



2014

## Gonorrhea Antimicrobial Resistance in Alberta

Gonorrhea Antimicrobial Resistance

Alberta Gonorrhea AMR  
Surveillance Working Group  
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## Background

Gonorrhoea is the second most common notifiable sexually transmitted infection (STI) in Canada. The incidence of gonorrhoea in Canada has been increasing since 1998 and the national gonorrhoea rate was 39.3 per 100,000 in 2013.<sup>1</sup> In Alberta, the provincial rate was 46.3 per 100,000 in 2014, with rates varying widely by zone (18.3/100,000 in the South Zone and 88.7/100,000 in the North Zone).<sup>2</sup> Infections can result in significant morbidity and increase the risk of HIV transmission and acquisition.<sup>1</sup>

Since the 1940s, gonorrhoea has developed resistance to multiple classes of antibiotics.<sup>3</sup> Following the widespread global use of oral cephalosporins for the treatment of gonorrhoea, initial reports of gonococci with reduced susceptibility and cases of treatment failure were reported in Japan.<sup>4,5</sup> Similar cases have since been reported from other parts of the world.<sup>3</sup> The creep of minimum inhibitory concentration (MIC) to expanded spectrum cephalosporins (ESC) continues to be reported in Canada and around the world.<sup>6-9</sup> The association of certain sequence types with decreased susceptibility to ESC continues to grow.<sup>10-13</sup> In addition, concerns with the use of azithromycin monotherapy have arisen as azithromycin resistance has emerged and continues to rise in Canada.<sup>14</sup>

Challenges to surveillance of antimicrobial resistance include the widespread use of nucleic acid amplification tests (NAAT) which allows diagnosis of the infection through non-invasive specimens like urine and increased sensitivity compared to culture, but does not provide information on susceptibilities. Currently, culture is the only test for attaining antibiotic susceptibilities. There are challenges with the ensuring a viable specimen can be transported to a laboratory given distance from collection sites and the need for controlled temperatures. In addition, the high proportion of asymptomatic gonorrhoea infections may defer people from screening and therefore cases remain undiagnosed.

In light of these challenges, Alberta maintains a surveillance system utilizing two main sentinel sites, the Calgary and Edmonton STI Clinics, to inform provincial and national treatment guidelines.<sup>15</sup>

## Objectives

The objectives of this analysis were:

1. To examine demographic and behavioural characteristics among culture positive gonorrhoea cases.
2. To examine the trends in AMR to multiple antibiotics on gonococcal isolates collected through Alberta's surveillance system.
3. To examine the trends in sequence typing data and its relationship to AMR.

## Methods

Under Alberta's *Public Health Act*, all positive gonorrhea results are reportable by all testing laboratories as well as testing clinicians to the designate of the provincial chief and senior medical officer of health (Alberta Health Services [AHS] Sexually Transmitted Infections Centralized Services). Gonorrhea is diagnosed by either nucleic acid amplification testing (NAAT) and/or culture. The Calgary and Edmonton STI clinics routinely screen using both methods. All clinical and behavioural data are submitted by the testing clinician on a STI Notifiable Disease Form and entered into a provincial database (AHS' STI module of the Communicable Disease Registry System [CDRS]). In addition, the Provincial Laboratory for Public Health (ProvLab) routinely conducts E-tests for susceptibility to multiple antibiotics on culture-based specimens and reports to the testing clinician the results of susceptibility testing on antibiotics currently recommended for treatment in the Alberta Treatment Guidelines for STI.<sup>16</sup> Isolates demonstrating resistance, isolates with cefixime MIC values of  $\geq 0.06$   $\mu\text{g}/\text{mL}$  (beginning in 2011), and susceptible isolates collected during the first 15 days of each month (beginning 2014) were submitted to the National Microbiology Laboratory (NML) for sequence typing.

### Data and Analysis

Data on culture positive isolates from ProvLab during 2007-2014 were extracted from the ProvLab database annually. For case-based analysis, one isolate was chosen to represent the case if more than one culture positive specimen per patient was submitted on the same day. MIC data for duplicate/triplicate specimens from the same patient submitted on the same day with the same sequence typing data were reviewed, and the most resistant isolate was selected. If MIC patterns were the same for multiple isolates, the following hierarchy was used to select the isolate: throat/genital/rectum.

A data extract of gonorrhea cases during the same time period was obtained from CDRS. CDRS data was merged with the ProvLab line list by specimen number. In 2014, 545 gonorrhea isolates were identified; after linking isolates to cases (which may involve multiple specimen sources) 465 cases were identified for case level analysis.

