AUSTRALIAN COMMISSION ON SAFETY AND QUALITY IN HEALTH CARE

AURA Antimicrobial Use and Resistance in Australia

January 2020

Antimicrobial prescribing practice in Australian hospitals

Results of the 2018 Hospital National Antimicrobial Prescribing Survey

HOSPITAL NAPS National Antimicrobial Prescribing Survey

NCAS National Centre for Antimicrobial Stewardship

GUIDANCE

Published by the Australian Commission on Safety and Quality in Health Care
Level 5, 255 Elizabeth Street, Sydney NSW 2000
Phone: (02) 9126 3600
Fax: (02) 9126 3613
Email: mail@safetyandquality.gov.au
Website: www.safetyandquality.gov.au
ISBN: 978–1–925948–16–5

Disclaimer

The content of this document is published in good faith by the Australian Commission on Safety and Quality in Health Care for information purposes. The document is not intended to provide guidance on particular healthcare choices. You should contact your healthcare provider on particular healthcare choices.

The Commission does not accept any legal liability for any injury, loss or damage incurred by the use of, or reliance on, this document.

Contents

Summary **5**
Introduction **7**
Methods **9**
Timing 9
Recruitment 9
Undertaking the survey 9
Data collection methodology 9
New indications list 10
Support for auditors 10
e-Learning module 11
Analyses 11
Limitations 12
Findings **13**
Participation 13
Number of prescriptions 18
Key performance indicators: 2018 18
Documentation of indication 18
Documentation of review or stop date 19
Surgical prophylaxis greater than 24 hours 19
Compliance with guidelines 19
Appropriateness 19
Trends for key performance indicators 2013–2018 24
Documentation of indication 24
Documentation of review or stop date 24
Surgical prophylaxis greater than 24 hours 24
Compliance with guidelines for assessable prescriptions 24
Appropriateness for assessable prescriptions 24
Reasons for inappropriateness 26
Most commonly prescribed antimicrobials 26
Appropriateness for the most commonly prescribed antimicrobials 28
Amoxicillin–clavulanic acid 30
Metronidazole 33
Most common indications for antimicrobial prescribing 35
Appropriateness of prescribing for the 20 most common indications 36
Compliance with guidelines for the 20 most common indications 38

Pneumonia ……..40
Chronic obstructive pulmonary disease……..43
Discussion **45**
Appendix 1: Hospital NAPS data collection form **48**
Appendix 2: Hospital NAPS appropriateness definitions **49**
Appendix 3: Tables and figures **50**
Appendix 4: Appropriateness of antimicrobial prescribing, 2018 Hospital NAPS contributors, by peer group **51**
References **58**

Summary

The 2018 Hospital National Antimicrobial Prescribing Survey (NAPS) provides an overview of antimicrobial prescribing in Australian public and private hospitals. This is the sixth year that the survey has been conducted. Consistent themes continue to emerge in relation to the appropriateness of antimicrobial prescribing across Australia, in NAPS contributor hospitals.

This report presents analyses of 26,714 prescriptions submitted to the Hospital NAPS database by 324 hospitals (231 public and 93 private) during 2018, and analyses of trends from 2013 to 2018.

Key findings of the 2018 Hospital NAPS:

- There were improvements in three key indicators of appropriateness of antimicrobial prescribing monitored by Hospital NAPS:
  - Documentation of indication increased to 80.3%, in 2018 compared with 70.0% in 2013
  - Documentation of review or stop date increased to 45.2%, compared with 34.8% in 2015 when this indicator was first reported
  - Proportion of surgical prophylaxis given for greater than 24 hours decreased to 28.0% in 2018, compared with 41.1% in 2013
- Whilst these improvements are encouraging there are a number of concerning patterns in regard to other aspects of appropriateness of antimicrobial prescribing:
  - Compliance with *Therapeutic Guidelines: Antibiotic* or local guidelines, declined from 72.1% in 2013 to 67.7% in 2018
  - There was minimal improvement in overall appropriateness of prescribing from 2013 to 2018 (75.8% to 77.7%)
- The five most commonly prescribed antimicrobials in Australian hospitals participating in NAPS in 2018 were: cefazolin, ceftriaxone, amoxicillin–clavulanic acid, piperacillin–tazobactam and metronidazole
- The antimicrobials with the highest rates of inappropriate prescribing in Australian hospitals participating in NAPS in 2018 were: cefalexin, cefazolin, azithromycin, amoxicillin–clavulanic acid, and metronidazole
- The five most common indications for prescribing antimicrobials in Australian hospitals that contributed to NAPS in 2018 were: surgical prophylaxis, community-acquired pneumonia, medical prophylaxis, cystitis, and cellulitis/erysipelas
- The highest proportions of prescriptions assessed as inappropriate in Australian hospitals participating in NAPS in 2018 were for: chronic obstructive pulmonary disease (COPD), surgical prophylaxis, non-surgical wound infections, community-acquired pneumonia and cystitis.

Implications for patient safety

In addition to the minimal improvement in overall appropriateness of prescribing from 2013 to 2018, the patient safety issues identified by analyses of the 2018 Hospital NAPS data are:

- Prescribing for specific indications, particularly COPD, surgical prophylaxis, non-surgical wound infections, and community-acquired pneumonia
- Appropriateness of prescribing, particularly inappropriate broad-spectrum antimicrobial use and duration of therapy
- Compliance with guidelines
- Inappropriate prescribing of selected antimicrobials, particularly for cefalexin, cefazolin, azithromycin and amoxicillin–clavulanic acid
- Documentation of indication and review or stop date.

.

To address these issues, the Commission will:

- Communicate the findings to states and territories and private hospital provider organisations to highlight the above priority areas for their antimicrobial stewardship (AMS) programs
- Promote the range of AMS implementation support resources that are currently available, including Therapeutic Guidelines shared decision-making tools and treatment pathways to guide the management of conditions such as urinary tract infection
- Encourage public and private health service organisations to routinely review their NAPS results and implement targeted strategies for departments with the highest rates of inappropriate prescribing, non-compliance with guidelines and incomplete documentation
- Work with states and territories to identify additional AMS resources and strategies that may be of assistance to smaller health service organisations, including sharing information on effective AMS quality improvement initiatives
- Review the Antimicrobial Stewardship Clinical Care Standard and associated implementation support resources in 2020
- Continue to collaborate with the Royal Australasian College of Surgeons and relevant specialty groups to improve prescribing of antimicrobials for surgical prophylaxis
- Collaborate with relevant specialty groups and societies in relation to improving appropriateness of prescribing for COPD
- Work with states, territories, and expert clinical groups to develop strategies and guidelines to improve the appropriateness of antimicrobial prescribing of broad-spectrum antimicrobials and duration of therapy.

Introduction

The Antimicrobial Use and Resistance in Australia (AURA) Surveillance System, is coordinated by the Australian Commission on Safety and Quality in Health Care (the Commission). It provides a national platform to inform the development of strategies to prevent and contain antimicrobial resistance (AMR) in human health and improve antimicrobial use across the acute and community healthcare settings. AURA also supports the National Safety and Quality Health Service (NSQHS) Preventing and Controlling Healthcare-Associated Infection Standard[1], and Australia's National Antimicrobial Resistance Strategy (2015–2019).[2] Funding for AURA is provided by the Australian Government Department of Health and state and territory health departments.

Antimicrobial use is a key factor in the development of AMR. Surveillance of antimicrobial use and appropriateness of prescribing is essential to inform prevention and containment strategies for AMR.

The Commission provides funding for the Hospital National Antimicrobial Prescribing Survey (NAPS) to contribute to AURA. The Hospital NAPS is a collaborative project between the National Centre for Antimicrobial Stewardship (NCAS) and the Guidance Group (Royal Melbourne Hospital). The NAPS is a standardised auditing tool that health service organisations may use to assess the quality of their antimicrobial prescribing. It can provide data on the quantity of prescriptions for antimicrobials for specific indications and by specialist admission type.

The Hospital NAPS supports Australian health service organisations, states and territories and private health service provider organisations to develop and conduct antimicrobial stewardship (AMS) programs by:

- Facilitating effective audit and review of antimicrobial use, including compliance with prescribing guidelines and prescribing appropriateness
- Facilitating effective communication regarding antimicrobial use and identifying key targets for interventions
- Supporting workforce education and training
- Supporting the implementation of AMS practices across all hospitals – public, private, major city, regional and remote
- Providing flexible and useful benchmarking within hospitals, across units and wards, and between hospitals and jurisdictions.

Participation in the Hospital NAPS assists health service organisations to demonstrate that they meet the AMS actions of the NSQHS Preventing and Controlling Healthcare-Associated Infection Standard. The intention of this Standard is to reduce the risk of patients acquiring preventable healthcare-associated infections, effectively manage infections if they occur, and limit the development of AMR through prudent use of antimicrobials as part of AMS. The AMS actions of this Standard promote implementation of systems for safe and appropriate antimicrobial prescribing and use of antimicrobials as part of an AMS program. This includes review of antimicrobial prescribing and use of surveillance data to support appropriate prescribing. AMS is a part of the broader system to improve patient safety and quality of care, and prevent and manage infections associated with AMR.

Since the launch of the web-based Hospital NAPS in 2013, the program has grown and diversified to provide a suite of auditing tools to support AMS across Australian public and private hospitals, and aged care settings. The data available from the NAPS program delivers insights into the appropriateness of antimicrobial prescribing and has contributed to local, state and territory, and national antimicrobial prescribing strategies to improve the quality of care delivered to patients, residents, and the community.

The Hospital NAPS has consistently demonstrated that surgical prophylaxis is the most common indication for antimicrobial prescribing, and also has one of the highest rates of inappropriateness.[3] A dedicated Surgical NAPS module was launched in July 2016, with funding support from the Commission, to investigate prescribing practices for surgical prophylaxis in more detail.[4]

Methods

Timing

Data collection for the 2018 Hospital NAPS commenced on 1 January 2018 and closed on 31 December 2018. Hospitals were encouraged to conduct their survey before Antibiotic Awareness Week in November, so that results would be available for discussion and education activities.

Recruitment

Using the NAPS registration database, approximately 1,500 individuals from 450 hospitals were invited via email to participate in the 2018 Hospital NAPS. Further promotion by the Commission and the NCAS occurred throughout the year via their websites, Twitter and the NAPS newsletter.

All hospitals offering overnight stays are able to participate in the Hospital NAPS. Facilities such as same day services, sleep clinics and other private specialty clinics without overnight stay were excluded.

Undertaking the survey

The NAPS is an online, web-based survey. Participants who register are granted access to the NAPS portal where they can submit their data. The data collected in the Hospital NAPS data collection form is shown in Appendix 1. Participants are advised that both the data collection and assessments of guideline compliance and appropriateness should ideally be performed by multidisciplinary teams.

The membership of the auditing team was determined by each participating facility, depending on the staffing resources available, and could consist of any combination of infectious diseases physicians, clinical microbiologists, other interested physicians, pharmacists, infection control practitioners or nurses. It was recommended that at least two auditors conduct the survey whenever possible, as this facilitates discussion about more challenging assessments. Preferably, auditors should have a sound clinical knowledge of antimicrobial prescribing and local prescribing guidelines.

If an on-site assessing team was not available, participants were encouraged to submit the data to an external assessment team for review, for example, within the hospital network. The NAPS support team was also available to provide additional clinical advice for facilities without infectious diseases expertise.

Data collection methodology

Depending on the hospital size and the staffing resources available, participants could choose to conduct their survey using one of the following methodologies.

Option 1: Hospital-wide point prevalence survey (preferred)
This methodology required all inpatients to be assessed so prevalence of antimicrobial use could be calculated. Data were collected on both the number of inpatients on antimicrobials (numerator) and the total number of inpatients (denominator). The data collection was recommended to be completed on a single calendar day. However, if this was not possible,

wards could be surveyed on separate days provided that all patients were surveyed once only.

Option 2: Repeat point prevalence surveys (for smaller hospitals)
While Option 1 will provide an estimate of antimicrobial prevalence, for smaller hospitals it may not allow enough data to be collected to assess prescribing appropriateness. Small hospitals (those with less than 100 acute beds) could conduct repeat point prevalence surveys whereby a whole hospital survey is conducted multiple times, with surveys at least one week apart, until at least thirty antimicrobial prescriptions have been collected. Auditors were advised that all inpatients should be included in the repeat surveys, including those who have been surveyed previously, as the appropriateness of their respective antimicrobial prescriptions may change over time.

Option 3: Random sampling point prevalence survey (for hospitals with ≥100 acute beds)
For large hospitals where a whole-hospital point prevalence survey is not able to be undertaken due to resource limitations, data could be collected from a random sample of inpatients provided the following guidelines were adhered to:

- A random sampling method should only be used in hospitals with ≥100 acute beds
- The random sampling should include patients from all wards within the hospital
- The proportion of patients sampled must be at least 50% of the inpatient population
- The random sampling is based on inpatients, not antimicrobial prescriptions.

New indications list

A new NAPS indication list was included in the Hospital NAPS in July 2018. This list incorporates a SNOMED CT coded list of infections and indications for antimicrobial use and includes selected pathogens for some common conditions.[5] It was developed and is maintained by the multidisciplinary team of infectious diseases clinicians at NCAS – Guidance Group. This extended list of indications allows for a greater ability to choose the correct indication, assisted by the addition of tag words to each indication. The list will also reduce the need to select 'other' as an indication.

Support for auditors

Auditors were able to access the following online resources to promote accurate data collection and prescription assessment, as well as assist with the reporting and feedback process:

- User guide
- Appropriateness definitions (Appendix 2)
- Case examples
- eLearning module
- Reporting templates to help hospitals communicate survey results locally
- Links to useful AMS-related presentations and posters.

The NAPS support team also provided direct support throughout the data collection period in the form of:

- Webinar training sessions
- Helpdesk support via phone and email
- A remote expert assessment service
- Assistance with the assessment of guideline compliance and prescription appropriateness for hospitals without access to infectious diseases specialists

- Capacity to request an assessment if hospitals felt it would improve the reliability of the audit.

e-Learning module

An online e-Learning module was available through the NAPS website throughout the data collection period. This provided information regarding setting up the survey, data collection and assessments of compliance with guidelines and appropriateness. An assessment quiz was also provided at the end of the module so participants could test their understanding of the Hospital NAPS data collection methodology. All participants were encouraged to complete the e-Learning module prior to data collection.

Analyses

Hospitals that conducted whole-hospital audits, including single point prevalence surveys, repeat point prevalent surveys and randomised sample surveys, were included in the analyses. To avoid issues with systematic bias, all other Hospital NAPS survey methodologies including directed surveys of selected antimicrobials, indications, specialities or wards, were excluded. De-identified hospital data are analysed by sector (public or private), state or territory, the Australian Bureau of Statistics (ABS) remoteness classifications[6] and the Australian Institute of Health and Welfare (AIHW) peer group classifications.[7] Key performance indicators are analysed and reported for these categories. The 'appropriateness' percentages include 'not assessable' prescriptions in the denominator unless otherwise specified.

Limitations

The results in this report should be interpreted in the context of the following limitations:

Sampling and selection bias
Participation in the Hospital NAPS is voluntary. The facilities that choose to participate do not represent a randomised sample, hence the results may not be representative of all Australian hospitals.

Comparison with previous surveys
In addition to the 2018 Hospital NAPS results, this report references elements of the 2013–2017 surveys. The ability to directly compare results year-to-year is limited as a result of changes over time to the inclusion criteria, methodology and distribution of participating hospitals. Modifications have been made to the methodology and data specifications of the Hospital NAPS over time, to help improve the robustness of the data and allow improved auditing and benchmarking.

New indications list
With the introduction of the new Hospital NAPS indications list in 2018, there are now more indications to choose from and, for some indications, specific pathogens have been introduced into the indication. This list also allows tag words to be added to encourage more accurate selection of indication. This may therefore impact on the selection of the indication compared with similar indications that were selected previously. This may impact on the comparisons to previous years. This issue will be mitigated by regrouping both the old indication and the new 2018 indications into reporting groups, which will be comparable to previous years' reports.

Patients may be counted multiple times
Regarding facilities that chose Option 2, certain patients may have been counted multiple times if they were still an inpatient on a subsequent audit day. This may artificially inflate the prevalence of some indications that require longer durations of treatment, or the antimicrobials that are used to treat these conditions.

Subjective nature of assessments
Individual auditors at each facility were responsible for assessing antimicrobial prescribing appropriateness and compliance with guidelines, although remote expert assessments were conducted by the NAPS support team on request. These assessments involve some degree of interpretation; the standardised appropriateness definitions used by auditors will help to moderate subjectivity.

Use of alternative audit tools
Depending on local AMS issues, casemix and resources, hospitals may have chosen to use other audit tools, such as the Surgical NAPS or Quality Improvement NAPS. This may have impacted on the number of hospitals that chose to participate in the 2018 Hospital NAPS.

Findings

Participation

This report analyses the data submitted by 324 hospitals (231 public and 93 private) that met the inclusion criteria. Participation in the Hospital NAPS has remained consistent for the past three years (Figure 1). Table 1 shows that one third of all eligible public and private hospitals participated in the 2018 Hospital NAPS, and all Australian states and territories were represented. Public hospital participation in the Northern Territory (NT) and Australian Capital Territory (ACT) reached 100%, although both territories have a smaller number of hospitals than other states. Participation by South Australian public (11.7%) and private (10.7%) hospitals remained lower than in other states.

Details of hospital participation by peer group are presented in Table 2 and displayed graphically in Figure 2. Principal Referral hospitals continue to have very high participation (87.1%), followed closely by public and private Acute Group A and B hospitals, which also have substantial participation rates above 60%. Among the Specialist Women's and Children's Hospitals, participation has been consistently high.

Hospitals from all remoteness classifications contributed data to the 2018 Hospital NAPS. Among public hospitals, participation by inner regional facilities continues to increase (44.4%), although those located in major cities (52.7%) still contribute the majority of the data. There was close to 25% participation from outer regional hospitals and less than 15% from remote hospitals. Very remote hospitals had a 6% participation rate. In private hospitals, the pattern of representation is different; participation by remoteness area is equally distributed across major cities (31.2%), inner regional (32.2%) and outer regional (31.1%) areas. There are no private hospitals located in remote or very remote areas. This data is summarised in Table 1 and Figure 3.

