be issued on advice from a microbiologist or ID physician, or under an agreed policy.

- **Use of single dose for surgical prophylaxis.** Prophylactic antimicrobial use has an important part to play in the prevention of postoperative wound infections. However, a key principle is to have a high concentration of the antimicrobial agent(s) in the relevant tissues at the time of the operation, when microbes may contaminate the tissues. For most operations, this requires only a single dose of the antimicrobial(s) at induction of anaesthesia. Only in lengthy operations (i.e. over four hours) may a second intraoperative dose be considered necessary. Policies for the prophylactic use of antimicrobials should state that the single dose is the preferred option.

### 1.10 Goals and measurable outcomes for antimicrobial stewardship

The AMS team should formulate measurable and defined goals and outcomes. A critical part of testing and implementing changes is the ability to measure them. This allows the team to know whether or not the changes they make are leading to improvements. AMS teams should coordinate the collection and analysis of key metrics to assess achievement of goals, including antimicrobial use, antimicrobial resistance and compliance with antimicrobial policies. Methods for monitoring antimicrobial prescribing and measuring AMS activities are discussed in Chapter 5.

The team should also consider how best to provide feedback to prescribers, other committees and groups, and hospital executive about the program results. As a guide to developing an AMS communication plan, key antimicrobial use should be reported at least quarterly to hospitals, directorates and specific clinical areas. Institutional laboratory susceptibility data should be reported to the same parties at least annually. Unexplained deviation from accepted prescribing practices should be promptly reported back to prescribers. Initially, presenting locally derived, meaningful data to small groups of clinicians (e.g. at departmental meetings) is likely to be more successful than emailing out formal reports; however, a range of strategies is likely to be necessary to disseminate all data. Institution-wide measures of the quality of prescribing should be regularly reported to prescriber groups, and patient safety and quality groups in the organisation.

The team may be able to use existing measurement systems (particularly for costing antimicrobials) or they may have to develop operational definitions for metrics. Similarly, data collection and feedback processes either may exist or need to be developed.

Measurement to support process improvement (in this case, antimicrobial prescribing practice) differs from measurement to evaluate performance or
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measurements gathered during research. Improvement measures aim to support bringing new knowledge into daily practice. Data should be collected in many sequential and observable tests, and with a sample size just big enough to learn from and complete further tests. Large blinded tests, controlling for bias and lengthy data collection processes are only appropriate in a research setting, and are unlikely to be practical or successful approaches for routine AMS team use.

The team should plan to collect and plot key measures data over time on a run chart or control chart. A ‘balanced’ set of measures is ideal and should include:

- **outcome** measures — what is the result? (e.g. restricted antimicrobial consumption, antimicrobial cost, CDI rate)
- **process** measures — are the steps in the process performing as planned? (e.g. compliance with surgical antibiotic prophylaxis prescribing, compliance with restriction conditions)
- **balancing** measures — are the changes causing new problems? (e.g. surgical site infection rate, topical antimicrobial usage, ID consultation rate, mortality due to sepsis).

During the testing and implementing process, frequent small samples are more useful than large infrequent surveys. This will allow the team to see whether changes are resulting in improvement. There are many resources that can be used to design and use measurements for clinical practice improvement, including the *Measurement for Improvement Toolkit* from the Australian Commission on Safety and Quality in Health Care.

Although economic outcomes are not more important than improved clinical outcomes, they are important to measure, especially at the beginning of a new program that is not yet established or funded. A recent review suggested the most likely outcomes associated with AMS programs are cost avoidance, a reduction in antimicrobial resistance rates and a decrease in CDI. Therefore, these are key minimum metrics to consider. This topic is further discussed in Chapter 5.

### 1.11 Specific antimicrobial stewardship strategies

Each AMS team should determine which AMS strategies are worth testing and how they could be implemented in their local context. These five strategies are considered essential for effective AMS in Australia:

1. Implementing clinical guidelines that are consistent with the latest version of *Therapeutic Guidelines: Antibiotic* and that take local microbiology and antimicrobial susceptibility patterns into account.
2. Establishing formulary restriction and approval systems that include restriction of broad-spectrum and later generation antimicrobials to patients in whom their use is clinically justified.
3. Reviewing antimicrobial prescribing with intervention and direct feedback to the prescriber. (This should, at a minimum, include intensive care patients.)

