AUSTRALIAN COMMISSION ON SAFETY AND QUALITY IN HEALTH CARE

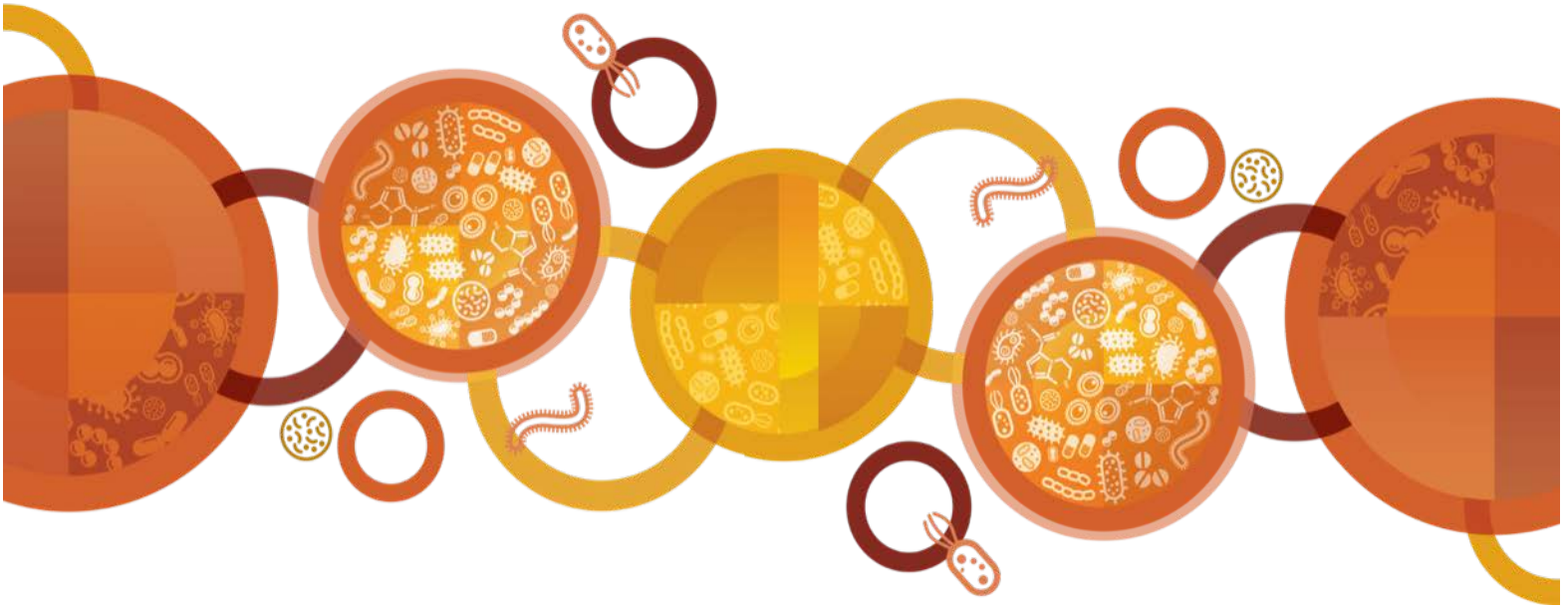
AURA Antimicrobial Use and Resistance in Australia

CARAlert THE NATIONAL ALERT SYSTEM FOR CRITICAL ANTIMICROBIAL RESISTANCE

CARAlert annual report

2019

May 2020



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Contents

Summary

This report provides analyses of data on confirmed critical antimicrobial resistances (CARs) submitted to the National Alert System for Critical Antimicrobial Resistances (CARAlert) for 2019, and trend data for 2017 to 2019.

There was an overall increase of 27% in CARs reported in 2019 compared to 2018 (*n* = 1,501), excluding new CARs introduced in 2019. Carbapenemase-producing Enterobacterales (CPE) are of most concern, because the number of reports and distribution has increased annually since 2016. This CAR poses a significant risk to patient safety, because bacteria that produce carbapenemase enzymes are almost always resistant to other important antibiotic 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.

Following a review of the CARAlert system, four additional CARs were added to CARAlert from July 2019. These were: transferrable resistance to colistin in Enterobacterales, carbapenemase-producing *Acinetobacter baumannii* complex, carbapenemase-producing *Pseudomonas aeruginosa* and *Candida auris*, which is a multidrug-resistant yeast that has caused outbreaks in multiple countries. Very low number of these CARs have been reported to date.

CARAlert is a voluntary reporting system. Timely submission of CAR data by confirming laboratories ensures that states and territories are able to rapidly follow up patients, implement appropriate prevention and control action and ensure that CARs remain low and risks to patients, due to infections that are difficult to treat, are minimised.

National overview of key findings: 2019 compared to 2018

- Carbapenemase-producing Enterobacterales (including those with ribosomal methyltransferase or transmissible colistin resistance) was the most frequently reported CAR (*n* = 877, 44.6%) in 2019, followed by azithromycin non-susceptible (low-level, MIC ≤ 256 mg/L) *Neisseria gonorrhoeae* (*n* = 424, 21.6%)
- The total number of CPE (either alone or in combination with other CARs) reported in 2019, compared to 2018, increased by 37.5% (*n* = 877 versus *n* = 638). There was a three-fold increase in the proportion of CPE from South Australia (5.1%; 45/877) compared to 2018 (1.7%; 11/638), due to an outbreak that has been controlled
- The number of reports of multidrug-resistant *Shigella* species increased by 218% in 2019 (*n* = 331 versus *n* = 104), which is concerning because empirical antimicrobial therapy choices for shigellosis may not be reliable
- There was a decrease in the number of ceftriaxone non-susceptible *Salmonella* species (*n* = 45, down 13.5%)
- There were 21 reports of multidrug-resistant *Mycobacterium tuberculosis*, compared with 27 reports in 2018
- The majority of CARs, excluding those from *N. gonorrhoeae*, were reported from public hospitals (*n* = 970, 71.5%). There were 185 from community settings, 92 from private hospitals, and 41 from aged care homes (22 daptomycin non-susceptible *Staphylococcus aureus*, 17 CPE, one carbapenemase-producing *Acinetobacter baumannii* complex, and one linezolid-resistant *Enterococcus faecium*).

Implications for patient safety

Increases in carbapenemase-producing Enterobacterales in Australian hospitals
Enterobacterales commonly cause urinary tract, biliary tract and other intra-abdominal infections and blood stream infections. Patients are likely to be affected by CPE if they: are hospitalised for a long time; have been hospitalised or had surgery overseas; have had multiple, or recent exposure to different antimicrobial agents, especially cephalosporins, fluoroquinolones and carbapenems; have diabetes mellitus; are on mechanical ventilation; are admitted to the intensive care unit; or

have an indwelling medical device (such as a central venous catheter, urinary catheter or biliary catheter).

In addition to the increase in the total number of CPE reported from 2017 to 2019, there was an increase in the distribution of CPE nationally during this period. More than a third of hospitals that reported CPE in 2019, did so for the first time. Carbapenemase-producing Enterobacterales has also contributed to invasive disease in Australian patients of all ages; in 2019, one in eight reports were from blood specimens. One in six reports (16%) were from settings other than public hospitals.

There was also a steady increase in reports of NDM-type CPE (with or without OXA-48-like), in the absence of documented outbreaks; this requires close monitoring. Carbapenemase types identified in Australia to date primarily include IMP, NDM, OXA48-like and KPC. This list will evolve because of changing local and global epidemiology. Each carbapenemase type has a slightly different spectrum of activity against different antimicrobials.

These increases in reports of CPE highlight the value of active surveillance and the importance of compliance with the *Australian Guidelines for the Prevention and Control of Infection in Healthcare*[1], and use of guidance for specific organisms, such as *Recommendations for the Control of Carbapenemase-Producing Enterobacteriaceae: A guide for acute care health facilities*.[2]

Arrangements for specialist oversight of, and access to restricted antimicrobials, should be considered for all Australian hospitals, along with implementation of systems that meet the antimicrobial stewardship actions of the National Safety and Quality Health Service (NSQHS) Standards.[3]

Changes in community-onset critical antimicrobial resistances

Reports of multidrug-resistant (MDR) *Shigella* species increased by 218% in 2019, compared with 2018 (*n* = 331 versus *n* = 104). Infections caused by *Shigella* species are generally food-borne or sexually transmitted, and are notifiable nationally. In 2019, New South Wales and Victoria reported increases in MDR *Shigella* amongst men who have sex with men. In response to the increase, both states issued public health alerts and implemented changes to management recommendations for shigellosis as part of their prevention and control strategies.[4-6]

The proportion of shigellosis notifications that were MDR increased in all jurisdictions in 2019 compared to 2018, most notably in Victoria, Queensland and the Australian Capital Territory.[7]

Increases in reports of MDR *Shigella* species require consideration of the reliability of empirical antimicrobial therapy recommendations for shigellosis. These increases also require ongoing close review by states and territories as, increasingly, there are limited oral antimicrobial options, and intravenous antimicrobials may be required to treat MDR infections of this type. There may also be additional resource implications for the health system because of increased testing, hospital admissions and transmission in the community. Public health messaging should continue to highlight the risk of sexual transmission of *Shigella* species, particularly through male-to-male sexual contact, and provide guidance on ways to reduce the risk of transmission.

From 2017 to 2019, *Neisseria gonorrhoeae* was the most commonly reported CAR from the community setting. Reports of azithromycin-nonsusceptible *N. gonorrhoeae* (MIC < 256 mg/L) declined in 2019 and there were sporadic reports of ceftriaxone-nonsusceptible and/or azithromycin-nonsusceptible *N. gonorrhoeae* (MIC > 256 mg/L). This decline in azithromycin-nonsusceptible *N. gonorrhoeae* (MIC < 256 mg/L) occurred in the context of continuing annual increases in notifications of gonococcal infections nationally.[7] Although most high MIC reports of this CAR were associated with a primary case related to overseas travel, local transmission may occur due to secondary cases acquired in Australia.[8] Public health messages should include the risk of multidrug-resistant *N. gonorrhoeae* related to travel, and the importance of culture and susceptibility testing to inform treatment decisions.

Aged care homes
In 2019, there were 40 CARs reported from aged care homes; the majority of these (*n* = 22) were daptomycin-nonsusceptible *Staphylococcus aureus*. There were 14 reports of CPE in aged care homes, of which 70% (*n* = 10) were from clinical isolates.

Skin and soft tissue infections are commonly caused by *S. aureus*, which is spread by contact with contaminated surfaces and hands of healthcare workers, which is why environmental cleaning and hand hygiene are so important. *S. aureus* can also be spread by from person to person, especially in group living situations such as aged care homes when people with skin infections may inadvertently share personal things like bed linen, towels, or clothing. In aged care homes, skin and soft tissue infections are the most common reason for antimicrobial prescriptions.[9] In some states and territories, the number of reports of this CAR from aged care homes was higher than, or similar to, reports from public hospitals.

There is a risk of transmission of these CARs within aged care homes, and in hospitals due to the frequent movement of aged care home residents between these two settings.

Control of CPE requires specific infection prevention and control measures, in all care settings, including aged care homes. Compliance with the infection prevention and control requirements of the Aged Care Quality and Safety Standards, which include compliance with national guidelines, will support capacity to control and prevent transmission of CPE in aged care homes.[10] In addition, aged care homes should ensure that they implement policies and practices consistent with specific CPE prevention and control guidance.[2]

Critical antimicrobial resistances in young Australians
The 0-4 year age group accounted for 15.6% (7/45) of all reports of ceftriaxone non-susceptible *Salmonella* species, 4.2% of multidrug-resistant S*higella* (14/331) and 3.9% of all CPE (34/868). The long-term impacts of antimicrobial-resistant pathogens in children are unknown; expert opinion suggests that clearance of many CARs cannot be assured.[11] In addition, antimicrobial exposure in early childhood has been associated with a variety of health risks.[12-14]

Emerging critical antimicrobial resistances
Reports of linezolid non-susceptible *Enterococcus* species increased by 50% from 2018 to 2019 (*n* = 21 versus *n* = 14); there were only five reports of this CAR in 2017. *Enterococcus* species commonly cause urinary tract, biliary tract and other intra-abdominal infections and blood stream infections. This CAR, in addition to CPE, has the potential to become a significant problem in the future, if it is not prevented and controlled. Australia has a very high reported rate of vancomycin-resistant *E. faecium* compared with European countries.[15] Resistance in enterococci, similar to some CPE and other Enterobacterales, is transmitted in hospital environments from patients' bowel flora.

Increasing health service demands and complexity
Data reported to the Antimicrobial Use and Resistance in Australia (AURA) Surveillance System signal implications for health service as a result of antimicrobial resistance (AMR). Increases in last-line antimicrobial use was seen in all peer group hospitals in 2018[16], which may be associated with treatment of CARs.

Critical antimicrobial resistances increase hospital length of stay, deaths and health service resource needs. Estimates of the impacts of AMR vary by organism, and are not available for the majority of CARs. Recent estimates of the impact of CPE include an additional 29 inpatient days, compared to non-CPE cases, after the isolation of the organism.[17] Patients with multidrug-resistant infections were also less likely to receive appropriate antimicrobial therapy initially.[17] For VRE, when it first emerged, estimated increases per case were 61.9% for hospital costs and an additional 13.8 days length of stay.[18]

What will be done to improve patient safety?
In response to the issues identified in analyses of CARAlert data from 2017 to 2019, the Commission will continue to:

- Maintain CARAlert and review CARs reported to CARAlert in collaboration with states, territories, the Australian Government Department of Health and relevant experts
- Liaise directly with states and territories and clinical stakeholders regarding specific CARs reported to CARAlert
- Ensure compliance with the *Australian Guidelines for the Prevention and Control of Infection in Healthcare*[1] as required by the NSQHS Preventing and Controlling Healthcare-Associated Infection Standard
- Develop guidance for specific organisms, which complements the *Australian Guidelines for the Prevention and Control of Infection in Healthcare*[1], such as such as the *Recommendations for the Control of Carbapenemase-Producing Enterobacteriaceae: A guide for acute care health facilities*[2]
- Liaise with the Aged Care Quality and Safety Commission and aged care provider organisations regarding the importance of infection prevention and control in aged care homes, consistent with the mandatory Aged Care Quality Standards, and specific considerations for the response to CPE and other CARs
- Promote implementation of systems that meet the antimicrobial stewardship actions of the NSQHS Standards
- Support collaboration between states and territories and hospital and community care settings to prevent and control CARs.

Results from CARAlert, 2019

Between 1 January 2019 and December 2019, a total of 1,965 CARs from 78 originating laboratories across Australia were entered into CARAlert by 23 confirming laboratories (Table 1). There was an average of 164 entries per month.

Critical antimicrobial resistances by state and territory

Most CARs were collected from patients who lived in the most populous states (New South Wales, 33%; Victoria, 38%; and Queensland (17%). There were five reports from Tasmania, and fewer than 35 reports from the Australian Capital Territory (Table 1).

CPE (including those with ribosomal methyltransferase or transmissible resistance to colistin) were the most frequently reported CAR (44.6%) in 2019. Overall, there was a 37% increase in reports of CPE in 2019; the greatest increase was seen in South Australia (*n* = 11 in 2018; *n* = 45 in 2019); CPE reports declined by over 40% in both Western Australia and the Australian Capital Territory.

In 2019, the number of azithromycin-nonsusceptible *N. gonorrhoeae* (low-level) reports declined by 18%. The decline was seen in all states and territories except Western Australia, where there was a 33% increase (*n* = 12 in 2018; *n* = 16 in 2019).

Reports of daptomycin-nonsusceptible *S. aureus* increased 32% in 2019. The greatest increase was in Queensland (*n* = 15 in 2018; *n* = 42 in 2019).

Reports of multidrug-resistant *Shigella* species increased by 218% from 2018 to 2019. The increase occurred in all states and territories when reported. The most notable increases were in Queensland (*n* = 18 in 2018; *n* = 65 in 2019), Victoria (*n* = 54 in 2018; *n* = 187 in 2019), New South Wales (*n* = 24 in 2018; *n* = 58 in 2019), and the Australian Capital Territory (*n* = 1 in 2018; *n* = 7 in 2019).

