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Annual Summary 2014

Streptococcus and STI Unit
Bacteriology and Enteric Diseases Program
National Microbiology Laboratory
Public Health Agency of Canada

Vaccine Preventable Diseases
Centre for Immunization and Respiratory Infectious Diseases
Public Health Agency of Canada

Provincial and Territorial Public Health Microbiology Laboratories

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EXECUTIVE SUMMARY

- ***Streptococcus pneumoniae:*** 2,473 isolates causing invasive pneumococcal disease (IPD) were characterized in 2014
- The crude incidence rate for IPD cases meeting the national case definition has remained relatively stable between 2009-2014, averaging 9.6 cases per 100,000 population per year (range 8.9-9.8). The incidence of IPD has declined in children under 5 years of age; however rates in the older age groups have remained relatively unchanged.
- In 2014, the **highest incidence rates** were observed in adults aged 60 years and older (21.5 cases per 100 000 population); infants aged less than 1 year of age (16.9 cases per 100 000 population); and, children aged 1 to 4 years (11.0 cases per 100,000 population).
- **PCV7** serotypes have declined from 9.5% to 4.9% of all IPD isolates from 2010 to 2014 ($p<0.001$).
- **PCV13** serotypes have declined in all ages, with an overall decline from 45.6% in 2010 to 26.0% in 2014 ($p<0.001$).
- **PPV23** serotypes have increased in all age groups, with an overall increase from 24.7% to 38.0% between 2010 and 2014 ($p<0.001$).
- **Serotype 22F** was the most prevalent serotype in 2014, declining slightly from 12.1% to 11.4% between 2013 and 2014 in all combined age groups ($p=0.443$).
- **Serotype 19A** has continued to decline from 11.6% in 2013 to 8.9% in 2014 ($p=0.001$). Reductions from 2013 levels have been observed in all age groups except in the 2-4 year olds where an increase from 17.6% to 25.0% ($p=0.253$).
- **Serotype 7F** has similarly decreased from 8.8% in 2013 to 7.5% in 2014 ($p=0.088$), and only 1 isolate was reported in each of the <2, and 2-4 year old age groups during 2014.
- **Serotype 3** has remained relatively unchanged overall at 8.9% of isolates from all ages combined. Decreases were seen in <2 year olds from 8.6% to 2.3% since 2013 ($p=0.353$), and in the 5-14 year old age group from 5.2% to 2.9% from 2013 to 2014 ($p=0.788$).
- **Antimicrobial susceptibility:** Testing of 1,125 isolates indicated levels of resistance were relatively stable or declining in 2014 with the following resistance rates: clarithromycin (22.1%), penicillin (8.6%), doxycycline (7.9%), clindamycin (4.4%), trimethoprim/sulfamethoxazole (5.8%), meropenem (1.5%), and imipenem (1.2%). **Multi-drug resistance** to 3 or more classes of antimicrobials was observed in 4.9% of the isolates tested in 2014, down from 7.5% in 2013. The highest rates of multi-drug resistance were seen in serotypes 15A (53.8%) and 19A (17.6%).
- ***S. pyogenes* (Group A *Streptococcus*):** of the 1,457 invasive tested during 2014, *emm*1 continues to be most predominant accounting for 27.5% of isolates from all age groups combined, and *emm*89 was the next most prevalent with 9.7% of all isolates.
- **Antimicrobial susceptibility:** erythromycin resistance (6.9%), clindamycin resistance (2.8%), two chloramphenicol non-susceptible isolates.
- ***S. agalactiae* (Group B *Streptococcus*):** 249 invasive were submitted to NML during 2014, with serotypes V (23.3%), III (21.1%) and IV (17.5%) being most predominant;
- **Antimicrobial susceptibility**: erythromycin and clindamycin resistance (49.4% and 27.3%, respectively) were relatively unchanged in 2014 compared to 2013.

INTRODUCTION

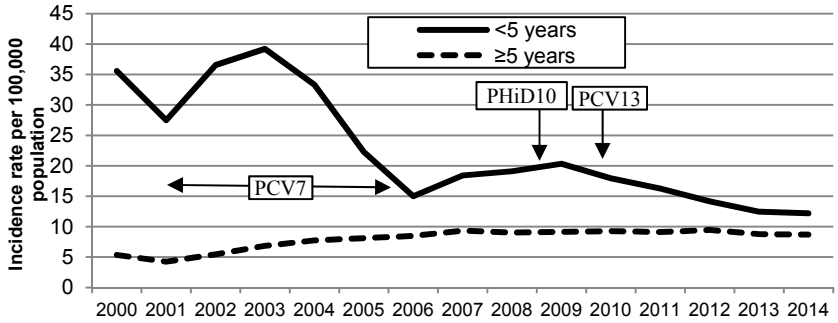
As of April 1, 2010, the National Microbiology Laboratory (NML), Winnipeg began offering surveillance, reference diagnostics and outbreak support on invasive *Streptococcus pneumoniae* (pneumococcus), *Streptococcus pyogenes* (Group A *Streptococcus*), and *Streptococcus agalactiae* (Group B *Streptococcus*). The Streptococcus and STI Unit also participates in a number of international, national and regional surveillance programs.

This report is intended to present the current distribution of serotypes of *S. pneumoniae*, *emm* types of *S. pyogenes*, and serotypes of *S. agalactiae* isolated from sterile sites that are forwarded from Canadian provincial and territorial public health laboratories, regional health units and reference centres to the NML. To broaden the representativeness of the data presented, the aggregated counts also include data submitted by Laboratoire de santé publique du Québec (LSPQ), Toronto Invasive Bacterial Diseases Network (TIBDN), and the Alberta Provincial Laboratory for Public Health (ProvLab Alberta), organizations that perform their own serotyping.

Invasive pneumococcal disease (IPD, *S. pneumoniae)* IPD causes severe infections such as meningitis and bacteraemia [Marchessault, 2002; Schuchat, 1997] with children and the elderly being at greatest risk for infection [Robinson, 2001; Scott, 1996]. Of the 92 distinct pneumococcal serotypes currently recognized, the majority of disease worldwide is caused by only a few serotypes.

A 7-valent pneumococcal conjugate vaccine (**PCV7),** consisting of serotypes 4, 6B, 9V, 14, 18C, 19F, and 23F, was introduced in all provincial and territorial vaccination programs between 2002 and 2006 [Bettinger, 2010]. This led to a dramatic decrease in incidence of disease and in the constituent serotypes in children [Bettinger, 2010; Bjornson, 2007; Bruce, 2008; Demczuk, 2012; Deng, 2013; DeWals, 2012; Kellner, 2008; Kellner, 2009; Lim, 2013; Lovgren, 1998; McIntosh, 2011; NACI, 2010; Shahidi, 2008; Tyrrell, 2009; Weinberger, 2011;] (Figure 1). After the introduction of vaccination programs, paediatric IPD increased due to serotype replacement among pneumococcal infections with increases in non-PCV7 serotype infections, such as serotypes 7F and 19A [Kellner, 2009; Tyrrell, 2009]. In 2009, a 10-valent Pneumococcal, *Haemophilus influenzae*, and Diptheria vaccine (**PHiD10)**; consisting of all the PCV7 serotypes plus serotypes 1, 5 and 7F; was used in Québec, Ontario and Newfoundland and Labrador. The 13-valent pneumococcal conjugate vaccine (**PCV13)**; consisting of all PHiD10 serotypes plus serotypes 3, 6A and 19A; was recommended for use in Canada in 2010 [National Advisory Committee on Immunization (NACI), 2010] and introduced by all provinces and territories between mid-2010 and mid-2011. Immunization schedules vary by jurisdiction, however National Advisory Committee on Immunization (NACI) / Public Health Agency of Canada (PHAC) recommendations have been published [NACI , 2010;

Figure 1. Annual incidence of IPD in Canada, 2000-2014



Public Health Agency of Canada (PHAC), 2013]. The 23-valent pneumococcal polysaccharide vaccine (**PPV23)** is available for adults; however it is not effective in children due to a poor T-cell-independent antibody response in immature immune systems [Merck & Co. Inc.]. Surveillance of the distribution of *S. pneumoniae* serotypes is important to inform vaccine composition and monitor for possible serotype replacement [Demczuk, 2010; Demczuk, 2013].

Invasive Group A *Streptococcus* (GAS, *S. pyogenes*) is responsible for a wide range of disease including bacteraemia, toxic shock syndrome and skin and soft tissue infections of which necrotizing fasciitis is most notorious [Cunningham, 2000]. Surveillance of strains is important to monitor increasing virulence patterns associated with this organism [Schwartz, 1990; Siljander, 2010]. The M protein, encoded by the *emm* gene, is an important virulence factor and an epidemiological marker used to characterize *S. pyogenes* isolates.

Group B *Streptococcus* (GBS, *S. agalactiae*) GBS is commonly associated with neo-natal disease where the highest infection risk is during childbirth, and often treated prophylactically with antibiotics. Group B Streptococcal disease of the newborn is nationally notifiable, however isolates submitted to NML include those that meet the case definition as well as sterile site isolates from all age groups since GBS is an increasing health concern among adults causing septicemia, meningitis, pneumonia, bone, joint and tissue infections. At risk adults groups include those with underlying medical conditions, pregnant women and those residing in extended health care facilities [Lamangni, 2013].

METHODS

A total of 2,473 invasive *S. pneumoniae,* 1,457 invasive *S. pyogenes* and 249 *S. agalactiae* isolates are included in this report for 2014. Data for 2014 include test results for isolates submitted to the NML by provincial and territorial public health laboratories and data provided by jurisdictions including 397 IPD isolates serotyped by Laboratoire de santé publique du Québec, 320 IPD by the Alberta Provincial Laboratory for Public Health and 371 IPD by the Toronto Invasive Bacterial Diseases Network.

Data submitted with bacterial isolates included patient age, gender, clinical source and date of collection. Multiple isolates with the same serotype and collected from the same patient within 14 days were only counted once with the most invasive isolation site assigned. Meningitis related isolates were regarded as most invasive, followed by blood and then other sterile sites. The data were aggregated by age (<2 year, 2-14 year, 15-49 year, 50-64 year and ≥65 year age groups) and regionally into Western (British Columbia, Alberta, Saskatchewan, Manitoba, Yukon Territories, Northwest Territories and Nunavut); Central (Ontario and Québec) and Eastern (New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland and Labrador) regions of Canada. Caution should be exercised when interpreting the data presented in this report as the overall interpretation of the results is difficult due to the limitations related to the isolates available for testing. Only a subset of laboratory isolates within each province may be submitted for testing and therefore this report does not reflect true incidence or rates of disease in Canada. Submission of isolates to the NML is voluntary and not standardized across the country. Accordingly, aggregated national and regional summaries are presented in this report.

Validated surveillance data for 2009 to 2014 were obtained through the Canadian Notifiable Disease Surveillance System (CNDSS) [PHAC, 2014]. Population data were obtained from Statistics Canada July 1st annual population estimates, 2009 to 2014. The population of provinces and territories for whom case data were not available were excluded from the denominator. CNDSS epidemiologic data and NML laboratory data were not linked. Because not all provinces and territories report line list data to CNDSS, only aggregated data are available at the national level. Therefore, CNDSS data and NML laboratory data were presented differently in terms of age grouping. The age grouping for NML data is consistent with that in NACI statements.

All IPD isolates were screened by bile solubility and optochin (Oxoid) analyses and GAS/GBS isolates were confirmed using PYR (Pyrrolidonyl-α-naphthylamide) reaction and susceptibility to bacitracin (Oxoid) and trimethoprim/sulfamethoxazole susceptibility discs (BBL; 1.25/23.75 µg/ml) [Spellerberg, 2007]. Sterile clinical isolation sites include blood, cerebrospinal fluid or other nervous tissue (CSF), peritoneal fluid, pericardial fluid, joint fluid, internal body sites and muscle including surgical or biopsy samples and aspirates. Although pleural fluid (empyema) does not currently meet the national case definition for invasive disease, these isolates are included in this report as they are widely considered as invasive in other jurisdictions. Additionally for *S. pyogenes,* any isolation site was tested if a case of toxic shock syndrome or necrotizing fasciitis was associated with the infection [Canadian Communicable Disease Report, 2009; Minnesota Department of Health].

