AUSTRALIAN COMMISSION ON SAFETY AND QUALITY IN HEALTH CARE

AURA
Antimicrobial Use and Resistance in Australia

Antimicrobial prescribing practice in Australian hospitals

Results of the 2019 Hospital National Antimicrobial Prescribing Survey

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HOSPITAL NAPS National Antimicrobial Prescribing Survey

NCAS National Centre for Antimicrobial Stewardship

GUIDANCE

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Summary

Analyses of the 2019 Hospital National Antimicrobial Prescribing Survey (NAPS) data confirm issues identified in successive surveys since 2013. The appropriateness of antimicrobial use in Australian public and private hospital contributors has not shown any sustained improvement over time, and compliance with national and local prescribing guidelines is frequently less than optimal.

During 2019, 377 hospitals (268 public and 109 private) submitted data on 31,424 prescriptions to the Hospital NAPS database.

Key findings of the 2019 Hospital NAPS

There have been long-term improvements in three key indicators of appropriateness of antimicrobial prescribing monitored by the Hospital NAPS:

- Documentation of indication increased to 84.2%, in 2019 compared with 70.5% in 2013
- Documentation of review or stop date increased to 48.0%, compared with 34.8% in 2015 when this indicator was first reported. However, the level of documentation is still unacceptably low
- Proportion of surgical prophylaxis given for greater than 24 hours was 30.0% in 2019, compared with 41.0% in 2013.

Whilst these improvements are encouraging, concerning patterns regarding other aspects of antimicrobial prescribing appropriateness, over time, are:

- Compliance with therapeutic guidelines or local guidelines, declined from 72.1% in 2013 to 65.3% in 2019
- Overall appropriateness of prescribing has essentially remained static since 2013, and was 75.7% in 2019
- Prescribing for specific indications, particularly:
  - chronic obstructive pulmonary disease (COPD); non-compliance with guidelines (almost 60%)
  - surgical prophylaxis; non-compliance with guidelines (45%)
  - non-surgical wound infections, non-compliance with guidelines (almost 30%)
  - community-acquired pneumonia, non-compliance with guidelines (almost 33%)
- Inappropriate prescribing of broad-spectrum antimicrobials, particularly for cefalexin, cefazolin, azithromycin and amoxicillin–clavulanic acid.

The nature of these areas of concern, provide a number of opportunities for improvement of practice in relation to prescribing of specific antimicrobials, and consequently, patient safety.

Whilst the proportion of prescriptions for vancomycin assessed as appropriate has been consistently high between 2015 and 2019; the main reasons for inappropriate prescribing of vancomycin were spectrum too broad; incorrect dose or frequency; and, incorrect duration. In 2019, very high proportions of inappropriate prescribing of vancomycin were recorded in relation to empiric therapy for community-acquired pneumonia and surgical prophylaxis. Australia has one of the highest rates of vancomycin-resistant *Enterococcus faecium* (VRE) in the world.[1] Appropriate use of vancomycin, along with adherence to infection prevention and control procedures, is critical to minimise the risk of further increases in VRE. The dosing of vancomycin can be complex, and access to therapeutic drug monitoring is required to support appropriate prescribing and use. VRE will be an area of particular emphasis by the Commission in its work with the states and territories and the private sector in 2020-2021.

Analyses of the Hospital NAPS data in relation to use of the reserve-line antimicrobial meropenem are reassuring. Overall, appropriateness was high from 2015 to 2019 for prescribing of meropenem, and the majority of indications were for directed therapy. One of the major indications for antimicrobials such as meropenem is directed therapy for multidrug-resistant organisms such as extended-spectrum β-lactamase (ESBL) producing bacteria. There are limited choices for treatment of infections caused by these organisms, which were found in 14.5% of *Escherichia coli* and 11.1% of *Klebsiella pneumoniae* bacteraemias, and were more common in hospital-onset episodes of bacteraemia in Australia in 2018.[2]

Appropriateness of prescribing and compliance with guidelines for use of amoxicillin–clavulanic acid was poor in 2019, and there has been minimal improvement over time in NAPS contributor hospitals. The volume of use of amoxicillin–clavulanic acid is high in Australia, and because of its broad spectrum, it has the potential to promote the development of antimicrobial resistance (AMR).[3] Appropriateness of use should be a priority for all prescribers and AMS programs.

Almost 45% of prescriptions for cefalexin, another broad-spectrum antimicrobial, were assessed as inappropriate in 2019, and non-compliance with guidelines was very high (61.7%). This finding is consistent with Hospital NAPS analyses from 2015 to 2019; there has been minimal improvement over time. In 2019, there was very high inappropriate use of cefalexin for surgical prophylaxis (88.0%) and as empiric therapy for community-acquired pneumonia (66%). Use of cefalexin for surgical prophylaxis should continue to be a priority for hospital AMS programs, along with increased focus on use of narrow-spectrum alternatives to cefalexin for treatment of community acquired pneumonia to reduce the volume of use and the potential for development of AMR.

What action will be taken?

To address the patient safety issues identified by the 2019 Hospital NAPS, the Commission will:

- Ensure widespread communication of 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 direct involvement of prescribers and clinicians involved in antimicrobial stewardship, in the senior review of local prescribing patterns as shown by the Hospital NAPS data, and other AMS data. The inclusion of clinical governance processes, such as morbidity and mortality (M&M) meetings, departmental meetings and grand rounds will also be promoted.
- 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
- Promote the value to patient care of public and private health service organisations routinely reviewing their NAPS results and dissemination of the findings to prescribers and specialty groups and implement targeted strategies for departments with the highest rates of inappropriate prescribing, non-compliance with guidelines and incomplete documentation
- Work with NCAS and the states and territories to facilitate enhanced access to Hospital NAPS data for public health service organisations to support system-wide targeting of AMS resources to priority areas, and the development of strategies for smaller health service organisations
- Facilitate and promote sharing information between states, territories and health service organisations on effective AMS quality improvement initiatives
- Review the Antimicrobial Stewardship Clinical Care Standard and associated implementation support resources in 2020[5]
- Continue to collaborate with the Royal Australasian College of Surgeons and establish relationships with 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 community-acquired pneumonia and COPD

- Develop specific AMS resources regarding appropriate use of amoxicillin–clavulanic acid and cefalexin
- Identify resources to support improved action in regard to VRE
- 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

As part of the Antimicrobial Use and Resistance in Australia (AURA) Surveillance System, the Hospital National Antimicrobial Prescribing Survey (NAPS) provides valuable information to support Australian health service organisations, states and territories and private health service provider organisations to enhance their antimicrobial stewardship (AMS) programs by:

- Facilitating effective audit and review of antimicrobial use, including compliance with prescribing guidelines and prescribing appropriateness
- Providing data to underpin effective communication regarding local antimicrobial use and identifying targeted strategies 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 also assists health service organisations demonstrate they meet the AMS actions of the National Safety and Quality Health Service (NSQHS) Preventing and Controlling Healthcare-Associated Infection Standard.[6]

The Australian Commission on Safety and Quality in Health Care (the Commission) provides funding for the National Centre in Antimicrobial Stewardship (NCAS) to conduct the Hospital NAPS and contribute data to the Antimicrobial Use and Resistance in Australia (AURA) Surveillance System. Funding for AURA is provided by the Australian Government Department of Health and state and territory health departments.

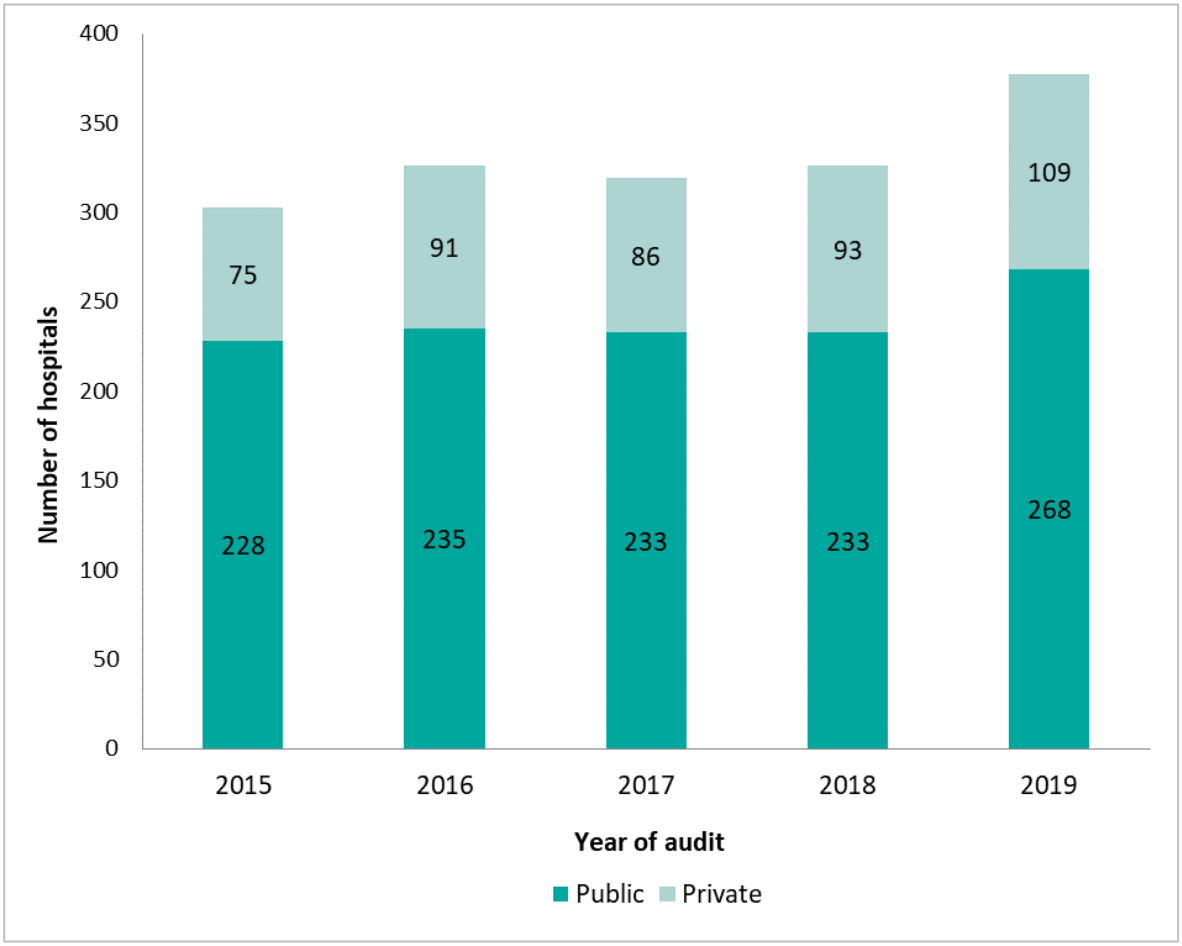
Methods, limitations and considerations for interpretation of the Hospital NAPS data are in Appendix 1.

Key results

Participation

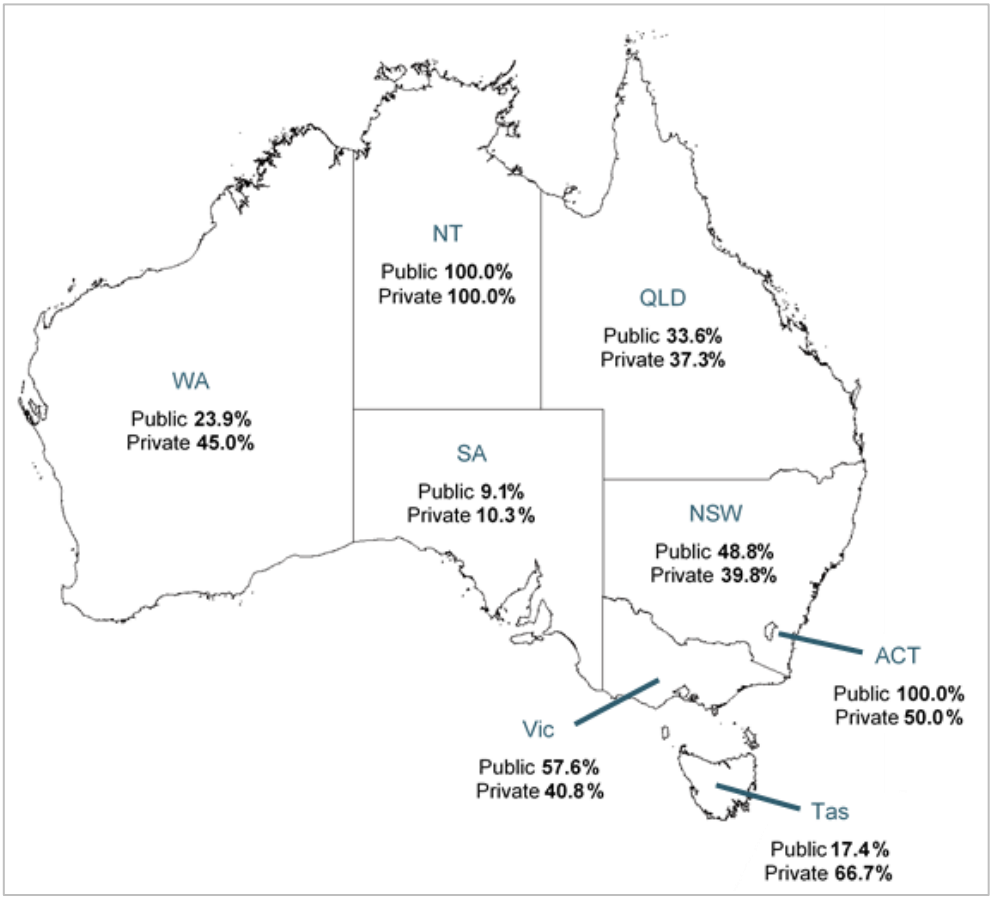
This report analyses the data submitted by 377 hospitals (268 public and 109 private) that met the Hospital NAPS inclusion criteria. An additional 51 hospitals participated in the survey in 2019, compared with 2018 (Figure 1). Data from 19,680 patients were submitted during the 2019 data collection period, generating 31,424 prescriptions for analysis. The overall prevalence of antimicrobial prescribing among contributor hospitals was 37.0%.

Figure 1: Number of public and private hospitals that contributed to the Hospital NAPS, 2015–2019



Nearly 40% of all eligible public and private hospitals participated in the survey, and all Australian states and territories were represented (Figure 2). In most states and territories, participation has remained consistent or increased over time across both the private and public sectors. There were increases in participation for all hospital peer groups from 2015 to 2019 (Appendix 2: figure A1). The full analysis of hospital participation by funding type, state and territory, peer group and remoteness classification can be found in Appendix 2: tables A1 and A2. See Appendix 2: table A3 for the breakdown of participation by number and percentage of prescriptions.

