

AURA

Antimicrobial Utilisation and Resistance in Australia

AUSTRALIAN COMMISSION
ON SAFETY AND QUALITY IN HEALTH CARE

Antimicrobial Prescribing Practice in Australia

Results of the 2013
National Antimicrobial
Prescribing Survey

November 2014

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Executive summary

This National Antimicrobial Prescribing Survey (NAPS) report provides insights into prescribing practices for antimicrobials in 151 Australian hospitals. It will inform quality improvement strategies, at the hospital level, for appropriate prescribing. The report identifies a range of opportunities for intervention at a hospital, regional and national level to improve prescribing practice in Australian hospitals.

First trialled in 2011, the NAPS conducted in 2013 used an online survey tool for the first time. The tool used a standardised audit process, with local auditors, and a 'snapshot' approach that could be easily accessed and used by all types of healthcare facilities. This approach enables healthcare facilities to review how well their antimicrobial prescribing practices align with a predefined matrix, so that they can judge the appropriateness of prescribing, and its compliance with national or local guidelines. Systemic and topical antimicrobial agents of all types—antibacterials, antifungals and antivirals—were captured in the NAPS.

A total of 151 hospitals (132 public and 19 private) contributed data, from every state and territory. This resulted in a dataset of approximately 12 800 individual prescriptions for 7700 patients. Approximately half of all large public hospitals in Australia participated. However, participation from smaller hospitals was much lower. The most common type of survey performed was a whole-hospital point prevalence survey (44%), followed by surveys of selected wards or specialties (26%), whole-hospital period prevalence surveys (22%) and surveys of randomly selected patients (8%). More than one-third (38%) of participating hospitals completed their survey in a 24-hour period, while one-fifth (21%) took more than a month to complete the survey. Over half of all auditors were pharmacists (53.0%); other auditors included infection control practitioners (16.8%) and medical practitioners (13.2%).

Of all the instances of prescribing recorded in the NAPS, 70.9% had a clinical indication documented in the medical record (more than 95% is considered best practice). Of all prescriptions, 70.8% were deemed to be appropriate (either optimal or adequate practice), where such a judgment could be made. The appropriateness of the top five most commonly prescribed agents was between 60% and 76%. Only half of the cephalexin prescriptions were deemed appropriate, but higher rates of appropriateness were seen with the narrow-spectrum agents such as flucloxacillin, benzylpenicillin and vancomycin.

The most common indications were surgical prophylaxis, community-acquired pneumonia, urinary tract infections, cellulitis/Erysipelas and Chronic Obstructive Pulmonary Disease (COPD). Inappropriate prescribing appeared to be particularly high (46%) in the treatment of acute exacerbations of COPD. Overall, only 59.7% of prescriptions were compliant with guidelines.

The most common reason for inappropriateness was use of an antimicrobial with too broad a spectrum.

Prophylactic use of antimicrobials in association with surgery was the commonest clinical indication overall. Surgical prophylaxis was given for more than 24 hours in 41.5% of cases (less than 5% is considered best practice). In contrast, medical prophylaxis was generally well prescribed, with more than 80% of prescriptions deemed appropriate.

The Australian Commission on Safety and Quality in Health Care will consider developing a Clinical Care Standard for antimicrobial use in surgical prophylaxis, as it was the highest indication for antibiotic use. The Commission will also consider appropriate action with regard to COPD.

The most common prescriptions were for ceftriaxone, which was considered inappropriate in 34% of cases, and cephazolin, which was the principal agent used for surgical prophylaxis. Cephalexin appeared to be the most inappropriately prescribed drug (39% inappropriate).

Background

Timely, accurate and comprehensive surveillance of antimicrobial resistance and antibiotic use is central to efforts to prevent and contain the spread of resistance nationally and globally. General awareness of bacteria that are resistant to multiple antimicrobials, and the potential threat that they pose to health, is increasing. Australian governments have recognised the importance of strategies to respond to antimicrobial resistance, and encourage the appropriate use of antimicrobials to minimise the development of resistance. The World Health Organization has identified this issue as critical and has called on all countries to control antimicrobial use as a major risk factor. Internationally, the literature indicates that up to 75% of patients in hospitals and health facilities will receive an antibiotic, and that 25–50% of these prescriptions are inappropriate (Van de Sande-Bruinsma et al 2008¹).

Antimicrobial stewardship is the coordinated effort to improve the quality and safety of antimicrobial use. In 2011, the Australian Commission on Safety and Quality in Health Care recommended that antimicrobial stewardship programs be established in all hospitals (Duguid & Cruickshank 2011²). In 2013, antimicrobial stewardship became an accreditation criterion in the National Safety and Quality Health Service (NSQHS) Standards. All hospitals in Australia are now required to audit and monitor antimicrobial prescribing.

The National Antimicrobial Prescribing Surveys (NAPS) are conducted by the Melbourne Health Antimicrobial Stewardship Research Team. The Surveys were designed as a voluntary annual audit to be undertaken by healthcare professionals in participating hospitals, allowing them to take a snapshot sample of their medication charts and patient records, to assess the appropriateness of prescribing.

The 2013 NAPS aims to build a more comprehensive picture of antimicrobial prescribing practices in Australian hospitals. It:

- provides a tool to
 - assist healthcare facilities to audit antimicrobial prescribing practices in a meaningful way
 - facilitate local quality improvement
- allows a variety of auditors with different levels of experience to perform both quantitative and qualitative assessments of antimicrobial prescribing

- provides data on antibiotic prescribing behaviour in Australian hospitals so that comparisons can be made between participating hospitals (depending on patient selection strategies used by hospitals)
- supports benchmarking, where possible
- helps to identify problematic areas in which prescribing frequently varies from recommendations in *Therapeutic Guidelines: Antibiotic*,³ or endorsed local guidelines
- helps to identify clinical indications and antimicrobial use patterns for which interventions might be designed.

Limitations in methodology

The results presented in this report should be interpreted in the context of several constraints:

- **Sampling and selection bias.** Participation in the NAPS was voluntary. Hence the hospitals included in this report were not a randomised sample, and the results might be skewed by self-selection.
- **Survey methodology.** Participating facilities were able to choose their own method of data collection (e.g. point prevalence survey, random sample, targeted patient types). This has an impact on the accuracy of some denominators.
- **Validation of audit tool and assessment of appropriateness.** Individual auditors at each participating facility were responsible for determining the appropriateness of each antimicrobial prescription. Although an algorithm and detailed instructions were provided, the audit tool has not yet been fully validated. An inter-auditor correlation study will be conducted to determine the consistency of assessments between auditors.



- 1 Van de Sande-Bruinsma N, Grundmann H, Verloo D, Tiemersma E, Monen J, Goossens H, Ferech M, European Antimicrobial Resistance Surveillance System Group & European Surveillance of Antimicrobial Consumption Project Group (2008). Antimicrobial drug use and resistance in Europe. *Emerging Infectious Diseases* 14(11):1722–1730.
- 2 Duguid M & Cruickshank M (eds) (2010). *Antimicrobial stewardship in Australian hospitals*, Australian Commission on Safety and Quality in Health Care, Sydney.
- 3 www.tg.org.au



The 2013 NAPS

Methods

Hospitals were encouraged to conduct the NAPS during Antibiotic Awareness Week 2013. The number of participating hospitals has grown from 32 pilot sites in 2011 to 76 in 2012; in 2013, 151 hospitals participated. The first two surveys (2011 and 2012) were performed using paper-based data collection tools. In 2013, a comprehensive web-based survey tool was used.

Survey types

Data collection for the NAPS was designed to be as flexible and practical as possible. Hospitals were able to collect data using a variety of methods:

- whole-hospital point prevalence survey
- whole-hospital period prevalence survey
- survey of particular wards or specialties
- survey of a randomly selected group of patients.

Auditors

The professional status of auditors at each participating site was documented as part of the NAPS. Training and support were provided to auditors through videos and online training sessions, and email and telephone support throughout the NAPS.

