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Annual Report, 2021

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Australian Gonococcal Surveillance Programme Annual Report, 2021

Monica M Lahra, Tiffany R Hogan, Benjamin H Armstrong, for the National Neisseria Network, Australia

Abstract

The Australian Gonococcal Surveillance Programme, established in 1981, has continuously monitored antimicrobial resistance in *Neisseria gonorrhoeae* for more than 40 years. In 2021, a total of 6,254 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 2021, of isolates tested, 0.9% were reported nationally with decreased susceptibility (DS) to ceftriaxone (minimum inhibitory concentration [MIC] value ≥ 0.06 mg/L). There was one isolate from non-remote Western Australia that was resistant to ceftriaxone (MIC value ≥ 0.25 mg/L).

Resistance to azithromycin (MIC value ≥ 1.0 mg/L) was reported nationally in 4.7% of *N. gonorrhoeae* isolates. This is increased from that reported in 2020 (3.9%) but similar to the percentage reported in 2019 (4.6%). Isolates with high-level resistance to azithromycin (MIC value ≥ 256 mg/L) are identified sporadically in Australia; none were reported in 2021.

In 2021, penicillin resistance was found in 38% of gonococcal isolates nationally, and ciprofloxacin resistance in 53%; however, there is 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 2021, in remote Northern Territory, one penicillin-resistant isolate was reported, and in remote Western Australia 2/83 of gonococcal isolates (2.4 %) were penicillin resistant. There were two ciprofloxacin-resistant isolates reported from remote Northern Territory; ciprofloxacin resistance rates remain comparatively low in remote Western Australia (3/83; 3.6 %).

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 long been influenced

by the 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 remains low, and relatively stable, since the introduction of dual therapy for gonorrhoea in 2014. However, continuous AMR surveillance remains imperative, to detect novel resistant strains which may become swiftly entrenched, 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.

The public health measures enacted in the coronavirus disease 2019 (COVID-19) pandemic have impacted many communicable diseases in Australia, including gonorrhoea notifications. In 2021, there were 26,853 gonorrhoea disease notifications, representing a 10% decline from 2020, and a 23% decline from pre-pandemic levels in 2019 (29,838 and 34,735 notifications, respectively).⁸ This is on a background of increasing gonococcal disease notifications in this country, from 68.1 per 100,000 population in 2014 to 135.1 per 100,000 population in 2019, an overall increase of 98%.⁹ Gonococcal disease rates in the Aboriginal and Torres Strait Islander population remain markedly higher than in the non-Indigenous population (717.3 per 100 000 population, which is 7.3 times higher than that of the non-Indigenous population at 98.9 per 100 000 population) and are highest in remote and very remote areas.⁹ 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 some remote regions the recommended therapeutic strategy, based on surveillance data, remains centred on oral penicillin.¹⁰

In recent years, the heightened international awareness of gonococcal AMR, and increasing disease rates reported in Australia and elsewhere,^{9,11-14} 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. Molecular tests can detect genetic mutations already known to be associated with resistance; however, such tests cannot detect resistance via novel mutations. Uniquely, in some remote regions of Australia, molecular assays are used to detect penicillin resistance in NG,^{15,16} the first documented use of such testing for NG AMR detection and surveillance.^{17,18} These data inform local treatment guidelines.¹⁸

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.¹⁵ 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.¹⁶

Methods

Gonorrhoea infections are notifiable in Australia to the National Notifiable Diseases Surveillance System (NNDSS) under legislation. 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 reported in the AGSP for the first time in 2020, and this reporting continues in 2021.¹⁹

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 AGSP conducts a programme-specific quality assurance program.²⁰

Gonococcal AST data from each jurisdiction are submitted quarterly to the World Health Organization Collaborating Centre for Sexually Transmitted Infection and Antimicrobial Resistance (WHO CC, Sydney), the coordinating laboratory for the NNN. 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 2021, a total of 6,254/26,853 gonococcal infections notified in Australia (23%) had isolates available for AST performed by the NNN laboratories (Table 1). Overall, from 2020, gonococcal notifications and clinical isolates both reduced in number, correlating with the ongoing impact of public health measures implemented during the COVID-19 pandemic. This is reflected in Figure 1, which plots culture-confirmed cases received by the AGSP against national notification data (that includes both the AGSP and culture-independent diagnosis).

