# 6 Measuring performance and evaluating antimicrobial stewardship programs

# Antimicrobial Stewardship in Australian Health Care

2018

Please note that revised antimicrobial stewardship actions are included in the Preventing and Controlling Infections Standard, which was released in May 2021. This version of the Standard supersedes the 2017 Preventing and Controlling Healthcare-Associated Infection Standard. The AMS Book will be updated to incorporate reference to the 2021 Standard.

# Chapter contents

# 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 |

Chapter 6: Measuring performance and evaluating antimicrobial stewardship programs

## 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?<br>• 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?<br>• Are they effective? | • Rates and volume of antimicrobial prescribing over time<br>• Rates of general practice visits, emergency visits or admissions for specific conditions<br>• Compliance with prescribing guidelines<br>• Compliance with antimicrobial restriction conditions<br>• Assessment of surgical prophylaxis given for >24 hours<br>• Assessment of appropriateness of prescribing<br>• Assessment of adequacy of documentation of indication for antimicrobial therapy<br>• 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)<br>• Surveillance of antimicrobial resistance (e.g. using cumulative antibiogram)<br>• 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)<br>• Incidence of allergic reactions<br>• Infection-related mortality<br>• Infection-related readmission in 28 days<br>• Rates of surgical site infection |

Source: Adapted from Nathwani and Sneddon[1]

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## 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
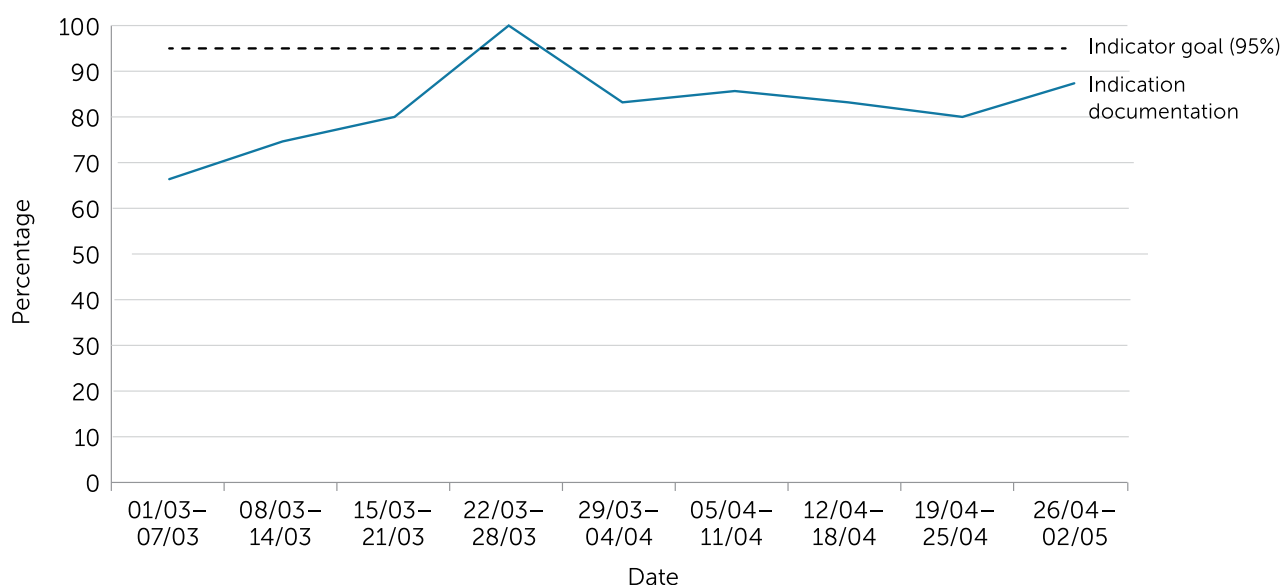


Source: NSW Clinical Excellence Commission[8]

