



Australian Government
**Department of Health
and Aged Care**

2023 · Volume 47

Communicable Diseases Intelligence

Australian Gonococcal Surveillance Programme

Annual Report, 2022

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<https://doi.org/10.33321/cdi.2023.47.45>

Electronic publication date: 24/8/2023

<http://health.gov.au/cdi>

Communicable Diseases Intelligence

ISSN: 2209-6051 Online

This journal is indexed by Index Medicus and Medline.

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Communicable Diseases Intelligence (CDI) is a peer-reviewed scientific journal published by the Office of Health Protection, Department of Health and Aged Care. The journal aims to disseminate information on the epidemiology, surveillance, prevention and control of communicable diseases of relevance to Australia.

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Australian Gonococcal Surveillance Programme Annual Report, 2022

Monica M Lahra, Sebastiaan J van Hal and Tiffany R Hogan for the National Neisseria Network, Australia

Abstract

The Australian Gonococcal Surveillance Programme (AGSP) has continuously monitored antimicrobial resistance in *Neisseria gonorrhoeae* for more than 40 years. In 2022, a total of 8,199 isolates from patients in the public and private sectors, in all jurisdictions, were tested for *in vitro* antimicrobial susceptibility by standardised methods.

The current treatment recommendation for gonorrhoea, for the majority of Australia, continues to be dual therapy with ceftriaxone and azithromycin. In 2022, of *N. gonorrhoeae* isolates tested, 0.51% (42/8,199) met the WHO criterion for ceftriaxone decreased susceptibility (DS), defined as a minimum inhibitory concentration value ≥ 0.125 mg/L.

Resistance to azithromycin was reported in 3.9% of *N. gonorrhoeae* isolates, proportionally stable since 2019. There were nine isolates with high-level resistance to azithromycin (MIC value ≥ 256 mg/L) reported in Australia: Queensland (4), New South Wales (3), Victoria (1) and non-remote Western Australia (1). This is the highest number detected annually by the AGSP.

In 2022, penicillin resistance was found in 38.8% of gonococcal isolates, and ciprofloxacin resistance in 63.3%, however, there was considerable variation by jurisdiction. In some remote settings, penicillin resistance remains low; in these settings, penicillin continues to be recommended as part of an empiric therapy strategy. In 2022, in remote Northern Territory, one penicillin-resistant isolate was reported; in remote Western Australia, 11.8% of gonococcal isolates (9/76) were penicillin resistant. There were three ciprofloxacin-resistant isolates reported from remote Northern Territory; ciprofloxacin resistance rates remain comparatively low in remote Western Australia (6/76; 7.9%).

Keywords: antimicrobial resistance; disease surveillance; gonococcal infection; *Neisseria gonorrhoeae*

Introduction

The National Neisseria Network (NNN) is a collaborative network established in the late 1970s that comprises jurisdictional *Neisseria* reference laboratories across Australia. The NNN laboratories provide reference-level services for the pathogenic *Neisseria* species: *N. gonorrhoeae* (NG) and *N. meningitidis*. The Australian Gonococcal Surveillance Programme (AGSP) is a key activity of the NNN and has been operational for more than 40 years.¹ Over these decades, the AGSP has reported the emergence

of resistance to antibiotics used in the treatment of gonorrhoea, and has detected and reported multi- and extensively-drug-resistant gonococcal strains in recent years. In 2017, the first evidence of sustained spread of multi-drug-resistant gonorrhoea was reported,² followed in 2018 by coincident reports from Australia and the United Kingdom of the first extensively-drug-resistant *N. gonorrhoeae* isolates.^{3–5} The emergence of NG antimicrobial resistance (AMR) in Australia has largely occurred following introduction of multi-resistant strains from overseas.^{5,6} The importation and spread of

ceftriaxone-resistant gonococcal strains, and/or of new resistance developing, remains an ongoing concern for disease control strategies, and is a focus of the work of the NNN.

The background rate of isolates with decreased susceptibility to ceftriaxone in Australia has remained low, and relatively stable, since the introduction of dual therapy for gonorrhoea in 2014. However, the AGSP has reported an increase in AMR notifications in 2022. Continuous AMR surveillance remains imperative, to detect the emergence and spread of resistant strains, endangering empirical therapeutic regimens.^{6,7} The increased proportion of gonococcal isolates with azithromycin resistance in recent years has also added to concerns about management strategies, and continues to be monitored.