Key data fields

The key data collection fields are shown in Appendix 1. Systemic and topical antimicrobial agents of all types—antibiotics (antibacterials), antifungals and antivirals—were captured in the survey. The data included whether the indication was documented, whether prophylactic use of antimicrobials in association with surgery ('surgical prophylaxis') was continued for more than 24 hours, and whether the prescription was compliant with prescribing guidelines (*Therapeutic Guidelines: Antibiotic* or endorsed local guidelines). A predefined assessment matrix (Appendix 2) was used to assess whether use of the antimicrobial was appropriate.

The auditors were asked to assess the overall appropriateness of each prescription using the guidelines in Appendix 3. The following five options were provided:

- compliant with *Therapeutic Guidelines: Antibiotic*
- compliant with local guidelines
- noncompliant with guidelines
- no guidelines available
- not assessable.

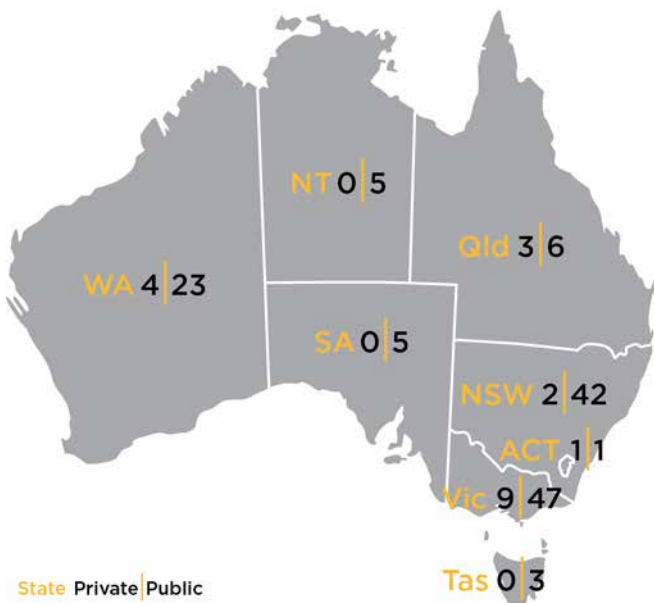
General findings

Participating hospitals

A total of 214 hospitals (174 public and 40 private) registered for the 2013 NAPS. Of these, 151 hospitals (132 public and 19 private) contributed data, as shown in Table 1. This compares with 76 hospitals that contributed data in 2012 and 32 in 2011.

Each state and territory was represented in the responses.

Map 1 Participating hospitals according to state and territory, and type



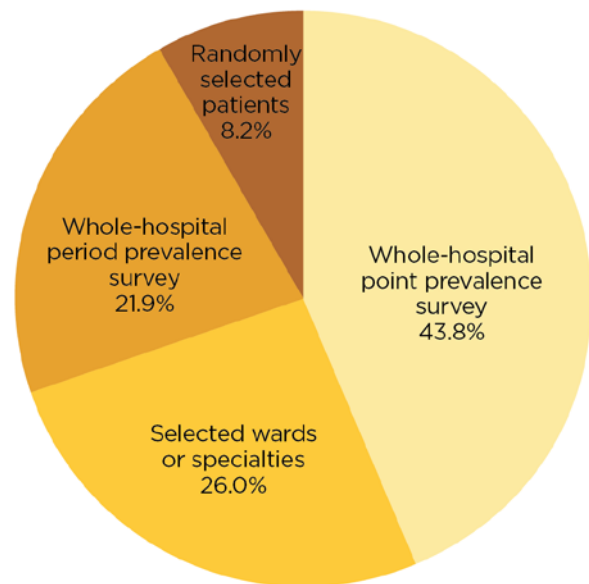
Among the participants, there was a good spread of representation by peer group and remoteness. These classifications were made in accordance with the Australian Institute of Health and Welfare report *Australian hospital statistics 2011–12*.

Overall, 22% of peer group public hospitals in Australia participated in the 2013 NAPS. The largest proportion was in peer group A (principal referral, and specialist women’s and children’s) and peer group B (large) hospitals, of which approximately half participated. Participation by smaller hospitals was much lower.

Types of surveys performed

Figure 1 shows the types of surveys performed. Most hospitals performed a whole-hospital point prevalence survey (43.8%). This was followed by surveys of selected wards or specialties (26%), whole-hospital period prevalence surveys (22%), and surveys of a randomly selected group of patients (8%). No hospital in 2013 performed a directed survey. Seventy-three hospitals also completed a questionnaire about the process, and the usability of the NAPS and website.

Figure 1 Types of surveys performed



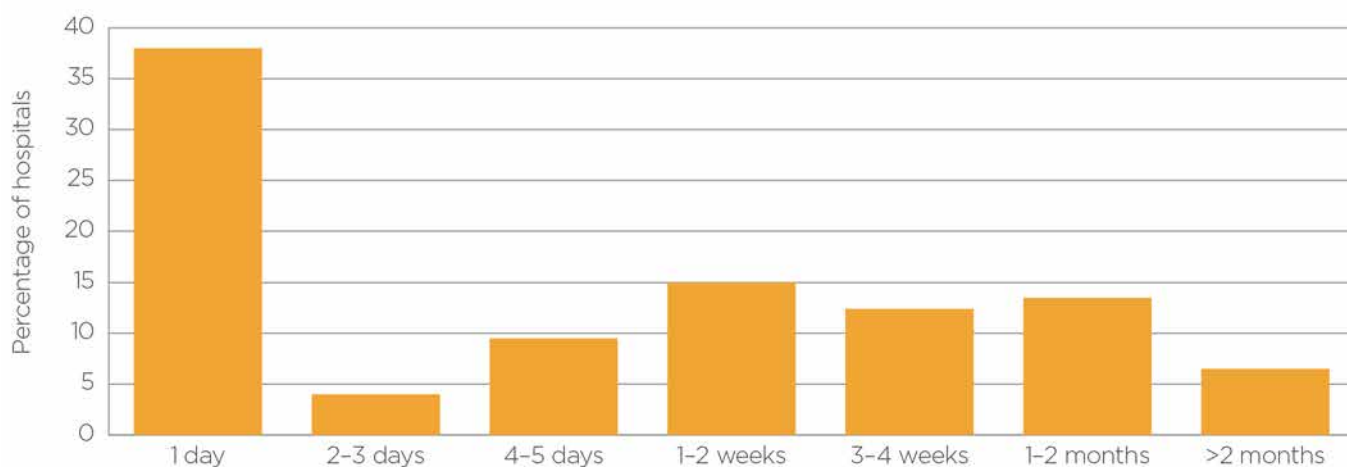
Source: NAPS user evaluation surveys

Thirty-eight per cent of hospitals conducted their survey over 1 day, 14% over 2–5 days, 27% over 1–4 weeks and 21% over more than a month (see Figure 2).

Types of auditors

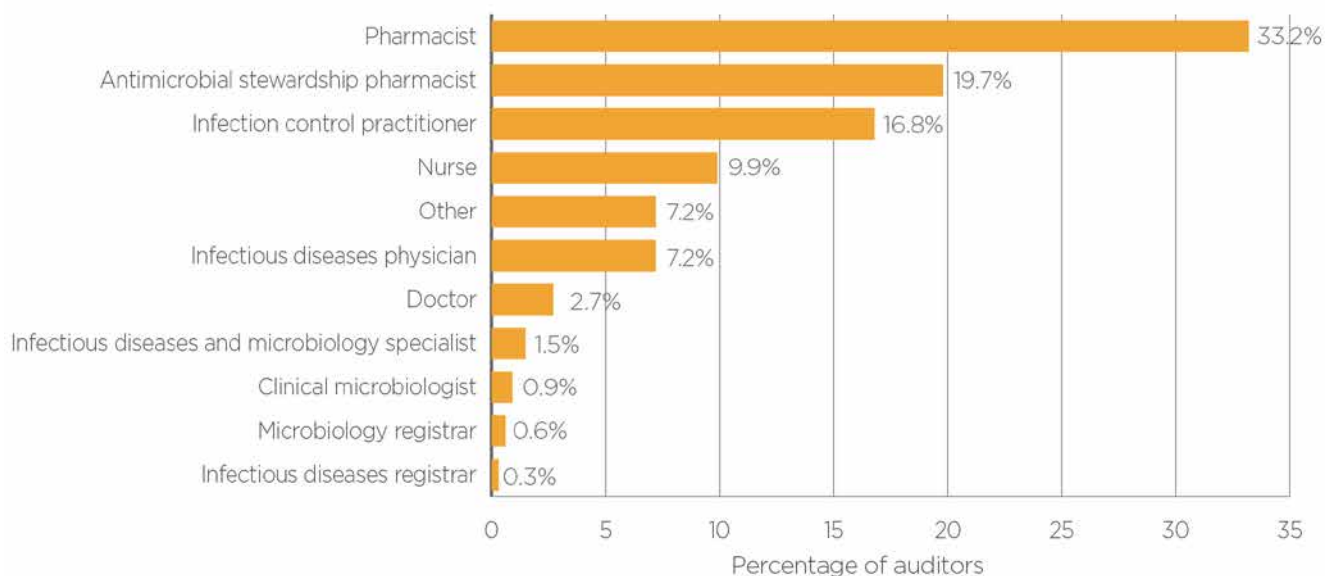
In the 2013 NAPS, 334 auditors participated. More than half (53.0%) of the auditors who registered were pharmacists, followed by infection control practitioners (16.8%) and medical practitioners (13.2%), as shown in Figure 3.