Figure 2: Percentage of public and private hospitals that contributed to the Hospital NAPS by state and territory, 2019



Key performance indicators

Documentation of indication

There was consistent improvement over time in documentation of the reason for the antimicrobial prescription; the rate was 84.2% in 2019 (Table 1). Among private hospitals, the indication documentation rate was 70.1%. In public hospitals, the rate was 87.8%, which is approaching the best-practice target of 95% that has been adopted by NCAS for the Hospital NAPS.

Table 1: Hospital NAPS key indicators, for assessable prescriptions, 2015–2019

Key indicator	Percentage of total prescriptions (%)				
	2015	2016	2017	2018	2019
Indication documented in medical notes (best practice > 95%)	72.0	76.0	77.6	80.2	84.2
Review or stop date documented (best practice > 95%)	34.8	38.0	40.7	45.2	48.0
Surgical prophylaxis given for >24 hours (best practice < 5%)*	26.8	30.1	30.0	27.9	30.0
Compliant with *Therapeutic Guidelines* or local guidelines†	70.1	66.0	67.4	67.7	65.3
Appropriate (optimal and adequate)§	76.4	76.1	76.3	77.8	75.8

* Where surgical prophylaxis was selected as the indication (*n* = 3,963 in 2019).

† Prescriptions for which compliance was assessable (*n* = 24,989 in 2019). 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* = 30,228 in 2019). Excludes prescriptions deemed to be 'not assessable'.

See Appendix 2: tables A3 and A4 for the breakdown of Hospital NAPS key indicators by funding type, state and territory, peer group and remoteness classification.

Appendix 2: Table A5 shows the changes over time for the different guideline compliance and appropriateness categories for Hospital NAPS prescriptions.

Documentation of review or stop date

Table 1 shows consistent improvement in documentation of the antimicrobial review or stop date (48.0%) from 2015 to 2019. For this metric, private hospitals are performing better (55.4%) compared to public hospitals (46.1%).

Surgical prophylaxis greater than 24 hours

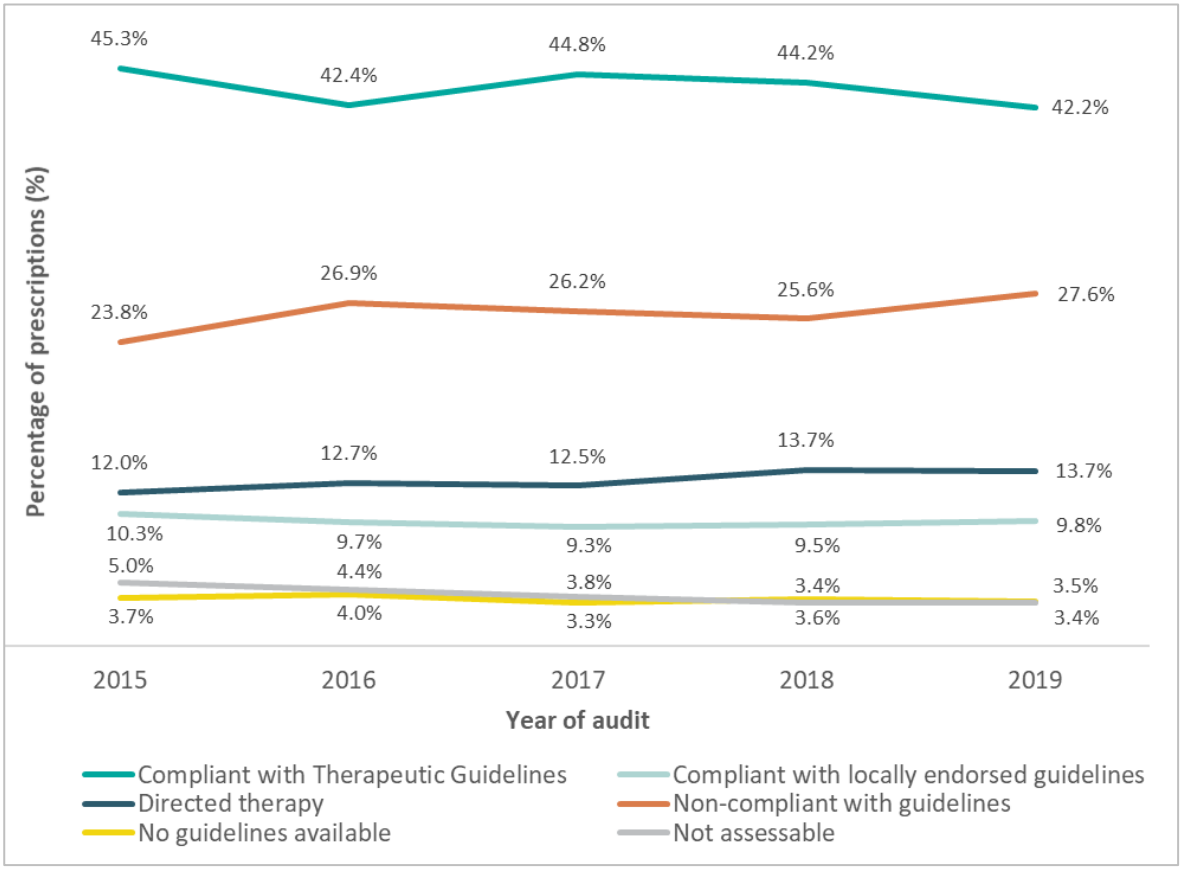
Approximately one third of patients who underwent a surgical procedure received prolonged antimicrobial prophylaxis during their hospital stay. This figure has essentially remained static over the last five years and was 30.0% in 2019. In depth analyses of the types and durations of post-operative surgical prophylaxis procedures can be found in the report on the 2019 Surgical NAPS.[7]

Compliance with guidelines

Compliance with therapeutic guidelines decreased from 44.2% in 2018 to 42.2% in 2019, which corresponded with the release of a new version of the *Therapeutic Guidelines: Antibiotic*. A similar decrease was seen in 2016, when the previous version of these guidelines was released, followed by improvement in the interim years (Figure 3).

The percentage of prescriptions assessed as directed therapy or compliant with local guidelines has effectively remained the same from 2015 to 2019, and has not been influenced by the release of different versions of the *Therapeutic Guidelines: Antibiotic*.

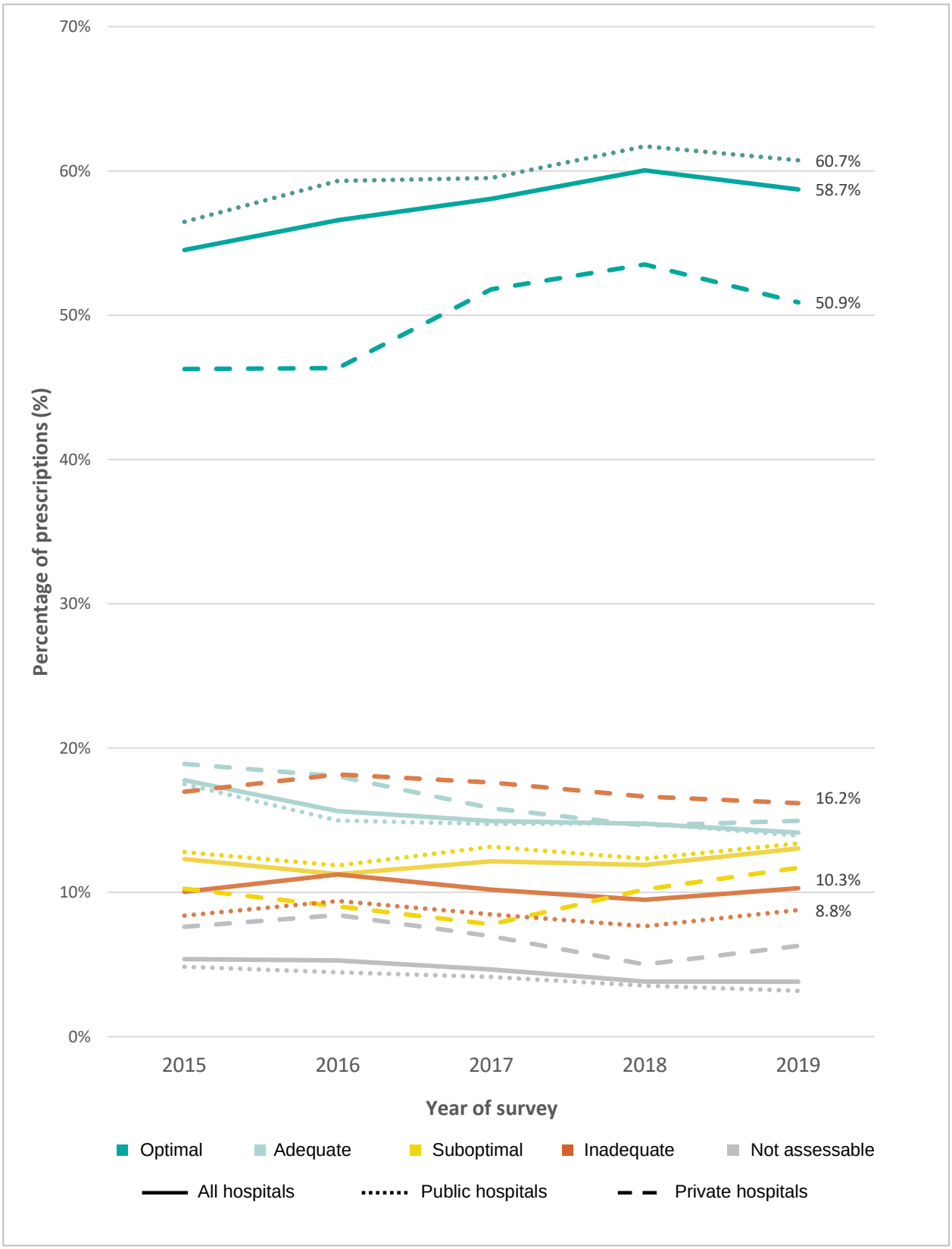
Figure 3: Compliance with guidelines for all prescriptions, 2015–2019



Appropriateness

Reflecting the drop in guideline compliance, the number of prescriptions assessed as inappropriate (those assessed as suboptimal and inadequate) rose from 21.4% in 2018 to 23.3% in 2019.The percentage of prescriptions considered to be inadequate in private hospitals was nearly double that of public hospitals (16.2% vs 8.8%), although the disparity has been decreasing over time (Figure 4).

Figure 4: Appropriateness for all prescriptions, 2015–2019



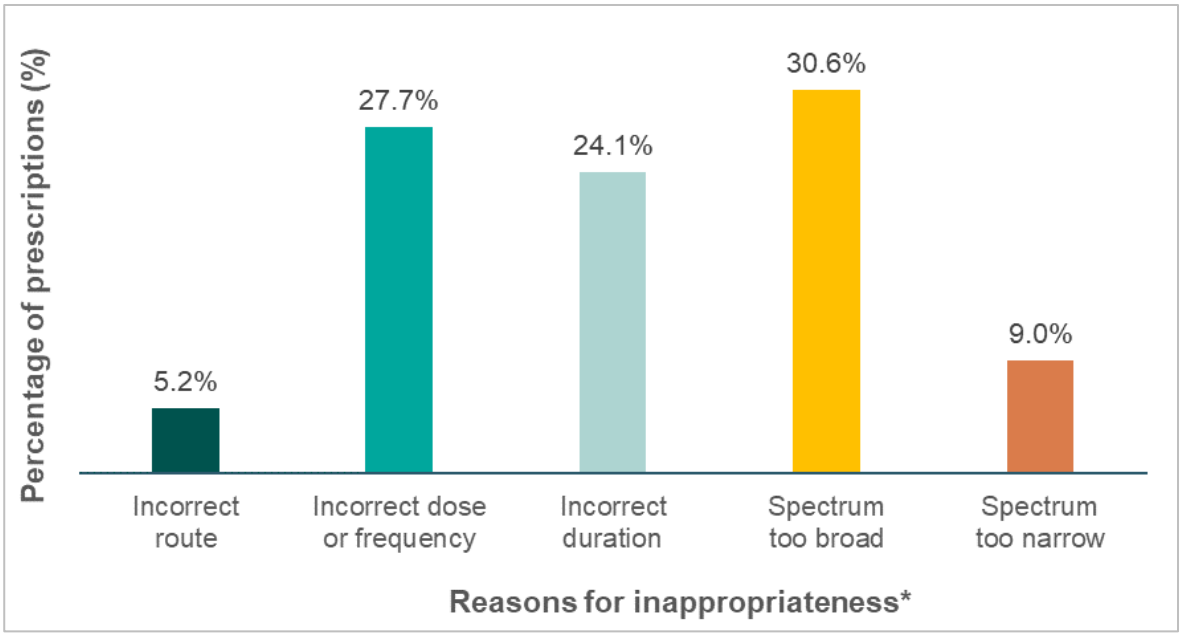
Reasons for inappropriateness

Of the 31,424 prescriptions entered in 2019, 0.3% were identified as having an allergy mismatch and 1.6% had a microbiology mismatch. These low rates are similar to previous Hospital NAPS data.

In 2019, as part of an upgrade to the Hospital NAPS database, it became mandatory for auditors to document why they had assessed a prescription as suboptimal or inadequate. These two categories, when combined, determine whether a prescription is assessed as inappropriate.

Of the 7,332 inappropriate prescriptions in the database, 21.3% were prescribed for patients whose conditions did not require antimicrobial therapy. The remaining reasons for inappropriateness have been determined by excluding these prescriptions from the analyses shown in Figure 5. Previously, these fields were optional and it was not possible to comment with certainty on the most common reasons for prescriptions being assessed as inappropriate. Incorrect dose or frequency, incorrect duration and spectrum too broad are the main reasons for prescriptions being assessed as inappropriate.

Figure 5: Reasons for a prescription being assessed as inappropriate, Hospital NAPS contributors, 2019



n = 5,770 prescriptions

* Each prescription is assessed against each quality indicator and thus can be represented in more than one category.

