Safer use of antimicrobials in hospitals: the value of antimicrobial usage data

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ABSTRACT

- The National Antimicrobial Utilisation Surveillance Program (NAUSP) collects aggregate data from hospitals in all Australian states and provides reports of monthly hospital inpatient antimicrobial usage to contributing hospitals.
- These data provide an Australian peer-group benchmark; hospitals can compare their usage with similar hospitals and identify areas of antimicrobial use that require more indepth analysis.
- Overall high usage has been used by hospitals and area health services as a stimulus for initiation or expansion of antimicrobial stewardship programs.
- High use of particular classes of antimicrobials has triggered individual drug audits and been used to tailor interventions.
- Longitudinal antimicrobial usage data have been used by hospitals to measure the effects of antimicrobial stewardship strategies and provide feedback to prescribers.

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Antimicrobial resistance is a major threat to the great advances in treatment of infectious diseases over the past 40 years.[1] The relationship between antimicrobials and resistant organisms is complex, encompassing selection and dissemination of resistance determinants between humans and bacterial hosts. Despite difficulties in proving a cause–effect relationship, there is good evidence that overuse and inappropriate use of antimicrobials lead to emergence and dissemination of resistant organisms, with studies showing that resistance rises with increased antimicrobial use and falls after reduced use.[1-3] Patients with infections due to resistant bacteria have poorer outcomes, experiencing delayed recovery, treatment failure and even death.[4] Inappropriate use of antimicrobials also increases the risk of patient harm from adverse effects such as *Clostridium difficile* infection, and increases costs to health care and society. Prudent use of antimicrobials is considered central to the control of resistance, and active surveillance of antimicrobial usage is paramount.

Changing antimicrobial use in hospitals is complex and challenging and requires an organised approach, such as an antimicrobial management program, also termed antimicrobial stewardship (AMS). AMS involves a systematic approach to optimising antimicrobial use. Successful hospital AMS programs have been shown to improve the appropriateness of antimicrobial use, and to reduce institutional resistance rates and, in turn, morbidity and mortality.[5-10] Together with infection control, hand hygiene and surveillance, AMS is considered a key strategy in local and national programs to decrease preventable health care-associated infections. When supported by hospital management, a decrease in inappropriate use, improved patient outcomes and savings in health care costs can be achieved.[5,6,8,9]

Hospital AMS programs include a range of different interventions aimed at improving antimicrobial prescribing. One of the essential components of an AMS program is monitoring antimicrobial usage[11] to:

- identify trends in prescribing that require further investigation through targeted audits;
- measure the effect of stewardship activities, including cost savings; and
- provide feedback to prescribers (one of the most effective interventions to influence prescribing behaviour).

The monitoring of antimicrobial usage is also critical to understanding antimicrobial resistance by linking patterns of usage with the emergence of resistant organisms. Box 1 provides an example of the temporal relationship between the prevalence of methicillin-resistant *Staphylococcus aureus* (MRSA) and the use of antimicrobial agents known to induce methicillin resistance.

Antimicrobial usage data

There are two main methods of antimicrobial data collection: patient-level surveillance and population surveillance.[13]

Patient-level surveillance involves collecting data about the dosage and duration of therapy for individual patients. This approach gives the most accurate information, particularly if the aim is to link excessive antimicrobial use with development of resistance in a particular area of practice.

Population-level surveillance data are aggregated antimicrobial use data. The data are generally derived from the volume of antimicrobial agents issued to wards and clinical units or from individual patient prescription data from pharmacy reports summarised at the level of a hospital or unit. Although not as accurate as patient-level surveillance, population-level surveillance is currently the only realistic option for ongoing, systematic monitoring of antimicrobial use.

Comprehensive data at individual patient level are not available from most hospitals in Australia, and aggregate data from issues to wards combined with individual patient dispensing records are most commonly used.[1] Here, we discuss how population surveillance data can be used to drive safety and quality improvement in hospital practice.