Notification rates of gonococcal infections in Australia increased by 127% between 2012 and 2019 (from 62.3 to 141.4 per 100,000 population per year), and then declined by 23% coincident with the coronavirus disease 2019 (COVID-19) restrictions in 2020 to 2021.⁸ In 2022 the notifications were similar to that reported in 2019.⁸ Gonococcal disease rates in the Aboriginal and Torres Strait Islander population remained markedly higher in 2022 than in the non-Indigenous population (484.1 per 100 000 population, five times higher than that of the non-Indigenous population at 93.1 per 100 000 population) and were highest in remote and very remote areas.⁸ Whilst gonococcal disease rates are highest in Australia in remote and very remote areas, NG AMR in these regions remains low, where infections are acquired locally. In remote regions the recommended therapeutic strategy, based on surveillance data, remains centred on oral penicillin.⁹

In recent years, the heightened international awareness of gonococcal disease has coincided with increased molecular diagnoses replacing bacterial culture and antimicrobial susceptibility testing (AST). The corollary of this is a reduction in gonococcal isolates available for AMR surveillance.^{8,10} Although molecular tests

can detect genetic mechanisms known to be associated with resistance, such tests cannot detect novel resistances. Uniquely, in some remote regions of Australia, molecular assays are used to detect penicillin resistance in NG,^{11,12} the first documented use of such testing for NG AMR detection and surveillance.^{12,13} These data inform local treatment guidelines.¹³

Strategies for treatment and control of gonorrhoea are based on regimens effecting cure in a minimum of 95% of cases. Surveillance data of antibiotics in clinical use are critical to monitor AMR; to detect imported or novel resistance; and to inform treatment guidelines.¹¹ The World Health Organization (WHO) has called for enhanced surveillance as a fundamental component of its Global Action Plan to control the spread and impact of gonococcal AMR.¹⁴

Methods

Gonorrhoea infections are notifiable under legislation in Australia to the National Notifiable Diseases Surveillance System (NNDSS). The isolates tested by the NNN, and reported by the AGSP, represent a proportion of the total number of notified cases. The NNN laboratories test gonococcal isolates for susceptibility to ceftriaxone, azithromycin, penicillin, ciprofloxacin, spectinomycin and tetracycline. In addition, many NNN laboratories are testing gentamicin; these data were first reported by the AGSP in 2020, and reporting continues in 2022.

Antimicrobial susceptibility testing is performed using standardised methodology to determine the minimum inhibitory concentration (MIC) value, the lowest antibiotic concentration that inhibits *in vitro* growth under defined conditions. The coordinating lab for the NNN, the World Health Organization Collaborating Centre for Sexually Transmitted Infection and Antimicrobial Resistance (WHO CC, Sydney), conducts a programme-specific quality assurance program.¹⁵ Gonococcal AST data from each jurisdiction are submitted quarterly to the WHO CC, Sydney. Where available, the AGSP collects data on the sex of the patient;

the country of acquisition of infection; and the site of isolation of gonococcal isolates. Data collected across jurisdictions are predominantly from urban centres. Data from the Northern Territory and Western Australia are further divided into non-remote and remote regions determined at the jurisdictional level.

Results

Proportion of gonococcal infections with antimicrobial susceptibility testing

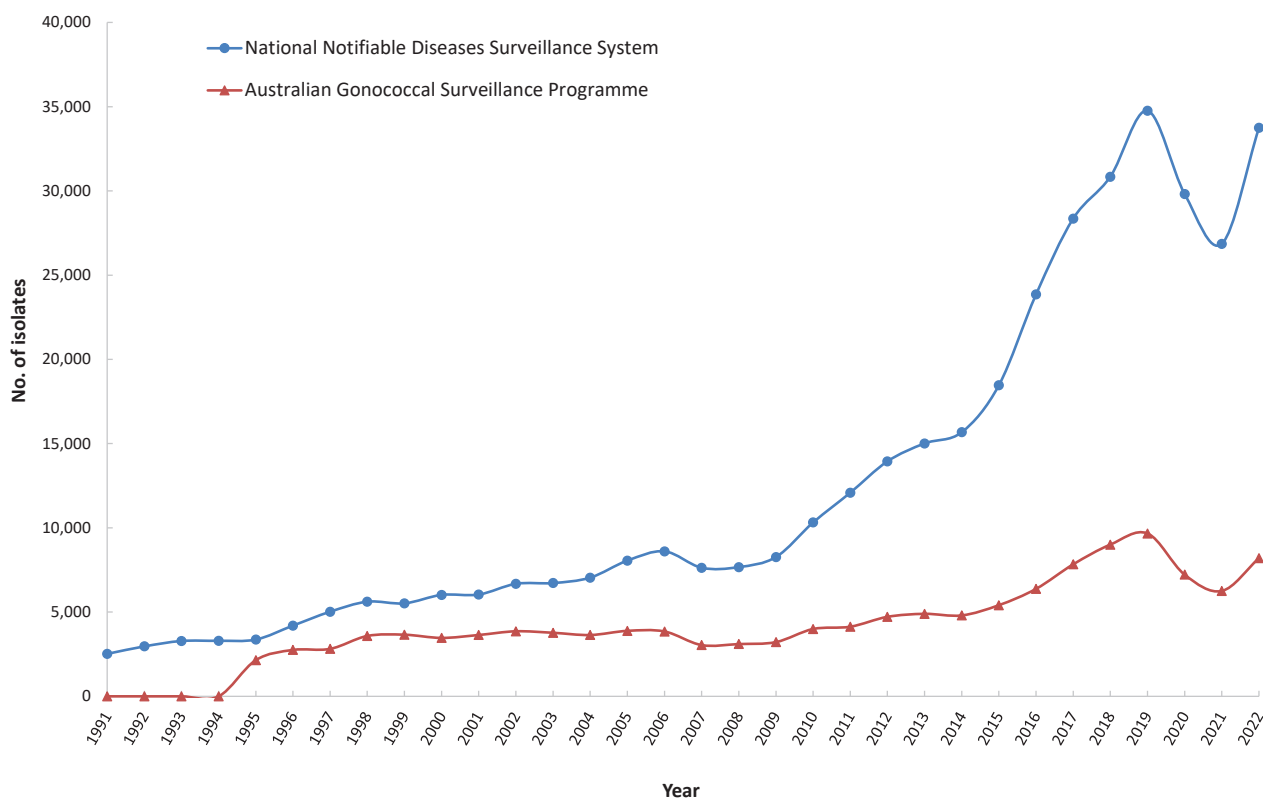
In 2022 there were 33,742 gonococcal infections notified in Australia,¹⁶ and 8,199/33,742 (24%) had isolates available for AST performed by the NNN laboratories (Table 1). This is reflected in Figure 1, which plots AGSP (culture-confirmed cases) against national notification data (which includes both the AGSP and culture-independent diagnosis).