In-depth analyses – selected antimicrobials and indications for prescribing

Vancomycin

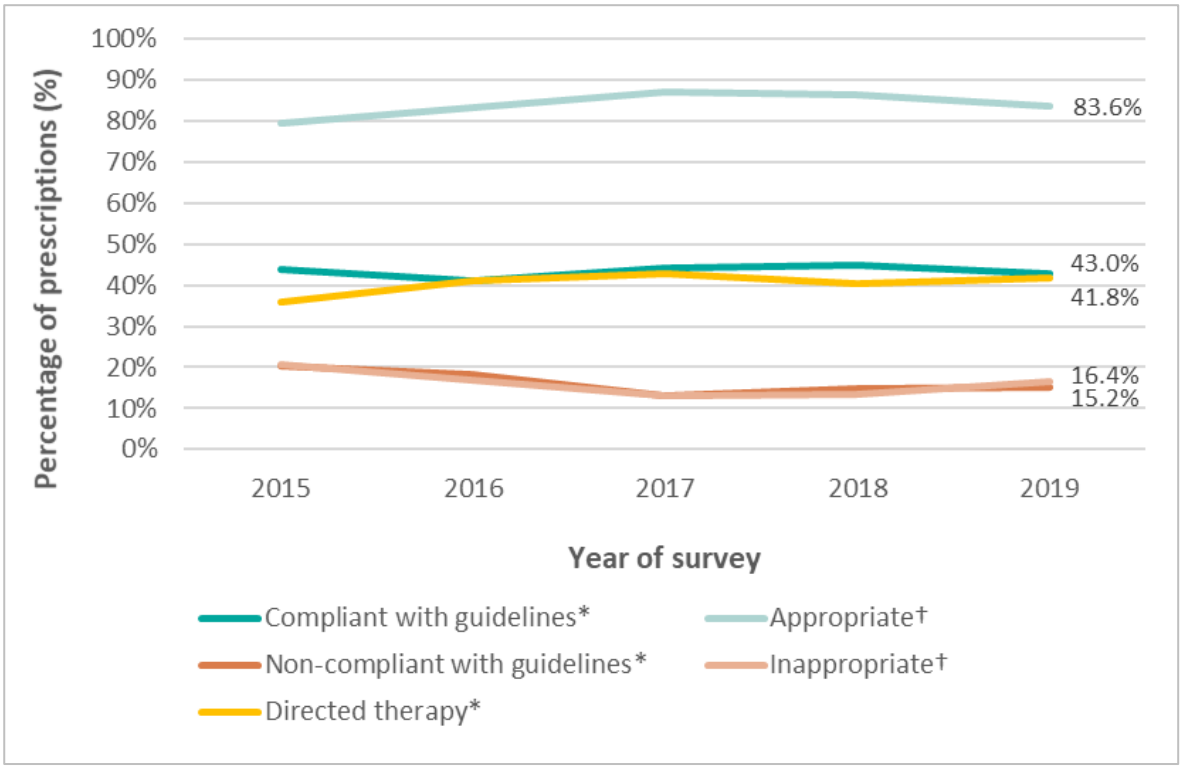
Australia has one of the highest rates of vancomycin-resistant *Enterococcus faecium* (VRE) in the world.[1] Appropriate use of vancomycin, along with adherence to infection prevention and control procedures, is critical to minimising the risk of further increases in VRE. The dosing of vancomycin can be complex; access to therapeutic drug monitoring is required to support appropriate prescribing and use.

A significant percentage of vancomycin prescriptions are written in response to microbiology results (41.8% in 2019), and overall the appropriateness of prescribing has been consistently high (83.6%) (Figure 6). However, compliance with local or national prescribing guidelines is lower (43.0% in 2019), and analysis of the reasons for inappropriateness provides insights into areas for education and improvement.

Of the 134 vancomycin prescriptions that were considered inappropriate in 2019, only 12 were assessed as not required. Of the remaining 122 inappropriate prescriptions, the most common reasons for this assessment were that the spectrum of vancomycin was too broad for the documented indication (41.8%), incorrect dose or frequency was prescribed (28.7%), or the duration of treatment was incorrect (20.5%).

The percentage of inappropriate prescriptions of vancomycin for treatment of pneumonia, surgical prophylaxis, wound infections or peritonitis was high (Figure 7).

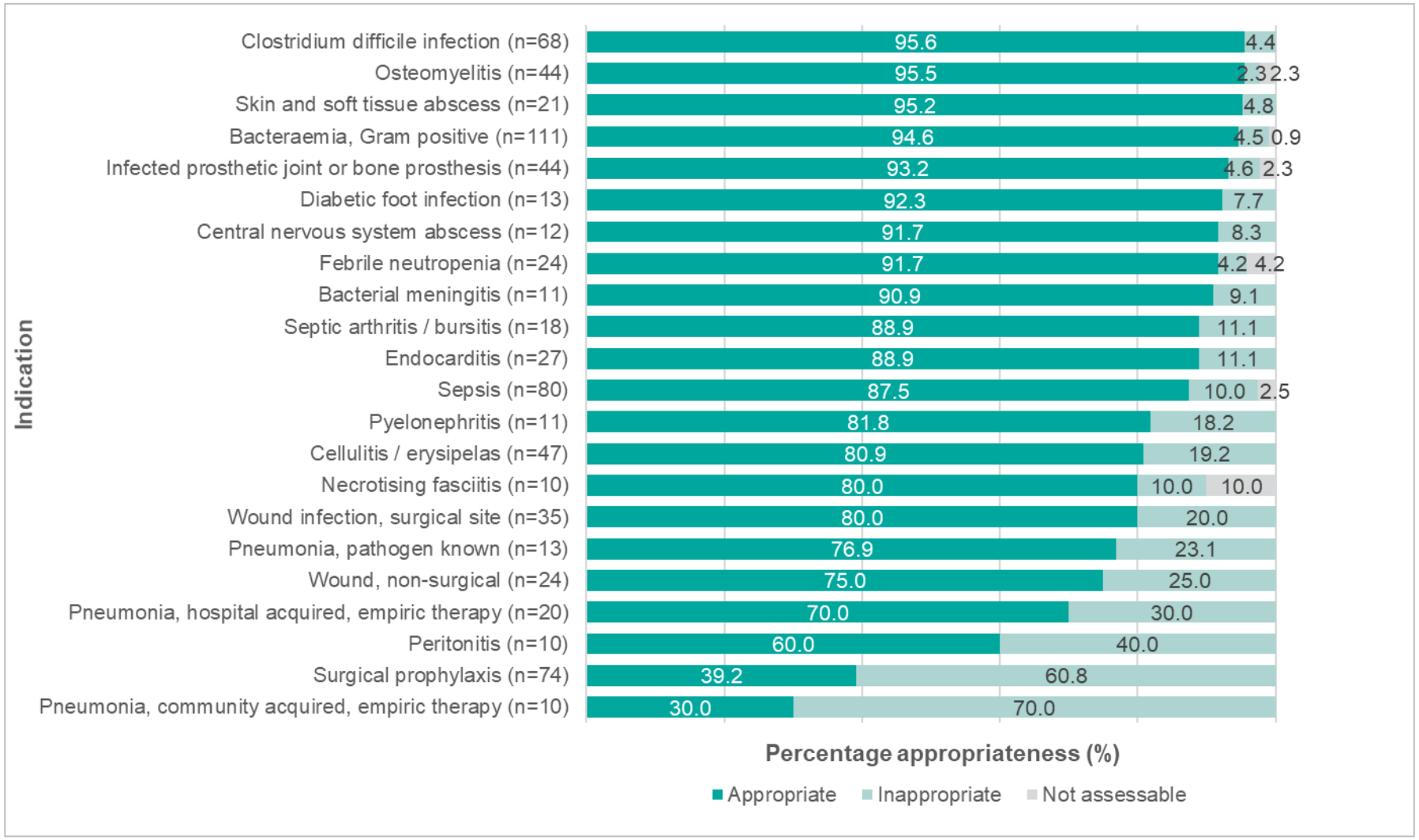
Figure 6: Guideline compliance and prescription appropriateness of vancomycin, 2015–2019



* Excludes prescriptions for which guidelines were not available or not assessable.

† Excludes prescriptions for which appropriateness was deemed to be not assessable.

Figure 7: Appropriateness of vancomycin prescriptions by indication, 2019*



*For indications with at least 10 prescriptions.

n = 828 vancomycin prescriptions

Meropenem

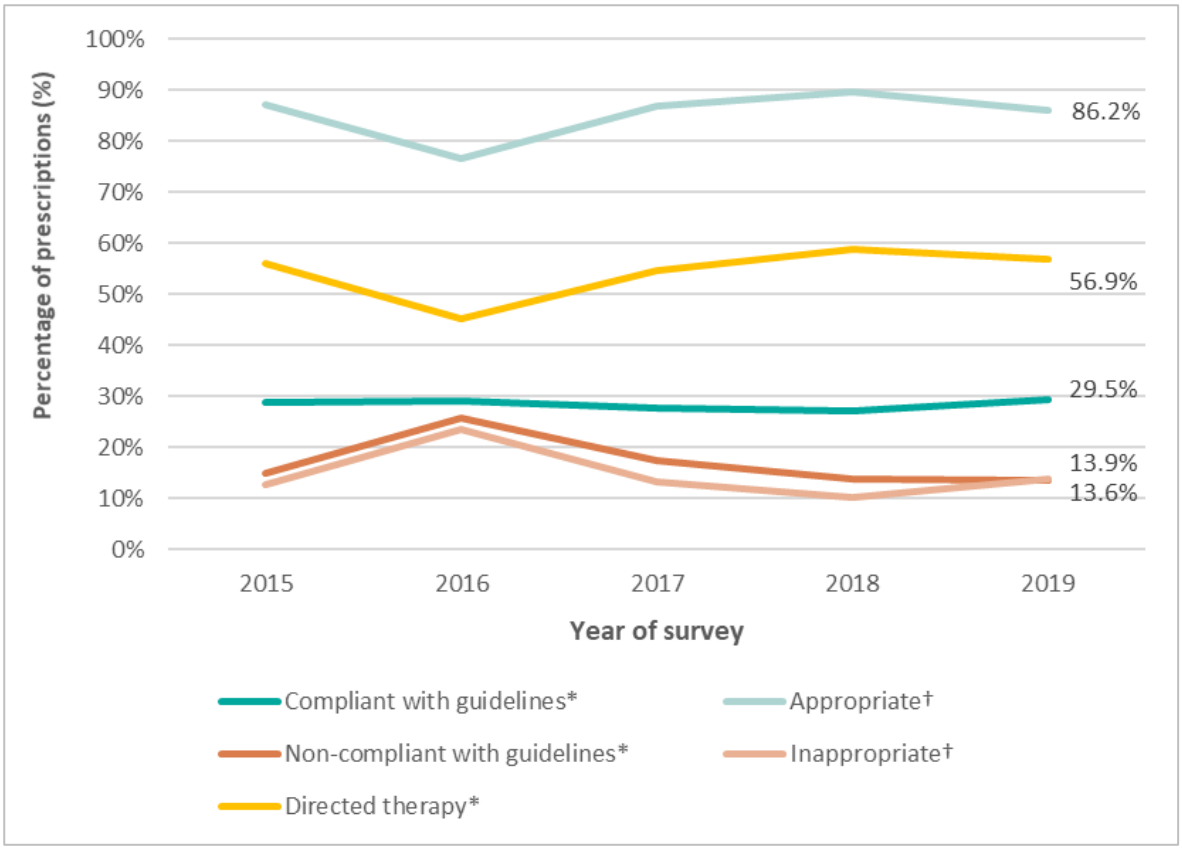
Carbapenems, such as meropenem, have a broad spectrum and are reserved for treatment of infections caused by multidrug-resistant organisms. Carbapenemase-producing Enterobacterales (CPE) have increased annually in Australia since 2016.[9] This poses a significant risk to patient safety, because these bacteria are almost always resistant to other important antimicrobial classes, such as other ß-lactams, ß-lactamase inhibitor combinations, fluoroquinolones and aminoglycosides. This means that effective treatment options for infections may be limited, and lengths of hospital admissions may increase. One of the reasons patients are likely to be affected by CPE includes exposure to different antimicrobial agents, especially cephalosporins, fluoroquinolones and carbapenems.

From 2014 to 2018, meropenem usage rates were generally low nationally, and highest in Principal Referral and Public Acute Group A NAUSP contributor hospitals to the National Antimicrobial Utilisation Surveillance Program (NAUSP). However, there was an upward trend in usage in most peer groups.[3]

The overall appropriateness of meropenem prescribing is high (86.2% in 2019), which reflects the fact that most of the prescriptions entered into the NAPS database are either prescribed as directed therapy or compliant with guidelines (Figure 8).

When analysed by indication, rates of inappropriateness for meropenem prescriptions for cystitis and the empiric treatment of pneumonia exceeded 20% (Figure 9). For indications where antimicrobial treatment was deemed necessary, 65 meropenem prescriptions were assessed as inappropriate in 2019. Of these, the spectrum was too broad for 64.6%, and for 20.0% the incorrect dose or frequency was prescribed.

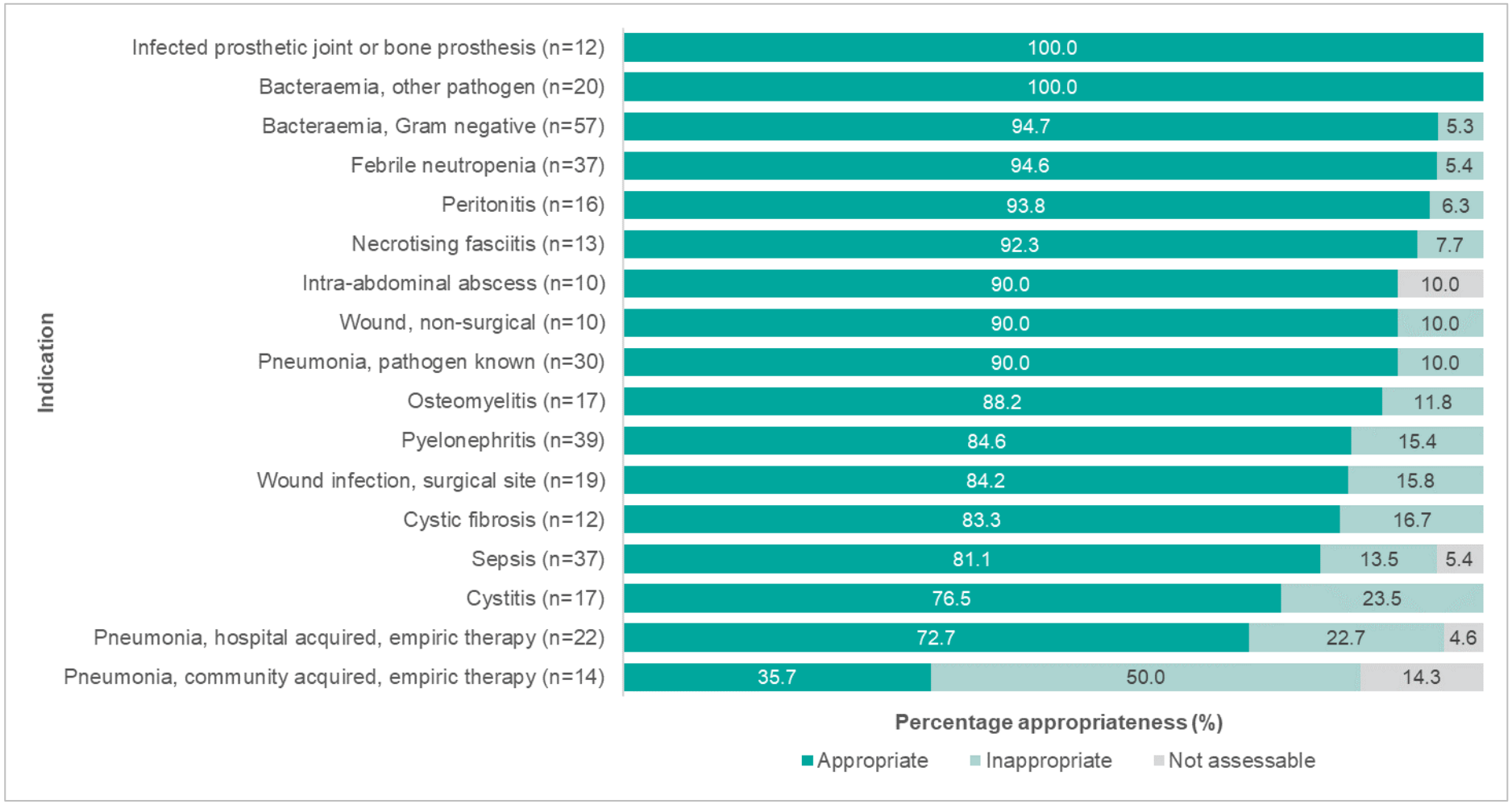
Figure 8: Guideline compliance and prescription appropriateness of meropenem, 2015–2019



* Excludes prescriptions for which guidelines were not available or not assessable.

