ANTIMICROBIAL SUSCEPTIBILITY AMONG *NEISSERIA GONORRHOEAE* IN NEW ZEALAND, 2002

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SUMMARY

Following the development of penicillin resistance, ciprofloxacin has become the most widely used treatment for gonorrhoea in New Zealand. However, there was a large increase in ciprofloxacin resistance in the Auckland area during 2001, with a four-fold rise in resistance that year to a rate of 10.1%.

In 2002, all gonococci isolated in New Zealand during a four-month period were collected for a national antimicrobial susceptibility survey. The aims of the survey were to provide current data on gonococcal susceptibilities in New Zealand and to determine whether the increase in ciprofloxacin resistance observed in the Auckland area had occurred in other parts of the country. The antimicrobial susceptibility of 413 gonococci isolated during the four months was tested at either LabPlus, Auckland District Health Board, or ESR by the same agar dilution method.

The prevalence of resistance to the antibiotics tested was: ciprofloxacin, 6.8%; penicillin, 9.0%; tetracycline, 27.8%; and no resistance to ceftriaxone, cefixime or spectinomycin. While there appeared to be some geographical differences in ciprofloxacin and penicillin resistance, the number of isolates from some areas was small. As a result, when 95% confidence intervals (CI) on the resistance estimates are allowed for there were very few statistically significant geographical differences.

Information on the country where the gonococcal infection was acquired was reported for less than half the isolates, and even when reported this information is considered to be often unreliable. Notwithstanding these limitations, compared with infections reportedly acquired in New Zealand, infections acquired in Asia were more likely to be ciprofloxacin resistant [57.1% (95% CI 28.9-82.3%) vs 6.8% (95% CI 3.5-11.9%)] and penicillin resistant [85.7% (95% CI 57.2-98.2%) vs 6.8% (95% CI 3.5-11.9%)]. This finding is consistent with reports of high rates of resistance to these two antimicrobials in many Asian countries.

The previous national survey of gonococcal susceptibilities was conducted in 1988. The methodology and interpretive criteria used were the same as those for the 2002 survey. The MIC_{90} values for all antimicrobials were higher in 2002. The prevalence of penicillin resistance and ciprofloxacin resistance increased between surveys. Penicillin resistance increased nearly four-fold from a rate of 2.5% in 1988, with most of the increase being due to chromosomally mediated penicillin resistance, rather than the plasmid-mediated production of penicillinase. No resistance to ciprofloxacin was observed in 1988.

When resistance to an antibiotic reaches 5% it is usually considered to no longer be an acceptable first-line treatment option for gonorrhoea. Based on the results of this survey, the prevalence of penicillin resistance and ciprofloxacin resistance in New Zealand is now above this 5% threshold. In addition, based on the antimicrobial resistance patterns, more than 5% of isolates would be resistant to either of two common empirical treatments for gonorrhoea and concurrent chlamydial infection: ciprofloxacin and tetracycline, or amoxicillin and tetracycline. These results indicate an increasing need for intramuscular or intravenous ceftriaxone to treat and control gonorrhoea in New Zealand.

RECOMMENDATIONS

- To provide further information on the epidemiology and clonality of antibiotic-resistant *Neisseria gonorrhoeae* in New Zealand, the resistant isolates identified in this survey should be typed.

- To both guide empirical treatment in New Zealand and contribute more representative national data to the World Health Organization regional surveillance, ideally the antimicrobial susceptibility of all gonococci isolated in New Zealand should be tested using a standardised method. Until this happens, national point-prevalence surveys should be repeated every 2-3 years to provide data on the current prevalence and trends in gonococcal resistance.

