Annual reports

Australian Gonococcal Surveillance Programme annual report, 2015

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Abstract

The Australian Gonococcal Surveillance Programme (AGSP) has continuously monitored antimicrobial resistance in clinical isolates of *Neisseria gonorrhoeae* from all Australian states and territories since 1981. In 2015, there were 5,411 clinical isolates of gonococci from public and private sector sources tested for *in vitro* antimicrobial susceptibility by standardised methods. Current treatment recommendations for the majority of Australian states and territories is a dual therapeutic strategy of ceftriaxone and azithromycin. Decreased susceptibility to ceftriaxone (minimum inhibitory concentration or MIC value 0.06–0.125 mg/L) was found nationally in 1.8% of isolates, which was lower than that reported in the AGSP annual report 2014 (5.4%). The highest proportions were reported from South Australia and New South Wales (3.6% and 2.7% respectively). High level resistance to azithromycin (MIC value ≥256 mg/L) was again reported in 2015, with 1 strain in each of New South Wales and urban Western Australia. There was no reported Azithromycin resistance in the Australian Capital Territory, the Northern Territory, or remote Western Australia. The proportion of strains resistant to penicillin in urban and rural Australia ranged from 8.7% in Tasmania to 33% in the Australian Capital Territory. In rural and remote Northern Territory, penicillin resistance rates remain low (2.2%). In remote Western Australia relatively low numbers of strains are available for testing, however there is now widespread molecular testing for penicillin resistance in Western Australia to monitor resistance and inform guidelines and these data are included in the AGSP annual report. Quinolone resistance ranged from 11% in the urban and rural areas of the Northern Territory, to 41% in South Australia. Quinolone resistance rates remain comparatively low in remote areas of the Northern Territory (3.3%) and remote areas of Western Australia (3.4%). There was no reported quinolone resistance in Tasmania, but the number of isolates tested was relatively low. Azithromycin resistance ranged from 1.8% in Victoria to 5.8% in Queensland. *Commun Dis Intell* 2017;41(1):E60–E67.

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

Introduction

Concerns regarding gonococcal antimicrobial resistance (AMR) persist internationally, and continues to be viewed as an urgent public health threat as identified by the United States Centers for Disease Control and Prevention in 2013.[1] The corollary of the emergence and spread of multidrug-resistant gonorrhoea is predicted to pose significant collateral health and financial costs.[1] The reliance on ceftriaxone and azithromycin for treatment in most settings continues with the future direction of gonococcal treatment uncertain, and there are no new or ideal alternative therapeutic strategies identified in the event of the spread of AMR.[2] In recent years in Australia, there has been a significant increase in rates of gonococcal disease observed in both males and females in the eastern states (Victoria, New South Wales and Queensland), and males in the Australian Capital Territory.[3] In contrast, gonococcal disease notification rates in the Indigenous populations from the remote regions of the Western states of Northern Territory and Western Australia, are markedly higher but relatively stable.[3] However, in these remote regions of Northern Territory and Western Australia with much higher rates of gonococcal disease notification rates, the AMR rate remains paradoxically low in locally-acquired infections, and an oral penicillin based therapeutic strategy remains recommended for use.[4]

In 2013, the Australian Gonococcal Surveillance Programme (AGSP) reported that the proportion of strains with decreased susceptibility to ceftriaxone nationally was 8.8%, double that reported in 2012 (4.4%). New South Wales and Victoria reported the highest proportions (11.8%) and these states also had the highest increases in disease notifications.[5] Coincident with this, in 2013, was the reporting of high level resistance to azithromycin (MIC value >256 mg/L), in 2 strains from Victoria and 2 from Queensland.[6] Also in 2013, an imported multidrug-resistant gonococcal strain, known as the A8806 strain, with a ceftriaxone MIC of 0.5 mg/L, the highest ever reported in Australia, was identified in Australia.[7] This A8806 strain showed key genetic similarities to the ceftriaxone-resistant strain H041, reported from a single case in Japan and not subsequently reported.[7]

Enhanced surveillance in the Northern Territory and Queensland has not detected further evidence of the A8806 strain in 2014 or 2015 (unpublished data from the National Neisseria Network).