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

**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<br>• Percentage of prescriptions for restricted antimicrobials that are concordant with drug and therapeutics committee–approved criteria<br>• Percentage of patients in whom doses of empirical aminoglycoside therapy are continued beyond 48 hours<br>• Percentage of adult patients with community-acquired pneumonia who are assessed using an appropriate validated objective measurement of pneumonia severity<br>• 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%)<br>• Surgical prophylaxis given for >24 hours (best practice <5%)<br>• Compliance with guidelines<br>• 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<br>• Antibiotic prescribing in accordance with current and peer-reviewed clinical guidelines<br>• Antibiotic allergy mismatch in prescribing<br>• Documentation of reason for prescribing antibiotics<br>• Review of patients prescribed broad-spectrum antibiotics<br>• Surgical antimicrobial prophylaxis in accordance with guidelines<br>• Timely administration of prophylactic antibiotics before surgery<br>• 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.
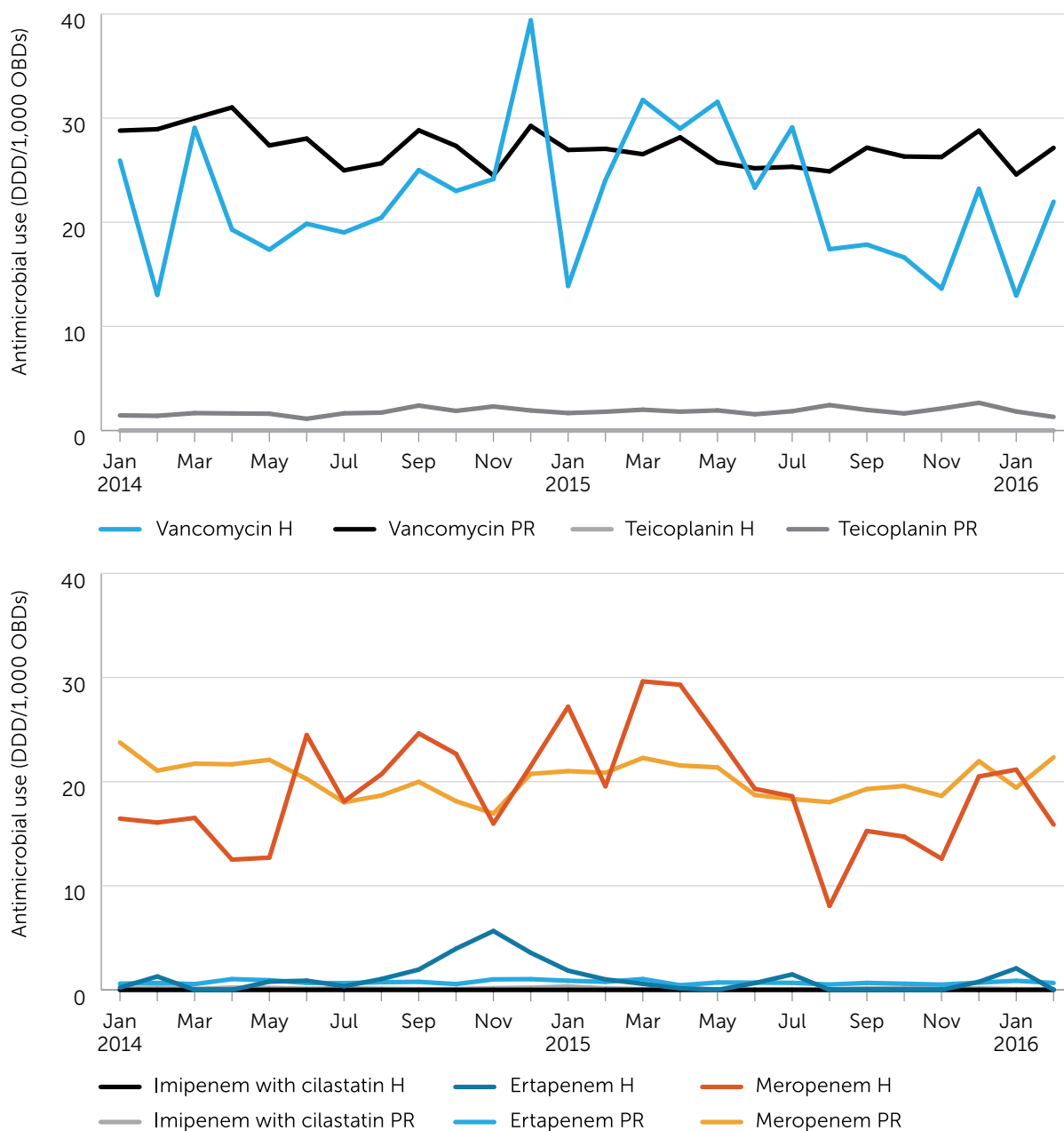
Hospitals choosing to calculate their total or ward-level antimicrobial consumption figures can use the AMC Tool: the antimicrobial consumption tool, which converts numbers of packages or vials into numbers of DDDs.