Across jurisdictions, the proportion of notifications that were made by culture varies, as shown in Table 1, ranging from 20% to 56% (with the exception of the Northern Territory, where bacterial cultures are performed less often in patients from remote and very remote communities where disease rates are high).⁹ The proportion is higher from the Australian Capital Territory; however, the number of notifications from this jurisdiction is small.

Gonococcal isolates, Australia, 2021, by sex, site and jurisdiction tested

There were 4,887 isolates from males (78.1%) and 1,326 (21.2%) from females tested in 2021 (Table 2). There were 41 isolates (0.7%) from patients whose gender was recorded as other, or was unknown. 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 83% for males. The infected site was reported as ‘other’ or not specified for 72 isolates from males, for 38 isolates from females, and for nine isolates from unknown or other gender (Table 2). Isolates from urine samples were regarded as genital tract isolates.

Antimicrobial resistance profile of *Neisseria gonorrhoeae*

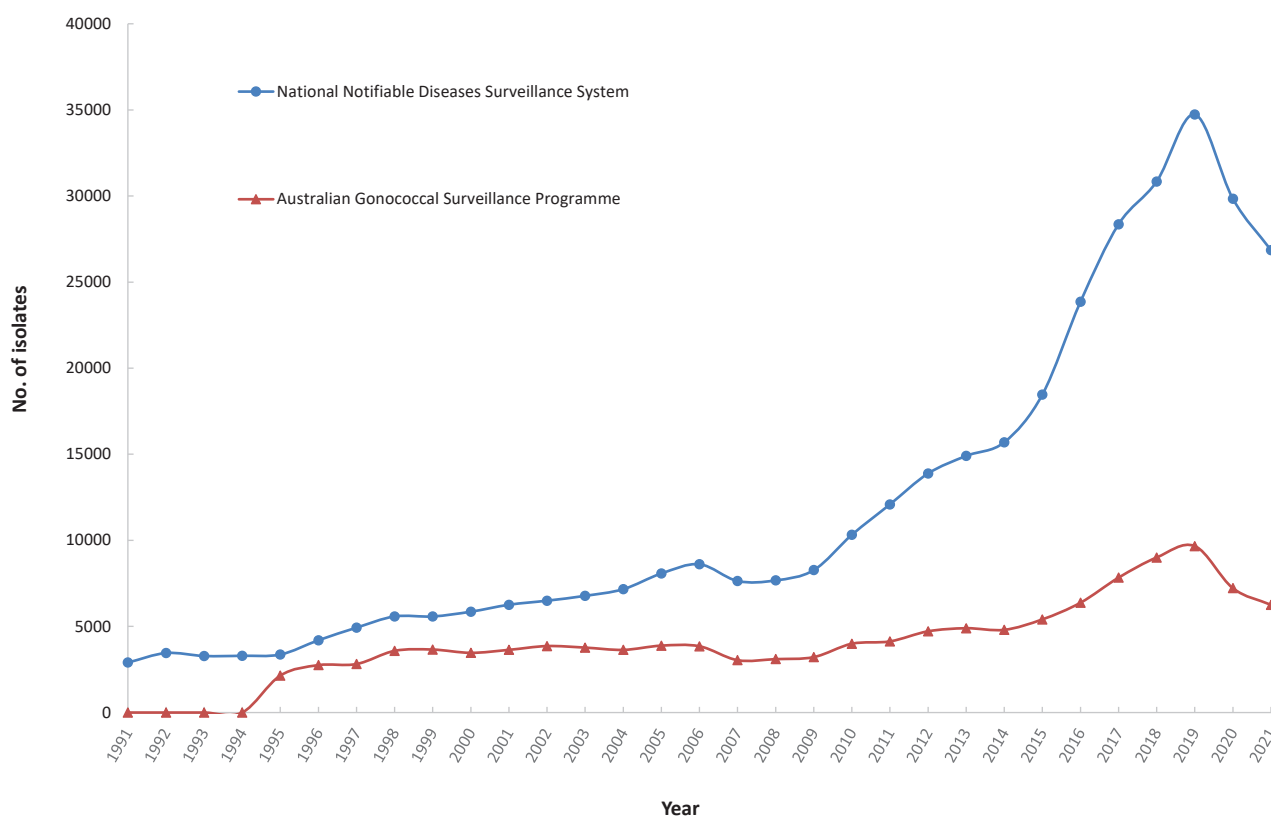
For 2021, the numbers and proportions of gonococcal isolates resistant to azithromycin, penicillin and ciprofloxacin, and with decreased susceptibility to ceftriaxone, are shown in Table 3. There continues to be variation across jurisdictions, as well as in remote settings when compared to non-remote settings.