There were very few reports of the four new CARs introduced in 2019. Carbapenemase-producing *Acinetobacter baumannii* complex were predominantly reported from Victoria; and carbapenemase-producing *Pseudomonas aeruginosa* were predominantly from New South Wales. *Candida auris* was reported from New South Wales (n = 2) and Western Australia (n = 1). Enterobacterales with transmissible resistance to colistin, other than in association with CPE, were reported from New South Wales (n = 2) and Victoria (n = 1).

Table 1: Number of critical antimicrobial resistances, by state and territory, 2019, and 2018

Species	Critical resistance	State or Territory								Year		
		NSW	Vic	Qld	SA	WA	Tas	NT	ACT	2018	2019	Relative change*
Acinetobacter baumannii complex	Carbapenemase-producing[†]	2	24	2	0	4	0	0	0	–	32	–
Candida auris	–[†]	2	0	0	0	1	0	0	0	–	3	–
Enterobacterales	Carbapenemase-producing (alone or in combination with other CARS)	304	301	182	45	26	3	7	9	638	877	▲ 37.5%
	Carbapenemase-producing	271	262	176	43	25	3	7	9	606	796	▲ 31.4%
	Carbapenemase and ribosomal methyltransferase-producing	12	24	1	2	1	0	0	0	32	40	▲ 25.0%
	Carbapenemase-producing and transmissible colistin resistance[†]	21	15	5	0	0	0	0	0	–	41	–
	Ribosomal methyltransferase-producing	2	4	1	0	1	0	0	0	10	8	▼ 20.0%
	Transmissible colistin resistance[† §]	2	1	0	0	0	0	0	0	–	3	–
Enterococcus species	Linezolid non-susceptible	2	4	1	4	8	1	0	1	14	21	▲ 50.0%
Mycobacterium tuberculosis	Multidrug-resistant – at least rifampicin- and isoniazid-resistant strains	10	4	2	1	2	0	1	1	27	21	▼ 22.2%
Neisseria gonorrhoeae	Azithromycin non-susceptible (low-level)	208	156	31	0	16	0	1	12	518	424	▼ 18.1%
	Azithromycin non-susceptible (high-level)	2	1	2	0	1	1	0	0	7	7	— 0.0%
	Ceftriaxone non-susceptible	1	2	0	0	1	0	0	0	3	4	▲ 33.3%
	Ceftriaxone non-susceptible and azithromycin non-susceptible (low-level)	0	0	0	0	0	0	0	0	1	0	▼ 100%
	Ceftriaxone non-susceptible and azithromycin non-susceptible (high-level)	0	0	0	0	0	0	0	0	2	0	▼ 100%

continued

Table 1: *continued*

Species	Critical resistance	State or Territory								Year		
		NSW	Vic	Qld	SA	WA	Tas	NT	ACT	2018	2019	Relative change*
Pseudomonas aeruginosa	Carbapenemase-producing†	18	7	1	1	1	0	0	0	–	28	–
Salmonella species	Ceftriaxone non-susceptible	18	2	12	3	9	0	1	0	52	45	▼ 13.5%
Shigella species	Multidrug-resistant	58	187	65	6	7	0	1	7	104	331	▲ 218%
Staphylococcus aureus	Daptomycin non-susceptible	27	53	42	0	35	0	0	4	122	161	▲ 32.0%
	Daptomycin and vancomycin non-susceptible	0	0	0	0	0	0	0	0	1	0	▼ 100%
	Linezolid non-susceptible	0	0	0	0	0	0	0	0	2	0	▼ 100%
	Vancomycin non-susceptible	0	0	0	0	0	0	0	0	0	0	–
Streptococcus pyogenes	Penicillin reduced susceptibility	0	0	0	0	0	0	0	0	0	0	–
	Total (reported by 31 January 2020)	**656**	**746**	**341**	**60**	**112**	**5**	**11**	**34**	**1,501**	**1,965**	**▲ 30.9%**
											1,899#	**▲ 26.5%**

High-level = azithromycin MIC > 256 mg/L; Low-level = azithromycin MIC < 256 mg/L; – = not applicable

* Relative change = absolute change between 2018 and 2019, for each CAR, expressed as a percentage of 2018 base

† New CAR added in July 2019 (retrospective data for 2019 included if available)

§ When not seen in combination with CPE

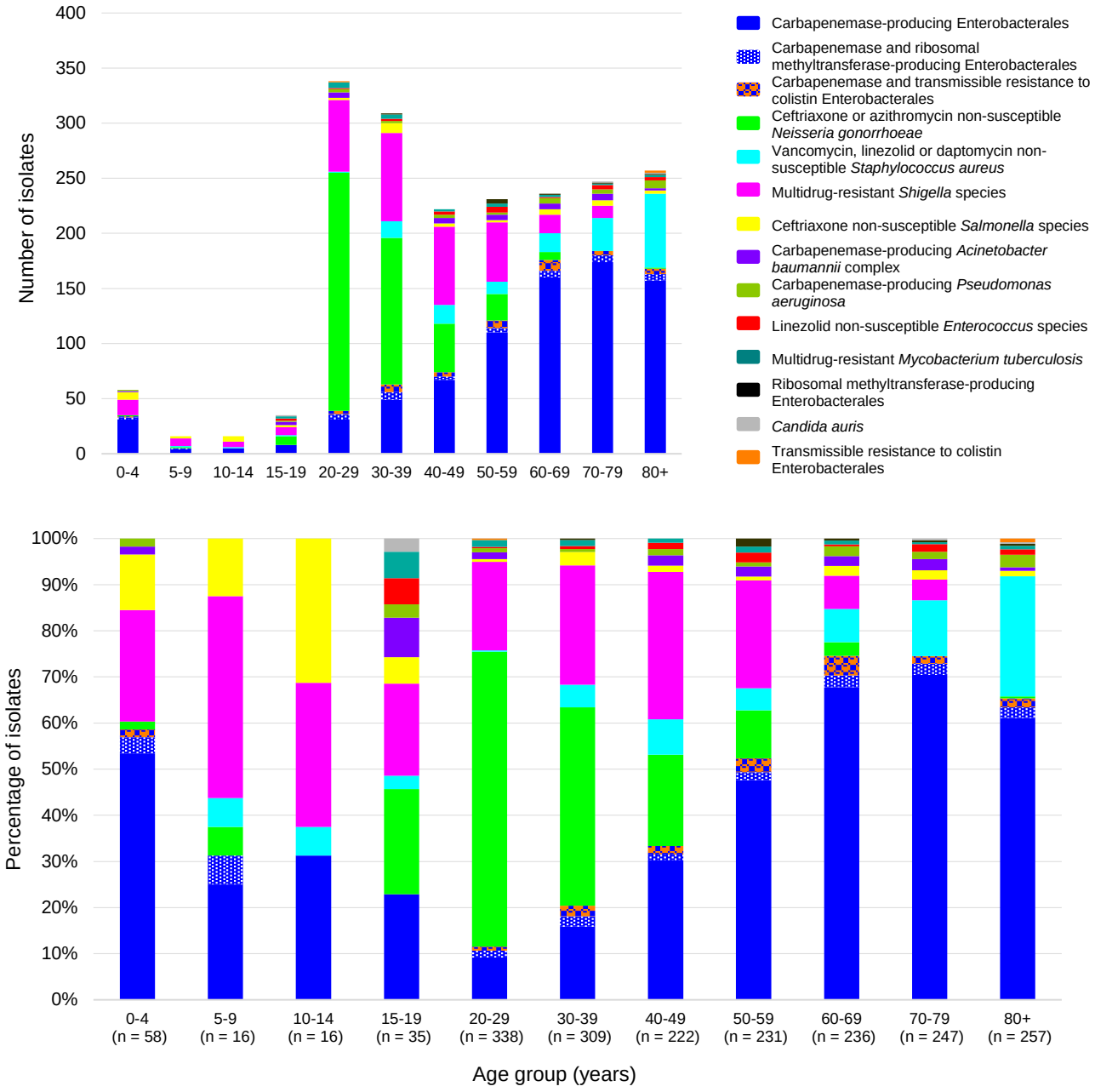
2019 total minus new CARS introduced in 2019

Note: The number of multidrug resistant *Shigella* species for 2019 have been updated to include additional submissions received after previous publication date

Critical antimicrobial resistances by age group

CARs were isolated from patients of all ages; the median age was 50–59 years (Figure 1). Almost three quarters of CPE were isolated from people aged 50 years and older (74%; 641/868). Azithromycin-nonsusceptible *N. gonorrhoeae* was the predominant CAR reported for the age groups 20–29 and 30–39 years. Only 4.6% (90/1,965) of all CARs were reported in children aged less than 15 years; CPE, multidrug-resistant *Shigella* species, and ceftriaxone-nonsusceptible *Salmonella* species were most frequently reported for this age group (89%). For the 0 to 4-year age group, CPE was the most frequently reported CAR (31 reports); followed by multidrug-resistant *Shigella* species (*n* = 14), and ceftriaxone-nonsusceptible *Salmonella* species (*n* = 7).

Figure 1: Critical antimicrobial resistances, by age groups, 2019



Critical antimicrobial resistances by facility type

Excluding azithromycin-nonsusceptible *N. gonorrhoeae*, which is generally isolated in the community, the majority of CARs (1,092/1,318, 83%) were detected in either hospitalised patients or hospital outpatients. Smaller proportions were isolated in the community (185/1,318, 14%) and in aged care homes (41/1,318, 3%) (Table 2).

Table 2: Number of critical antimicrobial resistance isolates, by setting, national, 2019

Species	Critical resistance	Setting					Total
		Public hospital	Private hospital	Aged care home	Community	Unknown	
Acinatobacter baumannii complex	Carbapenemase-producing	26	1	1	4	0	32
Candida auris	–	2	1	0	0	0	3
Enterobacterales	Carbapenemase-producing	644	75	15	41	21	796
	Carbapenemase and ribosomal methyltransferase-producing	36	1	0	2	1	40
	Carbapenemase-producing and transmissible colistin resistance	35	0	2	2	2	41
	Ribosomal methyltransferase-producing	7	0	0	1	0	8
	Transmissible colistin resistance	2	1	0	0	0	3
Enterococcus species	Linezolid non-susceptible	20	0	1	0	0	21
Mycobacterium tuberculosis	Multidrug-resistant – at least rifampicin- and isoniazid-resistant	18	0	0	1	2	21
Neisseria gonorrhoeae	Azithromycin non-susceptible (low-level)	60	0	0	202	162	424
	Azithromycin non-susceptible (high-level)	0	0	0	5	2	7
	Ceftriaxone non-susceptible	0	0	0	4	0	4
	Ceftriaxone non-susceptible and azithromycin non-susceptible (low-level)	0	0	0	0	0	0
	Ceftriaxone non-susceptible and azithromycin non-susceptible (high-level)	0	0	0	0	0	0
Pseudomonas aeruginosa	Carbapenemase-producing	19	2	0	5	2	28
Salmonella species	Ceftriaxone non-susceptible	25	1	0	13	6	45
Shigella species	Multidrug-resistant	78	3	0	84	166	331
Staphylococcus aureus	Daptomycin non-susceptible	89	7	22	32	11	161
	Daptomycin and vancomycin non-susceptible	0	0	0	0	0	0
	Linezolid non-susceptible	0	0	0	0	0	0
	Vancomycin non-susceptible	0	0	0	0	0	0
Streptococcus pyogenes	Penicillin reduced susceptibility	0	0	0	0	0	0
	Total (reported by 31 January 2020)	**1,061**	**92**	**41**	**396**	**375**	**1,965**

* Information on setting for *Neisseria gonorrhoeae* is often not available

High-level = azithromycin MIC > 256 mg/L; Low-level = azithromycin MIC < 256 mg/L

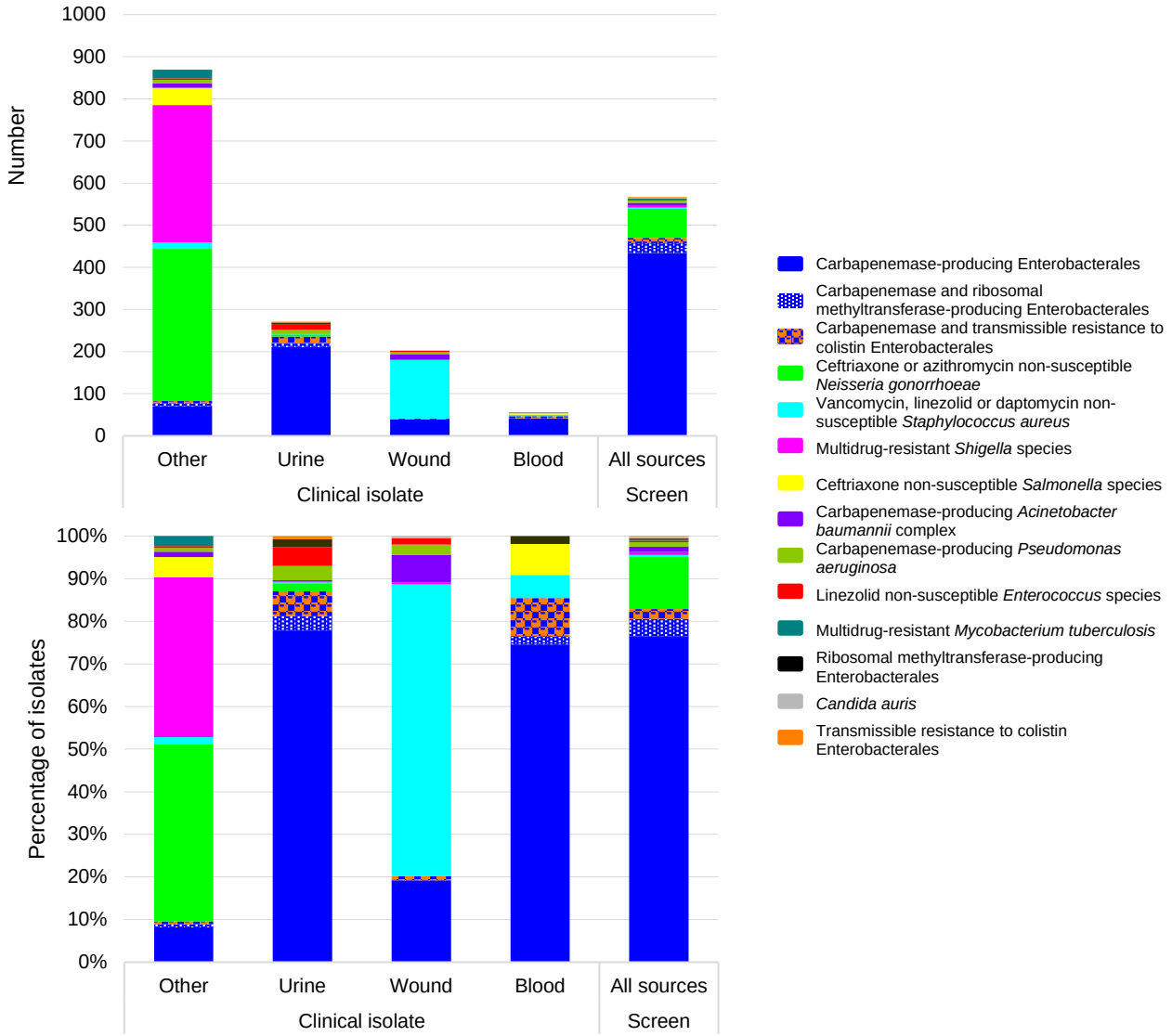
Critical antimicrobial resistances by specimen type

A little over two-thirds of all CARs reported in 2019 were from clinical specimens (71%), which are specimens collected for diagnostic purposes, rather than for screening. These included urine wound, blood and other (such as genital or respiratory) specimens (Figure 2).