#### 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)



Vancomycin H  Vancomycin PR  Teicoplanin H  Teicoplanin PR



Imipenem with cilastatin H  Ertapenem H  Meropenem H
Imipenem with cilastatin PR  Ertapenem PR  Meropenem PR

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
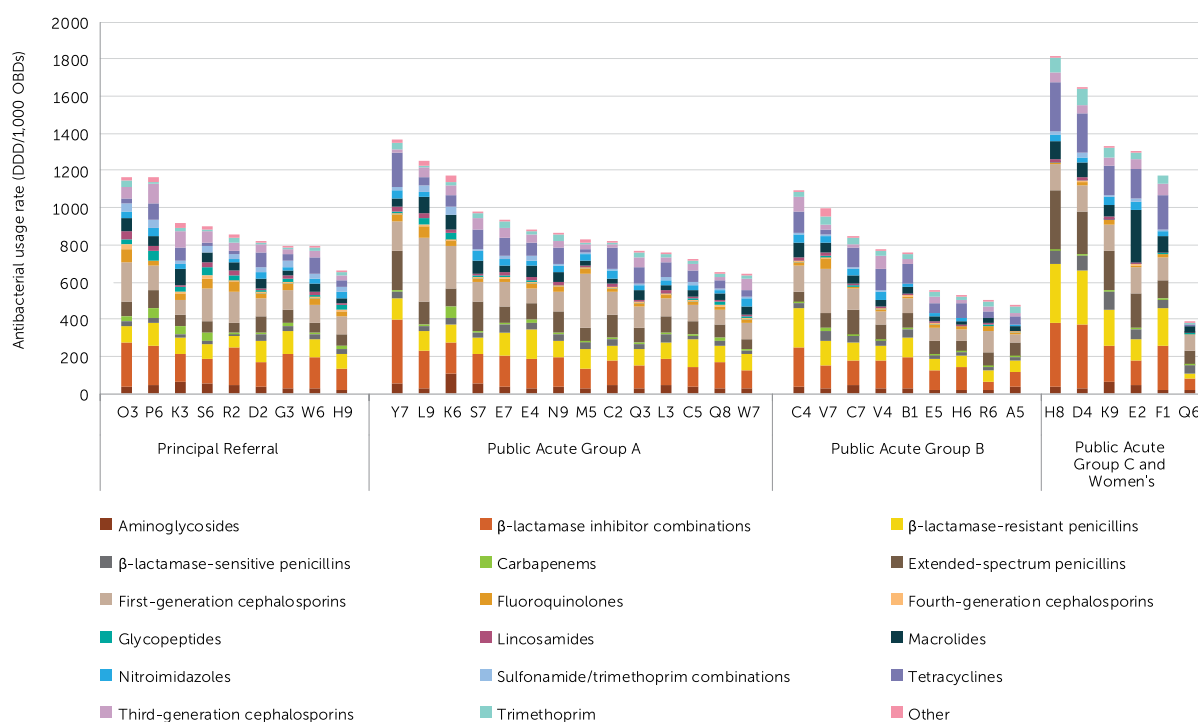