Across jurisdictions, the proportion of diagnoses made by culture varies, ranging from 12% to 79% as shown in Table 1. The lowest proportion is from the remote and very remote communities of the Northern Territory and Western Australia, where bacterial cultures are performed less often and where disease rates are high.⁸ The proportion is highest from the Australian Capital Territory, and likely reflects the small number of notifications in that jurisdiction.

Gonococcal isolates, Australia, 2022, by sex, site and jurisdiction tested

There were 6,474 isolates tested in 2022 from males (79%) and 1,666 (20.3%) from females (Table 2). There were 59 isolates (0.72%) from patients whose sex was not recorded or recorded as 'other'. The proportion of gonococcal isolates from males and females has remained stable over recent years (2009–2021), ranging between 17% and 22% for females and between 78% and

Figure 1: Number of gonococcal disease cases reported to the National Notifiable Diseases Surveillance System,^a compared with *Neisseria gonorrhoeae* isolates available for laboratory testing by the Australian Gonococcal Surveillance Programme, Australia, 1991–2022



a Source: National Notifiable Diseases Surveillance System. Accessed 8 March 2023.¹⁶

Table 1: Number of Australian Gonococcal Surveillance Programme gonococcal isolates tested as a proportion of National Notifiable Diseases Surveillance System (NNDSS) gonorrhoea notifications,^a Australia, 2022, by state or territory

State or territory	Number of isolates tested	Number of cases notified	Number of isolates tested/ Number of cases notified (%)
Australian Capital Territory	218	276	79%
New South Wales	2,756	10,297	27%
Northern Territory	251	2,104	12%
Queensland	1,379	6,405	22%
South Australia	458	1,789	26%
Tasmania	97	287	34%
Victoria	2,485	9,291	27%
Western Australia	555	3,293	17%
Australia	8,199	33,742	24%

a Source: National Notifiable Diseases Surveillance System. Accessed 8 March 2023.¹⁶

83% for males.¹⁷ The infected site was reported as ‘other’ or not specified for 132 isolates from males and for 34 isolates from females (Table 2). Isolates from urine samples were regarded as genital tract isolates.

Antimicrobial resistance profile of *Neisseria gonorrhoeae*

For 2022, the numbers and proportions of gonococcal isolates resistant to azithromycin, ciprofloxacin and penicillin, are shown in Table 3. There continues to be variation across jurisdictions, as well as in remote settings when compared to non-remote settings.

Ceftriaxone

Gonococcal isolates with ceftriaxone MIC values ≥ 0.06 mg/L have been detected and reported in Australia since 2001. The proportion reported by the AGSP increased to 4.4% in 2012, before doubling to 8.8% in 2013. However, from 2014, coincident with the introduction of dual ceftriaxone and azithromycin therapy, there has been an overall declining trend in the proportion of gonococcal isolates with decreased susceptibility to ceftriaxone in Australia, as shown in Table 4 and Table 5. In 2022 there was

a surge in the number and proportion of isolates with ceftriaxone MIC values ≥ 0.06 mg/L, reported in the majority from New South Wales (Table 4 and Table 5). Genomic investigations in New South Wales identified expansion of a clone of limited genomic diversity of multilocus sequence type (MLST) ST-7827, detected in male and female patients across the state. All these were susceptible to azithromycin, but resistant to ciprofloxacin. ST-7827 isolates were also reported in 2022 in lower numbers from South Australia.