Of CPE reports, more than 46% were from clinical specimens (408/877). Fifty-eight percent of isolates from clinical specimens were from urine (236/408), which is to be expected because Enterobacterales commonly cause urinary tract infections. Twelve percent of isolates from clinical specimens were from blood cultures (48/408). CPE comprised 86% of all CARs confirmed from blood specimens, highlighting the clinical spectrum of CPE infections compared with other CARs.

Three other CARs were also reported from blood cultures in 2019: ceftriaxone-nonsusceptible *Salmonella* species (*n* = 4), daptomycin-nonsusceptible *S. aureus* (*n* = 3), and ribosomal methytransferase-producing Enterobacterales (*n* = 1). Urine is an important specimen for certain CARs, such as CPE, because the urinary tract is a common site of infection.

Figure 2: Critical antimicrobial resistances, by specimen type, 2019



Summary by CAR, with trend data for 2017–2019

Data for each CAR for 2019, nationally and by state and territory, are shown in Figures 3 to 27. Trend data for 2017 to 2019 are also presented, where applicable.

Candida auris

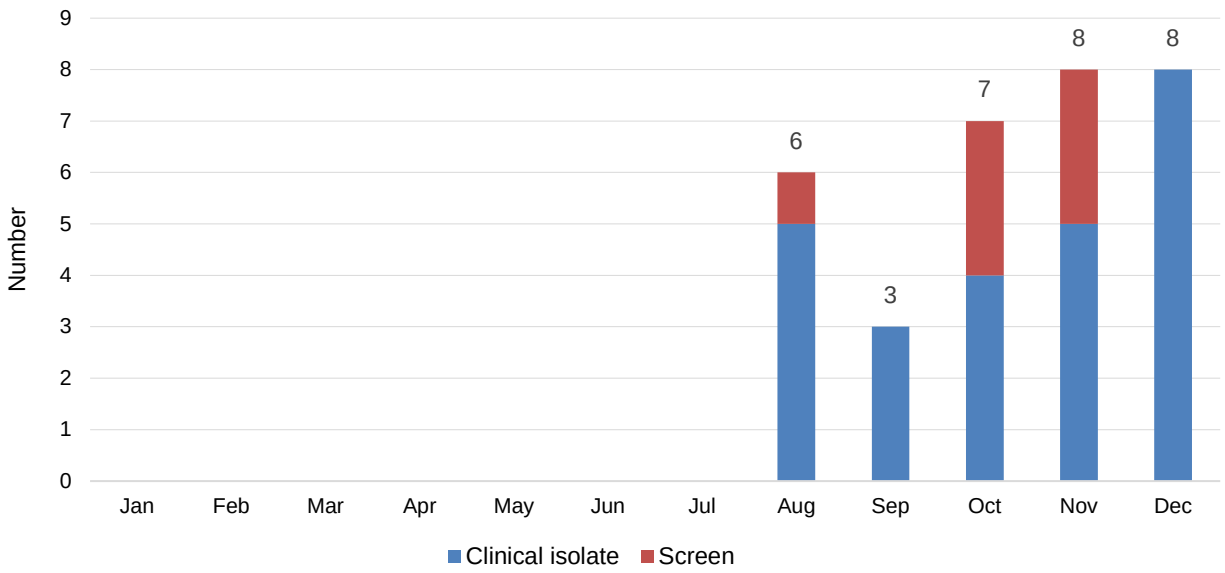
Reporting for *C. auris* began in July 2019. There were three reports of *C. auris* from July to December 2019: two from New South Wales and one from Western Australia.

Acinetobacter baumannii complex

Reporting for carbapenemase-producing *A. baumannii* complex began in July 2019 (Figure 3).

To December 2019, there were 32 reports of carbapenemase-producing *A. baumannii* complex; 24 from Victoria, four from Western Australia, and two each from New South Wales and Queensland (Figures 3 and 4). OXA-23-like types were dominant (*n* = 29, either alone [27] or in combination with NDM [2]). Four NDM types (alone [2] or in combination with OXA-23-like [2]) were reported.

Figure 3: Carbapenemase-producing *Acinetobacter baumannii* complex, number reported by specimen type for 2019*, national



* New CAR reported from July 2019

Figure 4: Carbapenemase-producing *Acinetobacter baumannii* complex, number reported by carbapenemase type and specimen type, state and territory, 2019

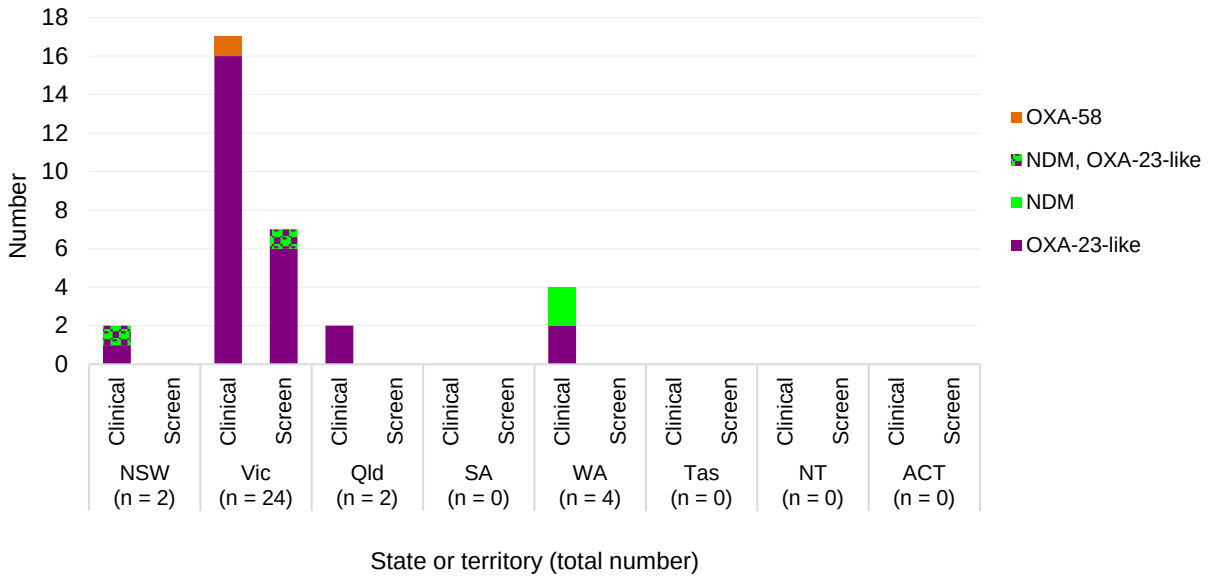


Table 3: Carbapenemase-producing *Acinetobacter baumannii* complex, number reported by setting, state and territory, 2019

Setting	State or territory								Total
	NSW	Vic	Qld	SA	WA	Tas	NT	ACT	
Total	**2**	**24**	**2**	**0**	**4**	**0**	**0**	**0**	**32**
Public hospital	1	20	1	0	4	0	0	0	26
Private hospital	0	1	0	0	0	0	0	0	1
Aged care home	0	1	0	0	0	0	0	0	1
Community	1	2	1	0	0	0	0	0	4

Enterobacterales

There was an increase in the number of reports of Enterobacterales in 2019, compared with 2017 and 2018, and there were sporadic increases in reports over the three years (Figure 5). There were monthly variations in the number of clinical and screening isolates of CPE, but no indication of any seasonal variation.

Monthly trends for the top five carbapenemase types (IMP; NDM; OXA-48-like; KPC; NDM-OXA-48-like) reported over three years are shown in Figure 8. There were increases in reports of all types, except KPC, from 2017 to 2019 (Figure 10).

The total number of CPE reports increased in 2019 (*n* = 877, up 37.5%) compared with 2018. There were increases in the number of IMP-, NDM-, and OXA-48-like types (IMP: *n* = 504 versus *n* = 371; NDM: *n* = 223 versus *n* = 143; OXA-48-like: *n* = 96 versus *n* =73; NDM+OXA-48-like: *n* = 22 versus *n* = 13) compared to 2018. However, there was a decline in the number of KPC-types (*n* = 18 versus *n* = 25).

IMP (57.5%), NDM (25.4%), and OXA-48-like (10.9%) types accounted for 93.8% of all CPE in 2019. There were no reports of IMP-types from South Australia and Tasmania in 2019. All IMP strains that have been sequenced to date (49%, 245/504) were $bla_{\text{IMP-4}}$.

The number of NDM-types from South Australia increased in 2019 compared to 2018 (*n* = 37 versus *n* = 10); 65% were from screening specimens. No NDM-types were reported from Tasmania. Four different genes were found in the strains sequenced to date (40%, 97/245): $bla_{\text{NDM - 5}}$ (58/97); $bla_{\text{NDM-1}}$ (22/97); $bla_{\text{NDM-4}}$ (12/97) and $bla_{\text{NDM-7}}$ (5/97).

Reports of IMP- and NDM-types increased in New South Wales and Victoria in 2019, compared to 2018 (Figure 12).

Three *Escherichia coli* with transmissible colistin resistance (mcr-1.1) were reported in 2019. They were from hospitalised patients residing in New South Wales (*n* = 2, urine isolates collected January 2019 and June 2019) and Victoria (*n* = 1, screen collected December 2019).

There were 41 reports of CPE that also harboured transmissible colistin resistance (mcr-9.1). Almost all of these (*n* = 40) were associated with IMP-4; one *K. oxytoca* had OXA-48+mcr-9.1. The isolates were from patients residing in New South Wales (*n* = 21), Victoria (*n* = 15) and Queensland (*n* = 5). Although this type of CPE was commonly isolated from *E. cloacae* complex (68%, 28/41), six other species were reported.

The majority of OXA-48-like types were reported from Victoria (*n* = 58, 60%); 34/58 were from screening specimens. Five different genes were found in strains sequenced to date (58%, 68/118): $bla_{\text{OXA-181}}$ (27/68), $bla_{\text{OXA-48}}$ (22/68), $bla_{\text{OXA-232}}$ (16/68), $bla_{\text{OXA-244}}$ (2/68) and $bla_{\text{OXA-248}}$ (1/68).

KPC-producing Enterobacterales were reported from five states and territories: Victoria (*n* = 11), Queensland (*n* = 3) New South Wales (*n* =2), Tasmania (*n* = 2) and South Australia (*n* = 1). One KPC-producing *Klebsiella pneumoniae* was reported from an aged care home in Victoria.

There were seven IMI-producing Enterobacterales reported; five *Enterobacter cloacae* complex from Queensland (*n* = 2), Victoria (*n* = 2), and South Australia (*n* = 1); and one *E. coli* and one *Serratia marcescens*, from Victoria.

Four OXA-23-like producing Enterobacterales were reported; three *E. coli* (Victoria [*n* = 2], New South Wales [*n* = 1]), and one *Proteus mirabilis* (Queensland [*n* = 1]).

Excluding CARs for which the setting was unknown, 16% of CPE were reported from settings other than public hospitals; 8.9% (*n* = 76), 5.3% (*n* = 45) and 2.0% (*n* = 17) respectively from private hospitals, community and aged care.

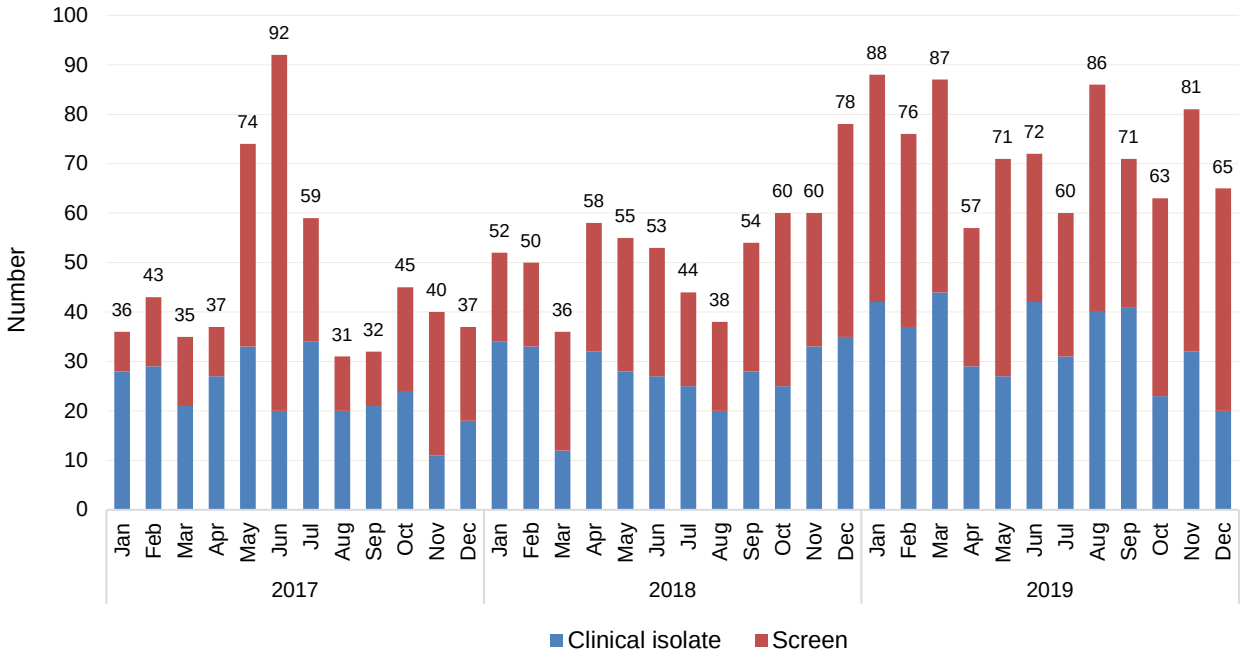
CPE were reported from 132 hospitals during 2019; 10 of which had more than one CPE. Nearly one-third (30%, 40/132) of these hospitals did not have a CPE during the period 2016 to 2018. Sixty-seven hospitals that had CPE notifications prior to 2019 did not have any reports in 2019. Eight hospitals had an increase of more than 200% in reports of NDM-types in 2019, compared to 2018: three in New South Wales, two in Victoria, two in South Australia, and one in Western Australia. One of the hospitals in Victoria also had an increase of more than 200% in IMP-types. An additional six hospitals (located in New South Wales [*n* = 3] and Queensland [*n* = 3]) had an increase of more than 200% in notifications of IMP-types in 2019, compared to 2018.

In 2019, there was variation in the proportion of isolates reported from clinical and screening specimens by state and territory (Figure 11). This may be due to differences in local infection control policies or in response to local outbreaks. Relatively fewer reports from screening specimens were identified in the Australian Capital Territory, Northern Territory, Tasmania and Western Australia.

Approximately one in eight reports of IMP-type CPE in 2019 originated from private hospitals (11.5%); other types were less commonly reported for private hospitals (Table 4). This may be due to large numbers of IMP-type reports from Queensland private hospitals (*n* = 50). Reports of IMP-type from aged care homes were also more common in Queensland.