1 INTRODUCTION

After chlamydia, gonorrhoea is the second most common bacterial sexually transmitted infection among attendees at sexual health clinics in New Zealand. The number of cases of gonorrhoea diagnosed at sexual health clinics has increased each year since 1996, with an overall increase of 95% between 1996 and 2001.[1] The incidence of gonorrhoea is reported to have increased in recent years in other developed countries, with the highest rates in certain socially and economically deprived subpopulations and in men who have sex with men.[2,3,4,5] Rates of gonorrhoea in many parts of the developing world, in particular South and South East Asia, sub-Saharan Africa, and Latin America, are estimated to be as much as 10 times those in developed countries.[6] However, the incidence in Pacific Island and East Asian nations is usually more similar to that in developed countries.

Increasing antimicrobial resistance, especially to penicillin and the fluoroquinolones, is compromising the effective treatment of gonorrhoea. Since penicillin resistance emerged in the late 1970s, it has spread to most parts of the world. Ciprofloxacin resistance first emerged and then become particularly common in South East Asia and the Western Pacific.[7,8] Based on data available from LabPlus, Auckland District Health Board, there was a large increase in ciprofloxacin resistance in the Auckland area during 2001, with a four-fold rise in resistance that year to a rate of 10.1%.[9,8]

There have been three previous national surveys of gonococcal antimicrobial susceptibility in New Zealand: in 1976,[10] 1980 (Green M, unpublished observations), and 1988.[11] This current survey was undertaken to provide up-to-date information on gonococcal susceptibilities in New Zealand and to determine whether the increase in ciprofloxacin resistance observed in the Auckland area has occurred in other parts of New Zealand.

2 METHODS

2.1 Isolate Collection

The antimicrobial susceptibility of *Neisseria gonorrhoeae* isolates included in the survey was tested at either LabPlus, Auckland District Health Board, or ESR. All gonococci isolated by hospital and community laboratories in Auckland and by Waikato Hospital are routinely referred to LabPlus for susceptibility testing. Therefore, for this survey, the antimicrobial susceptibility of gonococci referred to and isolated by LabPlus was tested at LabPlus. The antimicrobial susceptibility of gonococci isolated by other laboratories throughout the country was tested at ESR. These other laboratories were requested to refer to ESR all gonococci that they isolated during the four-month period, 17 April to 16 August 2002. Isolates referred to and isolated by LabPlus during these same four months were also included in the survey.

The data collected with each isolate included a patient identifier, usually name, so that duplicate isolates could be removed; date of birth or age; sex; site of isolation; and place (New Zealand versus an overseas country) where the infection was acquired.

2.2 Geographic Distribution Analysis

Based on the location of the laboratory in which the primary isolation was made, isolates were identified as originating from a health district. For geographic distribution analyses, health districts were aggregated as indicated in Table 1.

Table 1 Health district aggregation

Health district aggregate	Health districts included
Northland/Auckland	Northland, North West Auckland, Central Auckland and South Auckland
Waikato	Waikato
Bay of Plenty	Tauranga, Eastern Bay of Plenty and Rotorua
Gisborne/Hawkes Bay	Gisborne and Hawkes Bay
Taranaki/Wanganui/Manawatu	Taranaki ,Wanganui and Manawatu
Wellington	Hutt and Wellington
South Island	Nelson-Marlborough, West Coast, Canterbury, South Canterbury, Otago and Southland

2.3 Antimicrobial Susceptibility Testing

The antimicrobial susceptibility of the isolates was tested by agar dilution using the method of the Australian Gonococcal Surveillance Programme.[12] The following antimicrobials were tested: cefixime, ceftriaxone, ciprofloxacin, penicillin, spectinomycin and tetracycline. Cefixime was included, as, at the time the survey was planned, it seemed cefixime may have a

place in the future oral treatment of gonorrhoea in New Zealand. However, the manufacture of cefixime has since ceased.

Oxoid Isosensitest agar, supplemented with 8% horse blood lysed with saponin, was used to test all antimicrobials. An inoculum of 10^4 cfu was applied to plates using a multipoint inoculator. The plates were incubated at 35°C for 18-24 hours in 5% CO_2. Minimum inhibitory concentrations (MICs) were interpreted as described in Table 2. ß-lactamase production was determined with the chromogenic cephalosporin, nitrocefin.