Figure 2 Period over which surveys were conducted



Source: NAPS user evaluation surveys

Figure 3 Categorisation of auditors according to profession



Specific findings on prescribing practices

Most commonly prescribed antimicrobials

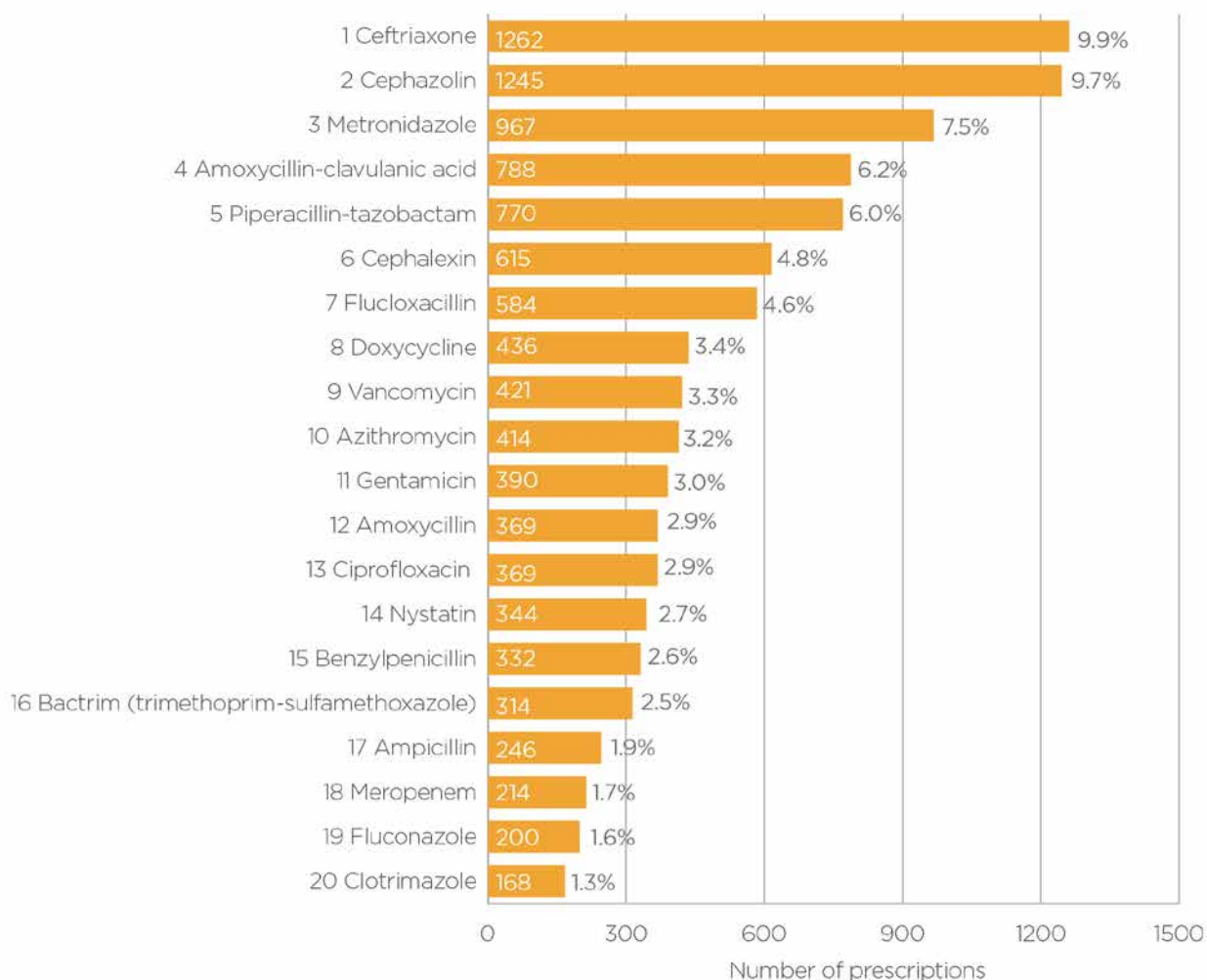
The most commonly prescribed antimicrobials (see Figure 4) were:

- ceftriaxone
- cephalosporin (principally as surgical prophylaxis)
- metronidazole
- amoxicillin-clavulanic acid
- piperacillin-tazobactam.

Documentation of indication

Overall, a clinical indication was documented in the medical record for 70.9% of antimicrobial prescriptions. The median was 80.9% (interquartile range[IQR]: 61.9 to 92.8%). These values fall short of the best-practice value of more than 95%. Documentation rates appeared to be higher in Queensland (87.2%) and South Australia (82.1%). Documentation was poorer in private hospitals (51.3%) than in public hospitals (72.6%).

Figure 4 Top 20 most commonly prescribed antimicrobials



Note: The figure shows the number of prescriptions for each antimicrobial and the percentage of the total prescriptions that this represents.

As shown in Figure 5, prophylaxis indications such as surgical and medical prophylaxis comprised a significant proportion (19.7%) of antimicrobial prescriptions. When these indications are excluded, the overall documentation of indication improved slightly, to 75.1%.