DDD = defined daily dose; OBD = occupied bed day
Note: Private hospitals are included in the Principal Referral, Public Acute Group A and Public Acute Group B Hospital peer groups.
Source: Australian Commission on Safety and Quality in Health Care[50]

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
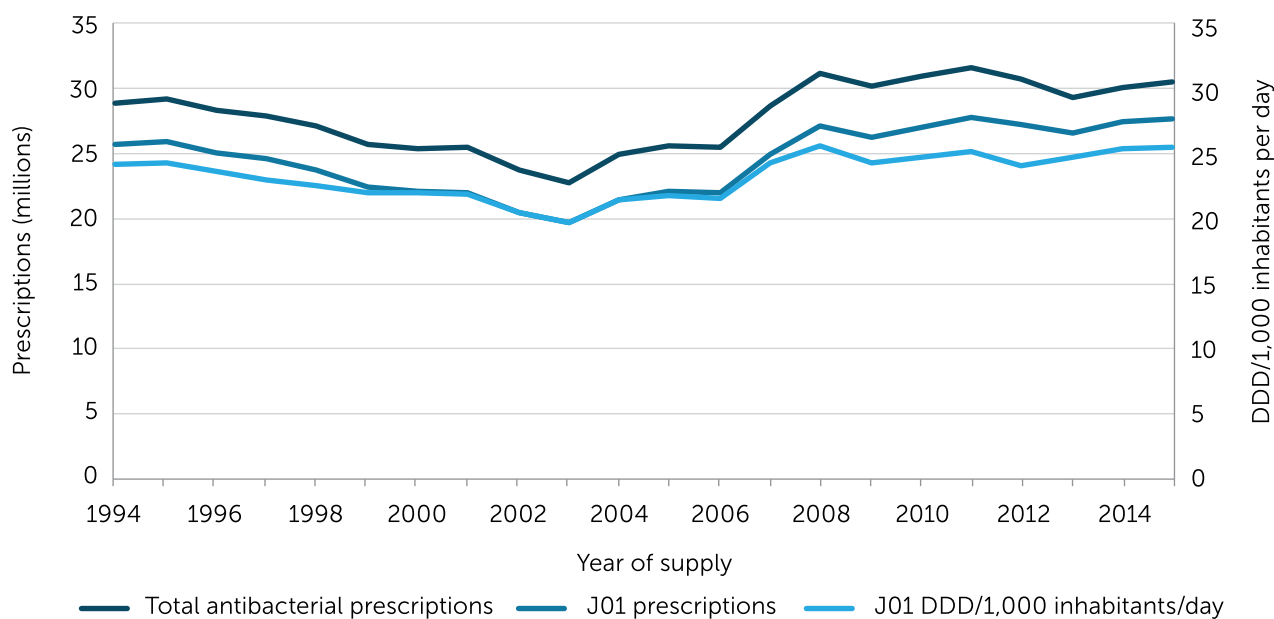