Table 2 MIC interpretive criteria for *Neisseria gonorrhoeae*[1]

Antimicrobial	MIC (mg/L)		
	Susceptible	Less susceptible/ reduced susceptibility	Resistant
Cefixime	≤0.25		
Ceftriaxone	≤0.03	0.06-0.25	
Ciprofloxacin	≤0.03	0.06-0.5	≥1
Penicillin	≤0.03	0.06-0.5	≥1
Spectinomycin	≤64		≥128
Tetracycline	≤0.5		≥1

Notes: 1 The interpretive criteria for all antimicrobials, except cefixime, are those specified for the Australian Gonococcal Surveillance Programme method (reference 12). The criteria for cefixime are those specified by NCCLS (reference 13).

The following controls were used:

- World Health Organization (WHO) *N. gonorrhoeae* antimicrobial susceptibility testing reference strains A-E (NZRM Acc 3172-6). These strains have penicillin MICs of 0.008, 0.06, 0.25, 1.0 and 2.0 mg/L, respectively.
- *N. gonorrhoeae* US CDC SPL-4 with a cefixime MIC of 0.25-0.5 mg/L

2.4 Data Analysis

The results were analysed using SAS.[14]

3 RESULTS

3.1 Survey Sample

A total of 413 *N. gonorrhoeae* isolates from 26 laboratories were included in the survey. As this survey aimed to include all gonococci isolated during a four-month period in New Zealand, this number of isolates equates to an annualised national incidence of culture-positive gonorrhoea of 33.2 cases per 100 000 population.

Based on the location of the laboratory in which the primary isolation was made, the geographic distribution of the isolates, by health district aggregate (Table 1), is shown in Table 3.

Table 3 Geographic distribution of *Neisseria gonorrhoeae* included in the survey

Health district aggregate[1,2]	Number of isolates	Percent
Northland/Auckland	215	52.1
Waikato	29	7.0
Bay of Plenty	29	7.0
Gisborne/Hawkes Bay	56	13.6
Taranaki/Wanganui/Manawatu	14	3.4
Wellington	33	8.0
South Island	37	9.0

Notes: 1 See Table 1.
2 Based on the location of the referring laboratory. This location may not always correlate with the patients' place of residence.

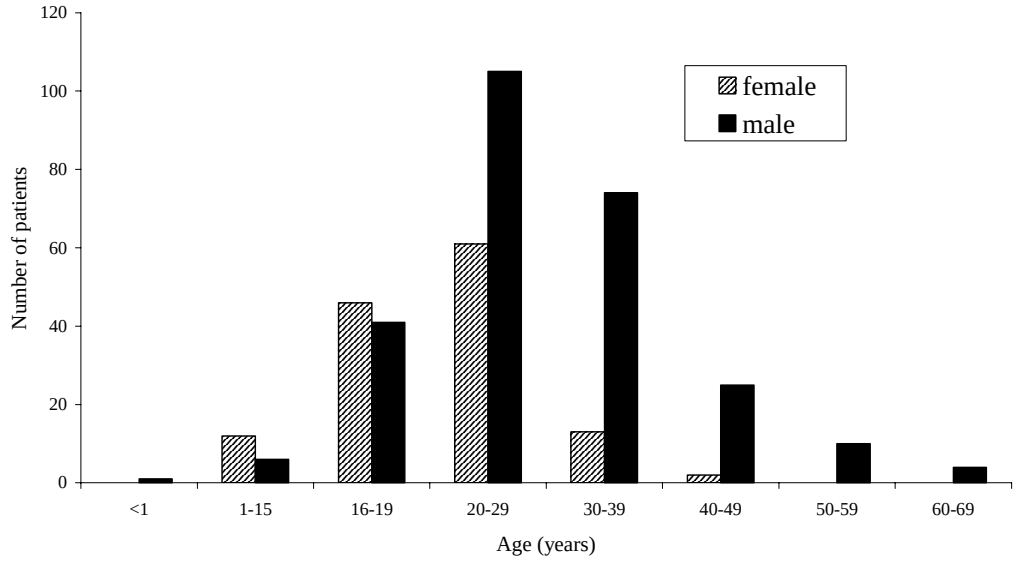
The site of isolation was reported for 390 (94.4%) of the isolates included in the survey (Table 4).