Criteria for interpretation of MIC values were based on Clinical Laboratory Standards Institute (CLSI) standards (Table 1).<sup>17</sup> Breakpoints for resistance to cefixime and ceftriaxone have not been defined by CLSI. However, isolates with an MIC of  $\leq 0.25$   $\mu\text{g}/\text{mL}$  are considered susceptible. To understand characteristics associated with rising MIC values in the case-based analysis, cefixime MIC values were grouped into 2 categories:  $\leq 0.016 - 0.03$   $\mu\text{g}/\text{mL}$  and  $\geq 0.06$   $\mu\text{g}/\text{mL}$ . This upper range was chosen to capture differences between E-test results from the ProvLab and Agar dilution results from the National Microbiology Laboratory (NML) which can differ by 1-2 dilutions. CLSI does not provide interpretive criteria for azithromycin; an MIC value of  $\geq 2.0$   $\mu\text{g}/\text{mL}$  is considered to have decreased susceptibility by the U.S. Gonococcal Isolate Surveillance Project.<sup>18</sup>

Table 1. Clinical Laboratory Standards Institute criteria for MIC Interpretations

	MIC ( $\mu\text{g}/\text{mL}$ )		
	Susceptible	Intermediate	Resistance
Penicillin	$\leq 0.06$	0.125-1.0	$\geq 2.0$
Tetracycline	$\leq 0.25$	0.5-1.0	$\geq 2.0$
Ciprofloxacin	$\leq 0.06$	0.125-0.5	$\geq 1.0$
Cefixime	$\leq 0.25$	-	-
Ceftriaxone	$\leq 0.25$	-	-

A data extract of all gonorrhea cases was provided from the STI module of CDRS to compare cases with culture results to NAAT-only cases. An extract of 2014 treatment data was also provided. As multiple drugs may be prescribed for gonorrhea cases, all treatments were reviewed to identify the use of a preferred or alternate treatment regime according to the 2012 Alberta STI Treatment guidelines.

P-values were calculated using chi-square or Fisher’s exact test depending on cell size. IBM SPSS Statistics version 19 was used to complete the analysis.

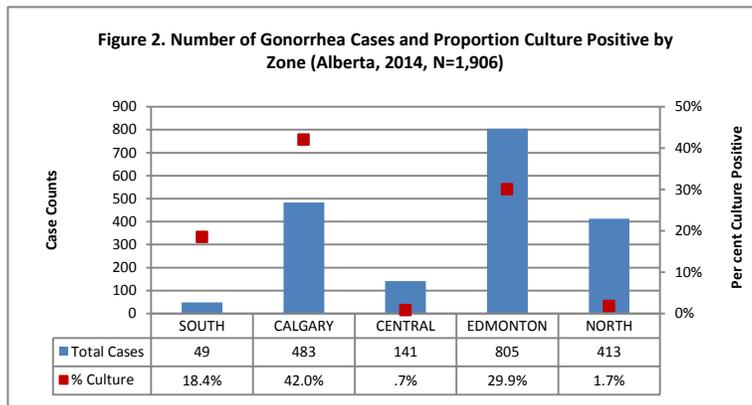
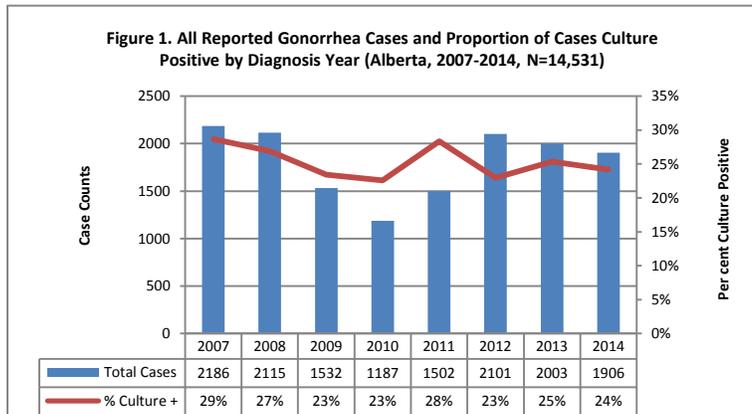
**Results**

**Sampling of Culture Positive Cases**

In Alberta, 1,906 cases of gonorrhea were reported in 2014. Nearly one-quarter of the cases (24.3%; n=465) were diagnosed by culture with the remainder of the cases identified through NAAT (Figure 1). Less than 5% of cases (3.6%; n=68) were diagnosed solely with culture. The majority of the culture-only cases were pharyngeal swabs (80.9%; n=55).