† Excludes prescriptions for which appropriateness was deemed to be not assessable.

Figure 9: Appropriateness of meropenem prescriptions by indication, 2019*



*For indications with at least 10 prescriptions

Oral amoxicillin–clavulanic acid

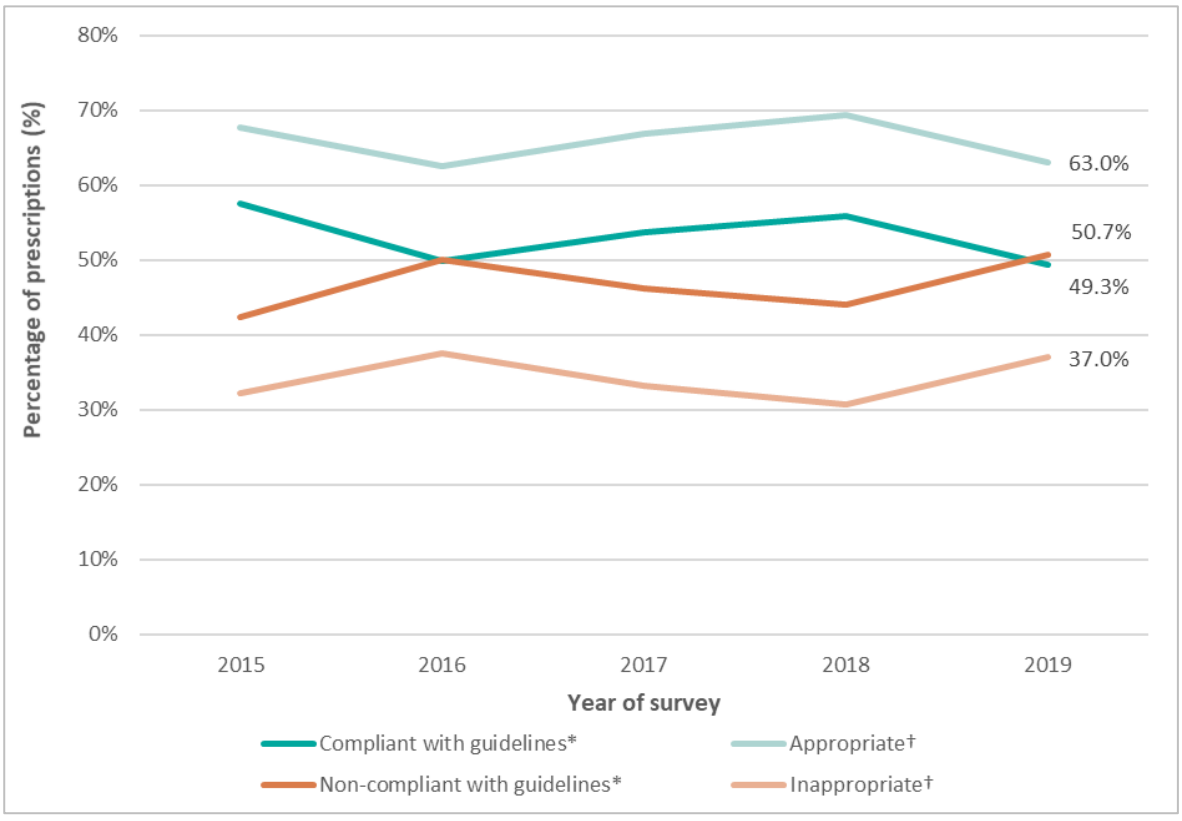
Broad-spectrum antimicrobials, such as amoxicillin–clavulanic acid, have the potential to affect the progression of AMR. Their use should be reduced when clinically appropriate and compliance with prescribing guidelines is critically important.

Since 2017, the use of intravenous amoxicillin–clavulanic acid has become more prominent in Australian hospitals, and the number of prescriptions reported to the Hospital NAPS has increased annually. In 2019, 459 prescriptions were reported. In 2018, the overall appropriateness of intravenous amoxicillin–clavulanic acid prescriptions was high.[10] Conversely, there are relatively high levels of guideline non-compliance and inappropriateness for use of oral amoxicillin–clavulanic acid. This is a concern because prescriptions for oral amoxicillin–clavulanic acid account for approximately 6% of all scripts reported to the Hospital NAPS each year; this figure has remained relatively unchanged over time. In 2019, just over half of all oral amoxicillin–clavulanate prescriptions were non-compliant with guidelines, and more than a third were deemed inappropriate overall (Figure 10).

Of the 609 inappropriate oral amoxicillin–clavulanic acid prescriptions, 23.5% were deemed to be not required by auditors. Removing these from the analysis, the remaining inappropriate prescriptions were overwhelmingly assessed as being too broad spectrum (60.1%). The second most common reason for inappropriateness was incorrect duration (20.2%).

For indications where at least 20 prescriptions were recorded in the 2019 Hospital NAPS, rates of inappropriate prescribing were high for almost every condition (Figure 11). In nearly 70% of cases, prescriptions for chronic obstructive pulmonary disease (COPD) were assessed as inappropriate. Approximately 60% of empiric therapy for community-acquired pneumonia and treatment of cellulitis/erysipelas was also assessed as inappropriate.

Figure 10: Guideline compliance and prescription appropriateness of oral amoxicillin–clavulanic acid, 2015–2019

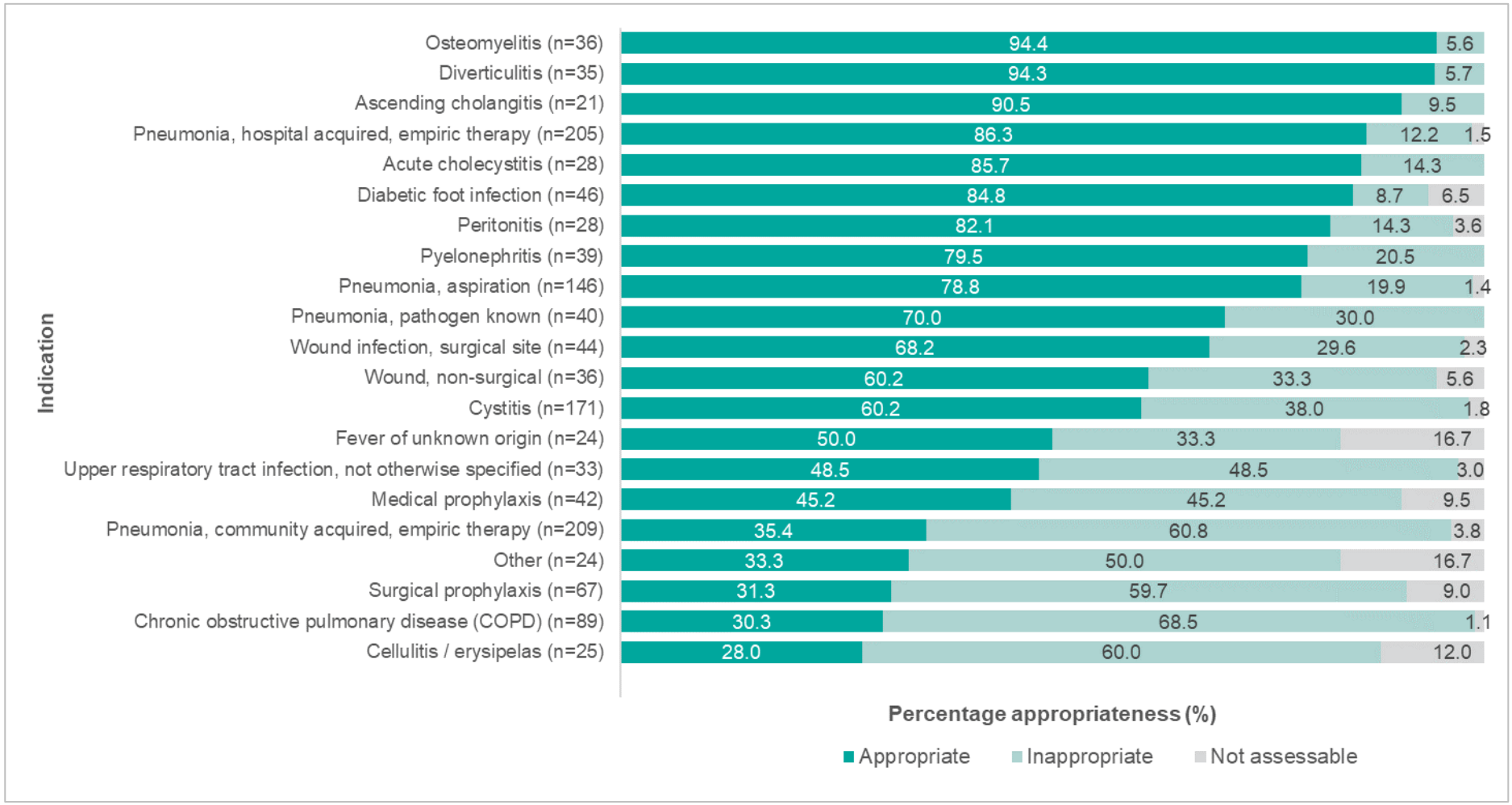


* Excludes prescriptions for which guidelines were not available, as well as prescriptions that were 'directed therapy' or 'not assessable'.

† Excludes prescriptions for which appropriateness was deemed to be 'not assessable'.

n = 1,745

Figure 11: Appropriateness of oral amoxicillin–clavulanic acid prescriptions by indication, 2019*



*For indications with at least 20 prescriptions. Excludes prescriptions where the indication for prescribing was unknown (*n* =64).

Cefalexin

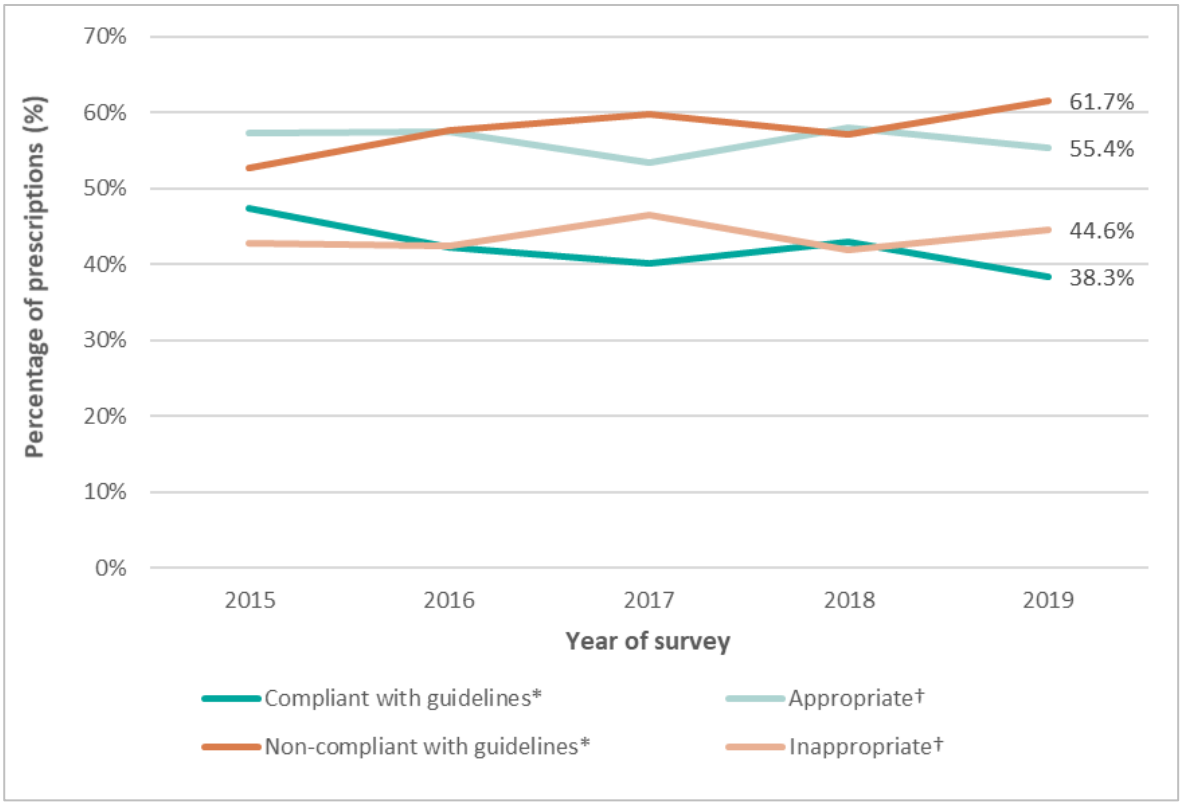
Cefalexin is another broad-spectrum antimicrobial that has the potential to affect the progression of AMR. Therefore, its use should be reduced when clinically appropriate and compliance with prescribing guidelines is critically important.

There were 2,173 cefalexin prescriptions recorded in the 2019 Hospital NAPS, of which 61.7% were non-compliant with guidelines and 44.6% were inappropriate. Disappointingly, there has been no noticeable improvement in cefalexin prescribing over time (Figure 12).

Just under 30% of inappropriate prescriptions were assessed as unnecessary therapy. Of the remaining 487 inappropriate scripts, 37.0% had an incorrect duration, 25.7% had the wrong dose or frequency, and for 11.7% the spectrum was considered too broad.

When cefalexin was used for surgical prophylaxis, 88.0% of prescriptions were recorded as inappropriate. Its use as empiric therapy for community-acquired or hospital pneumonias was also substantially inappropriate, 66.0% and 32.1% respectively (Figure 13).