DDD = defined daily dose

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
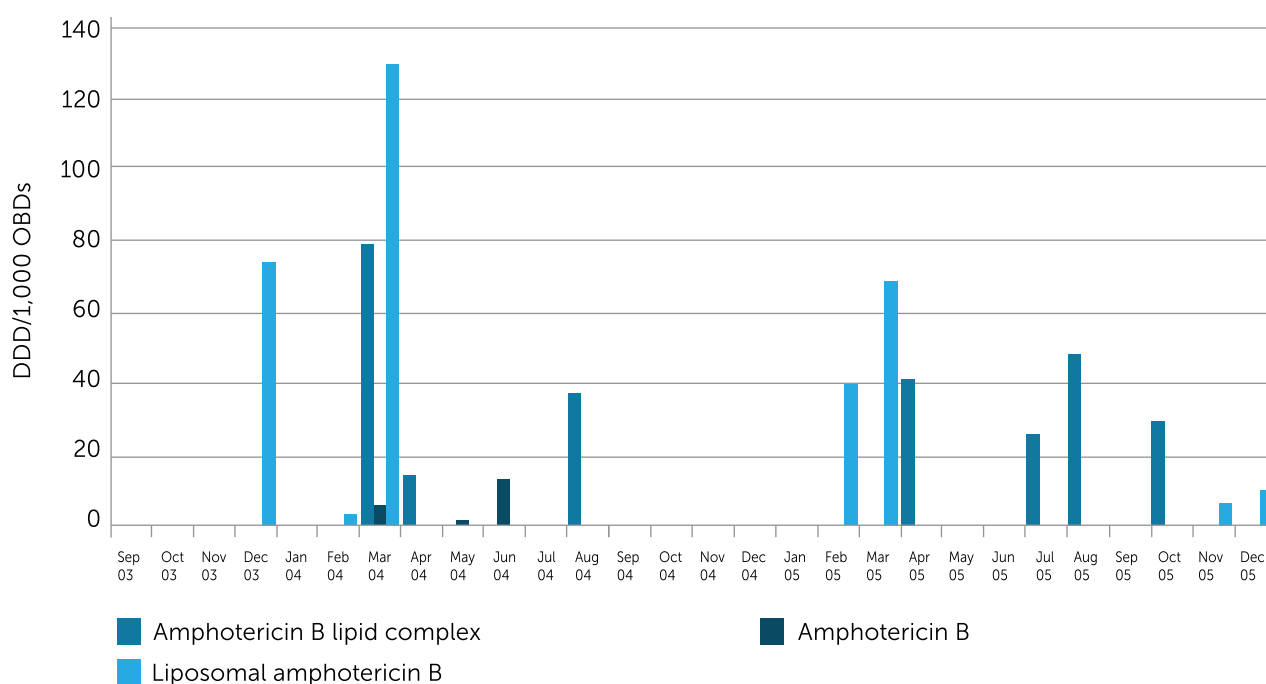


DDD = defined daily dose; OBD = occupied bed day
Source: D Looke, Princess Alexandra Hospital, Queensland