In the context of the heightened awareness of AMR, and increasing disease notification rates reported in Australia and elsewhere, the widespread move to nucleic acid amplification testing (NAATs), has been identified as a concern as broad based antimicrobial susceptibility testing is not possible with NAATs. However, directed NAATs such as the assay developed to detect *Neisseria gonorrhoeae* penicillinase production[8,9] (the primary cause of penicillin resistance in remote regions in Australia) was the first documented use of molecular testing for gonococcal antimicrobial resistance detection and surveillance to monitor AMR, and inform local treatment guidelines.[9]

Of the World Health Organization (WHO) estimated 106 million new *N. gonorrhoeae* infections reported in those aged 15–49 years annually worldwide, almost two-thirds occur in the Asia–Pacific Region.[10] The WHO data from the Asia–Pacific indicates that, along with a disproportionate burden of gonococcal disease, there are high levels of gonococcal AMR in the region. Compounding these factors is the concern that uncontrolled antimicrobial use in countries in these regions provides ideal conditions for the development of AMR.[11] AMR in *N. gonorrhoeae* has long been influenced by the introduction of multi-resistant strains from overseas.[12] In this context the importation and spread of resistant gonococcal strains and/or resistance developing under selection pressure is an ongoing concern.

Strategies for treating and controlling gonorrhoea are based on regimens effecting cure in a minimum of 95% of cases. Surveillance data, derived from continuous monitoring of resistance to the antibiotics in clinical use, is therefore critical to monitor AMR, detect imported or novel resistance and to inform treatment guidelines.[13] The WHO has called for enhanced surveillance as a fundamental component of the Global Action Plan to control the spread and impact of gonococcal AMR.[14]

The National Neisseria Network (NNN) is a collaboration of *Neisseria* reference laboratories in each state and territory that perform phenotypic and genotypic testing of clinical isolates of pathogenic *Neisseria* species. Clinical isolates are referred to the jurisdictional NNN laboratories from both public and private sector laboratories representing as wide a section of the community as possible, for determination of phenotypic and genotypic characteristics, including antimicrobial resistance, and additional investigations where required. The AGSP is a key activity of the NNN and has continuously monitored the susceptibility of *N. gonorrhoeae* since 1981, making it the longest, continually running, national surveillance system for gonococcal AMR. In this AGSP annual report we will also report the molecular surveillance data from the implementation of the penicillinase-producing *Neisseria gonorrhoeae* (PPNG) assay in remote Western Australia to supplement the AGSP data. This is amid increasing concerns nationally of the status of gonococcal AMR in Australia.

Methods

The NNN AMR data for gonococcal isolates are collated for the AGSP quarterly and annual reports. Gonorrhoea is a notifiable disease in Australia and each confirmed case is notified to the National Notifiable Diseases Surveillance System (NNDSS). The number of isolates tested by the NNN and reported by the AGSP represents a proportion of the number of cases reported to the NNDSS. The NNN tests approximately one-third of the number of notified cases in Australia.

The NNN laboratories test gonococcal isolates for susceptibility to penicillin (representing this group of antibiotics); ceftriaxone (representing later generation cephalosporin antibiotics); ciprofloxacin (representing quinolone antibiotics); azithromycin; spectinomycin; and for high level plasmid mediated resistance to tetracycline using previously described standardised methodology to determine the MIC values.[15–16] The MIC value is the least concentration of an antibiotic that inhibits *in vitro* growth under defined conditions. The AGSP conducts a program-specific quality assurance program.[17]

Antibiotic susceptibility data from each jurisdiction are submitted quarterly to the coordinating laboratory (the Neisseria Reference Laboratory and WHO Collaborating Centre for Sexually Transmitted Diseases, Sydney), which collates the results for reporting. Where available, the AGSP collects data on the gender of the patient, country of acquisition, and site of isolation of gonococcal strains. Data from isolates from all jurisdictions is predominantly from urban centres. Data from the Northern Territory and Western Australia are further divided into urban versus rural and remote as therapeutic recommendations differ.

Statistics

Statistical analysis was performed using Prism % version 5.0d. Results were compared using Fisher's exact test for differences in proportions.

Results

Number of isolates

There were 5,411 gonococcal isolates tested in NNN laboratories in 2015, representing 28% of the 19,092 cases of gonococcal infection notified to the NNDSS in 2015 (Table 1). This was lower than the proportion tested in 2014 (31%) and lower than the range of 33% to 42% referred between 2008 and 2013.