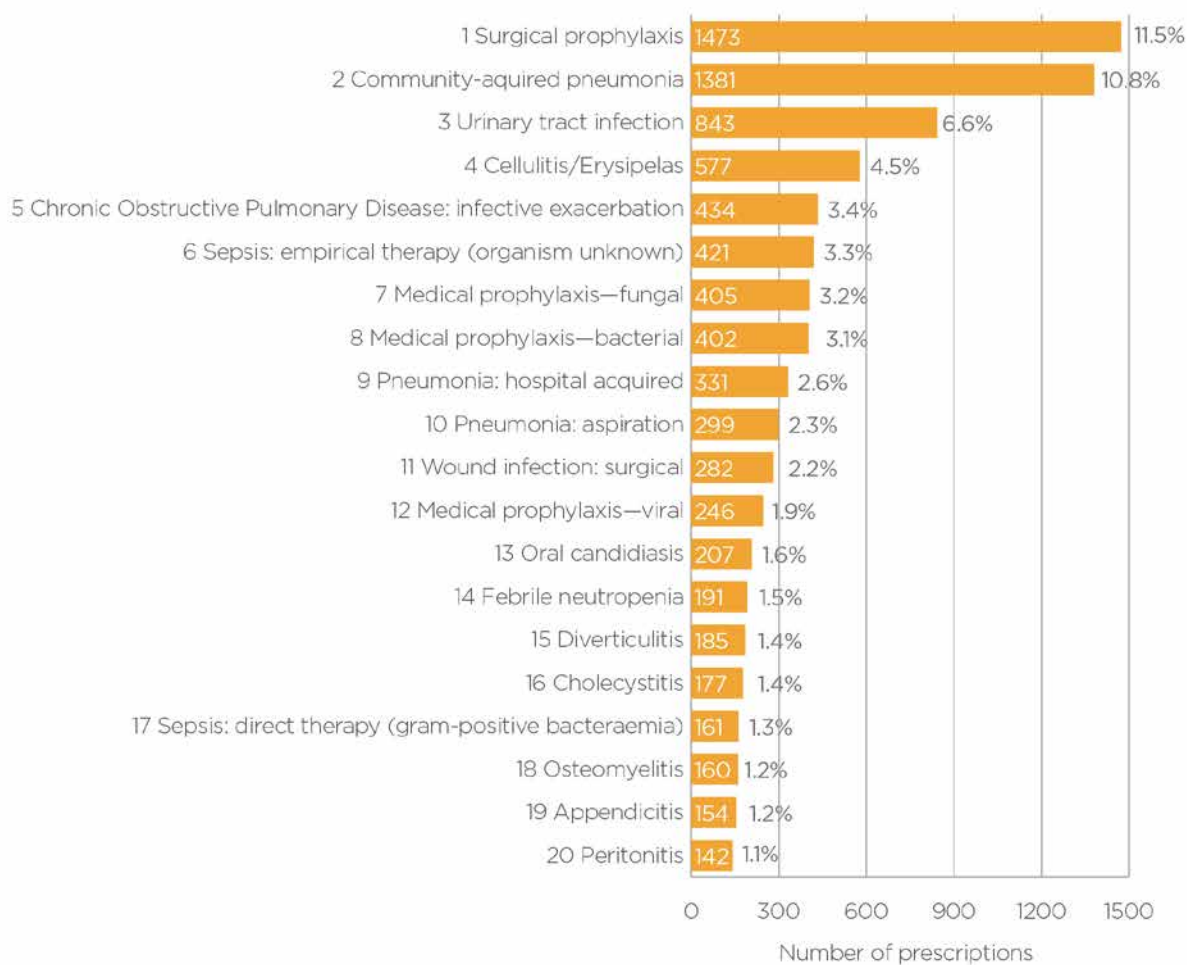
In this report, the categories 'Other' and 'Indication unknown' have been removed from graphs and tables.

Most common indications

The most common indications were:

- surgical prophylaxis
- community-acquired pneumonia
- urinary tract infection
- cellulitis/Erysipelas
- Chronic Obstructive Pulmonary Disease (COPD).

Figure 5 Top 20 most common indications



Note: The figure shows the number of documentations of each indication for which an antimicrobial was prescribed and the percentage of the total documentations that this represents.

Key indicators

Table 2 summarises the results for key indicators, including appropriateness and compliance with guidelines, for the contributing hospitals.

Appropriateness of prescribing

Overall appropriateness

The results for all 151 contributing hospitals show that 70.8% of prescriptions were deemed to be appropriate. Excluding those prescriptions marked 'Not assessable', 75.6% of prescriptions were appropriate, and 24.4% were inappropriate.

Appropriateness of assessable prescriptions

A more detailed breakdown of results according to peer group, remoteness and funding type is shown in Tables 3 and 4. Table 3 shows population-level percentages (analysis of all prescriptions), while Table 4 shows the median and interquartile ranges for key indicators by facility (analysis of prescriptions by facility). Note that these results are site-level medians and do not take into account the number of contributing prescriptions per site. Importantly, prescriptions marked 'Guideline not available' or 'Not assessable' are excluded from the denominators for compliance with guidelines and appropriateness.

No statistically significant differences were found between peer groups and remoteness area classifications.

Table 2 Results of key indicators for all contributing hospitals

Key indicator		% of total prescriptions	% of total assessable prescriptions ^a
Indication documented in medical notes (best practice >95%)		70.9	
Surgical prophylaxis given for >24 hours (best practice <5%)		41.5 ^b	
Compliance with guidelines	Compliant with <i>Therapeutic Guidelines: Antibiotic</i> or endorsed local guidelines	59.7	72.2
	Noncompliant	23.0	27.8
	No guideline available	11.0	
	Not assessable	6.3	
Appropriateness	Appropriate (optimal + adequate)	70.8	75.6
	Inappropriate (suboptimal + inadequate)	22.9	24.4
	Not assessable	6.3	

a Assessable means that the denominator excludes antimicrobial prescriptions marked 'Guideline not available' or 'Not assessable'.

b Where surgical prophylaxis was selected as the indication (1473 prescriptions)

Table 3 Key indicators, according to peer group, remoteness and funding type

	Number of hospitals	Number of prescriptions	Indication documented (%)	Surgical prophylaxis >24 hours (%) ^a	Compliance with guidelines (%)			Appropriateness (%)			
					Compliant	Noncompliant	Not available	Appropriate	Inappropriate	Not assessable	
A	54	8 633	72.3	46.1	58.7	22.3	13.5	5.4	71.1	23.4	5.5
B	20	1 266	77.0	45.0	59.9	26.2	6.4	7.4	71.0	22.5	6.5
C	25	1 129	65.6	13.3	65.0	24.0	3.1	7.9	71.6	20.8	7.6
D	22	605	70.8	53.9 ^b	66.6	23.8	5.1	4.5	73.7	22.7	3.6
E	10	120	87.9	No data	65	20	5.8	9.2	64.2	24.2	11.7
F	0	0	No data	No data	No data	No data	No data	No data	No data	No data	No data
G	2	36	91.7	No data	97.2	0	2.8	0.0	88.9	2.8	8.3
Major cities	65	8 742	74.0	47.6	58.2	22.2	14.0	5.6	71.4	23.0	5.6
Inner regional	46	1 933	66.5	25.3	65.8	26.0	1.9	6.3	71.6	22.2	6.2
Outer regional	14	654	67.3	45.5 ^b	59.0	24.8	6.6	9.6	65.8	24.5	9.8
Remote	6	426	73.5	66.7 ^b	71.6	21.1	4.9	2.4	75.6	23.2	1.2
Very remote	2	34	85.3	No data	67.7	23.5	5.9	2.9	76.5	23.5	0.0
Public	132	11 789	72.6	42.9	60.2	22.8	11.2	5.8	71.3	22.9	5.8
Private	19	1 021	51.3	38.2	54.1	25.5	9.1	12.3	65.0	22.2	12.7
Combined national result	151	12 810	70.9	41.5	59.7	23.2	10.9	6.3	70.8	22.9	6.3

a Where surgical prophylaxis was selected as the indication (1473 total prescriptions)

b Low numbers of surgical prophylaxis prescriptions (<30)

Table 4 Median and interquartile ranges of key indicators, according to peer group, remoteness and funding type