National antimicrobial usage surveillance

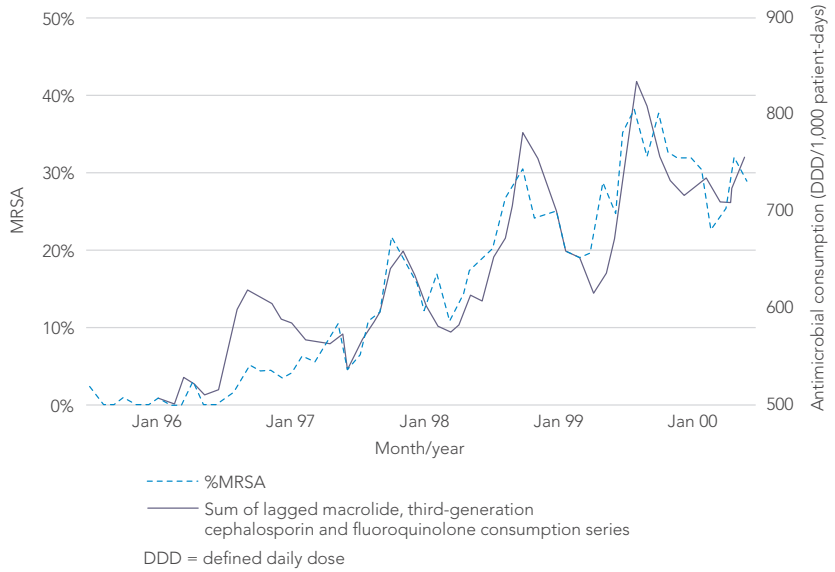
The National Antimicrobial Utilisation Surveillance Program (NAUSP) collects aggregate data from hospitals in all Australian states and territories and provides monthly reports of hospital inpatient antimicrobial usage to contributing hospitals, and to the Australian Government Department of Health and Ageing on a bimonthly basis. The NAUSP commenced in 2004 and currently collects data from 29 major public hospitals (from all states except Queensland) and two major private hospitals, representing approximately 60% of Australian tertiary referral beds. Separate usage rates are currently reported for intensive care units (ICUs) from 25 of these hospitals. The density of antimicrobial use within specialised units such as ICUs is several-fold higher than in other hospital

settings. This increased use has been shown to generate high rates of antimicrobial resistance and is a particular focus for surveillance and intervention.

How antimicrobial usage data contributes to patient safety and quality

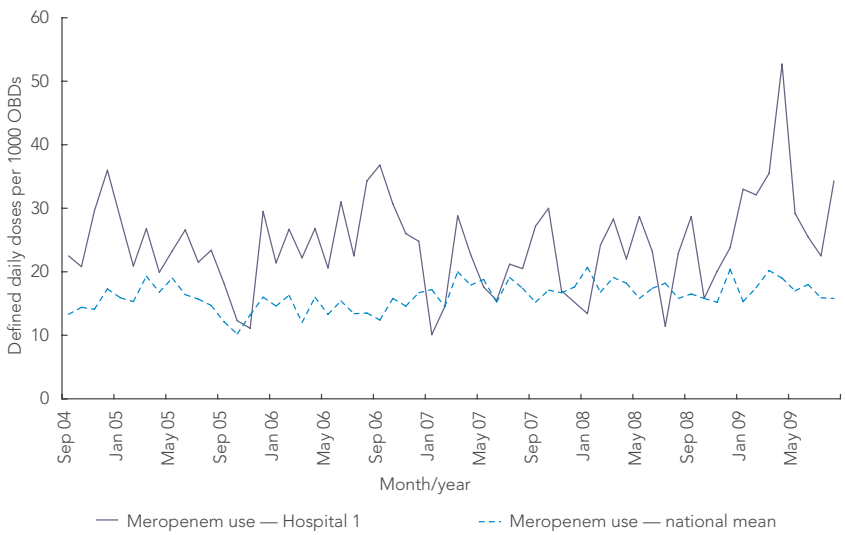
Surveillance data on antimicrobial usage provide information for determining the impact of usage patterns on bacterial resistance. Such data are also important for supporting containment strategies, such as AMS programs. Antimicrobial usage data can be used to guide safety and quality improvements at the local level by a hospital or health service, and can provide useful information at state and national levels.