Figure 1: Number of public and private hospitals that contributed to the Hospital NAPS, 2013–2018

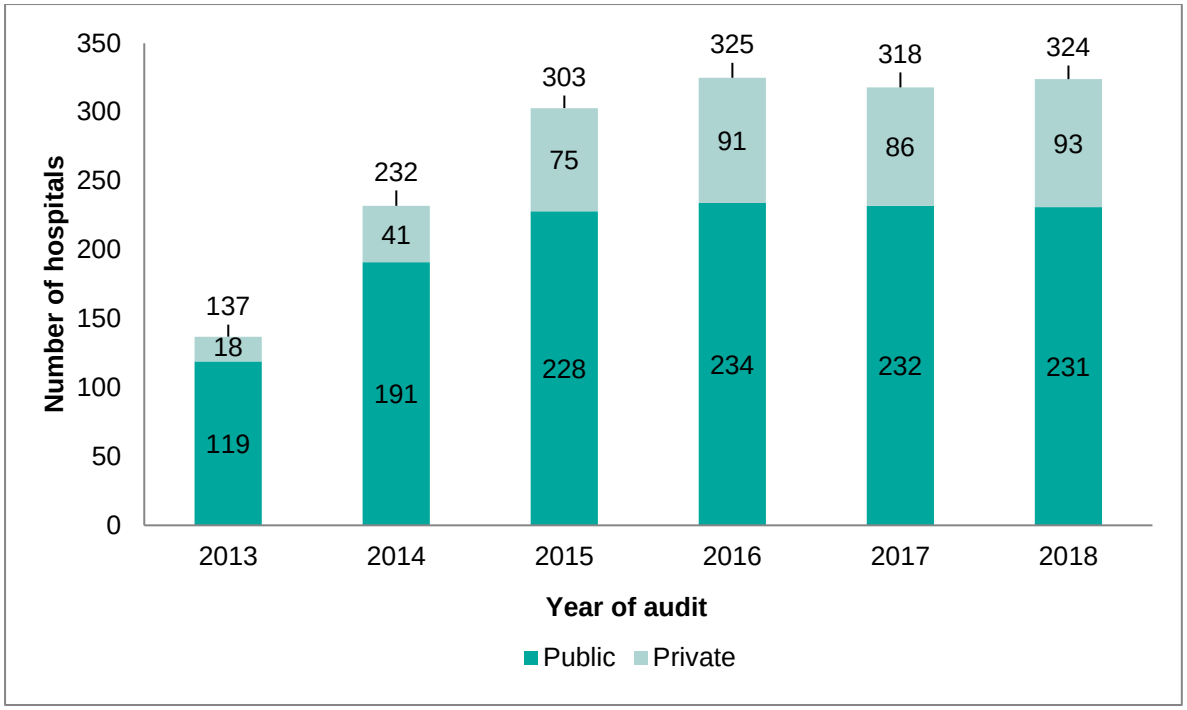


Table 1: Public and private hospitals that contributed to Hospital NAPS by state, territory and remoteness area, 2018

Participating hospitals		Funding type	Number of participating hospitals (*n*)	Number of hospitals in reporting group* (*n*)	Participation (%)	Number of participating hospitals (*n*)	Number of hospitals in reporting group* (*n*)	Total participating hospitals (%)
State or territory	NSW	Public	88	213	41.3	119	316	37.7
		Private	31	103	30.1			
	Vic	Public	71	144	49.3	98	215	45.6
		Private	27	71	38.0			
	Qld	Public	28	122	23.0	46	181	25.4
		Private	18	59	30.5			
	SA	Public	9	77	11.7	12	105	11.4
		Private	3	28	10.7			
	WA	Public	24	90	26.7	33	113	29.2
		Private	9	23	39.1			
	Tas	Public	4	23	17.4	8	30	26.7
		Private	4	7	57.1			
	NT	Public	5	5	100	5	6	83.3
		Private	na	1	na			
	ACT	Public	2	2	100	3	6	50.0
		Private	1	4	25.0			
Remoteness	Major cities	Public	87	165	52.7	156	386	40.4
		Private	69	221	31.2			
	Inner regional	Public	83	187	44.4	102	246	41.5
		Private	19	59	32.2			
	Outer regional	Public	49	213	23.0	54	229	23.6
		Private	5	16	31.3			
	Remote	Public	9	61	14.8	9	61	14.8
		Private	na	na	na			
	Very remote	Public	3	50	6.0	3	50	6.0
		Private	na	na	na			
Total		**Public**	**231**	**676**	**34.2**	**324**	**972**	**33.3**
		Private	**93**	**296**	**31.4**			

na – not applicable

*Numbers represent all eligible hospitals in the AIHW reporting groups for public and private, states and territories, and remoteness classifications

Table 2: Public and private hospitals that contributed to the Hospital NAPS by peer group, 2018

Participating hospitals		Number of participating hospitals (*n*)	Number of hospitals in reporting group (*n*)	Participation (%)
Public hospital peer group*	Principal referral	27	31	87.1
	Public acute group A hospitals	49	63	77.8
	Public acute group B hospitals	27	44	61.4
	Public acute group C hospitals	63	142	44.4
	Public acute group D hospitals	33	189	17.5
	Other acute specialised hospitals	1	3	33.3
	Children's hospitals†	6	6	100
	Women's hospitals	4	6	66.7
	Women's and children's hospitals	1	1	100
	Mixed subacute and non–acute hospitals	7	25	28.0
	Rehabilitation and GEM§ hospitals	4	13	30.8
	Very small hospitals	5	123	4.1
	Psychiatric hospitals	3	21	14.3
	Unpeered hospitals	1	9	11.1
Private hospital peer group#	Private acute group A hospitals	14	22	63.6
	Private acute group B hospitals	26	36	72.2
	Private acute group C hospitals	23	49	46.9
	Private acute group D hospitals	17	69	24.6
	Other acute specialised hospitals	5	15	33.3
	Private rehabilitation hospitals	7	23	30.4
	Private acute psychiatric hospitals	1	29	3.4

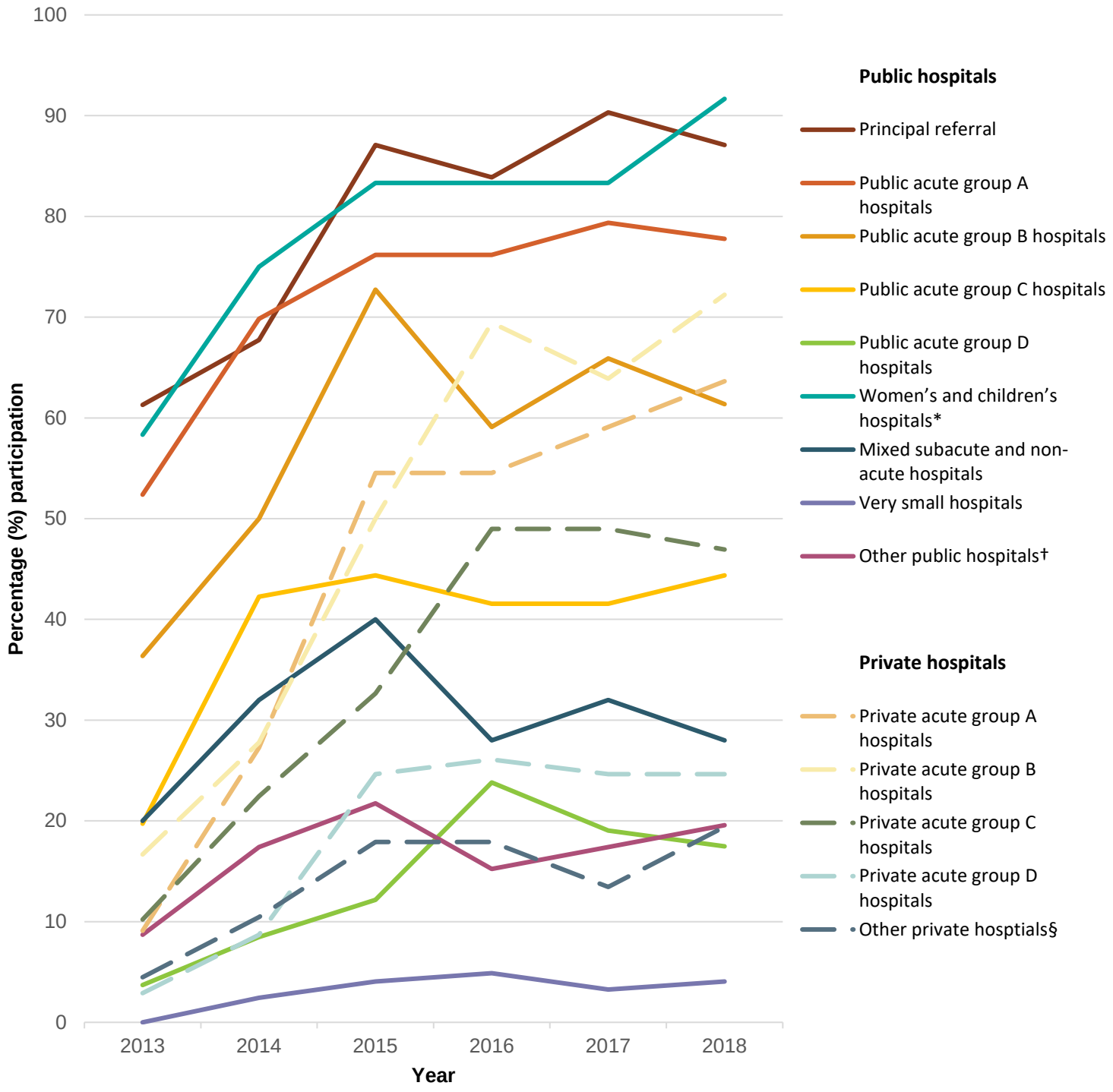
* Excludes early parenting centres, drug and alcohol hospitals, same day hospitals, outpatient hospitals

† There are now six children's hospitals in Australia, following the opening of a new hospital in Victoria. The AIHW list has not yet been updated to reflect this change. The 100% participation rate for Children's hospitals includes the new Victorian hospital.

§ GEM – Geriatric Evaluation and Management

Excludes ineligible private hospitals

Figure 2: Public and private hospital participation in Hospital NAPS by peer group classification, 2013–2018

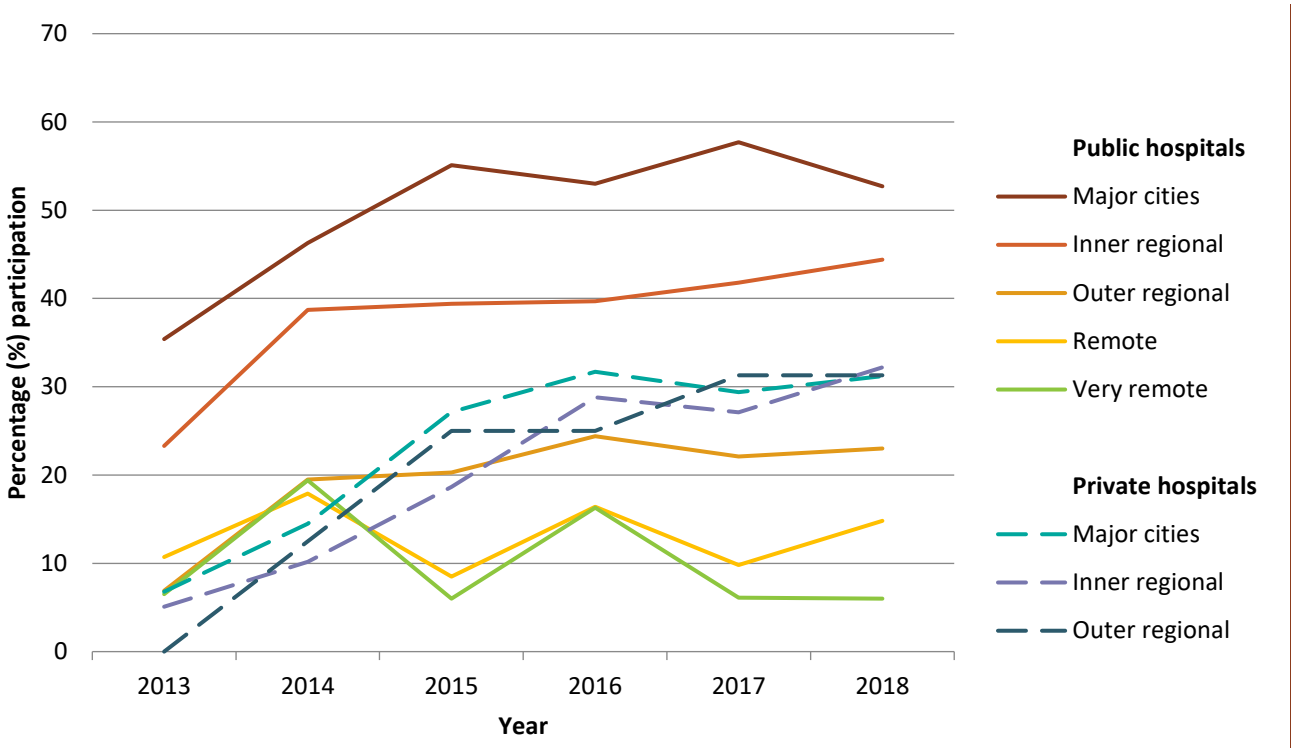


* This category includes public children's hospitals, women's hospitals and women's and children's hospitals

† This category includes public rehabilitation and geriatric evaluation and management hospitals, psychiatric hospitals and unpeered hospitals

§ This category includes private rehabilitation hospitals, acute psychiatric hospitals and other acute specialised hospitals

Figure 3: Public and private hospital participation in Hospital NAPS by remoteness area, 2013–2018



Number of prescriptions

Data from 17,175 patients were submitted during the 2018 Hospital NAPS data collection period, generating 26,714 prescriptions for analysis; this is similar to 2017 when 26,277 prescriptions were entered into the database. Private hospitals submitted approximately one-fifth (20.9%) of prescriptions in 2018. Hospitals in major cities accounted for almost one-half (48.2%) of all participating facilities and a little over two-thirds (69.1%) of total prescriptions. Just over half of the prescriptions (52.6%) were contributed by Principal Referral and Public Group A hospitals. See Tables 3 and 4 for the breakdown of participation, number of prescriptions and key performance indicators by hospital peer group.

Key performance indicators: 2018

Documentation of indication

The overall rate of documentation of indication was 80.3% (Tables 3 and 6), which is an improvement compared with 2017 (77.7%). In 2018, the rate of documentation of indication for public hospital contributors was 84.4%; across public hospital peer groups the rate ranged from 78.2 to 94.2%. For private hospital contributors, the rate was 64.5%; this is an improvement compared with 2017 (59.7%), but remains well below the best-practice target of 95% that has been adopted by NCAS for the Hospital NAPS (Table 3).

Documentation of review or stop date

In 2015, documentation of a review or stop date was introduced in the NAPS as a quality indicator. As there was no published best-practice target for review or stop date documentation, NCAS has applied the target of 95% in line with the other NAPS key quality indicators. In 2018, 45.2% of all audited antimicrobial prescriptions had a documented review or stop date; this was a large improvement compared with 2017 (40.7%) (Tables 3 and 6). Private hospitals routinely perform better than public hospitals for this indicator, with a documentation rate in 2018 of 56.2% compared with 42.3%. However, compared with previous years, almost every peer group showed improvements in the documentation of review and stop date in 2018 (Table 3).

Surgical prophylaxis greater than 24 hours

The rate of surgical prophylaxis that is prescribed for longer than 24 hours varies widely between states, remoteness areas and hospital peer groups (Table 3). On average, 28.0% of antimicrobial prophylaxis prescriptions extend 24 hours beyond the time of surgery, with hospitals reporting rates that ranged from 0 to 50%. This is an 6.7% relative reduction in extended surgical prophylaxis compared with 2017 (30.0%). In 2017, there was a 10% difference between the rates of prolonged surgical prophylaxis reported in public hospitals (36.4%) compared with private hospitals (26.5%). This difference is not apparent in 2018 due to large improvements in duration of surgical prophylaxis in public hospitals (27.9%), a relative improvement of 23.3% in one year.

Compliance with guidelines

One-quarter of all prescriptions (25.7%) were assessed as being non-compliant with either the *Therapeutic Guidelines*[8] or locally endorsed guidelines. The rate of non-compliance was lower in public hospitals (23.6%) than in private hospitals (33.6%). When analysed by remoteness classification, major city hospitals had the lowest non-compliance rate (23.8%). Principal Referral hospitals and specialised hospitals had lower rates of non-compliance than hospitals in other peer groups (Table 4).

Table 5 demonstrates how the different compliance with guidelines categories have changed over the six years. From 2013 to 2018, the rate of prescriptions being assessed as compliant with the *Therapeutic Guidelines*[8] has consistently been approximately 44%. In contrast, over that period there has been a decrease in the rate of prescriptions being assessed as compliant with locally endorsed guidelines, from 14.1% in 2013 to 9.4% in 2018. This significant decrease has been offset mainly by the increase in prescriptions being assessed as directed therapy. This may be in part due to increased rates of antimicrobial resistance within the hospital setting or better microbiological sampling over the years of audit. Over the same time, the proportion of prescriptions assessed as non-compliant with guidelines has consistently been approximately 25%. The rate of prescriptions being assessed as ‘not assessable’ has decreased, which may be as a result of improved documentation of indication.

Appropriateness

In the 2018 Hospital NAPS, 21.4% of prescriptions were assessed as inappropriate. One in five public hospital prescriptions (20.0%) was assessed as inappropriate, an improvement from 21.8% in 2017. In 2018, private hospitals reported a higher rate of inappropriate prescribing (26.8%) compared with 2017 (24.8%), which is a reversal of improvements seen in previous years. When analysed by peer group, almost all

classifications of public hospitals showed small improvements in the rate of inappropriate prescribing compared with 2017. The inverse is true for private hospital peer groups (Table 4).

Table 5 demonstrates how the different appropriateness categories have changed over time, with the proportion of those prescriptions that are assessed as ‘optimal’ increasing from 54.0% to 59.9%, which is very encouraging. As a result, the categories of ‘adequate’ and ‘suboptimal’ have both decreased over the same period. Approximately 10% of prescriptions continue to be assessed as inadequate, which is disappointing, as this category should be approaching 0% to ensure patient safety when prescribing antimicrobials. The rate of prescriptions being assessed as ‘not assessable’ has also decreased in relation to appropriateness, which may be as a result of the better documentation of indication, improved confidence of the auditors to make these assessments or improved clinical practice in relation to infectious diseases diagnosis.

Table 3: Hospital NAPS key indicator results, by state and territory, remoteness area and AIHW peer group, 2018

Key Indicators		Number of hospitals (*n*)	Percentage of sample (%)	Number of prescriptions (*n*)	Percentage of prescriptions (%)	Indication documented (%)	Review or stop date documented (%)	Surgical prophylaxis >24 hours (%)*
State or territory	NSW & ACT	122	37.7	9,770	36.6	80.4	44.4	31.8
	Vic	98	30.3	6,920	25.9	80.7	46.8	28.5
	Qld & NT	51	15.7	4,762	17.8	81.1	40.0	33.0
	SA	12	3.7	1,473	5.5	85.4	56.6	12.7
	WA	33	10.2	3,203	12.0	76.1	47.3	21.0
	Tas	8	2.5	586	2.2	76.6	43.7	25.3
Remoteness	Major Cities	156	48.2	18,448	69.1	80.6	48.2	28.9
	Inner regional	102	31.5	5,350	20.0	78.1	39.4	23.0
	Outer regional	54	16.7	2,183	8.2	80.7	38.2	25.7
	Remote	9	2.8	544	2.0	83.6	34.9	40.0
	Very remote	3	0.9	189	0.7	97.9	38.1	na
Public hospital peer group	Principal referral	27	8.3	7,945	29.7	85.4	43.3	32.1
	Public acute group A hospitals	49	15.1	6,096	22.8	84.6	43.5	30.1
	Public acute group B hospitals	27	8.3	1,604	6.0	81.6	38.0	25.2
	Public acute group C hospitals	63	19.4	2,695	10.1	79.8	36.5	14.5
	Public acute group D hospitals	33	10.2	739	2.8	85.3	40.7	28.6
	Other acute specialised hospitals	1	0.3	87	0.3	78.2	16.1	40.0
	Children's hospitals	6	1.5	998	3.7	88.2	44.2	33.9
	Women's hospitals	4	1.2	301	1.1	90.7	62.5	10.5
	Women's and children's hospitals	1	0.3	140	0.5	85.0	32.1	27.3
	Mixed subacute and non–acute hospitals	7	2.2	182	0.7	86.3	28.6	0.0
	Rehabilitation and GEM† hospitals	4	1.2	70	0.3	84.3	41.4	0.0
	Very small hospitals	5	1.5	32	0.1	90.6	62.5	na
	Psychiatric hospitals	3	0.9	190	0.7	94.2	76.8	na
	Unpeered hospitals	1	0.3	48	0.2	83.3	56.3	0.0
Private hospital peer group	Private acute group A hospitals	14	4.3	1,963	7.4	70.4	51.4	37.5
	Private acute group B hospitals	26	8.0	1,697	6.4	54.9	50.7	29.7
	Private acute group C hospitals	23	7.1	859	3.2	63.1	58.3	33.3
	Private acute group D hospitals	17	5.3	621	2.3	68.0	73.3	14.1
	Other acute specialised hospitals	5	1.5	191	0.7	63.9	80.1	0.8
	Private rehabilitation hospitals	7	2.2	237	0.9	79.3	60.3	50.0
	Private acute psychiatric hospitals§	1	0.3	19	0.1	–	–	–
Funding type	Public	231	71.3	21,127	79.1	84.4	42.3	27.9
	Private	93	28.7	5,587	20.9	64.5	56.2	28.0
Combined national result		**324**	**100**	**26,714**	**100**	**80.3**	**45.2**	**28.0**

na – not applicable
* Where surgical prophylaxis was selected as the indication (n=3,764)
† GEM – Geriatric Evaluation and Management
§ Results are not displayed if there are fewer than 30 prescriptions