	Number of hospitals	Indication documented (%) n = 12 810	Surgical prophylaxis >24 hours (%) n = 1473	Compliance with guidelines (%) ^a n = 10 599		Appropriateness (%) ^a n = 12 001	
				Compliant	Noncompliant	Appropriate	Inappropriate
A	54	79.6 (62.5, 88.9)	50 (17.6, 66.7)	73.2 (61.2, 85.3)	26.8 (14.7, 38.8)	75.2 (67.7, 83.9)	24.8 (16.1, 32.3)
B	20	80.9 (68.2, 92.8)	66.7 (5, 100)	76.9 (51.5, 81.8)	23.1 (18.2, 48.5)	78.8 (60.8, 84.9)	21.2 (15.1, 39.2)
C	25	77.4 (41.9, 87.5)	13.2 (0, 37.5)	76.1 (61.4, 92.9)	23.9 (7.1, 38.6)	84.4 (68.8, 92.6)	15.6 (7.4, 31.3)
D	22	98.4 (68.2, 100)	29.2 (0, 58.3)	67.5 (44.4, 100)	32.5 (0, 55.6)	73.9 (50, 81.0)	26.1 (19.0, 50)
E	10	100 (88.4, 100)	No data	75.9 (75, 100)	24.0 (0, 25)	73.0 (66.7, 100)	27.0 (0, 33.3)
F	0	No data	No data	No data	No data	No data	No data
G	2	95.7 (91.4, 100)	No data	98.6 (97.1, 100)	1.4 (0, 2.9)	98.4 (96.9, 100)	1.6 (0, 3.1)
Major cities	65	82.5 (67.3, 90.7)	50.8 (33.3, 78.0)	73.8 (62.1, 85.4)	26.2 (14.6, 37.9)	76.7 (68.2, 86.0)	25 (5.2, 36.5)
Inner regional	46	80.9 (60.9, 98.1)	17.7 (0, 50)	77.4 (50, 95.7)	22.6 (4.3, 50)	75 (63.5, 94.8)	23.3 (14.0, 31.8)
Outer regional	14	82.9 (70, 100)	0 (0, 81.8)	75.5 (58.9, 89.3)	24.5 (10.7, 41.1)	69.0 (66.7, 77.4)	31.0 (22.6, 33.3)
Remote	6	91.9 (68.2, 99.3)	58.3 (0, 100)	70.4 (51.4, 86.0)	29.6 (14.0, 48.6)	74.5 (65, 87.0)	25.5 (13.0, 35)
Very remote	2	83.7 (76.9, 90.5)	No data	75.9 (68.4, 83.3)	24.1 (16.7, 31.6)	75.1 (69.2, 81.0)	24.9 (19.0, 30.8)
Public	132	82.4 (67.0, 94.0)	50 (11.1, 74.2)	75 (58.4, 89.0)	25 (11.0, 41.6)	75.2 (66.7, 86.7)	24.8 (13.3, 33.3)
Private	19	57.1 (26.7, 82.9)	42.7 (3.4, 50)	73.5 (60, 91.7)	26.5 (8.3, 40)	76.5 (66.7, 94.7)	23.5 (5.3, 33.3)
National total	151	80.9 (61.9, 92.8)	46.8 (5.6, 66.7)	75.0 (58.4, 89.0)	25 (10.7, 41.5)	75.2 (66.7, 86.7)	24.4 (12.8, 33.3)

^a For compliance with guidelines and appropriateness, prescriptions marked 'Guideline not available' or 'Not assessable' have been excluded from the denominator.

Appropriateness of prescriptions for prophylaxis

Nationally, 41.5% of surgical prophylaxis prescriptions were for longer than 24 hours. This is substantially higher than the best-practice target of less than 5%. There were no statistically significant differences between the states and territories. The results were similar between public and private hospitals.

Surgical prophylaxis was the leading indication observed (Figure 5). However, the overall burden of antibiotics prescribed for this condition is likely to be lower than suggested by the percentage of prescriptions, given that most surgical antibiotic prophylaxis is of relatively short duration. Nevertheless, surgical antibiotic prophylaxis could be a target for future campaigns, especially given that 42% of these prescriptions were deemed to be inappropriate (see Table 7). The most commonly cited reasons for inappropriateness (Table 5) were an incorrect duration, and an incorrect dose or frequency.

Table 5 Reasons for inappropriateness of surgical prophylaxis prescriptions (613 prescriptions)

Reason	Yes (%)	No (%)	Not specified (%)
Incorrect duration	53.2	29.5	17.3
Incorrect dose or frequency	20.1	58.7	21.2
Spectrum too broad	11.6	60.7	27.7
Spectrum too narrow	1.8	68.4	29.9
Incorrect route	1.8	71.5	26.8

In contrast, antimicrobials for medical prophylaxis appeared to be well prescribed, with more than 80% of these prescriptions deemed to be appropriate.

Appropriateness of top 20 prescribed antimicrobials

The appropriateness of the top five most commonly prescribed antimicrobials ranged between 60% and 76% (Table 6). Outside the top five, only half of all cephalexin prescriptions were deemed to be appropriate, with 39% inappropriate and the remaining 10% not assessable. Higher rates of appropriateness were seen for some narrow-spectrum agents such as flucloxacillin, benzylpenicillin, vancomycin, trimethoprim-sulfamethoxazole and fluconazole.

Table 6 Level of appropriateness of the 20 most commonly prescribed antimicrobials

Rank	Antimicrobial	Number of prescriptions	Appropriate (%)	Inappropriate (%)	Not assessable (%)
1	Ceftriaxone	1262	60	34	5
2	Cephazolin	1245	65	32	3
3	Metronidazole	967	70	24	6
4	Amoxicillin-clavulanic acid	788	65	29	6
5	Piperacillin-tazobactam	770	76	20	4
6	Cephalexin	615	51	39	10
7	Flucloxacillin	584	80	16	3
8	Doxycycline	436	71	20	8
9	Vancomycin	421	82	15	3
10	Azithromycin	414	63	29	8
11	Gentamicin	390	75	18	7
12	Amoxicillin	369	75	20	5
13	Ciprofloxacin	369	68	25	7
14	Nystatin	344	79	5	16
15	Benzylpenicillin	332	82	14	5
16	Trimethoprim-sulfamethoxazole	314	80	13	7
17	Ampicillin	246	76	20	4
18	Meropenem	214	79	15	6
19	Fluconazole	200	84	9	7
20	Clotrimazole	168	73	12	15

Appropriateness by top 20 indications

The levels of appropriateness for the top 20 clinical indications are shown in Table 7.

In addition to surgical prophylaxis, levels of inappropriateness were high for treatment of infective exacerbation of COPD, where 46% of prescriptions were deemed to be inappropriate. Of these, the most common reason for inappropriateness was that the spectrum was too broad (see Table 8).

A number of indications in the top 20 had high rates of appropriateness (80 per cent or more), including fungal and viral medical prophylaxis, febrile neutropenia, osteomyelitis and gram-positive sepsis.

Table 7 Level of appropriateness for the top 20 most common indications

Rank	Indication	Number of prescriptions	Appropriate (%)	Inappropriate (%)	Not assessable (%)
1	Surgical prophylaxis	1473	55	42	3
2	Community-acquired pneumonia	1381	74	25	2
3	Urinary tract infection	843	72	25	2
4	Cellulitis/Erysipelas	577	76	23	1
5	Chronic Obstructive Pulmonary Disease: infective exacerbation	434	52	46	2
6	Sepsis: empirical therapy	421	82	14	4
7	Medical prophylaxis—fungal	405	85	6	9
8	Medical prophylaxis—bacterial	402	75	12	13
9	Pneumonia: hospital acquired	331	75	24	2
10	Pneumonia: aspiration	299	70	29	1
11	Wound infection: surgical	282	73	25	2
12	Medical prophylaxis—viral	246	92	2	6
13	Oral candidiasis	207	86	7	7
14	Febrile neutropenia	191	88	11	1
15	Diverticulitis	185	84	14	2
16	Cholecystitis	177	82	18	1
17	Sepsis: directed therapy (gram-positive bacteraemia)	161	86	11	3
18	Osteomyelitis	160	87	11	2
19	Appendicitis	154	76	24	0
20	Peritonitis	142	80	20	0

Table 8 Reasons for inappropriateness of prescriptions for infective exacerbation of Chronic Obstructive Pulmonary Disease (199 prescriptions)

Reason	Yes (%)	No (%)	Not specified (%)
Spectrum too broad	51.3	30.2	18.6
Incorrect route	9.5	66.8	23.6
Incorrect dose or frequency	9.0	71.9	19.1
Incorrect duration	8.0	68.3	23.6
Spectrum too narrow	6.5	68.8	24.6

Indications most commonly assessed to be appropriate

Overall, 70.8% of antimicrobials prescribed (9071 individual prescriptions) were classified as being appropriate. Of these, 75.4% (6836) were optimal and 24.6% (2235) were adequate. Appendix 2 provides a more detailed description of the criteria used to assess appropriateness.

Indications for which antimicrobials were most appropriately prescribed (at least 80% appropriate) are listed in Table 9.