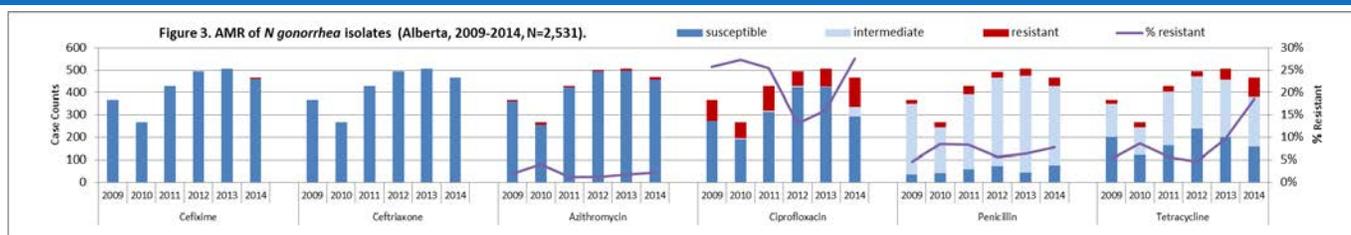
While the Calgary and Edmonton zones have the highest proportion of cases tested by culture (42.0% and 29.9%, respectively), the North zone had the lowest proportion of gonorrhea cases tested by culture (1.7%) while reporting 21.7% of provincial cases (Figure 2). The Central zone has the lowest proportion of culture positive cases with only 1 case reported in 2014.

The majority (92.0%, n=444) of culture positive cases were collected from the Calgary and Edmonton STI Clinics. Cases tested by culture were more likely to be male, older, Caucasian, and report same sex partners (Table 2).



**Table 2. Characteristics of Gonorrhea Cases by Culture versus NAAT Methods (Alberta, 2014, N=1,906).**

	Test Type n(%)			p-value
	Culture (N=464)	NAAT-only (n=1,442)	Total (N-1,906)	
<b>Male</b>	385 (83.0)	737 (51.1)	1,122 (58.9)	<0.001
<b>Median Age (IQR)</b>	28 (23-34)	25 (21-31)	25 (21-32)	<0.001
<b>Ethnicity</b>				
Aboriginal	55 (11.9)	544 (37.7)	599 (31.4)	<0.001
Asian	31 (6.7)	55 (3.8)	86 (4.5)	
Black	27 (5.8)	77 (5.3)	104 (5.5)	
Caucasian	314 (67.7)	512 (35.5)	826 (43.3)	
Other	18 (3.9)	16 (1.1)	34 (1.8)	
Unknown	19 (4.1)	238 (16.5)	257 (13.5)	
<b>Reported Sexual Partners</b>				
Heterosexual	180 (38.8)	1,085 (75.2)	1,265 (66.4)	<0.001
Same sex	242 (52.2)	146 (10.1)	388 (20.4)	
Bisexual	31 (6.7)	32 (2.2)	63 (3.3)	
<12 years	1 (0.2)	1 (0.1)	2 (0.1)	
Unknown	10 (2.2)	178 (12.3)	188 (9.9)	
<b>Case Zone</b>				
North	7 (1.5)	406 (28.2)	413 (21.7)	<0.001
Edmonton	241 (51.9)	564 (39.1)	805 (42.2)	
Central	1 (0.2)	140 (9.7)	141 (7.4)	
Calgary	203 (43.8)	280 (19.4)	483 (25.3)	
South	9 (1.9)	40 (2.8)	49 (2.6)	
Zone Not Identified	3 (0.6)	12 (0.8)	15 (0.8)	
<b>Testing Agency</b>				
STI Clinics	427 (92.0)	199 (13.7)	625 (32.8)	<0.001
Other Providers	37 (8.0)	1,244 (86.3)	1,281 (67.2)	



**Table 3. Cefixime, Ceftriaxone, Azithromycin, and Ciprofloxacin MIC value Distribution for Culture Positive Cases by Received Year (Alberta, 2009-2014, N=2,531)**

Year	n	Cefixime (µg/mL)		Ceftriaxone (µg/mL)		Azithromycin (µg/mL)		Ciprofloxacin (µg/mL)	
		Range	MIC <sub>90</sub>	Range	MIC <sub>90</sub>	Range	MIC <sub>90</sub>	Range	MIC <sub>90</sub>
2009	369	≤0.016-0.12	0.03	≤0.002-0.12	0.016	≤0.016-4.0	0.5	≤0.002-32.0	4.0
2010	268	≤0.016-0.25	0.06	≤0.002-0.12	0.03	≤0.016-16.0	1.0	≤0.002-32.0	32.0
2011	428	≤0.016-0.25	0.03	≤0.002-0.12	0.03	≤0.016-16.0	1.0	≤0.002-32.0	8.0
2012	494	≤0.016-0.12	≤0.016	≤0.002-0.25	0.016	≤0.016-4.0	1.0	≤0.002-32.0	4.0
2013	507	≤0.016-0.25	≤0.016	≤0.002-0.12	0.03	≤0.016-8.0	1.0	≤0.002-32.0	8.0
2014	465	≤0.016-0.5	0.03	≤0.002-0.12	0.03	≤0.016-16.0	0.5	≤0.002-32.0	12.0