Table 4 Site of isolation of *Neisseria gonorrhoeae* included in the survey

Isolation site	Number of isolates	Percent
urogenital	381	92.3
throat	8	1.9
eye	1	0.2
not reported	23	5.6

Both age and sex were reported for 400 (96.9%) of the 413 patients. The age and sex distribution of these patients is shown in Figure 1.

Figure 1 Age and sex distribution of patients from whom *Neisseria gonorrhoeae* were isolated



3.2 Antimicrobial Susceptibility

The MIC range, MIC_{50}, MIC_{90}, and prevalence of reduced susceptibility and resistance to each antimicrobial among the 413 isolates tested is shown in Table 5. The full MIC distribution for each antimicrobial is presented in Appendix 1.

The rate of ciprofloxacin resistance was 6.8%, with a further 5.8% of isolates demonstrating reduced susceptibility.

Penicillin resistance may be due to either plasmid-mediated production of β-lactamase (penicillinase-producing *N. gonorrhoeae*, PPNG) or chromosomally controlled mechanisms (CMRNG). Among the 9.0% (37) of isolates that were penicillin resistant, 3.9% (16) were PPNGs and 5.1% (21) had chromosomally mediated resistance. In addition to 9.0% penicillin resistance, another 68.5% (283) of isolates demonstrated reduced penicillin susceptibility, leaving only 22.5% of isolates fully susceptible to penicillin.

Tetracycline resistance may also be either plasmid or chromosomally mediated. Isolates with tetracycline MICs ≥16 mg/L are categorised as having plasmid-mediated, high-level resistance and are referred to as TRNG. Isolates with tetracycline MICs 1-8 mg/L are categorised as having low-level, chromosomal resistance. Among the 27.8% (115) of isolates that were tetracycline resistant, 21.3% (88) had low-level resistance and 6.5% (27) were TRNG.

There was no resistance or reduced susceptibility to ceftriaxone or cefixime, and no resistance to spectinomycin.

Table 5 MIC range, MIC_{50}, MIC_{90} and resistance among *Neisseria gonorrhoeae*, 2002

Antimicrobial	MIC (mg/L)			Percent less susceptible/reduced susceptibility[1]	Percent resistant[1]
	Range	MIC_{50}	MIC_{90}		
Cefixime	0.004-0.12	0.008	0.016	0	0
Ceftriaxone	0.004-0.03	0.004	0.016	0	0
Ciprofloxacin	0.004-4	0.004	0.06	5.8	6.8
Penicillin	0.008-4	0.12	0.5	68.5	9.0
Spectinomycin	2-16	8	16	-[2]	0
Tetracycline	0.06-16	0.5	2	-[2]	27.8

Notes: 1 See Table 2 for less susceptible/reduced susceptibility and resistant interpretive criteria.
2 No less susceptible/reduced susceptibility category for spectinomycin or tetracycline.

3.3 Resistance Patterns

The distribution of resistance patterns is shown in Table 6. Over a quarter (28.6%, 118) of the isolates were resistant to at least one of the antimicrobials tested.

In total, 6.3% of the isolates were resistant to both ciprofloxacin and tetracycline, and 8.5% were resistant to both penicillin and tetracycline.