There were eight isolates reported with ceftriaxone MIC values ≥ 0.25 mg/L in 2022: New South Wales (3); non-remote Western Australia (3); Queensland (1); and Victoria (1). All had the *penA* allele 60.001, which encodes key alterations in the penicillin binding protein 2 associated with ceftriaxone resistance—detected on genomic analysis by the NNN Laboratories. Public Health investigations were conducted at the jurisdictional level, with three of eight cases reporting contact in the Asia Pacific.

One of the three isolates with ceftriaxone MIC values ≥ 0.25 mg/L reported from non-remote Western Australia had an extensively drug resistant (XDR) profile with resistance to penicillin

Table 2: Gonococcal isolates, Australia, 2022, by sex, site and jurisdiction^a tested

Sex	Site	ACT ^a	NSW	NT	Qld	SA	Tas.	Vic.	WA	Australia
Male	Genital	69	1,110	169	587	216	36	914	335	3,436
	Rectal	54	659	8	190	71	16	683	30	1,711
	Pharynx	49	464	6	110	25	17	485	20	1,176
	DGI ^b	0	5	1	6	1	0	5	1	19
	Other/NS ^c	0	47	1	24	33	9	10	8	132
	Total	172	2,285	185	917	346	78	2,097	394	6,474
Female	Genital	33	363	65	413	96	17	303	148	1,438
	Rectal	2	15	0	12	6	0	8	4	47
	Pharynx	9	60	0	27	3	1	31	6	137
	DGI	1	3	1	1	0	0	1	3	10
	Other/NS	0	14	0	9	5	1	5	0	34
	Total	45	455	66	462	110	19	348	161	1,666
Other	Genital	1	8	0	0	1	0	12	0	22
	Rectal	0	2	0	0	0	0	9	0	11
	Pharynx	0	4	0	0	0	0	13	0	17
	DGI	0	0	0	0	0	0	0	0	0
	Other/NS	0	0	0	0	0	0	0	0	0
	Total	1	14	0	0	1	0	34	0	50
Unknown	Genital	0	0	0	0	0	0	4	0	4
	Rectal	0	2	0	0	0	0	1	0	3
	Pharynx	0	0	0	0	1	0	1	0	2
	DGI	0	0	0	0	0	0	0	0	0
	Other/NS	0	0	0	0	0	0	0	0	0
	Total	0	2	0	0	1	0	6	0	9
Total		218	2,756	251	1,379	458	97	2,485	555	8,199

a ACT: Australian Capital Territory; NSW: New South Wales; NT: Northern Territory; Qld: Queensland; SA: South Australia; Tas.: Tasmania; Vic.: Victoria; WA: Western Australia.

b DGI: Disseminated gonococcal infection.

c NS: not specified.

and ciprofloxacin and high-level azithromycin resistance (MIC value \geq 256mg/L). Jurisdictional investigations including genomics are ongoing, with a sequence type ST-16406 identified for this isolate at the time of this report, and reported confirmation of Asia-Pacific contact.

Azithromycin

Nationally, in 2022, azithromycin resistance was exhibited by 3.9% of isolates (Table 3), a decrease from 4.7% in 2021. Since 2012, rates of azithromycin resistance increased from 1.3% to a peak of 9.3% in 2017, then declined to 3.9% in 2020 (Table 6). Rates of azithromycin-resistant

Table 3: Number and proportion (%) of gonococcal isolates with resistance to azithromycin, ciprofloxacin and penicillin reported, Australia, 2022, by state or territory

State or territory	Number of isolates tested	Resistance					
		Azithromycin		Ciprofloxacin		Penicillin	
		n	%	n	%	n	%
Australian Capital Territory	218	7	3.2	125	57.3	71	32.6
New South Wales	2,756	109	4.0	2,093	75.9	1,043	37.8
Queensland	1,379	32	2.3	692	50.2	496	36.0
South Australia	458	3	0.7	222	48.5	188	41.0
Tasmania	97	5	5.2	43	44.3	22	22.7
Victoria	2,485	144	5.8	1,798	72.4	1,183	47.6
Northern Territory non-remote	89	1	1.1	21	23.6	19	21.3
Northern Territory remote	162	0	0	3	1.9	1	0.6
Western Australia non-remote	479	16	3.3	186	38.8	153	31.9
Western Australia remote	76	0	0	6	7.9	9	11.8
Australia	8,199	317	3.9	5,189	63.3	3,185	38.8

NG were highest in Victoria (5.8%), Tasmania (5.2%), New South Wales (4.0%), non-remote Western Australia (3.3%) and the Australian Capital Territory (3.2%) (Tables 5 and 6). In 2022, nine isolates exhibited high-level resistance to azithromycin (MIC \geq 256 mg/L), reported from Queensland (4), New South Wales (3), Victoria (1) and non-remote Western Australia (1).