#### AMR-Patterns among Culture Positive Cases

2014 marked the first year with isolates over the threshold for susceptibility for cefixime (>0.25 µg/mL, Figure 3). Five isolates among four cases were identified, representing 0.9% of culture positive cases. Three of the four cases resided in Calgary and three of the four cases were among women. All four cases reported heterosexual contacts. All 5 isolates were susceptible to ceftriaxone and azithromycin, resistant to ciprofloxacin, and had intermediate susceptibility to penicillin and tetracycline. Three of the four cases were ST-9551 (seen in the latter half of 2013) and one pharyngeal case was ST-11541 (first time reported in Alberta). These cases have caused the range of MIC values and the MIC<sub>90</sub> to increase (Table 3).

All culture positive cases between 2009 and 2014 have been susceptible to ceftriaxone. The range of MIC values and the MIC<sub>90</sub> have remained stable over time.

The proportion of culture positive cases with decreased susceptibility to azithromycin (≥2.0 µg/mL) has remained stable, ranging from 1.2% in 2011 to 2.1% in 2014, since its peak of 4.1% in 2010. The range of MIC values has increased in 2014; however, the MIC<sub>90</sub> has decreased a dilution. Ten (2.1%) culture positive cases in 2014 had decreased susceptibility to azithromycin. The majority of these cases were among males (n=8), all reporting same sex partners. Isolates were collected at the Edmonton (n=7) and Calgary (n=3) STI Clinics. All isolates were susceptible to cefixime and ceftriaxone. Nine isolates were sequenced type and only 2 cases shared the same type.

Both ciprofloxacin and tetracycline have seen a rise in the proportion of isolates resistant. Ciprofloxacin resistance has risen from 16.2% to 27.5% in 2014, while tetracycline resistance has risen from 9.7% in 2013 to 18.5% in 2014. The proportion of isolates resistant to penicillin has remained stable over the years, fluctuating from a low of 4.6% in 2009 to 7.7% in 2014.

An analysis of 2014 culture positive cases comparing cefixime isolates by MIC levels found a significant difference in the distribution of self-reported ethnicities between those with lower MIC values ( $\leq 0.016 - 0.03$   $\mu\text{g/mL}$ ) and those with higher MIC values ( $0.06 - 0.5$   $\mu\text{g/mL}$ ); however, when each ethnicity was compared to all other ethnicities the results were no longer significant. All other characteristics were similar among the two groups (Table 4). The proportion of isolates with an MIC level ( $\geq 0.06$   $\mu\text{g/mL}$ ) has increased from 3.2% ( $n=16$ ) in 2013 to 9.2% ( $n=43$ ) in 2014 ( $P<0.001$ ). Although not statistically significant, the number of culture positive cases with an elevated cefixime MIC level ( $\geq 0.06$   $\mu\text{g/mL}$ ) reporting same sex or bisexual partners has climbed from 43.8% ( $n=7$ ) in 2013 to 60.4% ( $n=26$ ) in 2014 ( $P=0.25$ ) and cases tested at the Edmonton STI Clinic have risen from 25.0% ( $n=4$ ) in 2013 to 39.5% ( $n=17$ ) in 2014 ( $P=0.37$ ).

#### AMR-Patterns among Culture Positive Specimens

A total of 544 culture positive specimens were reported in 2014. Over one-half of the specimens were collected from genitourinary sites (51.7%;  $n=281$ ), followed by rectal specimens (24.1%;  $n=131$ ), and pharyngeal specimens (23.2%;  $n=126$ ). In addition, 3 specimens were collected from the eye and 3 specimens were collected from abscesses. Of the 3 main specimen sites, all share similar ranges for cefixime, ceftriaxone, azithromycin, and ciprofloxacin MIC values (Table 5). Pharyngeal specimens MIC<sub>90</sub> for cefixime and ceftriaxone were one dilution above other specimen sites.