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4. Monitoring performance of antimicrobial prescribing by collecting and reporting unit or ward-specific usage data; auditing antimicrobial use; and using quality use of medicines indicators.

5. Ensuring the clinical microbiology laboratory uses selective reporting of susceptibility testing results that is consistent with hospital or antimicrobial treatment guidelines.

There are also other AMS activities that have been shown to be effective. We suggest that these are implemented according to local priorities and resources:

1. Educating prescribers, pharmacists and nurses about good antimicrobial prescribing practice and antimicrobial resistance.

2. Using point-of-care interventions including streamlining or de-escalation of therapy, dose optimisation or parenteral-to-oral conversion.

3. Using information technology such as electronic prescribing with clinical decision-support or online approval systems.

4. Publishing facility-specific antimicrobial susceptibility data annually.

Selected AMS strategies are briefly described in the following subsections with details included in subsequent chapters of this book.

1.11.1 Prescribing guidelines

Prescribing guidelines for antimicrobials are an essential component of AMS programs. Hospitals should have prescribing guidelines for treatment and prophylaxis for common infections relevant to the patient population, the local antimicrobial resistance profile and the surgical procedures performed in the institution. The *Therapeutic Guidelines: Antibiotic* are recognised as a national standard for antimicrobial prescribing in Australia.\(^2\) Institutional clinical guidelines developed for local use should accord with these guidelines. Guidance for switching from intravenous to oral therapy should also be available. The development and implementation of guidelines is discussed in more detail in Chapter 8.

The SACAR suggested list of ‘regimens’ serves as a guide to common clinical syndromes appropriate for local antimicrobial prescribing guidelines (see Box 3).

As a minimum, guidelines should be available for:

- common clinical scenarios
  - community acquired pneumonia
  - hospital acquired pneumonia
  - urinary tract infection
  - skin and soft tissue infection
  - intra-abdominal infection
  - bloodstream infections
  - sepsis
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- empirical use (all hospitals should specify use of *Therapeutic Guidelines: Antibiotic* for guidance on empirical use)
- surgical prophylaxis
- intravenous-to-oral antimicrobial switch.

**Box 3 United Kingdom Specialist Advisory Committee on Antimicrobial Resistance recommended guidelines**

**Treatment of:**
- urinary tract infections
- upper respiratory tract infections
- lower respiratory tract infections, including community and hospital acquired pneumonia, and exacerbations of chronic obstructive pulmonary disease
- soft tissue infections, including injuries or bites, cellulitis, chronic ulcers and necrotising fasciitis
- central nervous system infections, including bacterial meningitis, viral encephalitis
- gastrointestinal infections such as food poisoning and intra-abdominal sepsis
- genital tract infections
- bloodstream infections
- eye, ear, nose and throat infections
- sepsis of unknown origin
- specific confirmed infections; for example, treatment regimens for methicillin-resistant *Staphylococcus aureus*, *Clostridium difficile* and tuberculosis
- endocarditis.

**Prophylaxis use for:**
- prevention of bacterial endocarditis (procedure-specific criteria should be agreed upon to identify which patients should receive prophylaxis)
- endoscopic procedures (details should be given of which individuals, considered at high risk, should receive prophylaxis; for example, neutropenic patients)
- surgical procedures (recommendations should be made for all common surgical interventions, including timing of initial dose and exceptional circumstances for repeat doses)
- splenectomy patients (provide details of both the immunisation and antimicrobial prophylaxis requirements).

*Source: Specialist Advisory Committee on Antimicrobial Resistance (SACAR) Antimicrobial Framework*
See Chapters 6 and 8 for further information on guideline development and implementation. Examples of guidelines used in Australian hospitals are provided in Appendix 2.

1.11.2 Core antimicrobial stewardship interventions

The two core AMS strategies (formulary restriction and approval systems, or review with intervention and feedback) are described in Chapters 2 and 3. Table 1.1 compares key characteristics of these two approaches. They should be considered complementary and are both recommended as essential AMS elements.

An information technology system that supports these strategies is ideal, but there are many examples of effective AMS programs that have not had this advantage initially and that have been very successful.