Ceftriaxone

Gonococcal isolates with decreased susceptibility to ceftriaxone (MIC values ≥ 0.06 mg/L) have been detected in Australia since 2001. The proportion reported 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.

From 2016 to 2018, the proportion of isolates resistant to ceftriaxone (MIC values of ≥ 0.125 mg/L) 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

Figure 1: Number of gonococcal disease cases reported to the National Notifiable Diseases Surveillance System compared with *Neisseria gonorrhoeae* isolates available for laboratory testing by the Australian Gonococcal Surveillance Programme, Australia, 1991–2021^a



a Source: National Notifiable Diseases Surveillance System. Data extracted 14 April 2022.

Victoria, and in 2021 one isolate reported from non-remote Western Australia with ceftriaxone MIC ≥ 0.25 mg/L.

Azithromycin

Nationally, in 2021, azithromycin resistance (MIC value ≥ 1.0 mg/L) was exhibited by 4.7% of isolates (Table 3), an increase from 3.9% in 2020. 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 NG were highest in New South Wales (9.9%), Tasmania (5.8%), and non-remote Western Australia (3.7%) (Tables 3 and 6). In 2021, no isolate exhibited high-level resistance to azithromycin (MIC ≥ 256 mg/L).

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). Chromosomally-mediated resistance is defined as a penicillin MIC ≥ 1 mg/L.

In 2021, in Australia, 2,381 isolates (38.1%) 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. In 2021, there were 692 isolates (11.1%) with CMRP; 1,689 isolates (27.0%) were PPNG. Of penicillin-resistant isolates, 70.9% were PPNG.

Table 1: Number of Australian Gonococcal Surveillance Programme gonococcal isolates tested as a proportion of National Notifiable Diseases Surveillance System (NNDSS) gonorrhoea notifications, Australia, 2021, by state or territory^a

State or territory	Number of isolates tested	Number of cases notified	Number of isolates tested/ Number of cases notified (%)
Australian Capital Territory	186	330	56%
New South Wales	1,921	7,589	25%
Northern Territory	187	1,673	11%
Queensland	1,128	5,703	20%
South Australia	295	1,444	20%
Tasmania	69	183	38%
Victoria	1,899	7,028	27%
Western Australia	569	2,903	20%
Australia	6,254	26,853	23%

^a Source: National Notifiable Diseases Surveillance System. Data extracted 14 April 2022.

Penicillin resistance in remote Australia

In 2021, there were 187 isolates tested from the Northern Territory, with 130 derived from remote areas (including Alice Springs, Katherine, Tennant Creek, and Arnhem Land region) and 57 from Darwin and surrounding urban areas (non-remote). In 2021, there were 569 isolates tested from Western Australia, with 83 obtained from remote regions and 486 from urban and suburban Perth (non-remote).

Of the 130 isolates from remote Northern Territory, one was penicillin resistant PPNG (0.8%), while no isolates from Darwin and surrounding urban areas were penicillin resistant. Of the 83 isolates from remote Western Australia, two (2.4%) were penicillin resistant, both of which were PPNG.

Ciprofloxacin

Ciprofloxacin resistance is defined as MIC \geq 1 mg/L. In 2021, ciprofloxacin resistance was seen in 3,309 isolates (52.9%), a 45% increase from 36.4% in 2020 (Table 3). Ciprofloxacin has not been recommended in Australia as first-line therapy for gonococcal infections since the late 1990s; the rate of ciprofloxacin

resistance progressively declined in Australia since 2008, peaking at 71%, before reaching a nadir of 25.6% in 2018.⁷ The current impetus(es) behind the concerning proportional increase in ciprofloxacin resistance to 52.9% in 2021 remain unknown.

