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Antimicrobial prescribing practice in Australian hospitals

Results of the 2021 Hospital National Antimicrobial Prescribing Survey

2021

NCAS National Centre for Antimicrobial Stewardship

HOSPITAL NAPS National Antimicrobial Prescribing Survey

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Summary

Since it was first introduced 9 years ago, the Hospital National Antimicrobial Prescribing Survey (Hospital NAPS) has grown to be a widely adopted and valued tool to assess the quality of antimicrobial prescribing across Australian hospitals. It is a key contributor to Australia's National Antimicrobial Resistance Strategy[1] and the Antimicrobial Use and Resistance in Australia (AURA) program,[2] and also addresses many of the key indicators in the Antimicrobial Stewardship Clinical Care Standard.[3] Its focus on providing meaningful data for action with clear data visualisation for contributing hospitals has led to continued high participation from all Australian hospitals, funding types, peer groups and remoteness classifications.

During 2021, 407 hospitals (291 public and 116 private) submitted data on 29,305 prescriptions to the Hospital NAPS database. Analyses are also presented of trends from 2015 to 2021.

Key findings of the 2021 Hospital NAPS

There have been long-term improvements in 3 key indicators of appropriateness of antimicrobial prescribing monitored by the Hospital NAPS:

- Documentation of indication increased to 85.7% in 2021 compared with 72.0% in 2015.
- Documentation of review or stop date was 50.8% in 2021, compared with 34.8% in 2015. This is still unacceptably low and should be a key focus for antimicrobial stewardship (AMS) programs into the future.
- Overall non-compliance with guidelines was 26.3%, which, despite some minor fluctuations, has remained stable for several years.
- Overall inappropriateness was 22.0%, which has also remained relatively unchanged over the years. However, the trend by peer group for public hospitals has shown an improvement in appropriateness as AMS programs mature and AMS principles become further embedded into routine practice.

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

- Compliance with the Therapeutic Guidelines[4] or local guidelines has not improved over time; in fact there was a decline from 70.0% in 2015 to 67.5% in 2021.
- Rates of non-compliance with guidelines and inappropriateness for specific indications remained high, particularly for chronic obstructive pulmonary disease (COPD) and surgical prophylaxis.
- There continued to be inappropriate prescribing of broad-spectrum, high-use antimicrobials, particularly cefalexin, amoxicillin–clavulanic acid and ceftriaxone.
- Although the overall appropriateness of prescribing has essentially remained static since 2015, a deep dive into the data revealed that the quality of prescribing is improving across all public hospital peer groups. Conversely, appropriateness is decreasing across private hospital peer groups; however, this is likely due to increasing private hospital participation each year and the tendency that prescribing quality is often lower in the first years of conducting the Hospital NAPS audit.
- There were substantially higher rates of inappropriateness for antimicrobials in the Priority Antibacterial List for Antimicrobial Resistance Containment[9] Curb category (26.8% inappropriate) compared with the lower risk Access category (19.2%) and high-risk Contain category (12.1%). Antimicrobials in the Curb category are commonly prescribed with high rates of inappropriateness for indications such as surgical prophylaxis and respiratory illnesses.

Implications for clinical practice

There are a number of opportunities for improvement of practice:

- Continued improvement of documentation of indication and of review and stop dates is required to reach the best practice target of greater than 95%. This is expected to continue to improve as more hospitals implement electronic medication management systems.

- There is a need for improved prescribing and guideline adherence in the areas of surgical prophylaxis (particularly with regard to extended duration of prophylaxis), respiratory tract infections such as COPD and community-acquired pneumonia, acute cholecystitis and the management of wound infections. The 2019 update of the Therapeutic Guidelines expanded and clarified recommendations in these areas, and future Hospital NAPS will be analysed to see whether improvements have occurred.

- The 2020 update of the Antimicrobial Stewardship Clinical Care Standard expanded indicators in the areas of documentation of indication and review or stop date, surgical prophylaxis, adverse drug reactions and antimicrobial review. The Hospital NAPS will be updated in the future to specifically incorporate these indicators as data collection fields.

1. Introduction

The judicious use of antimicrobials is a key component of good patient care across all health settings. Australia's National Antimicrobial Resistance Strategy[1] has recommended the adoption of antimicrobial stewardship (AMS) programs, with the aim of enhancing patient healthcare outcomes whilst reducing the emergence and spread of antimicrobial resistance.

The National Antimicrobial Prescribing Survey (NAPS) has been adopted as an important platform to support AMS programs in hospitals and residential aged care homes, and to provide data for the Antimicrobial Use and Resistance in Australia (AURA) Surveillance System.[2] The NAPS program has been through a process of continuous improvement since its inception in 2013 and now comprises 4 modules: the Hospital NAPS, the Surgical NAPS, the Aged Care NAPS and the Quality Improvement NAPS.

Despite the voluntary nature of the survey activities, participation has continued to increase across public and private institutions. Globally, it is still the only national audit platform that measures, reports and benchmarks the quality of use of antimicrobials in facilities of all sizes and classifications across the hospital and aged care sectors. Its methodology has been demonstrated to be both feasible and acceptable, and supports data collection of all antimicrobials including topical agents, antivirals and antifungals.

The Hospital NAPS directly supports Australian health service organisations, state and territory health departments and private health service provider organisations to develop and conduct 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 action requirements of the National Safety and Quality Health Service (NSQHS) Standards[5] and the recently expanded Antimicrobial Stewardship Clinical Care Standard,[3] specifically:

- Indicator 2a: the proportion of antimicrobial prescriptions that are in accordance with the current Therapeutic Guidelines or evidence-based, locally endorsed guidelines
- Indicator 2b: the proportion of prescriptions for restricted antimicrobials that are in accordance with the locally endorsed approval policy
- Indicator 6a: the proportion of prescriptions for which the indication for prescribing the antimicrobial is documented
- Indicator 6b: the proportion of prescriptions for which the duration, stop date or review date for prescribing the antimicrobial is documented
- Indicator 8a: the proportion of patients for whom the perioperative prophylactic antimicrobial is prescribed in accordance with the current Therapeutic Guidelines or evidence-based, locally endorsed guidelines
- Indicator 8b: the proportion of patients for whom the perioperative prophylactic antimicrobial dose is prescribed in accordance with the current Therapeutic Guidelines or evidence-based, locally endorsed guidelines
- Indicator 8d: the proportion of patients who were prescribed prolonged antimicrobials following a surgery or procedure that is discordant with the current Therapeutic Guidelines or evidence-based, locally endorsed guidelines.

The Australian Government Department of Health and Aged Care provides funding for the National Centre for Antimicrobial Stewardship (NCAS) to conduct the Hospital NAPS and contribute data to the AURA Surveillance System.[2]

2. Methodology

2.1. Methods

The NAPS is a standardised auditing tool available to Australian health service organisations to assess the quality of their antimicrobial prescribing.

2.1.1. Timing

The Hospital NAPS module is open for data entry and reporting all year round; for the 2021 audit, participants could enter data from 1 January to 31 December 2021. This allows hospitals to complete the survey whenever time and staffing levels permit. All finalised data that were audited in 2021 have been included for analysis in this report.

2.1.2. Recruitment and eligibility

Using the NAPS registration database, individuals from more than 900 hospitals were invited via email to participate in the 2021 Hospital NAPS. Further promotion by NCAS occurred throughout the year via its website, Twitter and the NAPS newsletter.

All hospitals offering overnight stays can participate in the Hospital NAPS. Facilities such as same-day services, sleep clinics and other private specialty clinics without overnight stay are ineligible.

2.1.3. Undertaking the survey

The Hospital NAPS is a web-based survey. Participants who register are granted access to the NAPS portal where they can submit their data. Data can be entered directly into the database or collected on a paper-based data collection form first (Appendix 2).

Participants are advised that the assessments of guideline compliance and appropriateness should ideally be performed by multidisciplinary teams. The membership of the auditing team is determined by each participating facility, depending on its staffing resources, and can consist of any combination of infectious diseases physicians, clinical microbiologists, other interested physicians, pharmacists, infection prevention and control practitioners, or nurses. It is recommended that at least 2 members provide assessments whenever possible, as this facilitates discussion about more challenging assessments. Preferably, members providing assessments should have a sound clinical knowledge of antimicrobial prescribing and any local prescribing guidelines. If an on-site assessment team is not available, participants are encouraged to seek support from other appropriately experienced clinicians available within their hospital network. The NAPS support team is also available to provide additional clinical advice for facilities without infectious diseases expertise.

2.1.4. Data collection methodology

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

Option 1: Hospital-wide point prevalence survey (preferred)

This methodology requires all inpatients to be assessed so that prevalence of antimicrobial use can be calculated. Data are collected on both the number of inpatients on antimicrobials (numerator) and the total number of inpatients (denominator). It is recommended that the data collection be completed on a single calendar day; however, if this is not possible, wards can be surveyed on separate days provided that all patients are surveyed once only.

Option 2: Repeat point prevalence surveys (for smaller hospitals)

For small hospitals (those with fewer than 100 acute beds), Option 1 may not allow enough data to be collected to meaningfully reflect prescribing practices. Therefore, small hospitals can conduct repeat point prevalence surveys whereby a whole-hospital survey is conducted multiple times, with surveys at least one week apart, until at least 30 antimicrobial prescriptions have been collected. 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 cannot be undertaken due to resource limitations, data can be collected from a random sample of inpatients provided the following guidelines are 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 in 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.

2.1.5. Support for auditors

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

- a user guide
- appropriateness definitions (Appendix 3)
- case examples
- an eLearning module
- reporting templates to help hospitals communicate survey results locally
- links to useful AMS-related presentations and posters.

The NAPS support team also provides 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 or AMS specialists.

2.1.6. eLearning module

The Hospital NAPS online eLearning program is available on the NAPS website at any time. The package provides users with information regarding setting up the survey, data collection, and assessments of compliance with guidelines and appropriateness.

Hospital NAPS participants must achieve a pass mark of 80% or more before they can finalise patient data and generate reports. The pass mark is kept high to promote consistency amongst auditors when performing their data collection and prescription assessments. Users who fail to pass the eLearning program within 3 attempts are encouraged to contact the NAPS support helpdesk to discuss any difficulties they may be experiencing.

2.2. Analyses

Hospitals that conducted whole-hospital audits, including single point prevalence surveys, repeat point prevalence 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 funding type (public or private), state or territory, the Australian Bureau of Statistics remoteness classifications and the Australian Institute of Health and Welfare (AIHW) peer group classifications.[6,7] Key performance indicators are analysed and reported for these categories.

The Hospital NAPS database is live, and participating hospitals are free to amend, add or remove their data at any time. For the delivery of the annual national reports, the database is accessed and analysed each year; therefore this report may contain some small differences in results compared with the previously published NAPS reports.

3. Key results

3.1. Considerations for data interpretation

The nature of the Hospital NAPS is such that only patients who are prescribed antimicrobials are included in the survey; therefore, patients who are not receiving antimicrobials are excluded. It is important to understand that the survey does not describe the prescribing behaviour for an indication in the context of a whole patient population. Therefore, for indications where the usual recommended therapy is for no antimicrobial treatment, only patients who are receiving antimicrobials are included; hence the reported results may appear worse than they actually are for a given indication.

For example, patients undergoing surgical procedures who are receiving no surgical antimicrobial prophylaxis (high rate of appropriateness) are excluded from the survey. Therefore, the surgical prophylaxis greater than 24 hours metric, together with appropriateness and guideline compliance for this indication, may appear higher than if all patients undergoing a surgical procedure were included.

The Surgical NAPS module is specifically designed for assessing the quality of surgical antimicrobial prophylaxis and includes all patients undergoing a procedure, not just procedures where antimicrobial prophylaxis was administered. For more representative in-depth analysis, please refer to the Surgical NAPS report 2021.[8]

3.1.1. Representativeness

Whilst participation in the Hospital NAPS is still voluntary, there is now a high degree of representativeness across many hospital peer groups, especially for large public hospitals. Therefore, the results can be confidently presumed to be a true reflection of prescribing practices across most public hospitals.

3.1.2. Comparison with previous surveys

In addition to the 2021 Hospital NAPS results, this report references elements of the 2015–2020 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.

Data from 2013 and 2014 have been mostly removed from this report. The distribution of participating hospitals was substantially different in these early years, when the hospital accreditation criteria for monitoring the quality of antimicrobial prescribing had not yet become widely enforced. Furthermore, substantial revisions to the data collection fields and methodology occurred in 2015.

3.1.3. Subjective nature of assessments

The NAPS has a mandatory eLearning module, detailed user guides, standardised appropriateness definitions and remote expert support to assist facilities to conduct their assessments. Nevertheless, individual auditors at each facility are ultimately responsible for assessing antimicrobial prescribing appropriateness and compliance with guidelines, and there is some degree of interpretation involved.

3.1.4. Use of alternative audit tools

The NAPS program provides a suite of auditing tools to meet the needs of hospital AMS programs. Depending on local AMS issues, case mix and resources, hospitals may have chosen to use other modules, such as the Surgical NAPS or Quality Improvement NAPS. This may have impacted on the number of hospitals that chose to participate in the 2021 Hospital NAPS.

3.2. Participation

This report analyses the data submitted by 407 hospitals (291 public and 116 private) that met the Hospital NAPS inclusion criteria. Compared with 2020, the number of public hospitals participating slightly increased and the number of private hospitals decreased (Figure 1).