Table 6 Resistance patterns among *Neisseria gonorrhoeae*, 2002

	Number (%)	Resistance patterns[1]	Number (%) with each pattern
Resistant to 1 agent	71 (17.2)	Cip	1 (0.2)
		PPNG	1 (0.2)
		Tet	69 (16.7)
Resistant to 2 agents	32 (7.7)	Cip/PPNG	1 (0.2)
		Cip/Tet	11 (2.7)
		Pe/Tet	15 (3.6)
		PPNG/Tet	5 (1.2)
		Pen/Tet	20 (4.8)
Resistant to 3 agents	15 (3.6)	Cip/Pe/Tet	6 (1.5)
		Cip/PPNG/Tet	9 (2.2)
		Cip/Pen/Tet	15 (3.6)

Note: 1 Cip, ciprofloxacin resistance; Pe, chromosomally mediated penicillin resistance; PPNG, penicillinase-producing *N. gonorrhoeae*; Pen, both PPNG and chromosomally mediated penicillin resistance; Tet, tetracycline resistance.

3.4 Geographic Differences in Antimicrobial Susceptibility

The prevalence of ciprofloxacin and penicillin resistance by area, based on the location of the referring laboratory, is shown in Table 7. Because some laboratories process specimens from patients who live outside the area in which the laboratory is located, this geographic analysis may not strictly reflect the patients' place of residence. While there appeared to be some marked geographical differences in the prevalence of resistance to both antimicrobials, the number of isolates from some areas was small. As a result, when 95% confidence intervals on the resistance estimates are allowed for, the only significant differences in ciprofloxacin and penicillin resistance were lower rates of resistance in the Gisborne/Hawkes Bay area than in the Northland/Auckland area.

The prevalence of resistance among isolates tested by LabPlus was compared with that among all isolates. Ciprofloxacin, penicillin and tetracycline resistance were all more common among isolates tested by LabPlus, although the differences were only marginally significant for ciprofloxacin and penicillin: 10.5 vs 6.8% ciprofloxacin resistance (P=0.0963), 12.7 vs 9.0% penicillin resistance (P=0.1337), and 35.5 vs 27.8% tetracycline resistance (P=0.0433). There was no significant difference in the prevalence of TRNG: 7.9 vs 6.5% (P=0.5197).

Table 7 Ciprofloxacin and penicillin resistance among *Neisseria gonorrhoeae* by area, 2002

Health district aggregate[1,2]	Number of isolates	Percent resistance (95% confidence intervals)	
		Ciprofloxacin	Penicillin
Northland/Auckland	215	10.2 (6.5-15.1)	13.0 (8.8-18.3)
Waikato	29	10.3 (2.2-27.4)	6.9 (0.8-22.8)
Bay of Plenty	29	0 (0-11.9)	0 (0-11.9)
Gisborne/Hawkes Bay	56	0 (0-6.4)	0 (0-6.4)
Taranaki/Wanganui/Manawatu	14	14.3 (1.8-42.8)	21.4 (4.7-50.8)
Wellington	33	0 (0-10.6)	3.0 (0.1-15.8)
South Island	37	2.7 (0.1-14.2)	8.1 (1.7-21.9)

Notes: 1 See Table 1.
2 Based on the location of the referring laboratory; this location may not always correlate with the patients' place of residence.

3.5 Ciprofloxacin and Penicillin Resistance among New Zealand-acquired Infections Compared with Infections Acquired Overseas

The country or overseas region where the infection was acquired was reported for 185 (44.8%) of the 413 patients. Only 24 (13.0%) of these 185 patients were reported to have acquired their infection overseas.

While the number of infections reportedly acquired in any particular overseas region was very small, there was a significantly higher prevalence of both penicillin resistance and ciprofloxacin resistance among cases reportedly acquired in Asia than those reportedly acquired in New Zealand (Table 8).

Table 8 Ciprofloxacin and penicillin resistance among *Neisseria gonorrhoeae* by region where the infection was reportedly acquired, 2002

Region infection reportedly acquired	Number of isolates[1]	Percent resistance (95% confidence intervals)	
		Ciprofloxacin	Penicillin
Asia	14	57.1 (28.9-82.3)	85.7 (57.2-98.2)
Australia	4	0 (0-60.2)	25.0 (0.6-80.6)
Europe	3	33.3 (0.8-90.6)	33.3 (0.8-90.6)
Pacific Islands	3	0 (0-70.8)	0 (0-70.8)
New Zealand	161	6.8 (3.5-11.9)	6.8 (3.5-11.9)

Note: 1 The place the infection was acquired was only reported for 185 of the total 413 patients.