Tetracyclines

To optimise reporting of tetracycline resistance in *N. gonorrhoeae*, from 2018 NND reference laboratories have performed tetracycline MIC testing where possible. This replaces historical breakpoint testing for high-level tetracycline-resistant *N. gonorrhoeae* (TRNG) (MIC \geq 16 mg/L) that was previously reported as an epidemiological marker for plasmid-mediated resistance.

Tetracycline resistance is defined as MIC \geq 2 mg/L. Whilst tetracycline antibiotics are not a recommended treatment for gonorrhoea, and are rarely, if ever, used for treatment of gonorrhoea in Australia, there has been recent interest in the proportion of tetracycline resistance in NG, due to its use as a potential agent for prophylaxis of chlamydia and syphilis infections in high-risk populations.^{21, 22} This practice has already experienced some uptake in Australia.²³

Table 2: Gonococcal isolates, Australia, 2021, by sex, site and jurisdiction tested^a

Gender	Site	ACT	NSW	NT	Qld	SA	Tas.	Vic.	WA	Australia
Male	Genital	60	805	132	530	158	32	672	322	2,711
	Rectal	31	456	7	156	42	4	502	35	1,233
	Pharynx	47	295	1	77	14	9	376	28	847
	DGI ^b	0	15	1	2	3	0	1	2	24
	Other/NS ^c	0	17	6	15	4	2	25	3	72
	Total	138	1,588	147	780	221	47	1,576	390	4,887
Female	Genital	29	266	34	319	61	19	223	163	1,114
	Rectal	9	11	0	10	4	0	1	6	41
	Pharynx	10	43	0	13	2	2	51	6	127
	DGI	0	3	2	0	0	0	0	1	6
	Other/NS	0	7	3	6	6	1	12	3	38
	Total	48	330	39	348	73	22	287	179	1,326
Other	Genital	0	1	0	0	0	0	9	0	10
	Rectal	0	1	0	0	0	0	0	0	1
	Pharynx	0	1	0	0	0	0	11	0	12
	DGI	0	0	0	0	0	0	0	0	0
	Other/NS	0	0	0	0	0	0	7	0	7
	Total	0	3	0	0	0	0	27	0	30
Unknown	Genital	0	0	0	0	1	0	6	0	7
	Rectal	0	0	0	0	0	0	0	0	0
	Pharynx	0	0	1	0	0	0	1	0	2
	DGI	0	0	0	0	0	0	0	0	0
	Other/NS	0	0	0	0	0	0	2	0	2
	Total	0	0	1	0	1	0	9	0	11
Total		186	1,921	187	1,128	295	69	1,899	569	6,254

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.

Table 3: Number and proportion (%) of gonococcal isolates with decreased susceptibility to ceftriaxone and resistance to azithromycin, ciprofloxacin and penicillin reported, Australia, 2021, by state or territory

State or territory	Number of isolates tested		Decreased susceptibility		Resistance					
	Ceftriaxone MIC \geq 0.06 mg/L		Azithromycin MIC \geq 1.0 mg/L		Ciprofloxacin MIC \geq 1.0 mg/L		Penicillin MIC \geq 1.0 mg/L incl. PPNG ^a			
	n	%	n	%	n	%	n	%	n	%
Australian Capital Territory	186	0.5	6	3.2	76	40.9	65	34.9		
New South Wales	1,921	0.9	191	9.9	1,318	68.6	819	42.6		
Queensland	1,128	0.4	14	1.2	487	43.2	367	32.5		
South Australia	295	1.4	3	1.0	82	27.8	93	31.5		
Tasmania	69	1.4	4	5.8	27	39.1	16	23.2		
Victoria	1,899	1.3	59	3.1	1,125	59.2	869	45.8		
Northern Territory non-remote	57	0	1	1.8	12	21.1	0	0		
Northern Territory remote	130	0	0	0.0	2	1.5	1	0.8		
Western Australia non-remote	486	0.2	18	3.7	177	36.4	149	30.7		
Western Australia remote	83	0.0	0	0.0	3	3.6	2	2.4		
Australia	6,254	0.86	296	4.7	3,309	52.9	2,381	38.1		

a PPNG: penicillinase-producing *Neisseria gonorrhoeae*.