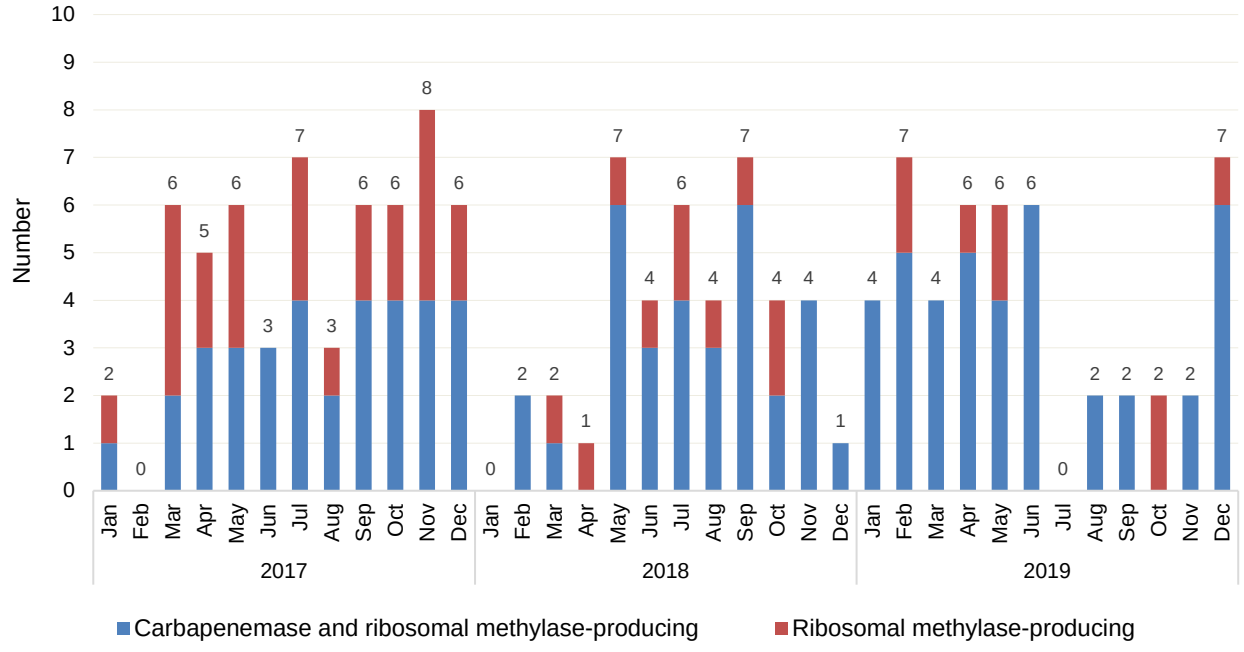
National data

Figure 5: Carbapenemase-producing Enterobacterales*, number reported by month and specimen type, 2017–2019, national



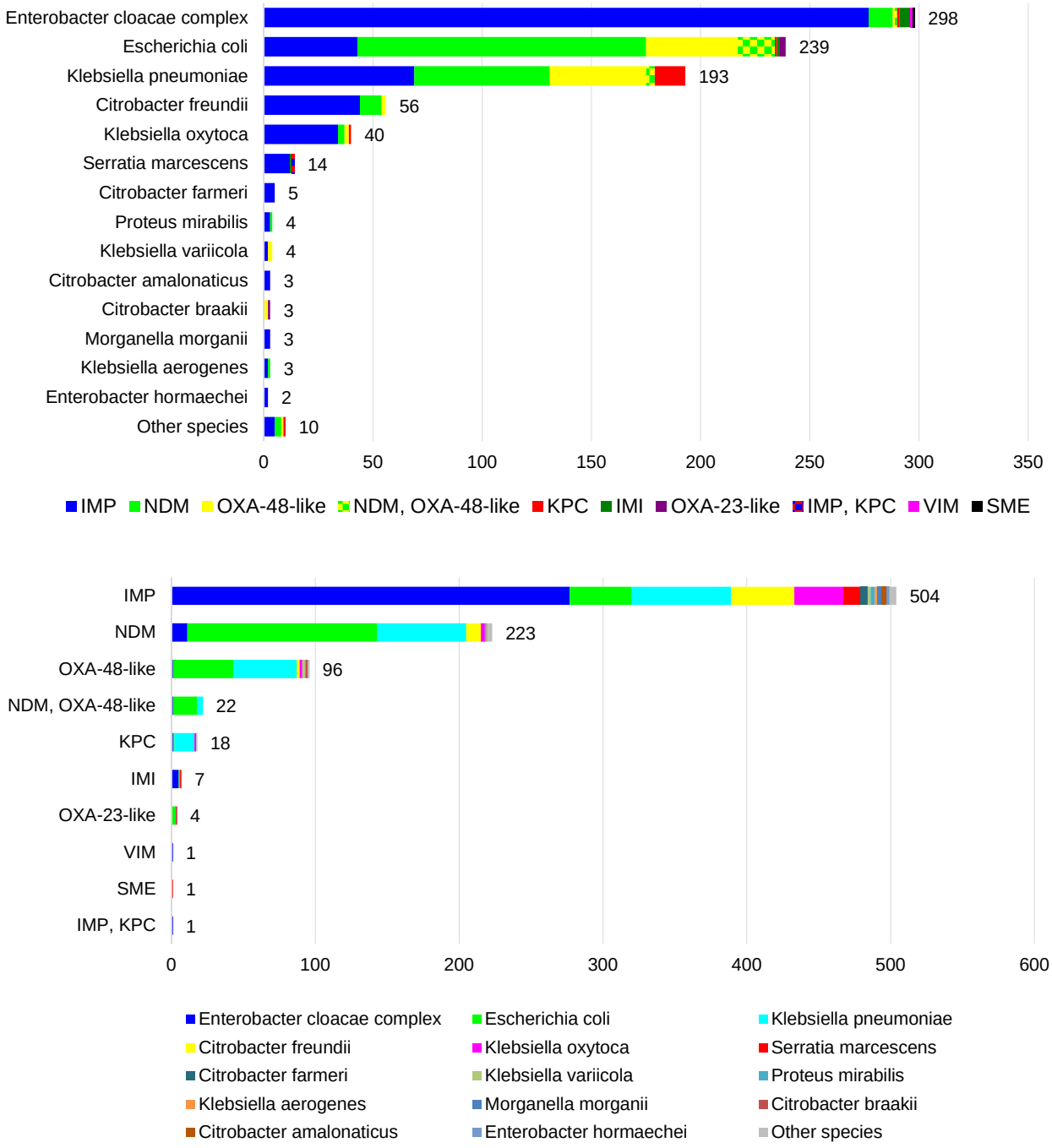
* Carbapenemase-producing Enterobacterales, including those with ribosomal methyltransferase or transmissible colistin resistance

Figure 6: Ribosomal methyltransferase-producing Enterobacterales*, number reported by month, 2017–2019, national



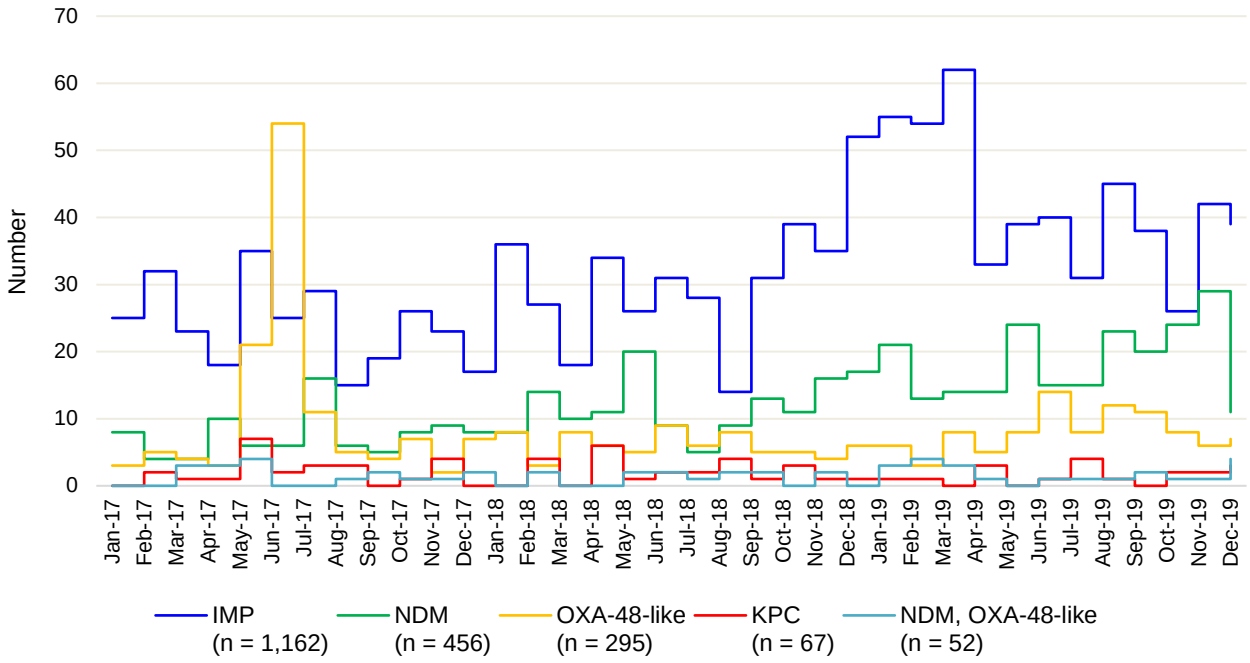
* Ribosomal methyltransferase-producing Enterobacterales, including those with carbapenemases

Figure 7: Carbapenemase-producing Enterobacterales*, number reported by species and carbapenemase type, 2019, national



* Carbapenemase-producing (*n* = 796), carbapenemase- and ribosomal methyltransferase-producing (*n* = 40); carbapenemase-producing and transmissible colistin resistance (*n* = 41)

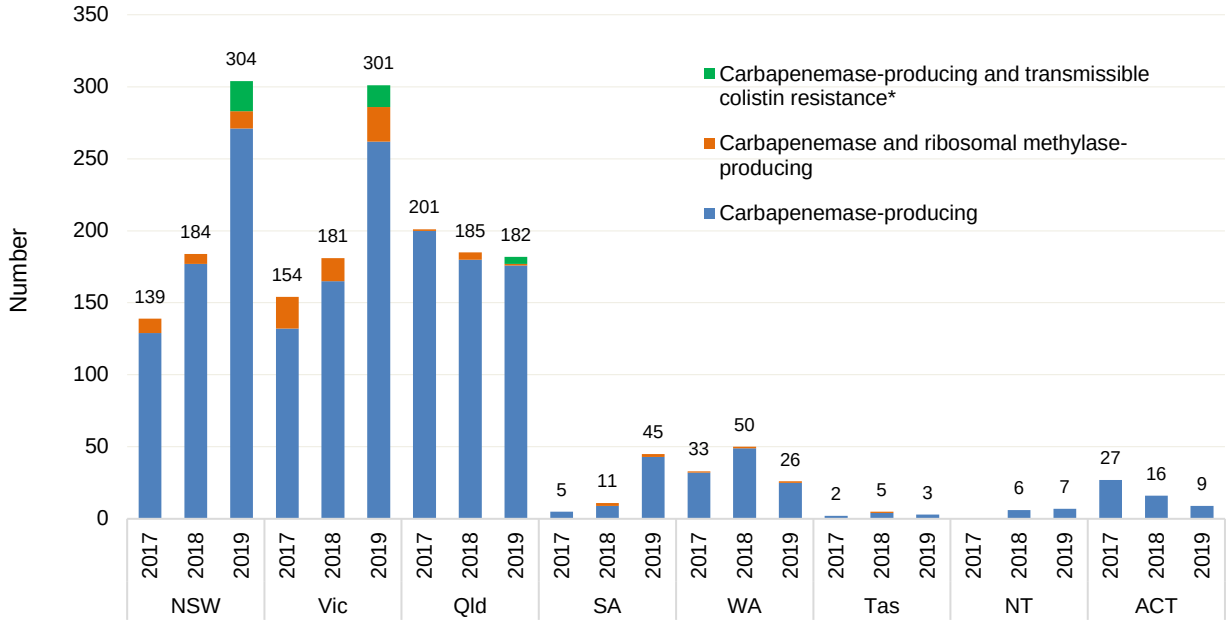
Figure 8: Trend for the top five reported carbapenemase types*, by month, 2017–2019, national



* Alone or in combination with another type for the reporting period indicated

State and territory

Figure 9: Carbapenemase-producing Enterobacterales, number reported by state and territory, 2017–2019



* Transmissible colistin resistance reported from July 2019

Figure 10: Three-year trend for the top four reported carbapenemase types from Enterobacterales, by state and territory and nationally, (three-month moving average), 2017–2019

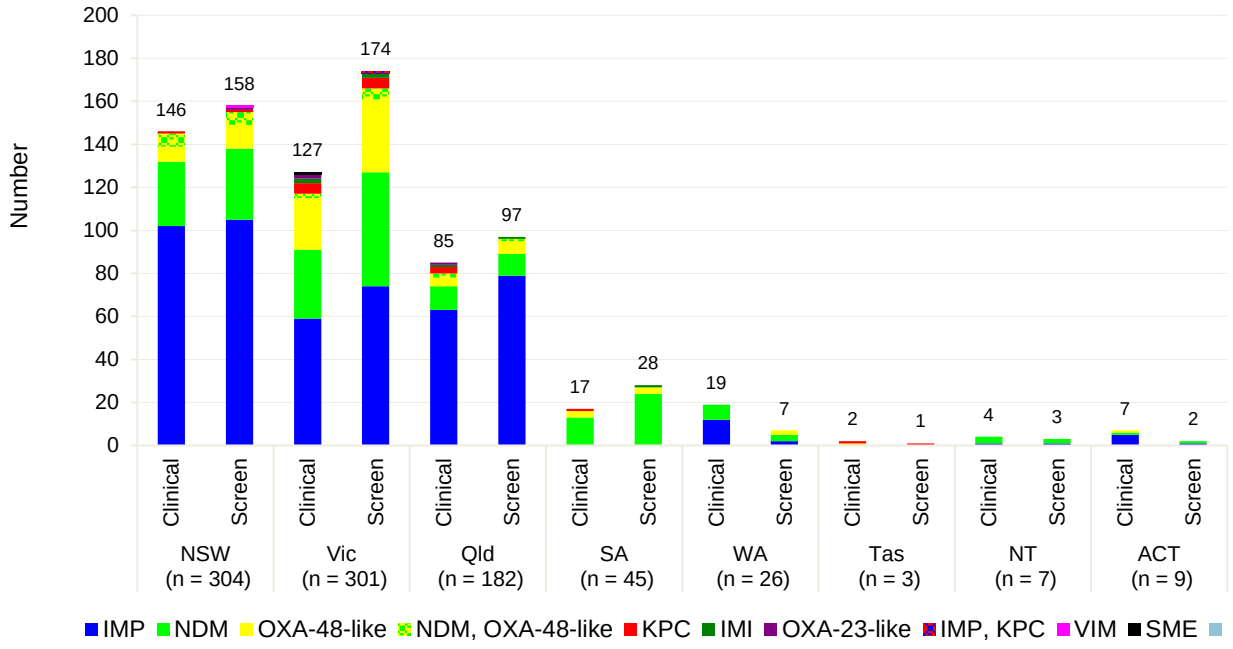
Type	NSW	Vic	Qld	SA	WA	Tas	NT	ACT	Australia
IMP	20 5	23 2	17 7	0 0	4 0	0 0	1 0	3 0	57 20
NDM	8 1	9 1	6 0	6 0	2 0	0 0	1 0	1 0	24 5
OXA-48-like	3 0	7 1	26 0	1 0	1 0	0 0	0 0	0 0	29 3
KPC	1 0	3 0	1 0	0 0	0 0	0 0	0 0	0 0	4 1
All types	28 7	35 8	38 8	7 0	6 1	1 0	1 0	3 0	84 31

Line graphs represent three-month moving average for the period 1 January 2017 to 31 December 2019, for each type, where maximum monthly average was greater than one.