Table 4: Compliance with guidelines and prescription appropriateness in Hospital NAPS contributors, by state and territory, remoteness area and AIHW peer group, 2018

	% Compliance with guidelines	% Appropriateness §

Key Indicators		Compliant	Non–compliant	Directed therapy	Not available	Not assessable	Appropriate	Inappropriate	Not assessable
State or territory	NSW & ACT	52.7%	25.7%	14.9%	3.6%	3.2%	73.3%	22.9%	3.8%
	Vic	54.1%	26.0%	11.2%	3.6%	5.1%	74.2%	21.0%	4.9%
	Qld & NT	52.4%	27.7%	13.7%	3.7%	2.6%	74.7%	21.7%	3.6%
	SA	60.0%	19.5%	14.7%	4.3%	1.6%	82.3%	15.6%	2.1%
	WA	55.3%	24.1%	14.6%	3.5%	2.6%	77.4%	20.1%	2.5%
	Tas	49.8%	29.0%	13.0%	5.5%	2.7%	75.1%	22.5%	2.4%
Remoteness	Major Cities	54.0%	23.8%	14.8%	3.9%	3.6%	75.5%	20.9%	3.7%
	Inner regional	50.8%	31.9%	10.8%	3.2%	3.3%	71.2%	24.7%	4.1%
	Outer regional	56.9%	25.1%	12.4%	2.8%	2.8%	77.5%	18.5%	4.0%
	Remote	55.2%	29.0%	9.0%	4.4%	2.4%	75.0%	21.7%	3.3%
	Very remote	61.9%	25.4%	7.9%	3.2%	1.6%	78.8%	19.1%	2.1%
Public Hospital Peer Group	Principal referral	53.4%	19.8%	19.9%	4.5%	2.4%	79.0%	18.2%	2.8%
	Public acute group A hospitals	49.3%	27.8%	14.6%	5.0%	3.4%	73.9%	23.2%	2.9%
	Public acute group B hospitals	53.3%	28.4%	11.2%	2.7%	4.4%	73.2%	21.8%	5.1%
	Public acute group C hospitals	59.6%	27.4%	7.2%	2.3%	3.5%	74.9%	20.9%	4.2%
	Public acute group D hospitals	50.6%	34.8%	8.9%	2.2%	3.5%	67.9%	24.8%	7.3%
	Other acute specialised hospitals	56.3%	16.1%	19.5%	2.3%	5.8%	73.6%	14.9%	11.5%
	Children's hospitals	68.3%	10.2%	12.5%	5.3%	3.6%	86.5%	11.0%	2.5%
	Women's hospitals	76.7%	5.0%	5.7%	8.0%	4.7%	89.4%	7.0%	3.7%
	Women's and children's hospitals	65.7%	7.9%	9.3%	12.9%	4.3%	83.6%	10.7%	5.7%
	Mixed subacute and non–acute hospitals	50.6%	30.2%	13.7%	0.6%	5.0%	64.8%	29.7%	5.5%
	Rehabilitation and GEM* hospitals	62.9%	7.1%	17.1%	0.0%	12.9%	80.0%	7.1%	12.9%
	Very small hospitals	81.3%	6.3%	6.3%	0.0%	6.3%	84.4%	6.3%	9.4%
	Psychiatric hospitals	68.4%	23.2%	4.2%	0.0%	4.2%	79.5%	17.4%	3.2%
	Unpeered hospitals	33.3%	22.9%	27.1%	8.3%	8.3%	64.6%	35.4%	0.0%
Private Hospital Peer Group	Private acute group A hospitals	44.1%	38.7%	11.2%	2.2%	3.8%	67.1%	28.3%	4.6%
	Private acute group B hospitals	52.7%	32.9%	9.1%	1.4%	3.9%	67.8%	27.2%	5.0%
	Private acute group C hospitals	50.3%	36.8%	6.1%	2.2%	4.7%	63.3%	30.9%	5.8%
	Private acute group D hospitals	65.1%	27.2%	2.4%	1.0%	4.4%	67.5%	27.5%	5.0%
	Other acute specialised hospitals	81.7%	10.5%	3.7%	1.1%	3.1%	86.9%	11.0%	2.1%
	Private rehabilitation hospitals	51.5%	21.5%	21.9%	1.3%	3.8%	82.7%	9.7%	7.6%
	Private acute psychiatric hospitals†	–	–	–	–	–	–	–	–
Funding type	Public	54.2%	23.6%	14.9%	4.2%	3.2%	76.5%	20.0%	3.5%
	Private	51.8%	33.6%	9.0%	1.8%	4.0%	68.2%	26.8%	5.0%
Combined national result		**53.7%**	**25.7%**	**13.6%**	**3.7%**	**3.4%**	**74.8%**	**21.4%**	**3.8%**

* GEM – Geriatric Evaluation and Management

† Results are not displayed if there are fewer than 30 prescriptions

§ Appropriateness percentages include 'not assessable' prescriptions in the denominator

Table 5: Hospital NAPS compliance with guidelines and prescription appropriateness, for all prescriptions 2013–2018

		Percentage of total prescriptions (%)					
		2013	2014	2015	2016	2017	2018
Compliance with guidelines	Compliant with *Therapeutic Guidelines*[1]	44.5	44.3	45.3	42.4	44.8	44.2
	Compliant with local guidelines	14.1	12.6	10.4	9.7	9.3	9.4
	Non compliant	22.7	23.8	23.8	26.9	26.2	25.7
	Directed therapy	na	9.5	12.0	12.7	12.5	13.6
	No guideline available	12.0	5.3	3.7	4.0	3.3	3.7
	Not assessable	6.6	4.5	5.0	4.4	3.8	3.4
Appropriateness	Optimal	54.0	55.2	54.5	56.6	58.1	59.9
	Adequate	16.9	16.9	17.8	15.6	14.9	14.9
	Suboptimal	15.0	12.7	12.3	11.3	12.1	11.9
	Inadequate	7.7	10.5	10.0	11.2	10.2	9.5
	Not assessable	6.6	4.7	5.4	5.3	4.7	3.8

na – not applicable as this indicator was introduced in 2014

Trends for key performance indicators 2013–2018

Table 6 shows the trends for the five key performance indicators for the Hospital NAPS from 2013 to 2018 (see also Figure 4).

Documentation of indication

There has been a significant increase in the documentation of indication from 70.0% in 2013 to 80.3% in 2018. While still low in comparison to the 95% best practice target all hospitals should be aiming for, it is encouraging nonetheless to see such ongoing improvements.

Documentation of review or stop date

Documentation of review or stop date as a performance indicator was only introduced in 2015. Since then, there has been an increase from 34.8% to 45.2%, a relative increase of 29.9% in four years. While this is well below the target of 95% for best practice, continued improvement at this rate should see a rapid rise to more acceptable levels.

Surgical prophylaxis greater than 24 hours

The appropriateness of antimicrobials prescribed for surgical prophylaxis has always been an area of low appropriateness, as assessed by previous Hospital NAPS surveys. There have recently been targeted quality and safety initiatives to improve use in this area, including an Advisory issued by the Commission in 2018.[9] Prescribing antimicrobials for greater than 24 hours is not consistent with clinical guidelines, where their use is usually recommended for a single dose prior to incision or for up to 24 hours in some more complex surgery. Prescribing antimicrobials for greater than 24 hours is discouraged, and the rate at which this occurs should be less than 5% of total surgical prophylaxis prescriptions in a facility.

The proportion of surgical prophylaxis prescriptions greater than 24 hours has decreased over the past six years, from 41.1% in 2013 to 28.0% in 2018. This is an encouraging trend, but still well above the best practice target of 5%.

Compliance with guidelines for assessable prescriptions

When considering only those prescriptions that had guidelines available for assessment (excluding directed therapy, guidelines not available and not assessable), the compliance rate for prescriptions that are 'compliant with *Therapeutic Guidelines*[8] or local guidelines' has decreased over the period. In 2018, approximately one in three prescriptions with an available guideline (32.3%) were non-compliant with the relevant guideline. Further investigation into the reasons for this may be useful for design of improvement programs.

Appropriateness for assessable prescriptions

In association with the demonstrated decrease in rates of compliance with guidelines, there has been a contrasting increase in prescriptions assessed as appropriate, when the 'not assessable' prescriptions are removed. There was minimal change in the rate of appropriate prescribing from 2013 to 2018, with an absolute 1.9% improvement since 2013 (Table 6).

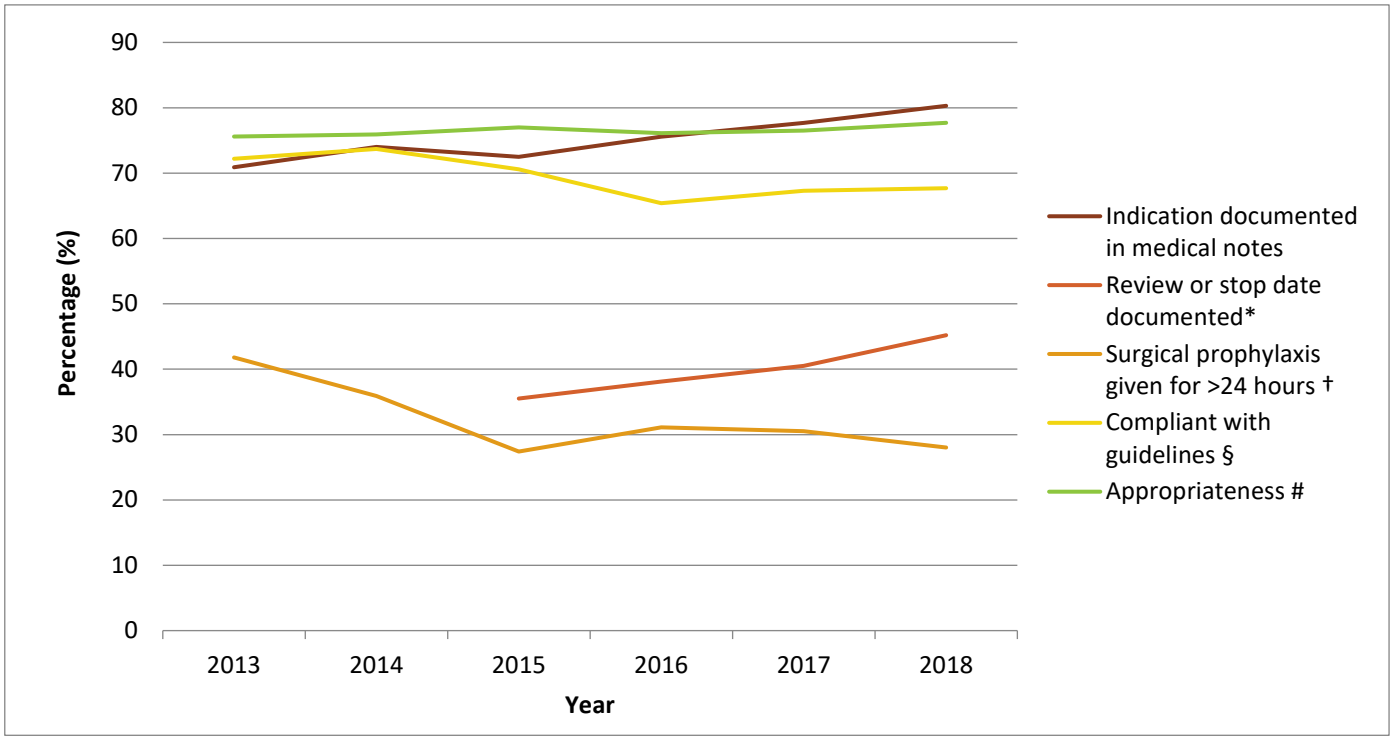
Appropriateness varied by institution, with Principal Referral hospitals having the lowest variability between facilities for this indicator compared to Public Acute Group A, B, C and D hospitals (Appendix 4).

Table 6: Hospital NAPS key indicators, for assessable prescriptions, 2013–2018

Key indicator	Percentage of comparator prescriptions (%)					
	2013	2014	2015	2016	2017	2018
Indication documented in medical notes (best practice > 95%)	70.0	74.7	71.9	75.5	77.7	80.3
Review or stop date documented (best practice > 95%)	na	na	34.8	38.0	40.7	45.2
Surgical prophylaxis given for >24 hours (best practice < 5%)*	41.1	36.1	26.8	30.1	30.0	28.0
Compliant with *Therapeutic Guidelines*[1] or local guidelines†	72.1	70.5	70.1	66.0	67.4	67.7
Appropriate (optimal and adequate)§	75.8	75.6	76.4	76.2	76.6	77.7

na – not applicable as this indicator was introduced in 2015
* Where surgical prophylaxis was selected as the indication (n=3,764 prescriptions in 2018)
† Prescriptions for which compliance was assessable (n=21,187 prescriptions in 2018). Excludes prescriptions for which guidelines were not available, as well as prescriptions that were 'directed therapy' or 'not assessable'.
§ Prescriptions for which appropriateness was assessable (n=25,706 prescriptions in 2018). Excludes prescriptions deemed to be 'not assessable'.

Figure 4: Hospital NAPS key indicators for comparator prescriptions by percentage, 2013–2018



*Collection of data on documentation of review and stop date commenced in 2015
† Where surgical prophylaxis was selected as the indication (n=3,764 prescriptions in 2018)
§ Prescriptions for which compliance was assessable (n=21,187 prescriptions in 2018). Excludes prescriptions for which guidelines were not available, as well as prescriptions that were 'directed therapy' or 'not assessable'.
# Prescriptions for which appropriateness was assessable (n=25,706 prescriptions in 2018). Excludes prescriptions deemed to be 'not assessable'.

Reasons for inappropriateness

Table 7 shows the most common reasons for prescriptions being assessed as inappropriate. The documentation of these fields is optional, and analysis of the Hospital NAPS data has shown that they are not specified for a significant percentage of prescriptions. The most common reasons for prescriptions being assessed as inappropriate include 'spectrum too broad' (23.7%), 'incorrect dose or frequency' (20.3%), and 'incorrect duration' (20.0%). These results were similar to the 2017 results apart from 'incorrect duration', which has increased from 16.5% to 20%.

Of the 26,714 prescriptions assessed, the percentage that were identified as having a microbiology mismatch (1.3%) or allergy mismatch (0.4%), continues to decrease from the 2017 results, (1.5% and 0.5% respectively). Although the targets for these are 0%, these very low rates are impressive.

Table 7: Reasons for a prescription being assessed as inappropriate, Hospital NAPS contributors, 2018

Reason	Yes	No	Not specified
Spectrum too broad	23.7%	40.4%	36.0%
Incorrect dose or frequency	20.3%	45.7%	34.0%
Incorrect duration	20.0%	47.6%	32.4%
Antimicrobial not required	16.6%	50.9%	32.5%
Spectrum too narrow	8.0%	52.3%	39.7%
Incorrect route	4.0%	55.2%	47.8%

n=4,773

Most commonly prescribed antimicrobials

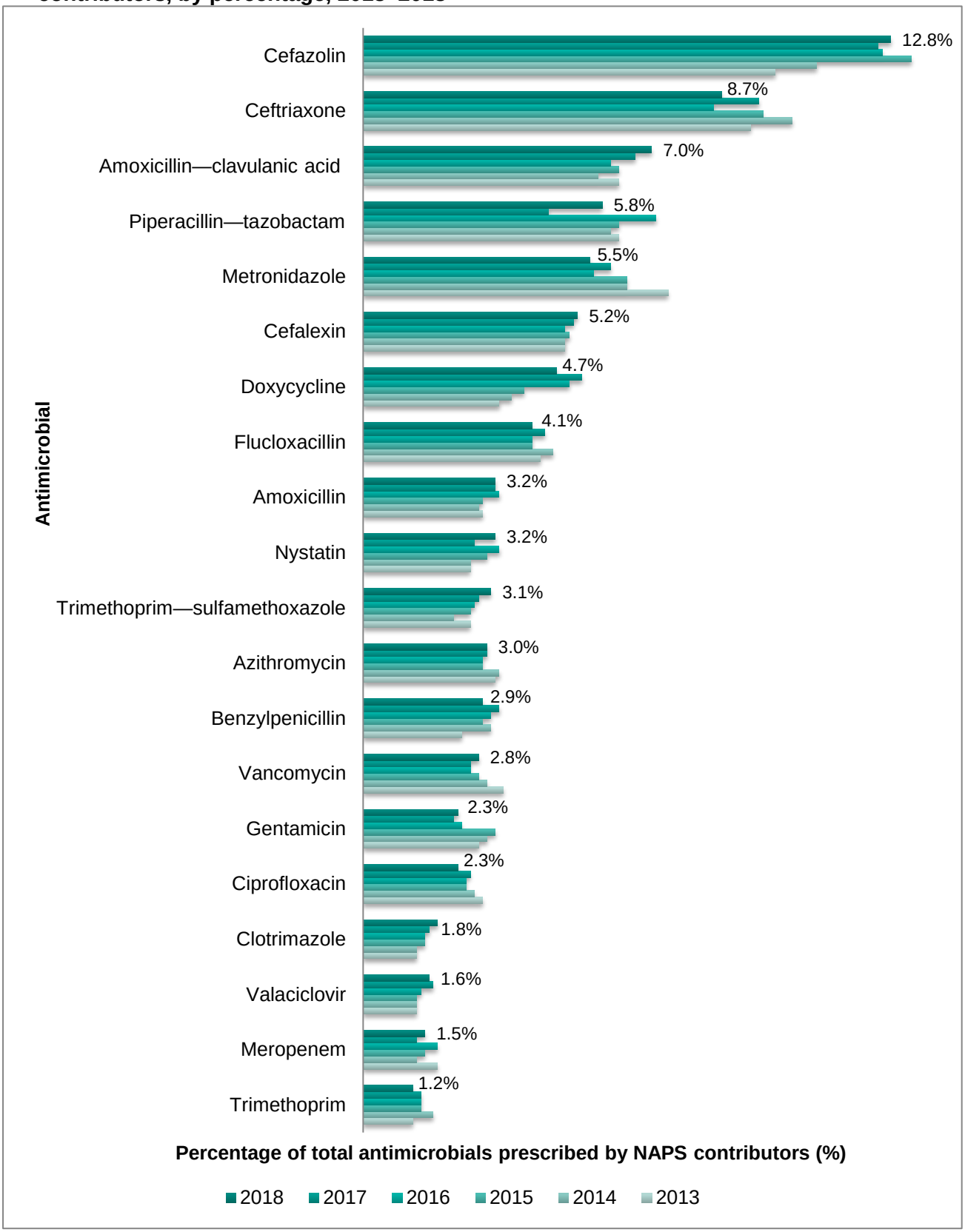
In 2017, Australia experienced a number of antimicrobial drug shortages, which impacted on clinician prescribing and altered the usual prescribing rates of many antibiotics in that year. A major driver of the change was a prolonged supply issue with piperacillin–tazobactam; the rate of prescribing of this agent reported by Hospital NAPS contributors fell to 4.5% in 2017. Concurrently, increases in use of agents such as benzylpenicillin, ceftriaxone and metronidazole were seen. This contrasts with usage changes in other surveillance programs. There were increases in usage of third (15.5%) and fourth (84.9%) generation cephalosporins and carbapenems (8.4%) in National Antimicrobial Utilisation Surveillance Program contributors, compared with 2016.[10] The differences were likely due to differences in surveillance methodologies.