Source of isolates

There were 4,505 isolates from men (83%) and 791 (17%) from women (Table 2). There were 6 isolates from patients of unknown gender. The proportion of gonococcal isolates from males and females tested by the AGSP has remained stable over recent years (2009–2014); ranging between 18% and 20% for women and 80% and 83% for men. The infected site was reported as 'other' or not specified for 35 isolates from males and 14 isolates from females (Table 2). Isolates from urine samples were regarded as genital tract isolates.

Table 1: Number of Australian Gonococcal Surveillance Programme gonococcal isolates tested as a proportion of National Notifiable Diseases Surveillance System gonorrhoea notifications, Australia, 2015, 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	69	141	49
New South Wales	1,905	5,460	35
Northern Territory	258	1,851	14
Queensland	728	3,033	24
South Australia	251	798	31
Tasmania	23	56	41
Victoria	1,695	5,497	31
Western Australia	482	2,256	21
Australia	5,411	19,092	28

Table 2: Gonococcal isolates, Australia, 2015, by sex, site and state or territory tested

Site	ACT	NSW	NT	Qld	SA	Tas.	Vic.	WA	Aust.
Male									
Genital	28	877	150	385	105	9	722	256	2,532
Rectal	23	474	2	110	55	4	446	49	1,163
Pharynx	11	323	2	56	33	6	305	23	759
DGI	0	7	2	4	0	0	3	0	16
Other/NS	1	9	2	8	4	2	7	2	35
Total	63	1,690	158	563	197	21	1,483	330	4,505
Female									
Genital	6	172	94	151	40	2	190	142	797
Rectal	0	3	0	2	6	0	1	3	15
Pharynx	0	32	0	2	6	0	19	5	64
DGI	0	0	4	4	1	0	0	1	10
Other/NS	0	3	1	6	1	0	2	1	14
Total	6	210	99	165	54	2	212	152	900
Unknown									
Total	0	5	1	0	0	0	0	0	6
Total	69	1,905	258	728	251	23	1,695	482	5,411

DGI Disseminated gonococcal infection
NS Not specified

Antibiotic susceptibility patterns

As in past years the patterns of gonococcal antibiotic susceptibility differed between the various states and territories. The data are presented by region as well as aggregated for Australia (Table 3).

Ceftriaxone

From 2001 onwards, gonococcal isolates categorised as having decreased susceptibility to ceftriaxone by the AGSP criteria (MIC values 0.06–0.125 mg/L) have been reported in Australia. The proportion of gonococci with decreased susceptibility to ceftriaxone nationally, increased incrementally from 0.6% in 2006, to 4.4% in 2012, then in 2013 doubled to 8.8%. In 2014, the proportion decreased to 5.4% and again decreased in 2015 to 1.8% (Table 4).

Ceftriaxone decreased susceptibility includes the MIC values 0.06 and 0.125 mg/L. The right shift in the distribution of ceftriaxone MIC values over recent years (2011–2013) (Table 5), is statistically significant with a sustained increase in the proportion of strains with an MIC value of 0.06 mg/L (2011–2012: ($P = 0.02$, 95% CI: 1.04–62), and 2012–2013 ($P < 0.0001$, 95% CI: 1.70–2.38)). The proportion of strains nationally with an MIC value of 0.06 mg/L–0.125 mg/L decreased in 2014 to 5.4% and then in 2015 to 1.7%.

Table 3: Proportion of gonococcal isolates with resistance to azithromycin, penicillin and ciprofloxacin and decreased susceptibility to ceftriaxone reported, Australia, 2015, by state or territory

State or territory	Number of isolates tested	Decreased susceptibility Ceftriaxone		Resistance Azithromycin		Penicillin		Ciprofloxacin	
		n	%	n	%	n	%	n	%
Australian Capital Territory	69	0	0.0	0	0.0	23	33.3	18	26.1
New South Wales	1,905	52	2.7	43	2.3	588	30.9	684	35.9
Queensland	728	7	1.0	42	5.8	201	27.6	186	25.5
South Australia	251	9	3.6	7	2.8	52	20.7	103	41.0
Tasmania	23	0	0.0	1	4.3	2	8.7	0	0.0
Victoria	1,695	25	1.5	30	1.8	257	15.2	383	23.0
Northern Territory/ Urban	76	0	0.0	0	0.0	11	14.5	8	10.5
Northern Territory/ Remote & Rural	182	0	0.0	0	0.0	4	2.2	6	3.3
Western Australia/Urban & Rural	395	5	1.3	15	3.8	77	19.5	82	20.8
Western Australia/Remote	87	0	0.0	0	0.0	2	2.3	3	3.4
Australia	5,411	98	1.8	138	2.6	1,217	22.5	1,473	27.2