National case definitions for IPD, GAS and GBS can be found at the following:
IPD: http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/09vol35/35s2/Pneumoco-eng.php
GAS: http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/09vol35/35s2/Strep_A-eng.php
GBS: http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/09vol35/35s2/Strep_B-eng.php

Serotyping of IPD at NML is performed by observing the Quellung reaction using pool, group, type and factor commercial antisera (SSI Diagnostica; Statens Serum Institute, Copenhagen, Denmark) [Austrian, 1976; Lovgren, 1998]. Isolates for which a Quellung reaction is not observed are confirmed by *rpoB* gene sequencing [Drancourt, 2004; Clinical Laboratory Standards Institute (CLSI), 2008] as well as PCR serotyping as outlined at: http://www.cdc.gov/streplab/pcr.html.

In 2011, the NML began a collaboration with the University of Manitoba – Health Sciences Centre - Canadian Antimicrobial Resistance Alliance (CARA) to provide antimicrobial susceptibility testing (AST) for *S. pneumoniae* isolates submitted to the NML called SAVE (*S. pneumoniae* Serotyping and Antimicrobial Susceptibility: Assessment for Vaccine Efficacy in Canada After the Introduction of PCV-13). All sterile-site isolates (2014, n=1,125) from any age group causing invasive pneumococcal disease submitted by 8 participating jurisdictions (Saskatchewan, Manitoba, Ontario, Quebec, Nova Scotia, Prince Edward Island, New Brunswick, Newfoundland and Labrador) are included in the study. A panel of 18 antimicrobials are tested, including: penicillin, amoxicillin/clavulanate, cefuroxime, ceftriaxone, clarithromycin, ertapenem, meropenem, clindamycin, vancomycin, ciprofloxacin, levofloxacin, moxifloxacin, linezolid, tigecycline, trimethoprim/sulfamethoxazole and doxycycline. MICs of these antimicrobials are determined by the CLSI broth microdilution method using 96-well custom designed microtitre plates [CLSI, 2015]. MIC interpretive standards were defined according to CLSI breakpoints (CLSI, 2015) for all antibiotics except ciprofloxacin for which EUCAST interpretative breakpoints were used [EUCAST, 2015].

The *emm* types were determined for all invasive Group A *Streptococcus* isolates submitted to the NML. Isolates were characterized using the *emm* sequencing CDC protocol available at: http://www.cdc.gov/streplab/M-ProteinGene-typing.html. The *emm* sequences obtained are compared with the CDC (Atlanta) data bank and results reported to the type level, not the subtype level (*emm*4.4 is reported as *emm*4). Antimicrobial susceptibilities were determined (2014 GAS n=1,443; GBS n=249) by Kirby-Bauer Disc diffusion for chloramphenicol (CHL, 30 µg), erythromycin (ERY, 15 µg), clindamycin (CLI, 2 µg), penicillin (PEN, 10 µg) and vancomycin (VAN, 30, µg) according to CLSI guidelines [CLSI, 2015].

Serotypes of Group B *Streptococcus* were determined using commercial latex agglutinating antisera (SSI Diagnostica; Statens Serum Institute, Copenhagen, Denmark).

Poisson regression was used to estimate the incidence difference using SAS EG5.1. Other statistical analyses were performed using chi square or Fisher exact test using OpenEpi version 2.3.1. Differences of $p<0.05$ were considered statistically significant.

RESULTS AND DISCUSSION

Streptococcus pneumoniae

Between 2009 and 2014, the overall incidence of IPD in Canada has decreased from 9.8 to 8.9 cases per 100,000 population ($p<0.001$). In 2014, the overall incidence rate of IPD was 8.9 cases per 100,000 population, with higher rates of disease still seen in infants <1 year of age (16.9 cases per 100,000 population), children 1-4 years of age (11.0 cases per 100,000 population) and in the 60+ age group (21.5 cases per 100,000 population) (Figure 2, Table 1). Over the study period, the significant decline of IPD incidence rates have been shown in the <1 year old age group ($p<0.001$), 1-4 year olds age group ($p<0.001$), 5-9 year olds age group, 30-39 year olds age group ($p=0.005$) and 60 and above age group ($p=0.02$) (Table 1).

Figure 2. Annual incidence of IPD cases in Canada, by age group, 2009 – 2014

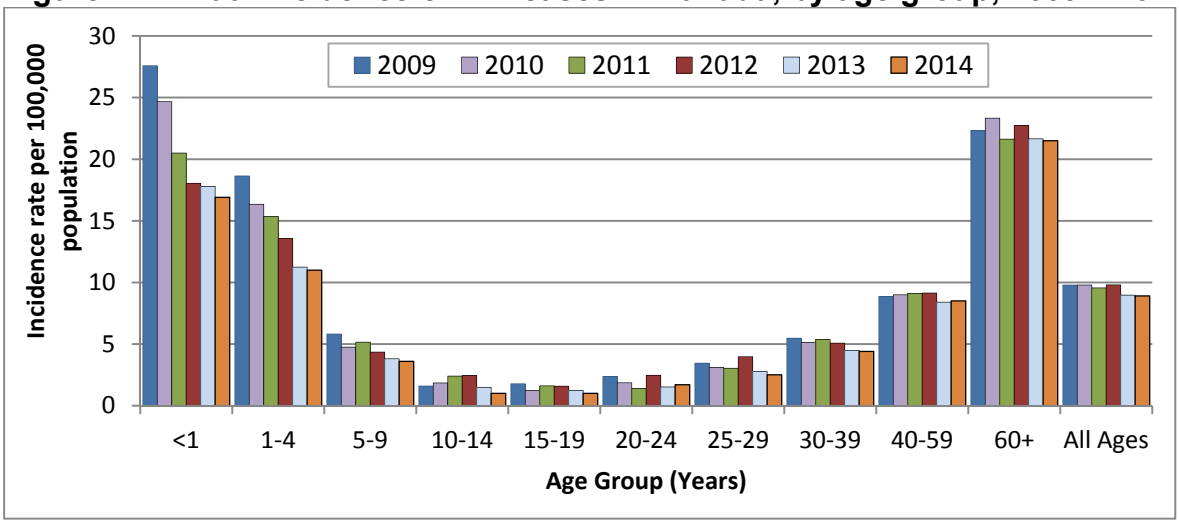


Table 1. Annual incidence rates of IPD cases per 100,000 in Canada, 2009 – 2014

Year	Age Group (Years)										
	<1	1-4	5-9	10-14	15-19	20-24	25-29	30-39	40-59	60+	All Ages
2009	27.6	18.7	5.8	1.6	1.8	2.4	3.5	5.5	8.9	22.3	9.8
2010	24.7	16.4	4.8	1.8	1.3	1.9	3.1	5.1	9	23.3	9.8
2011	20.5	15.3	5.2	2.4	1.6	1.4	3	5.4	9.1	21.6	9.6
2012	18.1	13.6	4.4	2.4	1.6	2.5	4	5.1	9.1	22.7	9.8
2013	17.8	11.2	3.8	1.5	1.2	1.5	2.8	4.5	8.4	21.7	9.0
2014	16.9	11.0	3.6	1.0	1.0	1.7	2.5	4.4	8.5	21.5	8.9

Population data were obtained from Statistics Canada July 1st annual population estimates, 2009 to 2014. The population of provinces and territories for whom case data were not available were excluded from the denominator.

Distribution of *Streptococcus pneumoniae* Serotypes

Of the 2473 IPD isolates serotyped in 2014, children <2 years of age accounted for 5.2% (n=128), children aged 2-4 years for 3.6% (n=88), children aged 5-14 years for 2.8% (n=69), adults aged 15-49 years for 20.5% (n=508), adults aged 50-64 years for 28.3% (n=700) and seniors aged ≥65 years for 39.1% (n=967) (Table 2). Of the 2,439 isolates with gender information specified, 55% (n=1345) were from male patients.

Blood was the most frequent clinical isolation site accounting for 92.3% (n=2,283) of all isolates (Figures 3a, 3b). Serotype 22F was prevalent in all sources (Figures 4-7) representing 11.5% (n=262) of all blood, 8.3% (n=6) of CSF, 14.3% (n=5) of pleural fluid and 16.7% (n=3) of synovial fluid isolates. Serotypes 23B, 11A and 12F represented a higher proportion of CSF isolates (11.1%, n=8; 9.7%, n=7; and 9.7%, n=7; respectively) compared to other clinical isolation sites ($p<0.001$). Similarly, serotype 3 was predominant in blood and pleural fluid ($p<0.001$) representing 8.9% (n=202) and 17.1% (n=6) of the isolates, respectively.

Regionally, serotypes 4 (4.5%, n=43), 12F (6.7%, n=64) and 20 (5.5%, n=53) were associated with Western regions ($p<0.001$); 15A (5.5%, n=75) with Central ($p=0.04$); and 9N (8.1%, n=13) and 6C (6.2%, n=10) with Eastern regions ($p<0.001$) (Figure 8).

The overall most predominant serotypes in 2014 were 22F (11.4%, n=282), 19A (8.9%, n=220), 3 (8.9%, n=220), 7F (7.5%, n=185) and 15A (4.5%, n=112), together representing 41.2% (n=1,019) of all IPD in Canada (Figure 10). After a steady increase since 2010 serotype 22F has declined slightly from 12.1% (n=312) to 11.4% (n=282, $p=0.443$) in 2014. Since 2010, serotypes 19A and 7F have declined by 57% and 52%, respectively, Serotype 19A decreased from 19.1% (n=517) in 2010 to 8.9% (n=220) in 2014 ($p<0.001$); and 7F decreased from 14.3% (n=388) to 7.5% (n=185) ($p<0.001$). From 2010 to 2014 overall prevalence of serotype 3 has remained relatively constant, increasing slightly from 8.3% (n=225) to 8.9% (n=220) ($p=0.48$) (Figures 9-16).

Serotype 22F: The largest increase in the relative proportion of 22F isolates between 2013 and 2014 was seen in the 5-14 year old age group increasing from 10.4% (n=8) to 14.5% (n=10) ($p=0.62$). Levels in other age groups have remained relatively constant at

12.5% (n=16) in the <2, 10.2% (n=9) in 2-4, 8.7% (n=44) in 15-49, 10.7% (n=75) in 50-64, and 13.2% (n=128) in ≥65 year old age groups.

Serotype 19A: Continued declines of 19A have been observed in all age groups, except in the 2-4 year olds where proportions have increased from 2013 to 2014 from 17.6% (n=13) to 25.0% (n=22) (p=0.25). Dramatic reductions over the 5 year period from 2010 to 2014 have been seen in <2 year olds from 40.0% (n=68) to 3.9% (n=5) (p<0.001); the 50-64 year olds from 17.2% (n=118) to 8.1% (n=57)(p<0.001); and in the ≥65 year olds from 17.8% (n=172) to 7.9% (n=76)(p<0.001). In the 5-14 year olds, after increasing from 2010 to 2013 from 12.7% (n=14) to 28.6% (n=22) (p=0.007), levels have declined in 2014 to 11.6% (n=8) (p=0.01). More modest declines were seen from 2010 to 2014 in the 15-49 year olds from 12.2% (n=71) to 9.6% (n=49) (p=0.19).

Serotype 7F: Only 1 isolate of serotype 7F was reported among each of the <2 and 2-4 year old age groups during 2014, which is considerably reduced from 2010 levels where there were 21 (p<0.001) and 14 isolates (p=0.01) in these age groups, respectively. Decreases from 2010 continue in other age groups with 2014 levels of 7F in 15-49 year olds at 12.8% (n=65, p<0.001), 50-64 year olds at 8.0% (n=56, p=0.007) and in the ≥65 year olds at 5.5% (n=53, p=0.003). After a large decrease from 30.5% (n=39) to 9.1% (n=7) from 2011 to 2013 (p=0.004) in the 5-14 year olds, levels have not changed dramatically in 2014 accounting for 11.6% (n=8, p=0.62) of the isolates in this age group.