**Table 4. Characteristics of Culture Positive Gonorrhea Cases by Cefixime MIC Groups (Alberta, 2014, N=465).**

	Cefixime MIC Groups $\mu\text{g/mL}$ n(%)		
	$\leq 0.016 - 0.03$	$0.06 - 0.5$	P-value
<b>N</b>	422 (90.6)	43 (9.2)	
<b>Male</b>	348 (82.5)	35 (81.4)	0.83
<b>Ethnicity<sup>1</sup></b>			
<b>Aboriginal</b>	55 (13.4)	1 (2.6)	0.02
<b>Asian</b>	26 (6.3)	6 (15.8)	
<b>Black</b>	21 (5.1)	5 (13.2)	
<b>Caucasian</b>	294 (71.5)	24 (63.2)	
<b>Other</b>	15 (3.6)	2 (5.3)	
<b>Sexual Partners</b>			
<b>Bisexual</b>	27 (6.4)	5 (11.6)	0.49
<b>Heterosexual</b>	169 (40.0)	17 (39.5)	
<b>Same Sex</b>	224 (53.1)	21 (48.8)	
<b>&lt;12 Not Applicable</b>	1 (0.2)	0	
<b>Unknown</b>	1 (0.2)	0	
<b>Case Zone</b>			
<b>North</b>	7 (1.7)	0	0.60
<b>Edmonton</b>	225 (53.3)	18 (41.9)	
<b>Central</b>	1 (0.2)	0	
<b>Calgary</b>	183 (43.4)	22 (51.2)	
<b>South</b>	6 (1.4)	3 (7.0)	
<b>Testing Agency</b>			
<b>Calgary STI Clinic</b>	177 (41.9)	22 (51.2)	0.06
<b>Edmonton STI Clinic</b>	208 (49.3)	17 (39.5)	
<b>Other</b>	37 (8.8)	4 (9.3)	
1. Excludes 17 cases with missing ethnicity.			

**Table 5. Cefixime, Ceftriaxone, Azithromycin, and Ciprofloxacin MIC value Distribution for Culture Positive Cases by Specimen Source and Received Year (Alberta, 2014, N=538)**

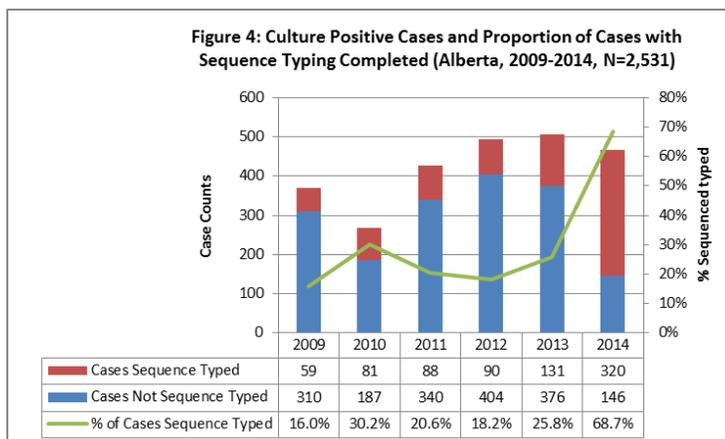
Source	n	Cefixime ( $\mu\text{g/mL}$ )		Ceftriaxone ( $\mu\text{g/mL}$ )		Azithromycin ( $\mu\text{g/mL}$ )		Ciprofloxacin ( $\mu\text{g/mL}$ )	
		Range	MIC <sub>90</sub>	Range	MIC <sub>90</sub>	Range	MIC <sub>90</sub>	Range	MIC <sub>90</sub>
<b>Genitourinary</b>	281	$\leq 0.016-0.5$	0.03	$\leq 0.002-0.12$	0.03	$\leq 0.016-8.0$	1.0	$\leq 0.002-32.0$	16.0
<b>Pharyngeal</b>	126	$\leq 0.016-0.5$	0.06	$\leq 0.002-0.12$	0.06	0.03-8.0	1.0	$\leq 0.002-32.0$	32.0
<b>Rectal</b>	131	$\leq 0.016-0.5$	0.03	$\leq 0.002-0.12$	0.03	0.03-4.0	0.5	0.003-32.0	32.0