3.6 Comparison with Previous Survey in 1988

The MIC ranges, MIC_{90} values, and percent resistance for the antimicrobials that were commonly tested in the previous survey in 1988 and this survey are shown in Table 9. The antimicrobial susceptibility testing methods and interpretive criteria used to analyse the results were the same for both surveys.

The MIC_{90} values for all antimicrobials were higher in 2002. No resistance or reduced susceptibility to ciprofloxacin was observed in 1988. By 2002, 6.8% of isolates were resistant to ciprofloxacin and another 5.8% showed reduced susceptibility.

Penicillin resistance increased from 2.5% (12/486) in 1988 to 9.0% (37/413) in 2002. The prevalence of PPNGs increased from 2.3% to 3.9%, while the prevalence of CMRNG increased from 0.2% to 5.1%. The proportion of penicillin resistance due to CMRNG rose from 8.3% (1/12) in 1988 to 56.8% (21/37) in 2002. The prevalence of reduced susceptibility to penicillin (MIC 0.06-0.5 mg/L) also increased from 47.7% in 1988 to 68.5% in 2002.

In 1988, all 27.0% tetracycline resistance was low level (MIC 1-8 mg/L), but by 2002 high-level resistance (TRNG) had emerged and reached a rate of 6.5%.

No resistance to ceftriaxone was observed in either survey. In 1988, one isolate (0.2%) had reduced susceptibility to ceftriaxone (MIC 0.12 mg/L). No reduced susceptibility to ceftriaxone was observed in 2002. No spectinomycin resistance was observed in either survey.

Table 9 Comparison of MIC ranges, MIC_{90} and resistance among *Neisseria gonorrhoeae* in 1988 and 2002

Antimicrobial	1988 n=486			2002 n=413		
	MIC range (mg/L)	MIC_{90} (mg/L)	Percent resistance	MIC range (mg/L)	MIC_{90} (mg/L)	Percent resistance
Ceftriaxone	0.004-0.12	0.004	0	0.004-0.03	0.016	0
Ciprofloxacin	0.004-0.008	0.004	0	0.004-4	0.06	6.8
Penicillin	0.008-64	0.12	2.5	0.008-4	0.5	9.0
Spectinomycin	2-32	8	0	2-16	16	0
Tetracycline	0.06-2	1	27.0	0.06-16	2	27.8

4 DISCUSSION

Amoxicillin and ciprofloxacin have been the most commonly recommended antibiotics for the treatment of gonorrhoea in New Zealand. Ceftriaxone is also effective, but is not currently funded by Pharmac. Of these antibiotics, ciprofloxacin has become the most widely used treatment for gonorrhoea because of its convenience and the prevalence of penicillin resistance.[15] However, based on the results of this survey, 6.8% of gonococci isolated in New Zealand are now resistant to ciprofloxacin, and a further 5.8% have reduced susceptibility. These results indicate an increasing need for intramuscular or intravenous ceftriaxone to treat and control gonorrhoea in New Zealand.

The emergence of resistance to fluoroquinolone drugs, such as ciprofloxacin, was first observed in South East Asia and the Western Pacific in the early 1990s. By 2001, there were extraordinarily high rates of fluoroquinolone resistance in many countries in the WHO Western Pacific region, which includes New Zealand. For example, 88% resistance in Hong Kong, 87% in China, 64% in Japan, 54% in the Philippines, and 43% in Cambodia.[8] In most developed countries, ciprofloxacin resistance was first associated with imported infections acquired in Asia and the Western Pacific, but there is now an endemic focus of ciprofloxacin-resistant strains in some of these countries, including Australia, [16] the state of California in the United States, [17] and the United Kingdom.[18]

This pattern of importation, followed by local spread, is also evident in New Zealand. DNA macrorestriction typing, auxotyping and serotyping of a selection of ciprofloxacin-resistant isolates from the Auckland area at the beginning of 2001, showed that the majority belonged to one strain.[19] This finding is consistent with local spread rather than ongoing importation. In the latter situation, a variety of strains is usually evident.