Serotype 3: After increasing in the <2 year olds from 6.5% (n=12) to 8.6% (n=10) of the isolates from 2010 to 2012 (p=0.35), levels of serotype 3 decreased in 2013 and now represents 2.3% (n=3) of the isolates in 2014 (p=0.017). Another decrease was seen in the 5-14 year old age group where levels of serotype 3 have declined from 2010 to 2014 from 7.3% (n=8) to 2.9% (n=2, p=0.22). Levels of serotype 3 have remained relatively unchanged over the 5 year period from 2010 to 2014 in the 2-4, 15-49, 50-64 and ≥65 year old groups accounting for 9.1% (n=8), 7.5% (n=38), 11.1% (n=78) and 9.2% (n=89) of the 2014 isolates, respectively.

Other Serotypes: In the <2 year old age group, levels of PPV23 serotypes 10A, 11A, 15B and 33F have increased over the previous 5 years, accounting for 7.8% (n=10, p=0.07), 8.6% (n=11, p=0.009), 9.4% (n=12, p=0.002), 7.8% (n=10, p=0.018) of 2014 isolates. Although still present in relatively low numbers, serotype 15A has increased over previous years in all age groups (p=0.014), ranging from 3.0% to 5.8% of the isolates in each age group. Similarly serotype 23B has increased in all groups and in 2014 (p=0.001) ranging from 2.6% to 8.7% of various age group isolates. Increases of 16F and 23A have also been observed in the older 15-49, 50-64, and ≥65 age groups (p=0.005 and p<0.001, respectively).

Table 2. Number of invasive *S. pneumoniae* isolates from each province and territory, 2014

Province	Age Groups (Years)						Not Given	Total
	< 2	2 – 4	5 – 14	15 – 49	50 – 64	≥ 65		
British Columbia	7	9	16	85	98	155	-	**370**
Alberta	13	11	8	110	92	86	-	**320**
Saskatchewan	5	1	8	37	32	40	-	**123**
Manitoba	6	5	1	38	45	33	1	**129**
Ontario	28	40	22	155	282	421	9	**957**
Québec	61	20	11	52	91	162	-	**397**
New Brunswick	2	-	1	8	18	22	2	**53**
Nova Scotia	1	1	-	14	25	21	-	**62**
Prince Edward Island	2	1	-	2	4	6	1	**16**
Newfoundland and Labrador	-	-	-	4	8	18	-	**30**
Yukon Territories	-	-	-	1	1	1	-	**3**
Northwest Territories	2	-	1	2	4	2	-	**11**
Nunavut	1	-	1	-	-	-	-	**2**
Canada	**128**	**88**	**69**	**508**	**700**	**967**	**13**	**2,473**

Figure 3a. 2014 Clinical Isolates from <5 years of age (N=216)

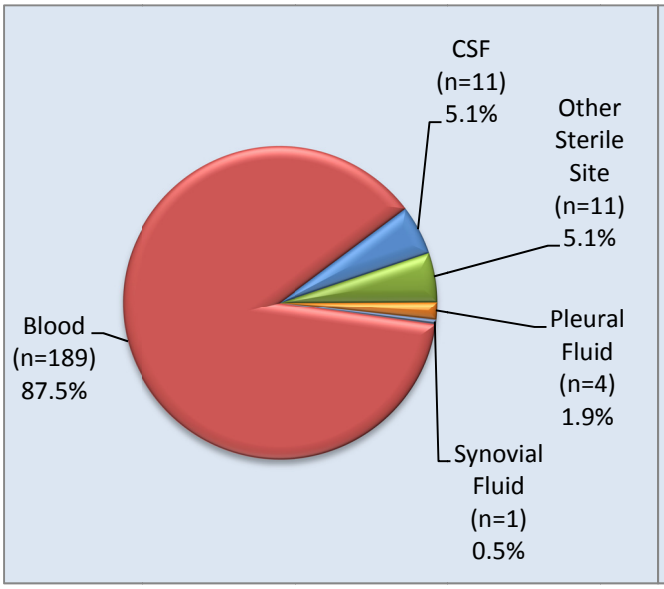
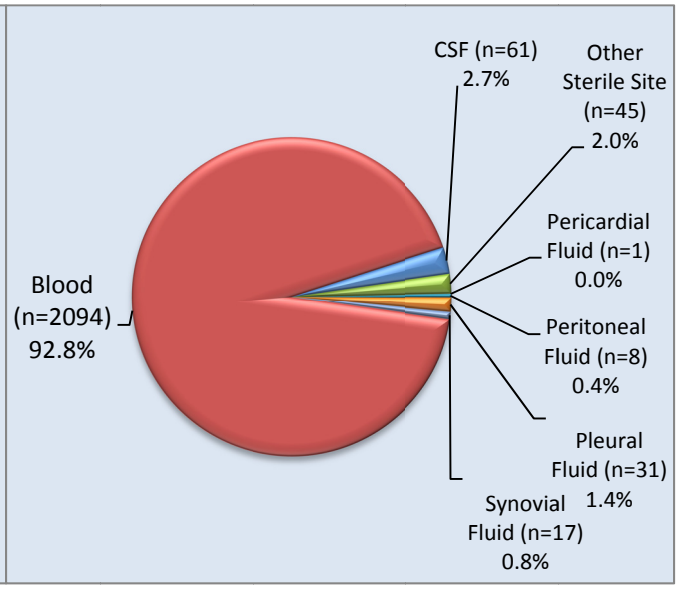


Figure 3b. 2014 Clinical Isolates from ≥5 years of age (N=2,257)*



*NOTE: Includes 13 isolates with age not available

Figure 4. Distribution of invasive *S. pneumoniae* serotypes from blood, 2014

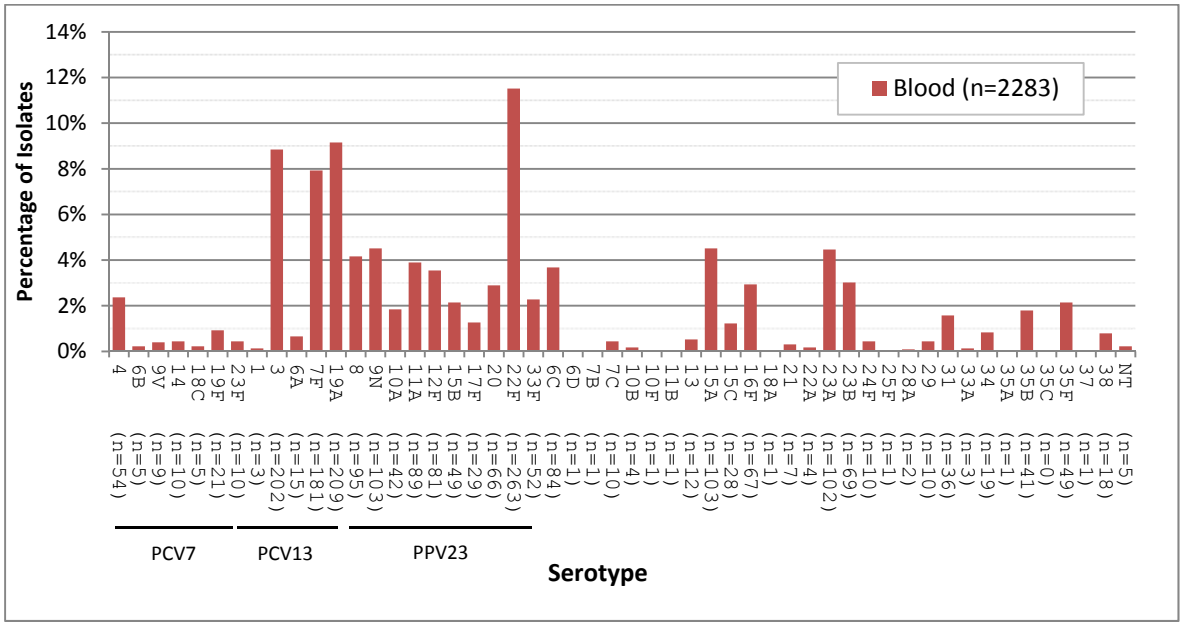


Figure 5. Distribution of invasive *S. pneumoniae* serotypes from CSF, 2014

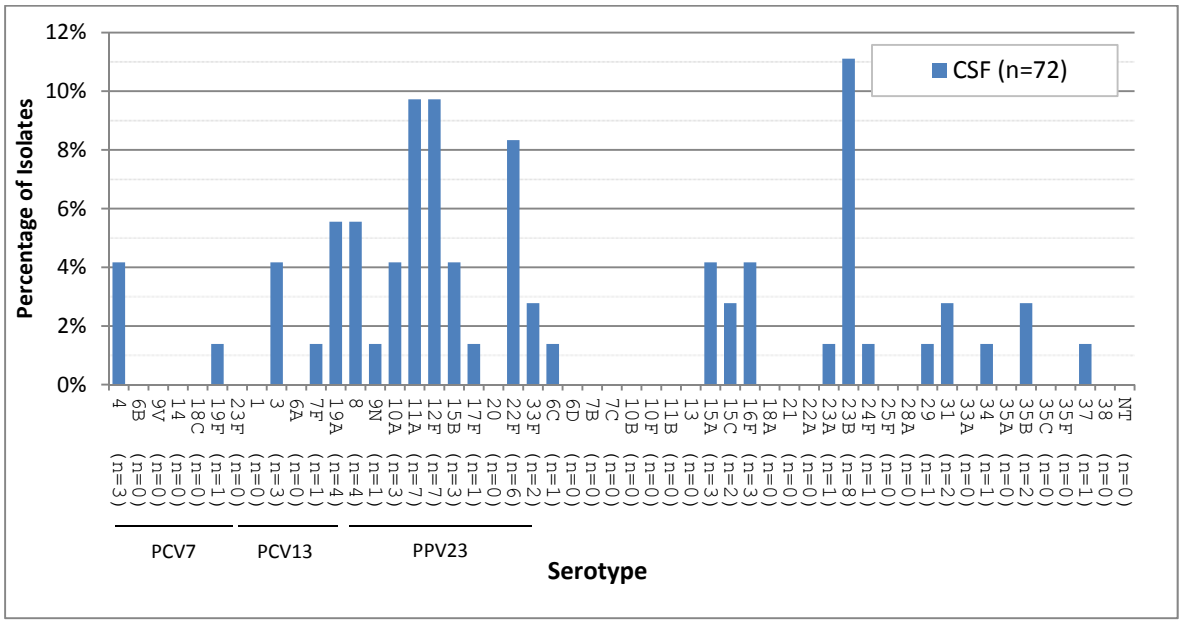


Figure 6. Distribution of invasive *S. pneumoniae* serotypes from pleural fluid, 2014