Penicillin

Penicillin resistance results from β -lactamase production (i.e., penicillinase) and/or from the aggregation of chromosomally-controlled resistance mechanisms. These are denoted respectively as penicillinase-producing *N. gonorrhoeae* (PPNG) and chromosomally-mediated resistance to penicillin (CMRP).

In 2022, in Australia, 3,185 isolates (38.8%) were penicillin resistant (Table 3), an increase from 2020 (26.6%). The proportion of penicillin-resistant isolates has fluctuated in the range 22% to 44% between 2008 and 2021.¹⁷ In 2022, of the 3,185 penicillin-resistant isolates, there were 1,137 (35.7%) with CMRP; 2,048 (64.3%) were PPNG.

Penicillin resistance in remote Australia

In 2022, there were 251 isolates tested from the Northern Territory, with 162 referred from remote areas (including Alice Springs, Katherine, Tennant Creek, and Arnhem Land region) and 89 from Darwin and surrounding urban areas (non-remote). In 2022, there were 555 isolates tested from Western Australia, with 76 referred from remote regions and 479 from urban and suburban Perth (non-remote).

Of the 162 isolates from remote Northern Territory, one was penicillin resistant, PPNG (0.6%). Of the 76 isolates from remote Western Australia, nine (11.8%) were penicillin resistant, all of which were PPNG.

Ciprofloxacin

In 2022, ciprofloxacin resistance was reported in 5,189 isolates (63.3%), an increase from 52.9% in 2021 (Table 3). Ciprofloxacin has not been recommended in Australia as first-line therapy for gonococcal infections since the late 1990s. As reported by the AGSP, the rate of ciprofloxacin resistance progressively declined

Table 4: Number and proportion (%) of gonococcal isolates with decreased susceptibility to ceftriaxone (MIC ≥ 0.06 mg/L), Australia, 2014 to 2022, by state or territory

State or territory	Decreased susceptibility to ceftriaxone (MIC ≥ 0.06 mg/L)																	
	2014		2015		2016		2017		2018		2019		2020		2021		2022	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Australian Capital Territory	2	2.7	0	0	1	0.9	0	0	4	1.9	1	0.5	0	0	1	0.5	6	2.8
New South Wales	119	7.1	52	2.7	45	2.0	13	0.5	30	0.8	44	1.2	30	1.2	18	0.9	332	12
Queensland	21	3.2	7	1.0	32	3.7	11	0.9	18	1.3	16	1.0	17	1.1	4	0.4	8	0.6
South Australia	2	1.0	9	3.6	2	0.6	2	0.6	3	1.3	9	1.6	0	0	4	1.4	18	3.9
Tasmania	0	0	0	0	1	3.6	0	0	4	7.3	1	2.1	0	0	1	1.4	0	0
Victoria	95	6.6	25	1.5	19	1.1	48	2.1	83	3.2	42	1.6	18	1.1	25	1.3	82	3.3
Northern Territory non-remote	3	3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1.1
Northern Territory remote	1	0.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Western Australia non-remote	14	3.6	5	1.3	9	1.3	9	1.4	14	2.1	11	1.5	3	0.4	1	0.2	9	1.9
Western Australia remote	1	0.9	0	0	0	0	0	0	0	0	2	2.4	0	0	0	0	0	0
Australia	258	5.4	98	1.8	109	1.7	83	1.1	156	1.7	126	1.3	68	0.9	54	0.9	456	5.6

in Australia since 2008, peaking at 71%, before reaching a nadir of 25.6% in 2018.⁷ The increase in ciprofloxacin resistance from 52.9% in 2021 can be attributed to an extent to the expansion of the ST-7827 clone, particularly in New South Wales.

Tetracyclines

To optimise reporting of tetracycline resistance in *N. gonorrhoeae*, from 2018, NNN reference laboratories have performed tetracycline MIC testing where possible. This replaces historical breakpoint testing for high-level tetracycline-resistant *N. gonorrhoeae* (TRNG) (MIC ≥ 16 mg/L) that was previously reported by the AGSP as an epidemiological marker for plasmid-mediated resistance. Tetracycline resistance is defined as MIC ≥ 2 mg/L. Nationally in 2022, sixty percent of isolates (4,898/8,199) were tested, and 45% of tested isolates (2,207/4,898)

were tetracycline resistant. Tetracycline resistance data are presented by jurisdiction and aggregated for Australia as shown in Table 7.

Spectinomycin

In 2022, all isolates tested (n = 7,545) were susceptible to spectinomycin.