During the 14 years since the last national survey in 1988, penicillin resistance has increased nearly four-fold, from 2.5% in 1988 to 9.0% in 2002. Most of the increase has been due to chromosomally mediated penicillin resistance (CMRNG), rather than plasmid-mediated penicillinase-producing *N. gonorrhoeae* (PPNG). As a consequence, the proportion of penicillin resistance due to CMRNG increased from less than 10% in 1988 to over half (56.8%) in 2002. Similar increases in the proportion of penicillin resistance due to CMRNG have been observed in other parts of the world, particularly in developed countries.[20,21]

Concomitant with the increase in CMRNG, the prevalence of strains with reduced penicillin susceptibility also increased markedly from 47.7% in 1988 to 68.5% in 2002. Chromosomally mediated resistance to penicillin in gonococci results in incremental increases in MIC with the gradual accumulation of chromosomal changes. While strains with reduced susceptibility can usually be effectively treated with higher doses of penicillin, they have the potential to accumulate further mutations, and become fully resistant and untreatable with penicillin.[22]

While the prevalence of penicillin resistance has increased in New Zealand, the rates in this country (3.9% PPNG, 5.1% CMRNG) are relatively low compared with most non-Pacific Island nations in the WHO Western Pacific region, including Australia.[8] In 2001, rates of penicillin resistance as high as 96% (83% PPNG, 13% CMRNG) were reported in Laos, 88% (54% PPNG, 34% CMRNG) in Korea, and 86% (67% PPNG, 19% CMRNG) in the Philippines, with 23% (8% PPNG, 15% CMRNG) in Australia.

There has been a decrease in low-level, chromosomally mediated tetracycline resistance since the last survey in 1988, but high-level, plasmid-mediated tetracycline resistance (TRNG) has emerged and reached a rate of 6.5%. Within the WHO Western Pacific region there is great variation in the prevalence of TRNGs, and in 2001 rates ranged from 98.9% in Laos to 1.1% in Korea.[8] The New Zealand rate is similar rate to that in Australia, which was reported as 9.4% in 2001.[8]

No resistance, or reduced susceptibility, to third-generation cephalosporins was observed among the isolates included in the survey. Isolates with reduced susceptibility have now been reported for several years, including in the WHO Western Pacific region.[8,23]

Given the high rates of gonococcal resistance in the many Asian countries, it was not surprising that infections acquired in Asia were more likely to be penicillin resistant and ciprofloxacin resistant than those acquired in New Zealand. However, information on the country or overseas region where the gonococcal infection was acquired was reported for less than half of the isolates included in the survey. Moreover, most of the isolates for which this information was reported were those tested at LabPlus, Auckland District Health Board. The clinicians using LabPlus' laboratory services have advised that they consider the information on the place of infection is often unreliable.

Typing of the resistant isolates identified in this survey is recommended as it could provide further useful information on the epidemiology and opportunities for the control of antibiotic-resistant *N. gonorrhoeae* in New Zealand. The identification of a limited number of strains would suggest that current control measures are ineffective. On the other hand, the presence of a wide variety of strains would suggest that strains are being successfully eradicated but there is ongoing reintroduction of resistant strains from overseas areas with high rates of resistance.

Access to current data on the antimicrobial susceptibility of gonococcal isolates is essential to the control of gonorrhoea, as treatment is usually on an empirical basis and administered as a single dose while the patient is still in attendance. A standard treatment regimen for gonorrhoea is expected to cure 95% or more of infections. There is a close correlation between *in vitro* resistance and clinical failure. Therefore, when resistance to an antibiotic reaches 5% it is usually considered to no longer be an acceptable first-line treatment option.[24] Based on the results of this survey, the prevalence of both penicillin resistance (9.0%) and ciprofloxacin resistance (6.8%) in New Zealand is above this 5% threshold. While resistance rates varied within New Zealand, there was no area where the upper estimate (95% confidence interval) of resistance to either antimicrobial was less than 5% (Table 7). In addition, based on the antimicrobial resistance patterns, more than 5% of isolates would be resistant to either of the two common empirical treatments for gonorrhoea and concurrent chlamydial infection: ciprofloxacin and tetracycline (6.3%) or amoxicillin and tetracycline (8.5%).