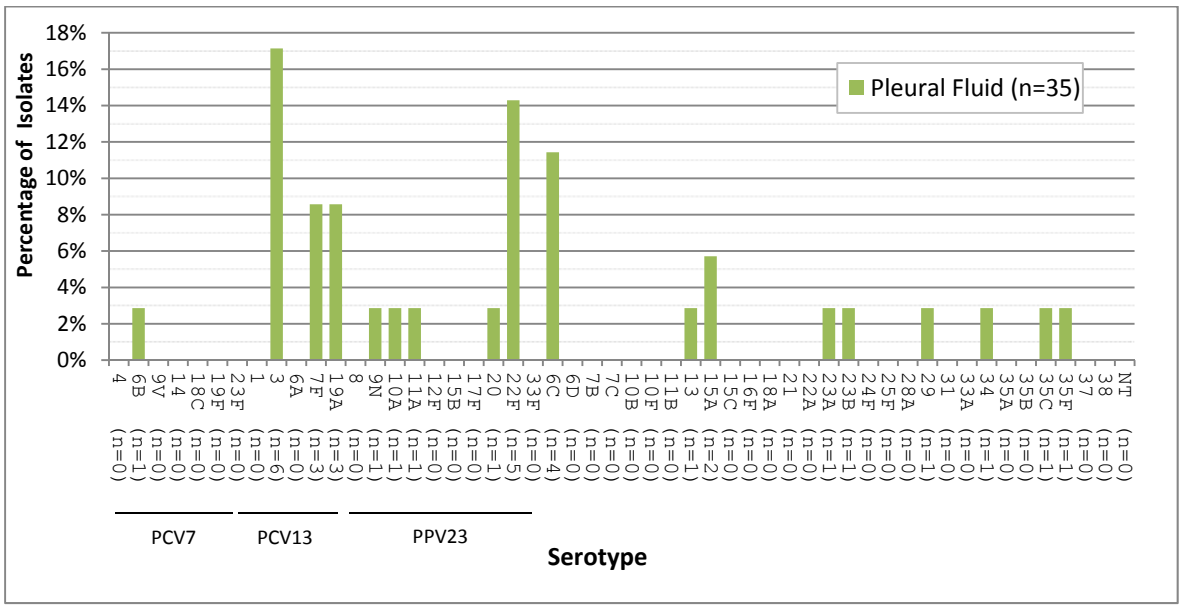
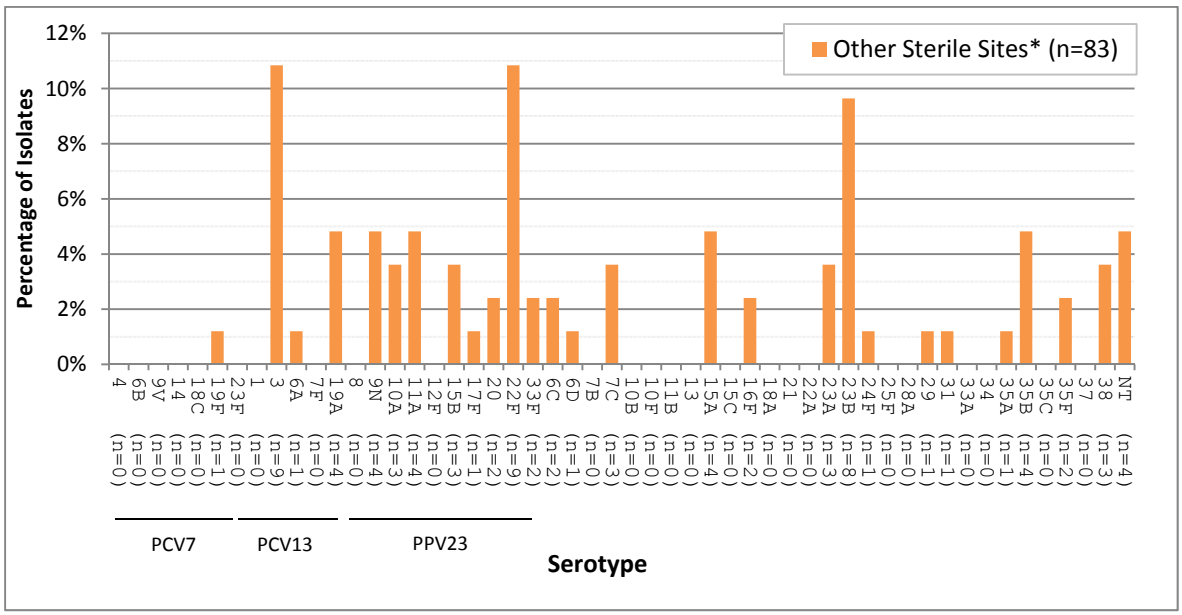
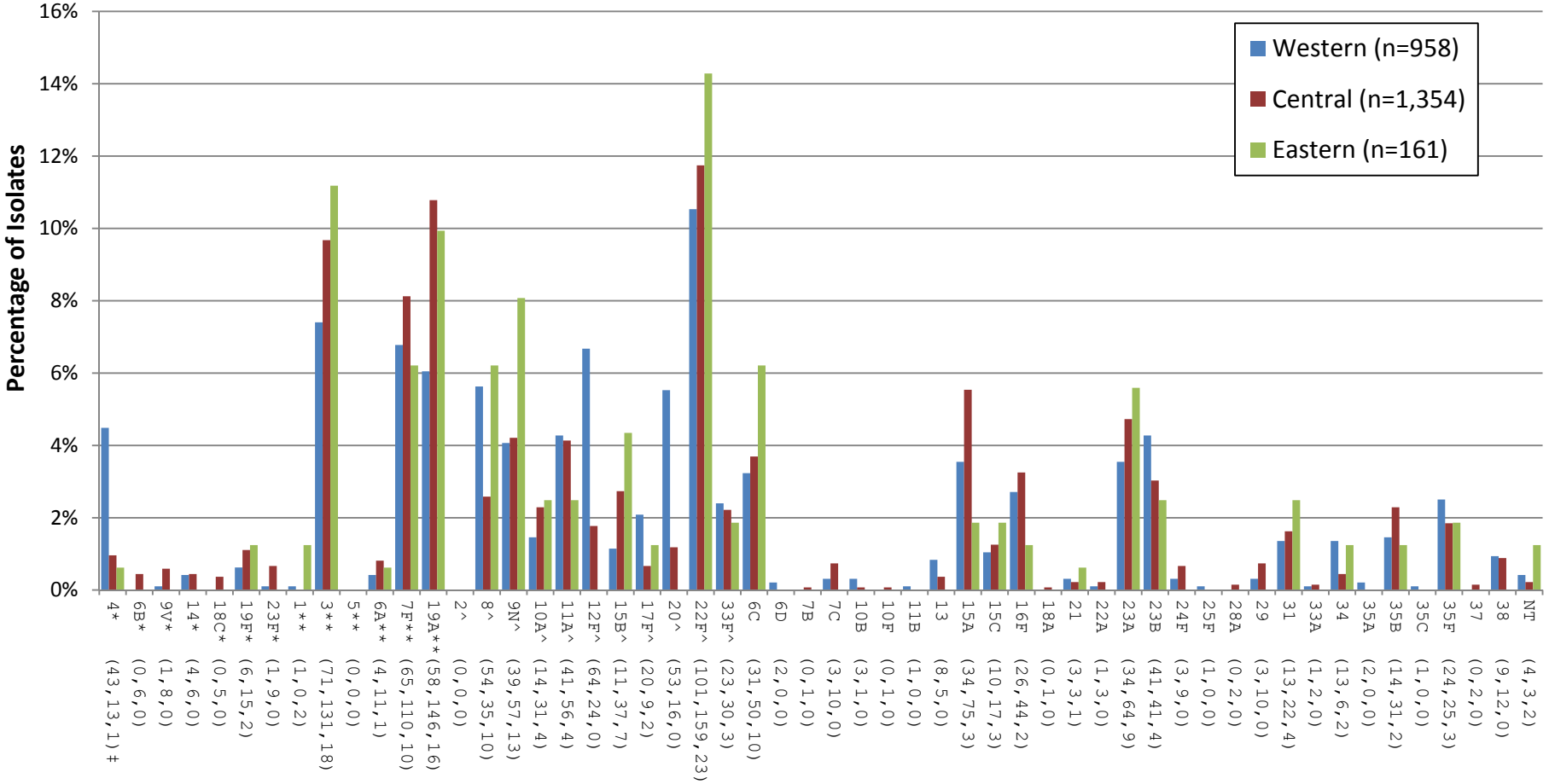


Figure 7. Distribution of invasive *S. pneumoniae* serotypes from other sterile sites, 2014



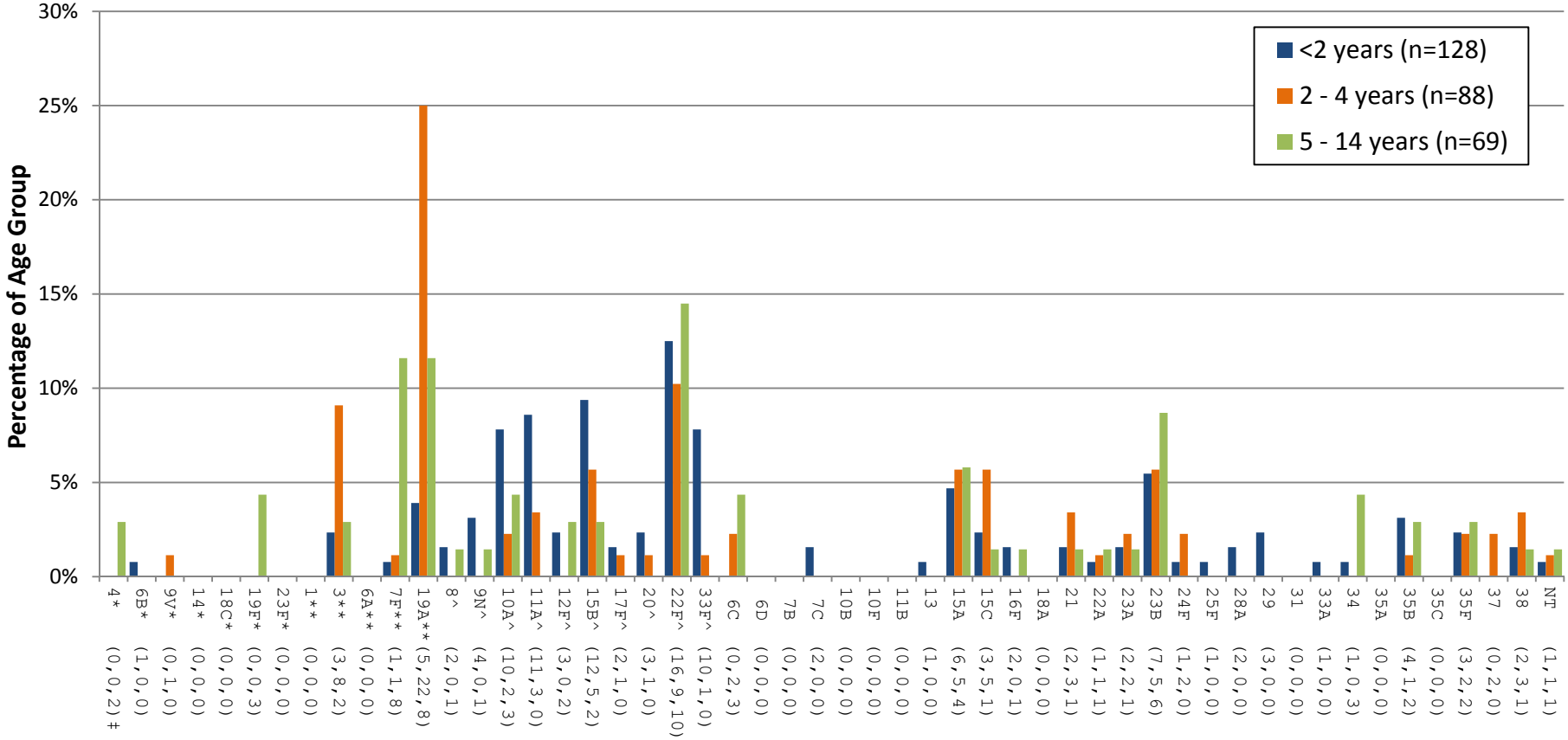
*Other Sterile Sites include: 1 pericardial fluid, 8 peritoneal fluid, 18 synovial fluid and 56 from sites such as deep tissue, biopsy and surgical samples.