Table 4: Number and proportion (%) of gonococcal isolates with decreased susceptibility to ceftriaxone (MIC \geq 0.06mg/L), Australia, 2014 to 2021, by state or territory

State or territory	Decreased susceptibility to ceftriaxone																	
	2014		2015		2016		2017		2018		2019		2020		2021			
	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		
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		
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		
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		
Tasmania	0	0	0	0	1	3.6	0	0	4	7.3	1	2.1	0	0	1	1.4		
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		
Northern Territory non-remote	3	3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Northern Territory remote	1	0.8	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		
Western Australia remote	1	0.9	0	0	0	0	0	0	0	0	2	2.4	0	0	0	0		
Australia	258	5.4	98	1.8	109	1.7	83	1.1	156	1.7	127	1.3	68	0.9	54	0.9		

Table 5: Proportion (%) of gonococcal isolates tested in Australia with ceftriaxone MIC values at 0.06 mg/L and \geq 0.125 mg/L, 2010–2021

Ceftriaxone MIC mg/L	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
	0.06	4.80%	3.20%	4.10%	8.20%	4.80%	1.70%	1.65%	1.02%	1.67%	1.19%	0.87%
\geq 0.125	0.10%	0.10%	0.30%	0.60%	0.60%	0.10%	0.05%	0.04%	0.06%	0.11%	0.07%	0.03%
Total decreased susceptibility	4.90%	3.30%	4.40%	8.80%	5.40%	1.80%	1.70%	1.06%	1.73%	1.30%	0.94%	0.86%

Table 6: Number and proportion (%) of gonococcal isolates with resistance to azithromycin (MIC ≥ 1.0 mg/L), Australia, 2012 to 2021, by state or territory

State or territory	Azithromycin resistance																			
	2012		2013		2014		2015		2016		2017		2018		2019		2020		2021	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Australian Capital Territory	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
New South Wales	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
Queensland	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
South Australia	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
Tasmania	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
Victoria	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
Northern Territory 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
Northern Territory remote	0	0	0	0	0	0	0	0	0	0	1	0.6	0	0	0	0	0	0	0	0
Western Australia 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
Western Australia 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
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

Table 7: Number and proportion (%) of gonococcal isolates with resistance to tetracycline (MIC \geq 2 mg/L), Australia, 2021, by state or territory

State or territory	Number of isolates tested ^a	Tetracycline resistance MIC \geq 2 mg/L	
	2021	n	%
Australian Capital Territory	159	54	34%
New South Wales	NT	NT	NT
Queensland	1,098	380	35%
South Australia	NT	NT	NT
Tasmania	69	8	12%
Victoria	1,881	962	51%
Northern Territory non-remote	NT	NT	NT
Northern Territory remote	NT	NT	NT
Western Australia non-remote	486	142	29%
Western Australia remote	83	3	4%
Australia	3,776	1,549	41%

a NT: not tested.

Nationally in 2021, sixty percent of isolates (3,776/6,254) were tested, and 41% (1,549/3,776) were tetracycline resistant. Tetracycline resistance data are presented by jurisdiction and aggregated for Australia as shown in Table 7.

Spectinomycin

In 2021, all isolates tested (n = 5,800) were susceptible to spectinomycin.

Gentamicin

In 2021, gentamicin susceptibility testing data was available for 2,803 isolates originating from New South Wales, Tasmania, Western Australia and the Northern Territory. The median MIC value was 4 mg/L and no isolate was resistant to gentamicin.

Discussion

The World Health Organization (WHO) recommends that treatment regimens for gonorrhoea are based on epidemiological surveillance of the distribution and extent of AMR,

and that a resistance rate of 5% or more is the nominal threshold for change of treatment recommendations.^{15,25,26}

In 2021, the NNN examined 6,254 isolates from urban and remote settings in the public and private health sectors, constituting a comprehensive sample of about one-quarter of all notifications nationally.¹¹ The remote populations of Western Australia and the Northern Territory have the highest rates of gonococcal disease, but the lowest of diagnosis by culture (n = 213), as a function of laboratory access. These remote communities have low rates of AMR in NG and require continued vigilance with monitoring of AMR in NG, using both culture and molecular-based surveillance strategies.