### NG-MAST Sequence Types (ST)

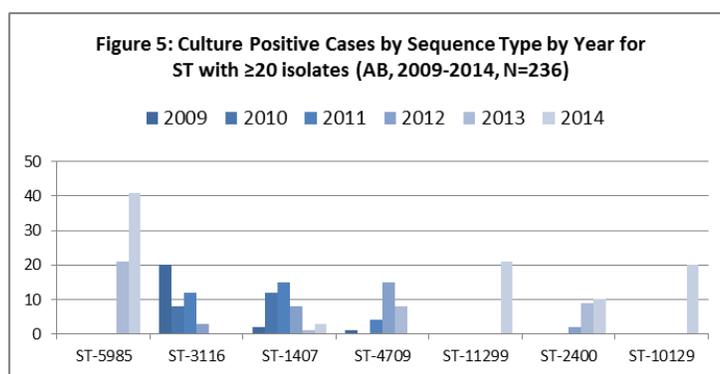
Overall, 30% (n=769) of culture positive cases between 2009 and 2014 had NG-MAST sequencing completed (Figure 4). In 2014, the proportion of cases with sequence typing completed rose to 68.7% from 25.8% in 2013. This rise is due to the sequence typing of susceptible isolates that began in 2014. Across time, 238 different ST were identified and the majority (61.3%, n= 146) of the ST were unique to a single culture positive case. The majority of sequence types identified each year are new to the Alberta data set (Table 6).

The most prevalent ST (>20 culture positive cases) in 2014 was ST-5985 (n=41), which was the most common ST in 2013 as well (n=21). ST-11299 (n= 21) and ST-10129 (n=20) were also common; both ST were new to the Alberta data set in 2014. ST-1407 is the only ST that has been found in every year since 2009 (Figure 5).

Sequence type groups were created from 2014 ST with ≥ 20 culture positive cases to pool characteristics among similar ST. A group was created when ST shared an allele (*porB* or *tbpB*) and the non-matching allele had <5 base pair differences (Table 7).



	Year Received					
	2009	2010	2011	2012	2013	2014
# isolates ST	59	81	88	90	131	320
# of different ST	24	34	42	43	55	107
# of new ST	-	27	31	31	43	82
% of ST that are new ST	-	79.4	73.8	72.1	78.2	76.6



NG-MAST Group	n	Predominant ST (n)	STs which differ by ≤1% for porB ST (n)
5985	69	5985 (62)	6968 (3), 11348 (1), 11544 (1), 11841 (1), 10131 (1)
10129	21	10129 (20)	11302 (1)
11299	21	11299 (21)	

The most common ST group was ST-5985 (n=69). The majority of culture positive cases belonging to this ST group were collected from MSM and reported primarily in the Calgary and Edmonton zones. Cases with this ST were reported beginning in 2012 at the Edmonton STI Clinic. Isolates were susceptible to cefixime, ceftriaxone, azithromycin and ciprofloxacin, with intermediate resistance to penicillin and resistance to tetracycline (Table 8).

The second largest ST group was ST-10129 (n=21). All cases were among MSM and were reported in 2014. Isolates were reported in both the Edmonton and Calgary zones. These isolates were susceptible to cefixime, ceftriaxone, azithromycin, ciprofloxacin, penicillin, and tetracycline.

The third largest ST group was ST-11299 (n=21) and all cases were reported in 2014. The majority of isolates were collected from MSM and were reported in both the Edmonton and Calgary zones, with one case reported from the South zone. All isolates were susceptible to cefixime and ceftriaxone, and azithromycin. All isolates were resistant to ciprofloxacin. The majority of isolates had intermediate susceptibility to penicillin and tetracycline with some isolates being resistant to these drugs.

Table 8. Characteristics of <i>Neisseria gonorrhoeae</i> Cases by NG-MAST groups (AB,2009-2014, N=111)			
	Sequence Type Group n(%)		
	5985 (69)	10129 (21)	11299 (21)
<b>Testing Agency</b>			
<b>Calgary STI Clinic</b>	44 (63.8)	9 (42.9)	9 (42.9)
<b>Edmonton STI Clinic</b>	23 (33.3)	12 (57.1)	9 (42.9)
<b>Other</b>	2 (2.9)	0	3 (14.3)
<b>Gender</b>			
<b>Male</b>	67 (97.1)	21 (100)	20 (95.2)
<b>Female</b>	2 (2.9)	0	1 (4.8)
<b>Ethnicity</b>			
<b>Aboriginal</b>	3 (4.3)	1 (4.8)	2 (9.5)
<b>Caucasian</b>	57 (82.6)	18 (85.7)	14 (66.7)
<b>Other</b>	6 (8.7)	2 (9.6)	3 (14.3)
<b>Unknown</b>	3 (4.3)	0	2 (9.5)
<b>Sexual Activity</b>			
<b>Heterosexual</b>	8 (11.6)	0	3 (14.3)
<b>MSM</b>	59 (85.5)	19 (90.5)	15 (71.4)
<b>Bisexual</b>	2 (2.9)	2 (9.5)	3 (14.3)
<b>Zone</b>			
<b>South</b>	0	0	1 (4.8)
<b>Calgary</b>	44 (63.8)	9 (42.9)	9 (42.9)
<b>Central</b>	1 (1.4)	0	0
<b>Edmonton</b>	24 (34.8)	12 (57.1)	11 (52.4)
<b>North</b>	0	0	0
<b>Minimum Inhibitory Concentration</b>			
<b>Cefixime &gt;0.25 µg/mL</b>	0	0	0
<b>Ceftriaxone &gt;0.25 µg/mL</b>	0	0	0
<b>Azithromycin ≥ 2.0 µg/mL</b>	0	0	0
<b>Ciprofloxacin Resistance</b>	0	0	21 (100)
<b>Penicillin Resistance</b>	0	0	0
<b>Tetracycline Resistance</b>	69 (100)	0	3 (14.3)
<b>Received Year</b>			
<b>2012</b>	3 (4.3)	0	0
<b>2013</b>	21 (30.4)	0	0
<b>2014</b>	45 (65.2)	21 (100)	21 (100)