Figure 1: Number of public and private hospitals that contributed to the Hospital NAPS, 2015–2021
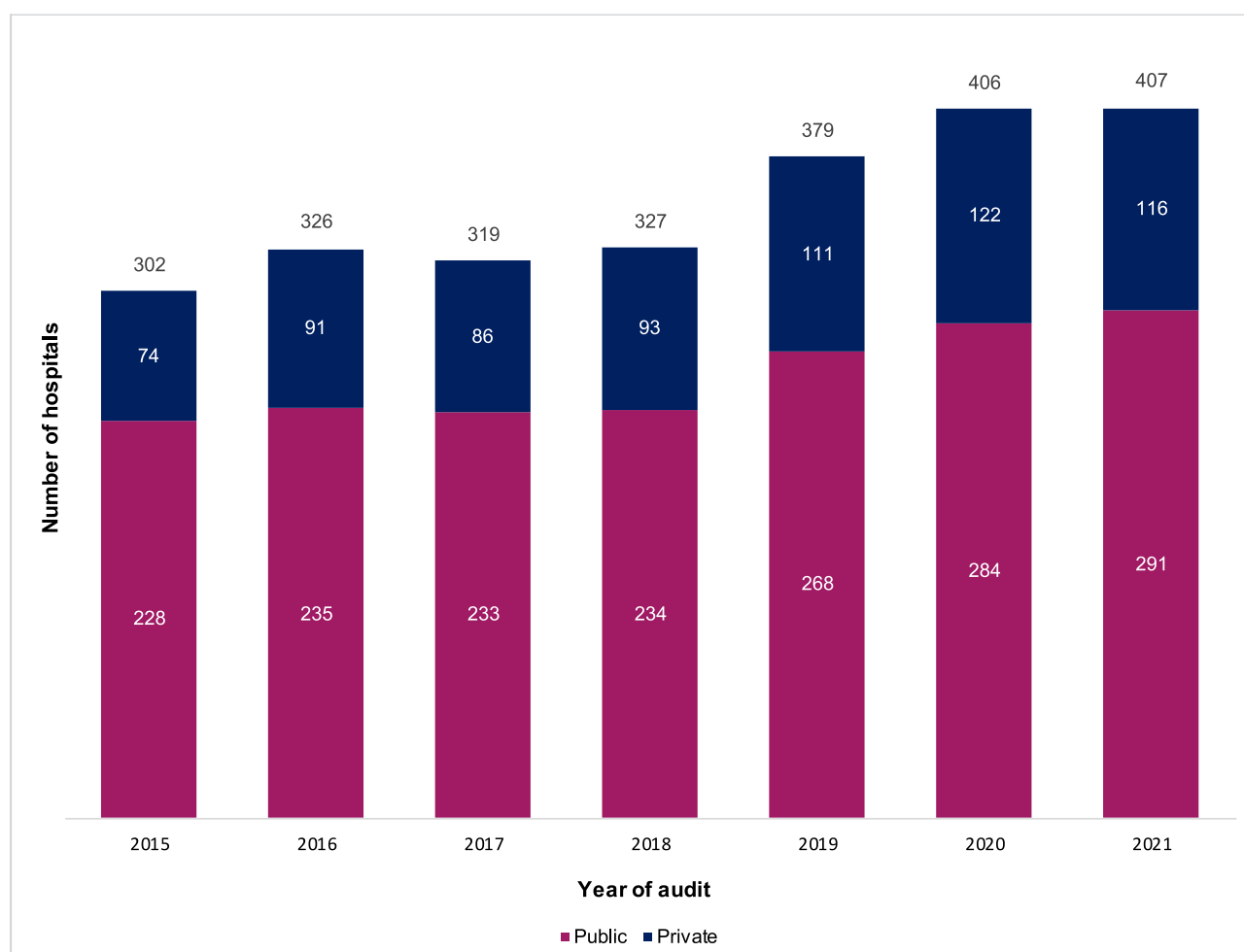
Overall, 42.1% of all eligible hospitals participated in the survey, with slightly higher participation from public hospitals (42.9%, 291 of 678) compared with private hospitals (40.3%, 116 of 288). All Australian states and territories were represented (Figure 2).

The full analysis of hospital participation by funding type, state and territory, peer group and remoteness classification can be found in Appendix 1: Figure 1A and Tables 1A and 1B.

Figure 2: Percentage of public and private hospitals that contributed to the Hospital NAPS by state and territory, 2021*

NT
Public **80% (n=4)**
Private **100% (n=1)**

Qld
Public **30% (n=37)**
Private **25% (n=15)**

WA
Public **24% (n=22)**
Private **55% (n=11)**

SA
Public **34% (n=26)**
Private **14% (n=4)**

NSW
Public **54% (n=116)**
Private **40% (n=37)**

ACT
Public **100% (n=2)**
Private **50% (n=2)**

Vic
Public **56% (n=80)**
Private **58% (n=44)**

Tas
Public **17% (n=4)**
Private **50% (n=2)**
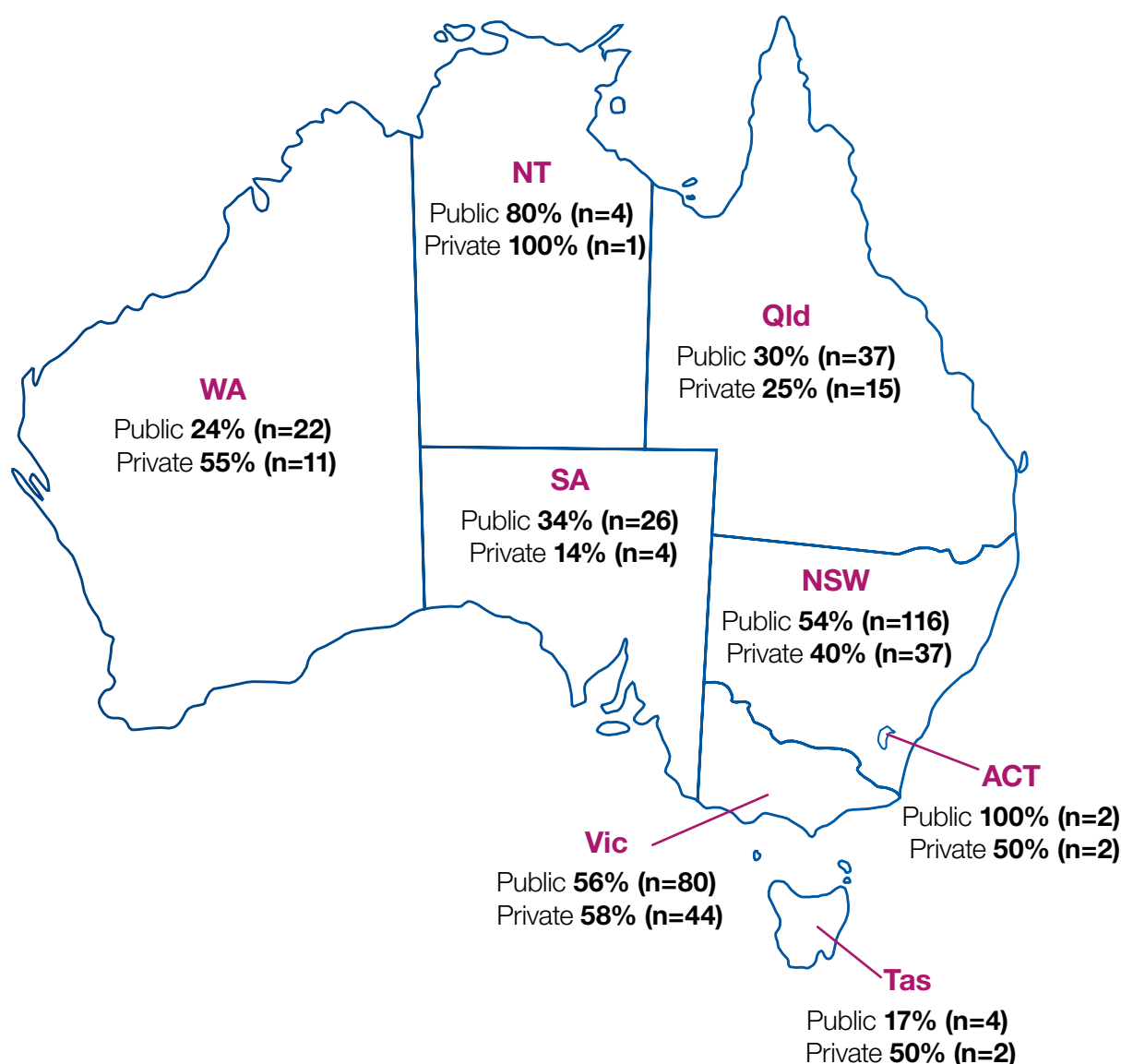
* Refer to Appendix 1: Table 1A for the total number of hospitals in each jurisdiction.

Data from 20,473 patients were submitted, generating 29,305 prescriptions for analysis. The majority of prescriptions were gathered from Victoria and New South Wales, which together represented 62.7% of all prescriptions submitted (Appendix 1: Table 1C).

The majority of auditing occurred in the months of October and November, which is consistent with previous years' surveys (Figure 3). There was also a moderate amount of auditing activity in May, June and September. A substantial reduction, particularly for Victorian hospitals, was seen in July, which coincided with the state-wide lockdown that occurred in Victoria due to the COVID-19 pandemic.

Figure 3: Distribution of prescription audit days amongst hospitals contributing to the Hospital NAPS, 2021
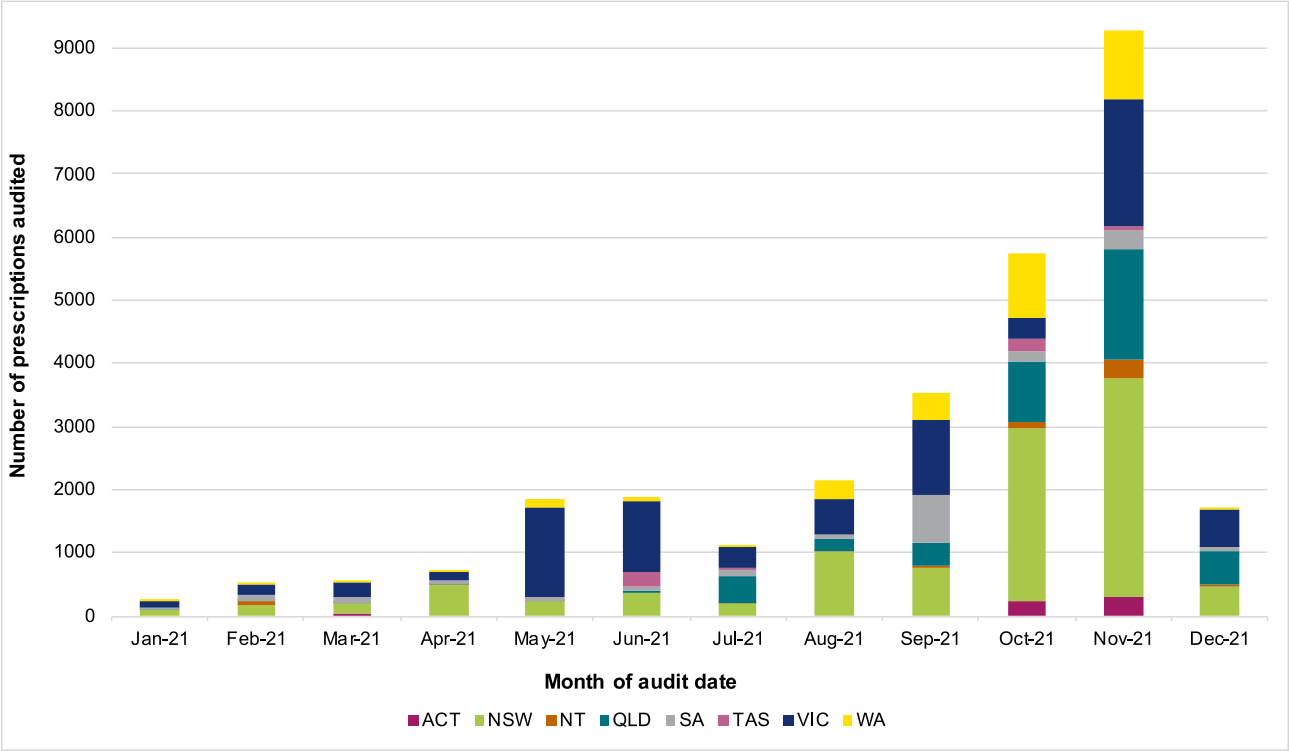
3.3. Key performance indicators

The 5 key indicators described in Figure 4 have been collected consistently since 2015.
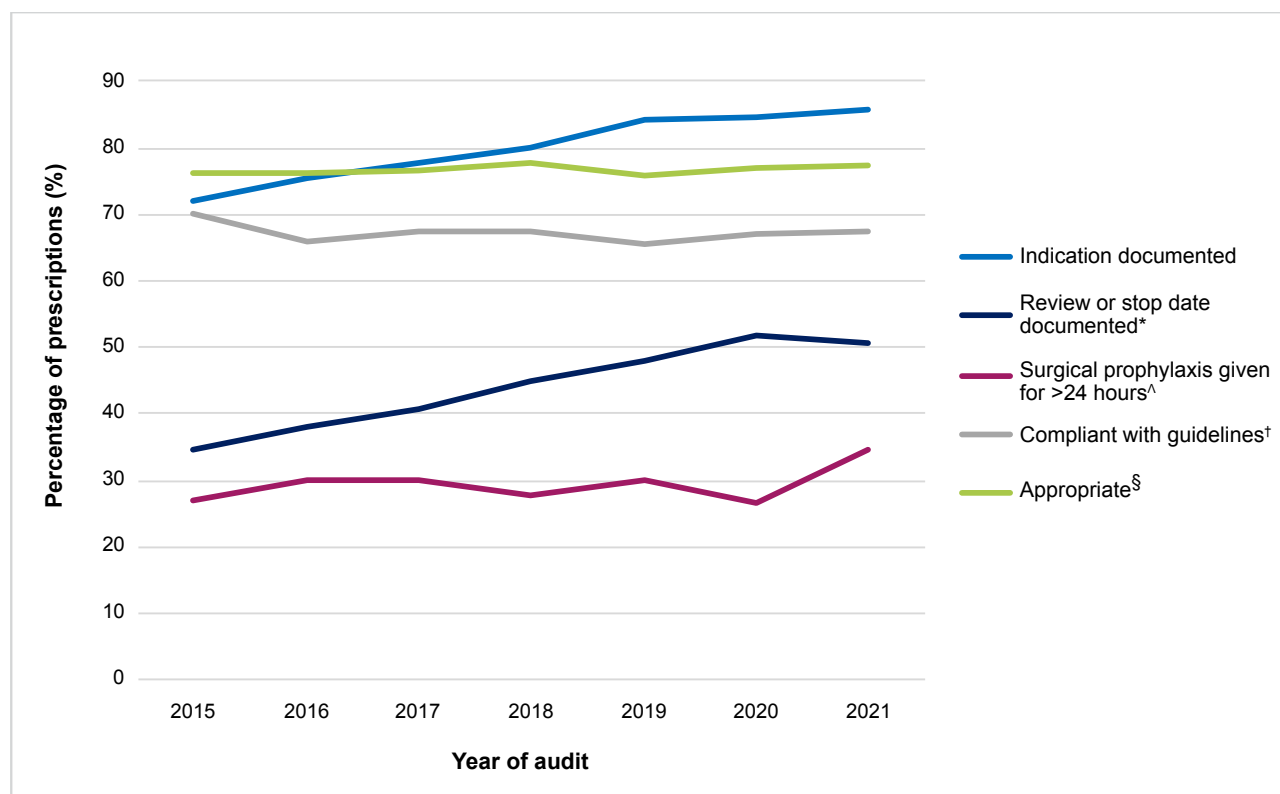
Figure 4: Hospital NAPS key indicators, for assessable prescriptions, 2015–2021

* The 'Review or stop date documented' indicator was introduced partway through 2015; the 2015 result excludes prescriptions where this measure was not specified (3,789 of 26,165 prescriptions).