Straight green line in cell = no carbapenemase type for that state or territory during the reporting period

Blank cell = maximum monthly average was one or less

Figure 11: Carbapenemase-producing Enterobacterales*, number reported by carbapenemase type and specimen type, by state and territory, 2019



* Carbapenemase-producing (*n* = 796), carbapenemase- and ribosomal methyltransferase-producing (*n* = 40); carbapenemase-producing and transmissible colistin resistance (*n* = 41)

Figure 12: Top five reported carbapenemase-producing Enterobacterales type by specimen type, by state and territory, 2017–2019

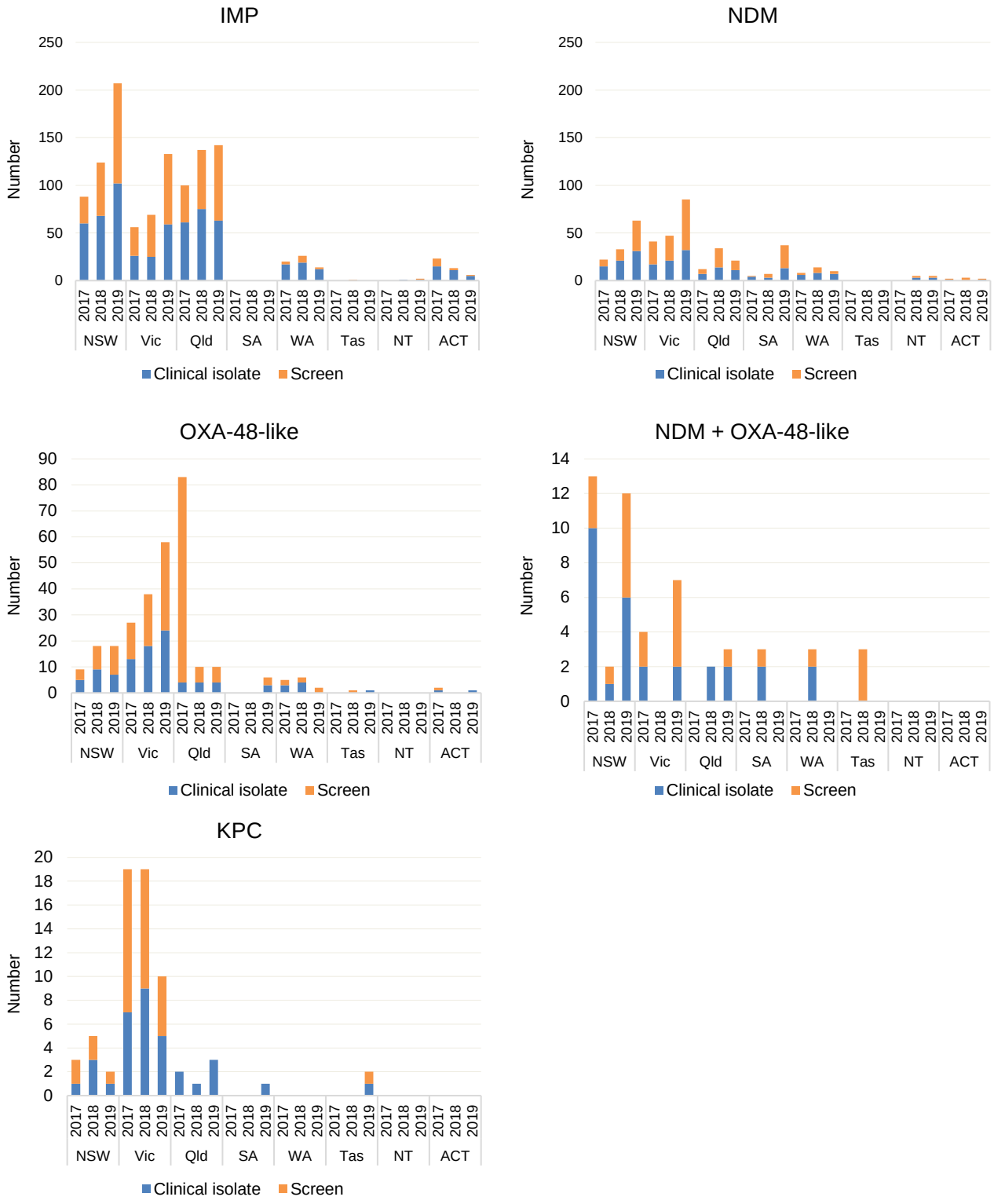


Table 4: Top four carbapenemase types from Enterobacterales, number reported by setting, state and territory, 2019

Carbapenemase type[†]	Setting	State or territory								Total
		NSW	Vic	Qld	SA	WA	Tas	NT	ACT	
IMP	**Total**	**207**	**133**	**142**	**0**	**14**	**0**	**2**	**6**	**504**
	Public hospital	200	125	74	0	12	0	2	6	419
	Private hospital	3	4	50	0	0	0	0	0	57
	Aged care home	1	0	8	0	0	0	0	0	9
	Community	1	4	2	0	1	0	0	0	8
	Unknown	2	0	8	0	1	0	0	0	11
NDM	**Total**	**63**	**85**	**21**	**37**	**10**	**0**	**5**	**2**	**223**
	Public hospital	53	69	9	30	6	0	4	2	173
	Private hospital	3	5	4	0	0	0	0	0	12
	Aged care home	1	0	0	5	0	0	1	0	7
	Community	4	11	4	2	2	0	0	0	23
	Unknown	2	0	4	0	2	0	0	0	8
OXA-48-like	**Total**	**18**	**58**	**10**	**6**	**2**	**1**	**0**	**1**	**96**
	Public hospital	18	47	6	6	1	1	0	0	79
	Private hospital	0	4	2	0	0	0	0	0	6
	Aged care home	0	0	0	0	0	0	0	0	0
	Community	0	5	2	0	0	0	0	1	8
	Unknown	0	2	0	0	1	0	0	0	3
NDM, OXA-48-like	**Total**	**12**	**7**	**3**	**0**	**0**	**0**	**0**	**0**	**22**
	Public hospital	11	6	2	0	0	0	0	0	19
	Private hospital	0	0	0	0	0	0	0	0	0
	Aged care home	0	0	0	0	0	0	0	0	0
	Community	0	1	1	0	0	0	0	0	2
	Unknown	1	0	0	0	0	0	0	0	1
KPC	**Total**	**2**	**10**	**3**	**1**	**0**	**2**	**0**	**0**	**18**
	Public hospital	2	9	2	1	0	2	0	0	16
	Private hospital	0	0	0	0	0	0	0	0	0
	Aged care home	0	1	0	0	0	0	0	0	1
	Community	0	0	1	0	0	0	0	0	1
	Unknown	0	0	0	0	0	0	0	0	0

* Top five carbapenemase types account for 98.4% (863/877) of all carbapenemase-producing Enterobacterales reported for this period. Other types were IMI (*n* = 7, Vic, Qld, SA); OXA-23-like (*n* = 4, NSW, Vic and Qld); IMP+KPC (*n* = 1, Vic); VIM (*n* = 1, NSW); and SME (*n* = 1, (Vic)

† Alone or in combination with another type for the reporting period indicated

Enterococcus species

In 2019, reports of linezolid-nonsusceptible *Enterococcus faecium* increased compared to 2018 (*n* = 13 versus *n* = 7).

Reports of linezolid-nonsusceptible *Enterococccus* species from Western Australia were disproportionate to its population in 2019, and there were no reports of this CAR in 2017 and 2018 (Figure 14).

Figure 13: Linezolid-nonsusceptible *Enterococcus* species, number reported by month, 2017–2019, national

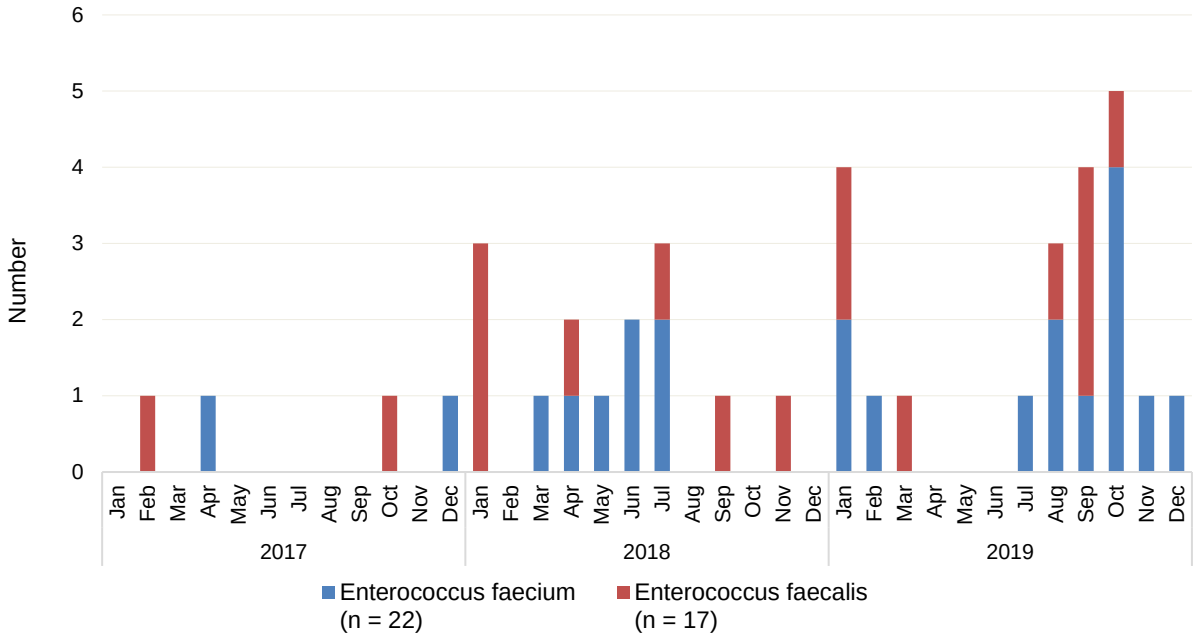
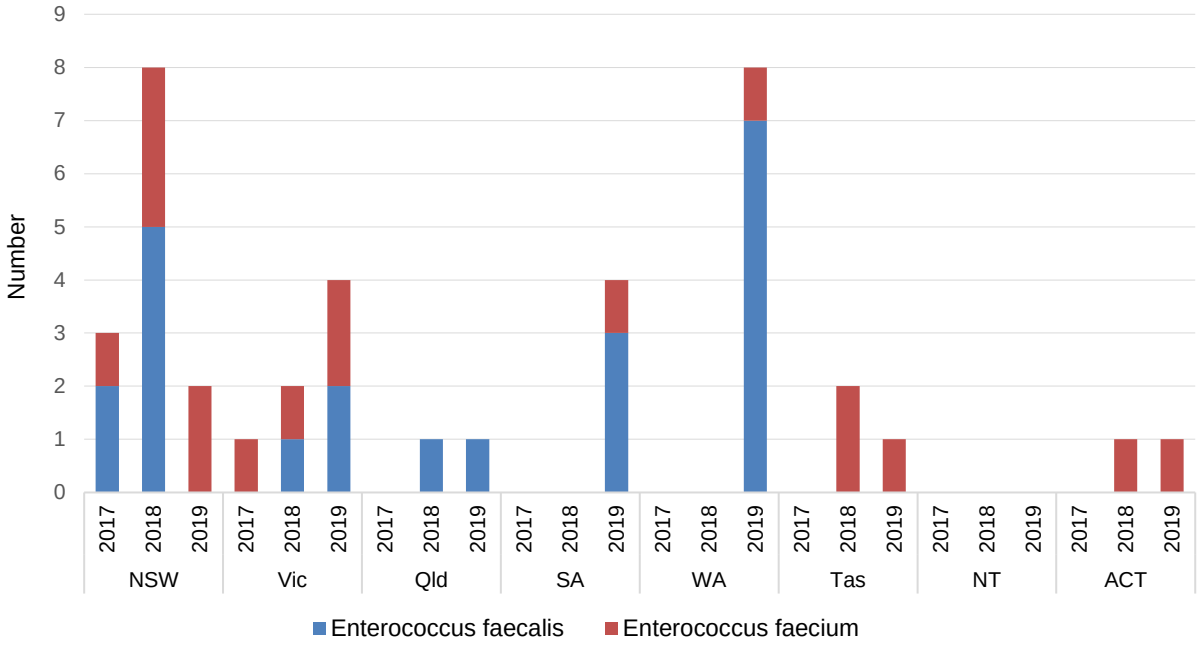


Figure 14: Linezolid-nonsusceptible *Enterococcus* species, number reported by state and territory, 2017–2019



Mycobacterium tuberculosis

Low numbers of multidrug-resistant *Mycobacterium tuberculosis* were reported to CARAlert from 2017 to 2019 (Figure 15). The majority of multidrug-resistant *M. tuberculosis* reports were from NSW (*n* = 27), followed by Queensland (*n* = 19) (Figure 16).

Figure 15: Multidrug-resistant *Mycobacterium tuberculosis,* number reported for by month, 2017–2019, national

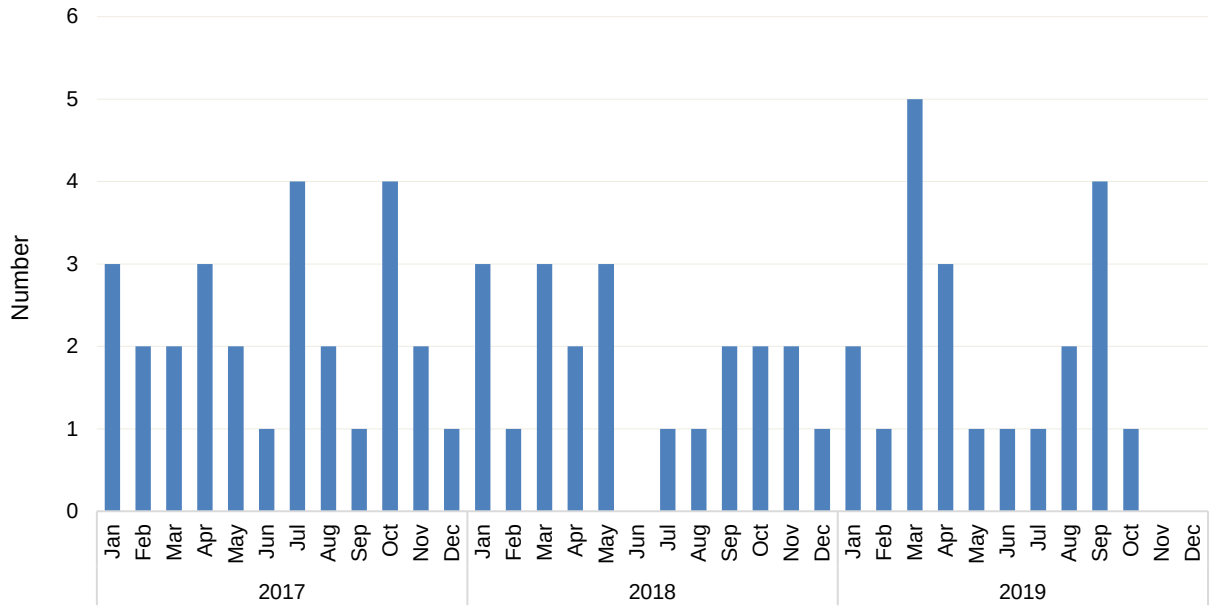
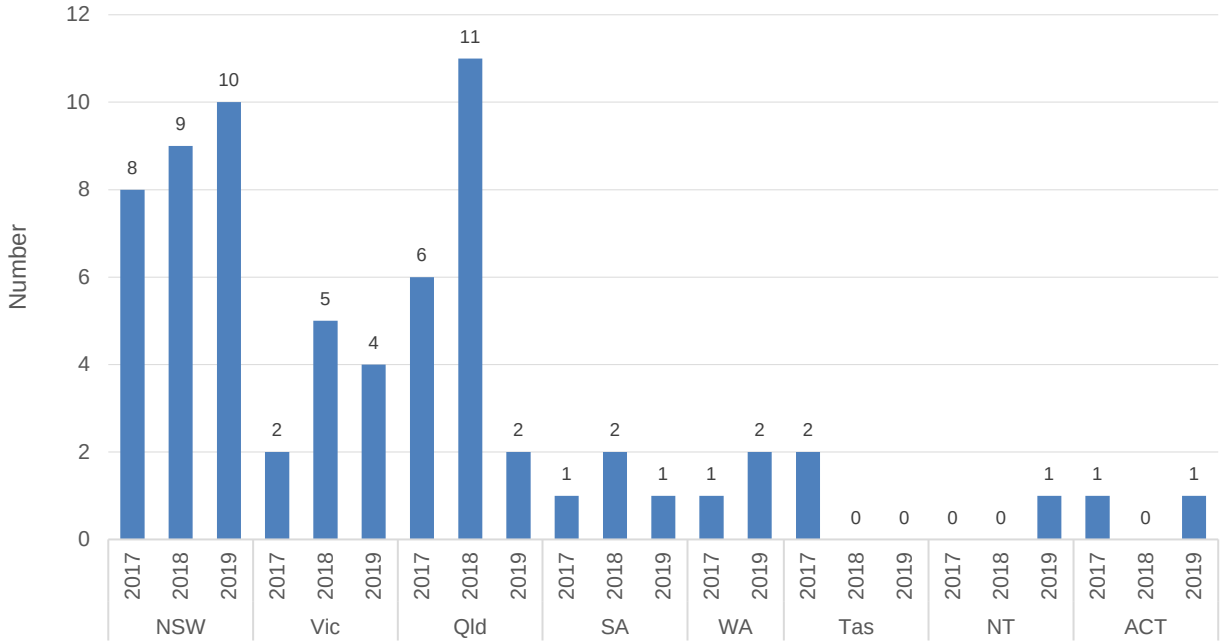