Table 9 Indications for which antimicrobials were most appropriately prescribed (≥80% appropriate)

Indication	Number of prescriptions	Appropriate (%)	Inappropriate (%)	Not assessable (%)
Sepsis: empirical therapy (organism unknown)	421	82	14	4
Medical prophylaxis—fungal	405	85	6	9
Medical prophylaxis—viral	246	92	2	6
Oral candidiasis	207	86	7	7
Febrile neutropenia	191	88	11	1
Diverticulitis	185	84	14	2
Cholecystitis	177	82	18	1
Sepsis: directed therapy (gram-positive bacteraemia, including <i>Staphylococcus aureus</i>)	161	86	11	3
Osteomyelitis	160	87	11	2
Peritonitis	142	80	20	0
Abscess	141	84	13	4
Sepsis: directed therapy (gram-negative bacteraemia)	133	80	20	0
Abscess: intra-abdominal	107	88	12	0
Pyelonephritis	104	80	20	0
<i>Clostridium difficile</i> infection	103	92	7	1
Prosthetic joint infection	102	86	12	2
Cutaneous and mucosal candidiasis	88	81	15	5
Human immunodeficiency virus infection	81	100	0	0
Septic arthritis	79	85	14	1
Pelvic inflammatory disease	75	81	17	1
<i>Mycobacterium tuberculosis</i> infection (tuberculosis)	41	88	5	7
<i>Pneumocystis jiroveci</i> pneumonia	40	85	10	5
Oesophageal candidiasis	40	80	20	0
Tonsillitis	30	87	13	0
Compound fracture	30	80	17	3

Note: A large number of rare indications contributed small numbers of prescriptions (<30 per indication); for simplicity, these indications have been removed from this table but are still included in the data analysis.

Overall reasons for inappropriateness

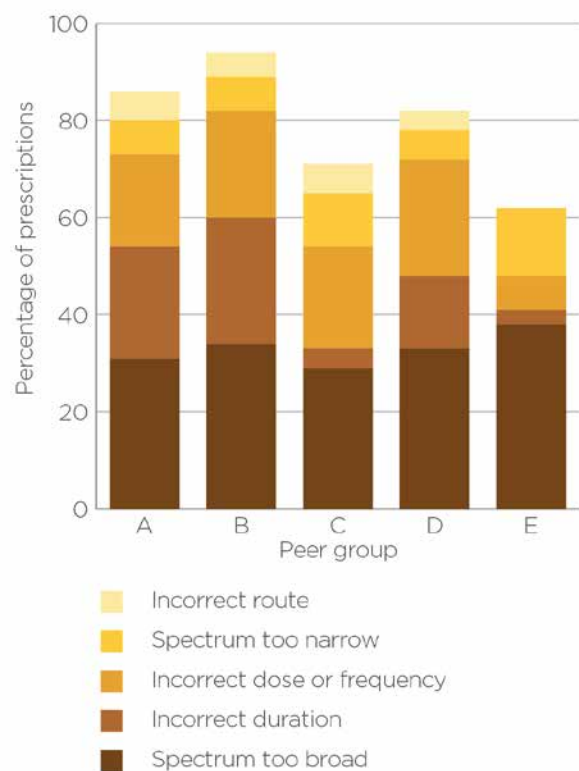
Prescriptions were classified as being inappropriate if they were determined to be either suboptimal or inadequate. A total of 2930 prescriptions (22.9%) were deemed to be inappropriate. Of these, 70.4% were also noncompliant with guidelines.

The most common reasons for inappropriateness were the spectrum of the antimicrobial being too broad (29.4%) and incorrect duration of the prescription (22.4%) (Table 10). Overall, across the various peer groups (Figure 6), and states and territories (Table 11), an unreasonably broad spectrum was cited as the most common reason for inappropriateness. (See Appendix 2 for a detailed explanation of the criteria used to assess appropriateness.)

Table 10 Reasons for inappropriateness (2930 prescriptions)

Reason	Yes (%)	No (%)	Not specified (%)
Spectrum too broad	29.4	45.7	24.8
Incorrect duration	22.4	56.0	21.5
Incorrect dose or frequency	19.7	58.7	21.5
Spectrum too narrow	7.9	64.4	27.6
Incorrect route	5.5	68.1	26.3
Microbiology mismatch	8.8	91.2	0.0
Allergy mismatch	2.4	97.6	0.0

Figure 6 Reasons for inappropriateness by peer group classification (public hospitals only,^a 2702 prescriptions)



^a No Group F hospitals participated. Group G hospitals are excluded from this analysis because of low numbers of prescriptions.

Table 11 Reasons for inappropriateness by state or territory (public and private hospitals, 2930 prescriptions)

Reason	ACT (%)	NSW (%)	NT (%)	Qld (%)	SA (%)	Tas (%)	Vic (%)	WA (%)
Spectrum too broad	52.6	30.9	36.5	36.5	30.6	39.0	24.9	30.0
Incorrect dose or frequency	26.3	18.4	28.4	29.9	15.3	3.4	16.5	31.1
Incorrect duration	21.1	23.2	31.1	15.3	16.7	28.8	22.5	22.0
Spectrum too narrow	5.3	7.4	4.1	4.4	9.7	20.3	7.1	11.0
Incorrect route	5.3	5.3	4.1	3.6	3.5	5.1	5.8	7.4

Of the inappropriate prescriptions, 66.6% (1951) were classified as suboptimal and 33.4% (979) as inadequate.

Of the 1951 prescriptions classified as suboptimal:

- 2% (39 prescriptions) had an allergy mismatch
 - 6 had an incorrect dose or frequency
 - 4 had too broad a spectrum
 - 3 had an incorrect route
 - 1 had a microbiology mismatch
 - 1 had an incorrect duration.

Some prescriptions had more than one reason selected.

Of the 979 prescriptions classified as inadequate:

- 3.3% (32 prescriptions) had an allergy mismatch
- 38.3% (375 prescriptions) were classified as surgical prophylaxis greater than 24 hours
 - 60 had an incorrect dose or frequency
 - 31 had too broad a spectrum
 - 8 had an incorrect route
 - 5 had a microbiology mismatch
 - 4 had an allergy mismatch
 - 1 had too narrow a spectrum.

Some prescriptions had more than one reason selected.

Indications for which antimicrobials were most inappropriately prescribed (at least 30% inappropriate) are listed in Table 12.

Table 12 Indications for which antimicrobials were most inappropriately prescribed ($\geq 30\%$ inappropriate)

Indication	Number of prescriptions	Appropriate (%)	Inappropriate (%)	Not assessable (%)
Surgical prophylaxis	1473	55	42	3
Chronic Obstructive Pulmonary Disease: infective exacerbation	434	52	46	2
Trauma (includes wound)	82	61	37	2
Bronchitis	53	43	49	8
Asthma: infective exacerbation	51	41	53	6
Pancreatitis	37	43	49	8
Colitis	33	67	33	0
Gastroenteritis	26	58	38	4
Catheter-associated infection	19	47	47	5
Diarrhoea	17	53	47	0
Sinusitis	12	42	58	0
Otitis media	10	60	40	0
Epiglottitis	9	22	78	0
Impetigo	7	57	43	0
Asymptomatic bactiuria	6	17	83	0

Note: Indications that contributed fewer than five prescriptions are excluded from this table but were still included in the data analysis.

Certain respiratory conditions feature prominently in the list in Table 12. Approximately half of all antimicrobial prescriptions for infective exacerbation of asthma, bronchitis and infective exacerbation of COPD were inappropriate. In addition, 37% of antimicrobial therapy used for trauma-related infections was deemed to be inappropriate.

As previously noted, surgical prophylaxis also had relatively high rates of inappropriate prescribing.

Compliance with guidelines

All prescriptions

As summarised in Table 2, 59.7% of prescriptions were compliant with guidelines (either *Therapeutic Guidelines: Antibiotic* or endorsed local guidelines), and 23.3% of prescriptions were noncompliant.

The remainder were either not assessable (6.3%) or had no guideline available for the indication (10.9%).

Noncompliance with guidelines (Table 3) was similar between public hospitals (22.8%) and private hospitals (25.5%). Hospitals in remote and very remote areas recorded the highest rates of compliance with guidelines (71.6% and 67.7%, respectively). However, this might be because a smaller percentage of prescriptions were not assessable or had no guideline available than for city and regional hospitals. Similarly, although compliance appeared to be lowest in major cities (58.2%), a significant proportion of prescriptions were for indications for which a guideline was not available (14%). A similar observation can be made for the hospitals in peer groups A (principal referral, and specialist women's and children's) and B (large hospitals).