^ Where surgical prophylaxis was selected as the indication (n=3,531 in 2021).

† Prescriptions for which compliance was assessable (n=23,677 in 2021). Excludes prescriptions for which guidelines were not available, as well as prescriptions that were 'directed therapy' or 'not assessable'. Refer to Appendix 4 for definitions.

§ Prescriptions for which appropriateness was assessable (n=28,253 in 2021). Excludes prescriptions deemed to be 'not assessable'. Refer to Appendix 3 for definitions.

See Appendix 1: Tables 1C and 1D for the breakdown of Hospital NAPS key indicators by funding type, state and territory, peer group and remoteness classification.

Appendix 1: Table 1E shows the changes over time for the different guideline compliance and appropriateness categories for Hospital NAPS prescriptions.

3.3.1. Documentation of indication

Encouragingly, the vast majority of antimicrobial prescriptions had an indication documented in the patient medical history. This measure has continued to improve year on year, from 72.0% in 2015 to 85.7% in 2021 (Figure 4).

The documentation rate in public hospitals was high, at 89.9%, which is approaching the best practice target of 95% that has been adopted by NCAS for the Hospital NAPS. In private hospitals, 68.9% of prescriptions had an indication documented, which is a slight decrease compared with 70.1% in 2020 (Appendix 1: Table 1C).

3.3.2. Documentation of review or stop date

There had previously been a consistent improvement in the documentation of antimicrobial review or stop date since the measure was first introduced in 2015. However, the 2021 data revealed a slight reduction (50.8%) compared with 2020 (51.8%). This reduction was seen in both public and private hospitals, although overall private hospitals generally performed better than public hospitals (56.3% compared with 49.5%; Appendix 1: Table 1C).

3.3.3. Surgical prophylaxis greater than 24 hours

There appears to have been a considerable increase in the proportion of surgical antimicrobial prophylaxis prescriptions with a duration of greater than 24 hours (34.5% in 2021 compared with 26.6% in 2020).

However, this result should be interpreted carefully as there was also a marked reduction in the number of surgical antimicrobial prophylaxis prescriptions audited in 2021 compared with 2020 (3,531 prescriptions compared with 4,759 in 2020).

Furthermore, the results of the 2021 Surgical NAPS show that 26.9% of procedures had antimicrobial prophylaxis that continued beyond 24 hours. The Surgical NAPS has a more accurate methodology for capturing surgical antimicrobial prophylaxis data. Further in-depth analyses of the types and durations of post-operative surgical prophylaxis procedures can be found in the 2021 Surgical NAPS report.[8]

3.4. Compliance with guidelines

A detailed breakdown of the compliance with guidelines assessment is shown in Figure 5.

Figure 5: Compliance with guidelines for all prescriptions in the Hospital NAPS, 2015–2021
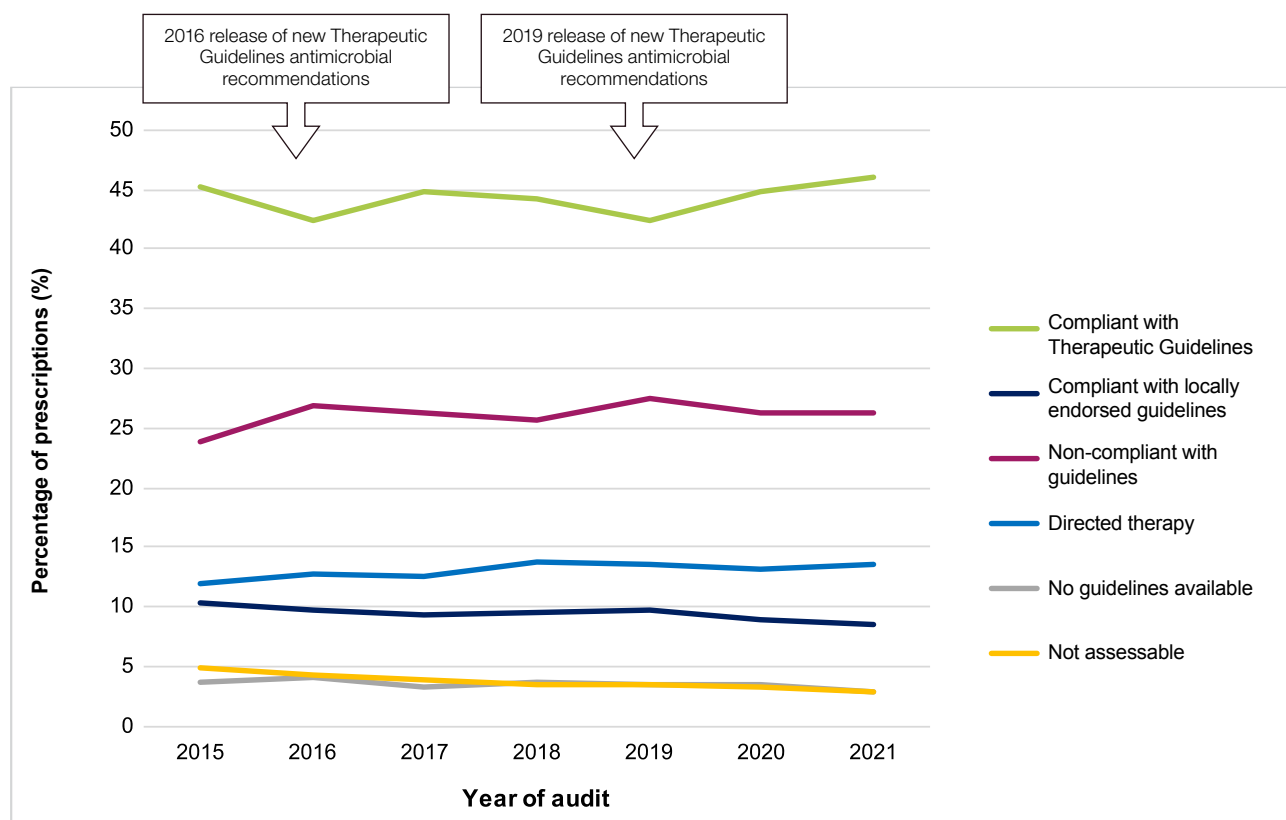
The release of the new Therapeutic Guidelines antimicrobial recommendations in 2019 saw an associated drop in the proportion of prescriptions deemed compliant with the Therapeutic Guidelines. Encouragingly, there was a continued improvement in this measure from 42.3% in 2019 to 46.1% in 2021, coupled with an associated improvement in appropriateness from 72.9% in 2019 to 74.5% in 2021 (Figure 6). This pattern is not surprising as it takes time for new guidelines to be disseminated throughout hospital systems and for clinicians to change their prescribing behaviour. A similar pattern was seen after the 2016 update of the Therapeutic Guidelines.

There continues to be a gradual reduction in compliance with locally endorsed guidelines, which may be because each successive update of the Therapeutic Guidelines provides recommendations for an increasingly broad range of clinical conditions, which in turn may reduce a hospital's need to produce local guidelines.

Unfortunately, despite some minor fluctuations, the rate of non-compliance with guidelines remained at approximately 26%.

The percentage of prescriptions assessed as directed therapy has effectively remained the same over the years and has not been influenced by the release of different versions of the Therapeutic Guidelines.

3.5. Appropriateness

Compared with 2020, the 2021 results show essentially unchanged rates of overall appropriateness (Optimal plus Adequate prescribing – 74.5% in 2021; 74.0% in 2020) and inappropriateness (22.0% in both years) (Figure 6). Appropriateness was generally higher amongst public hospitals compared with private hospitals (76.3% and 67.0% respectively; Appendix 1: Table 1D).

A detailed breakdown of the assessment of appropriateness is shown in Figure 6.

Figure 6: Appropriateness for all prescriptions in the Hospital NAPS, 2015–2021
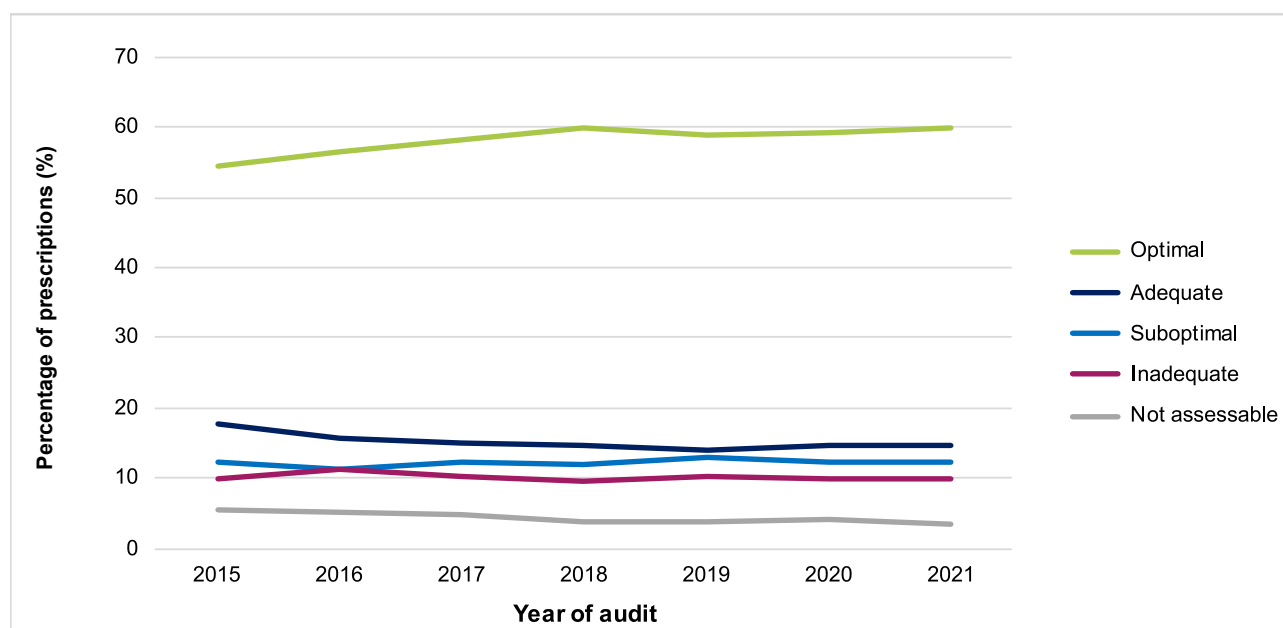
Although the rates of appropriateness appear to be generally stagnant, a more in-depth analysis of the data reveals the changing quality of prescribing within peer groups (Figure 7 and Figure 8).

Amongst public hospitals, principal referral hospitals, women's and children's hospitals and group D hospitals showed improved results compared with 2020. There was unfortunately a reduction in appropriateness amongst group A, B and C hospitals, although the overall trend line still shows improvement across time (Figure 7). The reasons for this are unclear, and future results will be carefully analysed to determine whether the trend of improvement continues.

Figure 7: Appropriateness of antimicrobial prescribing across public healthcare facilities in the Hospital NAPS, 2013–2021
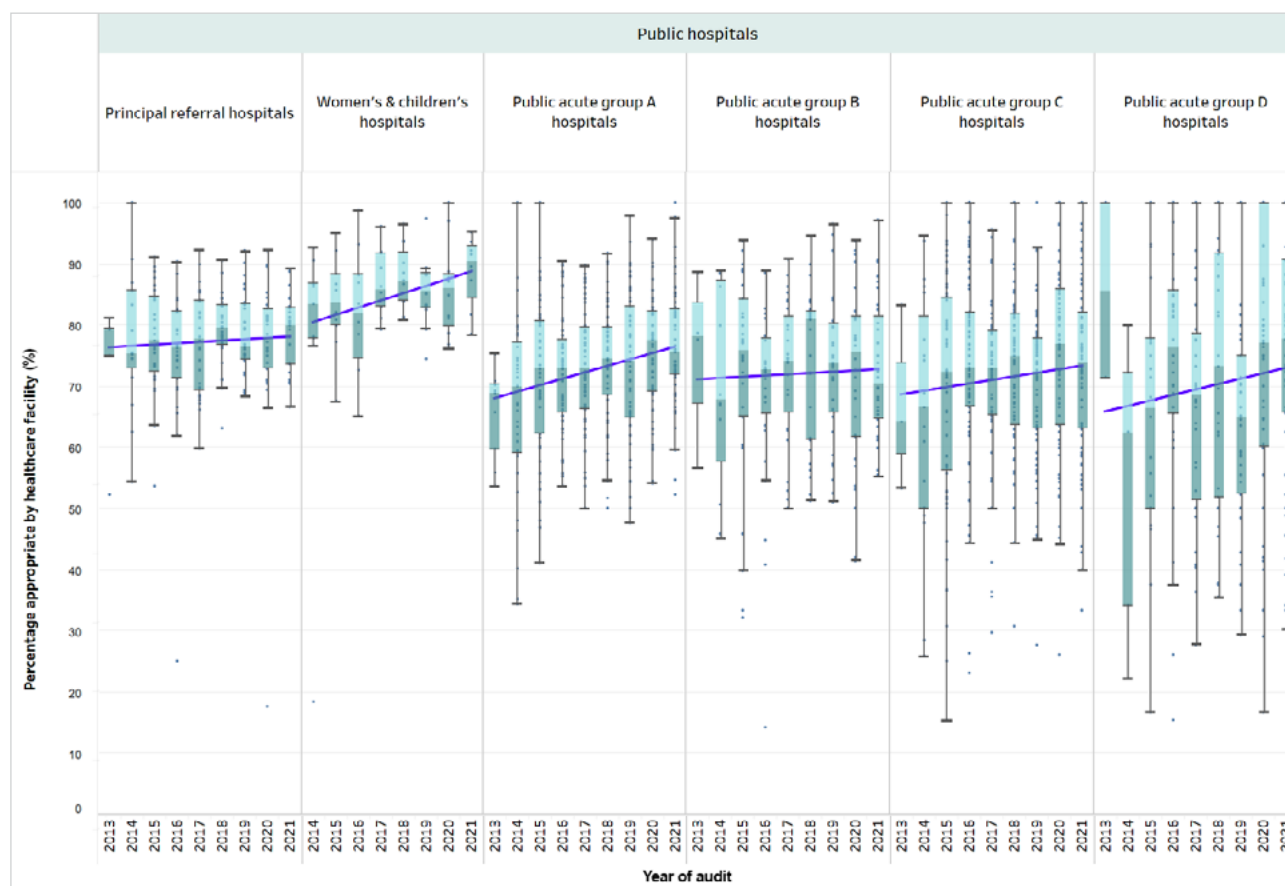
Source: AIHW[7] and NAPS.