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.
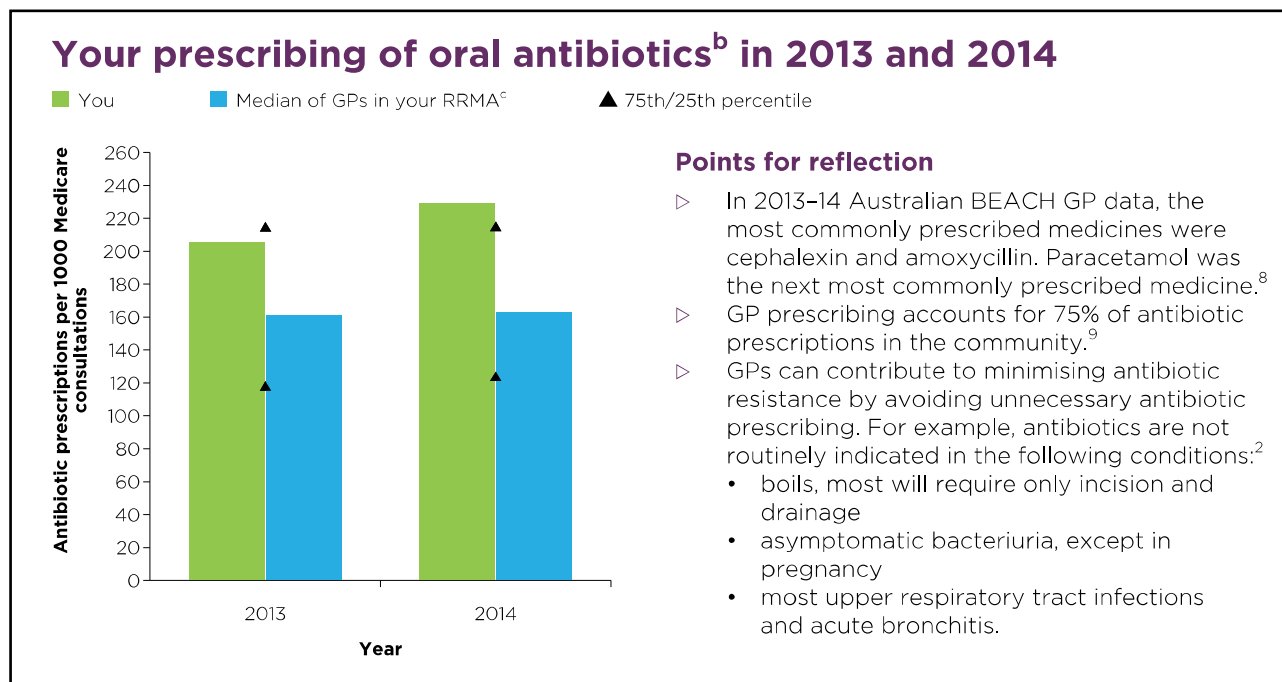
**Figure 6.6:** Use of third-generation cephalosporins in a 150-bed hospital before and after the appointment of an antimicrobial stewardship pharmacist, January 2012 to June 2016
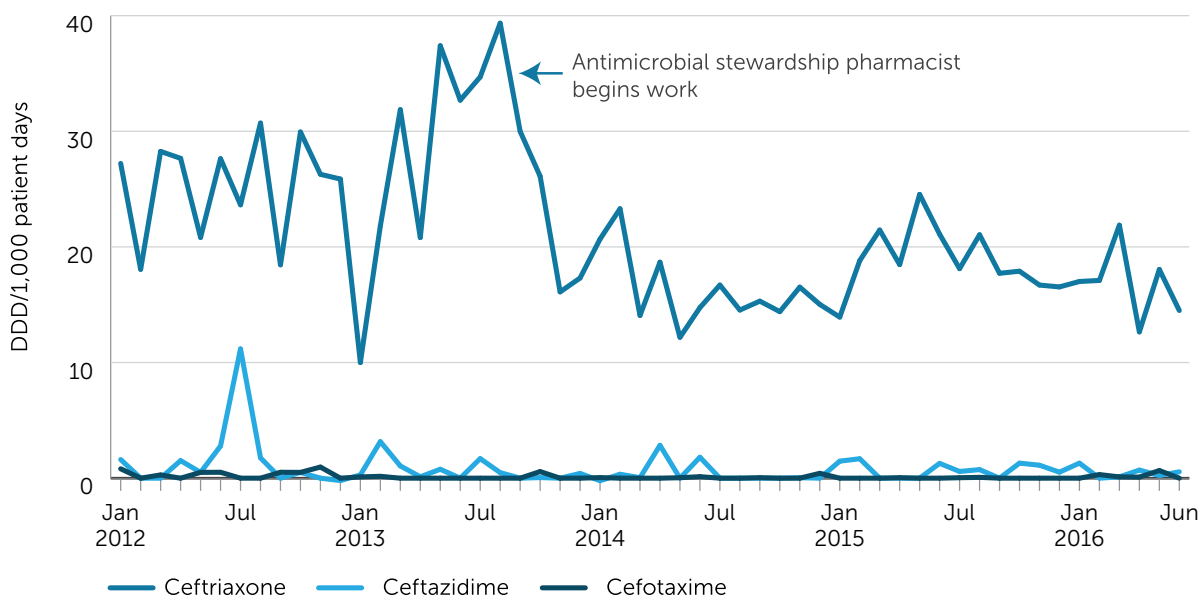


DDD = defined daily dose
Source: L Davis, Communicable Diseases Unit, Queensland Health; D Looke, Princess Alexandra Hospital, Queensland

**Figure 6.7:** Example of individual prescriber feedback in the MedicineInsight program



## Your prescribing of oral antibiotics[b] in 2013 and 2014

■ You    ■ Median of GPs in your RRMA[c]    ▲ 75th/25th percentile

**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.

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]

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P

### 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 | | | Percentage change from 2014 to 2015 | |
|---|---|---|---|---|---|---|
| | | 2013 | 2014 | 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

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

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.