Figure 5 shows the 20 most common antimicrobials prescribed in the 2018 Hospital NAPS. After the resolution of the piperacillin–tazobactam stock shortage, the 2018 prescribing rate has rebounded to 5.8%, which is still lower than the 2016 rate of 7.1%. The use of ceftriaxone and metronidazole appears to have normalised. The rates reported by 2018 Hospital NAPS contributors for these agents were 8.7% and 5.5% respectively; similar to values recorded in 2016. There is a steady upward trend in use of amoxicillin–clavulanic acid reported by Hospital NAPS contributors; in 2018, the rate reported was 7.0%.

The rates of prescribing of cefalexin, cefazolin and amoxicillin by Hospital NAPS contributors remained consistent from 2013 to 2018, as did usage of many other first-line, narrow spectrum antimicrobials. Antimicrobials that continue to increase in use are nystatin, trimethoprim–

sulfamethoxazole and clotrimazole (Figure 5), although these all have high rates of appropriateness; 73.4% for clotrimazole, 79.9% for nystatin and 88.9% for trimethoprim–sulfamethoxazole (Figure 6). There has been a downward trend in use of cefazolin since a peak in 2015; however, there was a slight increase in 2018.

Figure 5: The 20 most common antimicrobials prescribed by Hospital NAPS contributors, by percentage, 2013–2018



Appropriateness for the most commonly prescribed antimicrobials

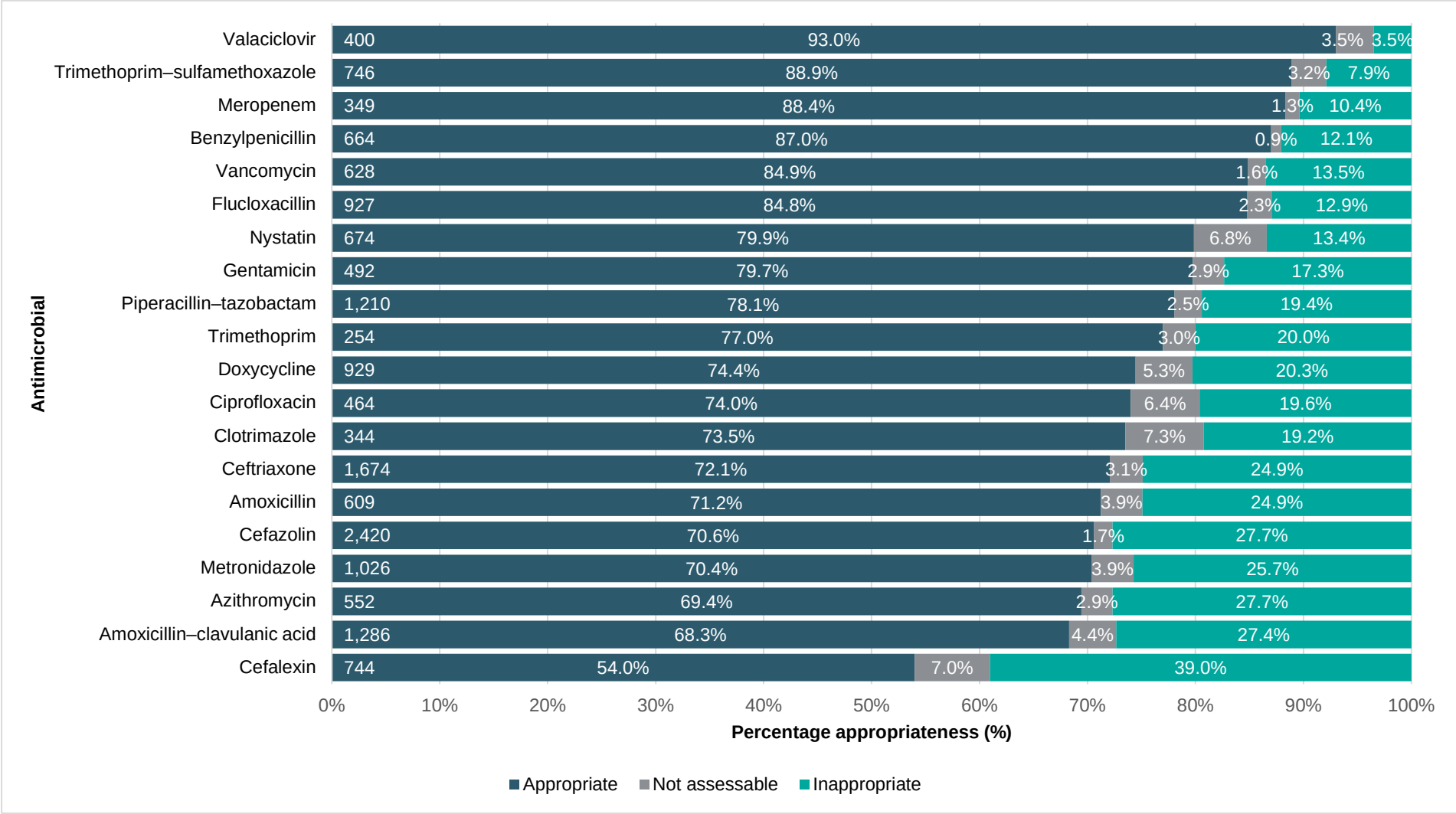
Figure 6 shows the appropriateness of prescribing for the 20 most commonly prescribed antimicrobials in 2018. The antimicrobials with the highest rates of inappropriate prescribing were cefalexin (39.0%), cefazolin (27.7%), azithromycin (27.7%), amoxicillin–clavulanic acid (27.4%) and metronidazole (25.7%). In previous Hospital NAPS reports, these antibiotics have routinely been among those where at least 1 in 4 prescriptions was assessed as inappropriate. The antimicrobials with the greatest improvements in inappropriateness assessments compared with 2017 were cefalexin (4.3% decrease), ceftriaxone (4.2% decrease) and benzylpenicillin (2.2% decrease). Of these, cephalexin had the greatest relative improvement (10%).

The antimicrobials that are commonly prescribed for medical prophylaxis, such as valaciclovir and trimethoprim–sulfamethoxazole, are usually given in accordance with guidelines or protocols. High rates of prescribing appropriateness have been consistently reported for these medications in the Hospital NAPS over time. Many narrow spectrum antimicrobials have also had high rates of appropriate use from 2013 to 2018, including benzylpenicillin (87.0%) and flucloxacillin (84.8%).

Antimicrobials that are usually restricted within the hospital setting, such as vancomycin and meropenem, are routinely assessed as having been prescribed with a high level of appropriateness (84.9% and 88.4% respectively). This is less often the case for piperacillin–tazobactam; in 2018, the appropriateness rate was 78.1%.

The antimicrobials with the greatest increase in inappropriateness from 2017 were nystatin with a 3.3% increase, azithromycin with a 2.3% increase and trimethoprim with a 2.0% increase.

Figure 6: Appropriateness for the most commonly prescribed antimicrobials in Hospital NAPS contributor hospitals, 2018



Amoxicillin–clavulanic acid

In the 2018 dataset, amoxicillin–clavulanic acid was prescribed 1,882 times and was the third most prescribed antimicrobial, with the second lowest rate of appropriateness (68.3%) of the top 20 most prescribed antimicrobials. The indications for which amoxicillin–clavulanic acid was prescribed most commonly were pneumonia (community-acquired, hospital-acquired and aspiration), and cystitis (Figure 7). Amoxicillin–clavulanic acid was prescribed for community-acquired pneumonia 232 times, and 37.1% of these prescriptions were deemed to be inappropriate. There were 93 prescriptions for chronic obstructive pulmonary disease (COPD), which has the lowest rate of appropriateness of the top 20 indications for prescribing amoxicillin–clavulanic acid (34.4%).

Amoxicillin–clavulanic acid can be prescribed either intravenously or orally. The intravenous form has only been widely available in Australia since 2017, and the indications for which this is being used nationally are of interest. Of the 1,883 prescriptions for amoxicillin–clavulanic acid, 1,573 (83.5%) were prescribed orally, while 310 (16.5%) were prescribed intravenously. There was a total of 79 indications for prescribing amoxicillin–clavulanic acid, 75 orally and 43 intravenously, and the top twenty prescribed by route are displayed in Table 8. The top indications for prescribing amoxicillin–clavulanic acid orally were: pneumonia, community acquired, empiric therapy (222); cystitis (166); and pneumonia, hospital-acquired, empiric therapy (156). The top indications for prescribing amoxicillin–clavulanic acid intravenously were diabetic foot infection (25), pneumonia, aspiration (25) and peritonitis (24). There was wide ranging appropriateness of amoxicillin–clavulanic acid when prescribed orally, while the appropriateness when prescribed intravenously was relatively high, possibly due to increased controls related to the intravenous versus oral forms in many hospitals. The compliance with guidelines for amoxicillin–clavulanic acid is shown in Table 9, where the highest percentage was for locally endorsed guidelines.

Figure 7: Appropriateness for the 20 most common indications for amoxicillin–clavulanic acid prescribing in Hospital NAPS contributor hospitals, 2018

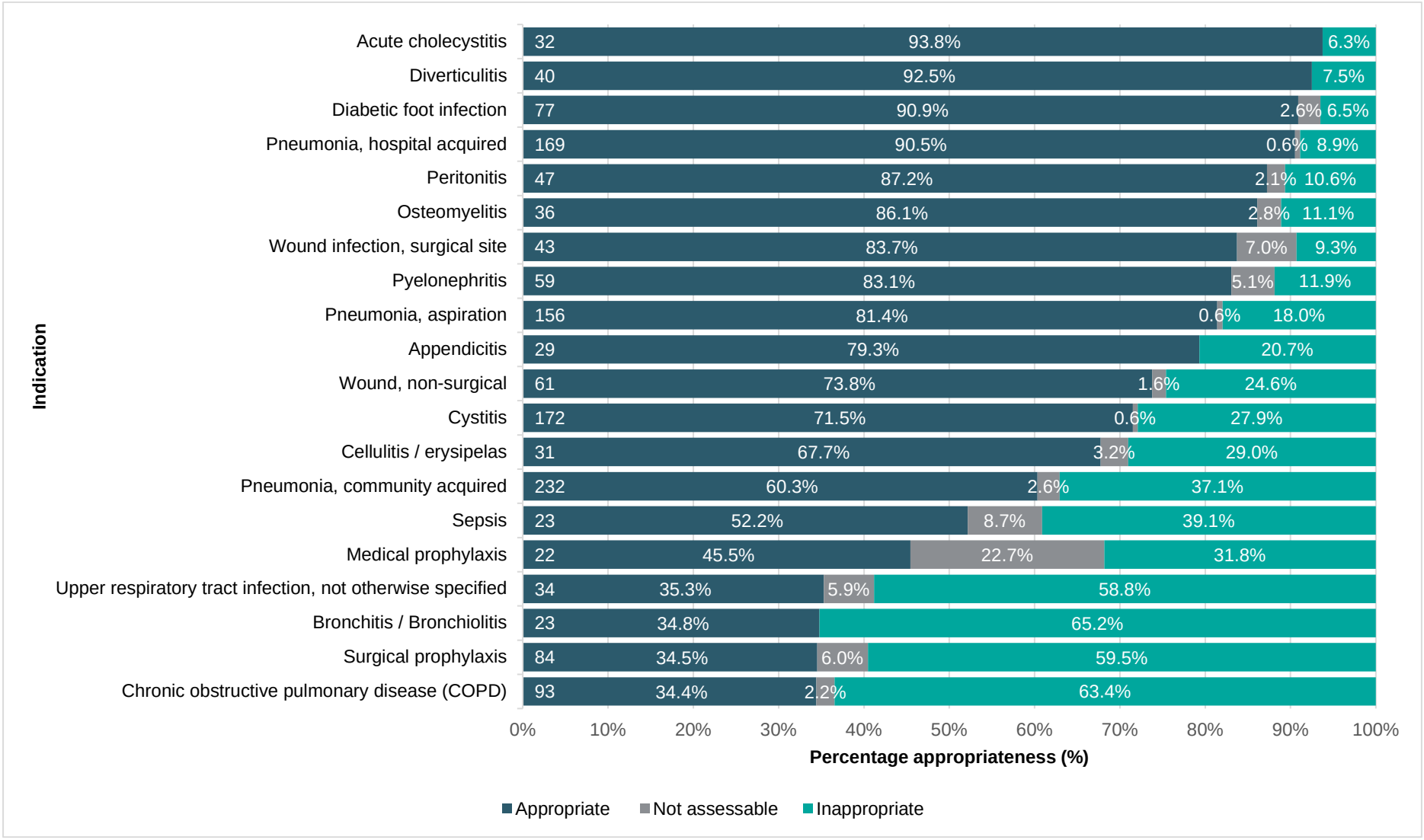


Table 8: Route of administration, the number and appropriateness for amoxicillin–clavulanic acid prescriptions in Hospital NAPS contributor hospitals, 2018

Prescribed orally			Prescribed intravenously		
Indication	Number	Appropriateness (%)	Indication	Number	Appropriateness (%)*
Pneumonia, community acquired, empiric therapy	222	61.7	Diabetic foot infection	25	96.0
Cystitis	166	71.1	Pneumonia, aspiration	25	84.0
Pneumonia, hospital acquired, empiric therapy	156	90.4	Peritonitis	24	83.3
Pneumonia, aspiration	131	80.9	Appendicitis	21	71.4
Chronic obstructive pulmonary disease	90	34.4	Diverticulitis	19	94.7
Surgical prophylaxis	68	32.4	Wound, non–surgical	19	94.7
Diabetic foot infection	52	88.5	Surgical prophylaxis	16	43.8
Pyelonephritis	47	85.1	Acute cholecystitis	15	93.3
Wound, non–surgical	42	64.3	Pneumonia, hospital acquired, empiric therapy	13	92.3
Wound infection, surgical site	36	86.1	Pyelonephritis	12	75.0
Upper respiratory tract infection, not otherwise specified	33	33.3	Osteomyelitis	11	81.8
Osteomyelitis	25	88.0	Pneumonia, community acquired, empiric therapy	10	30.0
Cellulitis / erysipelas	24	58.3	Intra–abdominal abscess	8	–
Bronchitis / Bronchiolitis	23	34.8	Cellulitis / erysipelas	7	–
Peritonitis	23	91.3	Sepsis	7	–
Febrile neutropenia	22	77.3	Wound infection, surgical site	7	–
Diverticulitis	21	90.5	Cystitis	6	–
Medical prophylaxis	20	45.0	Bacteraemia, gram-negative	5	–
Acute cholecystitis	17	94.1	Dental infection	5	–
Sepsis	16	43.8	Anorectal abscess and fistula	4	–

* Appropriateness results are not displayed if there are fewer than ten prescriptions

Table 9: Compliance with guidelines for intravenous administration of amoxicillin clavulanic acid prescriptions in Hospital NAPS contributor hospitals, 2018

Compliance	Percentage of prescriptions (%)
Compliant with guidelines	53.7
Compliant with *Therapeutic Guidelines*[1]	*(12.3)*
Compliant with locally endorsed guidelines	*(41.4)*
Non–compliant with guidelines	23.0
Directed therapy	14.6
No guidelines available	8.1
Not assessable	0.6

n=310

Metronidazole

Metronidazole is recommended for many different indications in the *Therapeutic Guidelines.*[8] In the 2018 dataset, metronidazole was prescribed 1,458 times and was the fifth most prescribed antimicrobial, with the fourth lowest rate of appropriateness (70.4%) of the top 20 most prescribed antimicrobials. The reasons for why almost 30% of these prescriptions are inappropriate are unclear.

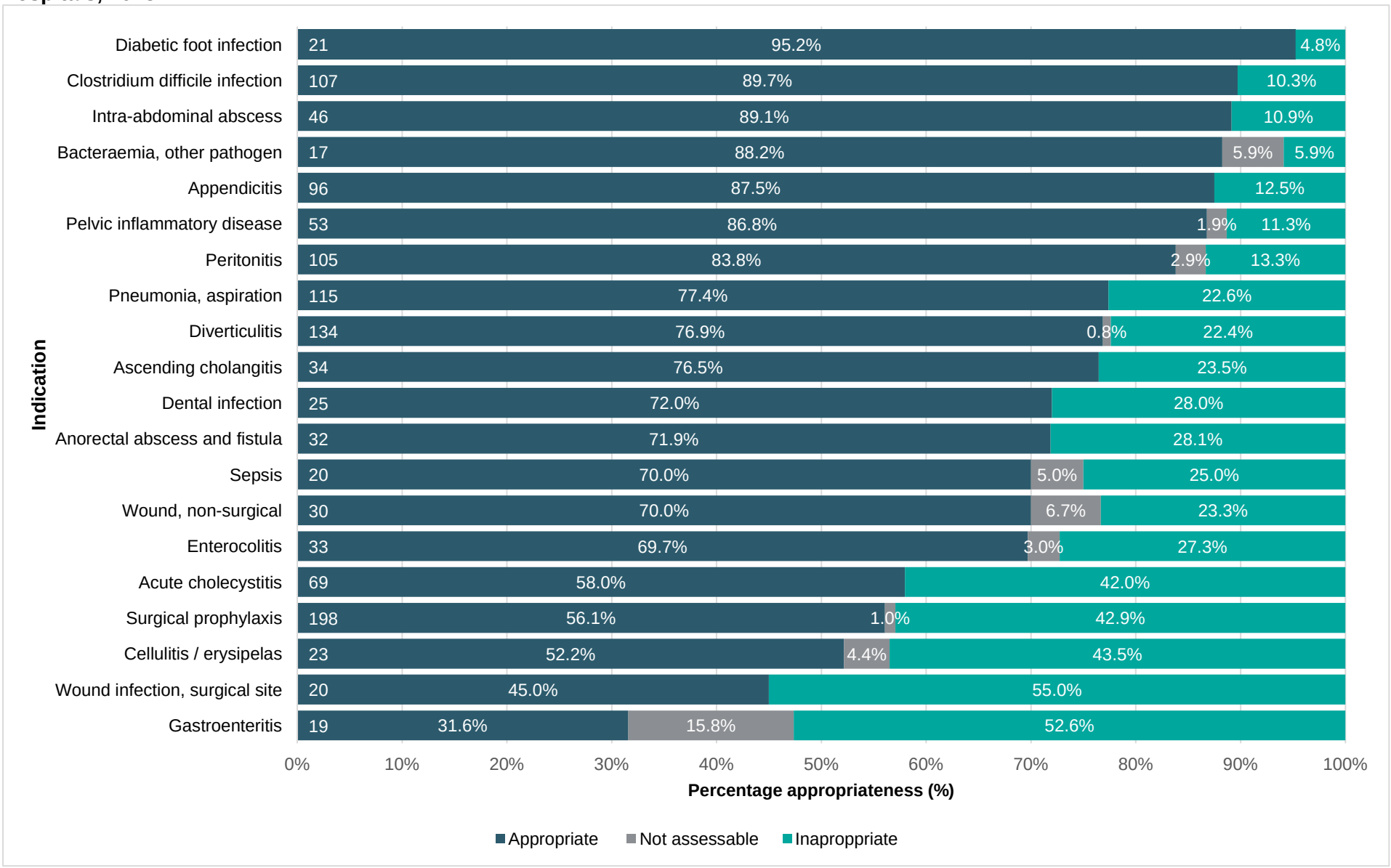
From the 2018 data, metronidazole was prescribed for 73 indications. The top 20 indications and their appropriateness are displayed in Figure 8. The indications with the highest rates of appropriate prescribing were diabetic foot infection (95.2%), *Clostridiodes difficile* infection (89.7%) and intra-abdominal abscess (89.1%). The indications with the lowest rates or prescribing appropriateness of the top 20 indications were gastroenteritis (31.6%), wound infection, surgical site (45.0%) and cellulitis/erysipelas (52.1%).

The rates of appropriateness for prescribing of metronidazole by route are displayed in Table 10. The majority of prescriptions were for intravenous administration, followed by oral administration then topical administration. The rate of appropriateness was highest for intravenous administration (71.3%), followed by oral administration (68.7%) and topical administration (61.5%). The top indications for prescribing metronidazole intravenously were surgical prophylaxis (n=157), diverticulitis (n=100) and peritonitis (n=91). The top indications for prescribing metronidazole orally were *Clostridioides difficile* infection (n=91), surgical prophylaxis (n=41), diverticulitis (n=34) and pneumonia, aspiration (n=34).