1.11.3 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 is a small, straightforward set of three to five evidence-based practices that, when performed collectively and reliably, have been proven to improve patient outcomes. 38

Cooke and Holmes 39 propose the use of care bundles to improve appropriate antimicrobial prescribing in acute care and surgical prophylaxis. Inherent in the approach is a goal of engaging specific clinical teams (e.g. individual medical or surgical units). The approach they describe combines routine compliance monitoring and feedback, combining essential AMS strategies 1, 3 and 4 (Section 1.11). The two bundles (‘treatment’ and ‘surgical prophylaxis’) could be implemented separately or in combination, and AMS teams could adapt the focus of the proposed bundles to their local context.

Treatment bundle

The Cooke and Holmes treatment bundle 39 is divided into measurable practices that the authors suggest should take place at both initiation and at continuation of treatment. In this approach, compliance with these elements is monitored and used as targets for improved practice.

At initiation of treatment, the prescriber should:

• provide a clinical rationale for antimicrobial initiation
• send the appropriate specimens to a diagnostic microbiology laboratory (according to local policy)
• select the antimicrobial according to local policy and having considered the patient risk group (including their drug allergy profile)
• consider removal of any foreign body, drainage of pus or other surgical intervention, as appropriate.
## Table 1.1 Comparison of core antimicrobial stewardship interventions

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<th>Principles of intervention</th>
<th>Formulary restriction and approval systems</th>
<th>Review with intervention and feedback</th>
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<td><strong>Mandatory, requires:</strong></td>
<td>• action by prescribers to seek approval to prescribe</td>
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<td>• resources to support the approval process</td>
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<td><strong>Effect only at point of prescription (i.e. only initial choice and dose)</strong></td>
<td>Recommendations made after prescribing</td>
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<td><strong>Intervenes after antimicrobial prescribing, when there is greater opportunity for effect</strong></td>
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<td><strong>Review may be:</strong></td>
<td>• <em>prospective</em>, with direct feedback provided to the clinician before the drug is dispensed. This requires antimicrobial restrictions and pre-authorisation systems to be in place. It provides an opportunity for additional education as well as feedback on the episode of care</td>
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<td>• <em>retrospective</em>, after therapy has been initiated. Examples of retrospective recommendations include</td>
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<td>» discontinuing therapy after 2–3 days where no infective cause is found</td>
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<td>» changing from broad spectrum to narrow spectrum based on results</td>
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<th>Scope of intervention</th>
<th>Scope limited to what is on restricted list</th>
<th>Can adjust to resources available (e.g. twice weekly retrospective review) or target to needs or priorities (e.g. notifying pharmacy or biochemistry laboratory if gentamicin is used)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>As a minimum, prospective review and feedback should be provided for intensive care patients</td>
</tr>
<tr>
<td><strong>Time required by clinician and pharmacist to provide follow up</strong></td>
<td>Time required by clinician and pharmacist to provide follow up</td>
<td></td>
</tr>
<tr>
<td><strong>The retrospective approach is likely to be less resource-intensive, but may be less effective overall</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost of intervention</th>
<th>Cheaper to implement if use computerised or phone approval (but 24-hour coverage is necessary)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Possible risks of intervention</strong></td>
<td>Can delay administration if prior approval required</td>
</tr>
</tbody>
</table>
During continuation of treatment, there should be:

- daily consideration of de-escalation, intravenous–oral switch or stopping antimicrobials (based on clinical picture and laboratory results)
- monitoring of antimicrobial drug levels, as required by local policy.

Routinely measuring compliance with these six processes provides a measure of how well treatment policy is being adhered to, and directs attention for AMS team activity.

**Surgical prophylaxis bundle**

The proposed bundle is similar to that used in other surgical safety quality improvement programs and includes:

- selecting antimicrobials that match local guidelines (having considered patient allergies)
- timing the first dose to be 30–60 minutes pre-incision
- stopping antimicrobial administration within 24 hours after the pre-operative dose or the first dose after the operation.

Routinely measuring compliance with these three processes provides a measure of how well surgical prophylaxis policy is being adhered to, and directs attention for AMS team activity.

Hospitals using the care bundle approach to antimicrobial prescribing should develop systems to monitor compliance with the above practices in appropriate patient groups and provide regular feedback to prescribers. This could improve local prescribing of antimicrobials and provide ready access to process measures as quality improvement indicators. This may be a particularly attractive strategy for sites that could incorporate this into existing quality improvement infrastructure, or for smaller sites with limited AMS team resources that could use clinical teams to take ownership of the improvement work.