Amongst public hospitals, the trend line indicates that appropriateness of prescribing within peer groups appears to be decreasing over the years (Figure 8). However, it is important to emphasise the changing mix of participating private hospitals over time; those performing the survey in the earlier years consisted of larger, well-established hospitals with existing AMS services. Over the years, smaller public hospitals joining the survey may have negatively impacted on the overall appropriateness of prescribing because they are early on in the process of establishing their AMS services and it takes time to implement initiatives to improve prescribing once they have been identified. Nonetheless, prescribing appropriateness improved in 2021 compared with 2020 for group A, B and C public hospitals.
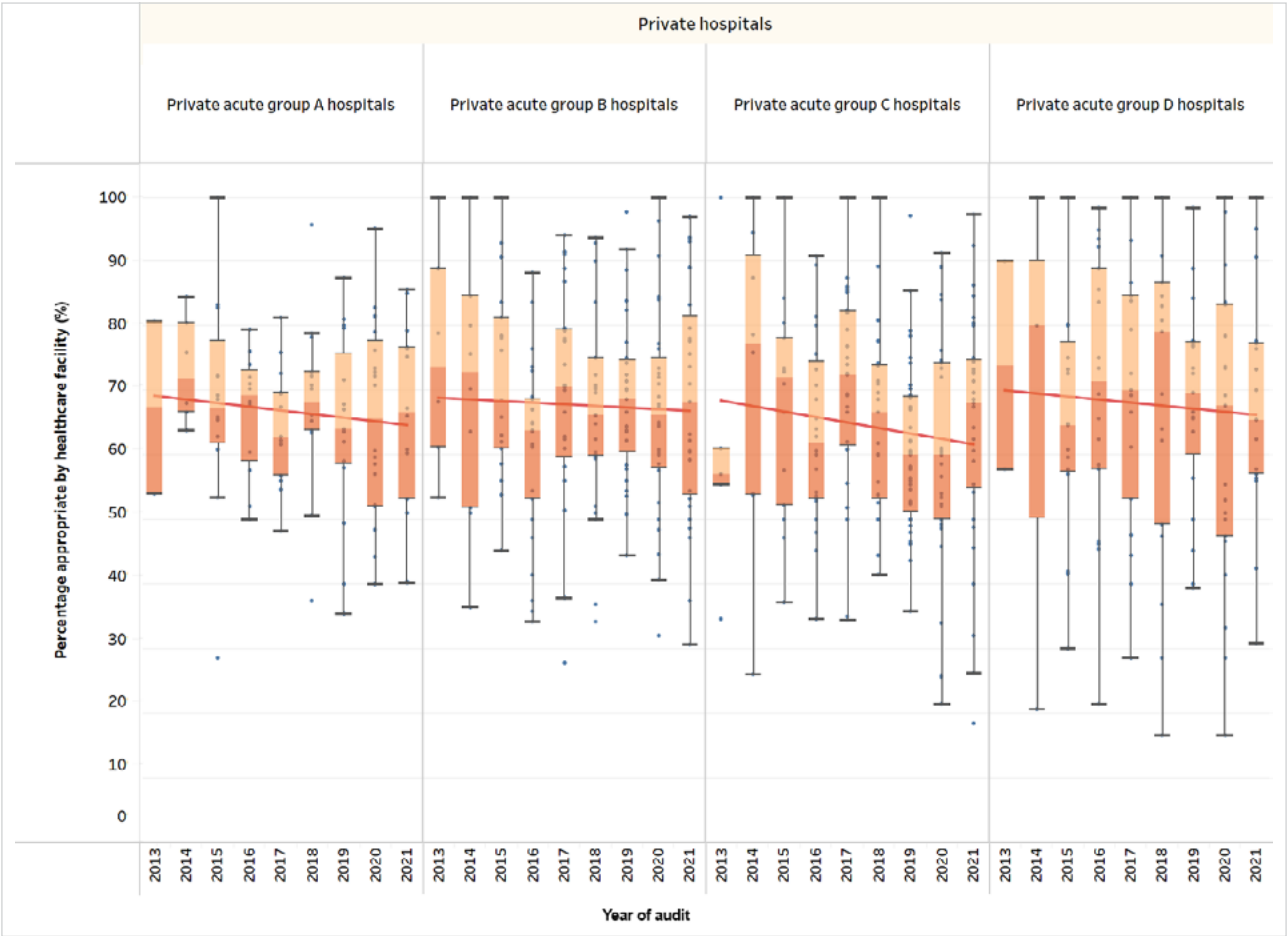
Figure 8: Appropriateness of antimicrobial prescribing across private healthcare facilities in the Hospital NAPS, 2013–2021

Source: AIHW[7] and NAPS.

3.5.1. Reasons for inappropriateness

The Hospital NAPS allows users to specify the reason why a prescription has been deemed inappropriate.

Figure 9: Reasons for inappropriateness for all prescriptions in the Hospital NAPS, 2021
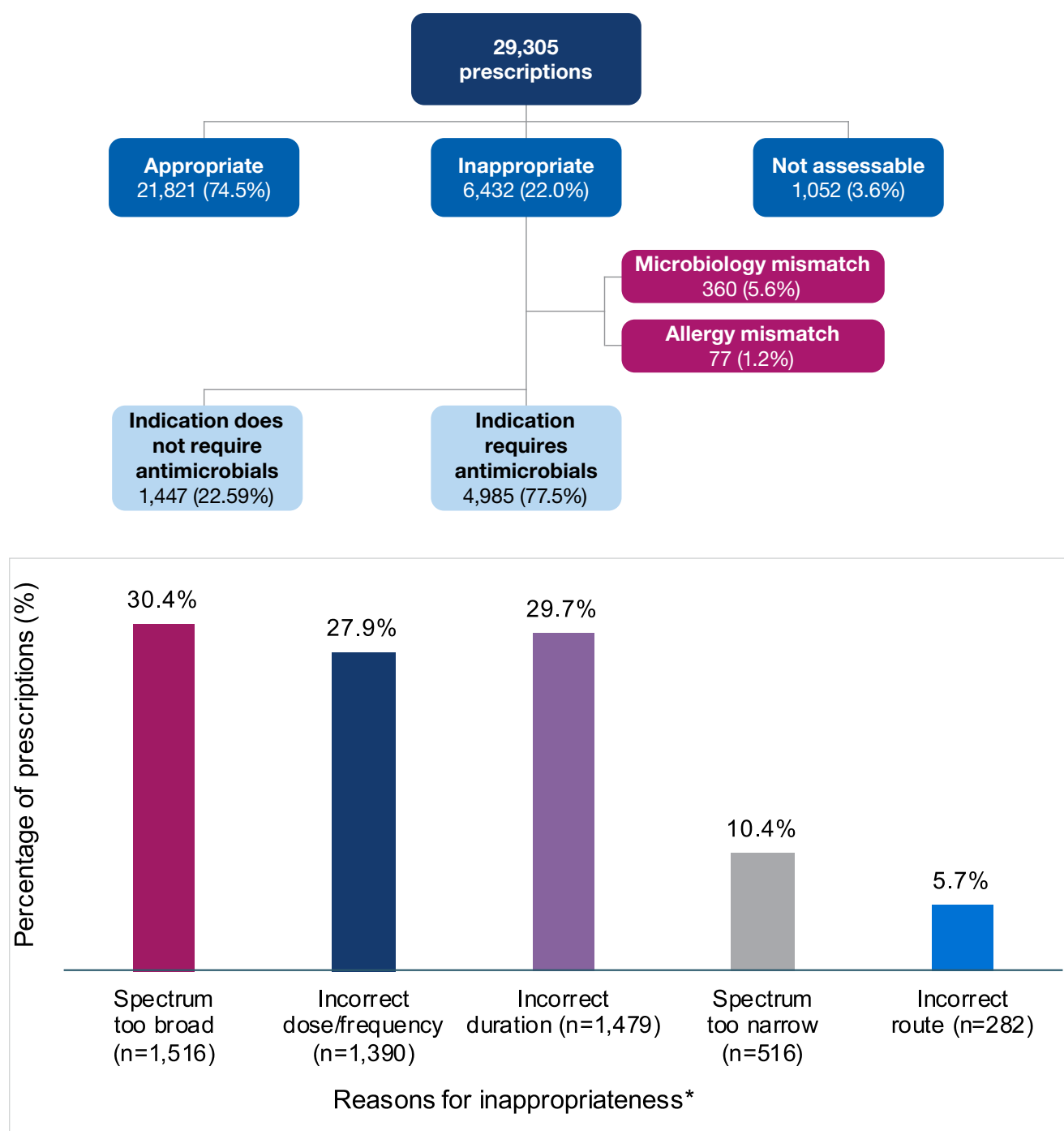
* Each prescription is assessed against each quality indicator and thus can be represented in more than one category.

Of the 29,305 prescriptions, 6,432 (22.0%) were assessed as inappropriate (suboptimal and inadequate) by the auditors. Of those, 77 (1.2%) were identified as having an allergy mismatch and 360 (5.6%) as having a microbiology mismatch. These low rates are consistent with findings in the previous years.

A substantial proportion of inappropriate prescriptions (22.5%) were for conditions that do not require antimicrobial therapy. The remaining reasons for inappropriateness (Figure 9) were primarily due to the antimicrobial spectrum being too broad, incorrect dose or frequency, and incorrect duration.

3.5.2. Appropriateness of antimicrobials on the Priority Antibacterial List

The Priority Antibacterial List for Antimicrobial Resistance Containment (the Priority Antibacterial List) was developed by the Australian Commission on Safety and Quality in Health Care to support local and national antimicrobial usage surveillance. Antibiotics are grouped into 3 categories (Appendix 5: Figure 5A and Figure 5B[9]):

- Access – first-line antimicrobials with low potential for resistance
- Curb – first-line antimicrobials with high resistance potential
- Contain – antimicrobials with high resistance potential; these are not recommended as first-line therapy.

The appropriateness of prescribing of antibiotics grouped according to each of these categories is shown in Figure 10.

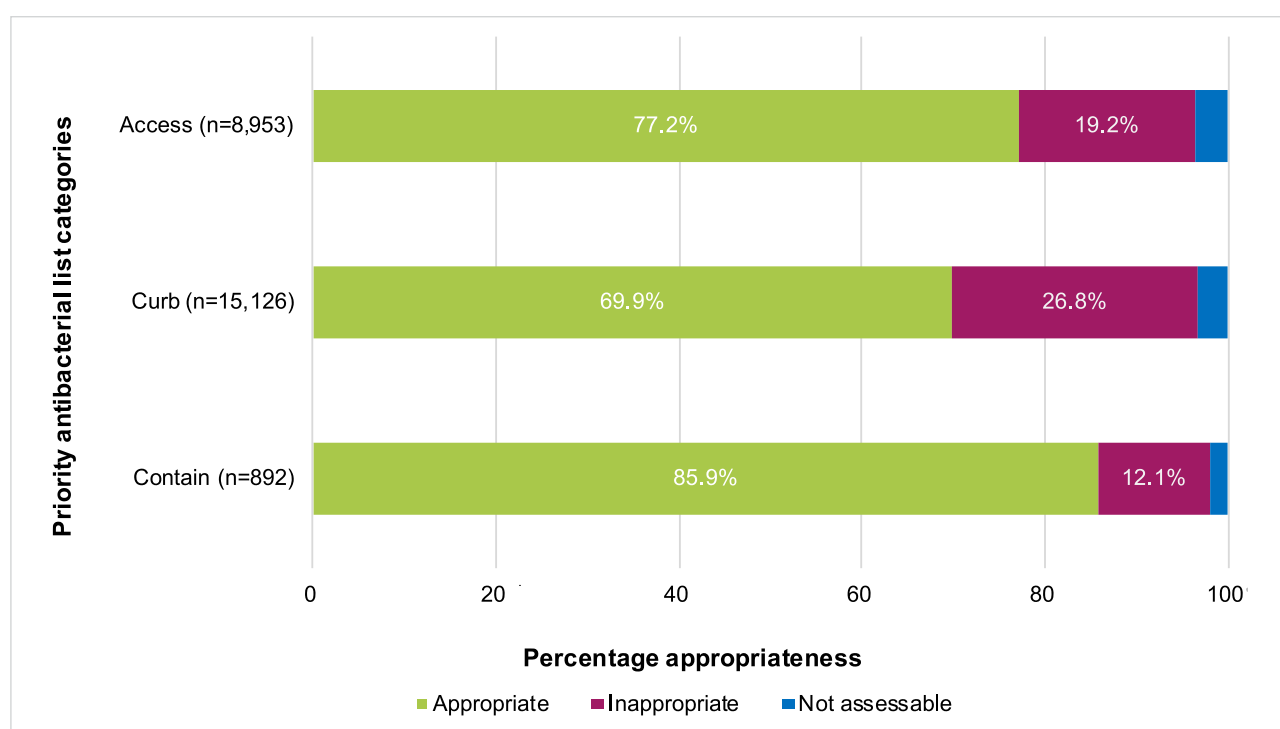**Figure 10: Appropriateness of prescribing for antibiotics on the Priority Antibacterial List, Hospital NAPS 2021**

A significantly higher proportion of antibiotic prescribing in the Curb category was assessed to be inappropriate (26.8%) compared to antibiotics in the Contain (12.1%) and Access (19.2%) categories (Figure 10). Antimicrobials in the Access category are often used as first-line therapy according to guidelines and hence more often deemed appropriate. Antimicrobials in the Contain category are often prescribed by or used in accordance with advice from specified infectious disease services, resulting in the high proportion of prescriptions being assessed as appropriate.