### Treatment Data

Provincial guidelines for the treatment of gonorrhea are broken in to two patient groups. Preferred treatment for MSM and pharyngeal infections was ceftriaxone 250 mg IM as a single dose (SD) plus azithromycin 1 gm po SD. Preferred treatment for heterosexuals and pregnant women was cefixime 800 mg po SD plus azithromycin 1 gm po SD. In September 2014, a letter was sent to provincial physicians informing them of a shortage of cefixime and that cefixime treatment should be replaced with ceftriaxone.

Treatment data for uncomplicated gonorrhea cases among patients  $\geq 14$  years of age diagnosed in 2014 was available for 1,805 cases. The majority (95.4%, n=429) of MSM and pharyngeal cases were treated according to guidelines (Table 9). 87.9% (n=1,190) of heterosexual or pregnant cases received a preferred or alternate treatment. The majority (79.6%; n=82) of cases receiving an “other” treatment included a cephalosporin either in combination with doxycycline or an inadequate dose.

### Summary

In Alberta, the first four culture positive cases (five isolates) with decreased susceptibility to cefixime have been reported. Although not statistically significant, the number of isolates with an elevated cefixime MIC level ( $\geq 0.06$   $\mu\text{g}/\text{mL}$ ) among cases with same sex or bisexual partners has climbed from 43.8% (n=7) in 2013 to 60.4% (n=26) in 2014 (P=0.25). There continues to be no isolates with decreased susceptibility to ceftriaxone, while isolates with decreased susceptibility to azithromycin continue to be identified. NG-MAST data continues to demonstrate the diversity of sequence types in Alberta. The most prevalent ST groups identified in 2014 were susceptible to cefixime and ceftriaxone. A limitation to our GC AMR surveillance is the lack of isolates from zones outside of Edmonton and Calgary, which may limit the generalizability of the findings to rural areas in the province. A review of treatment data showed that most cases had been treated according to Alberta treatment guidelines.

**Table 9. Medication Used for Treatment of Uncomplicated Gonorrhea (Alberta, 2014, N=1,805)**

MSM and Pharyngeal Infections (N=450)		
Met Treatment Guidelines	Ceftriaxone 250 mg IM PLUS azithromycin 1 gm PO	340 (75.6)
	Cefixime 800 mg PO PLUS azithromycin 1 gm PO	75 (16.7)
	Azithromycin 2 gm PO	14 (3.1)
Did Not Meet Treatment Guidelines	Cefixime alone	2 (0.4)
	Ceftriaxone alone	2 (0.4)
	Other	17 (3.8)
Heterosexual/Pregnant Women (n=1,355)		
Met Treatment Guidelines	Ceftriaxone 250 mg IM PLUS azithromycin 1 gm PO	249 (18.4)
	Cefixime 800 mg po PLUS azithromycin 1 gm PO	897 (66.2)
	Spectinomycin 2 g IM PLUS azithromycin 1 gm PO	4 (0.3)
	Azithromycin 2 gm PO	43 (3.2)
Did Not Meet Treatment Guidelines	Cefixime alone	26 (1.9)
	Ceftriaxone alone	13 (1.0)
	Chlamydia treatment only	37 (2.7)
	Other	86 (6.3)

### The Alberta Gonorrhoea AMR Surveillance Working Group\*

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<b>Jennifer Gratrix</b>	Epidemiologist, STI Services, Alberta Health Services
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## References