Table 10. Route of administration, number and appropriateness for metronidazole prescriptions in Hospital NAPS contributor hospitals, 2018

Route	Number	Appropriateness (%)
Intravenous (parenteral)	982	71.3
Oral	463	68.7
Topical	13	61.5

Figure 8: Appropriateness for the 20 most common indications for metronidazole prescribing in Hospital NAPS contributor hospitals, 2018



Most common indications for antimicrobial prescribing

The allocation of each indication to a broader reporting category (such as those shown in Figure 9) was reconsidered as part of the design of the new indications list, introduced in July 2018. The overall groupings of the 20 most common indications remain similar to previous Hospital NAPS reports. Surgical prophylaxis (14.1%), community-acquired pneumonia (10.1%), medical prophylaxis (9.0%) and cystitis (5.1%) are still the most common reasons why patients receive antimicrobial prescriptions in the hospital setting.

However, rankings of some of these groupings have been affected by the change. For example, when selecting sepsis as an indication in the new NAPS indication list, the sepsis category is reserved for those patients with sepsis from an unknown source. For all other patients regarded having sepsis, the reviewer is directed to select the underlying indication causing the sepsis. This is reflected by the incidence of prescribing for pyelonephritis, which appears to have increased; this is likely due to the inclusion of patients assessed as having sepsis from a urinary source selecting pyelonephritis, which may have previously been categorised under sepsis.

Of the 20 most common indications for prescribing antimicrobials, the conditions with the highest proportions of prescriptions assessed as inappropriate were COPD (42.1%), surgical prophylaxis (39.5%), and non-surgical wounds (29.6%) (Figure 10).

In contrast, the indications with the highest rates of appropriate prescribing were gram-positive bacteraemia (93.8%), osteomyelitis (90.8%), medical prophylaxis (85.9%), febrile neutropenia (84.4%) and sepsis (84.1%). These indications often have either well-embedded protocols to guide therapy or their use is overseen by infectious diseases specialists.

Figure 9: The 20 most common indications for prescribing antimicrobials in Hospital NAPS contributors, 2013–2018

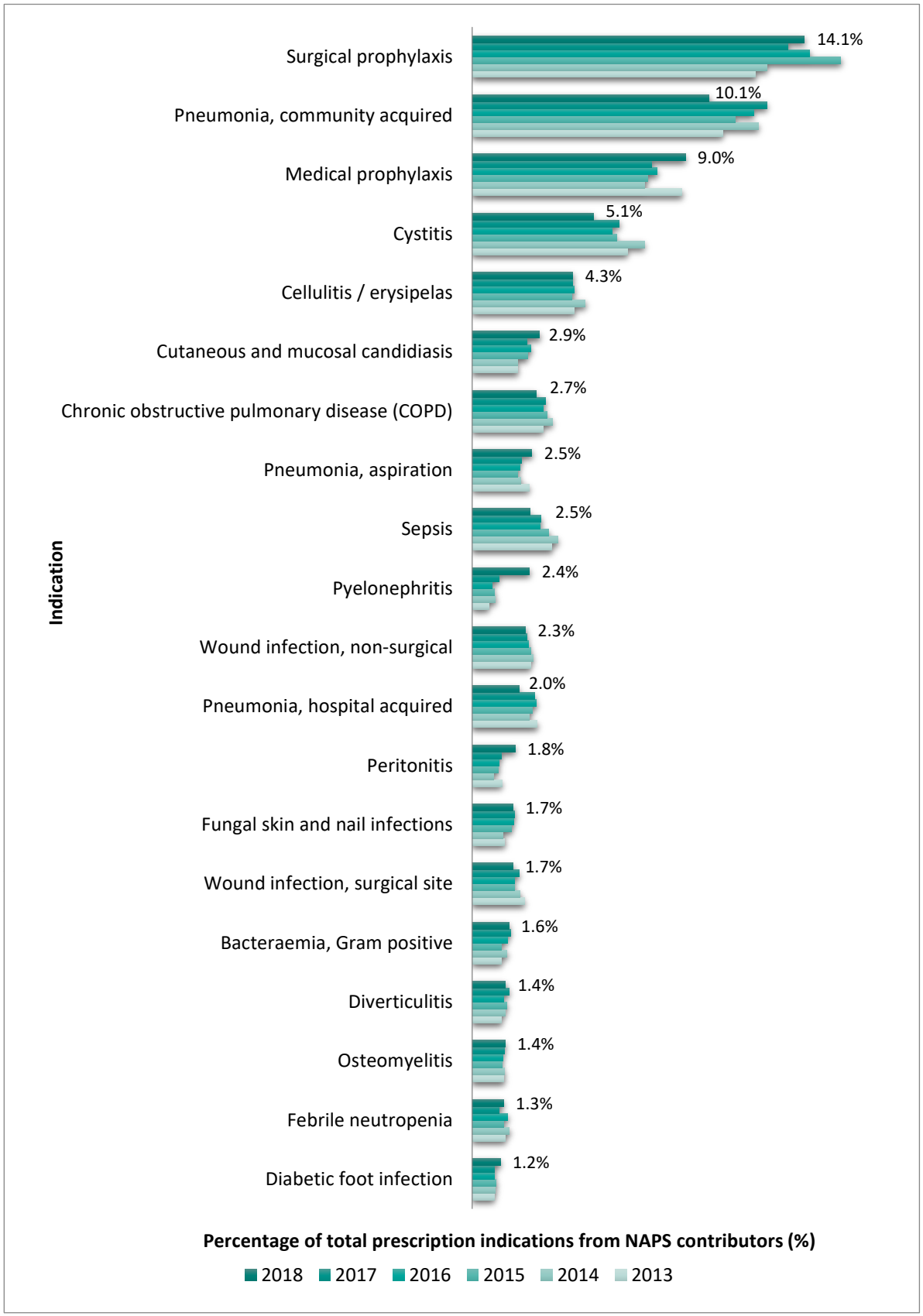
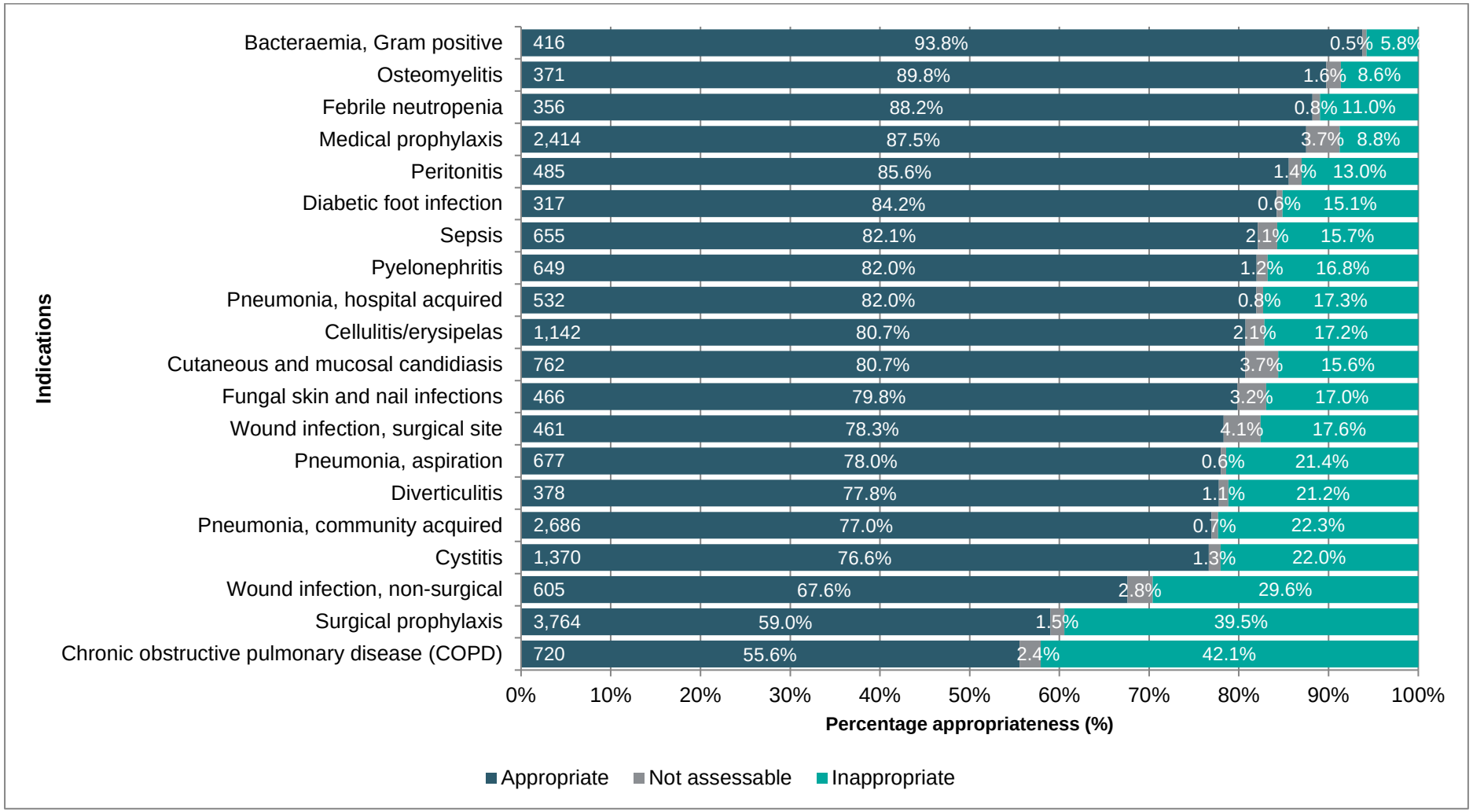


Figure 10: Appropriateness of prescribing for the 20 most common indications in the Hospital NAPS contributors, 2018



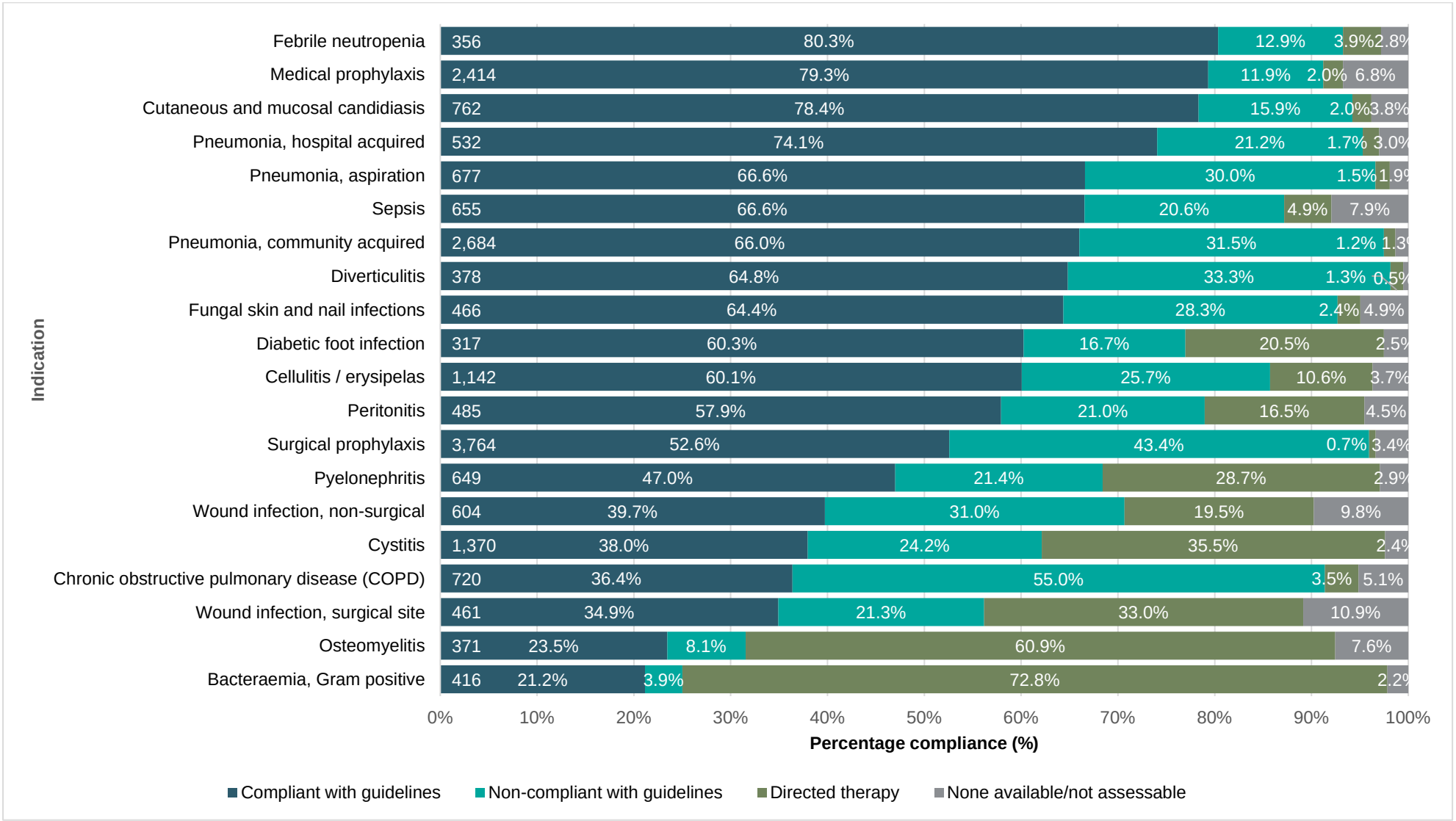
Compliance with guidelines for the 20 most common indications

The Hospital NAPS requires surveyors to make assessments as to whether each prescription is compliant with guidelines and appropriate for the patient. While these assessments are effectively independent of each other, there is a strong association between them. Figure 11 shows the percentage of prescriptions assessed as compliant with guidelines for the 20 indications that most commonly required antimicrobial therapy in 2018. Febrile neutropenia (80.3%), medical prophylaxis (79.3%), and cutaneous and mucosal candidiasis (78.4%) had the highest rates of guideline compliance.

Prescriptions that are compliant with guidelines are often also assessed as appropriate, and vice versa. In addition, conditions where prescribing is often guided by microbiology results, such as gram-positive bacteraemia and osteomyelitis (Figure 11), tend to have a high level of appropriateness (Figure 10).

Indications that were frequently evaluated as being non-compliant with guidelines were COPD (55.0%), surgical prophylaxis (43.3%) and non-surgical wound infections (31.0%). These conditions are also examples of indications that were often assessed an inappropriate as shown in Figure 10.

Figure 11: Compliance with guidelines for the 20 indications most commonly requiring antimicrobials in Hospital NAPS contributors, 2018

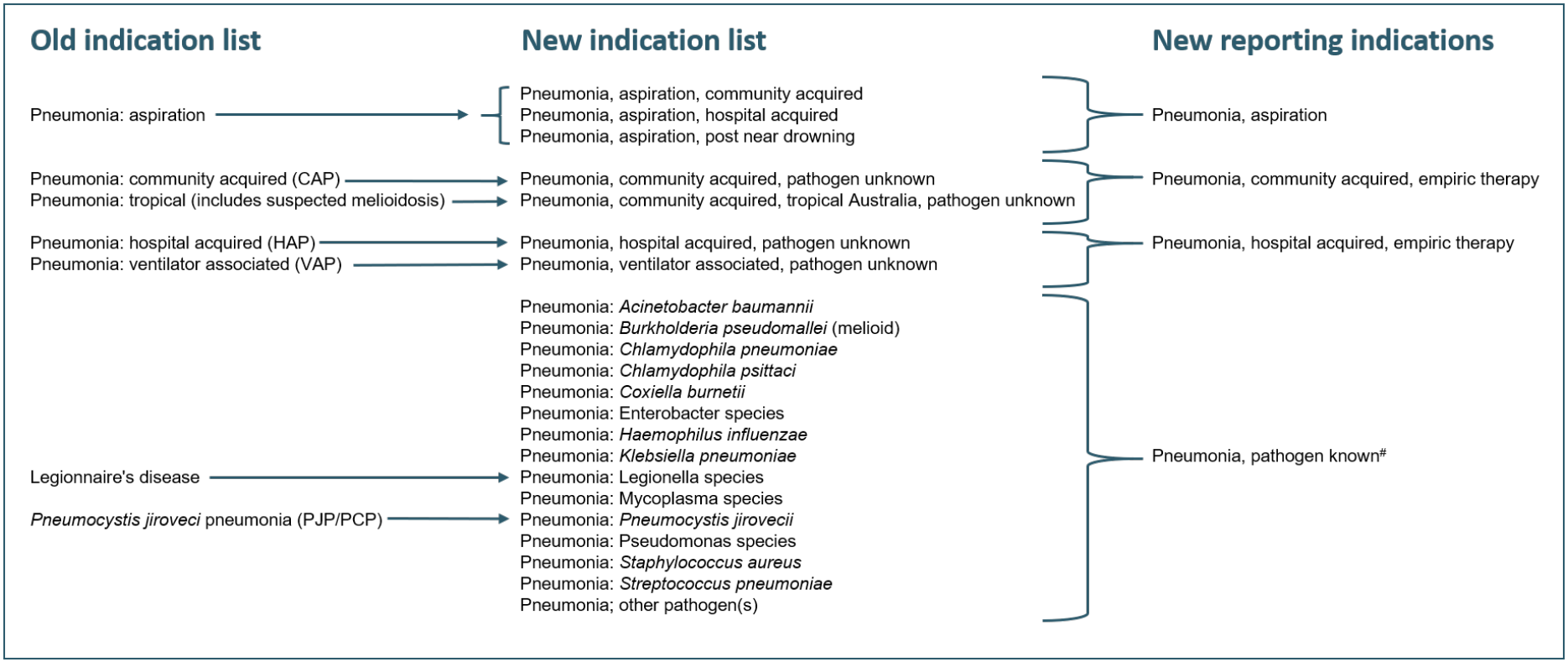


Pneumonia

Figure 12 displays the list of indications that fall into the pneumonia indications from the original NAPS list, the new NAPS list implemented in 2018, and the reporting indications to which these indications belong. From Table 11, it can be seen that the number of prescriptions for the pneumonia reporting indications has increased each year, apart from 2018, when there was a decrease. With the new indications list, the breakdown of the different reporting indications has remained fairly stable for the years 2013 to 2017. The introduction of the new indication list in 2018 has affected the breakdown by reporting indications, with a greater percentage of 'Pneumonia, pathogen known' and less of 'Pneumonia, community-acquired, empiric therapy' and 'Pneumonia, hospital-acquired, empiric therapy'. This is due to the increasing number of indications for pathogens causing pneumonia and including a 'Pneumonia: other pathogen(s)' indication. The new list has allowed for a more accurate analysis of the reasons for appropriate prescribing, based on whether it was for empiric therapy, where the pathogen was unknown, or for specific pathogens that have been isolated, see Table 12.

The pneumonia indications with the poorest prescribing appropriateness are for those with greater than ten prescriptions: 'Pneumonia: Pseudomonas species' (73.0%), 'Pneumonia; other pathogen(s)' (76.4%), 'Pneumonia, aspiration, community-acquired' (76.7%) and 'Pneumonia, community-acquired, pathogen unknown' (76.8%) (Table 12). The pneumonia indications with the higher rates of appropriateness were generally the indications where the pathogens were known, although there were very low numbers of these prescriptions.

Figure 12: Old and new indications list and reporting indications for pneumonia category



[#] Pneumonia: Legionella species and Pneumonia: *Pneumocystis jirovecii* were directly mapped to indications included in the old indications list, all other pneumonias with known pathogens may have been included in any of the other pneumonia categories in the old indication list.