Figure 16: Multidrug-resistant *Mycobacterium tuberculosis*, number reported by state and territory, 2017–2019



Neisseria gonorrhoeae

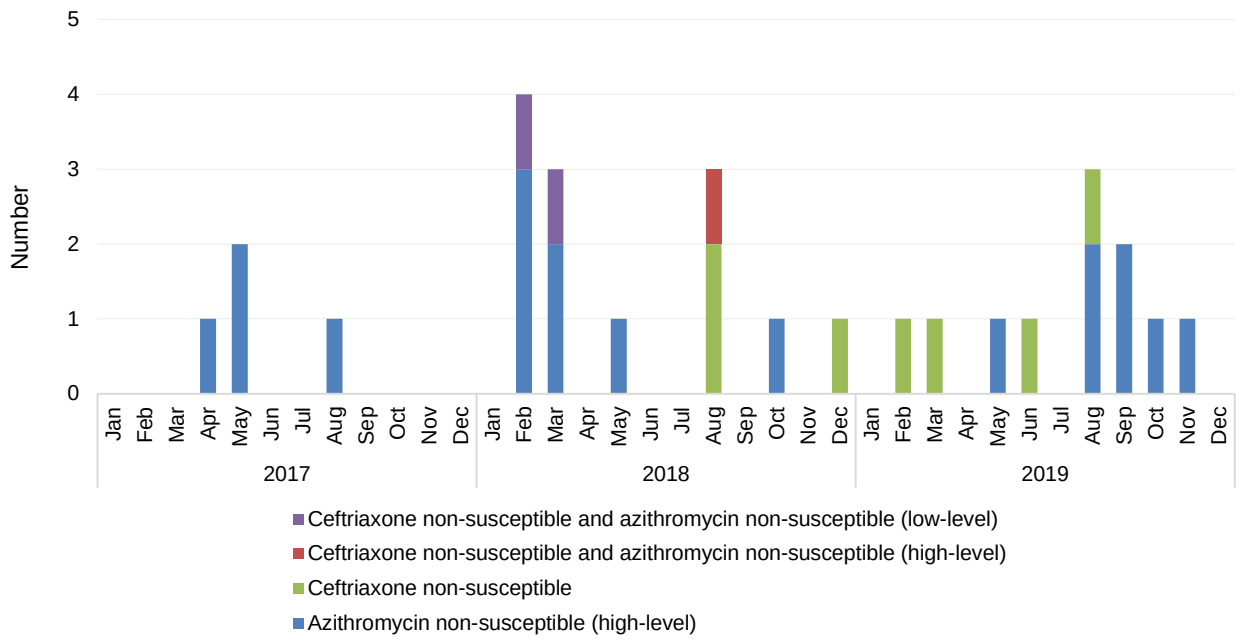
There were sporadic reports of ceftriaxone-nonsusceptible and/or azithromycin-nonsusceptible (high-level) *N. gonorrhoeae* from 2017 to 2019 (Figure 17). Ceftriaxone-nonsusceptible isolates were reported for the first time in late 2018, and there were four reports of this CAR in 2019.

Reports of azithromycin-nonsusceptible (low-level) *N. gonorrhoeae* decreased from 2017 to 2019 (Figure 18). The majority of reports over this period were from New South Wales and Victoria, and there was a notable decrease in Victoria from 2017 to 2019 (Figure 19). The total number of reports of this CAR declined in 2019 (*n* = 424, down 18.1%), compared to 2018. There was a decrease in the number from Victoria (*n* = 156 versus *n* = 216) and Queensland (n = 31 versus *n* = 70), and an increase in the number from Western Australia (*n* = 16 versus *n* = 12).

There were seven reports of azithromycin non-susceptible (high-level) *N. gonorrhoeae* from five states and territories: New South Wales (*n* = 2), Queensland (*n* = 2), and one each from Victoria, Western Australia and Tasmania.

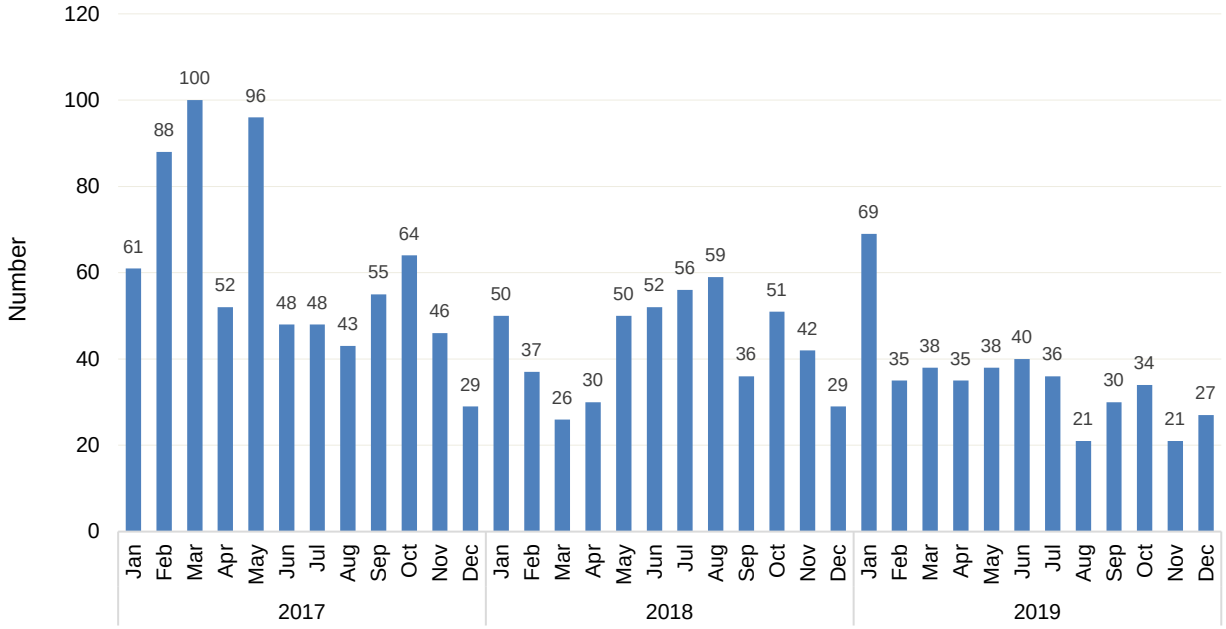
Four ceftriaxone non-susceptible *N. gonorrhoeae* were reported in 2019, one each from New South Wales, Victoria, Queensland and Western Australia; there were no reports of this CAR in 2017, and three reports in 2018.

Figure 17: Ceftriaxone-nonsusceptible and/or azithromycin-nonsusceptible (high-level) *Neisseria gonorrhoeae,* number reported by month, 2017–2019



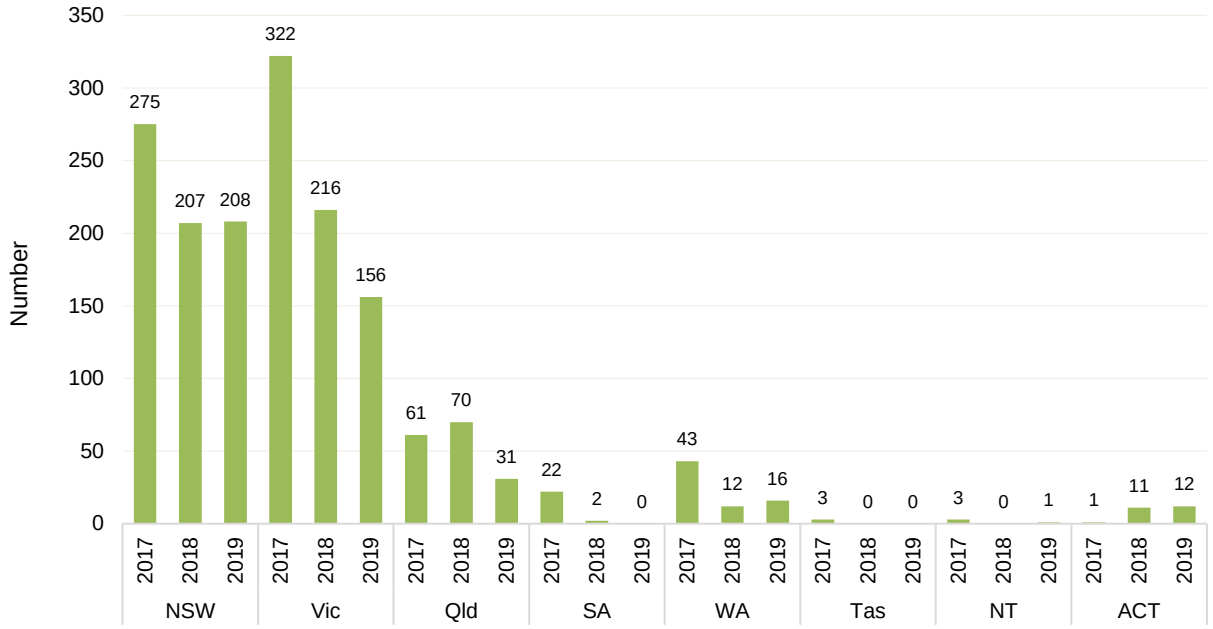
Low-level = azithromycin MIC < 256 mg/L; High-level = azithromycin MIC > 256 mg/L

Figure 18: Azithromycin-nonsusceptible (low-level) *Neisseria gonorrhoeae,* number reported by month, 2017–2019



Low-level = azithromycin MIC < 256 mg/L

Figure 19: Azithromycin-nonsusceptible (low-level) *Neisseria gonorrhoeae,* number reported by state and territory, 2017–2019

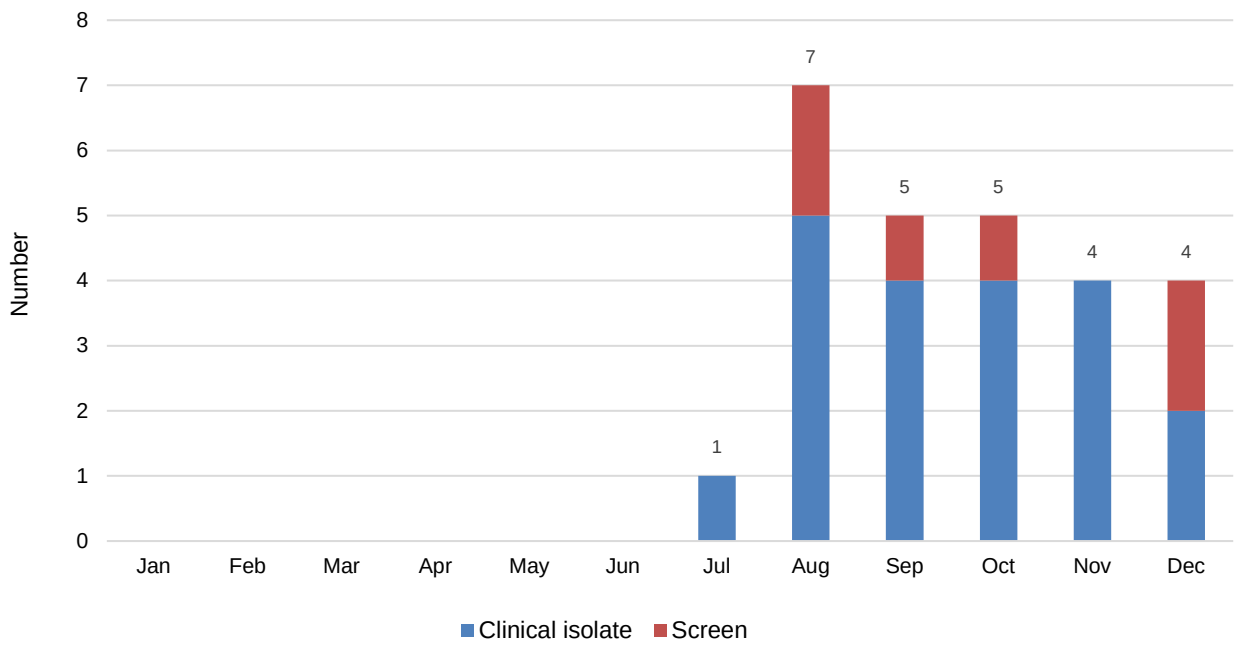


Low-level = azithromycin MIC < 256 mg/L

Pseudomonas aeruginosa

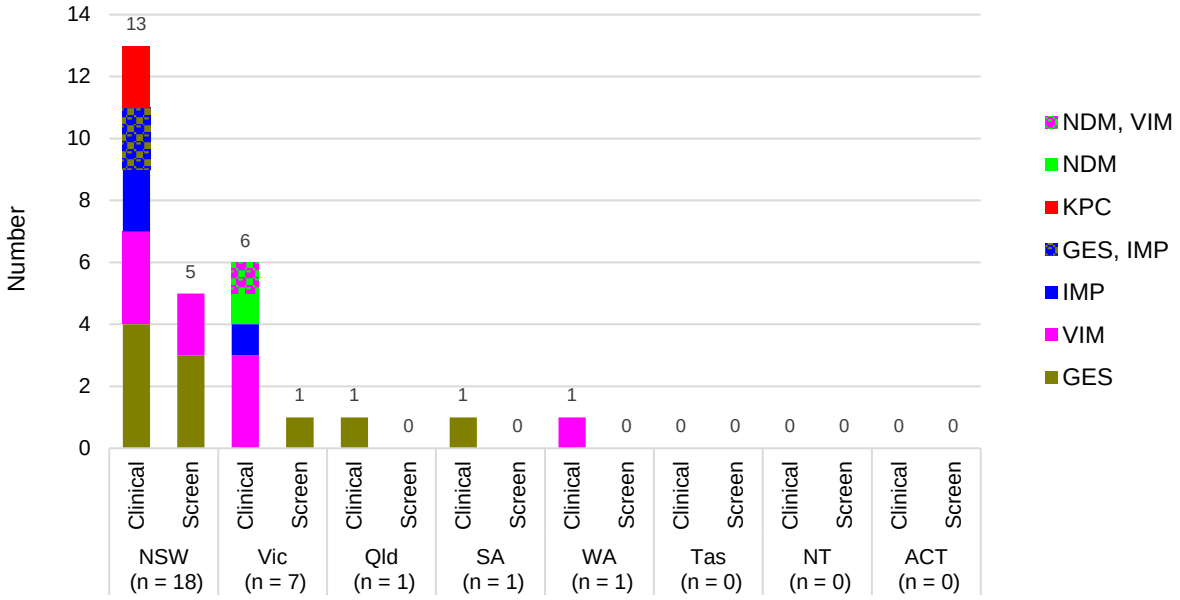
Reporting for carbapenemase-producing *P. aeruginosa* began in July 2019. Twenty-eight carbapenemase-producing *P. aeruginosa* were reported during 2019; 18 from New South Wales, seven from Victoria, and one each from Queensland, South Australia and Western Australia (Figures 20 and 21). Just over two-thirds were either GES [*n* = 10] or VIM [*n* = 9] types. Two KPC-producing *P. aeruginosa* were reported from New South Wales.