In the absence of national point-prevalence surveys, current data on the antimicrobial susceptibility of gonococci isolated in New Zealand is somewhat limited. Surveillance of antimicrobial resistance among gonococci isolated in the Auckland area and by Waikato Hospital is very effectively achieved by the routine referral of all isolates to LabPlus for antimicrobial susceptibility testing. However, based on the susceptibility data reported annually to ESR,[25] there is only limited susceptibility testing of gonococcal isolates in laboratories in other parts of the country. This may in part be due to many of these laboratories isolating relatively small numbers of gonococci and therefore being unable to maintain the expertise and materials required for this susceptibility testing.

In addition, this limited amount of testing in parts of the country may be affecting the representativeness of the New Zealand data being contributed to the WHO's Western Pacific Region Gonococcal Antimicrobial Surveillance Programme (GASP). Only the results of the antimicrobial susceptibility testing performed at LabPlus (i.e., gonococci isolated in the Auckland area and by the laboratory at Waikato Hospital), have been included in this surveillance programme, as other laboratories have been unable to routinely contribute data. The results of this survey indicate that these data may not be representative of the whole of New Zealand, and are likely to be overestimates of ciprofloxacin, penicillin and tetracycline resistance among gonococci in New Zealand.

Ideally, both to guide empirical treatment in New Zealand and to contribute more representative data to the WHO's regional surveillance, it is important that the susceptibility of all gonococci isolated in New Zealand is either tested in the primary laboratory or referred to another laboratory for susceptibility testing using a standardised method. Unless or until this happens, it will be important to repeat national point-prevalence surveys approximately every 2-3 years to provide data on the current prevalence and trends in gonococcal resistance.

The epidemiology of gonococcal infection, including resistance patterns, reflects the fact that gonorrhoea is only transmitted by intimate human-to-human contact. Controlling resistance will therefore be best achieved by effective treatment of cases and tracing of sexual contacts. Quinolone resistance in New Zealand gonococcal isolates most likely originates from local transmission of infection acquired overseas, rather than local over-prescribing of quinolones for other infections.[25] The very high rates of chlamydia in New Zealand underscore the fact that general safer sex messages are having limited impact on reducing the transmission of sexually transmitted infections.

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Appendix 1. MIC distribution among *Neisseria gonorrhoeae*, 2002

Antimicrobial agent	Number (%) of isolates with a MIC (mg/L) of:												
	0.004	**0.008**	**0.016**	**0.03**	**0.06**	**0.12**	**0.25**	**0.5**	**1**	**2**	**4**	**8**	**16**
Cefixime	158 (38.3)	129 (31.2)	91 (22.0)	28 (6.8)	6 (1.5)	1 (0.2)							
Ceftriaxone	309 (74.8)	60 (14.5)	32 (7.8)	12 (2.9)									
Ciprofloxacin	333 (80.6)	13 (3.2)	13 (3.2)	2 (0.5)	16 (3.9)	4 (1.0)	1 (0.2)	3 (0.7)	8 (1.9)	20 (4.8)			
Penicillin		35 (8.5)	27 (6.6)	31 (7.5)	84 (20.3)	138 (33.4)	38 (9.2)	23 (5.6)	20 (4.8)	3 (0.7)	14 (3.4)		
Spectinomycin										18 (4.4)	70 (17.0)	277 (67.1)	48 (11.6)
Tetracycline					35 (8.5)	55 (13.3)	110 (26.6)	98 (23.7)	66 (16.0)	17 (4.1)	4 (1.0)	1 (0.2)	27 (6.5)