Table 11: Percentage of prescriptions for the pneumonia reporting indications, 2013 to 2018

Reporting indication	Percentage of prescriptions (%)					
	2013	2014	2015	2016	2017	2018
Pneumonia, community acquired, empiric therapy	65.9	71.9	70.7	70.7	71.3	64.0
Pneumonia, aspiration	15.0	12.2	12.2	12.0	11.9	16.1
Pneumonia, hospital acquired, empiric therapy	17.0	14.3	16.1	16.1	15.1	12.7
Pneumonia, pathogen known	2.2	1.5	1.0	1.2	1.7	7.2
Total number of prescriptions	**1,880**	**3,342**	**4,129**	**4,313**	**4,716**	**4,198**

Table 12: Number of prescriptions and appropriateness for each pneumonia indication, in Hospital NAPS contributors, 2018

Indication for antimicrobials	Number	Appropriateness (%)*
Pneumonia, community-acquired, pathogen unknown	2,599	76.8
Pneumonia, hospital-acquired, pathogen unknown	518	81.9
Pneumonia, aspiration, community-acquired	480	76.7
Pneumonia; pathogen known	303	80.5
Pseudomonas species	*(63)*	*(73.0)*
Streptococcus pneumoniae	*(50)*	*(90.0)*
Haemophilus influenzae	*(45)*	*(77.8)*
Pneumocystis jirovecii	*(23)*	*(87.0)*
Staphylococcus aureus	*(20)*	*(80.0)*
Enterobacter species	*(9)*	–
Klebsiella pneumoniae	*(8)*	–
Mycoplasma species	*(6)*	–
Chlamydophila pneumoniae	*(2)*	–
Burkholderia pseudomallei (melioid)	*(2)*	–
Legionella species	*(1)*	–
Chlamydophila psittaci	*(1)*	–
Acinetobacter baumannii	*(1)*	–
Other pathogen(s)	*(72)*	*(76.4)*
Pneumonia, aspiration, hospital-acquired	194	80.9
Pneumonia, community-acquired, tropical Australia, pathogen unknown	87	82.8
Pneumonia, ventilator-associated, pathogen unknown	14	85.7
Pneumonia, aspiration, post near drowning	3	–
Total number	**4,198**	**78.0**

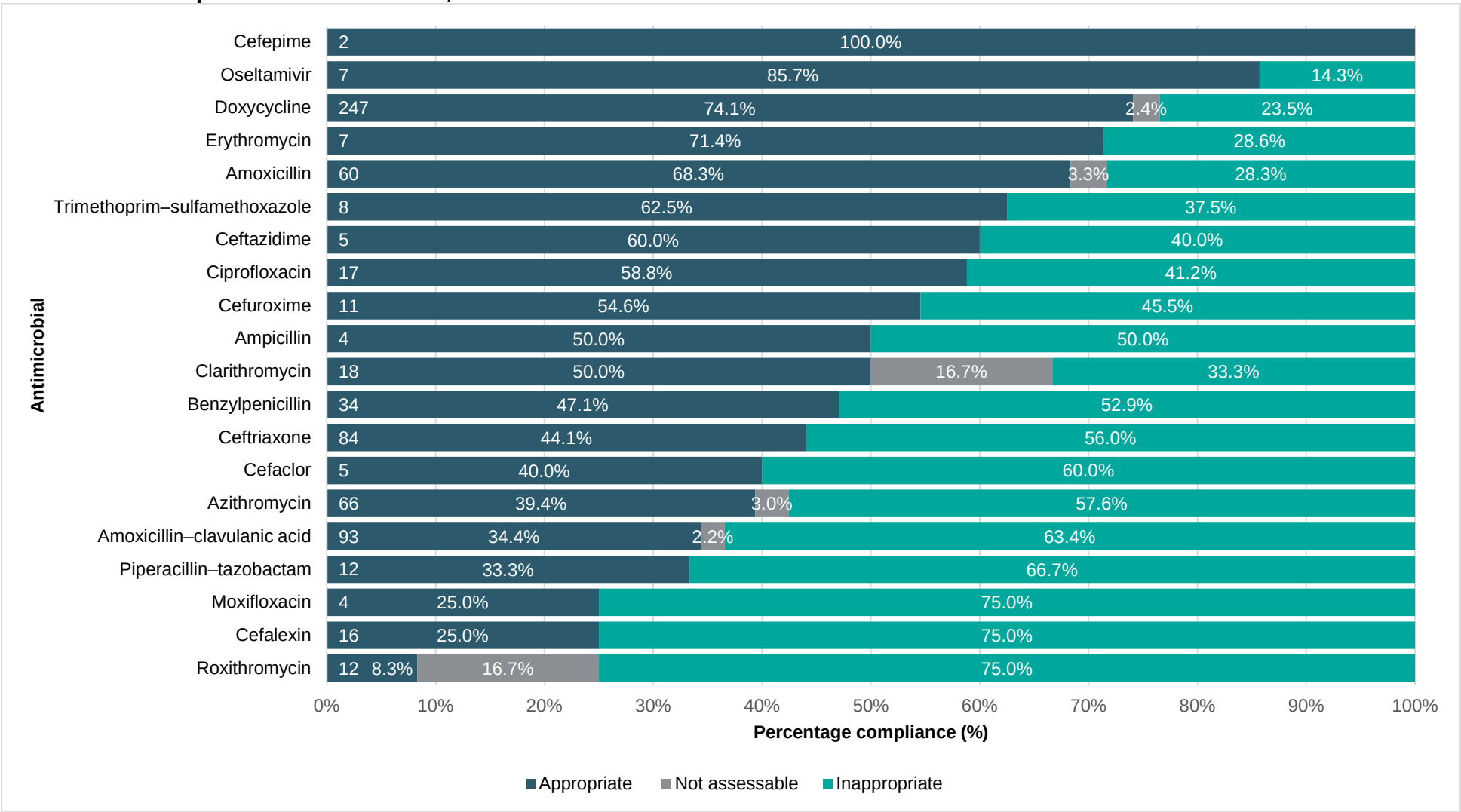
* Appropriateness results are not displayed if there are fewer than ten prescriptions

Chronic obstructive pulmonary disease

Chronic obstructive pulmonary disease (COPD) was the seventh most frequent indication for prescribing antimicrobials in the 2018 Hospital NAPS (2.7%), and had the lowest rate of appropriateness (55.6%) of the top 20 most recorded indications. There were 28 different antimicrobials prescribed for COPD, with 27 prescribed for acute exacerbations and eight prescribed for long term management. The most common antimicrobials prescribed for acute exacerbations of COPD were doxycycline (44.3%), amoxicillin–clavulanic acid (20.8%) and ceftriaxone (20.0%). The most common antimicrobials prescribed for long-term management of COPD were azithromycin (33.3%) doxycycline (31.1%), and erythromycin (13.3%).

Five antimicrobials made up 77.9% of all antimicrobials prescribed for COPD. Of these, amoxicillin–clavulanic acid, azithromycin and ceftriaxone had the highest rates of inappropriateness (63.4%, 57.6% and 56.0% respectively), Figure 13. Considering the burden of inappropriate prescribing for this common condition, an AMS initiative targeting these three antimicrobials when prescribed for COPD, could drive significant improvements at both a local and national level.

Figure 13: Appropriateness of prescribing for the 20 most common antimicrobials prescribed for chronic obstructive pulmonary disease in the Hospital NAPS contributors, 2018



Discussion

The Hospital NAPS is now in its sixth year, and has demonstrated consistent trends to inform ongoing quality improvement in Australian hospitals. Addressing these trends based on the data that Hospital NAPS provides is a priority, given the concurrent static rate of total hospital antimicrobial use in 2017 and 2018 reported in NAUSP, after many years of sustained reductions.[10]

The number of hospitals participating in Hospital NAPS has been relatively consistent since 2016. Approximately one third of all public and private facilities participated in the Hospital NAPS in 2018. Participation is highest in public hospitals in major cities (52.7%), whilst only 6% of very remote facilities participate. Participation across the public and private settings are similar. Understanding the barriers to participation in these settings is important to address patient safety and improve participation in national surveillance and support for AMS programs.

Despite minimal improvement in overall appropriateness of antimicrobial prescribing from 2013 to 2018, the 2018 Hospital NAPS demonstrated some improvements, including the progressive increase in documentation of indication for prescribing antimicrobials, improvements in optimal prescribing and increases in prescribing based on directed therapy since 2015. Electronic medication management (EMM) systems have been implemented in a number of facilities across Australia over the same period, which may have contributed to improved documentation of prescribing. It is possible that increased attention to prescribing antimicrobials alongside implementation of these systems has supported these improvements. In the 2019 Hospital NAPS, contributors are being requested to advise of their EMM status, which may assist in answering this question in the future.

There has been an absolute improvement of 5.9% since 2013 in prescriptions assessed as optimal, which represents a relative improvement of 10.9%. These are generally prescriptions that are consistent with guidelines, have infectious diseases or microbiologist oversight or are the narrowest choice for the likely or cultured pathogens and may be considered best practice prescribing.

Increases in prescribing based on directed therapy are pleasing, as directed therapies are more likely to be appropriately prescribed. The AMS Clinical Care Standard highlights the importance of microbiological sampling, where clinically indicated, to support appropriate antimicrobial selection.[11] Detailed analysis of the 2018 Hospital NAPS data on prescribing indications for pneumonia shows that therapy is more appropriate when the pathogen is known. Improving the use of diagnostic sampling in treatment of pneumonia may further improve appropriateness for this common indication for antimicrobial prescribing in hospitals.

Improvements also varied by setting, including peer group and remoteness classification. Appropriateness and guidelines compliance was generally higher in Principal Referral hospitals, compared with smaller hospitals such as Acute Group D hospitals. NAUSP has reported high levels of complex antimicrobial use in regional and remote settings and high volumes of total antimicrobial use.[10] Inappropriate prescribing rates have increased in private hospitals, compared with public facilities. Private hospital contributors to NAUSP have also reported greater use of first-generation cephalosporins than broad-spectrum antibiotic use, compared with public hospitals, likely related to their higher surgical casemix. Private hospitals and smaller regional and remote facilities have unique AMS, audit and implementation needs.[12] Supporting the delivery of AMS programs tailored to the local context, with input from relevant experts, is important for patient safety in all hospital settings and to ensure that the requirements of the NSQHS Standards are met.

There have been variable results for other Hospital NAPS indicators. For example, compliance with the *Therapeutic Guidelines* has not substantially improved since 2013, while there has been a relative decrease of 4.7% in compliance with local guidelines. In 2018, approximately 1 in 3 prescriptions overall were assessed as non-compliant, where guidelines were available for assessment.

Addressing barriers to compliance with prescribing guidelines requires further consideration. Common factors that limit uptake of guidelines include: access at point of care; perceptions of the currency of the guideline with respect to evidence or antimicrobial resistance; clinician engagement in their development; and, perceptions regarding the reliability of guidelines.[13]

Inappropriate prescribing has also remained fairly constant since 2013 for some specific indications. These include surgical prophylaxis and respiratory prescribing, including COPD and community-acquired pneumonia. These indications are a continuing focus for improvement action.

In designing and implementing AMS interventions to achieve reductions in the volume of antimicrobial use and increases in appropriateness, it is important to consider feasibility, sustainability, antimicrobial burden, choice and duration of prescribing for specific indications. When considering the burden of prescribing, the top five conditions for inappropriate prescribing were surgical prophylaxis (n = 1,486), pneumonia, community acquired (n = 598), COPD (n = 303), cystitis (n = 301) and medical prophylaxis (n= 212). Surgical prophylaxis continues to be the most common prescribing indication reported by Hospital NAPS contributors, and has the second highest rate of inappropriate prescribing. COPD is the seventh most common prescribing indication, and has the highest rate of inappropriate prescribing.

Whilst the proportion of prescriptions for surgical prophylaxis continuing for greater than 24 hours has improved since 2013, almost 1 in 3 prescriptions continued past 24 hours in 2018, and 2 in 5 (39.5%) prescriptions were inappropriate; further improvement in this area is required. A number of initiatives have supported these improvements so far, including: state and territory specific guidelines[14, 15]; provision of guidance for accrediting agencies in relation to surgical prophylaxis[9]; and development and completion of targeted surgical prophylaxis audits, such as the Surgical NAPS. In addition, during 2018, the Commission collaborated with the Royal Australasian College of Surgeons, the Australian and New Zealand College of Anaesthetists, the Australian College of Perioperative Nurses, the private health sector and states and territories to develop targeted resources on surgical prophylaxis.

The Surgical NAPS report offers further insights into these prescribing practices. Surgical prophylaxis prescribing patterns are specialty dependent[16], and the reasons for inappropriate prescribing also vary procedurally or post-procedurally. The largest contributor to inappropriate antimicrobials administered in the operating theatre was incorrect timing. The most common reason for inappropriate post-procedural prescribing was incorrect duration of antimicrobials. Topical antimicrobials were generally prescribed inappropriately for surgical prophylaxis, as their use is limited to a small number of few specific indications. Targeted interventions are required to improve the quality of surgical prescribing, including for surgical subspecialties and for surgery more generally.

Oral cefalexin and amoxicillin–clavulanic acid have consistently had the highest proportion of the inappropriate prescribing in successive Hospital NAPS. These may be associated with the high rates of inappropriate prescribing of these agents for surgical, respiratory and urinary indications. However, in 2018, there was a promising improvement in cefalexin prescribing, with a 10% relative improvement in one year. Small improvements in the prescribing of frequently prescribed antimicrobials such as cefazolin, ceftriaxone, cefalexin and amoxicillin-clavulanic acid can have large impacts overall on reducing the volume of antimicrobial use.

The introduction of the new extended indications list to the Hospital NAPS in 2018 reduced the need for selection of 'other' as an indication, allowing for greater clarity regarding prescribing indication in the 2018 dataset. As the new list was implemented in July 2018, when the data collection was already under way, the impact of this change on reporting of indications may not be fully apparent until the 2019 Hospital NAPS data have been analysed. Although the number of cases for specific indications was relatively small in 2018, even in a national dataset, the extended indications list may in time offer opportunities for targeting improvement actions further.

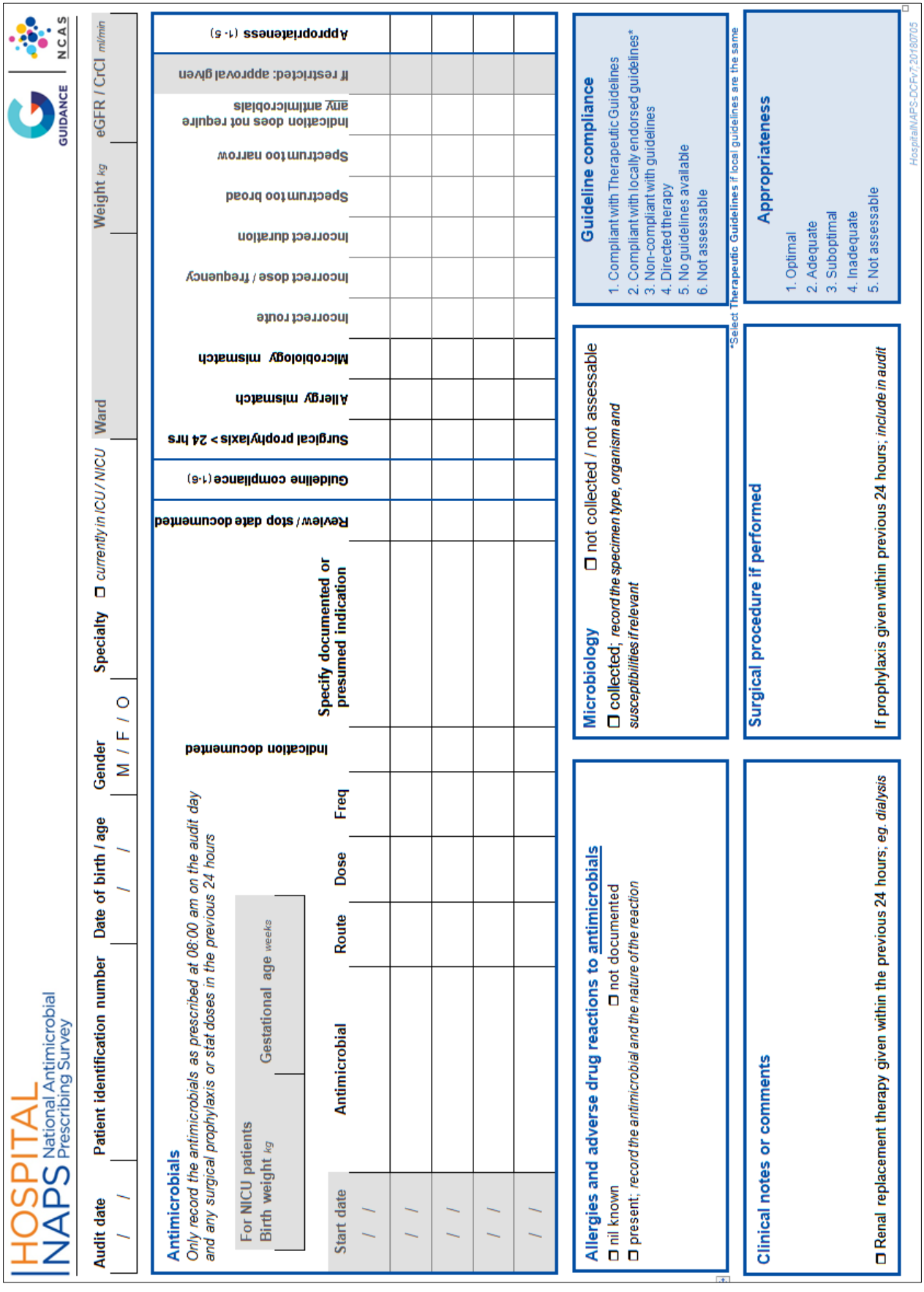
In summary, similar themes for improvement of the quality of prescribing, and safety of care provided to patients, have been identified by Hospital NAPS each year since 2013.

To address these issues, the Commission will:

- Communicate the findings to states and territories and private hospital provider organisations to highlight the above priority areas for their antimicrobial stewardship (AMS) programs
- Promote the range of AMS implementation support resources that are currently available, including Therapeutic Guidelines shared decision-making tools and treatment pathways to guide the management of conditions such as urinary tract infection
- Encourage public and private health service organisations to routinely review their NAPS results and implement targeted strategies for departments with the highest rates of inappropriate prescribing, non-compliance with guidelines and incomplete documentation
- Work with states and territories to identify additional AMS resources and strategies that may be of assistance to smaller health service organisations, including sharing information on effective AMS quality improvement initiatives
- Review the Antimicrobial Stewardship Clinical Care Standard and associated implementation support resources in 2020
- Continue to collaborate with the Royal Australasian College of Surgeons and relevant specialty groups to improve prescribing of antimicrobials for surgical prophylaxis
- Collaborate with relevant specialty groups and societies in relation to improving appropriateness of prescribing for COPD
- Work with states, territories, and expert clinical groups to develop strategies and guidelines to improve the appropriateness of antimicrobial prescribing of broad-spectrum antimicrobials and duration of therapy.