In contrast, antimicrobials in the Curb category are commonly used for indications that are often assessed as inappropriate – for example, cefazolin in surgical prophylaxis and ceftriaxone in treating respiratory illnesses including COPD. Of the Curb antimicrobials, cefazolin, ceftriaxone, cefalexin, amoxicillin–clavulanic acid and piperacillin–tazobactam make up 83.4% of all the inappropriate prescriptions. Therefore, targeting these antimicrobials, perhaps through a combination of restrictive policies and educational initiatives, will support improvement of antimicrobial prescribing appropriateness nationally.

3.6. Most commonly prescribed antimicrobials

Figure 11 shows the 20 most common antimicrobials prescribed by NAPS contributor hospitals in 2021. This distribution of antimicrobials has remained relatively consistent in NAPS results over the years. Cefazolin continues to be the most frequently prescribed antimicrobial, although there was a noticeable reduction in 2021 compared with 2020 (11.5% in 2021; 13.9% in 2020). This is likely due to the corresponding reduction in surgical prophylaxis prescribing seen in the 2021 results (surgical prophylaxis comprised 68.7% of all cefazolin prescriptions).

Figure 11: The 20 most common antimicrobials prescribed by Hospital NAPS contributor hospitals, 2015–2021
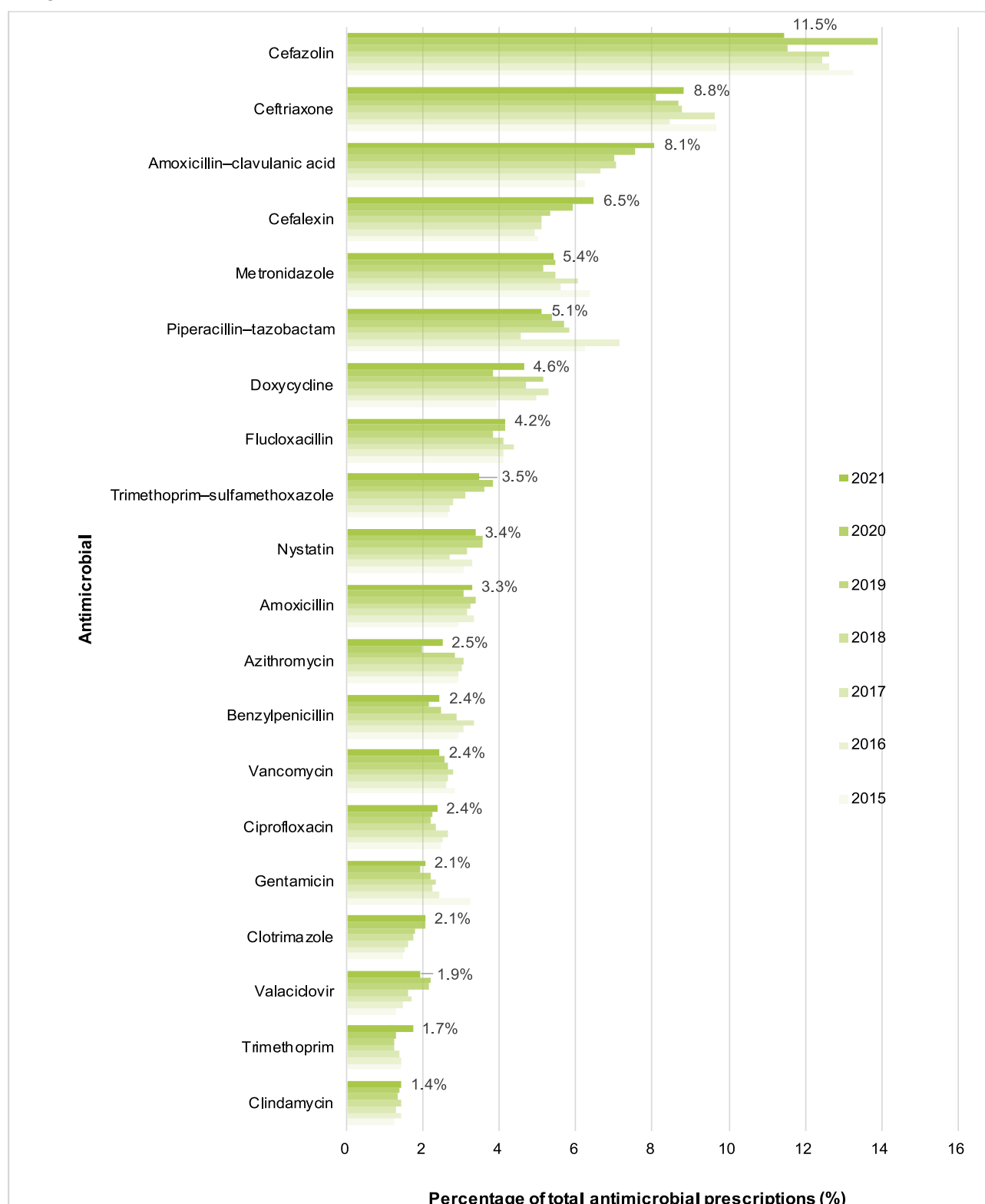
3.6.1. Appropriateness of the most commonly prescribed antimicrobials

The 5 most commonly prescribed antimicrobials (cefazolin, ceftriaxone, amoxicillin–clavulanic acid, cefalexin and metronidazole) also had amongst the highest rates of inappropriateness (Figure 12). These results are relatively consistent compared with 2020 and other previous years' results.

Figure 12: Appropriateness of the 20 most commonly prescribed antimicrobials in Hospital NAPS contributor hospitals, 2021
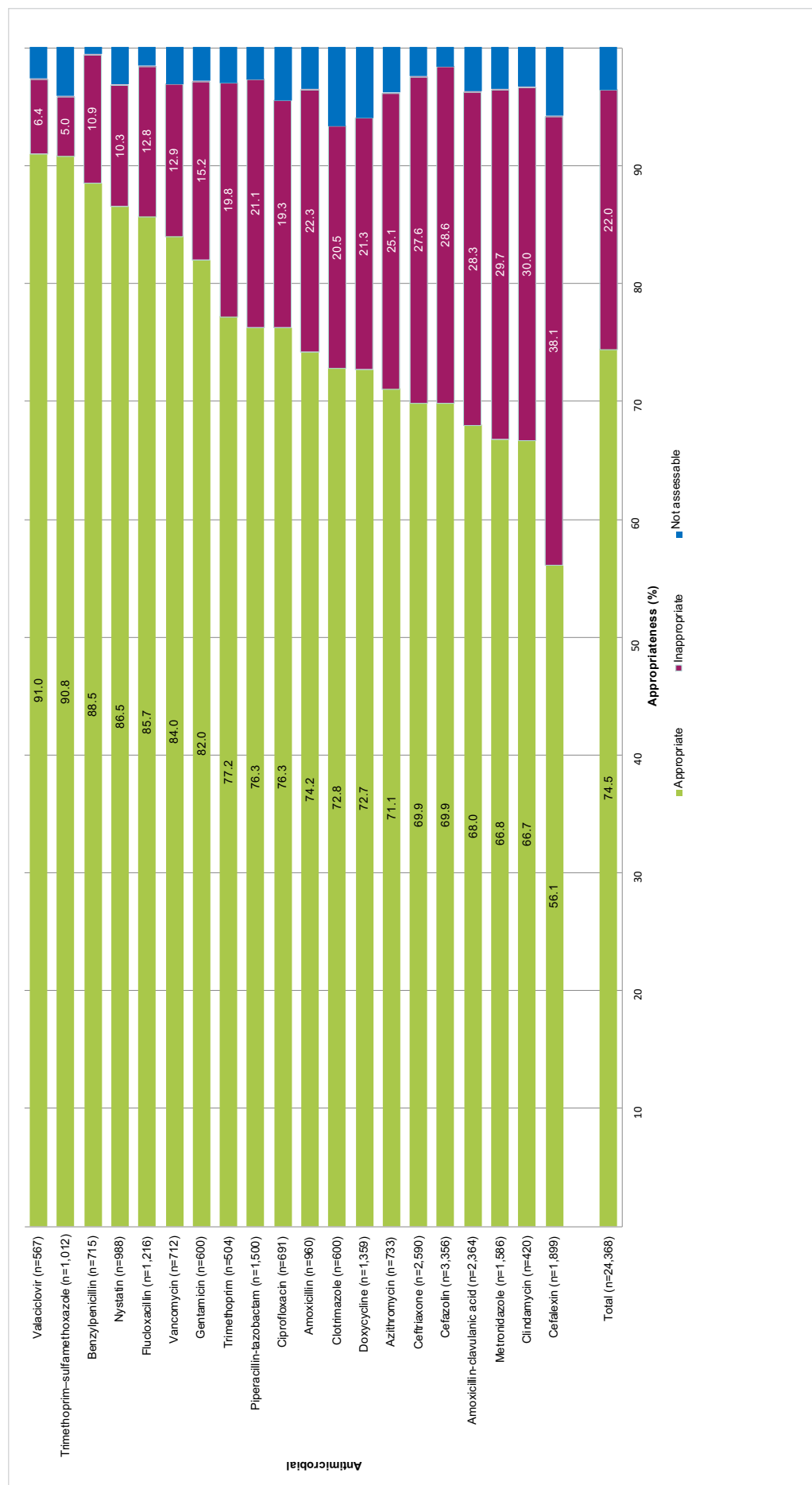
Cefalexin

The most inappropriately prescribed antimicrobial continued to be cefalexin, with 38.1% of all prescriptions deemed to be inappropriate.

The most common indications for which cefalexin was prescribed were cystitis (31.1%), surgical prophylaxis (17.2%) and cellulitis (12.5%). For these indications, 88.0% of surgical prophylaxis prescriptions were deemed to be inappropriate, which is not surprising given that cefalexin is not in any surgical prophylaxis recommendations in the Therapeutic Guidelines. The inappropriateness of cystitis prescriptions was 26.3%, followed by 20.3% for cellulitis prescriptions.

Metronidazole

Almost 30% of metronidazole prescriptions were assessed as being inappropriate. The most common reasons for metronidazole use were surgical prophylaxis (15.1%), diverticulitis (10.7%) and acute cholecystitis (7.5%). Of these surgical prophylaxis prescriptions, 42.3% were inappropriate, with the most common reasons being prolonged duration and that therapy was not required at all. Almost 40% of acute cholecystitis prescriptions were inappropriate. In the vast majority of cases, this was because the spectrum of therapy was too broad.

Amoxicillin–clavulanic acid

Amoxicillin–clavulanic acid was the third most commonly prescribed antimicrobial (8.1%, 2,364 prescriptions), and had the fourth highest rate of inappropriateness (28.3%) of the top 20 antimicrobials. Amoxicillin–clavulanic acid can be prescribed either orally or intravenously. The intravenous formulation only became widely available in Australia from 2017. Since that time, there has been a consistent increase in the proportion of intravenous amoxicillin–clavulanic acid prescriptions seen in the NAPS, from 8.6% of total amoxicillin–clavulanic acid prescriptions in 2017 to 28.4% in 2021. Its place in therapy is still emerging; however, it is seen as an alternative to piperacillin–tazobactam in patients with severe infections where specific cover against *Pseudomonas aeruginosa* is not required.

Interestingly, a substantially higher proportion of oral amoxicillin–clavulanic acid prescriptions were inappropriate compared with intravenous prescriptions (32.0% and 20.1% respectively). The most common reasons for prescription of oral amoxicillin–clavulanic acid were community-acquired pneumonia, cystitis, and hospital-acquired pneumonia. Approximately half of community-acquired pneumonia prescriptions were inappropriate, followed by 30.0% of cystitis and 13.3% of hospital-acquired pneumonia prescriptions.

The most common reasons for prescription of intravenous amoxicillin–clavulanic acid were aspiration pneumonia, non-surgical wound infection, and appendicitis. Interestingly, the rate of inappropriateness is increasing over time. In 2017, when this formulation was first introduced, only 13.7% of prescriptions were deemed inappropriate; this is likely because its newness meant that hospitals had more controls placed around it and only specialist prescribers were familiar enough to prescribe it. Since then, it has become more widely utilised by prescribers who are less familiar with its appropriate use.

3.7. Most common indications for antimicrobial prescribing

The 20 most common indications for antimicrobial prescribing seen in the 2021 survey are shown in Figure 13.

There have been some noticeable shifts in the proportions of indications for prescribing compared with 2020. The percentage of antimicrobials prescribed for surgical prophylaxis reduced noticeably from 15.2% in 2020 to 12.1% in 2021. The reasons for this are unclear. However, the continued impact of the COVID-19 pandemic in 2021 meant that there was a reduction in elective surgeries being performed, which in turn may have contributed to this reduction in surgical prophylaxis indications. It is also possible that surgical hospitals chose to instead perform the Surgical NAPS as it provides more tailored and meaningful data for that patient mix.

The 2020 survey saw a substantial reduction in the proportion of antimicrobials prescribed for community-acquired pneumonia compared with what had been observed in previous years. It was hypothesised that this may have been due to the pandemic lockdown measures limiting the transmission of respiratory-related illnesses. Whilst lockdown measures continued in 2021, there was nonetheless a correction in this figure, with community-acquired pneumonia accounting for 8.1% of prescriptions, an increase from 6.6% in 2020.