1 Monthly rates of methicillin-resistant *Staphylococcus aureus* (MRSA) infection and monthly antimicrobial use, Aberdeen Royal Infirmary, Scotland, January 1996 – December 2000[12]



DDD = defined daily dose

2 Meropenem use in a non-intensive care unit setting (Case study 1)



OBD = occupied bed-days. ◆

Data related to antimicrobial use in hospitals have been used to promote positive health outcomes in several ways. Firstly, by providing an Australian peer-group benchmark, hospitals can compare their usage with similar hospitals and identify areas of antimicrobial use that require more indepth analysis. Overall high usage has been used by hospitals and area health services as a stimulus for initiation or expansion of AMS programs. High use of particular classes of antimicrobials has triggered individual drug audits and been used to tailor interventions. Secondly, longitudinal antimicrobial usage data has been used by hospitals to measure the effects of AMS strategies and provide feedback to prescribers.

Use of data by hospitals

Local-level data can be used to:

- provide regular feedback enabling institutions to examine their antimicrobial usage rates over time and to target areas of high antimicrobial usage for local intervention programs (see Case study 1 and Case study 2); and
- initiate and evaluate the effect of programs in addressing the incidence of resistant organisms and associated patient morbidity, mortality and health care costs (see Case study 3 and Case study 4).

Use of data to target antimicrobial stewardship interventions

Case study 1 demonstrates how antimicrobial usage data revealed a high usage of the broad spectrum antimicrobial meropenem compared with the mean of reporting hospitals. A targeted review of usage was undertaken with subsequent interventions, including dosing optimisation.

Case study 1

A 600-bed teaching hospital established an AMS program in 2003. Data have been contributed to the NAUSP since July 2004 and its usage of antimicrobials compared with similar hospitals. High comparative meropenem usage was noted in 2006. This stimulated a point prevalence study of the use of meropenem in late 2006 in an effort to determine reasons for higher than peer-group usage. A lower dosing regimen was encouraged and usage monitored.

In early 2009, the meropenem usage rate more than doubled, triggering a second point prevalence study. This study identified an increase in the number of patients in unstable or septic conditions being treated; these comprised 70% of cases in 2009, compared with 24% in the 2006 study. Use outside of restrictions was very low in both studies. The dosing campaign commencing in 2006 resulted in a reduction in the mean daily dosing of 2.75 g/patient/day in 2006 to 2.125 g/patient/day in the 2009 study.

Meropenem usage continues to be targeted at the patient level by the hospital's AMS Committee via AMS postprescribing rounds, and usage at hospital and ICU levels monitored via NAUSP reports (Box 2).