Appendix 1: Hospital NAPS data collection form

Figure A1: Hospital NAPS data collection form



Appendix 2: Hospital NAPS appropriateness definitions

Figure A2: Hospital NAPS appropriateness definitions

HOSPITAL NAPS National Antimicrobial Prescribing Survey

Hospital NAPS appropriateness definitions

GUIDANCE | NCAS

			If endorsed guidelines are present	If endorsed guidelines are absent
Appropriate	1	Optimal[1]	Antimicrobial prescription follows either the Therapeutic Guidelines[2] or endorsed local guidelines *optimally*, including antimicrobial choice, dosage, route and duration[3]	The antimicrobial prescription has been reviewed and endorsed by an infectious diseases clinician or a clinical microbiologist OR The prescribed antimicrobial will cover the likely causative or cultured pathogens ***and*** there is not a narrower spectrum or more appropriate antimicrobial choice, dosage, route or duration[3] available
	2	Adequate	Antimicrobial prescription does not optimally follow the Therapeutic Guidelines[2] or endorsed local guidelines, including antimicrobial choice, dosage, route or duration[3], however, is a ***reasonable*** alternative choice for the likely causative or cultured pathogens OR For surgical prophylaxis, as above ***and*** duration[3] is less than 24 hours	Antimicrobial prescription including antimicrobial choice, dosage, route and duration[3] is not the most optimal, however, is a ***reasonable*** alternative choice for the likely causative or cultured pathogens OR For surgical prophylaxis, as above ***and*** duration[3] is less than 24 hours
Inappropriate	3	Suboptimal	There may be a mild or non-life-threatening allergy mismatch OR Antimicrobial prescription including antimicrobial choice, dosage, route and duration[3], is an ***unreasonable*** choice for the likely causative or cultured pathogens, including: • spectrum excessively broad, unnecessary overlap in spectrum of activity, dosage excessively high or duration excessively long • failure to appropriately de-escalate with microbiological results	
	4	Inadequate	Antimicrobial prescription including antimicrobial choice, dosage, route or duration[3] is ***unlikely*** to treat the likely causative or cultured pathogens OR The documented or presumed indication does not require ***any*** antimicrobial treatment 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 local 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 weight or renal function, if this information is available

[2] Antibiotic Expert Group. Therapeutic Guidelines: Antibiotic. Version 15 (2014), or online version

[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

Doc:nNAPS.AD.v6.1; 20161117

Appendix 3: Tables and figures

Figure 1: Number of public and private hospitals that contributed to the Hospital NAPS, 2013–2018

Figure 2: Public and private hospital participation in Hospital NAPS by peer group classification, 2013–2018

Figure 3: Public and private hospital participation in Hospital NAPS by remoteness area, 2013–2018

Figure 4: Hospital NAPS key indicators for comparator prescriptions by percentage, 2013–2018

Figure 5: The 20 most common antimicrobials prescribed by Hospital NAPS contributors, by percentage, 2013–2018

Figure 6: Appropriateness for the most commonly prescribed antimicrobials in Hospital NAPS contributor hospitals, 2018

Figure 7: Appropriateness for the 20 most common indications for amoxicillin–clavulanic acid prescribing in Hospital NAPS contributor hospitals, 2018

Figure 8: Appropriateness for the 20 most common indications for metronidazole prescribing in Hospital NAPS contributor hospitals, 2018

Figure 9: The 20 most common indications for prescribing antimicrobials in Hospital NAPS contributors, 2013–2018

Figure 10: Appropriateness of prescribing for the 20 most common indications in the Hospital NAPS contributors, 2018

Figure 11: Compliance with guidelines for the 20 indications most commonly requiring antimicrobials in Hospital NAPS contributors, 2018

Figure 12: Old and new indications list and reporting indications for pneumonia category

Figure 13: Appropriateness of prescribing for the 20 most common antimicrobials prescribed for chronic obstructive pulmonary disease in the Hospital NAPS contributors, 2018

Table 1: Public and private hospitals that contributed to Hospital NAPS by state, territory and remoteness area, 2018

Table 2: Public and private hospitals that contributed to the Hospital NAPS by peer group, 2018

Table 3: Hospital NAPS key indicator results, by state and territory, remoteness area and AIHW peer group, 2018

Table 4: Compliance with guidelines and prescription appropriateness in Hospital NAPS contributors, by state and territory, remoteness area and AIHW peer group, 2018

Table 5: Hospital NAPS compliance with guidelines and prescription appropriateness, for all prescriptions 2013–2018

Table 6: Hospital NAPS key indicators, for assessable prescriptions 2013–2018

Table 7: Reasons for a prescription being assessed as inappropriate, Hospital NAPS contributors, 2018

Table 8: Route of administration, the number and appropriateness for amoxicillin–clavulanic acid prescriptions in Hospital NAPS contributor hospitals, 2018

Table 9: Compliance with guidelines for intravenously administration of amoxicillin–clavulanic acid prescriptions in Hospital NAPS contributor hospitals, 2018

Table 10: Route of administration, number and appropriateness for metronidazole prescriptions in Hospital NAPS contributor hospitals, 2018

Table 11: Percentage of prescriptions for the pneumonia reporting indications, 2013 to 2018

Table 12: Number of prescriptions and appropriateness for each pneumonia indication, in Hospital NAPS contributors, 2018.

Appendix 4: Appropriateness of antimicrobial prescribing, 2018 Hospital NAPS contributors by peer group

Figure A4.1 Percentage total appropriateness of antimicrobial prescribing, Hospital NAPS contributors, by peer group, 2018

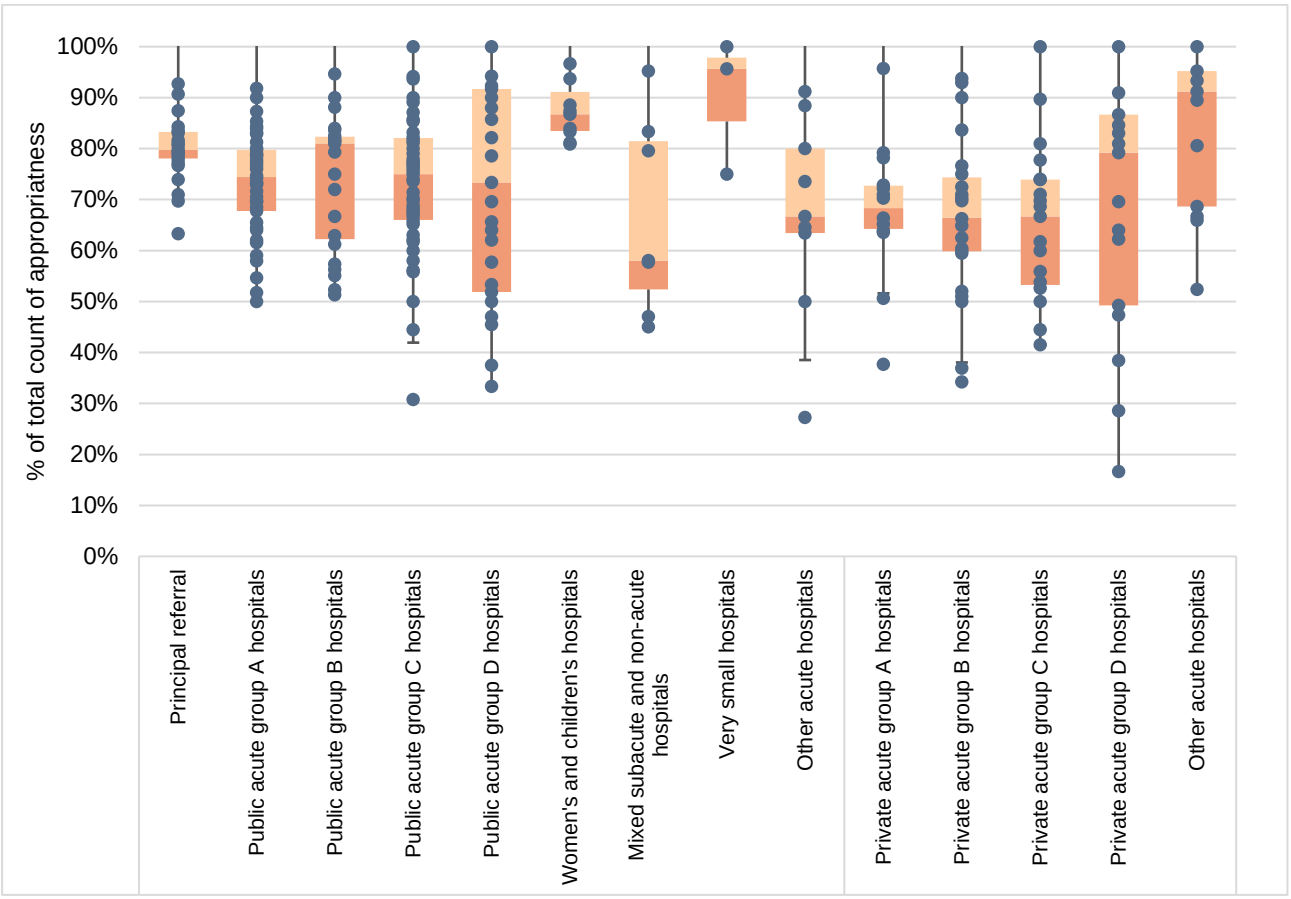


Figure A4.2: Appropriateness of antimicrobial prescribing, Hospital NAPS contributors, Principal Referral hospitals, 2018

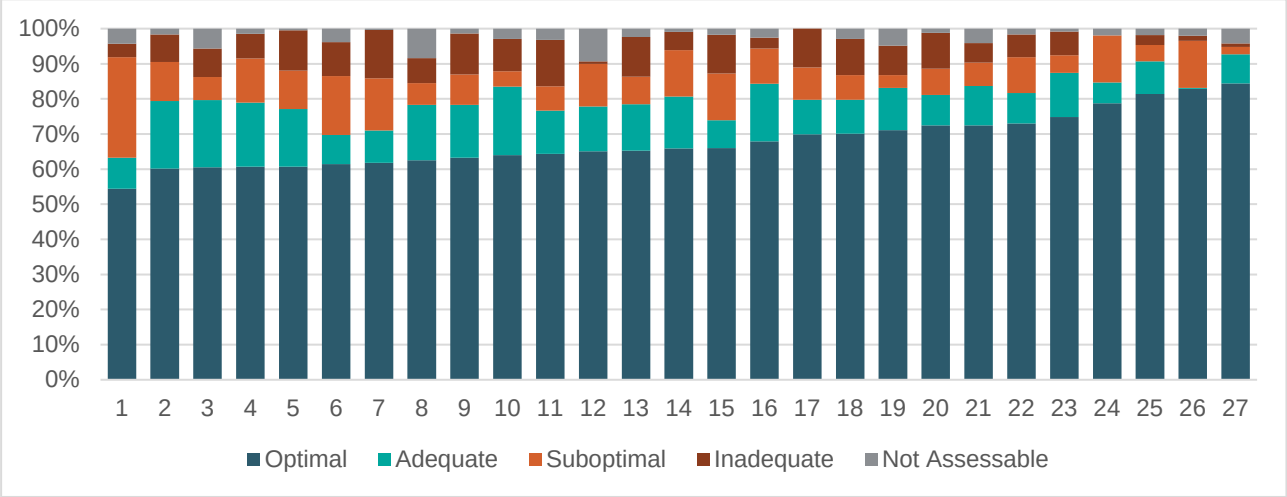


Figure A4.3 Appropriateness of antimicrobial prescribing, Hospital NAPS contributors, Public Group A hospitals, 2018

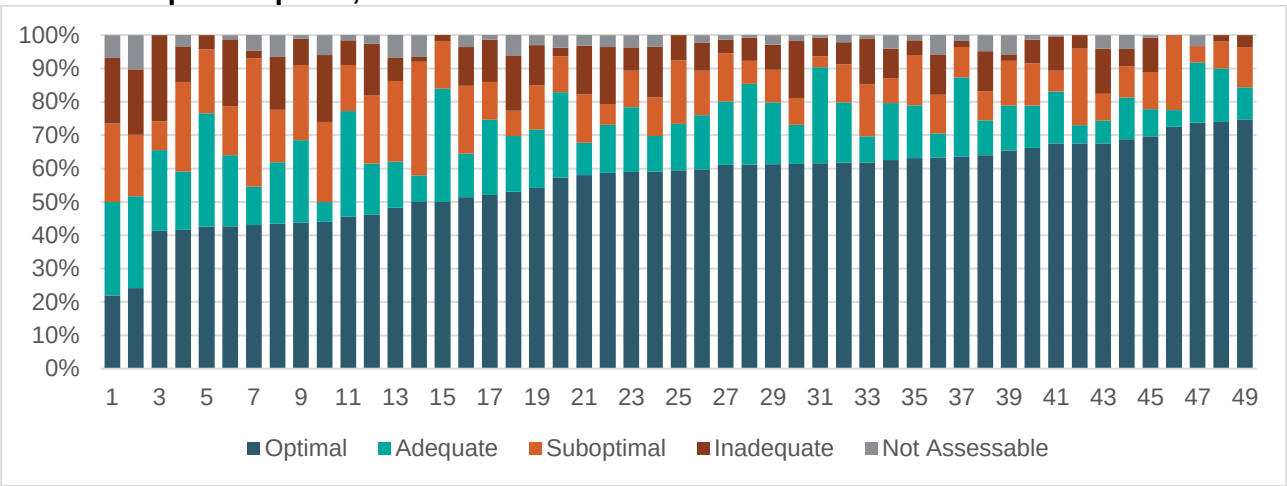


Figure A4.4 Appropriateness of antimicrobial prescribing, Hospital NAPS contributors, Public Group B hospitals, 2018

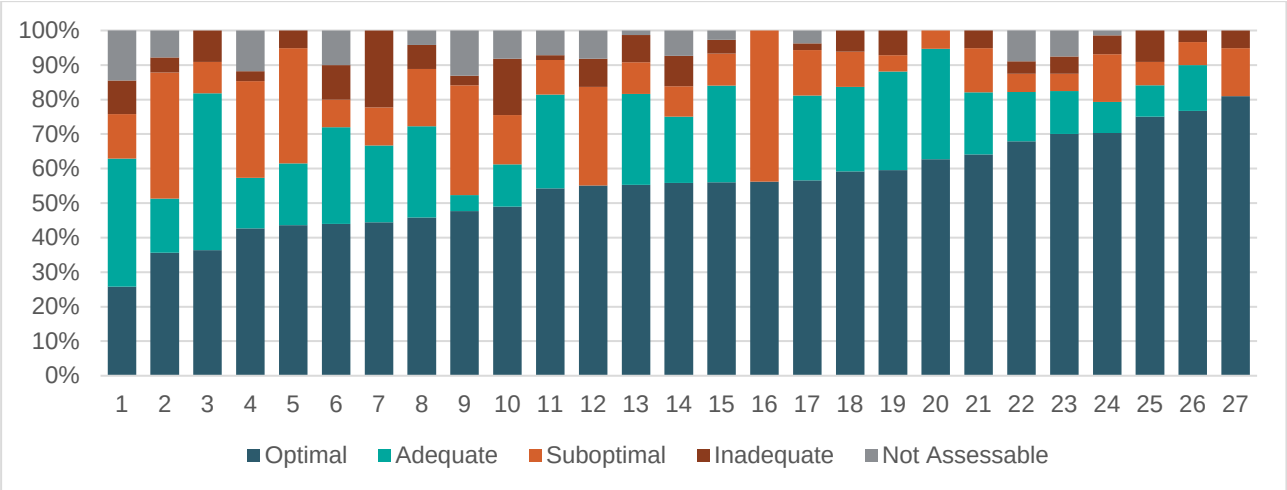


Figure A4.5: Appropriateness of antimicrobial prescribing, Hospital NAPS contributors, Public Group C hospitals, 2018

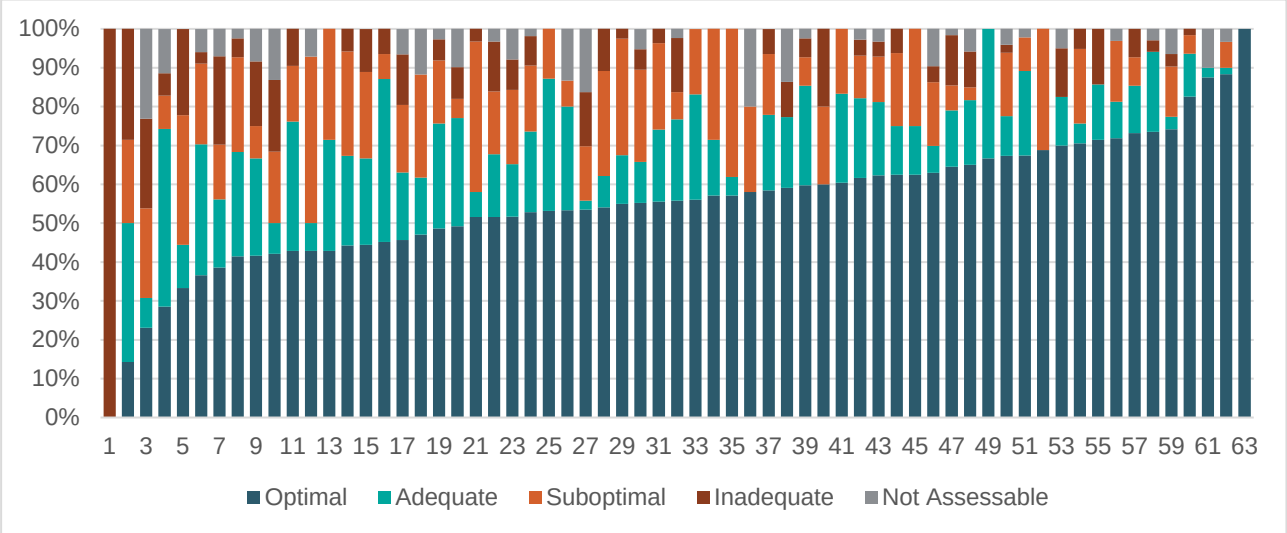


Figure A4.6: Appropriateness of antimicrobial prescribing, Hospital NAPS contributors, Public Group D hospitals, 2018

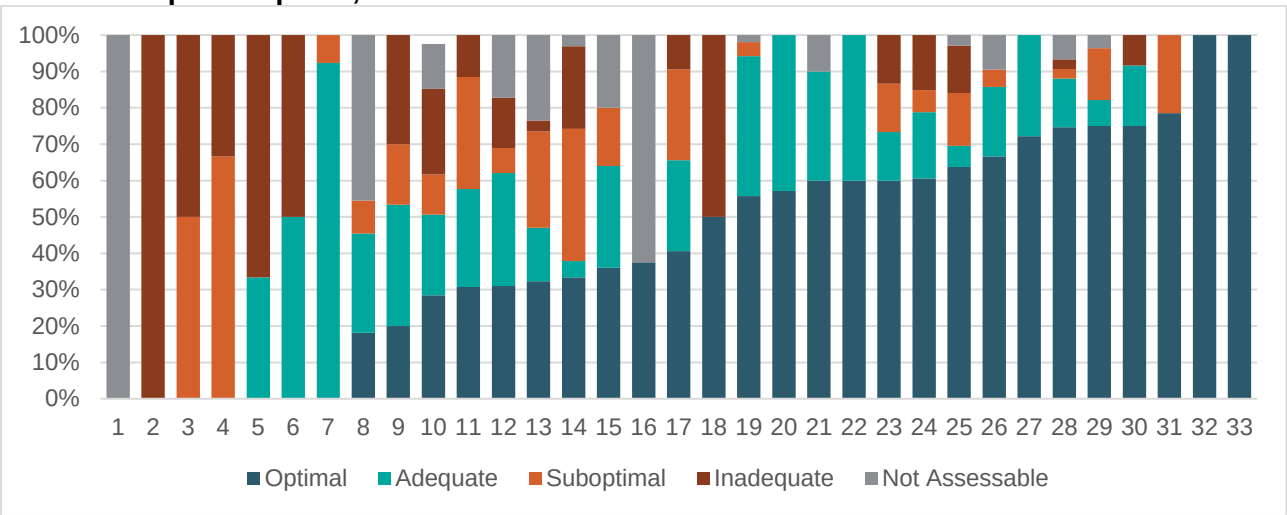


Figure A4.7: Appropriateness of antimicrobial prescribing, Hospital NAPS contributors, Women's and Children's hospitals, 2018