Assessable prescriptions

Excluding prescriptions marked 'Guideline not available' and 'Not assessable', compliance with guidelines was 72.2% and noncompliance was 27.8% (Table 2). The median results by healthcare facility were 75.0% (IQR: 58.4 to 89.0%) compliant and 25.0% (IQR: 10.7 to 41.5%) noncompliant. No statistically significant differences were observed between the various categories of hospitals.

Indications

Table 13 shows the indications for which prescription of antimicrobials had the highest rate of compliance with *Therapeutic Guidelines: Antibiotic*.

Reasons for noncompliance

Twenty-three per cent of prescriptions were noncompliant with guidelines. Of these, 26.8% were still deemed to be appropriate, but 70.1% were inappropriate.

The most common reasons for noncompliance with guidelines (Table 14) were too broad a spectrum for the antimicrobial (29.9%), and incorrect dose or frequency (21.7%). These two reasons remained the top two most commonly cited reasons across the various peer group classifications (Figure 7), and across the states and territories (Table 15).

Table 13 Indications for which prescription of antimicrobials was most commonly deemed to be compliant with *Therapeutic Guidelines: Antibiotic* (version 14) ($\geq 80\%$ compliant)

Indication	Number of prescriptions	Compliant (%)	Noncompliant (%)	No guideline available (%)
Oral candidiasis	207	83	7	2
<i>Clostridium difficile</i> infection	103	90	7	0
<i>Mycobacterium tuberculosis</i> infection (tuberculosis)	41	85	7	7
Endocarditis: prosthetic valve	27	81	11	4
<i>Helicobacter pylori</i> infection	23	100	0	0
Cystitis	12	92	0	8
Hepatitis B virus infection	11	91	0	0

Note: Indications that contributed fewer than five prescriptions are excluded.

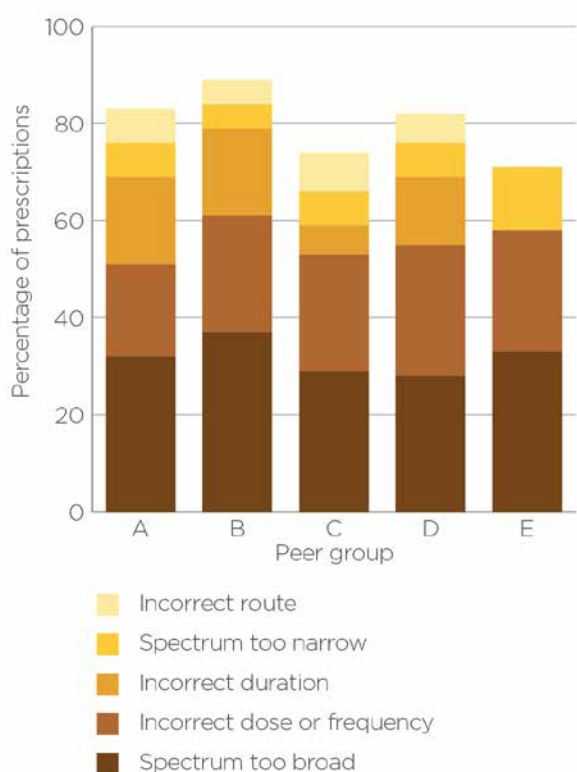
Table 14 Reasons for noncompliance with guidelines (2946 prescriptions)

Reason	Yes (%)	No (%)	Not specified (%)
Spectrum too broad	29.9	45.9	24.6
Incorrect dose or frequency	21.7	58.1	20.6
Incorrect duration	17.8	60.9	21.7
Spectrum too narrow	6.4	66.7	27.3
Incorrect route	6.0	68.4	26.0

Indications for which prescription of antimicrobials was most often noncompliant with guidelines (at least 30% noncompliance) are listed in Table 16.

Interestingly, many of these indications mirror those in Table 12, suggesting that the indications that were deemed to be inappropriate were also noncompliant with guidelines.

Figure 7 Reasons for noncompliance with guidelines by peer group classification (public hospitals only,^a 2686 prescriptions)



^a No Group F hospitals participated. Group G hospitals are excluded from this analysis because of low numbers of prescriptions.

Table 15 Reasons for noncompliance with guidelines by state (public and private hospitals, 2946 prescriptions)

Reason	ACT (%)	NSW (%)	NT (%)	Qld (%)	SA (%)	Tas (%)	Vic (%)	WA (%)
Spectrum too broad	58.8	31.8	41.6	37.5	25.7	30.1	24.0	34.3
Incorrect dose or frequency	17.6	15.9	27.0	30.3	18.6	23.3	22.2	33.4
Incorrect duration	17.6	19.1	24.7	12.5	11.4	18.4	17.5	17.2
Spectrum too narrow	5.9	5.9	5.6	3.9	8.6	10.7	5.5	9.6
Incorrect route	5.9	6.1	5.6	7.2	2.9	4.9	5.6	7.8

Table 16 Indications for which prescription of antimicrobials was most commonly deemed to be noncompliant with *Therapeutic Guidelines: Antibiotic* (version 14) ($\geq 30\%$ noncompliant)

Indication	Number of prescriptions	Compliant (%)	Noncompliant (%)	No guideline available (%)
Surgical prophylaxis	1473	38	39	7
Chronic Obstructive Pulmonary Disease: infective exacerbation	434	38	46	8
Trauma (includes wound)	82	35	33	18
Bronchitis	53	30	55	8
Asthma: infective exacerbation	51	24	43	33
Pancreatitis	37	43	43	5
Compound fracture	30	43	47	7
Tonsillitis	30	57	37	3
Gastroenteritis	26	38	50	4
Diarrhoea	17	29	53	6
Sinusitis	12	50	42	8
Otitis media	10	20	40	0

Note: Indications that contributed fewer than five prescriptions are excluded.

Conclusion

The 2013 Survey on national antimicrobial prescribing practice has generated some important new insights into prescribing practices in Australian hospitals, particularly the large public hospitals, where most of our sickest patients are found. Although the survey methodology had some limitations, it also had significant benefits in terms of providing guidance and training for auditors, and encouraging high participation rates. The 2013 participants have been able to generate their own data for local use, as well as benchmark themselves against similar hospitals across Australia. Participation has the added benefit of providing guidance for local antimicrobial stewardship teams, and evidence of action within the framework of the NSQHS Standards, which are used for accreditation. The success of the 2013 NAPS is likely to generate even greater rates of participation in 2014.

The overall findings of the NAPS on appropriateness of antimicrobial use and compliance with guidelines demonstrate a number of areas where significant improvements can be made at the hospital level, as well as regionally and nationally. Prominent among these are the following:

- The appropriateness of the top five most commonly prescribed antimicrobials ranged from 60% to 76%. Overall, 30% of prescriptions were deemed to be inappropriate. Inappropriate use was mainly related to unnecessary use of broad-spectrum antimicrobials and incorrect duration of treatment.
- Inappropriate prescribing was very common for patients with acute exacerbation of COPD, for which 46% of prescriptions were noncompliant with guidelines.
- Overall, surgical prophylaxis was the highest indication for antimicrobial use. Surgical prophylaxis was given for more than 24 hours in 41.5% of cases; this falls short of the best practice of less than 5%.
- 70.9% of antibiotic prescriptions had a reason documented in the medical notes.
- The most common prescriptions were for the cephalosporin antibiotics ceftriaxone and cephazolin.

The Australian Commission on Safety and Quality in Health Care will consider developing a Clinical Care Standard for antimicrobial use in surgical prophylaxis, as it was the highest indication for antibiotic use. The Commission will also consider appropriate action with regard to COPD.

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Appendix 1 Data collection form



National Antimicrobial Prescribing Survey

Audit date: / /

Patient identification no.