Table 4: Number of gonococcal isolates with decreased susceptibility to ceftriaxone (MIC 0.06–0.125 mg/L), Australia, 2011 to 2015, by state or territory

State or territory	Decreased susceptibility to ceftriaxone 2011		2012		2013		2014		2015	
	n	%	n	%	n	%	n	%	n	%
Australian Capital Territory	2	3.1	2	3.6	0	0.0	2	2.7	0	0.0
New South Wales	58	4.4	76	4.5	183	11.8	119	7.1	52	2.7
Northern Territory	2	0.4	0	0.0	4	1.5	4	1.7	0	0.0
Queensland	18	2.3	17	2.4	33	4.9	21	3.2	7	1.0
South Australia	1	0.7	1	0.7	4	1.9	2	1.0	9	3.6
Tasmania	0	0.0	0	0.0	11	24.4	0	0.0	0	0.0
Victoria	50	5.3	105	8.4	181	11.8	95	6.6	25	1.5
Western Australia	3	0.7	6	1.2	13	2.7	15	3.0	5	1.0
Australia	134	3.2	207	4.4	429	8.8	258	5.4	98	1.8

The proportion of strains with a ceftriaxone MIC 0.125 mg/L also increased from 0.1% in 2010 and 2011, to 0.3% in 2012 and to 0.6% in 2013 and 2014. These differences were not significant, which may be attributable to the low number of strains in this MIC category. In 2015, the proportion of strains with an MIC value of 0.125 mg/L decreased to 0.1% (Table 5). No isolates of *N. gonorrhoeae* with an MIC value greater than 0.125 mg/L were reported from Australia in 2015.

Azithromycin

Nationally, the proportion of isolates exhibiting resistance (2.6%) (Table 3) was slightly higher than that reported for 2014 (2.4%) and 2013 (2.1%) and higher than in 2011 to 2012 (1.1% to 1.3%). The proportion of isolates exhibiting resistance was highest in Queensland (5.8% in 2015, compared with 3.5% in 2014), followed by urban Western Australia (3.8% in 2015, compared with 5.3% in 2014). In 2015, there were 2 isolates, 1 from New South Wales and 1 from urban Western Australia that both exhibited high level resistance to azithromycin (MIC value ≥ 256 mg/L).

Penicillin

Resistance to the penicillin group of antibiotics (penicillin, ampicillin and amoxycillin with or without clavulanic acid) in gonococci is a result of the production of a specific beta-lactamase: penicillinase; and/ or by the aggregation of chromosomally-controlled resistance mechanisms. These are denoted respectively, PPNG; and chromosomally mediated resistant to penicillin (CMRP). Chromosomal resistance is defined as an MIC to penicillin of 1 mg/L or more.

In 2015 in Australia, 1,217 (22.5%) isolates were penicillin resistant; a proportional decrease from 2014 (29%) and lower than 2012–2013 (32% to 35%), 2010–2011 (25% to 29%), and 2008–2009 (36% to 44%). In 2015, there were 511 (9.4%) isolates with CMRP; and 706 (13%) with PPNG. In 2014, the proportion of isolates with CMRP was 14%, and 15% were PPNG.

Penicillin resistance in the Northern Territory

In 2015, there were 258 isolates tested from the Northern Territory. There were 76 from Darwin and surrounding urban areas, and 182 from remote areas of the Northern Territory (Alice Springs, Katherine and other areas).

Of the isolates tested from the Northern Territory, 11 (14%) from the city of Darwin and surrounding urban areas were penicillin resistant: (2 CMRP and 9 PPNG) (Table 3: Northern Territory – Urban). Of these, 1 also had decreased susceptibility to ceftriaxone. In contrast, from the remote regions of the Northern Territory, 4 (2.2%) strains tested were penicillin resistant (1 CMRP and 3 PPNG). None of these strains had decreased susceptibility to ceftriaxone.

Penicillin resistance in Western Australia

In 2015 there were 482 isolates tested from Western Australia, 87 from remote regions and 395 from rural and urban regions. Of the isolates tested from rural and urban regions, 19% were reported as resistant, whereas of the 87 from remote regions there were 2 isolates (2.3%) that were penicillin resistant (both PPNG).