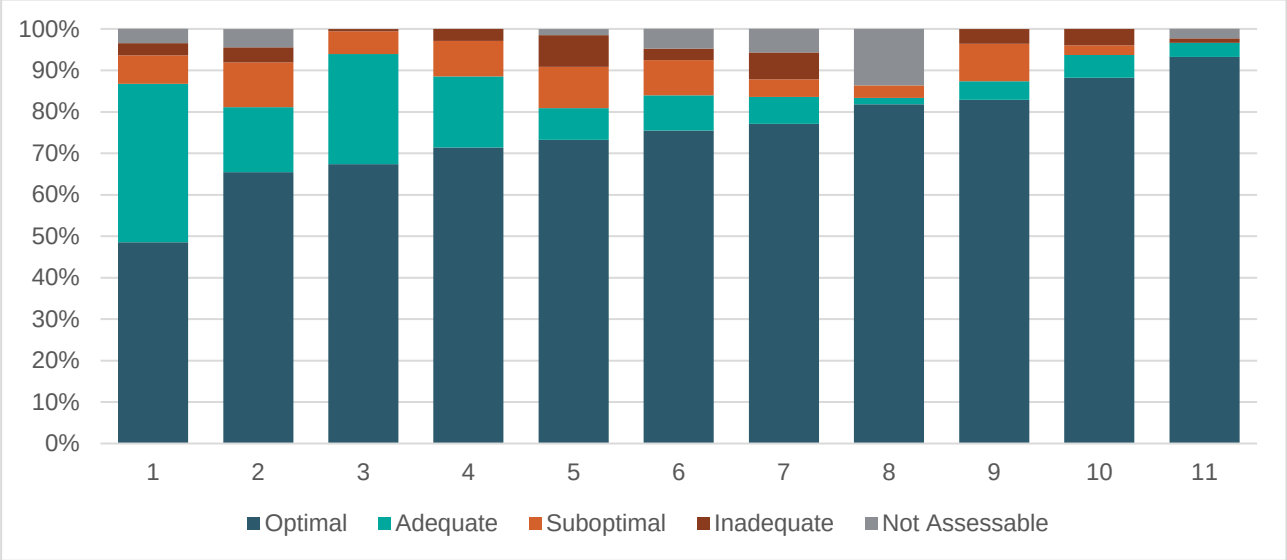


Figure A4.8: Appropriateness of antimicrobial prescribing, Hospital NAPS contributors, Other Public Acute hospitals, 2018

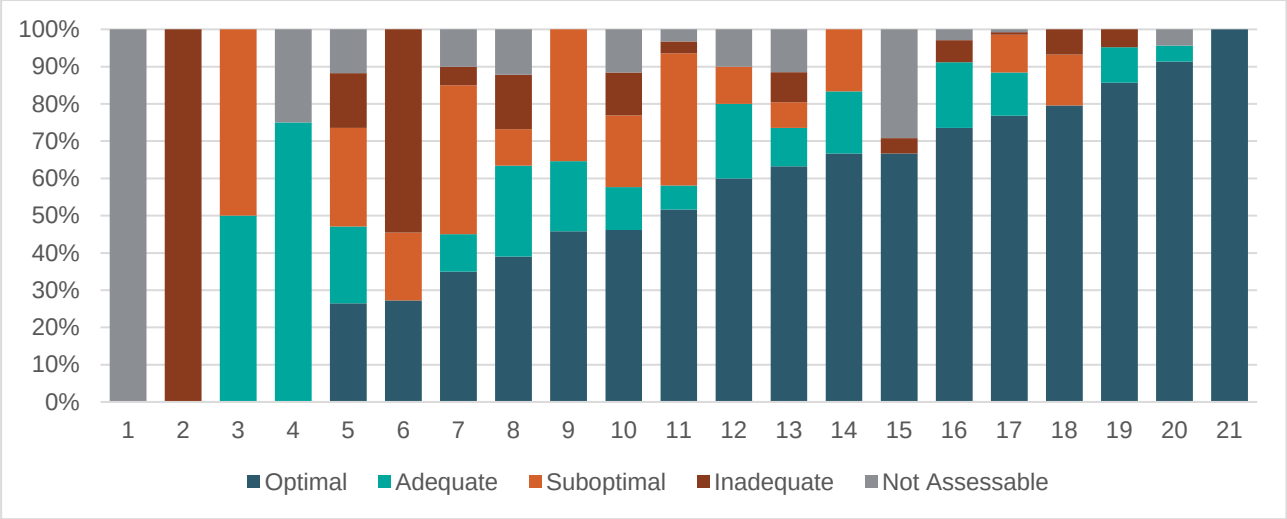


Figure A4.9: Appropriateness of antimicrobial prescribing, Hospital NAPS contributors, Private Group A hospitals, 2018

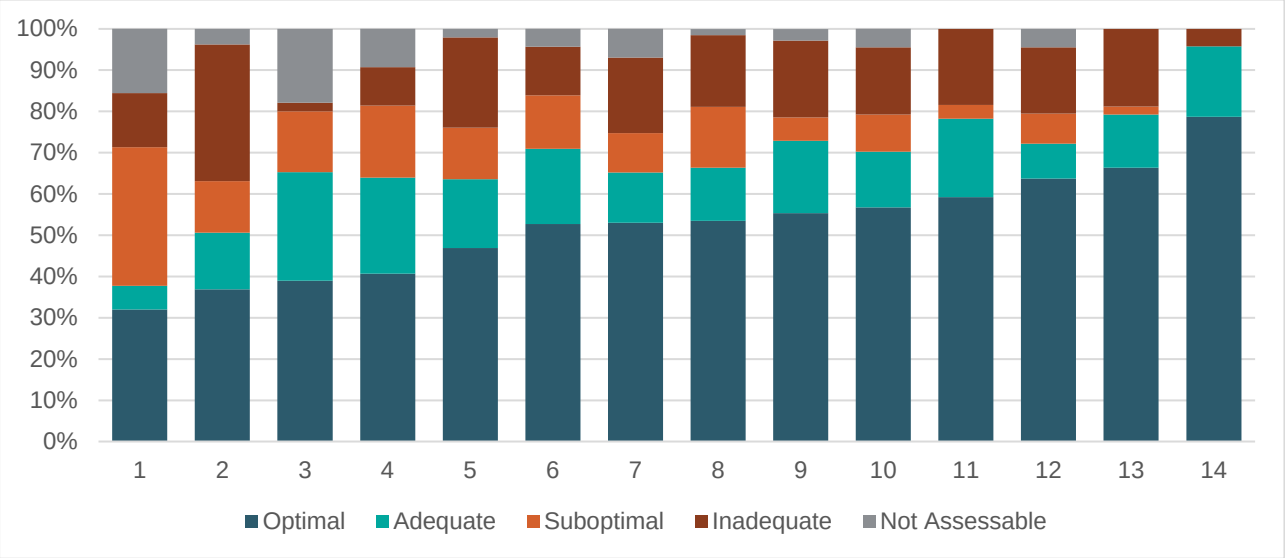


Figure A4.10: Appropriateness of antimicrobial prescribing, Hospital NAPS contributors, Private Group B hospitals, 2018

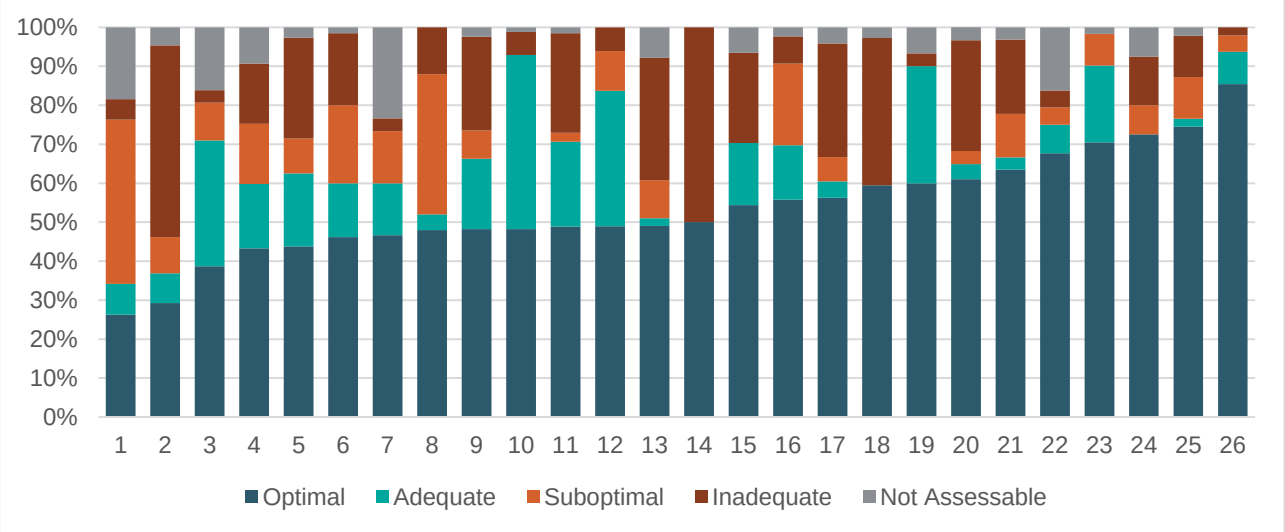


Figure A4.11: Appropriateness of antimicrobial prescribing, Hospital NAPS contributors, Private Group C hospitals, 2018

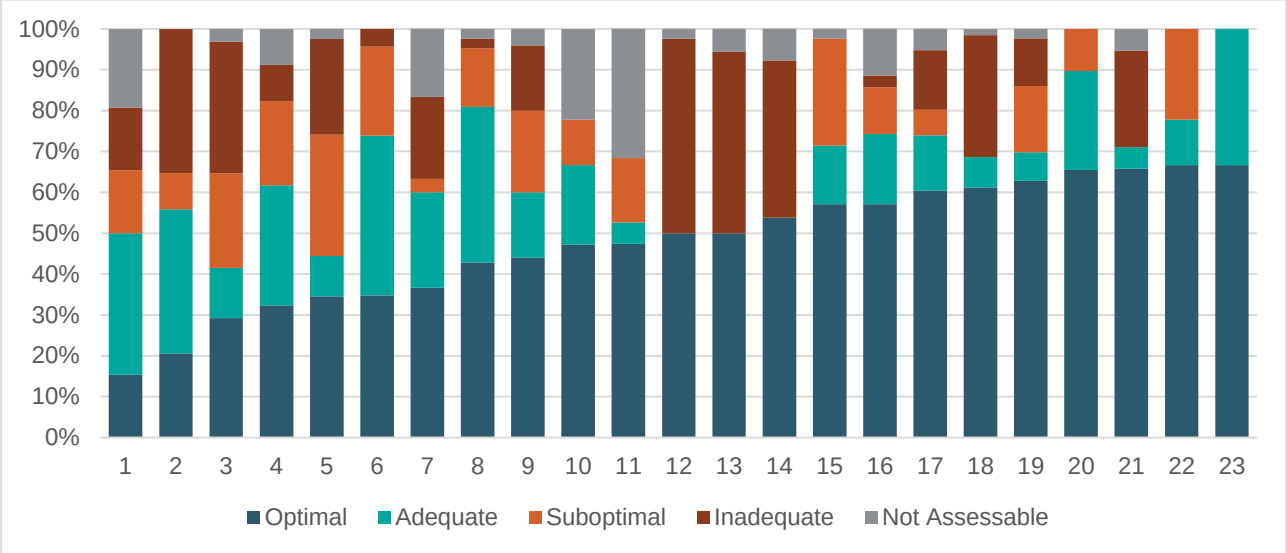


Figure A4.12: Appropriateness of antimicrobial prescribing, Hospital NAPS contributors, Private Group D hospitals, 2018

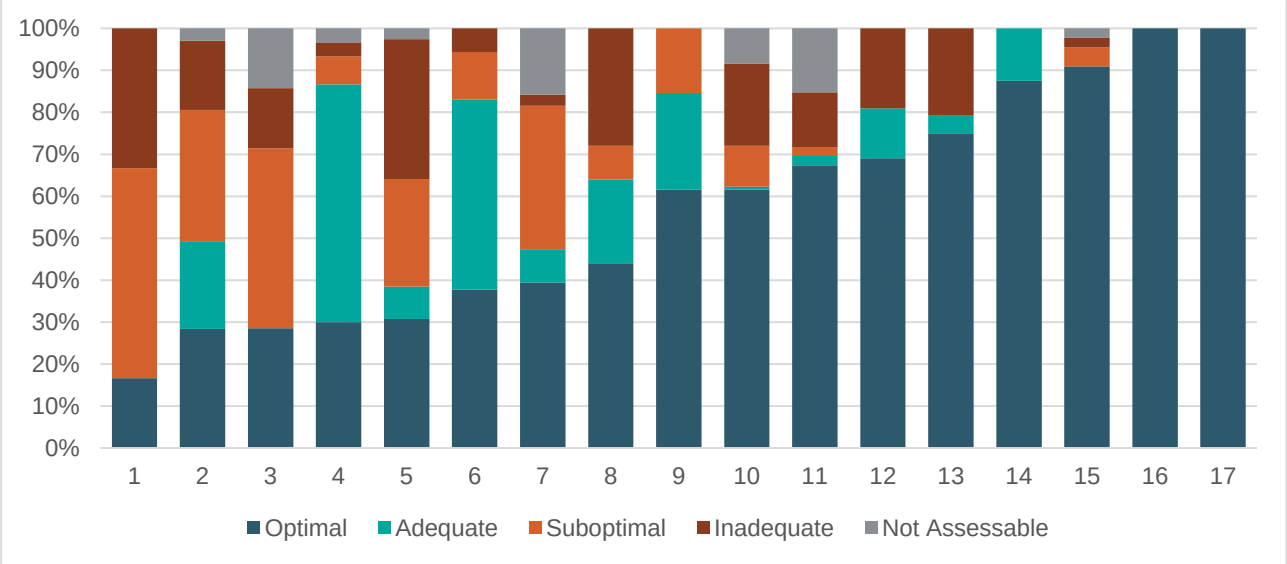
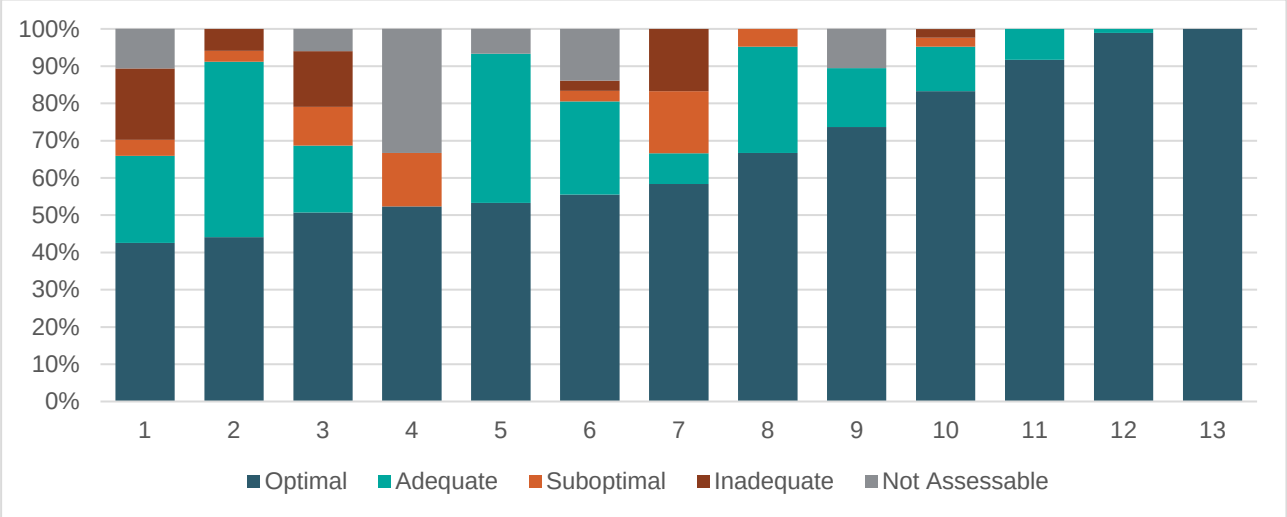


Figure A4.13: Appropriateness of antimicrobial prescribing, Hospital NAPS contributors, Other Private Acute hospitals, 2018



References

[1] Australian Commission on Safety and Quality in Health Care. National Safety and Quality Health Service Standards. 2nd ed. Sydney: ACSQHC; 2017.
[2] Australian Government Department of Health, Australian Government Department of Agriculture. Responding to the threat of antimicrobial resistance: Australia's first National Antimicrobial Resistance Strategy 2015–2019. Canberra: Australian Government Department of Health; 2015 (accessed Sep 2019)
[3] National Centre for Antimicrobial Stewardship and Australian Commission on Safety and Quality in Health Care. Antimicrobial prescribing practice in Australian hospitals: Results of the 2017 National Antimicrobial Prescribing Survey. Sydney: ACSQHC; 2018
[4] National Centre for Antimicrobial Stewardship and Australian Commission on Safety and Quality in Health Care. Surgical National Antimicrobial Prescribing Survey: results of the 2016 pilot. Sydney: ACSQHC; 2017.
[5] SNOMED CT AU and Australian Medicines Terminology (AMT). August 2017 Release. Available from: www.digitalhealth.gov.au/news–and–events/news/snomed–ct–au–and–australian–medicines–terminology–amt–august–2017–release
[6] Australian Bureau of Statistics. The Australian statistical geography standard (ASGS) remoteness structure [Internet]. Australian Bureau of Statistics; 2016 [updated 2018 Mar 15; cited 2018 Jul 6]. Available from: www.abs.gov.au/websitedbs/D3310114.nsf/home/remoteness+structure
[7] Australian Institute of Health and Welfare. Australia's hospitals at a glance 2015–16. Canberra: AIHW, 2017. Available from: www.aihw.gov.au/reports/hospitals/australiashospitals–at–a–glance–2015–16/contents/tableof–contents
[8] eTG complete [Internet]. Melbourne: Therapeutic Guidelines Limited; 2015 Jul. Available from: www.tg.org.au/
[9] Australian Commission on Safety and Quality in Health Care. Advisory. Antimicrobial stewardship. https://www.safetyandquality.gov.au/publications-and-resources/resource-library/as1808-antimicrobial-stewardship
[10]SA Health, Australian Commission on Safety and Quality in Health Care. Antimicrobial use in Australian hospitals: biennial report of the National Antimicrobial Utilisation Surveillance Program, 2017–2018. Sydney: ACSQHC; 2019.
[11] Australian Commission on Safety and Quality in Health Care. Antimicrobial Stewardship Clinical Care Standard. Sydney: ACSQHC, 2014.
[12] Broom A, Broom J, Kirby E, Gibson A, Davis M. Antibiotic optimisation in 'the bush': Local know-how and core-periphery relations. Health Place 2017 Nov;48:56-62. doi: 10.1016/j.healthplace.2017.09.003. Epub 2017 Sep 23. Available from: https://www.ncbi.nlm.nih.gov/pubmed/28941843
[13] Broom J, Broom A, Kirby E, Post JJ. Improvisation versus guideline concordance in surgical antibiotic prophylaxis: a qualitative study. 2018 Aug;46(4):541-548. doi: 10.1007/s15010-018-1156-y. Epub 2018 May 28. Available at: https://www.ncbi.nlm.nih.gov/pubmed/29808462
[14] SA Health. Surgical Antimicrobial Prophylaxis Clinical Guideline. Version No: 2.0. Approval date: 2 November 2017. Available at: https://www.sahealth.sa.gov.au/wps/wcm/connect/6bb523804358edbd883b9ef2cadc00ab/Surgical+Antimicrobial+Prophylaxis_v2.0_23112017.pdf?MOD=AJPERES&CACHEID=ROOTWORKSPACE-6bb523804358edbd883b9ef2cadc00ab-mMHP6uy
[15] NSW Clinical Excellence Commission. Guide. Auditing Surgical Antibiotic Prophylaxis. July 2018. Available at: http://www.cec.health.nsw.gov.au/__data/assets/pdf_file/0010/440776/Auditing-surgical-antibiotic-prophylaxis-prescribing-Guide.pdf
[16] Australian Commission on Safety and Quality in Health Care (ACSQHC). AURA 2019: Third Australian report on antimicrobial use and resistance in human health. Sydney: ACSQHC; 2019. Available at: www.safetyandquality.gov.au/antimicrobial-use-andresistance-in-australia/resources-page/