Specialty

Ward

D.O.B./Age yrs
/ /

Gender
M / F / U

Weight kg

eGFR/CrCl ml/min

For NICU patients
Birth weight kg

Gestational age weeks

Start date / /	Antimicrobial	Route	Dose	Freq.	Indication documented	Specify documented or presumed indication	Compliance with guidelines (only fill one box)					Surgical prophylaxis >24 hrs	Allergy mismatch	Microbiology mismatch	Incorrect route	Incorrect dose/frequency	Incorrect duration	Spectrum too broad	Spectrum too narrow	If restricted: approval given	Appropriateness (1-5)
							Therapeutic Guidelines	Local guidelines	None available	Not assessable	Non-compliant										
/ / 1.																					
/ / 2.																					
/ / 3.																					
/ / 4.																					
/ / 5.																					

Allergies to antimicrobials

 Nil known Not documented
 Present; please specify drug and nature

Microbiology

 Collected Not collected / Not assessable
 Please provide any relevant results

Clinical notes/comments

Surgical procedure performed

 Procedure:

 If prophylaxis given within the previous 24 hours, please include in audit

(1 optimal, 2 adequate, 3 suboptimal, 4 inadequate, 5 not assessable)

Doc: NAPS-DCF3; 20131029

Appendix 2 Guidelines to assist with the assessment of appropriateness



Guidelines to assist with the assessment of appropriateness

Appropriateness		If endorsed guidelines are <u>present</u>	If endorsed guidelines are <u>absent</u>
Appropriate	1 Optimal ¹	Therapy follows either the Therapeutic Guidelines ² or endorsed local guidelines optimally, including antimicrobial choice, dosage, route and duration ³ , (including for surgical prophylaxis)	Therapy will cover the (likely) causative pathogens <i>and</i> there is not a narrower spectrum or more appropriate antimicrobial choice, dosage, route or duration ³ available, (including for surgical prophylaxis) OR The patient has been reviewed by an "expert", such as an infectious diseases physician or registrar, clinical microbiologist or registrar, or specialist pharmacist
	2 Adequate	Therapy does not optimally follow the Therapeutic Guidelines ² or endorsed local guidelines, including antimicrobial choice, dosage, route or duration ³ , however, is a <i>reasonable</i> alternative choice for the (likely) causative pathogens OR For surgical prophylaxis, as above <i>and</i> duration ³ is less than 24 hours	Therapy, including antimicrobial choice, dosage, route and duration ³ is not the most optimal, however, is a <i>reasonable</i> alternative choice for the (likely) causative pathogens OR For surgical prophylaxis, as above <i>and</i> duration ³ is less than 24 hours
Inappropriate	3 Suboptimal	Therapy, including antimicrobial choice, dosage, route and duration ³ , is an <i>unreasonable</i> choice for the (likely) causative pathogens, including: <ul style="list-style-type: none"> spectrum excessively broad or failure to appropriately de-escalate with microbiological results unnecessary overlap in spectrum of activity dosage excessively high/low duration³ excessively long OR There may be a mild or non-life-threatening allergy mismatch	
	4 Inadequate	Therapy, including antimicrobial choice, dosage, route or duration ³ is <i>unlikely</i> to treat the causative pathogens OR There may be a severe or possibly life-threatening allergy mismatch, or the potential risk of toxicity due to drug interaction OR For surgical prophylaxis, the duration ³ is greater than 24 hours (except where guidelines endorse this)	
	5 Not assessable	The indication is not documented and unable to be determined from the notes OR The notes are not comprehensive enough to assess appropriateness OR The patient is too complex, due to multiple co-morbidities, allergies or microbiology results, etc.	

¹ Taking into account acceptable changes due to the patient's age, weight, renal function (eGFR/CrCl), etc. or other prescribed medications, if any of this information is available

² Antibiotic Expert Group. Therapeutic Guidelines: Antibiotic. Version 14. Melbourne: Therapeutic Guidelines Limited; 2010. <http://online.tg.org.au/tg/>

³ Duration should only be assessed if the guidelines state a recommended duration and the antimicrobial has already been dispensed for longer than this, or if there is a clear planned 'end date' documented

Appendix 3 Guidelines to assist with the assessment of concordance with guidelines

Compliant with <i>Therapeutic Guidelines</i>	The prescription complies with the current paper or online <i>Therapeutic Guidelines</i> , including route, dose and frequency; and takes into account acceptable alterations due to the patient's age, weight, renal function (eGFR/CrCl), etc, or other prescribed medications.
Compliant with local guidelines	<p>The prescription complies with officially endorsed local guidelines, including route, dose and frequency; and takes into account acceptable alterations due to the patient's age, weight, renal function (eGFR/CrCl), etc, or other prescribed medications.</p> <p>This does not include individual consultant, departmental or historical guidelines that do not have executive, or drug and therapeutic committee approval.</p> <p>If the local guidelines are based exactly on the <i>Therapeutic Guidelines</i>, choose the 'Therapeutic Guidelines' box in preference to the 'Local guidelines' box.</p>
Noncompliant with guidelines	There is noncompliance with both <i>Therapeutic Guidelines</i> and any officially endorsed local guidelines.
Guideline not available	<p>There are no guidelines available for the documented or presumed indication.</p> <p>OR</p> <p>The prescription has changed from empirical therapy to directed therapy with microbiology results and sensitivities.</p>
Not assessable	<p>The medical records are not comprehensive enough to determine a documented or presumed indication.</p> <p>OR</p> <p>It is difficult to assess if there is compliance.</p>

Glossary

allergy mismatch	Prescription of an antimicrobial that is in a class to which there is a documented allergy. (Known side effects such as nausea and vomiting are not considered to be an allergy.)
antimicrobial	A chemical substance that inhibits or destroys bacteria, viruses or fungi and that can be safely administered to humans or animals.
antimicrobial resistance	Failure of an antimicrobial to inhibit a microorganism at the antimicrobial concentrations usually achieved over time with standard dosing regimens.
antimicrobial spectrum	The range and different types of organisms that are affected by a particular antimicrobial. The antimicrobial may affect many organisms (broad spectrum) or target a specific few (narrow spectrum).
antimicrobial stewardship	An ongoing effort by a health service organisation to optimise antimicrobial use in order to improve patient outcomes, ensure cost-effective therapy and reduce adverse sequelae of antimicrobial use, including antimicrobial resistance.
clinical indication	An infection that makes a particular treatment or procedure advisable.
directed survey	A type of survey that looks specifically at a particular antimicrobial, indication, specialty, ward, etc. A directed survey may be useful following a point prevalence survey that identifies a particular issue, such as overprescription of a particular antimicrobial, or when a particular specialty or ward is not prescribing within guidelines.
interquartile range	The range of values between the first and third quartiles of the data.
microbiology mismatch	Prescription of an antimicrobial to which an organism is resistant or likely to be resistant.
National Safety and Quality Health Service (NSQHS) Standards	Standards developed by the Australian Commission on Safety and Quality in Health Care to drive the implementation of safety and quality systems and improve the quality of health care in Australia. The 10 NSQHS Standards provide a nationally consistent statement about the level of care consumers can expect from health service organisations. (See www.safetyandquality.gov.au/our-work/accreditation-and-the-nsqhs-standards for more information.)
peer group	Hospitals of a similar type and complexity, as defined by the Australian Institute of Health and Welfare. (See www.aihw.gov.au/WorkArea/DownloadAsset.aspx?id=60129547084 for more information on each of the peer groups.)
surgical prophylaxis	Administration of an antimicrobial to prevent post-operative infection.
<i>Therapeutic Guidelines: Antibiotic</i>	An evidence-based guideline, prepared by an expert group of experienced clinicians, that combines a consensus approach to best practice with critical appraisal of the evidence regarding the treatment and prophylaxis of infections in Australia.
whole-hospital period prevalence survey	A method of performing serial surveys, which is recommended for sites that may have only a small number of patients on antimicrobials on any given day. For example, a survey can be performed on the same day every week until data for a minimum of 30 patients who have met the inclusion criteria have been collected. Patients with data already collected from surveys in the preceding weeks should be excluded.
whole-hospital point prevalence survey	A survey that collects data on all patients within a facility who meet the selection criteria. Because of the extensiveness of this type of survey, an appropriate number of assessors are required. This survey can be performed over a one-week period by auditing different specialties or different wards on different days. However, it is important to collect and maintain audited bed numbers and patients for each ward to produce an accurate denominator number at the end of the survey, and not to collect the same patient's details twice.

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