1. Public Health Agency of Canada. Notifiable Diseases On-Line. Available at: [dsol-smed.phac-aspc.gc.ca/dsol-smed/ndis/charts.php?c=y1](http://dsol-smed.phac-aspc.gc.ca/dsol-smed/ndis/charts.php?c=y1) (Accessed October 28, 2015).
2. Alberta Health, Surveillance and Assessment Branch. Interactive Health Data Application. Available at: [ahw.gov.ab.ca/IHDA\\_Retrieval/redirectToURL.do?cat=81&subCat=466](http://ahw.gov.ab.ca/IHDA_Retrieval/redirectToURL.do?cat=81&subCat=466) (Accessed July 16, 2015).
3. Lewis, D. The Gonococcus fights back; is this time a knock out? *Sex Transm Infect.* 2010; 86:415-421.
4. Deguchi T et al. Treatment of uncomplicated gonococcal urethritis by double-dosing of 200 mg cefixime at a 6-h interval. *J Infect Chemother.* 2003 Mar; 9(1):35-9.
5. Ito M et al. Remarkable increase in central Japan in 2001-2002 of *Neisseria gonorrhoeae* isolates with decreased susceptibility to penicillin, tetracycline, oral cephalosporins, and fluoroquinolones. *Antimicrob Agents Chemother.* 2004 Aug; 48(8):3185-7.
6. Hottes TS, Lester, RT, Hoang LMN et al. Cephalosporin and azithromycin susceptibility in *Neisseria gonorrhoeae* isolates by site of infection, British Columbia, 2006 to 2011. *Sex Transm Dis.* 2013; 40:46-51.
7. Mehta, SD et al. (2011). Emergence of quinolone resistance and cephalosporin MIC creep in *Neisseria gonorrhoeae* isolates from a cohort of young men in Kisumu, Kenya, 2002-2009. *Antimicrob Agents Chemother.* 55(8), 3882-3888.
8. Centers for Disease Control and Prevention 2011 Sexually Transmitted Disease Surveillance. Available at: [cdc.gov/std/stats11/gonorrhoea.htm](http://cdc.gov/std/stats11/gonorrhoea.htm) (Accessed December 30, 2015).
9. Lahra, MM. (2012). Surveillance of antibiotic resistance in *Neisseria gonorrhoeae* in the WHO Western Pacific and South East Asian regions, 2010. *Commun Dis Intell.* 36(1):95-100.
10. Chisholm SA. et al. Emergence of a *Neisseria gonorrhoeae* clone showing decreased susceptibility to cefixime in England and Wales. *J Antimicrob Chemother.* 2011; 66:2509-12.
11. Camara, J. et al. 2012. Molecular characterization of two high-level ceftriaxone-resistant *Neisseria gonorrhoeae* isolates detected in Catalonia, Spain. *J Antimicrob Chemother.* 67(8), 1858-60.
12. Unemo, M. et al. (2012). High-level cefixime- and ceftriaxone-resistant *Neisseria gonorrhoeae* in France; Novel *penA* mosaic allele in a successful international clone causes treatment failure. *Antimicrob Agents Chemother.* 56(3), 1273-1280.
13. Heymans R, Bruisten SM, Golparian D, Unemo M, de Vries HJ, van Dam AP. Clonally related *Neisseria gonorrhoeae* isolates with decreased susceptibility to the extended-spectrum cephalosporin cefotaxime in Amsterdam, the Netherlands. *Antimicrob Agents Chemother.* 2012; 56:1516-22.
14. Public Health Agency of Canada. National Surveillance of Antimicrobial Susceptibilities of *Neisseria gonorrhoeae* Annual Summary 2013. Ottawa, ON; 2014.

15. Plitt S, Boyington C, Sutherland K, Lovgren M, Tilley PAG, Read R, Singh AE. Antimicrobial resistance in gonorrhea: the influence of epidemiologic and laboratory surveillance data on treatment guidelines: Alberta, Canada 2001-2007. *Sex Transm Dis* 2009; 36:665-9.
16. Alberta Health and Wellness, 2012. Alberta treatment guidelines for sexually transmitted infections in adolescents and adults. Available at: [health.alberta.ca/documents/STI-Treatment-Guidelines-2012.pdf](http://health.alberta.ca/documents/STI-Treatment-Guidelines-2012.pdf) (Accessed December 30, 2015).
17. Clinical and Laboratory Standards Institute, 2012. Performance standards for antimicrobial susceptibility testing: Twenty-second informational supplement. M100-S22 Vol. 32 No. 3.
18. Centers for Disease Control and Prevention. Interpreting STD Surveillance Data. Available at: [cdc.gov/std/stats13/app-interpret.htm](http://cdc.gov/std/stats13/app-interpret.htm) (Accessed December 30, 2015).