Figure 8. Regional Distribution of Invasive *S. pneumoniae* serotypes, 2014



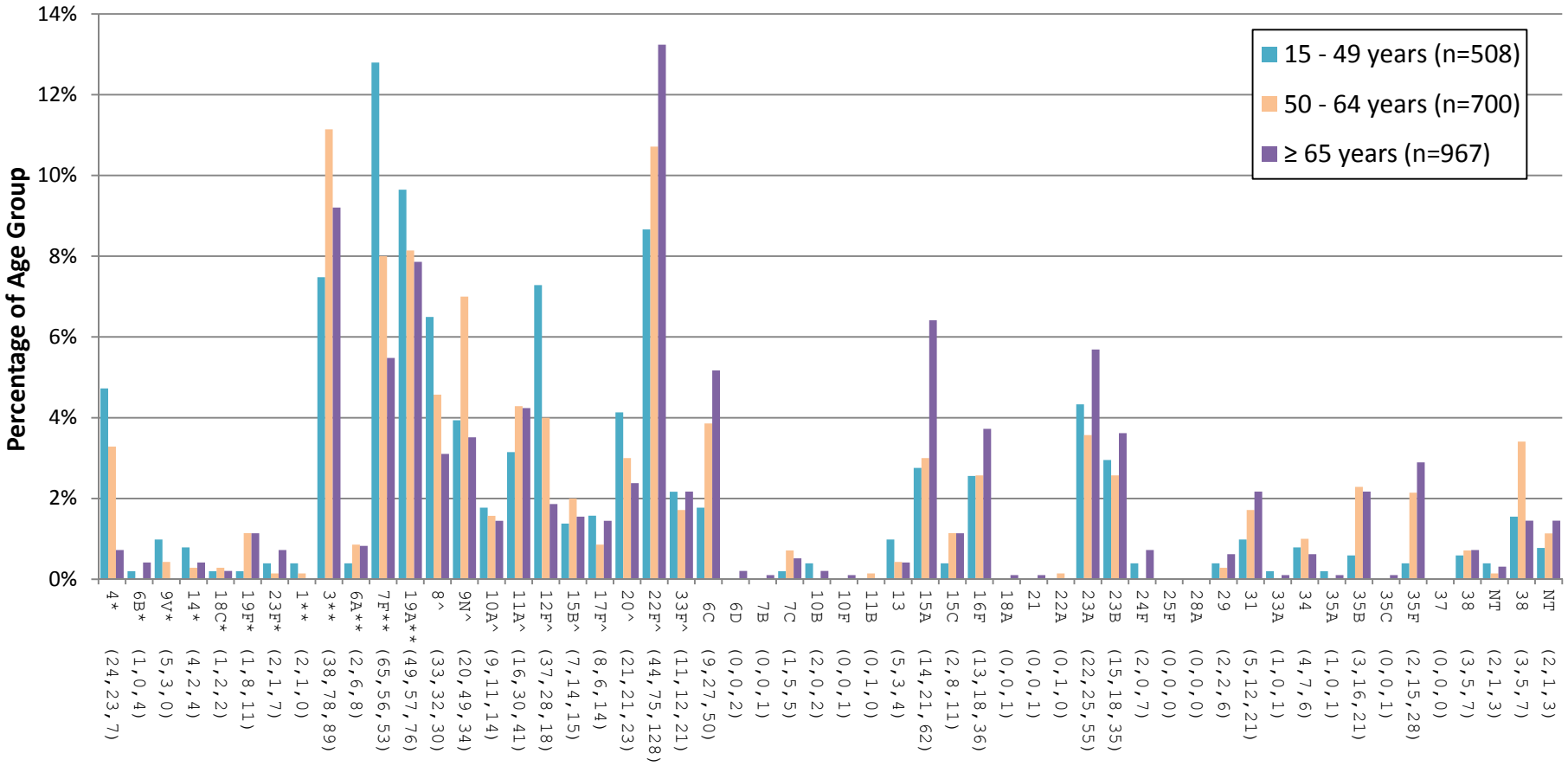
*Component of PCV7; ** Component of PCV13; ^ Component of PPV23; ‡ Number of isolates for Western, Central and Eastern Canada, respectively.

Figure 9a. Age Group Distribution of Invasive *S. pneumoniae* serotypes isolated in 2014: <2, 2-4 and 5-14 year old age groups



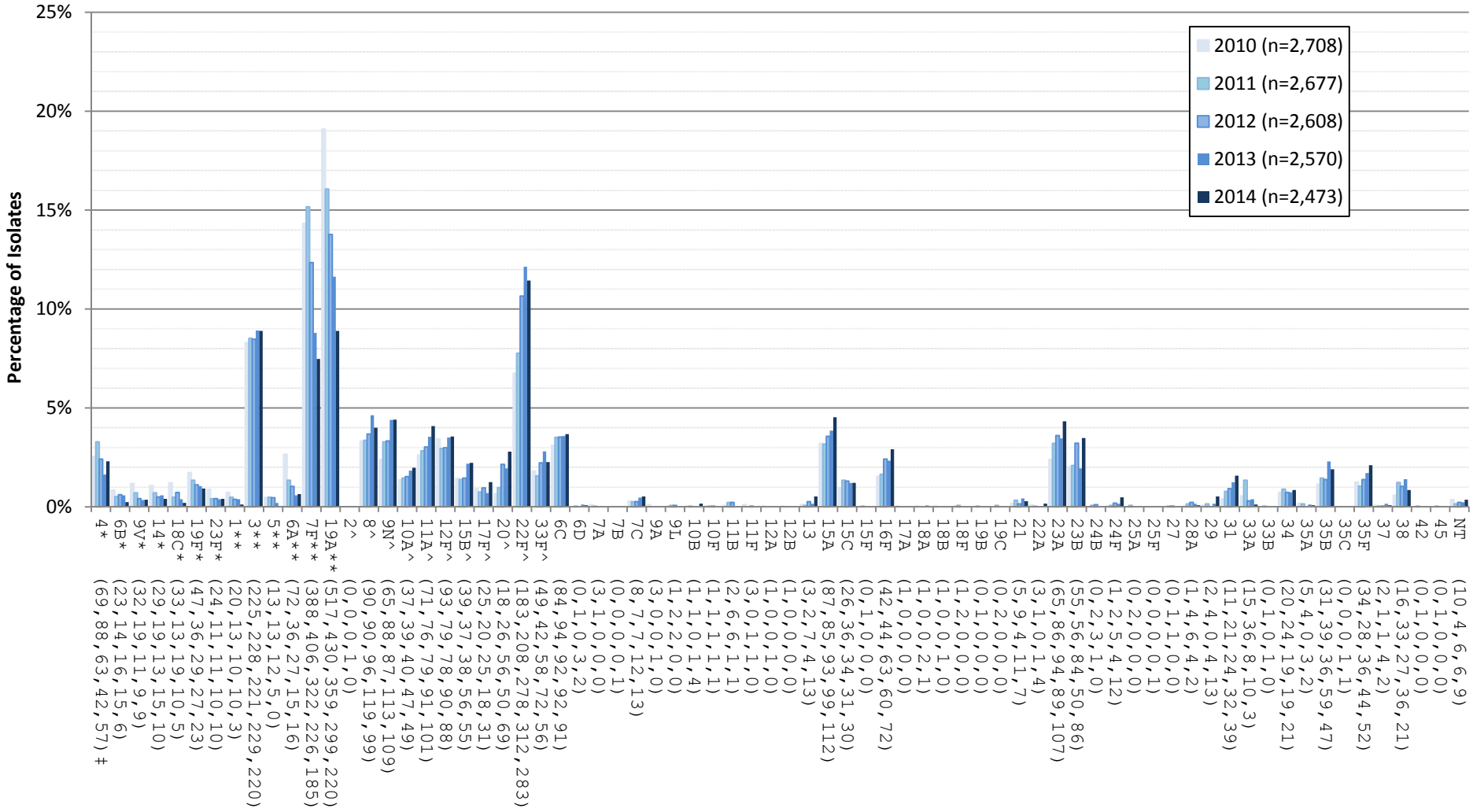
*Component of PCV7; ** Component of PCV13; ^ Component of PPV23; ‡ Number of isolates for <2, 2-4 and 5-14 year old age groups, respectively.

Figure 9b. Age Group Distribution of Invasive *S. pneumoniae* serotypes isolated in 2014: 15-49, 50-64, and ≥65 year old age groups



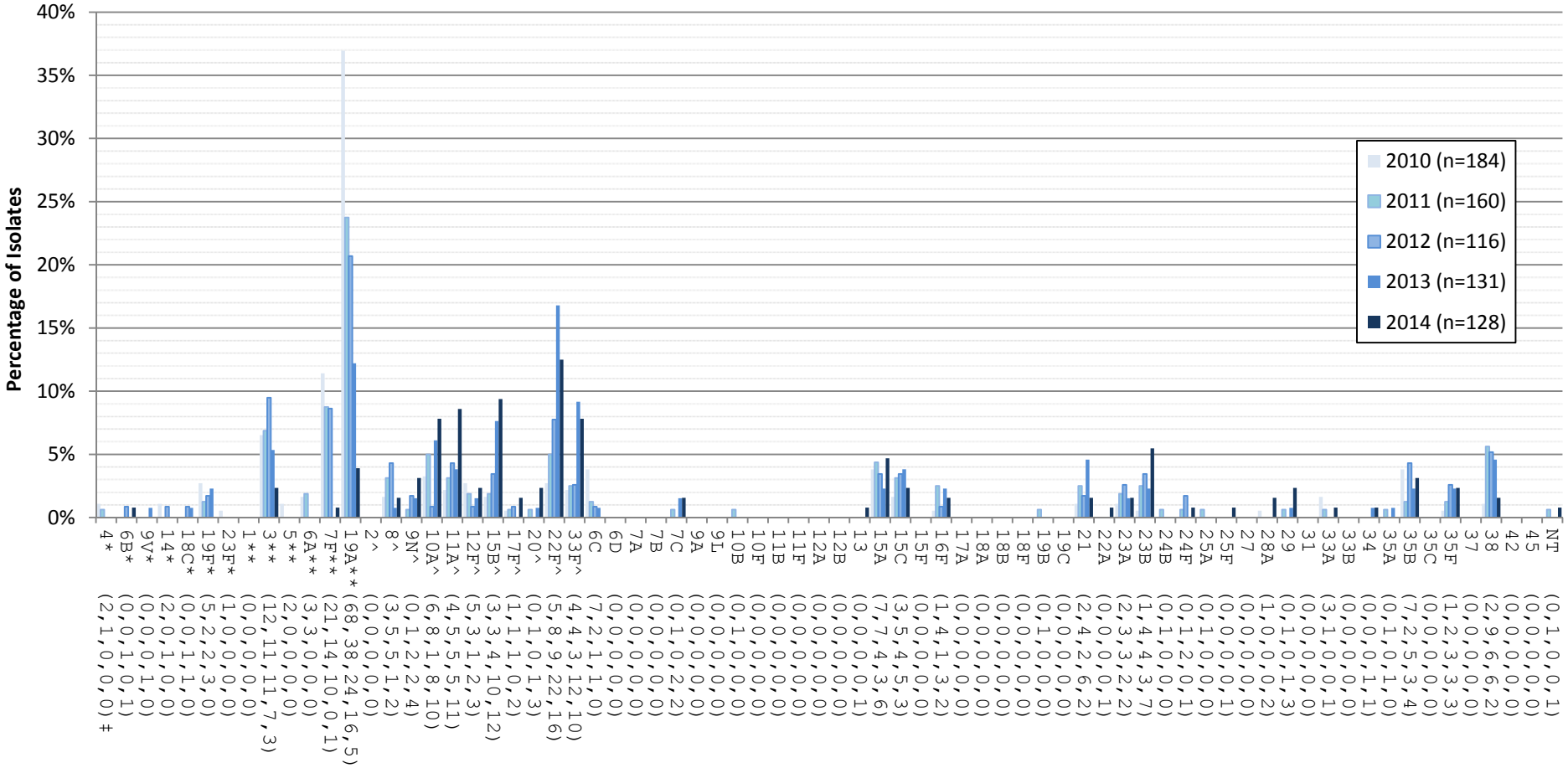
*Component of PCV7; ** Component of PCV13; ^ Component of PPV23; ‡ Number of isolates for 15-49, 50-64 and ≥65 year old age groups respectively.