Gentamicin

In 2022, gentamicin susceptibility testing data was available for 3,774 isolates originating from New South Wales, Tasmania, Western Australia and the Northern Territory. The median MIC value was 4 mg/L; and the range was ≤ 1.0–16 mg/L. There are no gentamicin breakpoints defined for *N. gonorrhoeae*.

Discussion

In 2022, there was a return to pre-pandemic numbers of notifications of *N. gonorrhoeae*

Table 5: Proportion (%) of gonococcal isolates tested in Australia with ceftriaxone MIC values at 0.06 mg/L and \geq 0.125 mg/L and resistance to azithromycin, 2010–2022

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Number of isolates tested nationally	4,100	4,230	4,718	4,897	4,804	5,411	6,378	7,835	9,006	9,668	7,222	6,254	8,199
Ceftriaxone MIC 0.06 mg/L	4.80%	3.20%	4.10%	8.20%	4.80%	1.70%	1.65%	1.02%	1.67%	1.19%	0.87%	0.83%	5.05%
Ceftriaxone MIC \geq 0.125 mg/L	0.10%	0.10%	0.30%	0.60%	0.60%	0.10%	0.05%	0.04%	0.06%	0.11%	0.07%	0.03%	0.51%
Ceftriaxone DS total^a	4.90%	3.30%	4.40%	8.80%	5.40%	1.80%	1.70%	1.06%	1.73%	1.30%	0.94%	0.86%	5.56%
Azithromycin resistance	n/a	1.1%	1.3%	2.1%	2.5%	2.6%	5.0%	9.3%	6.2%	4.6%	3.9%	4.7%	3.9%

a DS: decreased susceptibility.

infections in Australia (n = 33,742).¹⁶ The NNN jurisdictional reference laboratories reported data from clinical testing of 8,199 *N. gonorrhoeae* isolates (representing 24% of infections) from urban and remote settings in both public and private health sectors. The remote regions of Western Australia and the Northern Territory continue to report the highest rates of gonococcal disease, relatively low rates of AMR, and low numbers of isolates available for AST.

From 2016 to 2018, the proportion of isolates with ceftriaxone MIC values of \geq 0.125 mg/L reported by the AGSP remained stable in the range 0.04–0.06%; however, in 2019, this increased to 0.11% (Table 5). In 2020, there was one isolate reported from Victoria, and in 2021 one isolate (0.9%) reported from non-remote Western Australia with ceftriaxone MIC \geq 0.25 mg/L. In 2022 the AGSP reported a surge in the number and proportion of isolates with ceftriaxone MIC values \geq 0.06 mg/L (historically reported as decreased susceptibility by the AGSP), from 0.9% in 2021 to 5.6%.

Nationally, there were 42 isolates with ceftriaxone MIC values \geq 0.125mg/L (meeting the WHO criteria for ceftriaxone decreased susceptibility):¹⁴ New South Wales (27); Victoria (7); Western Australia (4); South Australia (3);

and Queensland (1). Genomic investigations of the 27 ceftriaxone DS isolates reported in New South Wales identified expansion of a clone of limited genomic diversity of sequence type ST-7827 in 24/27 (89%) isolates, detected in male and female patients across the state. These ST-7827 isolates had a non-mosaic *penA* allele, and all were susceptible to azithromycin, but were resistant to ciprofloxacin (reflected in the increase in ciprofloxacin resistance in New South Wales, ranging from 29–36% in the period 2015–2019 to 76% in 2022). Public health investigations in New South Wales reported no treatment failures. At the time of this report, detection of ST-7827 *N. gonorrhoeae* in New South Wales has subsided. Similarly, from Norway *N. gonorrhoeae* ST-7827 rates increased rapidly in the population from 2% to 20% in two years (2016–2018) and then waned.¹⁸ The ST-7827 clone emerged around 2013 from Southeast Asia and spread globally.¹⁸ In 2022, ST-7827 isolates were also reported in 2022 in lower numbers from South Australia.

Of the 42 isolates with decreased susceptibility to ceftriaxone, 8/42 had ceftriaxone MIC values of \geq 0.25mg/L: New South Wales (3); Western Australia (3); Victoria (1); and Queensland (1). Of these, all were confirmed by whole genome sequencing to harbour the mosaic *penA* allele

Table 6: Number and proportion (%) of gonococcal isolates with resistance to azithromycin, Australia, 2012 to 2022, by state or territory