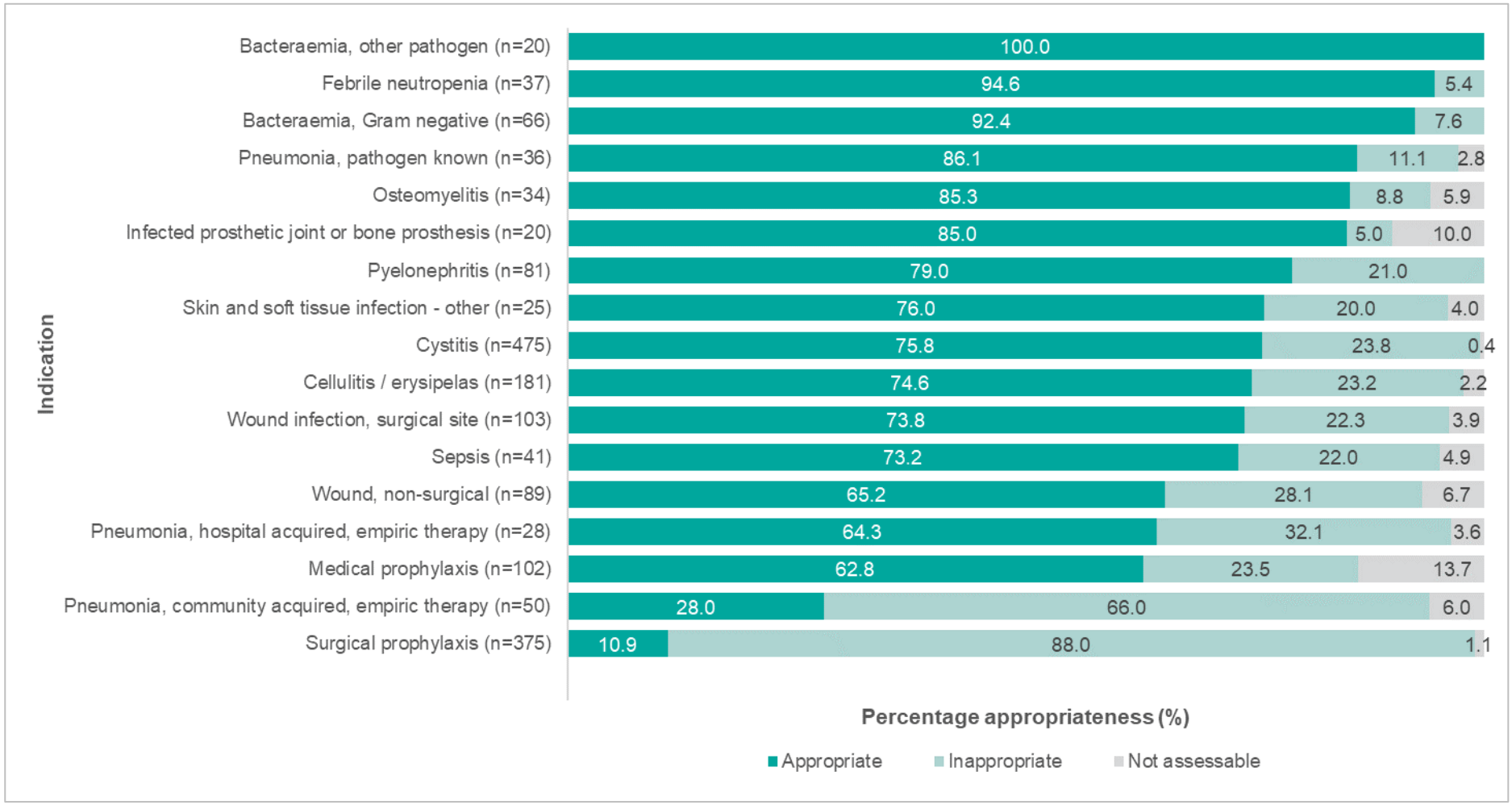
Figure 12: Guideline compliance and prescription appropriateness of cefalexin, 2015-2019



* Excludes prescriptions for which guidelines were not available, as well as prescriptions that were 'directed therapy' or 'not assessable'.

† Excludes prescriptions for which appropriateness was deemed to be 'not assessable'.

Figure 13: Appropriateness of cefalexin prescriptions by indication, 2019*

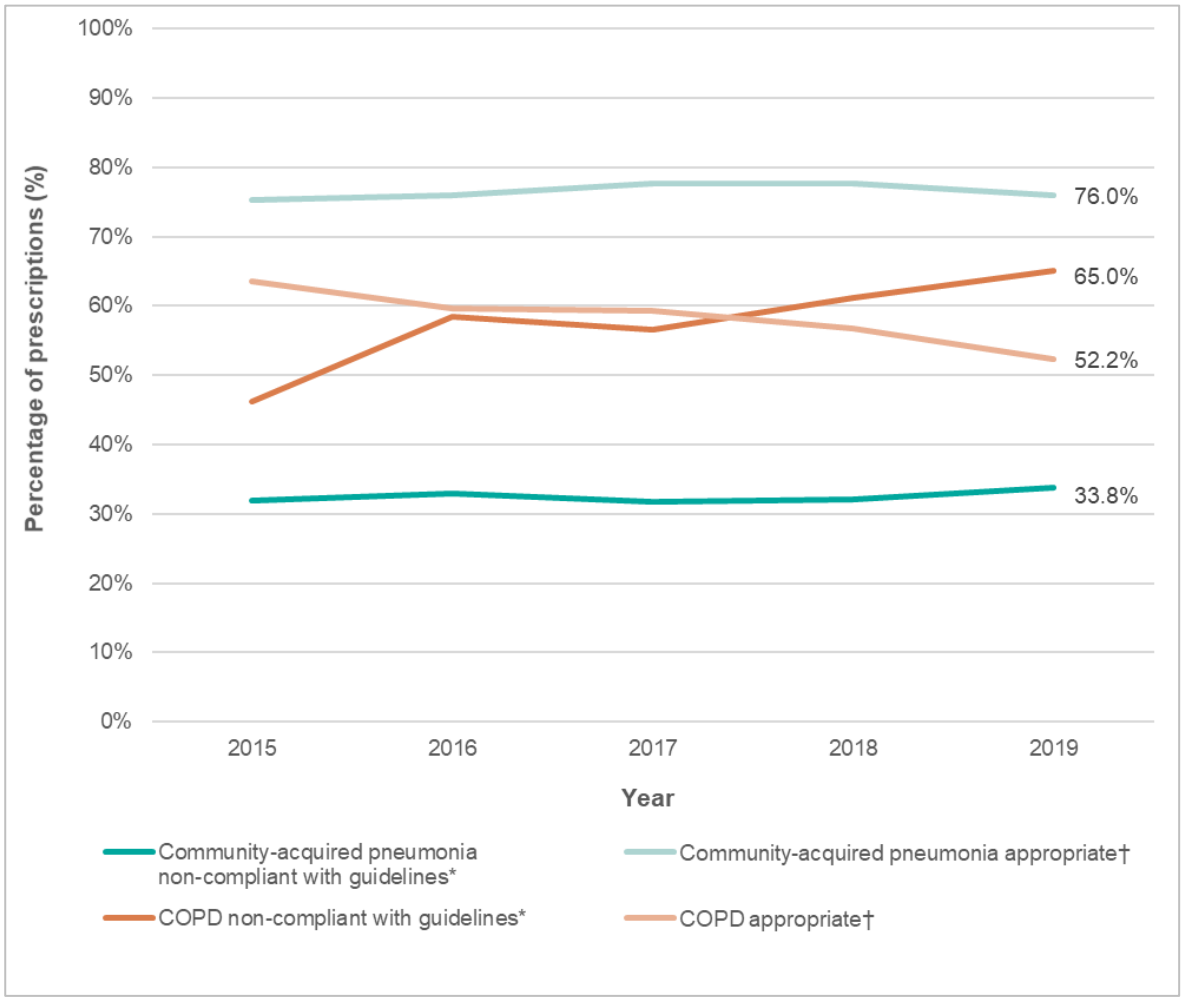


*For indications with at least 20 prescriptions. Excludes prescriptions where the indication for prescribing was unknown (*n* = 69).

Community acquired pneumonia and chronic obstructive pulmonary disease

Community-acquired pneumonia and COPD account for 10.2% (*n* = 3,202) and 2.8% (*n* = 886) respectively of all prescriptions reported for the 2019 Hospital NAPS, and both feature in the top 10 most common indications. Figure 14 shows that the rate of guideline compliance for community-acquired pneumonia has not improved over time, although the level of appropriateness remains relatively high. The trends for COPD require urgent intervention, as non-compliance with guidelines continues to rise and the level of appropriate prescribing has declined.

Figure 14: Non-compliance with guidelines and appropriateness of community-acquired pneumonia and chronic obstructive pulmonary disease (COPD) prescriptions, 2019



* Excludes prescriptions for which guidelines were not available, as well as prescriptions that were 'directed therapy' or 'not assessable'.

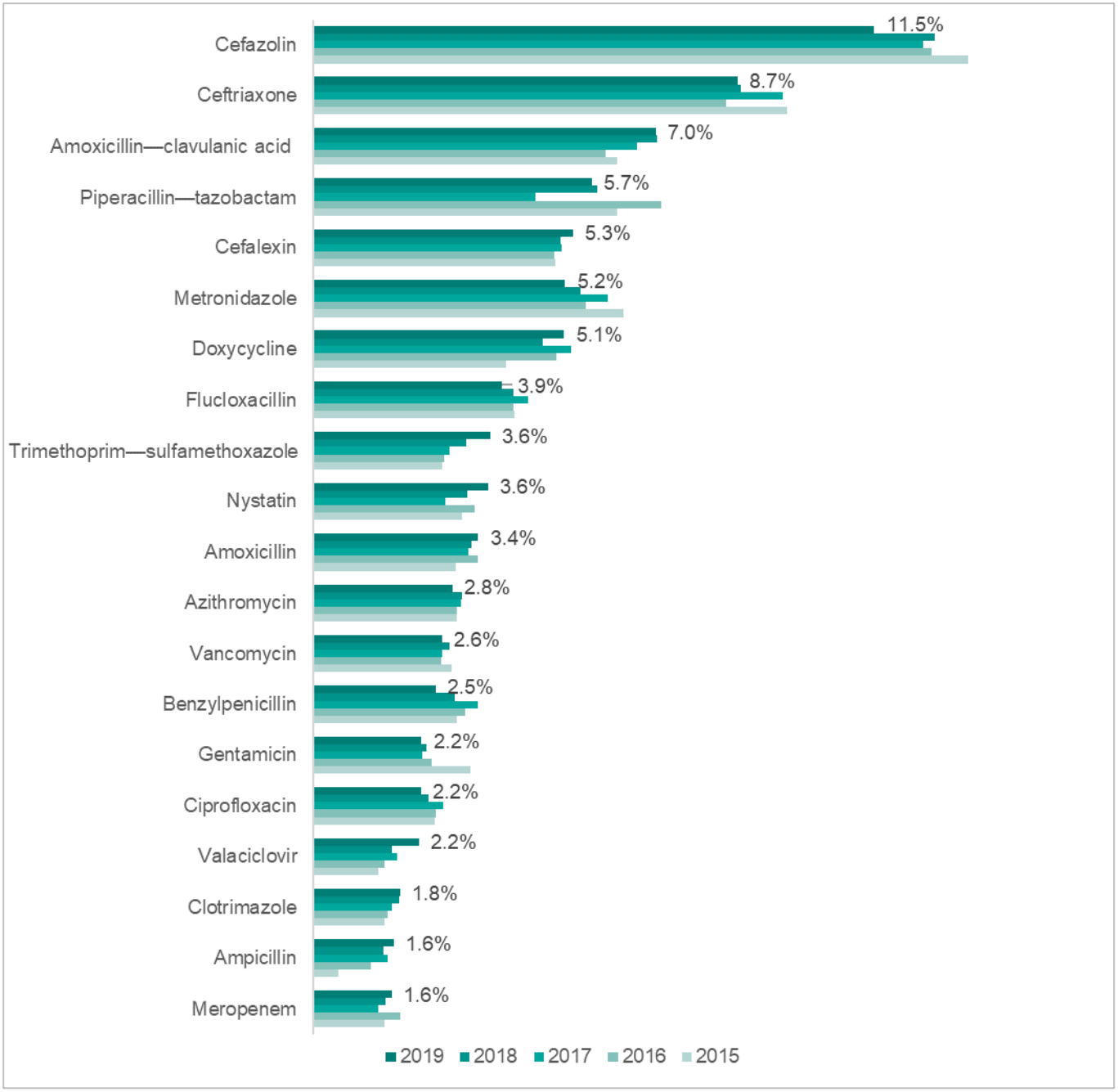
† Excludes prescriptions for which appropriateness was deemed to be 'not assessable'.

Other results

Most commonly prescribed antimicrobials

Figure 15 shows the 20 most common antimicrobials prescribed by NAPS contributor hospitals in 2019. Cefazolin continues to be the most frequently prescribed antimicrobial although there is a downward trend in usage over time. Usage of piperacillin–tazobactam peaked in 2016 at 7.1% but was followed by a stock shortage in 2017. The prescribing rate has subsequently rebounded but is still lower than in the pre-shortage period. The use of ceftriaxone and metronidazole appears to have normalised now that the supply of piperacillin–tazobactam has stabilised.