Figure 20: Carbapenemase-producing *Pseudomonas aeruginosa*, number reported by specimen type, 2019*



* New CAR reported from July 2019

Figure 21: Carbapenemase-producing *Pseudomonas aeruginosa*, number reported by carbapenemase type and specimen type, by state and territory, 2019*



* New CAR reported from July 2019

Table 5: Carbapenemase-producing *Pseudomonas aeruginosa*, number reported by setting and state and territory, 2019*

	State or territory								
Setting	**NSW**	**Vic**	**Qld**	**SA**	**WA**	**Tas**	**NT**	**ACT**	**Total**
Total	**18**	**7**	**1**	**1**	**1**	**0**	**0**	**0**	**28**
Public hospital	14	3	0	1	1	0	0	0	19
Private hospital	1	1	0	0	0	0	0	0	2
Aged care home	0	0	0	0	0	0	0	0	0
Community	1	3	1	0	0	0	0	0	5
Unknown	2	0	0	0	0	0	0	0	2

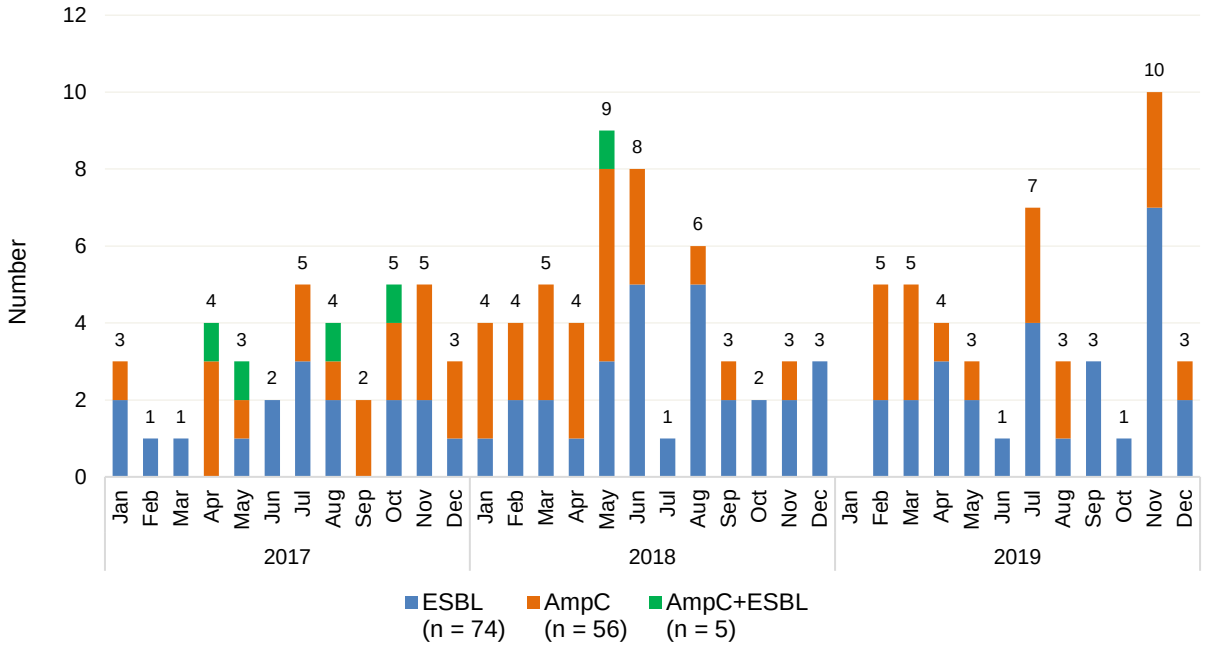
* New CAR reported from July 2019

Salmonella species

In 2019, ceftriaxone-nonsusceptible *Salmonella* species were reported all states and territories except Tasmania and the Australian Capital Territory; the majority (87%, 39/45) were reported from New South Wales (*n* = 18), Queensland (*n* = 12) and Western Australia (*n* = 9). Four typhoidal isolates producing ESBL were reported; three from two patients residing in New South Wales (one patient presented to two different facilities), and one from Victoria.

The number of reports of ceftriaxone-nonsusceptible *Salmonella* species decreased in 2019 compared to 2018 (*n* = 45 versus *n* = 52) (Figure 22). These reductions were mainly due to decreases in reports of the AmpC-type (*n* = 24 versus *n* = 16), particularly from Victoria. There were increases in reports of AmpC-type from Queensland and New South Wales in 2019 compared to 2018 (Figure 23). Reports from public hospitals are likely due to admissions associated with severe disease acquired in the community (Figure 24).

Figure 22: Ceftriaxone-nonsusceptible *Salmonella* species*, number reported by month, 2017–2019



* Non-typhoidal *Salmonella* species (n = 129) and typhoidal *Salmonella* species (n = 6)

Figure 23: Ceftriaxone-nonsusceptible *Salmonella* species, number reported by state and territory, 2017–2019

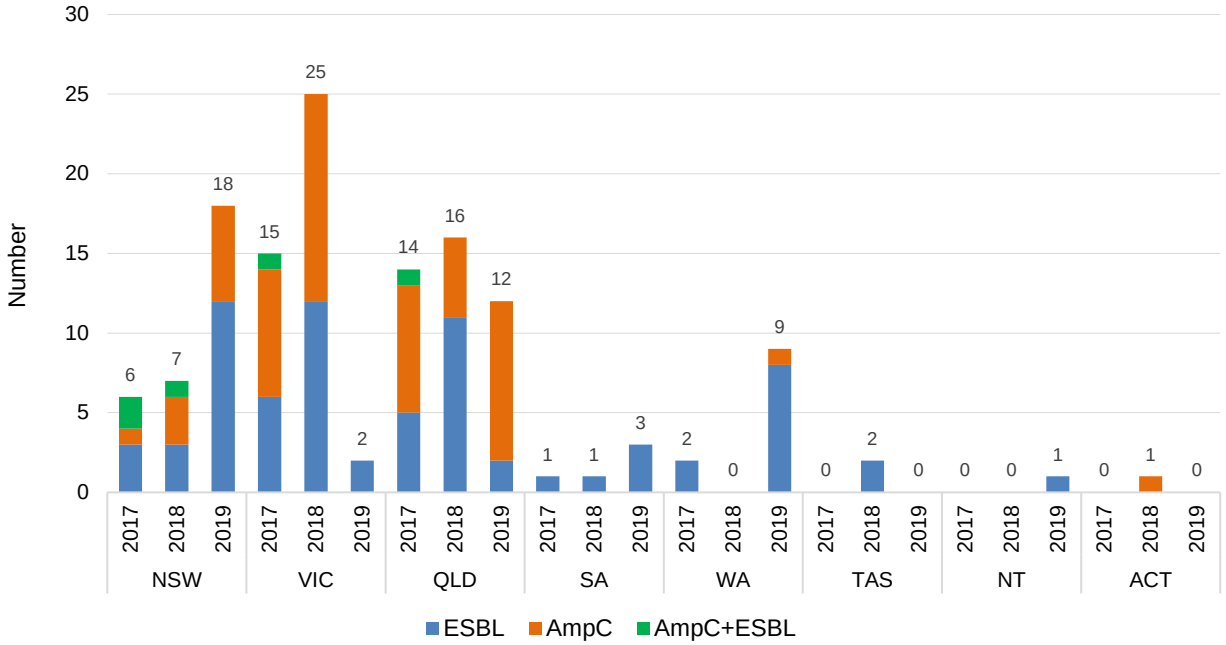


Table 6: Ceftriaxone-nonsusceptible *Salmonella* species, number reported by setting, state and territory, 2019

	State or territory								
Setting	**NSW**	**Vic**	**Qld**	**SA**	**WA**	**Tas**	**NT**	**ACT**	**Total**
Total	**18**	**2**	**12**	**3**	**9**	**0**	**1**	**0**	**45**
Public hospital	12	2	5	1	4	0	1	0	25
Private hospital	0	0	1	0	0	0	0	0	1
Aged care home	0	0	0	0	0	0	0	0	0
Community	3	0	4	2	4	0	0	0	13
Unknown	3	0	2	0	1	0	0	0	6

Shigella species

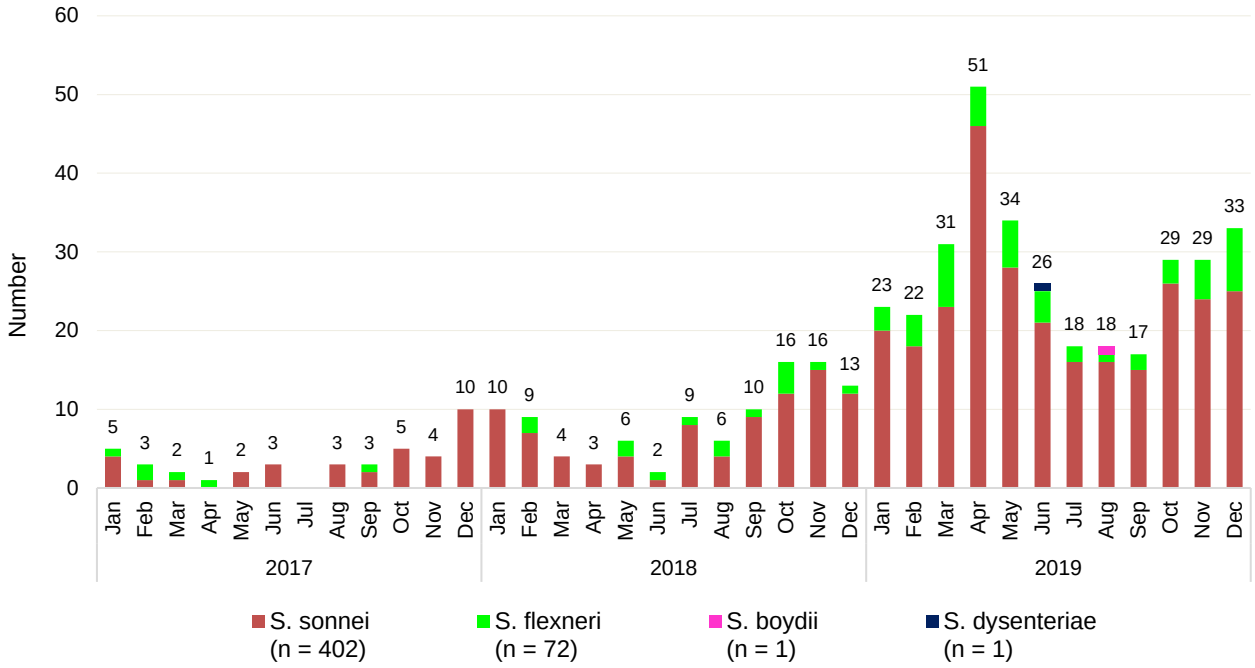
In 2019, the majority of multidrug-resistant *Shigella* species were reported from Victoria (*n* = 187, 56%), Queensland (*n* = 65, 20%); and New South Wales (*n* = 58, 18%) (Figure 24 and 25). A vast majority (>90%) were *S. sonnei* in all regions except in Queensland, where *S. flexneri* comprised 41% (27/65) of all reports. There was one report of *S. dysenteriae* from New South Wales, and one *S. boydii* from Western Australia. There were no reports from Tasmania.

Reports of multidrug-resistant *Shigella* species increased from 2017 to 2019, with a peak in April 2019. Reports from Victoria were up 246% in 2019 compared to 2018 (187 versus 54). A sharp increase in reports were also seen in Queensland (up 261%, 65 versus 18), and in New South Wales (up 142%, 58 versus 24). There were also increased reports for *S. flexneri* from Queensland in 2019 (Figure 25).

The proportion of shigellosis notifications that were MDR increased in all jurisdictions in 2019 compared to 2018, most notably in Victoria, Queensland and the Australian Capital Territory (Figure 26).

National data

Figure 24: Multidrug-resistant *Shigella* species, number reported for by month, 2017–2019



State and territory

Figure 25: Multidrug-resistant *Shigella* species, number reported by state and territory, 2017–2019

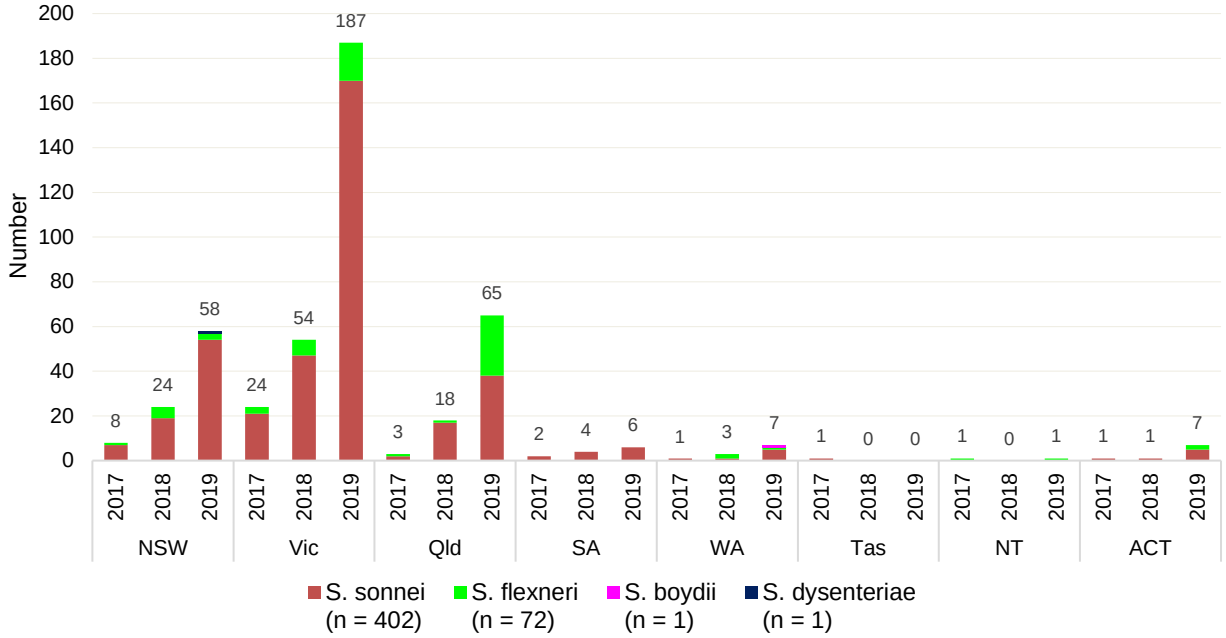
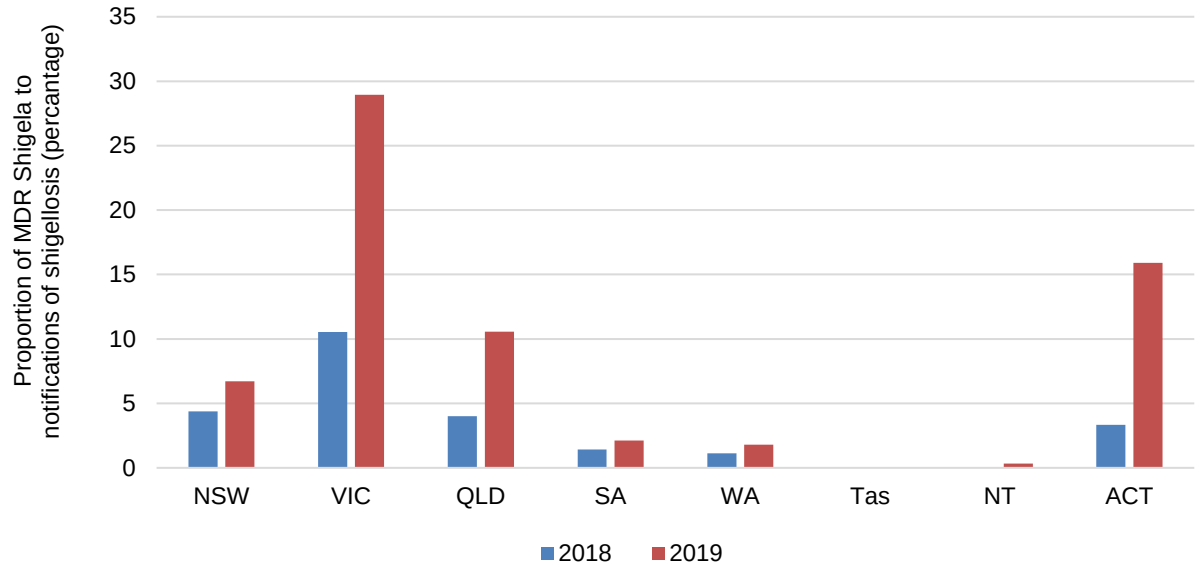