State or territory ^a	Azithromycin resistance																							
	2012		2013		2014		2015		2016		2017		2018		2019		2020		2021		2022			
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%		
ACT	0	0	1	2.2	7	9.3	0	0	8	7.1	3	2.1	18	8.7	14	7.1	9	6.1	6	3.2	7	3.2		
NSW	9	0.5	14	0.9	33	2.0	43	2.3	82	3.6	261	9.3	230	6.5	215	6.0	181	7.0	191	9.9	109	4.0		
Qld	15	2.1	38	5.7	23	3.5	42	5.8	10	1.2	61	4.9	68	4.9	32	1.9	43	2.9	14	1.2	32	2.3		
SA	1	0.7	6	2.8	1	0.5	7	2.8	68	19.5	46	12.8	7	3.0	11	2.0	1	0.3	3	1.0	3	0.7		
Tas.	0	0	0	0	1	3.3	1	4.3	4	14.3	5	9.0	3	6.0	1	2.0	0	0	4	5.8	5	5.2		
Vic.	34	2.7	35	2.3	33	2.3	30	1.8	93	5.4	304	13.5	217	8.3	161	6.2	29	1.7	59	3.1	144	5.8		
NT non-remote	0	0	1	1.0	0	0	0	0	1	1.9	1	1.7	1	1.5	1	1.8	2	3.9	1	2.0	1	1.1		
NT remote	0	0	0	0	0	0	0	0	0	0	1	0.6	0	0	0	0	0	0	0	0	0	0		
WA non-remote	3	0.6	9	1.9	21	5.3	15	3.8	51	7.6	40	6.4	16	2.5	12	1.6	18	2.6	18	3.7	16	3.3		
WA remote	0	0	0	0	0	0	0	0	1	0.8	4	3.4	1	0.9	1	1.2	1	0.9	0	0	0	0		
Australia	62	1.3	104	2.1	119	2.5	138	2.6	318	5.0	726	9.3	561	6.2	448	4.6	284	3.9	296	4.7	317	3.9		

a ACT: Australian Capital Territory; NSW: New South Wales; Qld: Queensland; SA: South Australia; Tas.: Tasmania; Vic.: Victoria; NT: Northern Territory; WA: Western Australia.

Table 7: Number and proportion (%) of gonococcal isolates with resistance to tetracycline (MIC \geq 2 mg/L), Australia, 2022, by state or territory

State or territory	Number of isolates tested	Tetracycline resistance MIC \geq 2mg/L	
	2022	n	%
Australian Capital Territory	196	51	26%
New South Wales	258	52	20%
Queensland	1,341	500	37%
South Australia ^a	NT	NT	NT
Tasmania	97	16	16%
Victoria	2,428	1,451	60%
Northern Territory non-remote	10	1	10%
Northern Territory remote	17	1	6%
Western Australia non-remote	479	127	27%
Western Australia remote	72	8	11%
Australia	4,898	2,207	45%

a NT: not tested.

60.001 (encoding key alterations in the penicillin binding protein 2 associated with ceftriaxone resistance) and all cases had a confirmed travel history or association with the Asia Pacific region. A recent report from the United Kingdom (UK),¹⁹ describing a surge in detection of *N. gonorrhoeae* isolates harbouring the *penA* 60.001 allele, heightened concerns regarding emergence of gonococcal AMR. Previously, the UK reported nine cases from December 2015 to September 2021.

One of the three ceftriaxone MIC \geq 0.25 mg/L isolates reported from Western Australia in 2022 had an extensively drug resistant (XDR) profile (ceftriaxone MIC \geq 0.5 mg/L; azithromycin MIC \geq 256 mg/L). The first reports of XDR *N. gonorrhoeae* were from Australia (two unrelated cases, one with a travel history in the Asia-Pacific) and one from the UK (with travel link to Thailand) in 2018.^{20,21} On genomic analysis, there was limited diversity between the 2018 UK and Australian XDR isolates, suggesting these isolates belonged to the same gonococcal clone.²² In 2022 two further cases were reported, one in Austria with travel links

in Cambodia,²³ and another in the UK with contact in the Asia-Pacific.²¹ Genomic analysis found the 2022 UK and European isolates to be identical²¹ and related to the case reported in the UK in 2018. These findings strongly suggest these strains are in circulation in the Asia-Pacific.²¹ The detection of such an isolate in WA is extremely concerning; further investigations at the jurisdictional level are ongoing and will be reported.

Azithromycin resistance has been reported by the AGSP since 2007. Following the introduction of dual therapy in 2014, resistance to azithromycin in all jurisdictions of Australia has been observed (Table 6), increasing from 2016, and peaking at 9.3% in 2017. However, rates halved in 2019 (4.6%), and have remained relatively stable for the last three years (Table 6). In 2022, azithromycin resistance was highest in Victoria (5.8%), Tasmania (5.2%), New South Wales (4.0%), non-remote Western Australia (3.3%) and the Australia Capital Territory (3.2%). In 2013, high-level resistance (HLR; MIC \geq 256 mg/L) to azithromycin in gonococci was reported for the first time. Since then, there

have been sporadic reports of *N. gonorrhoeae* isolates with HLR to azithromycin in Australia annually; none were reported in 2021. In 2022, there were nine such isolates reported nationally. Data from the jurisdictions, where available, has indicated some of these were associated with overseas travel to South America and Africa.