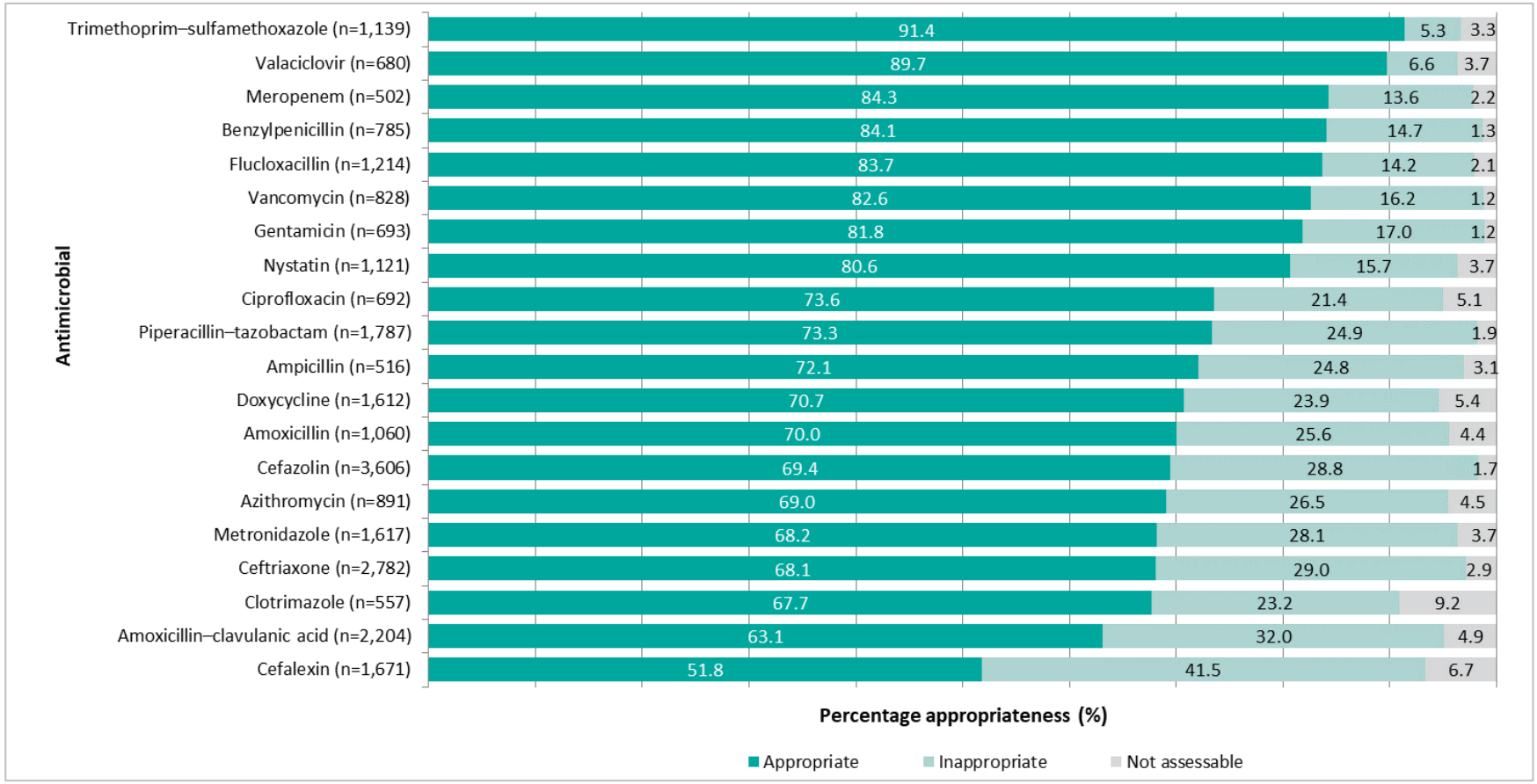
Figure 15: The 20 most common antimicrobials prescribed by Hospital NAPS contributor hospitals, 2015-2019



Appropriateness for the most commonly prescribed antimicrobials

The rate of inappropriateness for ceftriaxone prescribing is the most notable change between 2018 and 2019 Hospital NAPS data, increasing from 24.9% to 29.0%. One possible explanation is that, for many conditions, the recommended dose of ceftriaxone changed with the release of the *Therapeutic Guidelines: Antibiotic* v.16.[8] The new guidelines suggest that two grams are administered for a number of conditions, whereas in previous versions one gram was generally recommended. Depending on the patient's circumstances, auditors may have assessed such prescribing as under-dosing with the potential risk of treatment failure. In accordance with the Hospital NAPS appropriateness definitions (Appendix 4), these scripts would be considered 'inadequate' and therefore 'inappropriate'.

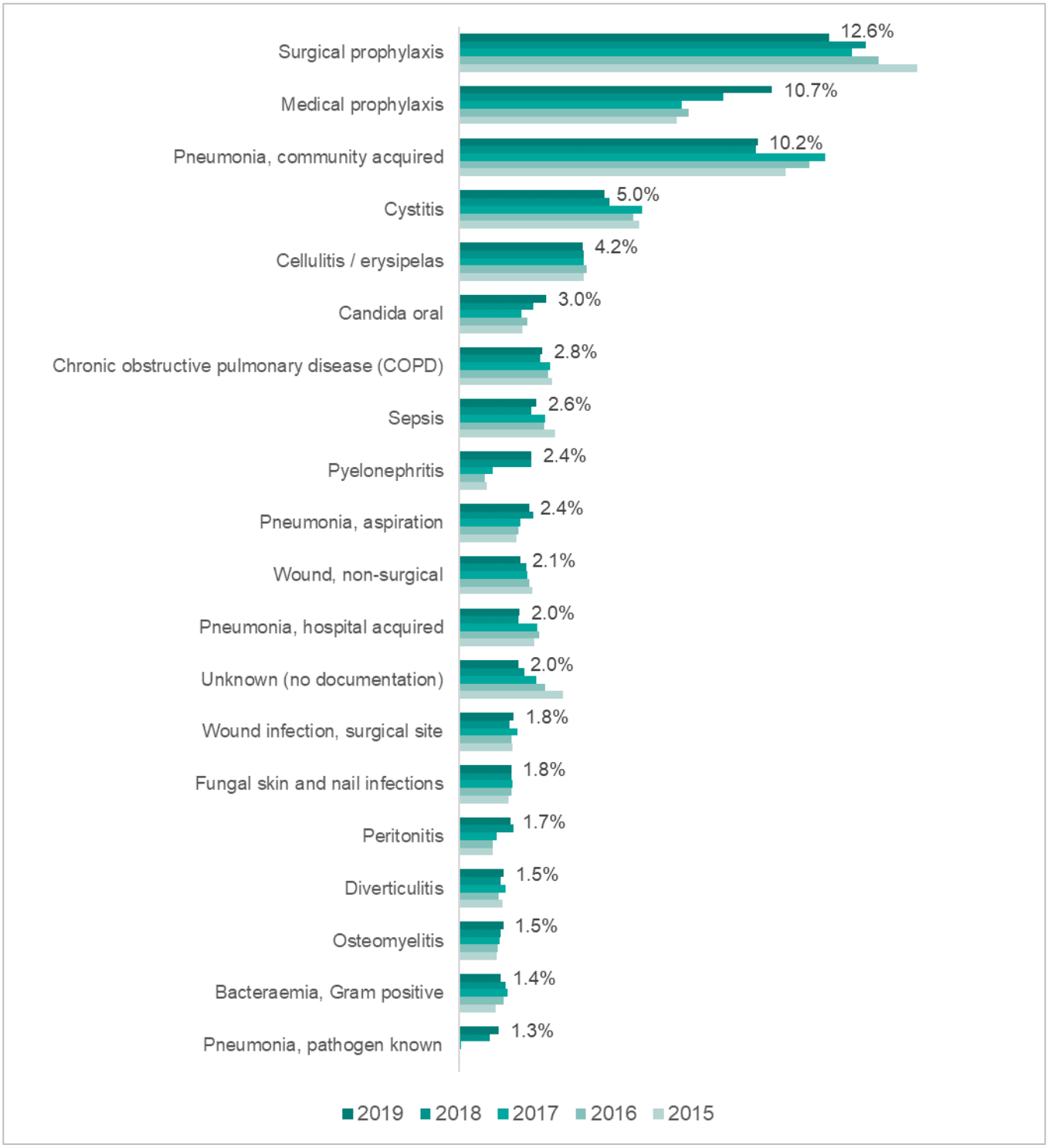
Figure 16: Appropriateness for the most commonly prescribed antimicrobials in Hospital NAPS contributor hospitals, 2019



Most common indications for antimicrobial prescribing

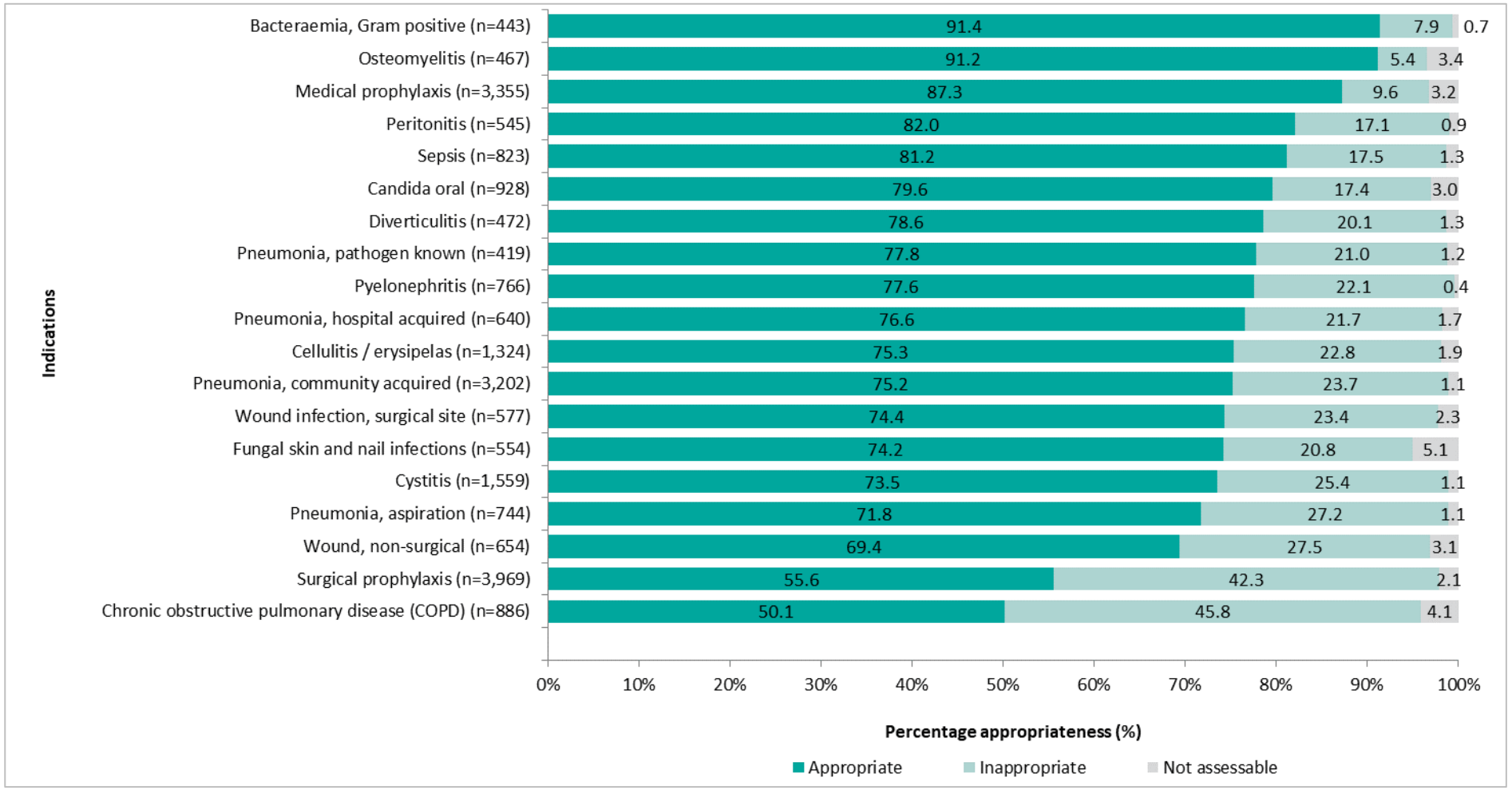
The percentage of patients that have surgical prophylaxis as the documented indication on the prescription being assessed has fallen from 13.9% in 2018 to 12.6% in 2019, and has generally decreased over time (Figure 17). Over the same period, medical prophylaxis has increased. The reasons for these shifts are unclear, given that the proportion of patients with other common indications for antimicrobial prescribing have largely remained unchanged.

Figure 17: The 20 most common indications for prescribing antimicrobials in Hospital NAPS contributors, 2015-2019



The top three indications with the most inappropriate prescribing did not change from 2018 to 2019: COPD, surgical prophylaxis, and non-surgical wounds (Figure 18). The indications with the highest rates of appropriate prescribing were also similar: Gram-positive bacteraemia, osteomyelitis, and medical prophylaxis. These indications often have either well-embedded protocols to guide therapy or the use of antimicrobials is overseen by infectious diseases specialists.

Figure 18: Appropriateness of prescribing for the 20 most common indications in the Hospital NAPS contributors, 2019*

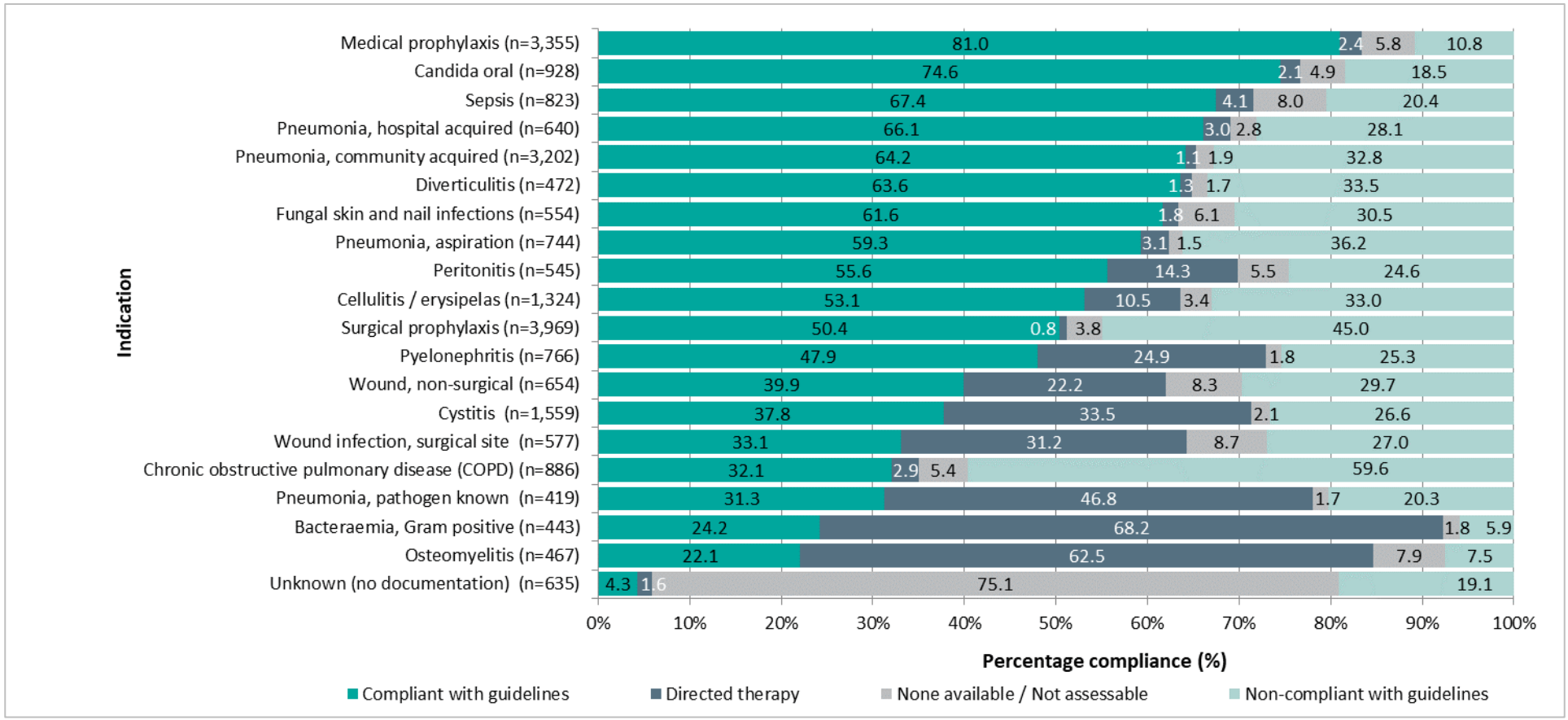


* Excludes prescriptions where the indication for prescribing was unknown (*n* = 635).