Figure 10. Invasive *S. pneumoniae* serotypes in all combined age groups, 2010 – 2014



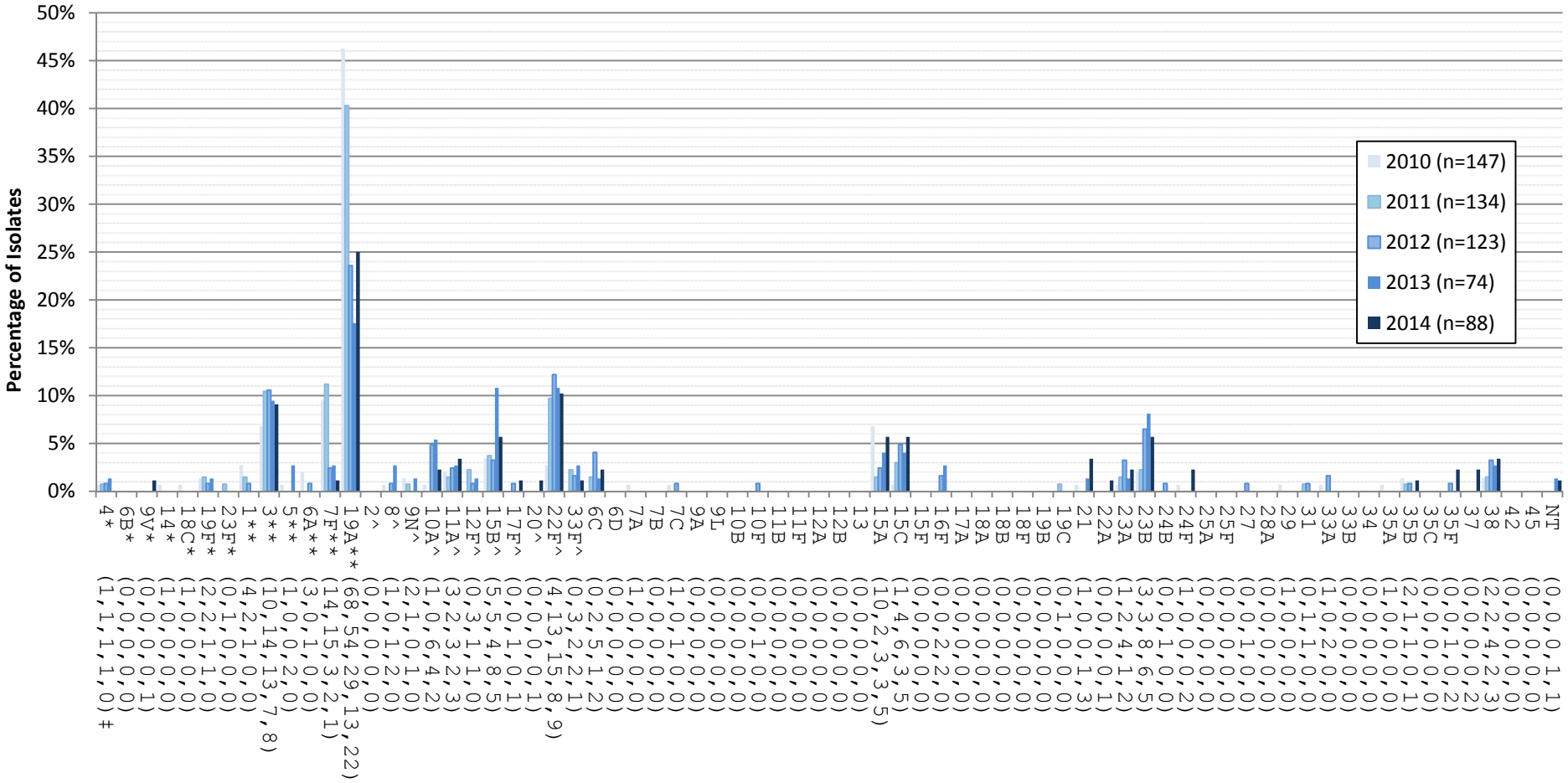
*Component of PCV7; ** Component of PCV13; ^ Component of PPV23; ‡ Number of isolates for 2010, 2011, 2012, 2013 and 2014 respectively.

Figure 11. Invasive *S. pneumoniae* serotypes in <2 year olds, 2010 – 2014



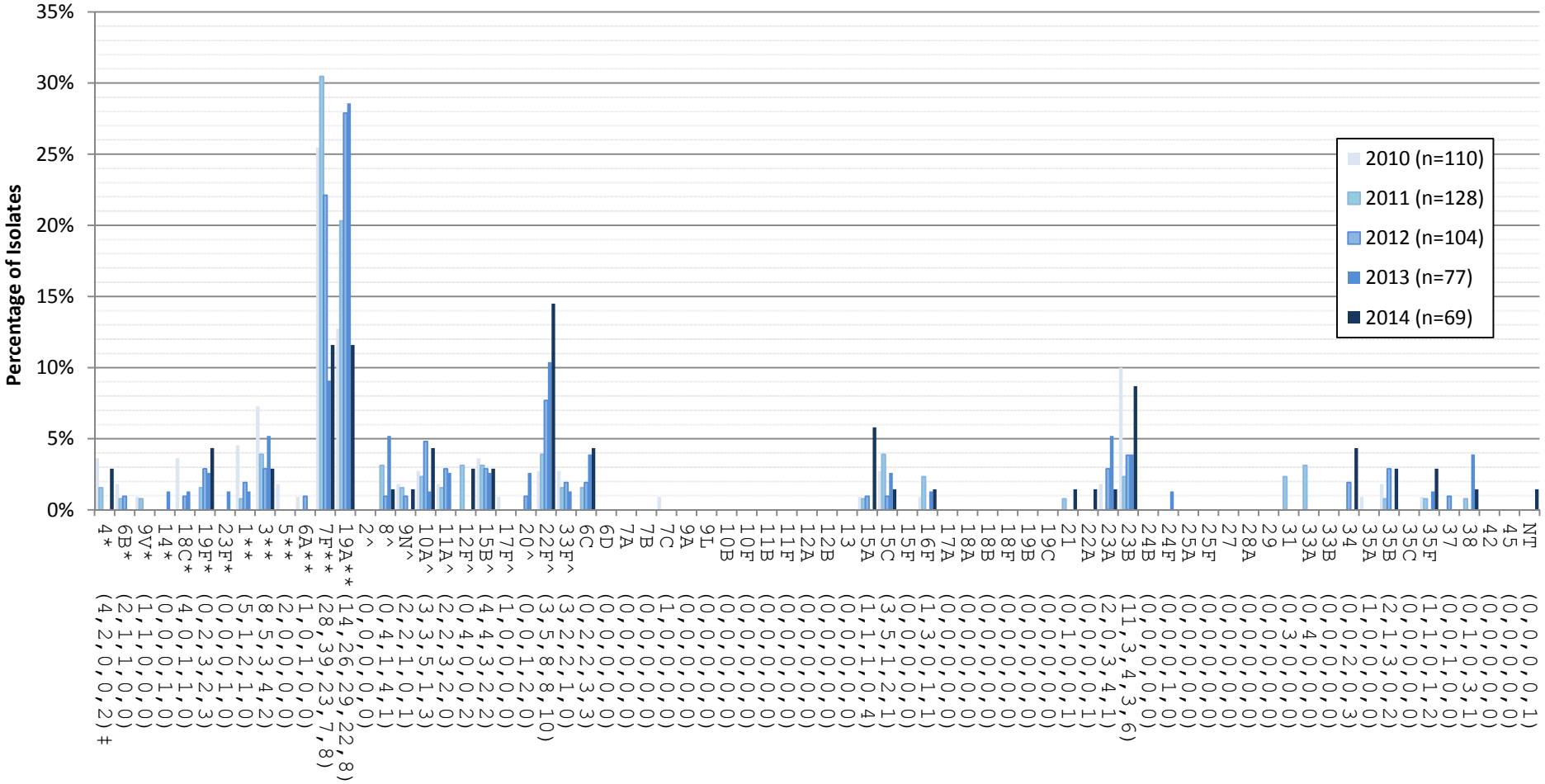
*Component of PCV7; ** Component of PCV13; ^ Component of PPV23; ‡ Number of isolates for 2010, 2011, 2012, 2013 and 2014, respectively.

Figure 12. Invasive *S. pneumoniae* serotypes in 2-4 year olds, 2010 – 2014



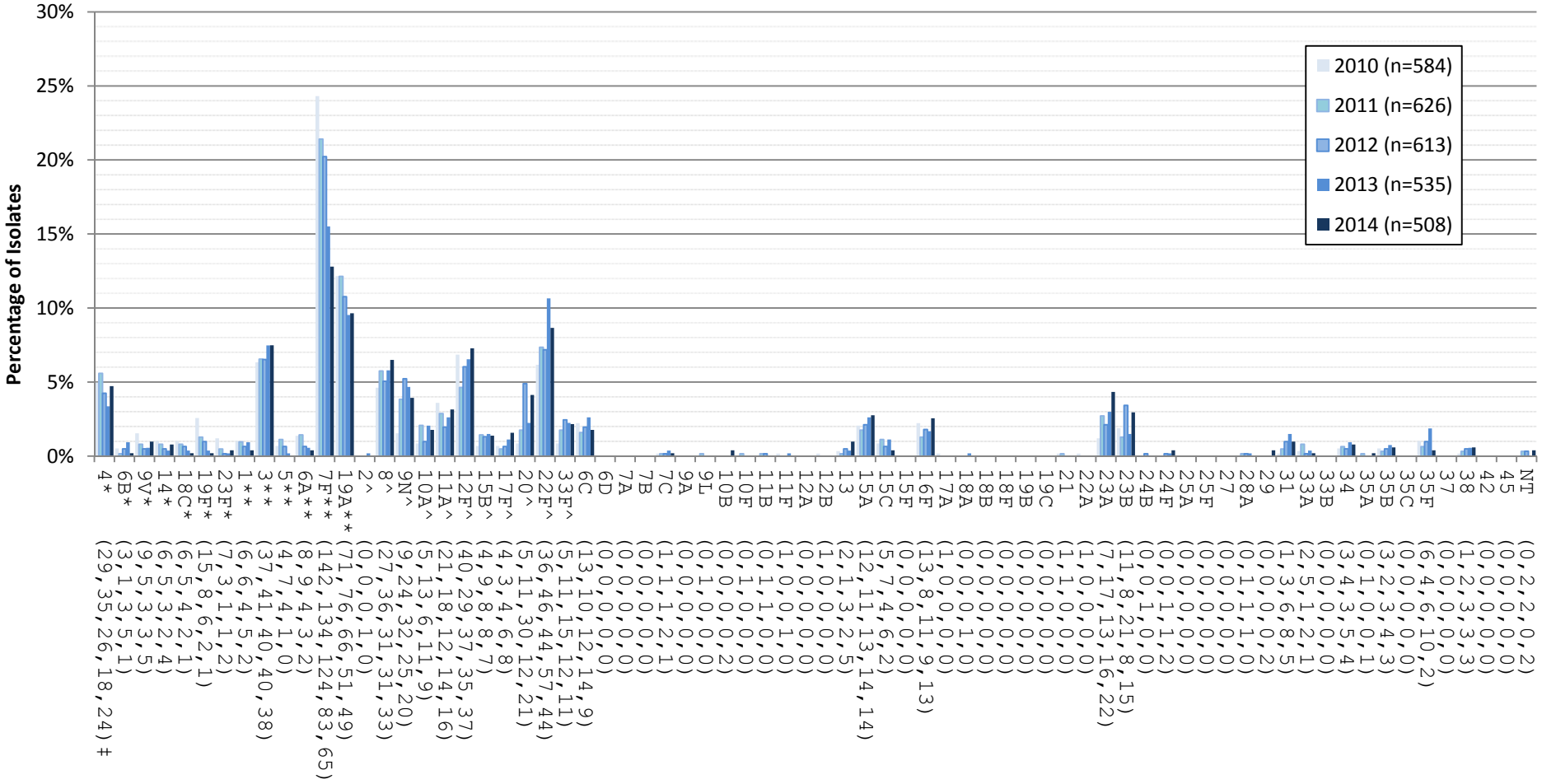
*Component of PCV7; ** Component of PCV13; ^ Component of PPV23; ‡ Number of isolates for 2010, 2011, 2012, 2013 and 2014, respectively.