In addition to the isolate based surveillance for penicillin, specimens that were *N. gonorrhoeae* positive by NAAT in Western Australia were tested using a PPNG assay now routinely in use at PathWest.[8,9] In 2015, there were 60,790 specimens tested and 1,201 gonococcal detections by NAATs at PathWest confirmed by postcode to be from across Western Australia and of those, 952 (79%) were able to be tested for PPNG. Perth continues to have high rates of PPNG; detected in 58/396 extracts tested (15%). Much lower numbers of specimens were tested from other populated regions: Wheatbelt 0/6; Great Southern 1/8 (12%); and SouthWest 5/14 (36%) and therefore results should be interpreted with caution. Conversely, the remote regions continue to have lower rates of PPNG positive *N. gonorrhoeae*: 2/120 (1.6%) from the Pilbara and 0/341 (0%) from the Kimberley

Table 5: Proportion (%) of gonococcal isolates tested in Australia with MIC values at 0.06 mg/L and 0.125 mg/L 2011 to 2015

Ceftriaxone MIC mg/L	2011	2012	2013	2014	2015
0.06	3.2%	4.1%	8.2%	4.8%	1.7%
0.125	0.1%	0.3%	0.6%	0.6%	0.1%

region. Lower rates of PPNG were also reported from the Midwest and Goldfields (4.7 % and 0 % respectively), but these rates must also be interpreted with caution as lower numbers were tested in these regions (43 and 22 respectively). These data support and enhance the isolate-based surveillance findings of the AGSP, and indicate that PPNG rates remain low in the remote regions of Western Australia. All PPNG positive *N. gonorrhoeae* from remote regions were determined to be in non- Indigenous residents or residents in the major regional centres. There was no PPNG positive *N. gonorrhoeae* detected from the remote Indigenous community (personal communication from Dr David Speers, PathWest).

Quinolone antibiotics

The AGSP uses ciprofloxacin as the representative quinolone. Quinolone resistant *N. gonorrhoeae* (QRNG) are defined as MICs ≥ 1 mg/L. The resistance mechanism in *N. gonorrhoea* has thus far been mediated only by chromosomal mechanisms so that incremental changes in MIC values are observed.

In 2015, 1,473 of the 5,411 gonococci examined (27%) were resistant to ciprofloxacin (Table 3). This was lower than the proportion of isolates resistant in 2014 (36%), and overall there has been a trend of decreasing proportions since 2008, when 54% of isolates were reported as ciprofloxacin resistant.

High-level tetracycline resistance

High-level tetracycline resistant *N. gonorrhoeae* (TRNG) is used as an epidemiological marker, even though tetracyclines are not a recommended treatment for gonorrhoea and are rarely, if ever used for treatment of gonorrhoea in Australia. The proportion of TRNG detected nationally between 2006 and 2014 has ranged from 12% to 21%. In 2015, the proportion of TRNG was 16%.

TRNG were present in all jurisdictions in 2015, with the highest proportions in remote Northern Territory (47%), urban and rural Northern Territory (21%) and urban and rural Western Australia (20%).

Spectinomycin

In 2015, all isolates tested were susceptible to spectinomycin.

Discussion

The 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.[13] The AGSP has continuously monitored antimicrobial resistance in Australia since 1981, and has established quality assurance and quality control for gonococcal AMR testing with the AGSP External Quality Assurance Program, and WHO *N. gonorrhoeae* reference strains, thus ensuring the quality of the AGSP data.[17,18]

The overall number of gonococcal strains examined by the AGSP in 2015 was higher both in number and proportion when compared with 2014. The clinical isolates were referred from both the public and private health sectors, constituting a comprehensive sample of 33% of all notifications nationally. However, the increasing use of molecular diagnostic assays as an alternative to bacterial culture, in both urban and remote settings, threatens the scope of gonococcal AMR surveillance programs worldwide. This is because resultant decrease in the numbers of strains cultured thus limits the proportion with AMR testing and therefore limits AMR surveillance data. Whilst the advantages of molecular diagnostic assays over culture, in terms of sensitivity, and robustness and reliability for remote settings where cultures may not survive transportation, their primary disadvantage is that they cannot test broadly for AMR. However, molecular AMR testing strategies can give targeted and specific information, which is clinically and epidemiologically important,[2] and can contribute to surveillance programs; and be used to inform treatment guidelines.[9] This report again includes PPNG NAAT data from Western Australia, providing additional situational AMR surveillance data for the AGSP in a region where penicillin based treatment strategies are in place. Introduction of this assay is planned for the Northern Territory where penicillin-based treatment strategies are also in use, to provide enhanced surveillance data for 2016.