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. Prescriptions that are compliant with guidelines are often also assessed as appropriate, and vice versa. There were high levels of guideline compliance (Figure 18) and appropriateness (Figure 19) for medical prophylaxis, oral candida and sepsis. In addition, conditions where prescribing is often guided by microbiology results, such as gram-positive bacteraemia and osteomyelitis, had high levels of appropriateness and guideline compliance. Indications that were frequently evaluated as being non-compliant with guidelines were COPD and surgical prophylaxis. These conditions are also examples of indications that were often assessed an inappropriate as shown in Figure 18.

Figure 19: Compliance with guidelines for the 20 indications most commonly requiring antimicrobials in Hospital NAPS contributors, 2019



Impact of electronic medical records on the results of the Hospital NAPS

The uptake and potential impact of electronic prescribing on the survey results of the Hospital NAPS was able to be examined for the first time in 2019. Five hospitals were excluded from the analysis, as they submitted their survey early in 2019 before the software enhancements were deployed that capture electronic medical record (EMR) data. Of the 372 remaining hospitals, 63.4% used paper-based records, 28.0% reported having an EMR and 8.6% reported they used a combination of EMR and paper-based medical records.

The hospitals with an EMR were predominantly principal referral hospitals, children's hospitals, or Public Acute group A, B, C or D hospitals. The larger public hospitals contribute more patient data to the Hospital NAPS than private hospitals, which explains why more than half of all prescriptions were submitted in 2019 by a hospital using an EMR or a combination of EMR and paper medical record. No private hospitals reported using an EMR exclusively, but three sites indicated they used an EMR in conjunction with paper records.

For all public hospital peer groups, the prescription indication was documented at a higher rate (91.6%) when sites had an EMR compared to those using paper-based systems (81.7%). Public hospitals that used a combination of both methods had an indication documentation rate of 90.8%. EMR systems may present prescribers with a field in which to document the indication for a prescription and, in some hospitals, this may be mandatory. While other factors may contribute to better documentation of indication in certain hospitals, it is plausible that EMRs help to improve prescription documentation standards, and this is reflected in the consistent improvement in the Hospital NAPS results for this metric since the survey began.

The documentation of a medication review or stop date in an EMR is not as straightforward as it may be for a paper medication chart. Some EMRs may have a field to prompt clinicians to add this to an antimicrobial prescription, but others may not. In some cases, the intended stop or review date may need to be documented in the medical history and not of the medication chart, where it would be more visually apparent.

The overall documentation rate of review or stop date was 47.1% for facilities with an EMR; 52.0% in facilities using a combination of both methods; and, 47.8% in hospitals with paper-based medical records. Analysis of the results from public hospitals showed a modest benefit to using an EMR, with documentation rates of 47.1%, 51.1% and 43.0%, respectively. It is unclear why hospitals that use a combination of paper-based and EMR systems are recording better results for this metric, but given there are only 32 hospitals overall in this category, the results should be interpreted with caution. The specific details of how medication prescribing is undertaken at these sites is unknown and substantial differences may exist between the hospitals that are included in this subset.

There was no difference in the assessment of prescription appropriateness between those facilities with or without an EMR.

Discussion

The 377 hospitals that participated in the 2019 survey represented just under 40% of all eligible Australian hospitals, which is a substantial increase compared with 2018. While there were some improvements, particularly for documentation of antimicrobial prescriptions, other important metrics remained static. To facilitate change and improve patient safety, it is necessary to extend AMS quality improvement initiatives to all hospitals, and engage with and educate prescribers. In addition, it is essential that health service organisation executives and state and territory health authorities have ready access to Hospital NAPS data to assist with setting health system improvement priorities, and AMS program development and implementation.

The implementation of electronic medication management (EMM) systems has progressed in recent years, and many Australian hospitals have implemented EMR systems that can prompt clinicians to record essential routine information. Over a third of hospitals that participated in the 2019 Hospital NAPS survey reported that their hospital had electronic prescribing of some kind. Increased access to this technology may be contributing to improved documentation for antimicrobial prescriptions.

Successive Hospital NAPS have demonstrated low levels of guideline compliance, and the release of a new version of the *Therapeutic Guidelines: Antibiotic* in 2019 was associated with a decrease in compliance to 42.2%. This finding is not surprising, as major changes to national guidelines have a flow-on effect for hospital AMS programs, particularly in relation to common conditions. It takes time for new guidelines to disseminate through hospitals and for practice change to occur. A similar decline was observed in 2016 in association with the release of the previous version of *Therapeutic Guidelines: Antibiotic*, followed by a small increase in compliance in subsequent years. Notwithstanding the change in guidelines, sub-optimal compliance with both local and national prescribing guidelines is a longstanding issue that should be a priority for AMS programs.

The static level of prescribing appropriateness over time is also concerning, as is the difference in assessments of optimal appropriateness between public (60.7%) and private (50.9%) Hospital NAPS contributors in 2019. Addressing this issue should be a priority for AMS programs in the private sector.

The *Priority Antibacterial List for Antimicrobial Resistance Containment* (the Priority Antibacterial List) was developed by the Commission to support local and national antimicrobial usage surveillance.[11] The Priority Antibacterial List is stratified according to preferred use categories for containment of AMR in human health in Australia. Antibacterials in the Access category are recommended as first-line treatment for common infections, and have low potential to increase the development of AMR and healthcare-associated infection (HAI). Antibacterials in the Curb category are recommended as first-line treatments for common bacterial infections, but have high potential for promoting the development of AMR. The Contain category includes agents with high AMR or HAI potential that are not recommended as first-line agents for common bacterial infections.

About half of the 20 most commonly prescribed antimicrobials in the Hospital NAPS are assigned to the Access category; for example, metronidazole, doxycycline and flucloxacillin. However, the top five most commonly prescribed antimicrobials (cefazolin, ceftriaxone, amoxicillin–clavulanic acid, piperacillin–tazobactam and cefalexin) in the Hospital NAPS dataset are all assigned to the Curb category. Together, these five antibacterials accounted for 38.2% of all prescriptions submitted for the 2019 Hospital NAPS. They are also the antibacterials for which the highest rates of inappropriate prescribing have been identified in successive Hospital NAPS.

In 2019, nearly a third of the prescriptions for cefazolin, ceftriaxone, amoxicillin–clavulanic acid, piperacillin–tazobactam and cefalexin were assessed as inappropriate. One in five of these inappropriate scripts was assessed as not required. Addressing the inappropriate prescribing of these agents would likely have a significant impact on overall appropriateness and improve patient safety.

Of the 20 most commonly prescribed antimicrobials reported to the Hospital NAPS, meropenem is the only one listed in the Contain category of the Priority Antibacterial List. Extended spectrum β-lactamase bacteria are increasingly identified in Australian healthcare settings and it is reassuring that meropenem use in contributor hospitals is highly appropriate, and prescribed as directed therapy more than half of the time.

Vancomycin usage, which was also found to be highly appropriate, could still be improved by ensuring that it is the narrowest spectrum agent that could safely be used to treat the patient and for the shortest effective duration. Selecting the best dosing strategy, and correctly conducting and interpreting the associated therapeutic drug monitoring, is complex and may require specialist advice.

The longstanding, and slowly increasing, rate of non-compliance with prescribing guidelines for treatment of community-acquired pneumonia and COPD is concerning. These conditions are frequently identified as indications for antimicrobial prescribing in the Hospital NAPS. Targeting use of antimicrobials for respiratory indications should be a priority for AMS programs.

Surgical prophylaxis was the most common indication for a hospital patient to be prescribed antimicrobials and the rates of appropriateness (55.6% overall) and guideline non-compliance (45%) still have considerable room for improvement, consistent with previous years. The Surgical NAPS reports offer further insights into prescribing practices for this indication and highlight variations between surgical specialties in relation to procedural and post-procedural prescribing.[7,12] Incorrect timing was the most frequent reason for inappropriate prescribing of antimicrobials administered in the operating theatre. The most common reason for inappropriate post-procedural prescribing was incorrect duration. Targeted interventions developed in collaboration with surgical specialty groups are required to improve the quality of prescribing of surgical prophylaxis.

In summary, similar themes for improvement of the quality of prescribing, and safety of care provided to patients have been identified by analyses of Hospital NAPS data each year since 2013, along with clear trends regarding how Australian hospital prescribers use antimicrobials. The Commission will continue to work with states, territories and private health service providers to respond to these issues and promote improved safety of care for patients.

Appendix 1

Methods

The NAPS is a standardised auditing tool that health service organisations may use to assess the quality of their antimicrobial prescribing.

Timing

The Hospital NAPS module is usually open for data entry and reporting all year round, allowing hospitals to complete the survey whenever time and staffing levels permit. However, the release of the revised edition of the *Therapeutic Guidelines: Antibiotic* had the potential to impact on the NAPS results and targeted communication with users was required to outline how best to participate in 2019.

To minimise the possibility of surveyors assessing prescriptions against different versions of the *Therapeutic Guidelines: Antibiotic*, some changes were made to how the survey operated in 2019.

- Facilities could continue to enter survey data at any time throughout 2019. However, only data entered after the release of the new guidelines counted towards the benchmarking for that year.
- The official benchmarking period was 1 May to 31 December, 2019.
- Those hospitals using the point prevalence survey or randomised sample survey methodologies, where the hospital normally audits only once per year, were encouraged to plan their audits for the second half of 2019.
- Smaller hospitals using the repeat point prevalence survey methodology were requested to continue auditing as usual, as their data is collected intermittently over the calendar year. Only the data entered after the release of the new *Therapeutic Guidelines: Antibiotic* was included in the 2019 benchmarking, but each site could run their own local reports as required throughout the year.

All finalised data that was entered in 2019 has been included for analysis in this report.

Recruitment

Using the NAPS registration database, individuals from more than 450 hospitals were invited via email to participate in the 2019 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 Hospital NAPS is an online, web-based survey and participants who register are granted access to the NAPS portal where they can submit their data. The information required to complete the survey for each patient can be seen in the Hospital NAPS data collection form (Appendix 3). 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 assessment 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.

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 4)
- 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.

eLearning module

The hospital NAPS online e-Learning program was available on the NAPS website throughout the data collection period. The package provides users with information regarding setting up the survey, data collection and assessments of compliance with guidelines and appropriateness.

In April 2019, the eLearning and assessment quiz were reviewed and updated to align with the new content in the *Therapeutic Guidelines: Antibiotic* and from 1 May all Hospital NAPS participants needed achieve a pass mark of 80% or more before they could finalise patient data and generate reports in 2019. The pass mark is kept high to promote consistency among auditors when performing their data collection and prescription assessments. Users who fail to pass the eLearning within three attempts are encouraged to contact the NAPS support helpdesk to discuss any difficulties they may be experiencing.

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, specialties 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 and the Australian Institute of Health and Welfare (AIHW) peer group classifications.[13,14] Key performance indicators are analysed and reported for these categories. The 'appropriateness' percentages include 'not assessable' prescriptions in the denominator unless otherwise specified.

Limitations and considerations for data interpretation

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 2019 Hospital NAPS results, this report references elements of the 2015–2018 surveys. The ability to directly compare results from year to year is limited as a result of changes over time to the inclusion criteria, methodology and distribution of participating hospitals.

Patients may be counted multiple times
In regard to 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.

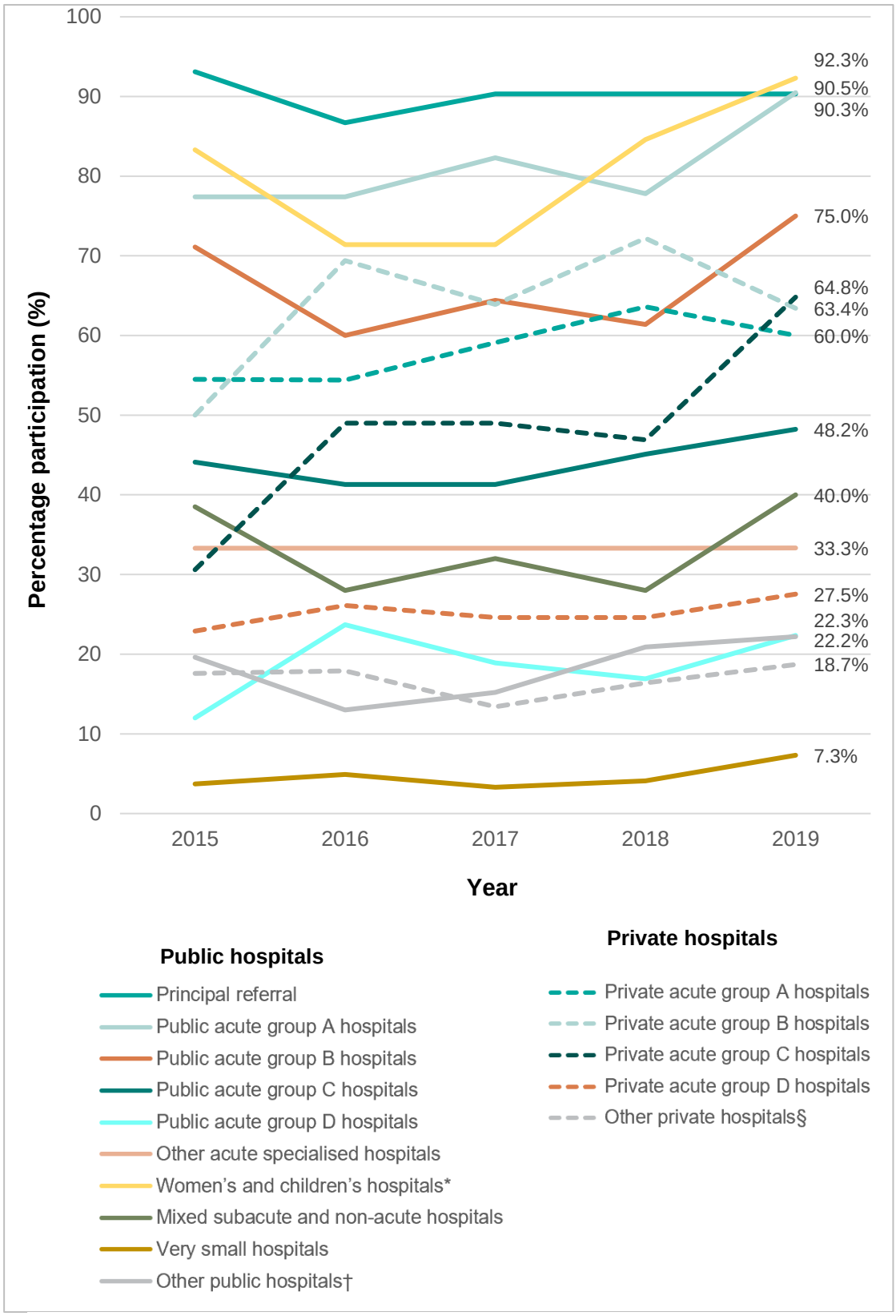
Subjective nature of assessments
Individual auditors at each facility were responsible for assessing antimicrobial prescribing appropriateness and compliance with guidelines, although remote expert assessments were conducted by the NAPS support team on request. These assessments involve some degree of 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 2019 Hospital NAPS.