**1.11.4 Other antimicrobial stewardship strategies**

Other activities that are complementary to those outlined above that should be considered for inclusion in an AMS program are: education of prescribers, pharmacists and nurses; point-of-care interventions (such as streamlining or de-escalation of therapy, dose optimisation, and parenteral-to-oral conversion, often provided as part of prospective review and feedback strategy); the use of information technology (such as electronic prescribing with clinical decision-support or online approval systems); and annual publication of facility-specific antimicrobial susceptibility data.
1.11.5 Selecting antimicrobial stewardship strategies to test

Although we regard the strategies listed above as necessary elements of any AMS program, there is not one single AMS model that will deliver optimal antimicrobial prescribing in every context. In addition to selecting the strategies that have the best efficacy, the AMS team needs to consider which strategies are most likely to be successful in their specific context and how best to implement them. When making this decision, teams should consider attributes of changes that are more likely to be successfully spread and sustained in an organisation. Evidence from the work of Everett Rogers suggests that there are five attributes of ‘worthy’ ideas to consider for testing and implementation:

- relative advantage over the status quo or alternative ideas
- compatibility with existing values, experiences and needs
- relative simplicity (as complexity can inhibit an adopter’s ability to understand and use the ideas)
- ability to trial the idea locally, allowing ideas to be tested on a small scale and reversed if desired
- ability to observe the ideas in practice.

The information gathered during the readiness assessment (described in Section 1.8) could be used to determine the strategies to be tested and considered for implementation.

A program demonstrating some success in the short term (i.e. ‘quick wins’) is more likely to be well regarded, and gain acceptance and support. The major short-term benefits of AMS are overall cost savings and, if existing infrastructure and resources are very limited, AMS teams may want to start with targeting specific high-cost drugs that have suboptimal local use. Pharmacy costing data, comparative-use rates or a baseline audit of the appropriateness of antimicrobial use will provide a guide to local priorities. Common examples of such high-cost drugs are IV quinolones, carbapenems (such as meropenem) and aztreonam. Third-generation cephalosporins are another important target group, but demonstrable cost savings for this drug class may be less. Other low-cost but high-risk agents (e.g. aminoglycosides) can be included for safety reasons. Patients that receive these agents can be reviewed with feedback to prescribers providing an opportunity to intervene in a timely and ongoing manner. The review can be used to provide education and to gather additional information about intended versus actual use to demonstrate savings and improvement.

An example of a successful AMS program that uses such a strategy is described in Box 4.
Box 4 An example of a successful Australian antimicrobial stewardship (AMS) program

Context for AMS program

- 800-bed, metropolitan teaching hospital
- an existing restricted formulary that required prior approval from a microbiologist or an infectious diseases (ID) physician to use selected antimicrobials
- an existing drug and therapeutics committee, drug use and audit group, and an infection control committee
- existing data (collected as part of an international collaborative study) demonstrating high antibiotic use rates; cost of antimicrobials steadily increasing each year; recent outbreaks of vancomycin-resistant Enterococcus and methicillin-resistant Staphylococcus aureus; and previous surveys of surgical antibiotic prophylaxis showing suboptimal compliance
- a history of difficulty in introducing and supporting clinical information technology systems
- some local clinical guidelines developed and promoted, widespread availability of Therapeutic Guidelines: Antibiotic\(^{19}\)
- book and electronic resources
- a clinical pharmacist on staff with overseas experience in AMS.

The team

A team for AMS implementation was proposed:

- The hospital executive was presented with evidence of suboptimal antimicrobial use and high cost. This lead to a request to appoint a clinical pharmacist 2.5 days a week for six months to work with a nominated ID physician to lead an AMS program with continuation contingent on proof of savings.
- An AMS committee was formed and reported to the drug and therapeutics committee. The committee comprised an ID physician (nominated by the committee as chair), an ID pharmacist (secretary) and representatives from the infection control, drug use and assessment group; a hospital executive; and two more physicians (an intensivist and a nephrologist).
Box 4  An example of a successful Australian antimicrobial stewardship (AMS) program continued

The strategies

The strategies developed to implement the AMS program included:

• **restrictive strategies**
  » continuing to use the restricted antimicrobial formulary
  » using a locally designed Microsoft Access database to directly enter details of patients for whom permission has been given for prescription of key restricted antibiotics (carbapenems, intravenous quinolones, vancomycin, and third or fourth-generation cephalosporins)
  » notifying the ID pharmacist of patients receiving restricted antibiotics
  » generating a list 3–5 days each week of all patients receiving restricted agents to be seen on the AMS round (list generated by the ID pharmacist)

• **review and feedback**
  » commencing AMS rounds as a means of prospective review, intervention and feedback
  » reviewing the clinical notes, results of microbiology and other investigations of patients on restricted antimicrobials (aiming to review within two days of start date) and recommending (in writing) in the integrated notes or by direct phone call to the treating doctor (to be done by the ID physician and pharmacist)

• **prescribing guidelines**
  » developing more local clinical treatment and management guidelines

• **monitoring performance of the AMS program**
  » auditing compliance with community acquired pneumonia protocol, surgical antibiotic prophylaxis and gentamicin use
  » participating in the National Antimicrobial Utilisation Surveillance Program (NAUSP) to monitor antimicrobial use

• **other strategies**
  » promoting further antimicrobial prescribing education
  » lobbying for the microbiology laboratory to provide local antibiogram data
  » investigating the introduction of a computerised decision-support program.
Box 4  An example of a successful Australian antimicrobial stewardship (AMS) program continued

Results of the AMS program

- In the first six months of the AMS round in 2005, 273 patients were reviewed and 87% of the recommendations made were followed, resulting in estimated savings of $85 000. Only one complaint from a prescriber has been received in the four years of the AMS program, during which time the antimicrobial treatment of over 2000 patients has been reviewed.

- The success of the program and demonstrated cost savings resulted in the creation of a permanent full-time position for an ID pharmacist. This increased capacity allowed the program to expand to include an ongoing intravenous–oral switch campaign, the development of a number of clinical guidelines, increased compliance auditing, and improved prescriber and pharmacist education.

- Thus far, any attempts to introduce computerised decision support have been unsuccessful.

- The round has provided a dynamic and efficient mechanism to respond to emerging issues. For example, as a result of concerns about adverse events from aminoglycoside use, patients receiving more than four days of aminoglycosides were added to the AMS round, as were all inpatients with *Staphylococcus aureus* infection.

The size and elements of an AMS program will need to be scaled to meet hospital requirements and resources. The program should also be expected to evolve over time, depending on the results of testing, evaluation and ongoing monitoring of key metrics. A principal referral hospital will benefit from a comprehensive program with multiple strategies supported by a pharmacist (ideally with ID training), and an ID physician or clinical microbiologist. Smaller hospitals, with few resources, may need to prioritise their activities, but can still effect cost savings and improved use of antimicrobials. LaRocco described an AMS team led by an ID physician (8–12 hours per week) and a clinical pharmacist performing review and feedback in a 120-bed nonteaching hospital, effecting a 19% reduction in antimicrobial costs.

Some examples of the types of strategies employed in successful AMS programs overseas and in Australia are provided in Table 1.2. Other examples of outcomes of Australian AMS programs are provided in Appendix 1.
Table 1.2  Examples of strategies employed in successful antimicrobial stewardship programs

<table>
<thead>
<tr>
<th>Country</th>
<th>Size of hospital</th>
<th>Strategy</th>
</tr>
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</table>
| United States | Large teaching hospital | Goals in the first year were to:  
• create a formulary pocket guide  
• begin prospective review with feedback and intervention  
• optimise dosing  
• reduce unnecessary combination therapy  
• switch from IV to oral therapy. |
| United States | Medium-sized community hospital | Prospective review with feedback on:  
• discontinuing therapy after 2–3 days where no infective cause found  
• changing from broad spectrum to narrow spectrum based on results  
• switching from IV to oral therapy  
Pharmacy Committee-based formulary management  
Automatic stop orders after 7 days  
Limited reporting of susceptibility testing  
Ongoing education programs for residents and staff physicians  
Exclusion of pharmaceutical industry representative detailing antimicrobials in the hospital |
| United States | Large teaching hospital | Guidelines for antimicrobial treatment and prophylaxis  
Establishing appropriate dosing and dosage intervals  
Restriction and prior approval systems  
Evaluation of agents for addition or deletion to formulary  
Streamlining therapy  
Ongoing education initiatives  
Continuous monitoring of antimicrobial use |
| Australia | Large, tertiary teaching hospital | Local antimicrobial guidelines with clinical teams engaged in development and implementation  
Online registration (approval) system for broad-spectrum agents  
Twice-weekly ID and microbiology rounds in ICU  
Regular targeted drug usage evaluations and audits of antimicrobial use, clinical syndromes or surgical prophylaxis with feedback to clinicians  
Use of data contributed to the National Antimicrobial Utilisation Surveillance Program to monitor use and benchmark against similar hospitals |