For the AGSP, ceftriaxone MIC values of \geq 0.06 mg/L have been reported historically to have decreased susceptibility. In Australia, the proportion of isolates with decreased susceptibility to ceftriaxone has steadily and substantially declined since 2013, from 8.8% to 0.86% in 2021 (Table 5). In recent years, multiple- and extensively-drug-resistant strains have been reported from Asia, Europe and Australia,^{25–28} and it is

known that continued importation of resistant *N. gonorrhoeae* strains is the first step to establishment of resistance.^{6,29} However in Australia, since 2020, a reduction in ceftriaxone-resistant isolates in this country has coincided with the public health strategies of the COVID-19 pandemic, including restrictions on international travel.

In 2013, high-level resistance (HLR; MIC \geq 256 mg/L) to azithromycin in gonococci was reported for the first time in Australia in four strains, two with suspected contact in China.³⁰ Since then, there have been only sporadic reports of HLR to azithromycin in Australia annually; none were reported in 2021. Continued close observation is ongoing, as evidence of co-evolving cephalosporin and azithromycin resistance has been reported.³¹ 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). Importantly, in South Australia there was a rapid increase in azithromycin resistance from 2.8% in 2015 to 19.5% in 2016; however, azithromycin resistance rates in that jurisdiction have now fallen and stabilised (Table 6).³⁰ In 2021, azithromycin resistance was highest in New South Wales (9.9%), Tasmania (5.8%), and non-remote Western Australia (3.7%). Globally, there have been increasing reports of azithromycin resistance.²⁹

In 2021, the AGSP report continues the inclusion of AST data for gentamicin which commenced in 2020. Gentamicin is recommended by both the most recent WHO and Australian guidelines for management of resistant gonococcal infections.^{32,33} Although there is a paucity of clinical data relative to other anti-gonococcal therapies, recent clinical studies have demonstrated efficacy for gentamicin treatment of urethral gonorrhoea, but with reduced rates of oropharyngeal clearance compared to current standard therapy; data on rectal and other body

site infections are limited.^{34,35} A recent large-scale laboratory-based evaluation of gentamicin susceptibility in 2,768 clinical *N. gonorrhoeae* isolates from New South Wales demonstrated no *in vitro* resistance to gentamicin, and no detectable gentamicin MIC creep, over the years 2015–2020.⁷ A further 2,803 isolates were tested in this reporting period by New South Wales, Tasmania, the Northern Territory, and Western Australia, demonstrating comparable gentamicin MICs across all isolates tested; no gentamicin resistance was detected in any isolate. 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).

The recent reports of international spread of NG with resistance to ceftriaxone,⁴ and the emergence of azithromycin resistance, heighten concerns about the future treatment strategies for NG AMR.³⁶ As developed nations continue to transition to widespread pharmacological prevention of HIV infection in high-risk populations, a return to, and reinvigoration of, public health strategies promoting primary prevention (e.g. condoms) of gonorrhoea and other sexually transmissible infections is urgently required.^{37,38} Additionally, NG vaccine development is a research priority and may be key in the control of this disease. As Australian clinicians become increasingly dependent on molecular testing for diagnosis of NG (72% of diagnoses in 2021), health care provider education regarding the continued importance of bacterial culture and AST is paramount. Whilst advances in molecular detection of AMR have great promise, this report underscores the ongoing importance of bacterial culture and AST of NG for clinical management, detection of resistance and novel resistant strains, AMR surveillance, and test of cure. Given its strong history and association with NG AMR in Australia, treating clinicians should pay particular note to patient travel history, as for imported cases of NG, the benefit of bacterial culture and susceptibility testing is critical.

The WHO Global Action Plan states that disease control strategies need to be informed by quality-assured AMR surveillance data, nationally and internationally.¹⁶ These data are critically important to inform therapeutic strategies; to monitor for the presence and spread of resistance; and to detect instances of treatment failure.

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