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
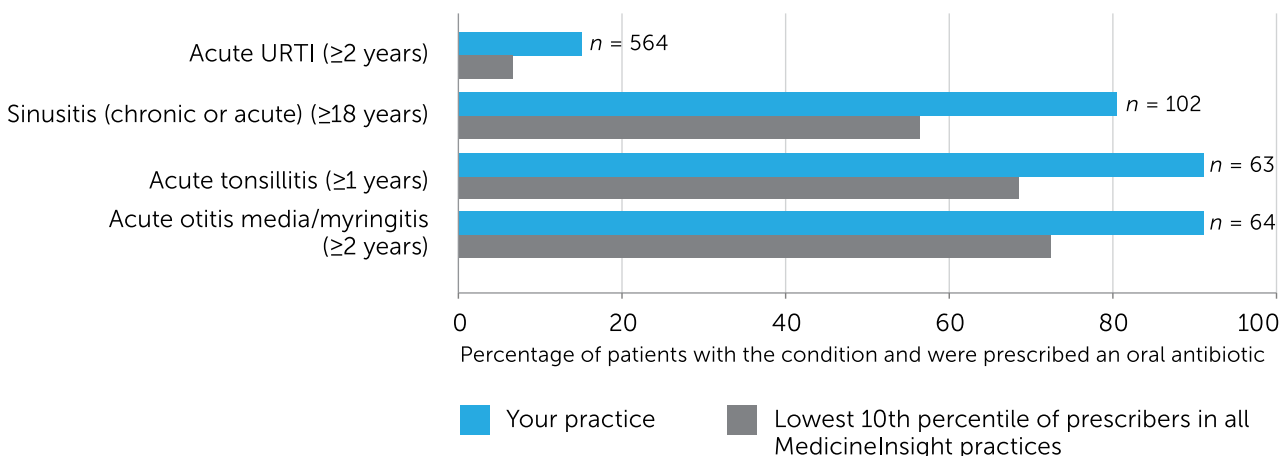


URTI = upper respiratory tract infection
Source: NPS MedicineWise[63]

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.

### 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.

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**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<br>• Provision of advice on symptomatic management |
| Antimicrobial use | • Use of a recommended antimicrobial, dose, frequency and duration where antimicrobial therapy is recommended<br>• 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<br>• Use of a recommended dose and frequency where a recommended antimicrobial is prescribed<br>• Use of the recommended duration of therapy where a recommended antimicrobial is prescribed<br>• 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<br>• Use of a recommended dose and frequency where a recommended antimicrobial is prescribed<br>• Use of the recommended duration of therapy where a recommended antimicrobial is prescribed<br>• 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<br>• Use of a recommended dose and frequency where a recommended antimicrobial is prescribed<br>• Use of the recommended duration of therapy where a recommended antimicrobial is prescribed<br>• 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<br>• Develop and revise guidelines<br>• Inform public health priorities<br>• Inform regulatory decisions<br>• Coordinate, where necessary, the response to critical antimicrobial resistances | • Coordinated and integrated efforts across Australia<br>• Increased awareness of antimicrobial resistance and the One Health approach* |
| State and territory | • Inform policy and program development<br>• Develop and revise guidelines<br>• Inform public health priorities<br>• Inform regulatory decisions<br>• Detect and respond to critical antimicrobial resistances and outbreaks | • Improved knowledge of local antimicrobial resistance profiles<br>• Timely response to emerging resistance<br>• Appropriate and effective use of antimicrobials |
| Healthcare services | • Inform clinical practice<br>• Inform policy development<br>• Develop local strategies to improve antimicrobial stewardship<br>• Detect and respond to outbreaks of resistant organisms | • Appropriate and effective use of antimicrobials<br>• Improved capacity for timely response to emerging resistance |
| Individual | • Raise awareness of appropriate use in the community | • Appropriate use of antimicrobials as prescribed<br>• 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*

## 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

- Royal College of General Practitioners: TARGET Antibiotic Toolkit

## 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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