Figure 13. Invasive *S. pneumoniae* serotypes in 5-14 year olds, 2010 - 2014



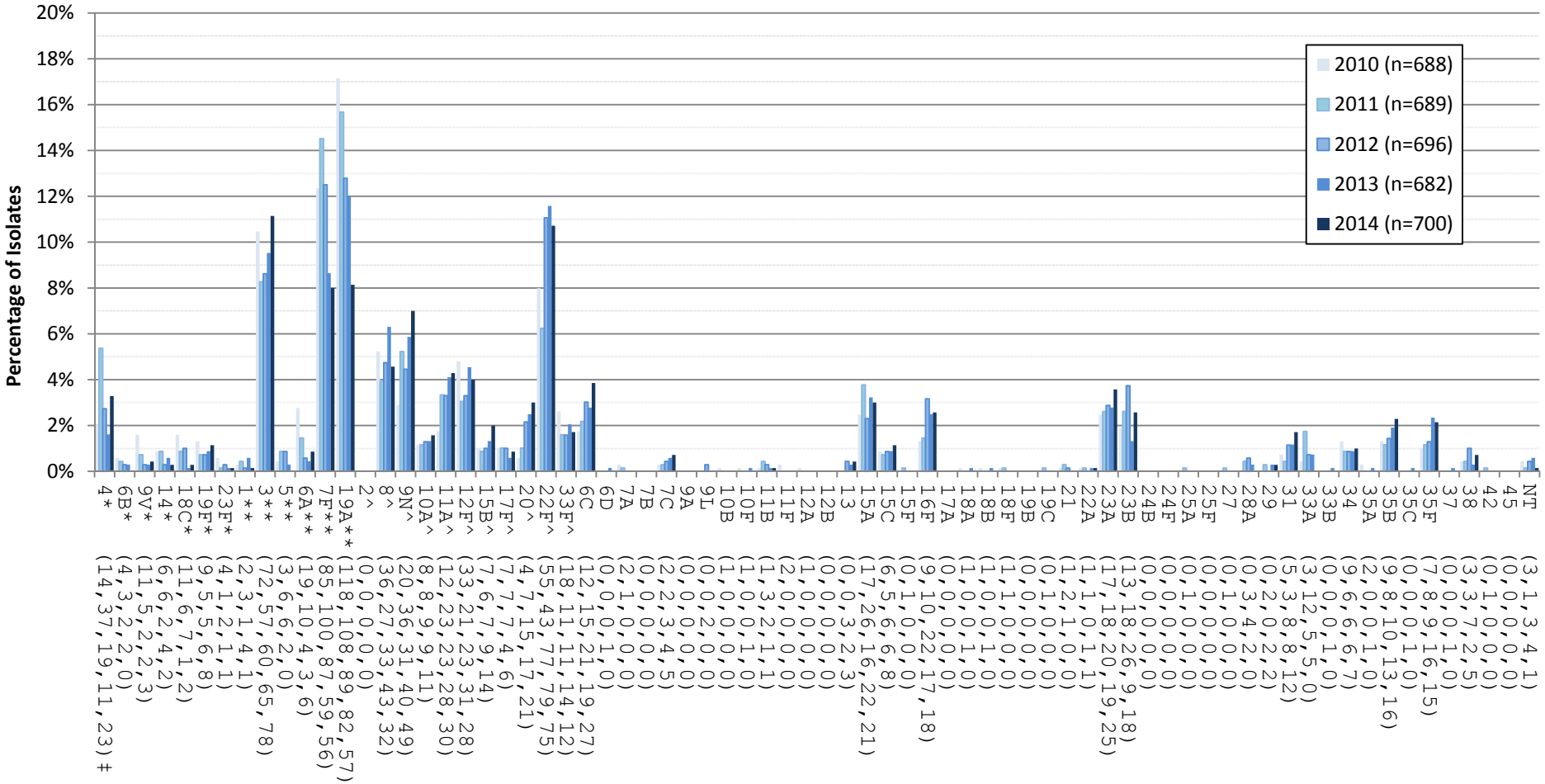
*Component of PCV7; ** Component of PCV13; ^ Component of PPV23; ‡ Number of isolates for 2010, 2011, 2012, 2013 and 2014, respectively.

Figure 14. Invasive *S. pneumoniae* serotypes in 15-49 year olds, 2010 - 2014



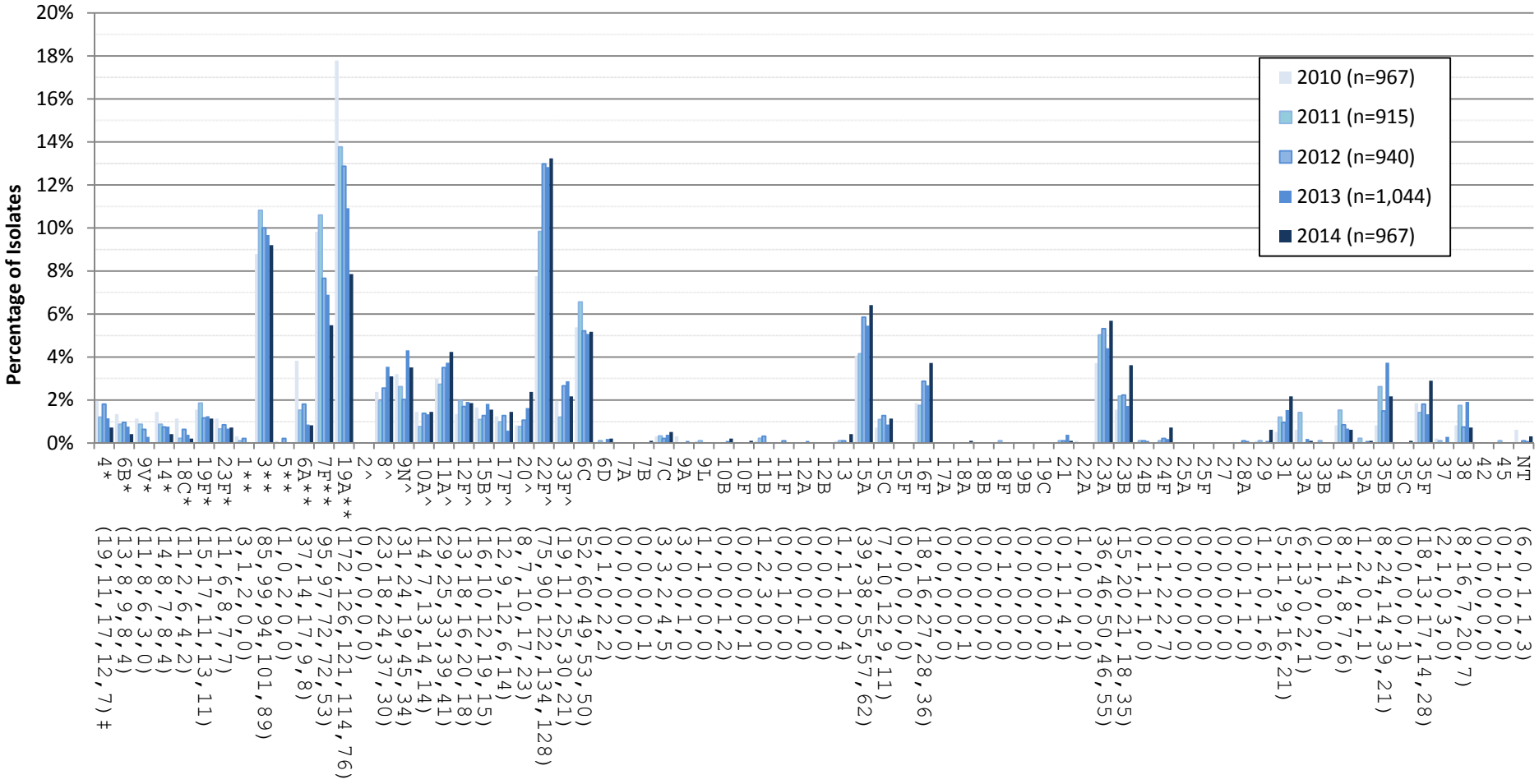
*Component of PCV7; ** Component of PCV13; ^ Component of PPV23; ‡ Number of isolates for 2010, 2011, 2012, 2013 and 2014, respectively.

Figure 15. Invasive *S. pneumoniae* serotypes in 50-64 year olds, 2010 - 2014



*Component of PCV7; ** Component of PCV13; ^ Component of PPV23; ‡ Number of isolates for 2010, 2011, 2012, 2013 and 2014, respectively

Figure 16. Invasive *S. pneumoniae* serotypes in ≥65 year olds, 2010 - 2014



*Component of PCV7; ** Component of PCV13; ^ Component of PPV23; ‡ Number of isolates for 2010, 2011, 2012, 2013 and 2014, respectively

Vaccine Serotypes

Pneumococcal vaccine serotype distribution by age is represented in Table 3. PCV7 serotypes (4, 6B, 9V 14, 18C, 19F, 23F) in 2014 continue to represent a small number of isolates in the <15 year old age groups during 2014, with only 1 isolate in each of the <2 and 2-4 year olds, and 5 isolates in the 5-14 year old age groups. Overall, rates for all age groups combined have declined from 9.5% (n=257) to 4.9% (n=120, p<0.001) over the 5 year period from 2010 to 2014 (Figure 17, Table 4).

The proportion of PCV13 serotypes (1, 3, 5, 6A, 7F and 19A) in Canada has also continued to decrease in all combined age groups from 45.6% (n=1235) in 2010 to 26.0% (n=644, p<0.001) in 2014 (Figure 18, Table 5). Decreases of serotypes 6A, 7F and 19A have led to the overall decrease of PCV13 serotypes in all age groups between 2013 and 2014 (Table 5) (< 2 year olds p<0.010; 5-14 years p=0.023; 15-49 years p=0.229; 50-64 years p=0.189; ≥65 years p=0.011), except in the 2-4 year olds where a slight increase of serotype 19A has increased the overall proportion of PCV13 serotypes from 32.4% (n=24) to 35.2% (n=31, p=0.708) in this age group. Overall PCV7+PCV13 serotypes declined in all combined ages from 55.1% (n=1,492) to 30.9% (n=764, p<0.001)) from 2010 to 2014.

The proportion of isolates representing PPV23 serotypes (2, 8, 9N, 10A, 11A, 12F, 15B, 17F, 20, 22F, 33F) have continued to increase in all combined age group isolates from 24.7% (n=670) to 38.0% (n=939, p<0.001) between 2010 and 2014 (Figure 19, Table 6). The largest increase in 2014 has been observed in the <2 year old age group which increased from 2013 to 2014 from 48.1% (n=63) to 57.0% (n=73, p=0.150). A small decrease of PPV23 serotypes was seen in the 2 – 4 year old age group from 2013 to 2014 from 37.8% (n=28) to 25.0% (n=22, p=0.078). Non-vaccine serotypes have increased in all combined age groups from 20.2% (n=546) to 31.1% (n=770, p<0.001) from 2010 to 2014 (Figure 20, Table 7).

Table 3. Pneumococcal Vaccine Serotypes 2014

	Age Group						
Vaccine*	**<2 years**	**2-4 years**	**5-14 years**	**15-19 years**	**50-64 years**	**≥65 years**	**All Ages****
PCV7	0.8% (1)***	1.1% (1)	7.2% (5)	7.5% (38)	5.6% (39)	3.6% (35)	**4.9% (120)**
PCV13	7.0% (9)	35.2% (31)	26.1% (18)	30.7% (156)	28.3% (198)	23.4% (225)	**26.0% (644)**
PCV13 All	7.8% (10)	36.4% (32)	33.3% (23)	38.2% (194)	33.9% (237)	27.0% (261)	**30.9% (764)**
PPV23	57.0% (73)	25.0% (22)	27.5% (19)	40.6% (206)	39.7% (278)	35.0% (338)	**38.0% (939)**
PPV23 All	64.8% (83)	61.4% (54)	60.9% (42)	78.3% (398)	72.7% (509)	61.1% (591)	**68.2% (1687)**
NVT	35.2% (45)	38.6% (34)	39.1% (27)	21.3% (108)	26.4% (185)	38.1% (368)	**31.1% (770)**
Total	**(129)**	**(88)**	**(69)**	**(508)**	**(700)**	**(967)**	**(2,473)**

*PCV7 includes serotypes 4, 6B, 9V, 14, 18C, 19F and 23F. PCV13 serotypes include 1, 5, 7F, 3, 6A, and 19A; and PCV13 All serotypes include all PCV7 and PCV13 serotypes. PPV23 serotypes include 2, 8, 9N, 10A, 11A, 12F, 15B, 17F, 20, 22F and 33F and PPV23 All includes all PCV7, PCV13 (except 6A) and PPV23 serotypes. NVT includes all other non-vaccine serotypes. ** Includes isolates for which an age was not available: PCV7 = 1, PCV13 = 6, PPV23 = 3 and NVT = 3. *** Percentage of isolates (number of isolates).