In 2022, penicillin resistance was reported in 38.8% of isolates (3,185/8,199) (Table 3), an increase from 2020 (26.6%). The proportion of penicillin-resistant isolates has been reported in the range 22% to 44% between 2008 and 2021. In 2022, of the penicillin-resistant isolates, there were 1,137 isolates (35.7%) with CMRP; 2,048 isolates (64.3%) were PPNG. With regards to the isolates from remote regions, of the 162 isolates from remote Northern Territory, one was penicillin resistant, PPNG (0.6%). There were 76 isolates from remote Western Australia, nine (11.8%) were penicillin resistant, all of which were PPNG.

In 2022, ciprofloxacin resistance was reported in 63.3% of tested isolates, an increase from 52.9% in 2021 (Table 3). The rate of ciprofloxacin resistance reported in Australia had progressively declined since 2008 (71%) to 25.6% in 2018. The increase in ciprofloxacin resistance from 2021 can be attributed to an extent to the expansion of the ST-7827 clone, particularly in New South Wales.

In 2022, gentamicin susceptibility testing data were available for 3,774 *N. gonorrhoeae* isolates from New South Wales, Tasmania, Western Australia and the Northern Territory. The median MIC value was 4 mg/L; and the range was ≤ 1.0 –16 mg/L. There are no gentamicin breakpoints defined for *N. gonorrhoeae*. The inclusion of gentamicin as an indicator for ongoing surveillance by the AGSP is in line with the WHO Global Antimicrobial Resistance Surveillance System (GLASS).

Nationally in 2022, sixty percent of isolates (4,898/8,199) were tested for tetracycline resistance; 45% (2,207/4,898) were tetracycline resistant. Tetracycline resistance data are presented

by jurisdiction and aggregated for Australia as shown in Table 7. The highest rate was reported from Victoria (60%), with resistance reported in other jurisdictions (excluding remote Northern Territory and Western Australia) in the range 16–37%, noting there are no data from South Australia. There has been recent interest in the proportion of tetracycline resistance in NG in Australia, due to considerations of using this agent for possible pre- and post-exposure prophylaxis of bacterial sexually transmitted infections in high-risk populations.

With the relaxation of restrictions, a number of concerning observations are reported by the AGSP in 2022. Of the greatest concern are the surge in *N. gonorrhoeae* isolates detected nationally with the *penA* 60.001 allele; the detection of an isolate with a pan-resistant profile from WA; and the rapid expansion of the ST-7827 clone in New South Wales which has waned at the time of this report. Additional clinical, public health and laboratory investigations, including genomic analysis at the jurisdictional level, have been implemented as part of the response to these events. These include follow up, test of cure and investigations regarding travel history. The findings from this report underscore the ongoing importance of surveillance based on bacterial culture and AST of *N. gonorrhoeae*. These data are critically important to inform future therapeutic strategies; to monitor for the presence and spread of resistant isolates; and to detect instances of treatment failure.

Acknowledgements

The NNN is supported by the Australian Government Department of Health and Aged Care to provide the AGSP. We thank the many laboratories, private and public, throughout Australia for referral of isolates for testing.

Members of the NNN in 2022 (and to whom isolates should be referred): Amy Jennison, Vicki Hicks, Helen Smith and Gino Micalizzi (Queensland Public Health Microbiology, Forensic and Scientific Services, Coopers Plains, Queensland); Athena Limnios, Tiffany Hogan, Ratan Kundu, Sanghamitra Ray, Jasmin El-Nasser, Sebastiaan J van Hal and Monica M Lahra (WHO CC for STI and AMR New South Wales Health Pathology Department of Microbiology, The Prince of Wales Hospital, Randwick, New South Wales and School of Medical Sciences, Faculty of Medicine, the University of New South Wales, Kensington, New South Wales); Kerrie Stevens, Samantha Tawil, Paula Roydhouse, Angela Todd and Benjamin P Howden (The Microbiological Diagnostic Unit (PHL), Department of Microbiology and Immunology, Peter Doherty Institute for Infection and Immunity, The University of Melbourne, Parkville, Victoria); Megan Hodgson, Lex Leong, Casey Moore and Ivan Bastian (SA Pathology, South Australia); Julie Pearson, Hui Leen Tan and David Speers (Department of Microbiology and Infectious Diseases, PathWest Laboratory Medicine, Fiona Stanley Hospital, Western Australia); Belinda McEwan (Department of Microbiology and Infectious Diseases, Royal Hobart Hospital, Hobart, Tasmania); Kevin Freeman and Rob Baird (Microbiology Laboratory, Territory Pathology, Royal Darwin Hospital, Tiwi, Northern Territory); and Susan Bradbury, Cherie O'Brien, Mayleen Robles and Peter Collignon (Microbiology Department, The Canberra Hospital, Garran, Australian Capital Territory).

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