Figure 13: The 20 most common indications for antimicrobial prescribing in Hospital NAPS contributors, 2015–2021

Percentage of total antimicrobial prescriptions
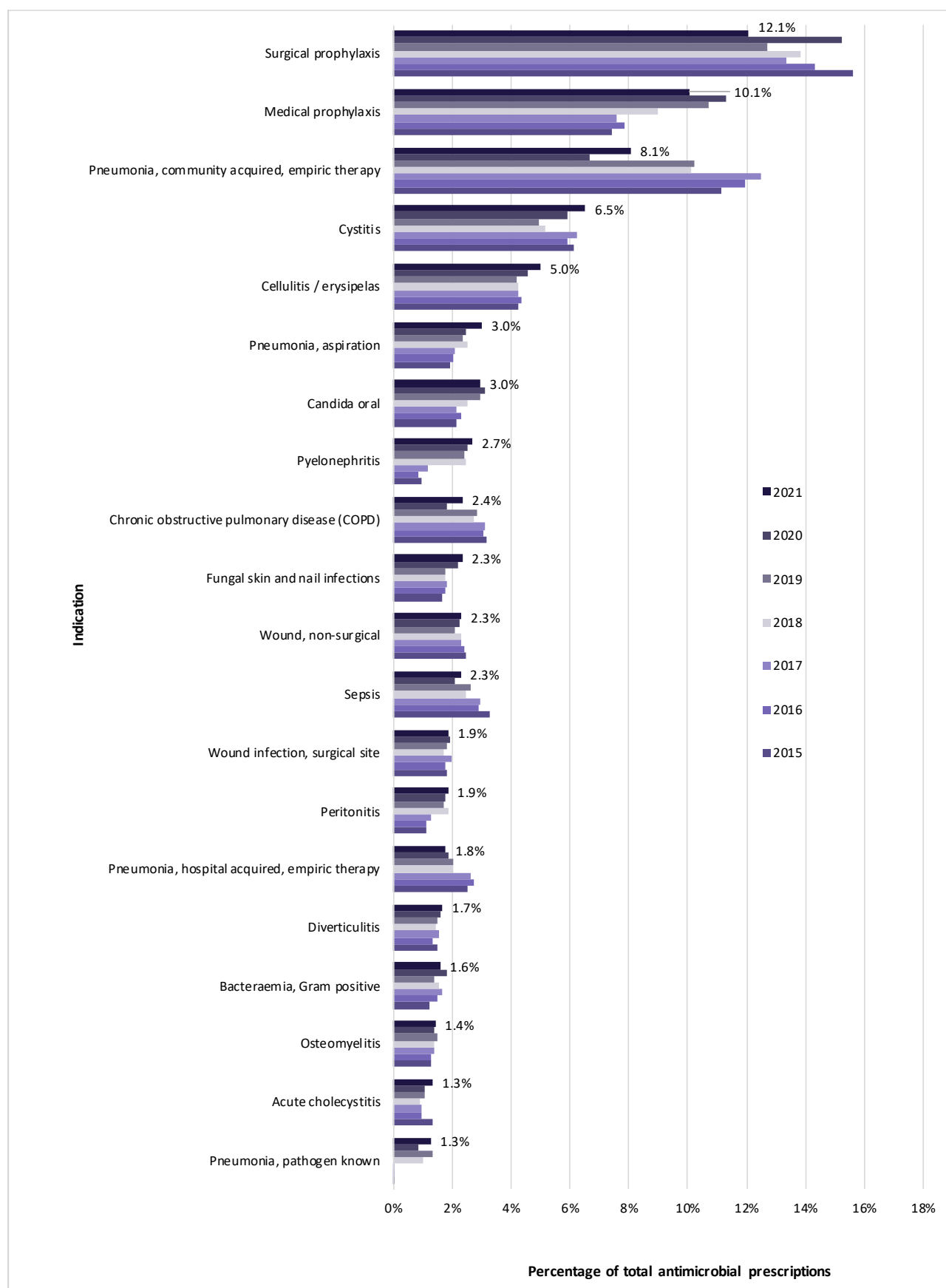
3.7.1. Appropriateness of prescribing for the 20 most common indications

Of the 20 most common indications in 2021, the 3 indications with the most inappropriate prescribing continued to be COPD, surgical prophylaxis and acute cholecystitis (Figure 14); this distribution has remained unchanged for several years. Interestingly, very few surgical prophylaxis prescriptions were deemed to be not assessable (possibly due to the heavily protocolised nature of this indication), yet there were still very high rates of inappropriate prescribing.

In contrast, other indications with clear prescribing protocols, such as medical prophylaxis, had very high rates of appropriate prescribing. Gram-positive bacteraemia and osteomyelitis also had high rates of appropriate prescribing, likely due to the specialised infectious diseases oversight required for the management of these patients.

Figure 14: Appropriateness of prescribing for the 20 most common indications, Hospital NAPS contributors, 2021*
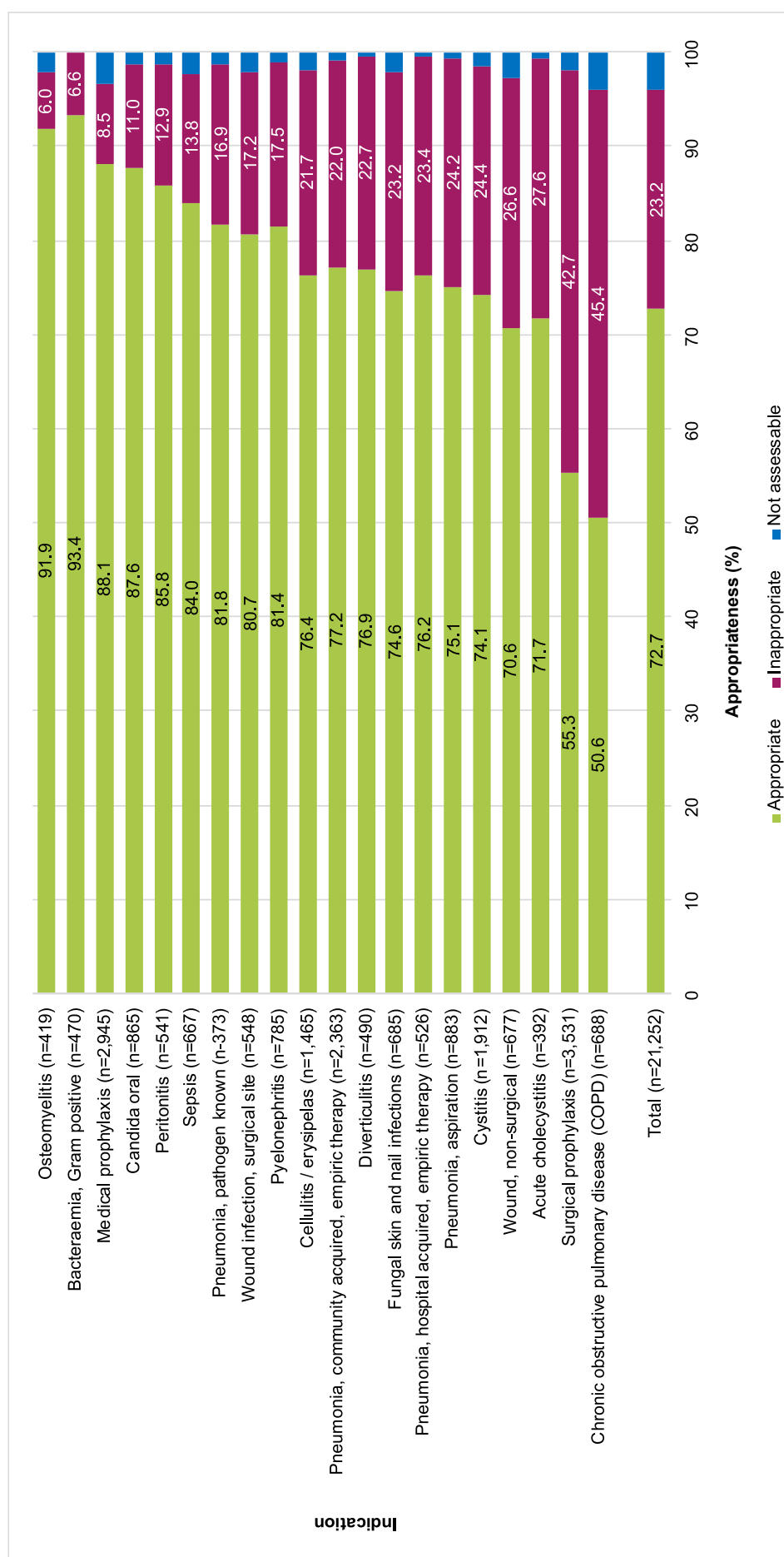
* Excludes prescriptions where the indication for prescribing was unknown (n=564).

3.7.2. Compliance with guidelines for the 20 most common indications

Of the top 20 most common indications, the average rate of non-compliance (neither Therapeutic Guidelines nor locally endorsed guidelines) was 26.3%

Figure 15: Compliance with guidelines for the 20 indications most commonly requiring antimicrobials in Hospital NAPS contributors, 2021*
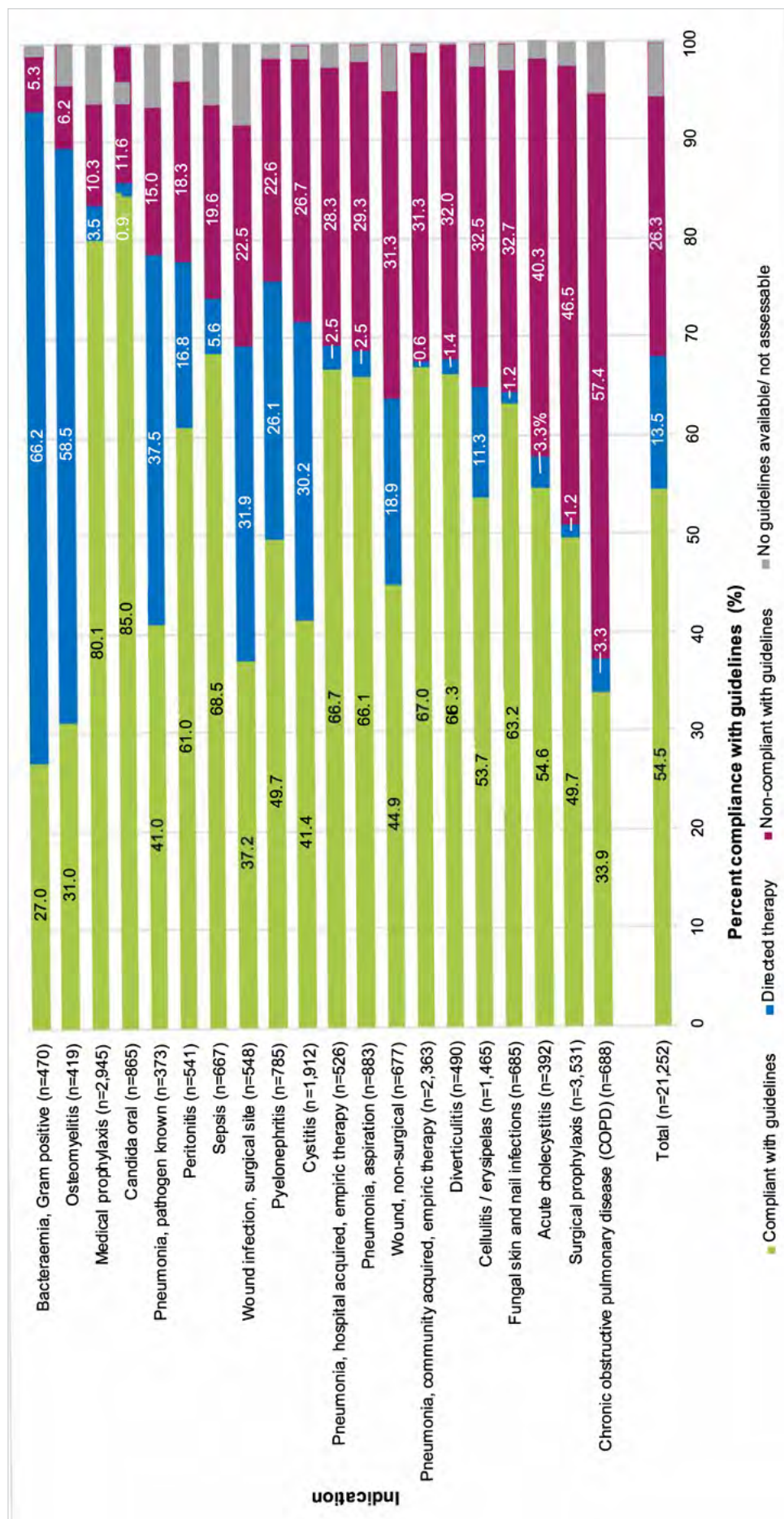
* Excludes prescriptions where the indication for prescribing was unknown (n=564).

Indications with the highest rates of non-compliance were COPD, surgical prophylaxis and acute cholecystitis (Figure 15). Both COPD and surgical prophylaxis have consistently remained areas of high non-compliance; not surprisingly, these were also the indications with the highest rates of inappropriateness (Figure 14). These findings have remained consistent across many years of NAPS surveys despite the existence of clear national guidelines and a substantial revision to the antimicrobial recommendations in the Therapeutic Guidelines in 2019. This suggests there is still considerable work to be done in supporting and educating prescribers in good antimicrobial prescribing. It is also possible that the continued impact of COVID-19 meant that many hospital stewardship services did not have the resources to implement education initiatives on the new guidelines for the relevant medical teams.

In previous years, the treatment of wound infections (both surgical and non-surgical) had consistently high rates of non-compliance with guidelines. Whilst the rates of non-compliance are still relatively high, prescribing for these conditions appears to have slightly improved in 2021 compared with 2020 and therefore did not feature as prominently as in previous years (surgical site wound infections: 22.5% non-compliant in 2021 compared with 26.2% in 2020; non-surgical wound infections: 31.3% non-compliant in 2021 compared with 34.5% in 2020).

Conditions where prescribing is often guided by microbiology and susceptibility results, such as bacteraemia and osteomyelitis, had high rates of being categorised as directed therapy and had correspondingly high levels of appropriateness. Similarly, other indications with well-implemented protocols and guidelines, such as medical prophylaxis, were also more likely to be assessed as appropriate.