Use of data to measure the effect of antimicrobial stewardship activities

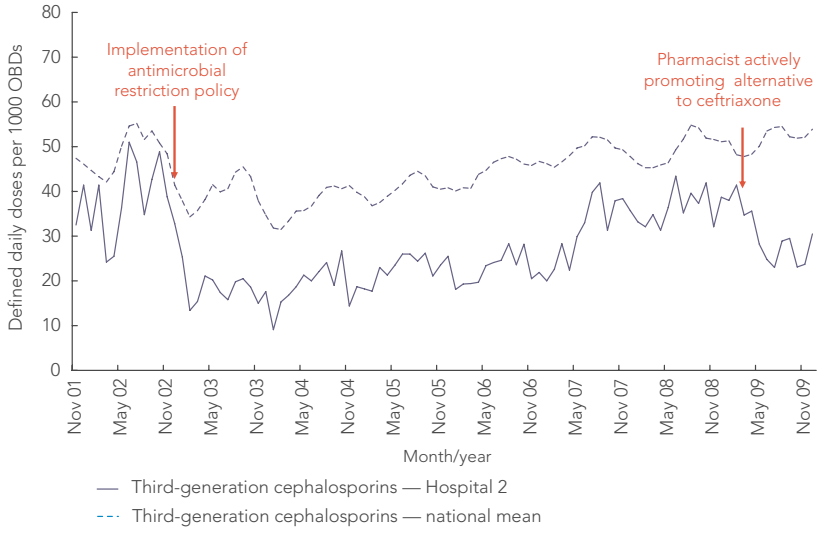
Intervention programs that restrict use of broad-spectrum antimicrobials have shown dramatic effects on antimicrobial prescribing. Case study 2 demonstrates the usefulness of surveillance of antimicrobial use in monitoring the effect of a restrictive AMS intervention.

Initially, surveillance detected high usage of a specific broad-spectrum antimicrobial agent (ceftriaxone). This information stimulated investigation and subsequent implementation of a targeted intervention, followed by monitoring of the effect of the intervention. This case study also illustrates the importance of continued routine surveillance and the need for hospitals to include a range of different interventions in their AMS programs.

Case study 2

High usage of third-generation cephalosporins in a major South Australian metropolitan hospital was noted in 2002 through data collection and analysis by the South Australian Antimicrobial Utilisation Surveillance Program. The hospital implemented an antimicrobial restriction policy in January 2003. The intervention focused on community-acquired pneumonia treatment protocols, which had been identified through pharmacy audit as an area of inappropriate use of ceftriaxone. The usage of ceftriaxone decreased significantly following the implementation of the new policy, and this level of use was sustained for about 4 years. However, ceftriaxone use then rose again. A second intervention commenced in 2009, in which an AMS pharmacist actively promoted the use of alternative agents and instituted a program of switching to oral therapy within agreed periods according to the patient's condition. These strategies resulted in a decline in ceftriaxone usage (Box 3).

3 Ceftriaxone usage over 8 years at a major teaching hospital in South Australia (Case study 2)

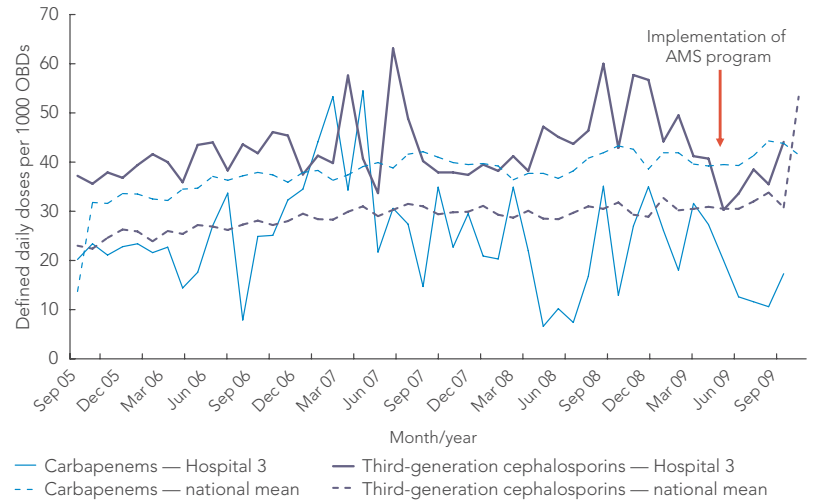


OBD = occupied bed-days. ◆

Use of data to obtain resources for antimicrobial stewardship activities

In Case study 3, antimicrobial usage data was used alongside microbiological data to demonstrate the need for an AMS program and to obtain the resources required to set up the program. The case also demonstrates the value of monitoring usage to measure the effect of an AMS program.