ICU = intensive care unit; ID = infectious diseases; IV = intravenous
1.12 Testing antimicrobial stewardship strategies

Testing in quality improvement work allows unforeseen problems to be resolved, and interventions to be evaluated and refined before full implementation into widespread day-to-day operations. In general, testing should follow a sequence of Plan-Do-Study-Act (PDSA) cycles. Each sequence should increase in scope and scale, and be analysed, allowing subsequent tests to be refined.\(^{27-28}\)

For example, a hospital AMS team decides to introduce a restricted antimicrobial formulary, with required prior phone approval from an ID physician before selected agents are dispensed. They would be wise to initially test the approval and dispensing process in a range of conditions. For example, they could work with one cooperative prescriber to see if the process works well at different times of the day, on weekends, and when different dispensing pharmacists or ID physicians are on duty. After making any necessary refinements, the team could then plan on including all respiratory patients, then all medical patients and so on.

1.13 Implementing and sustaining successful antimicrobial stewardship programs

Once changes have been developed and tested, it is time to implement the changes on the basis of what was learned. Implementing complex broad-scale changes, such as AMS strategies, is challenging and will benefit from careful planning, providing support during and after implementation, and recognising and addressing social aspects of change.

An implementation plan should consider approaches to standardisation, training, and ongoing measurement and feedback. These elements all support making changes that are permanent in an organisation.\(^{27}\)

The social aspects of change should not be underestimated — AMS interventions may be perceived differently by different healthcare professionals. For example, introducing a prior approval system could be perceived as restricting prescriber autonomy, adding work to ID physicians or placing pharmacists in a position of potential confrontation if asked to enforce restrictions. Resistance to change can be minimised by communicating why change is required, providing information on how the change will occur, and reporting ongoing progress to affected individuals and groups. Incorporating a range of individuals and perspectives in the planning and testing phase will also be helpful.\(^{27}\)

An example of an organisation’s approach to implement a stewardship program is provided in Table 1.3. The plan was developed by staff at the North Coast Area Health Service in New South Wales (a regional health service comprising 18 hospitals).
## Table 1.3 North Coast Area Health Service culture change initiatives

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<tr>
<td>Advocate prescriber compliance with the MINDME philosophy, as recommended by NSW Health through email and poster placement in all wards and pharmacies M microbiology guides therapy wherever possible I indications should be evidence based N narrowest spectrum required D dosage appropriate to the site and type of infection M minimise duration of therapy E ensure monotherapy in most cases</td>
<td>Ensure optimal pharmacy staffing Remove ceftriaxone from ward stock Provide training in ID for one clinical pharmacist from each B2 hospital Develop a program of parenteral-to-oral antibiotic prescribing Provide feedback to prescribers via antibiograms Commence recording antimicrobial consumption rates Conduct regular drug use studies and regular AHS microbial audits Ensure optimal infection control staffing Employ an AHS ID physician or clinical microbiologist (ideally, an ID physician at each B2 hospital)</td>
<td>Engage AHS DTC to make appropriate antimicrobial prescribing a priority. AHS DTC to draft an area antimicrobial prescribing policy that includes: • (initial) empowering clinical pharmacists with ID training to change certain antimicrobials from parenteral-to-oral administration • (initial) specifying antimicrobials that require monitoring • (initial) developing and supporting AMS programs at each B2 hospital • (ongoing) monitoring compliance with area policy; assessing effectiveness of interventions with regular audit • (ongoing) reviewing specified antimicrobials that require annual monitoring to reflect antimicrobial consumption rates</td>
<td>Regularly remind prescribers that the most recent version of the <em>Therapeutic Guidelines: Antibiotic</em> can be accessed through the intranet of every ward of the B2 hospitals Engage the National Prescribing Service to provide education and quality assurance programs Engage the NSW TAG to share resources regarding strategies to improve antimicrobial prescribing Use AMS development guidelines outlined by IDSA and SHEA to tailor area-wide programs</td>
<td>Recruit respected educators (i.e. clinical pharmacists, ID physicians) Increase prescriber awareness through education about the benefits of judicious antimicrobial prescribing and the serious consequences of inappropriate prescribing Invite prescribers to provide input into the development of AMS programs prior to implementation to promote ownership through involvement Cultivate opinion leaders (if there is no ID physician at each site, administrators need to engage medical staff to find opinion leaders willing to drive change)</td>
<td>Continue to improve infection control processes to reduce the spread of multiresistant organisms by ensuring compliance with NSW Health strategies to reduce HAIs Invest in rapid diagnostic testing for multiresistant organisms as this will allow more rapid intervention of infection control measures to prevent secondary spread</td>
<td></td>
</tr>
</tbody>
</table>