Table 7: Multidrug-resistant *Shigella* species, number reported by setting, state and territory, 2019

Setting	State or territory								Total
	NSW	Vic	Qld	SA	WA	Tas	NT	ACT	
Total	**58**	**187**	**65**	**6**	**7**	**0**	**1**	**7**	**331**
Public hospital	23	38	11	0	1	0	1	4	78
Private hospital	2	0	1	0	0	0	0	0	3
Aged care home	0	0	0	0	0	0	0	0	0
Community	26	2	45	5	4	0	0	2	84
Unknown	3	147	2	0	1	0	0	0	166

Figure 26: Multidrug-resistant *Shigella* species and notifications of shigellosis*, proportion reported by state and territory, 2018–2019



* National Notifiable Diseases Surveillance System[7]

Note: Notifications may include diagnosis by PCR only

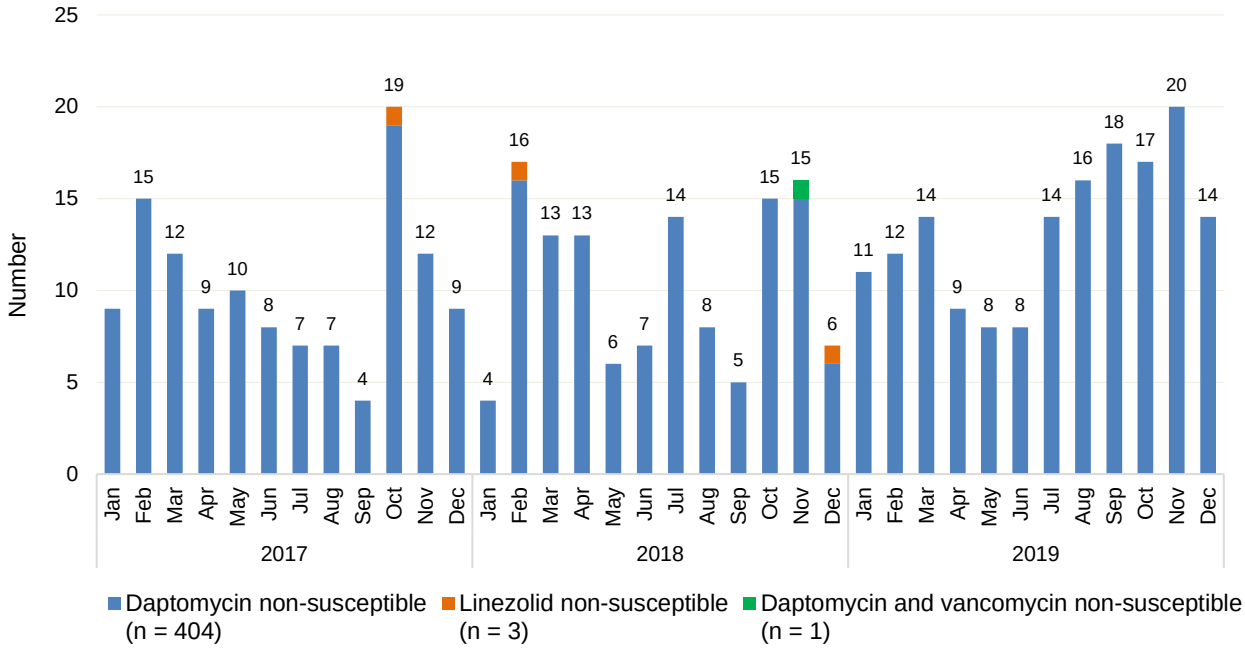
Staphylococcus aureus

From 2017 to 2019, the majority of reports of vancomycin-, linezolid- or daptomycin-nonsusceptible *S. aureus* were from Victoria and Western Australia (Figure 27). Daptomycin non-susceptibility was most frequently reported.

The total number of reports of daptomycin non-susceptible *S. aureus* increased in 2019 (*n* = 161, up 32% compared to 2018). There was an increase in the numbers from Queensland (*n* = 42 versus *n* = 15) and New South Wales (*n* = 27 versus *n* = 14) compared 2018; however, reports from Western Australia declined (*n* = 35 versus *n* = 40). In 2019, increases in Queensland were predominantly due to reports from aged care and the community (Table 8); sixteen of 42 daptomycin non-susceptible *S. aureus* were from aged care homes.

National data

Figure 27: Vancomycin-, linezolid- or daptomycin-nonsusceptible *Staphylococcus aureus*, number reported by month, 2017–2019



Note: No vancomycin-nonsusceptible *S. aureus* were reported from 2017 to 2019

State and territory

Figure 28: Vancomycin-, linezolid- or daptomycin-nonsusceptible *Staphylococcus aureus*, number reported, 2017–2019

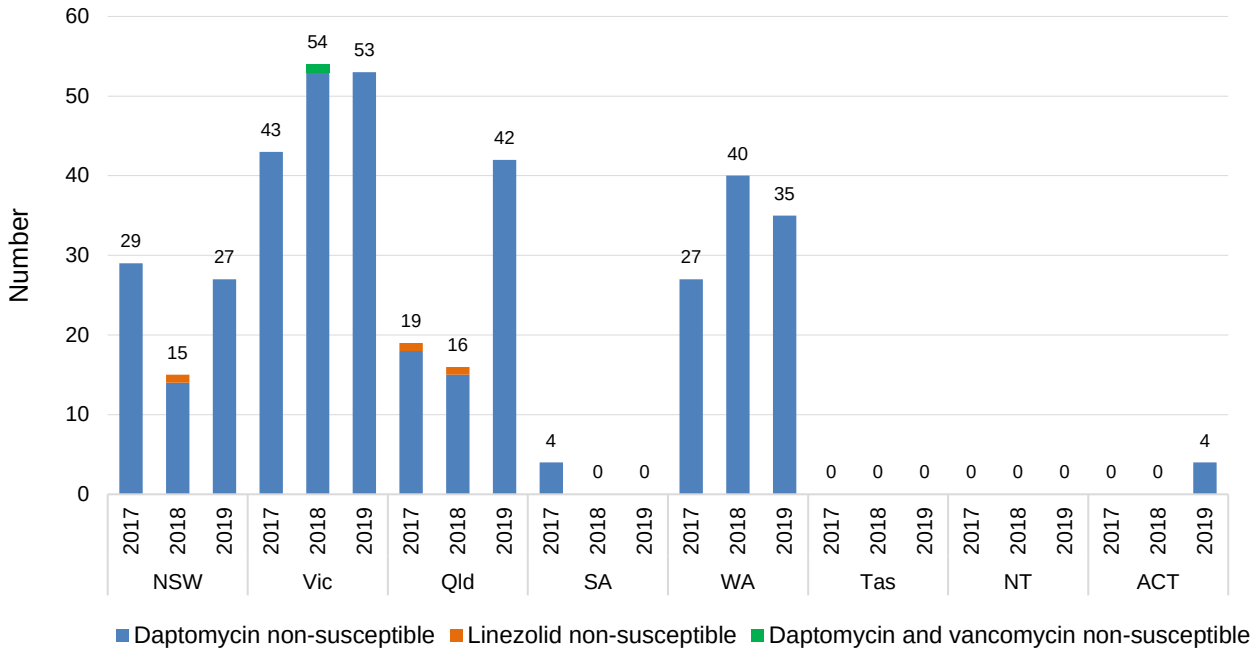


Table 8. Daptomycin-nonsusceptible *Staphylococcus aureus,* number reported by setting and state and territory, 2019

Setting	State or territory								Total
	NSW	Vic	Qld	SA	WA	Tas	NT	ACT	
Total	**27**	**53**	**42**	**0**	**35**	**0**	**0**	**4**	**161**
Public hospital	25	24	5	0	32	0	0	3	89
Private hospital	0	4	3	0	0	0	0	0	7
Aged care home	1	4	16	0	1	0	0	0	22
Community	1	18	11	0	1	0	0	1	32
Unknown	0	3	7	0	1	0	0	0	11

Streptococcus pyogenes

No *S. pyogenes* with reduced susceptibility to penicillin were reported from 2017 to 2019.

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Appendix 1 About CARAlert

CARAlert was established by the Australian Commission on Safety and Quality in Health Care (the Commission) in March 2016 as a component of the Antimicrobial Use and Resistance in Australia (AURA) Surveillance System. Participating confirming laboratories submit data to CARAlert on priority organisms with critical resistance to last-line antimicrobial agents. No patient-level data are held in the CARAlert system. Funding for AURA is provided by the Australian Government Department of Health, with contributions from the states and territories.

In 2019, 28 confirming laboratories participated in CARAlert. CARAlert generates a weekly summary email alert to report information on confirmed CARs to state and territory health authorities, the Australian Government Department of Health and confirming laboratories. The CARAlert system is based on routine processes used by pathology laboratories for identifying and confirming potential CARs. Information on CARAlert processes is in Appendix 1. Notes on considerations for interpreting CARAlert data are in Appendix 2.

CARAlert data support timely responses to CARs by hospitals, and state and territory health departments. Some states have made selected CARs, such as carbapenemase-producing Enterobacterales (CPE) and *Candida auris*, notifiable either using their public health legislation or by policy. Some states and territories have standalone systems for monitoring selected CARs, which complement CARAlert, but these are not widespread.

The CARs reported under CARAlert are listed in Table 1. These CARs were drawn from the list of high-priority organisms and antimicrobials which are the focus of the AURA Surveillance System.

The AURA National Coordination Unit reviewed CARAlert in 2018, in conjunction with relevant experts, and the states and territories. The review identified four new CARs that have been included in reporting to CARAlert since July 2019:

- Transferrable resistance to colistin in Enterobacterales
- Carbapenemase-producing *Acinetobacter baumannii* complex
- Carbapenemase-producing *Pseudomonas aeruginosa*
- *Candida auris*, which is a multidrug-resistant yeast that has caused outbreaks in multiple countries.

Table 1: List of critical antimicrobial resistances reported to CARAlert

Species	Critical Resistance
Acinetobacter baumannii complex	Carbapenemase-producing*
*Candida auris**	–
Enterobacterales	Carbapenemase-producing, and/or ribosomal methyltransferase-producing
Enterobacterales	Transmissible colistin resistance*
Enterococcus species	Linezolid resistant
Mycobacterium tuberculosis	Multidrug-resistant – resistant to at least rifampicin and isoniazid
Neisseria gonorrhoeae	Ceftriaxone non-susceptible or azithromycin non-susceptible
Salmonella species	Ceftriaxone non-susceptible
Shigella species	Multidrug-resistant
Staphylococcus aureus†	Vancomycin, linezolid or daptomycin non-susceptible
Streptococcus pyogenes	Penicillin reduced susceptibility
Pseudomonas aeruginosa	Carbapenemase-producing*

* Reported from July 2019

† For CARAlert, *S. aureus* includes *S. argenteus*

Appendix 2 CARAlert reporting processes

All of the following criteria must be met for organisms and resistances to be categorised as a CAR for reporting to CARAlert:

- Inclusion as a priority organism for national reporting as part of the AURA Surveillance System
- A serious threat to last-line antimicrobial agents
- Strongly associated with resistance to other antimicrobial classes
- At low prevalence in, or currently absent from, Australia and potentially containable
- Data not otherwise collected nationally in a timely way.

The CARAlert system is based on the following routine processes used by pathology laboratories for identifying and confirming potential CARs:

- Collection and routine testing – the isolate is collected from the patient and sent to the originating laboratory for routine testing
- Confirmation – if the originating laboratory suspects that the isolate is a CAR, it sends the isolate to a confirming laboratory that has the capacity to confirm the CAR
- Submission to the CARAlert system – the confirming laboratory advises the originating laboratory of the result of the test, and the originating laboratory reports back to the health service that cared for the patient; the confirming laboratory then submits the details of the resistance and organism to the secure CARAlert web portal.

No patient-level data are held in the CARAlert system. Authorised officers in each state and territory health department can access the CARAlert web portal directly for further information about their jurisdiction, including the name of the public hospital where a patient with a confirmed CAR was cared for, and to extract reports on their data.

CARAlert generates a weekly summary email alert to report information on confirmed CARs to state and territory health authorities, the Australian Government Department of Health and confirming laboratories.

Australian public and private laboratories that have the capacity to confirm CARs were identified through consultation with state and territory health authorities, the Public Health Laboratory Network and AGAR. In 2019, 28 confirming laboratories participated in CARAlert, and there was at least one confirming laboratory in each state and territory. The CARs that each of the confirming laboratories are able to confirm are regularly reviewed.

Appendix 3 Data Notes

The following are important considerations for interpreting CARAlert data:

1. The data are based on the date that the isolate with the confirmed CAR was collected.
2. States and territories refer to the state or territory where the CAR was detected. If place of residence is unknown or overseas, the state or territory of the originating laboratory is reported.
3. The same CAR/type/species is not submitted where the sample originated from the same patient who had the previous CAR, and the isolate was collected on the same day, or collected in the same admission or within three months.
4. Comparison between reports may be influenced by delayed detection or late submissions of CARs.
5. Number of CARs reported does not always equal the number of patients, as patients may have more than one CAR, or species, detected in a specimen.
6. Cut-off date for data that are included in updates and reports is four weeks after the end of each reporting period.
7. National summary data is provided; comparison across states and territories is provided for organisms where there are large numbers reported and a comparison is meaningful.
8. Revision of the CARAlert Laboratory Handbook in July 2019 may have a small impact on the reporting of some CARs.

Appendix 4 CARAlert confirming laboratories, 2019

The Commission thanks all the originating and confirming laboratories for their support for CARAlert and AURA. The following confirming laboratories contributed to CARAlert in 2019:

State or Territory	Institution
Australian Capital Territory	ACT Pathology, Garran
New South Wales	NSW Health Pathology, Concord Hospital, Concord
	NSW Health Pathology, Liverpool Hospital, Liverpool
	NSW Health Pathology, John Hunter Hospital, New Lambton Heights
	NSW Health Pathology, Royal North Shore Hospital, St Leonards
	NSW Health Pathology, Royal Prince Alfred Hospital, Camperdown
	NSW Health Pathology, St George Hospital, Kogarah
	NSW Health Pathology, The Prince of Wales Hospital, Randwick
	NSW Health Pathology, Westmead Hospital, Westmead
	St Vincent's Pathology (SydPath), Darlinghurst
Northern Territory	Territory Pathology, Tiwi
Queensland	Pathology Queensland, Central laboratory, Royal Brisbane and Women's Hospital, Herston
	Pathology Queensland, Forensic & Scientific Services, Coopers Plains
	QML Pathology, Murarrie
	Sullivan Nicolaides Pathology, Bowen Hills
South Australia	SA Pathology, Royal Adelaide Hospital, Adelaide
Tasmania	Royal Hobart Hospital, Hobart)
Victoria	Alfred Pathology Service, Melbourne
	Austin Pathology, Heidelberg
	Dorevitch Pathology, Heidelberg
	Microbiological Diagnostic Unit Public Health Laboratory, Melbourne
	Victorian Infectious Diseases Reference Laboratory (VIDRL), Melbourne
	Melbourne Pathology, Collingwood
	Monash Pathology, Clayton
	St Vincent's Hospital, Fitzroy
Western Australia	PathWest Laboratory Medicine WA, Fiona Stanley Hospital, Murdoch
	PathWest Laboratory Medicine WA, QEII Medical Centre, Nedlands
	Australian Clinical Labs, Osborne Park

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