3.8. Impact of COVID-19 on 2021 Hospital NAPS

The global pandemic of COVID-19, caused by the novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), significantly impacted on human health and the daily life of people across the world. Although there was limited community transmission in Australia compared to other parts of the world, COVID-19 continued to significantly impact on the Australian healthcare system both directly and indirectly in 2021.

The strain on the healthcare workforce caused by COVID-19 in 2020 may have continued in 2021 and therefore impacted on the resources available to conduct the Hospital NAPS and also to implement AMS quality initiatives. Nonetheless, the overall number of facilities participating in the Hospital NAPS remained steady compared with 2020, and there was even a slight increase compared with pre-pandemic 2019 (Figure 1). Victoria had the most stringent and most prolonged lockdown of any state or territory in Australia, with a total of 113 days in lockdown, primarily between July and October 2021. However, this does not appear to have had an impact on participation, as there was an increase in participation of Victorian hospitals (124 compared with 113 in 2020).

4. Implications for clinical practice

4.1. Documentation

Accurate documentation of an antimicrobial's indication and review or stop date is a vital AMS measure to ensure that all clinicians treating the patient clearly understand the reasons for the antimicrobial and when it should be reassessed or ceased. Encouragingly, there was continued improvement in these 2 key performance indicators. Whilst there is still some work to be done before the best practice target of 95% documentation is reached, this improvement is nonetheless to be commended and demonstrates the positive impact of having nationally endorsed AMS standards as well as the NAPS program itself.

It is expected that the continued adoption of electronic medication management systems across many Australian hospitals will help to improve documentation into the future. These systems can be configured to require clinicians to document the indication and a review or stop date at the point of prescribing.

4.2. Clinical areas for improvement

Five key antimicrobials – cefazolin, ceftriaxone, amoxicillin–clavulanic acid, cefalexin and metronidazole – have been the most commonly prescribed and most inappropriately prescribed agents across many survey years. These agents have been closely coupled with the most common indications seen and their reasons for inappropriateness.

There were higher rates of guideline non-compliance and inappropriateness observed for respiratory tract infections (particularly COPD and community-acquired pneumonia), surgical prophylaxis, wound infections and acute cholecystitis.

These clinical areas have been consistently identified in all previous years' NAPS reports. The revised antimicrobial guidelines in the Therapeutic Guidelines released in 2019 considerably expanded recommendations in these areas. Nonetheless, it takes time for new guidelines to disseminate through hospitals and for practice change to occur. It is possible that, due to the COVID-19 pandemic's impact on hospital staffing, hospitals may not have had the resources required to implement quality initiatives based on these recommendations. Nonetheless, there have been improvements in compliance and appropriateness since the initial dip in 2019. We will await the results of future surveys to further analyse these trends.

4.3. Updated clinical care standards

The new version of the Antimicrobial Stewardship Clinical Care Standard (CCS) was released in mid-2020 with expanded indicators in several of the problem areas identified in previous NAPS: documentation of indication and review or stop date, surgical prophylaxis measures such as guideline compliance, dosage and prolonged therapy, adverse drug reactions, and antimicrobial review at 48 hours.[3]

Given that the CCS is now a key requirement in hospital accreditation standards, the NAPS will be updated in 2022 to explicitly incorporate the CCS indicators as part of the survey data collection fields.

5. Conclusion

Despite the ongoing challenges arising from the COVID-19 pandemic, participation in the Hospital NAPS across public and private hospitals remained high in 2021. The results showed some improvements in several key indicators such as documentation of indication and compliance with the Therapeutic Guidelines, as well as ongoing themes of poor prescribing in areas such as surgical prophylaxis, respiratory tract infections and wound infections. Additionally, higher inappropriateness was observed for frequently prescribed antimicrobials such as cefalexin, amoxicillin–clavulanic acid and ceftriaxone.

Whilst overall appropriateness of prescribing has remained steady for several years, in-depth analysis of the peer groups shows that appropriateness is improving across most public hospital peer groups. Whilst appropriateness remains lower in private hospitals, there was an observed improvement in 2021 compared with 2020 in the large private hospital peer groups. This improvement is expected to continue into the future as more private hospitals participate and their antimicrobial stewardship programs mature and become embedded into practice.

There have been some recent expansions in national guidelines and quality standards, particularly the expanded antimicrobial recommendations in the Therapeutic Guidelines and expanded indicators in the Antimicrobial Stewardship CCS. Many of these updates directly address problem areas identified in previous NAPS. We will await the results of future surveys to determine longer term impact.

Appendix 1: Results

Figure 1A: Public and private hospital participation in Hospital NAPS by peer group classification, 2015–2021
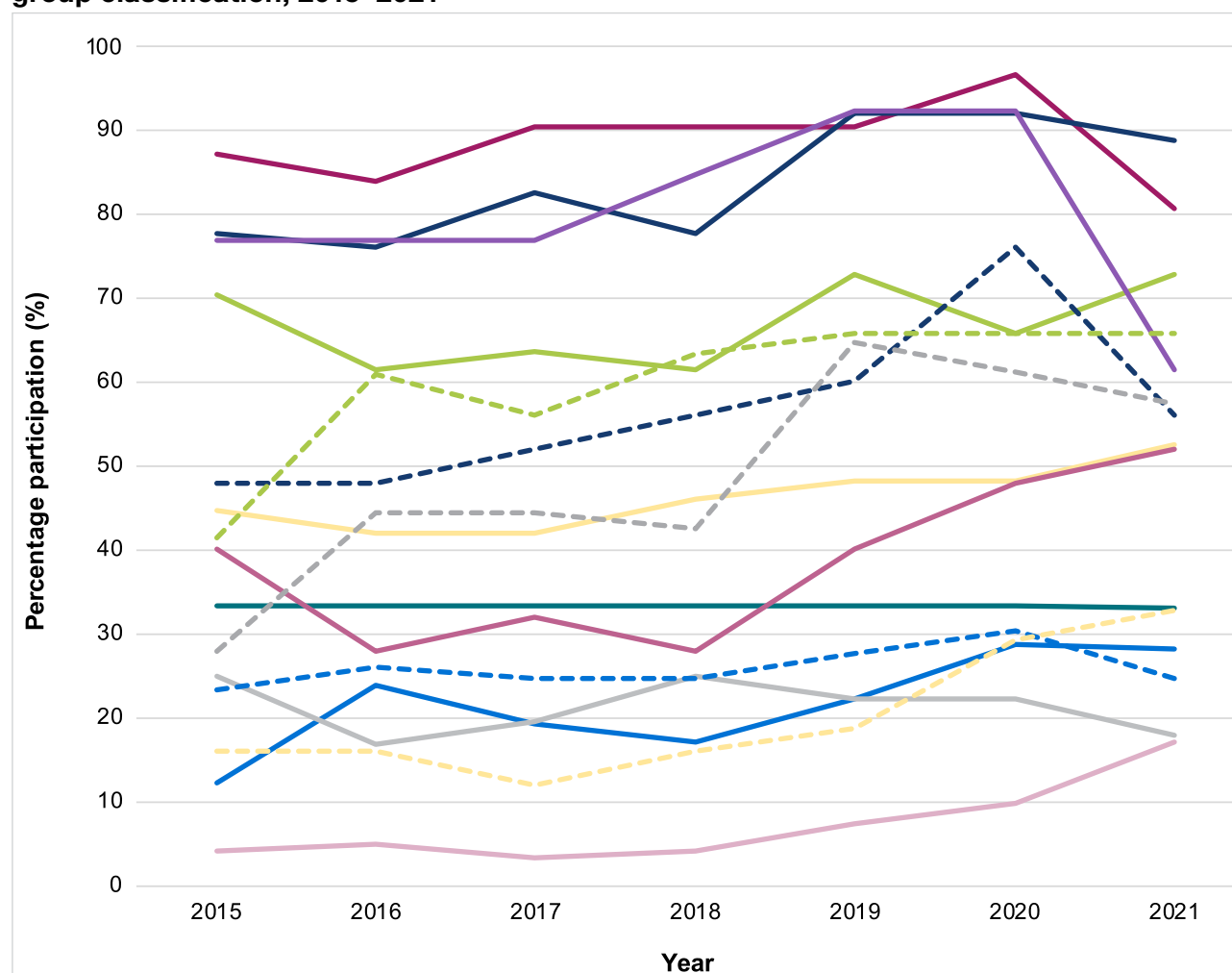
* This category includes public children's hospitals, women's hospitals, and women's and children's hospitals.

† 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.

Public hospitals

— Principal referral
— Public acute group A hospitals
— Public acute group B hospitals
— Public acute group C hospitals
— Public acute group D hospitals
— Other acute specialised hospitals
— Women's and children's hospitals*
— Mixed subacute and non-acute hospitals
— Very small hospitals
— Other public hospitals†

Private hospitals

--- Private acute group A hospitals
--- Private acute group B hospitals
--- Private acute group C hospitals
--- Private acute group D hospitals
--- Other private hospitals§

Table 1A: Public and private hospitals that contributed to Hospital NAPS by state, territory and remoteness area, 2021

	Funding type	Number of participating hospitals (No.)	Number of hospitals in reporting group^* (No.)	Participation (%)	Number of participating hospitals (No.)	Number of hospitals in reporting group^* (No.)	Representative participation (%)
State or territory							
ACT	Public	2	2	100.0	4	6	66.7
	Private	2	4	50.0			
NSW	Public	116	213	54.5	153	306	50.0
	Private	37	93	39.8			
NT	Public	4	5	80.0	5	6	83.3
	Private	1	1	100.0			
Qld	Public	37	122	30.3	52	181	28.7
	Private	15	59	25.4			
SA	Public	26	77	33.8	30	106	28.3
	Private	4	29	13.8			
Tas	Public	4	23	17.4	6	29	20.7
	Private	2	6	33.3			
Vic	Public	80	144	55.6	124	220	56.4
	Private	44	76	57.9			
WA	Public	22	92	23.9	33	112	29.5
	Private	11	20	55.0			
Remoteness							
Major cities	Public	102	170	60.0	194	389	49.9
	Private	92	219	42.0			
Inner regional	Public	102	190	53.7	121	244	49.6
	Private	19	54	35.2			
Outer regional	Public	74	208	35.6	79	224	35.3
	Private	5	16	31.3			
Remote	Public	11	60	18.3	11	60	18.3
	Private	N/A	N/A	N/A			
Very remote	Public	2	50	4.0	2	50	4.0
	Private	N/A	N/A	N/A			
Total	**Public**	291	678	42.9	407	966	42.1
	Private	116	288	40.3			

^ Numbers represent all eligible hospitals in the AIHW reporting groups for public and private, states and territories, and remoteness classifications.[6,7]

* Excludes early parenting centres, same-day hospitals and outpatient hospitals.

N/A = not applicable.

Table 1B: Public and private hospitals that contributed to the Hospital NAPS by peer group, 2021

		Number of participating hospitals	Number of hospitals in reporting group^*	Participation
		No.	No.	%
Public hospital peer groups*	Principal referral	25	31	80.6
	Public acute group A hospitals	56	63	88.9
	Public acute group B hospitals	32	44	72.7
	Public acute group C hospitals	74	141	52.5
	Public acute group D hospitals	53	188	28.2
	Other acute specialised hospitals	1	3	33.3
	Children's hospitals	3	6	50.0
	Women's and children's hospitals	5	7	71.4
	Mixed subacute and non-acute hospitals	13	25	52.0
	Rehabilitation and GEM hospitals†	5	13	38.5
	Very small hospitals	21	123	17.1
	Psychiatric hospitals	2	23	8.7
	Unpeered	1	9	11.1
Private hospital peer groups§	Private acute group A hospitals	14	25	56.0
	Private acute group B hospitals	27	41	65.9
	Private acute group C hospitals	31	54	57.4
	Private acute group D hospitals	17	69	24.6
	Other acute specialised hospitals	5	18	27.8
	Private rehabilitation hospitals	17	25	68.0
	Private acute psychiatric hospitals	3	30	10.0
	Women's hospitals	1	2	50.0
	Haematology and oncology clinics	1	10	10.0
TOTAL		**407**	**950**	**42.8**

^ Numbers represent all eligible hospitals in the AIHW reporting groups for public and private, states and territories, and remoteness classifications.[6,7]

* Excludes early parenting centres, same-day hospitals and outpatient hospitals.

† GEM = geriatric evaluation and management.

§ Excludes ineligible private hospitals.

Table 1C: Hospital NAPS key indicator results, by state and territory, remoteness area and AIHW peer group^, 2021

		Number of participating hospitals (No.)	Percentage of participating hospitals (%)	Number of prescriptions (No.)	Percentage of all prescriptions (%)	Indication documented (%)	Review or stop date documented (%)	Surgical prophylaxis >24 hours (%*)
State or territory	ACT	4	1.0	548	1.9	77.0	32.1	57.5
	NSW	153	37.6	10,171	34.7	88.0	51.0	45.9
	NT	5	1.2	517	1.8	93.8	58.0	46.2
	Qld	52	12.8	4,332	14.8	87.1	46.3	29.1
	SA	30	7.4	1,885	6.4	77.6	46.9	19.2
	Tas	6	1.5	507	1.7	79.1	45.8	25.4
	Vic	124	30.5	8,217	28.0	86.1	55.9	31.6
	WA	33	8.1	3,128	10.7	81.9	48.2	25.0
Remoteness	Major cities	194	47.7	19,068	65.1	84.9	53.0	34.3
	Inner regional	121	29.7	6,238	21.3	86.5	48.1	34.2
	Outer regional	79	19.4	3,370	11.5	88.6	44.6	42.6
	Remote	11	2.7	479	1.6	86.9	41.1	16.7
	Very remote	2	0.5	150	0.5	97.3	56.7	12.5
Public hospital peer group	Principal referral	25	6.1	7,370	25.1	91.0	48.9	37.5
	Public acute group A hospitals	56	13.8	6,872	23.4	89.8	48.4	36.9
	Public acute group B hospitals	32	7.9	2,074	7.1	88.4	50.3	47.0
	Public acute group C hospitals	74	18.2	3,794	12.9	87.9	49.1	30.1
	Public acute group D hospitals	53	13.0	1,344	4.6	87.9	38.1	100.0
	Other acute specialised hospitals	1	0.2	134	0.5	98.5	33.6	75.0
	Children's hospitals	3	0.7	346	1.2	80.1	43.4	60.0
	Women's and children's hospitals	5	1.2	144	0.5	97.2	38.9	21.1
	Women's hospitals	4	1.0	247	0.8	96.4	85.4	19.3
	Mixed subacute and non-acute hospitals	13	3.2	436	1.5	94.7	78.0	66.7
	Rehabilitation and GEM hospitals†	5	1.2	162	0.6	98.8	67.3	66.7
	Very small hospitals	21	5.2	270	0.9	92.6	65.9	0.0
	Psychiatric hospitals	2	0.5	318	1.1	93.1	58.5	100.0
	Unpeered hospitals	1	0.2	32	0.1	68.8	56.3	N/A

Private hospital peer group	Private acute group A hospitals	14	3.4	1,707	5.8	73.6	58.1	29.9
	Private acute group B hospitals	27	6.6	1,541	5.3	63.6	51.7	37.4
	Private acute group C hospitals	31	7.6	1,147	3.9	66.9	58.6	31.9
	Private acute group D hospitals	17	4.2	584	2.0	64.0	53.9	27.8
	Other acute specialised hospitals	5	1.2	225	0.8	56.9	50.7	25.2
	Private rehabilitation hospitals	17	4.2	414	1.4	81.2	60.9	92.9
	Private acute psychiatric hospitals	3	0.7	56	0.2	80.4	53.6	N/A
	Women's hospitals§	1	0.2	22	0.1	–	–	–
	Haematology and oncology clinics§	1	0.2	66	0.2	95.5	81.8	0.0
Funding type	Public	291	71.5	23,543	80.3	89.9	56.3	37.4
	Private	116	28.5	5,762	19.7	68.9	49.5	32.5
Combined national result		**407**	**100**	**29,305**	**100**	**85.7**	**50.8**	**34.5**

^ Categorised according to the AIHW reporting groups for public and private, states and territories, and remoteness classifications.[6,7]

* Where surgical prophylaxis was selected as the indication (n=3,531 in 2021).