AHS = Area Health Service; AMS = antimicrobial stewardship; B2 = large regional and remote hospitals; DTC = drug and therapeutics committee; HAI = healthcare associated infection; ID = infectious diseases; IDSA = Infectious Diseases Society of America; NSW = New South Wales; NSW TAG = NSW Therapeutic Advisory Group; SHEA = Society for Healthcare Epidemiology of America

1.14 Summarising requirements for antimicrobial stewardship programs

The elements of hospital AMS programs are well described in the literature and have been used to formulate the key recommendations of this chapter.\textsuperscript{1, 12, 15-17} Minimum AMS measures have been developed,\textsuperscript{16} and evidence-based guidelines\textsuperscript{1} and recommendations for good antimicrobial practice in hospitals published.\textsuperscript{17, 18} The most comprehensive guidelines for developing a hospital AMS program have been published by the Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America.\textsuperscript{1}

This work, along with the evidence from the Cochrane Collaboration review of interventions for improving antimicrobial prescribing practice in hospitals\textsuperscript{22} has been used to develop requirements for AMS programs in Australian hospitals, summarised in Box 5.

\begin{tabular}{|l|}
\hline
\textbf{Box 5 Requirements for antimicrobial stewardship programs} \\
\hline
\end{tabular}

\begin{tabular}{|l|}
\hline
\textbf{Structure and governance} \\
\hline
The overall accountability for antimicrobial management control lies with the hospital administration. They are responsible for ensuring an antimicrobial management program is developed and implemented, and outcomes are evaluated. Hospital management support is needed, including:
\begin{itemize}
\item providing dedicated resources for stewardship activities, education, and measuring and monitoring antimicrobial use
\item establishing a multidisciplinary antimicrobial stewardship (AMS) team with core membership (wherever possible) of either an infectious diseases physician, clinical microbiologist or nominated clinician (lead doctor), and a clinical pharmacist
\item ensuring that AMS resides within the hospital’s quality improvement and patient safety governance structure, and clear lines of accountability exist between the chief executive; clinical governance; drug and therapeutics, and infection prevention and control committees; and the AMS team.
\end{itemize}
\hline
\end{tabular}
Box 5  Requirements for antimicrobial stewardship programs  

continued

Essential strategies for all hospitals

The following five strategies are considered essential for effective AMS in Australia:

• implementing clinical guidelines that are consistent with the latest version of Therapeutic Guidelines: Antibiotic, 19 and which take into account local microbiology and antimicrobial susceptibility patterns

• establishing 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 — this should, at a minimum, include intensive care patients

• monitoring performance of antimicrobial prescribing by collecting and reporting unit or ward-specific use data, auditing antimicrobial use, and using quality use of medicines indicators

• ensuring the clinical microbiology laboratory uses selective reporting of susceptibility testing results that is consistent with hospital antimicrobial treatment guidelines.

Antimicrobial stewardship activities according to local priorities and resources

The following activities may be undertaken according to local priorities and available resources:

• educating prescribers, pharmacists and nurses about good antimicrobial prescribing practice and antimicrobial resistance

• using point-of-care interventions, including streamlining or de-escalation of therapy, dose optimisation, or parenteral-to-oral conversion

• using information technology such as electronic prescribing with clinical decision-support or online approval systems

• annually publishing facility-specific antimicrobial susceptibility data.