4 Usage of carbapenems and third-generation cephalosporins over 4 years illustrating the effect of implementing an AMS program (Case study 3)



AMS = antimicrobial stewardship. OBD = occupied bed days. ◆

Case study 3

A 550-bed teaching hospital identified increased rates of *C. difficile* and vancomycin-resistant enterococcus colonisation/infection together with a growth rate in their antimicrobial expenditure of 11% per year. In the context of a vancomycin-resistant enterococcus outbreak, the importance of implementing an AMS program was discussed with the hospital executive and a team of infectious diseases physicians, clinical microbiologists and pharmacists. Data provided by the NAUSP were presented and were instrumental in obtaining funding for a full-time infectious diseases pharmacist to support the implementation of an electronic antimicrobial approval system (with decision support), previously purchased by the state health department. Daily AMS rounds were introduced; patients on restricted antimicrobials are reviewed and feedback to prescribers is provided. Twice-weekly liaison rounds also occur in the adult ICU and haematology/oncology unit.

Since the electronic antimicrobial approval system commenced in May 2009, there has been a decline in the usage of carbapenems and third-generation cephalosporins (Box 4). The use of these broad-spectrum antimicrobials is known to be linked with development of multidrug-resistant organisms and an increase in incidence of *C. difficile* infection.[14]

Use of data to determine cost savings

Several published studies indicate that AMS programs cover at least their costs and can be financially self-supporting.[5,6] Case study 4

demonstrates the use of comparative antimicrobial usage data to determine the savings in drug costs attributable to the hospital's AMS program.

Case study 4

A large tertiary teaching hospital in New South Wales has an active approach to AMS, underpinned by locally relevant antimicrobial guidelines and enthusiastic staff in the areas of pharmacy, infectious diseases and microbiology. This team promotes AMS through guidelines, patient-specific discussion between prescribers and the AMS team, rounds in ICUs, an online anti-infective approval system, and regular prospective audits.

Monthly usage data is supplied to the NAUSP. This allows for benchmarking of both ICU and non-ICU usage against other large Australian hospitals. In 2006, a study of usage of selected high-cost (predominantly broad-spectrum) antimicrobials indicated that, for most agents, use in ICU and non-ICU situations in this hospital was far lower than the national mean. Based on purchase cost alone, the net cost difference in 2006 was estimated to be $278 000 ($59 000 of this was for ICU use lower than the national mean).

Use of data at state and national levels

To date, antimicrobial usage data have not been fully utilised to initiate interventions at state and national levels. There is potential to use the information to:

- examine trends in hospital antimicrobial use at state and national levels as the basis for larger-scale interventions to rationalise hospital antimicrobial prescribing;
- provide an Australian peer-group benchmark, and to enable comparison with international data (it is known that aggregate use of antimicrobials is higher in Australia than that reported by several European surveillance programs[15]); and
- provide longitudinal antimicrobial usage data which may be used to demonstrate links between antimicrobial use and resistance.

Conclusion

National antimicrobial usage data allows contributing hospitals to compare their usage with peer-group hospitals, identify trends in prescribing requiring further investigation and measure the effectiveness of AMS programs, including cost savings. The regular feedback is a useful tool for educating prescribers and monitoring the effect of targeted interventions. Overall high usage has been used by hospitals and area health services as a stimulus for initiation or expansion of AMS programs.

There is potential to further utilise the data, including linking longitudinal usage data with resistance data, at national and hospital levels, to identify reduction in resistant organisms and emerging patterns of resistance.

Comparison of national usage data with international data indicates that Australian hospitals are relatively high users of antimicrobials when compared with their northern European counterparts. The national focus on implementing AMS programs in hospitals, which is led by the Australian Commission on Safety and Quality in Health Care, is aimed at improving patient safety by reducing inappropriate antimicrobial prescribing and by reducing health care-associated infections from resistant organisms. Antimicrobial usage data, such as that provided through NAUSP, will be useful for monitoring the effect of these programs on influencing antimicrobial prescribing at hospital, state and territory, and national levels.

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Competing interests

None identified.

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