† GEM = geriatric evaluation and management.

§ Results are not displayed if there are fewer than 30 prescriptions.

N/A = not applicable.

Table 1D: Compliance with guidelines and prescription appropriateness in Hospital NAPS contributors, by state and territory, remoteness area and AIHW peer group^, 2021

		Compliance with guidelines§ (%)					Appropriateness (%)		
		Compliant	Non-compliant	Directed therapy	Not available	Not assessable	Appropriate	Inappropriate	Not assessable
State or territory	ACT	52.4	24.8	14.6	4.6	3.7	75.6	20.6	3.8
	NSW	52.2	27.1	16.3	1.8	2.6	73.6	23.4	3.1
	NT	64.6	18.2	14.9	1.6	0.8	85.3	13.2	1.6
	Qld	59.1	23.3	12.4	3.0	2.3	76.1	20.6	3.3
	SA	57.9	25.8	12.2	2.2	1.9	79.8	16.8	3.4
	Tas	50.1	29.2	10.1	6.1	4.5	73.0	21.5	5.5
	Vic	54.7	28.2	9.7	3.8	3.5	72.0	23.5	4.5
	WA	52.8	23.9	17.3	3.2	2.9	76.7	20.0	3.4
Remoteness	Major cities	54.0	25.1	14.5	3.4	3.1	74.3	22.0	3.7
	Inner regional	55.4	28.4	11.0	2.3	3.0	74.2	21.8	4.0
	Outer regional	55.6	28.0	13.5	1.4	1.5	75.4	22.0	2.6
	Remote	55.7	32.2	10.4	0.6	1.0	74.3	24.2	1.5
	Very remote	64.7	22.0	10.7	0.0	2.7	86.0	13.3	0.7
Public hospital peer group	Principal referral	54.0	20.8	19.0	4.0	2.2	78.5	18.9	2.6
	Public acute group A hospitals	54.9	25.6	13.8	3.1	2.6	75.7	21.2	3.1
	Public acute group B hospitals	50.3	30.3	13.2	2.8	3.4	72.0	24.8	3.2
	Public acute group C hospitals	57.0	28.7	11.2	0.9	2.2	75.1	22.2	2.7
	Public acute group D hospitals	49.9	36.8	11.0	0.5	1.9	69.6	27.2	3.1
	Other acute specialised hospitals	86.6	7.5	4.5	1.5	0.0	91.0	9.0	0.0
	Children's hospitals	71.7	12.4	5.2	10.1	0.6	85.8	13.0	1.2
	Women's and children's hospitals	73.6	4.9	9.7	7.6	4.2	89.6	6.9	3.5
	Women's hospitals	84.2	10.9	3.2	1.2	0.4	89.1	10.1	0.8
	Mixed subacute and non-acute hospitals	48.6	25.7	17.9	3.7	4.1	74.5	21.1	4.4
	Rehabilitation and GEM hospitals*	54.3	17.9	20.4	3.7	3.7	81.5	14.2	4.3
	Very small hospitals	58.9	32.2	7.0	0.0	1.9	70.0	27.4	2.6
	Psychiatric hospitals	60.4	34.0	0.6	2.2	2.8	79.9	16.7	3.5
	Unpeered hospitals	56.3	6.3	25.0	0.0	12.5	84.4	3.1	12.5

	Private acute group A hospitals	45.9	33.6	13.4	3.6	3.5	66.9	27.7	5.5
	Private acute group B hospitals	50.7	31.9	10.1	2.9	4.5	66.8	27.1	6.1
	Private acute group C hospitals	51.6	34.4	7.5	1.8	4.6	62.4	29.7	7.9
Private Hospital peer group	Private acute group D hospitals	65.6	22.1	5.7	0.7	6.0	68.2	24.8	7.0
	Other acute specialised hospitals	78.7	20.4	0.9	0.0	0.0	78.2	21.8	0.0
	Private rehabilitation hospitals	51.2	22.2	16.2	2.4	8.0	70.3	19.1	10.6
	Private acute psychiatric hospitals	51.8	26.8	10.7	1.8	8.9	75.0	14.3	10.7
	Women's hospitals†	–	–	–	–	–	–	–	–
	Haematology and oncology clinics	57.6	24.2	10.6	0.0	7.6	75.8	16.7	7.6
Funding type	Public	55.1	25.2	14.4	2.9	2.4	76.3	20.8	2.9
	Private	52.3	30.6	10.2	2.5	4.5	67.0	26.5	6.5
Combined national result		**54.5**	**26.3**	**13.5**	**2.8**	**2.8**	**74.5**	**22.0**	**3.6**

^ Categorised according to the AIHW reporting groups for public and private, states and territories, and remoteness classifications.[6,7]

* GEM = geriatric evaluation and management.

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

§ Compliance with guidelines: aggregate of 'Compliant with Therapeutic Guidelines' and 'Compliant with locally endorsed guidelines'.

Table 1E: Hospital NAPS compliance with guidelines and prescription appropriateness, for all antimicrobial prescriptions, 2015–2021

Key indicator			Percentage of total prescriptions (%)						
		2015	2016	2017	2018	2019	2020	2021
Compliance with guidelines	Compliant with Therapeutic Guidelines	45.2	42.4	44.8	44.2	42.3	44.8	46.1
	Compliant with local guidelines	10.4	9.7	9.3	9.5	9.8	8.9	8.4
	Non-compliant	23.8	26.9	26.2	25.7	27.5	26.3	26.3
	Directed therapy	12	12.7	12.5	13.7	13.7	13.2	13.5
	No guideline available	3.7	4	3.3	3.6	3.4	3.4	2.8
	Not assessable	4.9	4.4	3.8	3.4	3.4	3.3	2.8
Appropriateness	Optimal	54.5	56.6	58.1	60	58.8	59.3	59.9
	Adequate	17.8	15.6	14.9	14.8	14.1	14.7	14.6
	Suboptimal	12.3	11.3	12.2	11.9	13	12.2	12.2
	Inadequate	10	11.2	10.2	9.5	10.3	9.8	9.8
	Not assessable	5.4	5.3	4.7	3.8	3.8	4	3.6

Appendix 2: Data collection form

HOSPITAL NAPS — National Antimicrobial Prescribing Survey

GUIDANCE | NCAS

Audit date / /

Patient identification number

Date of birth / age / /

Gender M / F / O

Specialty ☐ currently in ICU / NICU

Ward

Weight kg

eGFR / CrCl ml/min

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)
/ /																			
/ /																			
/ /																			
/ /																			
/ /																			

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

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

*Select Therapeutic Guidelines if local guidelines are the same

Microbiology ☐ not collected / not assessable
☐ collected; record the specimen type, organism and susceptibilities if relevant

Allergies and adverse drug reactions to antimicrobials
☐ nil known   ☐ not documented
☐ present; record the antimicrobial and the nature of the reaction

Surgical procedure if performed
If prophylaxis given within previous 24 hours; include in audit

Clinical notes or comments
☐ Renal replacement therapy given within the previous 24 hours; eg. dialysis

Appendix 3: Appropriateness definitions

Hospital NAPS appropriateness definitions

NCAS | GUIDANCE

		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)	
Not assessable	5	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

Appendix 4: Compliance with guidelines assessment criteria

Compliance with guidelines (only choose <u>one</u> of the following five criteria)

Compliant with Therapeutic Guidelines[1]	• The prescription complies with the current Therapeutic Guidelines[1], including: 　○ *route, dose, frequency* 　**AND** 　○ *takes into account acceptable alterations due to age, weight, renal function, allergies, other prescribed medications etc.*
Compliant with locally endorsed guidelines[2]	• The prescription complies with an officially endorsed local guideline, including: 　○ *route, dose, frequency* 　**AND** 　○ *takes into account acceptable alterations due to age, weight, renal function, allergies, other prescribed medications etc.* • This does not include individual, departmental, or historical guidelines that do not have executive or drug and therapeutic committee approval • If the local guidelines are based exactly on the Therapeutic Guidelines[1], then choose the '*Therapeutic Guidelines*' in preference to '*Local guidelines*'
Non-compliant with guidelines	• There is non-compliance with both Therapeutic Guidelines[1] and local guidelines. 　**UNLESS** 　*the prescription takes into account acceptable alterations due to age, weight, renal function, allergies, other prescribed medications etc.*
Directed therapy	• The prescription has changed from empiric to directed therapy with microbiology culture or susceptibility results available
No guidelines available	• There are no guidelines available for the documented or presumed indication
Not assessable	• The medical records are not comprehensive enough to determine a documented or presumed indication 　**OR** • It is difficult to assess if there is compliance

1. Antibiotic Expert Group. Therapeutic Guidelines: Antibiotic. Version 16 (2019). Melbourne http://online.tg.org.au/ip/

2. Local guidelines must be authorised and readily available on wards or on the hospital intranet. They cannot be a web link to international guidelines or other non-approved sites. Exceptions include paediatric and neonatal guidelines from an Australian children's hospital and links to other official guidelines within a hospital's network.

Appendix 5: Access, Review, Curb and Contain (ARCC) classification system

Figure 5A: ARCC classification for first-line recommended agents[9]

Criteria		First-line treatment for common infections*	
		Yes	No
Final Risk Review	Low	Access	Access
	Medium	Review: Curb	Review: Curb
	High	Review: Curb	Review: Contain

*Excludes first-line recommended treatments for allergy and agents used for prophylaxis

Figure 5B: Priority Antibacterial List based on ARCC classification[9]

Access	Review	
	Curb	Contain
amoxicillin	amoxicillin–clavulanic acid	amikacin
ampicillin	azithromycin	aztreonam
benzathine benzylpenicillin	cefaclor	cefepime
benzylpenicilli	cefalexin	ceftaroline
chloramphenicol	cefalotin	ceftazidime
dicloxacillin	cefazolin	ceftazidime–avibactam
doxycycline	cefotaxime	ceftolozane–tazobactam
flucloxacillin	cefoxitin	colistin
gentamicin	ceftriaxone	daptomycin
metronidazole	cefuroxime	doripenem
minocycline	clarithromycin	ertapenem
nitrofurantoin	ciprofloxacin	fosfomycin
phenoxymethylpenicillin	clindamycin	imipenem–cilastatin
procaine benzylpenicillin	erythromycin	linezolid
streptomycin	fidaxomicin	meropenem
sulfamethoxazole–trimethoprim	lincomycin	moxifloxacin
tetracycline	norfloxacin	pivmecillinam
tinidazole	piperacillin-tazobactam	polymyxin b
tobramycin	rifampicin	pristinamycin
trimethoprim	rifaximin	tigecycline
	roxithromycin	
	sodium fusidate	
	spiramycin	
	teicoplanin	
	vancomycin	

Appendix 6: List of abbreviations

Abbreviation	Definition
ACSQHC	Australian Commission on Safety and Quality in Health Care
AIHW	Australian Institute of Health and Welfare
AMS	Antimicrobial stewardship
ARCC	Access, Review, Curb and Contain
AURA	Antimicrobial Use and Resistance in Australia
CCS	Clinical Care Standard
COPD	Chronic Obstructive Pulmonary Disease
COVID-19	Coronavirus-19
GEM	Geriatric evaluation and management
NAPS	National Antimicrobial Prescribing Survey
NCAS	National Centre for Antimicrobial Stewardship
NSQHS	National Safety and Quality Health Service

Acknowledgements

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2. Department of Health and Aged Care. Antimicrobial Use and Resistance in Australia Surveillance System. Available from: Surveillance of antimicrobial use and resistance in human health | Antimicrobial resistance (amr.gov.au) [accessed May 2022].

3. Australian Commission on Safety and Quality in Health Care. Antimicrobial Stewardship Clinical Care Standard. 2nd ed. Sydney: ACSQHC; 2020.

4. Therapeutic Guidelines. Melbourne: Therapeutic Guidelines Limited. Available from: https://tgldcdp.tg.org.au/etgcomplete [accessed July 2022].

5. Australian Commission on Safety and Quality in Health Care. National Safety and Quality Health Service Standards. 2nd ed. Sydney: ACSQHC; 2017.

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9. Australian Commission on Safety and Quality in Health Care. Priority Antibacterial List for Antimicrobial Resistance Containment: A stewardship resource for human health. Sydney: ACSQHC; 2020. Available from: https://www.safetyandquality.gov.au/sites/default/files/2020-04/priority_antibacterial_list_for_amr_containment_-_mar_2020.pdf [accessed July 2022].

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