Appendix 2

Figure A1: Public and private hospital participation in Hospital NAPS by peer group classification, 2015–2019



* 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

Table A1: Public and private hospitals that contributed to Hospital NAPS by state, territory and remoteness area, 2019

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	104	213	48.8	141	306	46.1
		Private	37	93	39.8			
	Vic	Public	83	144	57.6	114	220	51.8
		Private	31	76	40.8			
	Qld	Public	41	122	33.6	63	181	34.8
		Private	22	59	37.3			
	SA	Public	7	77	9.1	10	106	9.4
		Private	3	29	10.3			
	WA	Public	22	92	23.9	31	112	27.7
		Private	9	20	45.0			
	Tas	Public	4	23	17.4	8	29	27.6
		Private	4	6	66.7			
	NT	Public	5	5	100.0	6	6	100.0
		Private	1	1	na			
	ACT	Public	2	2	100.0	4	6	66.7
		Private	2	4	50.0			
Remoteness	Major cities	Public	109	170	64.1	193	389	49.6
		Private	84	219	38.4			
	Inner regional	Public	90	190	47.4	110	244	45.1
		Private	20	54	37.0			
	Outer regional	Public	56	208	26.9	61	224	27.2
		Private	5	16	31.3			
	Remote	Public	9	60	15.0	9	60	15.0
		Private	na	na	na			
	Very remote	Public	4	50	8.0	4	50	8.0
		Private	na	na	na			
Total		**Public**	**268**	**678**	**39.5**	**377**	**966**	**39.0**
		Private	**109**	**288**	**37.8**			

*Numbers represent all eligible hospitals in the AIHW reporting groups for public and private, states and territories, and remoteness classifications - na – not applicable

Table A2 Public and private hospitals that contributed to the Hospital NAPS by peer group, 2019

Participating hospitals		Number of participating hospitals (*n*)	Number of hospitals in reporting group (*n*)	Participation (%)
Public hospital peer groups*	Principal referral	28	31	90.3
	Public acute group A hospitals	57	63	90.5
	Public acute group B hospitals	33	44	75.0
	Public acute group C hospitals	68	141	48.2
	Public acute group D hospitals	42	188	22.3
	Other acute specialised hospitals	1	3	33.3
	Children's hospitals	6	6	100.0
	Women's hospitals	5	6	83.3
	Women's and children's hospitals	1	1	100.0
	Mixed subacute and non-acute hospitals	10	25	40.0
	Rehabilitation and GEM hospitals†	7	13	53.8
	Very small hospitals	9	123	7.3
	Psychiatric hospitals	1	23	4.3
Private hospital peer groups§	Private acute group A hospitals	15	25	60.0
	Private acute group B hospitals	26	41	63.4
	Private acute group C hospitals	35	54	64.8
	Private acute group D hospitals	19	69	27.5
	Other acute specialised hospitals	4	18	22.2
	Private rehabilitation hospitals	7	25	28.0
	Private acute psychiatric hospitals	2	30	6.7
	Women's hospitals	1	2	50.0

* Excludes early parenting centres, same day hospitals and outpatient hospitals
† GEM – Geriatric Evaluation and Management
§ Excludes ineligible private hospitals

Table A3 Hospital NAPS key indicator results, by state and territory, remoteness area and AIHW peer group, 2019

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	141	37.4	11,315	36.0	84.6	51.7	34.2
	Vic	114	30.2	9,586	30.5	83.2	45.5	32.7
	Qld	63	16.7	4,815	15.3	87.7	42.8	24.6
	SA	10	2.7	1,210	3.9	85.4	57.9	9.5
	WA	31	8.2	2,916	9.3	79.6	45.5	23.7
	Tas	8	2.1	533	1.7	77.3	37.2	48.4
	NT	6	1.6	521	1.7	89.6	52.6	32.0
	ACT	4	1.1	528	1.7	87.1	58.3	35.2
Remoteness	Major Cities	193	51.2	22,301	71.0	84.1	51.0	30.1
	Inner regional	110	29.2	5,678	18.1	84.0	40.0	29.1
	Outer regional	61	16.2	2,866	9.1	83.6	43.0	29.9
	Remote	9	2.4	365	1.2	89.9	37.0	22.2
	Very remote	4	1.1	214	0.7	94.4	47.2	na
Public hospital peer group	Principal referral	28	7.4	9,619	30.6	90.4	49.5	33.2
	Public acute group A hospitals	57	15.1	6,775	21.6	86.0	42.7	31.5
	Public acute group B hospitals	33	8.8	2,218	7.1	86.2	42.7	48.5
	Public acute group C hospitals	68	18.0	2,969	9.5	88.2	40.5	30.9
	Public acute group D hospitals	42	11.1	1,214	3.9	79.6	32.9	35.7
	Other acute specialised hospitals	1	0.3	103	0.3	47.6	21.4	50.0
	Children's hospitals	6	1.6	953	3.0	89.9	64.4	30.3
	Women's hospitals	5	1.3	314	1.0	92.4	66.6	14.1
	Women's and children's hospitals	1	0.3	103	0.3	95.2	46.6	30.8
	Mixed subacute and non-acute hospitals	10	2.7	427	1.4	87.1	57.6	50.0
	Rehabilitation and GEM hospitals[†]	7	1.9	200	0.6	85.0	61.0	na
	Very small hospitals	9	2.4	68	0.2	100.0	72.0	na
	Psychiatric hospitals[§]	1	0.3	26	0.1	-	-	na

Table A3 Hospital NAPS key indicator results, by state and territory, remoteness area and AIHW peer group, 2019 (continued)

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 (%)*
Private hospital peer group	Private acute group A hospitals	15	4.0	1,909	6.1	73.4	48.2	34.0
	Private acute group B hospitals	26	6.9	1,864	5.9	68.3	54.7	25.6
	Private acute group C hospitals	35	9.3	1,385	4.4	68.6	55.1	31.0
	Private acute group D hospitals	19	5.0	716	2.3	60.6	65.5	23.3
	Other acute specialised hospitals	4	1.1	221	0.7	92.3	89.1	18.0
	Private rehabilitation hospitals	7	1.9	295	0.9	72.5	55.6	64.3
	Private acute psychiatric hospitals	2	0.5	35	0.1	68.6	51.4	na
	Women's hospitals§	1	0.3	10	0.03	-	-	na
Funding type	Public	268	71.1	24,989	79.6	87.8	46.1	33.3
	Private	109	28.9	6,435	20.4	70.2	55.4	27.7
Combined national result		**377**	**100**	**31,424**	**100**	**84.2**	**48.0**	**30.0**

* Where surgical prophylaxis was selected as the indication (*n* = 3,963) in 2019
† GEM - geriatric evaluation and management
§ Results are not displayed if there are fewer than 30 prescriptions

Table A4: Compliance with guidelines and prescription appropriateness in Hospital NAPS contributors, by state and territory, remoteness area and AIHW peer group, 2019

Key Indicators		% Compliance with guidelines				% Appropriateness			
		Compliant	Non-compliant	Directed therapy	Not available	Not assessable	Appropriate	Inappropriate	Not assessable
State or territory	NSW	49.9	29.9	14.7	2.0	3.5	70.8	25.4%	3.9
	Vic	52.9	26.3	12.4	4.7	3.7	73.5	22.4%	4.1
	Qld	53.0	26.8	13.0	3.4	3.8	70.8	24.6	4.6
	SA	58.6	18.5	16.5	3.7	2.6	84.2	13.6	2.2
	WA	51.4	27.3	15.5	3.8	2.0	77.0	20.6	2.4
	Tas	52.9	31.5	8.8	4.3	2.4	74.5	21.8	3.8
	NT	57.4	25.9	11.5	2.5	2.7	75.4	22.7	1.9
	ACT	51.3	26.5	10.0	9.5	2.7	72.9	24.2	2.8
Remoteness	Major Cities	52.2	25.3	15.3	3.9	3.4	73.9	22.5	3.6
	Inner regional	52.7	33.0	8.6	2.6	3.1	70.0	25.8	4.3
	Outer regional	49.0	32.4	12.4	2.0	4.2	71.0	24.5	4.5
	Remote	45.8	38.9	9.9	2.5	3.0	69.9	27.7	2.5
	Very remote	58.4	31.3	5.4	2.3	2.8	75.7	22.9	1.4
Public hospital peer group	Principal referral	52.9	21.6	19.8	3.6	2.2	78.2	19.4	2.5
	Public acute group A hospitals	50.4	28.7	12.8	4.2	3.9	72.9	23.6	3.5
	Public acute group B hospitals	51.2	30.2	12.3	3.9	2.5	71.8	24.8	3.4
	Public acute group C hospitals	53.9	31.7	8.4	2.5	3.6	70.6	24.5	5.0
	Public acute group D hospitals	39.3	46.5	9.7	1.3	3.2	61.0	35.4	3.5
	Other acute specialised hospitals	71.8	7.8	14.6	3.9	1.9	82.5	15.5	1.9
	Children's hospitals	68.1	13.2	12.2	5.1	1.4	82.5	16.7	0.8
	Women's hospitals	81.5	9.2	5.1	3.2	1.0	89.2	10.2	0.6
	Women's and children's hospitals	66.0	14.6	9.7	6.8	2.9	86.4	10.7	2.9
	Mixed subacute and non-acute hospitals	52.7	23.0	16.6	5.2	2.6	74.5	22.0	3.5
	Rehabilitation and GEM hospitals*	46.5	20.0	22.0	2.0	9.5	74.5	16.5	9.0
	Very small hospitals	55.9	33.8	5.9	na	4.4	69.1	26.5	4.4
	Psychiatric hospitals†	-	-	-	-	-	-	-	-

Table A4: Compliance with guidelines and prescription appropriateness in Hospital NAPS contributors, by state and territory, remoteness area and AIHW peer group, 2019 (continued)

Key Indicators		% Compliance with guidelines					% Appropriateness		
		Compliant	Non-compliant	Directed therapy	Not available	Not assessable	Appropriate	Inappropriate	Not assessable
Private hospital peer group	Private acute group A hospitals	46.4	33.8	11.0	2.9	6.0	66.4	27.5	6.1
	Private acute group B hospitals	49.4	33.4	10.7	2.6	3.9	67.7	26.9	5.4
	Private acute group C hospitals	45.5	38.0	9.1	2.7	4.8	60.3	34.6	5.1
	Private acute group D hospitals	61.3	27.2	2.9	4.1	4.5	67.6	24.3	8.1
	Other acute specialised hospitals	72.0	23.5	2.7	na	1.8	76.9	21.3	1.8
	Private rehabilitation hospitals	52.9	20.0	13.9	3.1	10.2	70.2	17.0	12.9
	Private acute psychiatric hospitals	11.4	51.4	na	na	37.1	5.7	51.4	42.9
	Women's hospitals†	-	-	-	-	-	-	-	-
Funding type	Public	52.0	26.2	14.8	3.6	2.9	74.7	22.2	3.2
	Private	49.8	32.9	9.4	2.8	5.1	65.8	27.9	6.3
Combined national result		**52.0**	**27.6**	**13.7**	**3.5**	**3.4**	**72.9**	**23.3**	**3.8**

na - not applicable
* GEM - geriatric evaluation and management
† Results are not displayed if there are fewer than 30 prescriptions

Table A5 demonstrates the changes over time for the different guideline compliance and appropriateness categories. The slight drop in 'compliance with Therapeutic Guidelines and the proportion of prescriptions assessed as 'optimal' may be associated with the release of the 2019 edition of the *Therapeutic Guidelines: Antibiotic*.[8] The categories of 'suboptimal' and 'inadequate' have both increased slightly, which highlights the continuing risk to patient safety associated with antimicrobial prescribing. Few conditions do not have guidelines available to direct antimicrobial treatment and the rate of prescriptions being assessed as 'not assessable' is consistent with the 2018 results.

Table A5: Hospital NAPS compliance with guidelines and prescription appropriateness, for all prescriptions, 2015–2019

Key indicator		Percentage of total prescriptions (%)				
		2015	2016	2017	2018	2019
Compliance with guidelines	Compliant with *Therapeutic Guidelines*	45.3	42.4	44.8	44.2	42.2
	Compliant with local guidelines	10.3	9.7	9.3	9.5	9.8
	Non-compliant	23.8	26.9	26.2	25.6	27.6
	Directed therapy	12.0	12.7	12.5	13.7	13.7
	No guideline available	3.7	4.0	3.3	3.6	3.5
	Not assessable	5.0	4.4	3.8	3.4	3.4
Appropriateness	Optimal	54.5	56.6	58.1	60.0	58.7
	Adequate	17.8	15.6	14.9	14.8	14.1
	Suboptimal	12.3	11.3	12.2	11.9	13.0
	Inadequate	10.0	11.2	10.2	9.5	10.3
	Not assessable	5.4	5.3	4.7	3.8	3.8

Appendix 3

HOSPITAL NAPS National Antimicrobial Prescribing Survey

GUIDANCE | NCAS

Audit date	Patient identification number	Date of birth / age	Gender	Specialty ❒ *currently in ICU / NICU*	Ward	Weight *kg*	eGFR / CrCl *ml/min*
/ /		/ /	M / F / O				

Antimicrobials

Only record the antimicrobials as prescribed at 08:00 am on the audit day and any surgical prophylaxis or stat doses in the previous 24 hours

For NICU patients Birth weight *kg*	Gestational age *weeks*

Start date	Antimicrobial	Route	Dose	Freq	Indication documented	Specify documented or presumed indication	Review / stop date documented	Guideline compliance (1-6)	Surgical prophylaxis > 24 hrs	Allergy mismatch	Microbiology mismatch	Indication does not require any antimicrobials	Incorrect route	Incorrect dose / frequency	Incorrect duration	Spectrum too broad	Spectrum too narrow	If restricted: approval given	Appropriateness (1- 5)
/ /																			
/ /																			
/ /																			
/ /																			
/ /																			

Allergies and adverse drug reactions to antimicrobials

❒ nil known ❒ not documented

❒ present; *record the antimicrobial and the nature of the reaction*

Microbiology ❒ not collected / not assessable

❒ collected; *record the specimen type, organism and susceptibilities if relevant*

Guideline compliance

1. Compliant with Therapeutic Guidelines
2. Compliant with locally endorsed guidelines*
3. Non-compliant with guidelines
4. Directed therapy
5. No guidelines available
6. Not assessable

*Select **Therapeutic Guidelines** if local guidelines are the same

Clinical notes or comments

❒ Renal replacement therapy given within the previous 24 hours; *eg. dialysis*

Surgical procedure if performed

If prophylaxis given within previous 24 hours; *include in audit*

Appropriateness

1. Optimal
2. Adequate
3. Suboptimal
4. Inadequate
5. Not assessable

Appendix 4

Hospital NAPS appropriateness definitions

			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, allergy status, renal or hepatic function, or relevant drug interactions (if this information is available)

[2] Antibiotic Expert Group. Therapeutic Guidelines: Antibiotic. Version 16 (2019), 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

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