The primary focus for gonococcal AMR surveillance for the majority of Australia, and in most countries, is the monitoring of ceftriaxone MIC values. Gonococci with MIC values in the range 0.06–0.125 mg/L are reported to have decreased susceptibility to ceftriaxone and these strains have been found in increasing proportions in Australia, with the rate doubling over the period 2012 to 2013 from 4.4% to 8.8%.[5] In 2014, there was a decrease in the proportion of isolates with decreased susceptibility to ceftriaxone reported nationally 5.4% and this decreased further in 2015 to 1.8%.

However, little reassurance should be taken from this, as fluctuation of clones within a population is to be expected. In recent years increasing proportions of strains with decreased susceptibility to the

cephalosporin antibiotics has been accompanied by an increasing number of reports of treatment failures; and multidrug-resistant strains with high level resistance to ceftriaxone have been reported from Japan, France, Spain and now Australia.[7,15,16,19] All of these strains with high level resistance to ceftriaxone have been shown to have a mosaic penicillin binding protein 2 (PBP2), encoded by a mosaic *PenA* gene, with as few as one additional amino acid substitution required to confer high level resistance.[20] However, molecular studies have shown that strains harbouring the mosaic PBP2 are present in a significant proportion of circulating *N. gonorrhoeae* strains globally and paradoxically these strains, with a mosaic PBP2, may not have an elevated ceftriaxone MIC value, but are potentially only one point mutation from high level ceftriaxone resistance, and are under constant selection pressure. Given these considerations, the level of concern about the development of ceftriaxone resistance has heightened globally.[20]

In 2012, the WHO Global Action Plan nominated the criteria for decreased susceptibility to ceftriaxone as an MIC value ≥ 0.125 mg/L.[14] The proportion of strains tested by the AGSP with a ceftriaxone MIC value of 0.125 mg/L also doubled from 0.3% in 2012 to 0.6% in 2013 and 2014, then decreased in 2015 to 0.1%, the same as reported for 2011.

A dual therapy strategy of ceftriaxone with oral azithromycin for uncomplicated gonococcal infection continues to be recommended in Australia.[4] In 2013, high level resistance to azithromycin in gonococci was reported for the first time in Australia in 4 strains; 2 from Victoria and 2 from Queensland, and of these, 2 were most likely acquired from China.[6] In 2014, there were 2 further strains reported with high level azithromycin resistance in New South Wales. In 2015, there were again 2 sporadic incidents, 1 from New South Wales and 1 from urban Western Australia where isolates exhibited high level resistance to azithromycin (MIC value ≥ 256 mg/L). This continues to be closely observed as evidence of co-evolving cephalosporin and azithromycin resistance is being observed outside Australia and is of significant concern.[20]

The proportion of gonococci with high-level tetracycline resistance in Australia increased from 2006 to 2008 and stabilised at 21% in 2009 to 2010. The proportion of TRNG decreased to 18% in 2011, then to 14% in 2012 and remained unchanged (14%) in 2013. In 2014, there was an increase to 19%. In 2015 the proportion of TRNG was 16%. Outside the remote regions of Western Australia and the Northern Territory penicillin and ciprofloxacin resistance rates remain high. There was no resistance to spectinomycin reported in the jurisdictions testing for this antibiotic.

The recent fluctuations in proportions of *N. gonorrhoeae* with decreased susceptibility to ceftriaxone offer little reassurance in the context of what is known about gonococcal AMR, which continues to be recognised as a global public health threat. Broad-based disease control strategies, including the rational use of antibiotics, have been called for. The WHO Global Action Plan states that disease control strategies and the understanding of the global scope of AMR need to continue to be informed by surveillance programs of AMR, nationally and internationally.[14] The ongoing need for close and enhanced monitoring of gonococcal AMR can be supported to a limited extent by molecular-based assays; however isolate-based surveillance programs, and sentinel site surveillance in high risk populations are critically important to inform therapeutic strategies and to detect instances of treatment failure.

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