Figure 17. PCV7 serotypes (4, 6B, 9V, 14, 18C, 19F, 23F) by age group, 2010 – 2014

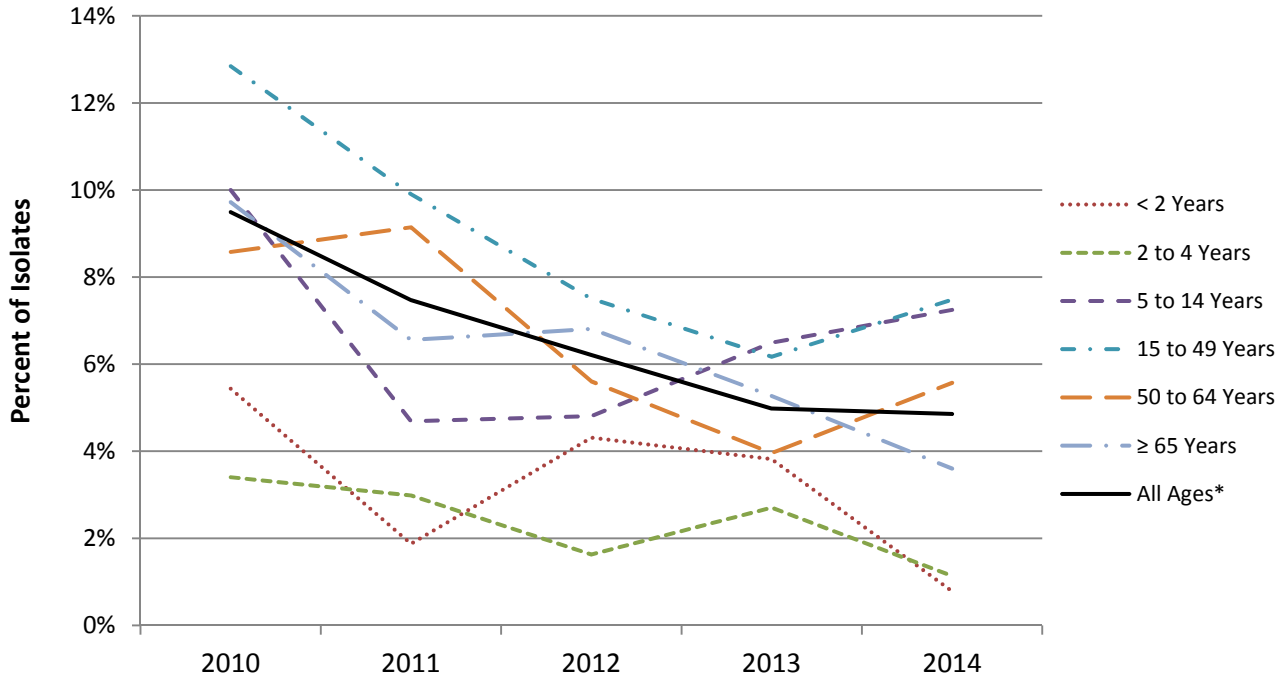


Table 4. PCV7 serotype isolates by age group, 2010-2014

Age Group (Years)	Year				
	2010	2011	2012	2013	2014
<2	5.4% (10)**	1.9% (3)	4.3% (5)	3.8% (5)	0.8% (1)
2 - 4	3.4% (5)	3.0% (4)	1.6% (2)	2.7% (2)	1.1% (1)
5 - 14	10.0% (11)	4.7% (6)	4.8% (5)	6.5% (5)	7.2% (5)
15 - 49	12.8% (75)	9.9% (62)	7.5% (46)	6.2% (33)	7.5% (38)
50 - 64	8.6% (59)	9.1% (63)	5.6% (39)	4.0% (27)	5.6% (39)
≥65	9.7% (94)	6.6% (60)	6.8% (64)	5.3% (55)	3.6% (35)
All Ages*	9.5% (257)	7.5% (200)	6.2% (162)	5.0% (128)	4.9% (120)

* Includes isolates for which an age was not available. ** Percentage of isolates (number of isolates).

Figure 18. PCV13 serotypes (1, 5, 7F, 3, 6A, 19A) by age group, 2010 – 2014

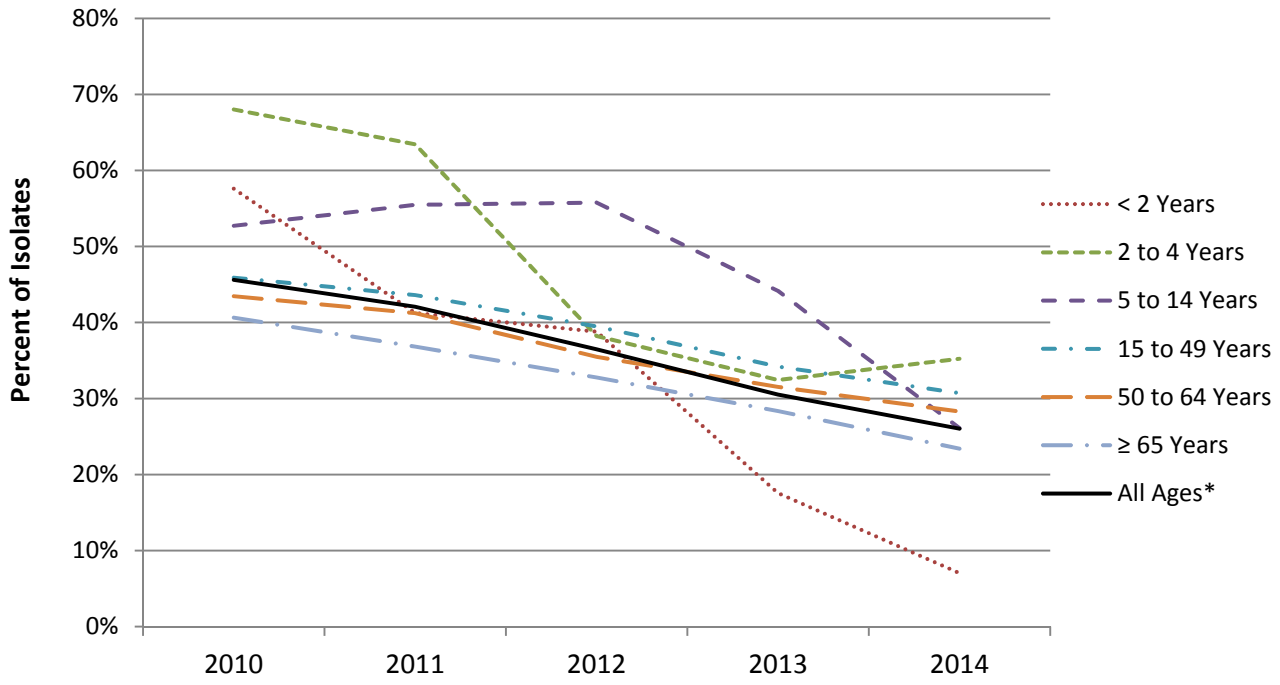


Table 5. PCV13 serotype isolates by age group, 2010 – 2014

Age Group (Years)	Year				
	2010	2011	2012	2013	2014
<2	57.6% (106)**	41.3% (66)	38.8% (45)	17.6% (23)	7.0% (9)
2 - 4	68.0% (100)	63.4% (85)	38.2% (47)	32.4% (24)	35.2% (31)
5 - 14	52.7% (58)	55.5% (71)	55.8% (58)	44.2% (34)	26.1% (18)
15 - 49	45.9% (268)	43.6% (273)	39.5% (242)	34.2% (183)	30.7% (156)
50 - 64	43.5% (299)	41.2% (284)	35.5% (247)	31.5% (215)	28.3% (198)
≥65	40.6% (393)	36.8% (337)	32.8% (308)	28.4% (296)	23.4% (226)
All Ages*	45.6% (1235)	42.1% (1126)	36.5% (951)	30.5% (784)	26.0% (644)

* Includes isolates for which an age was not available. ** Percentage of isolates (number of isolates).

Figure 19. PPV23 serotypes (2, 8, 9N, 10A, 11A, 12F, 15B, 17F, 20, 22F, 33F) by age group, 2010 – 2014

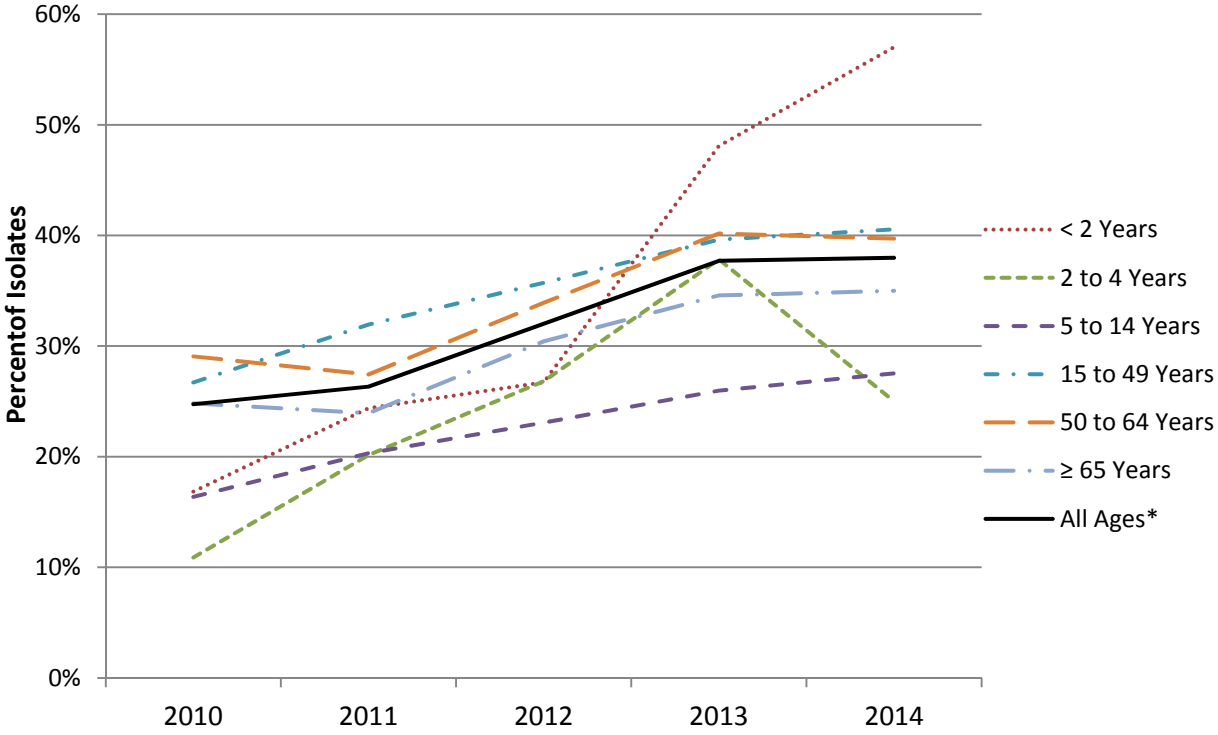


Table 6. PPV23 serotype isolates by age group, 2010 – 2014

Age Group (Years)	Year				
	2010	2011	2012	2013	2014
<2	16.8% (31)**	24.4% (39)	26.7% (31)	48.1% (63)	57.0% (73)
2 - 4	10.9% (16)	20.1% (27)	26.8% (33)	37.8% (28)	25.0% (22)
5 - 14	16.4% (18)	20.3% (26)	23.1% (24)	26.0% (20)	27.5% (19)
15 - 49	26.7% (156)	31.9% (200)	35.7% (219)	39.6% (212)	40.6% (206)
50 - 64	29.1% (200)	27.4% (189)	33.9% (236)	40.2% (274)	39.7% (278)
≥65	24.8% (240)	23.9% (219)	30.4% (286)	34.6% (361)	35.0% (338)
All Ages*	24.7% (670)	26.3% (705)	32.0% (835)	37.7% (969)	38.0% (939)

* Includes isolates for which an age was not available. ** Percentage of isolates (number of isolates).

Figure 20. Non-vaccine serotypes by age group, 2010 – 2014

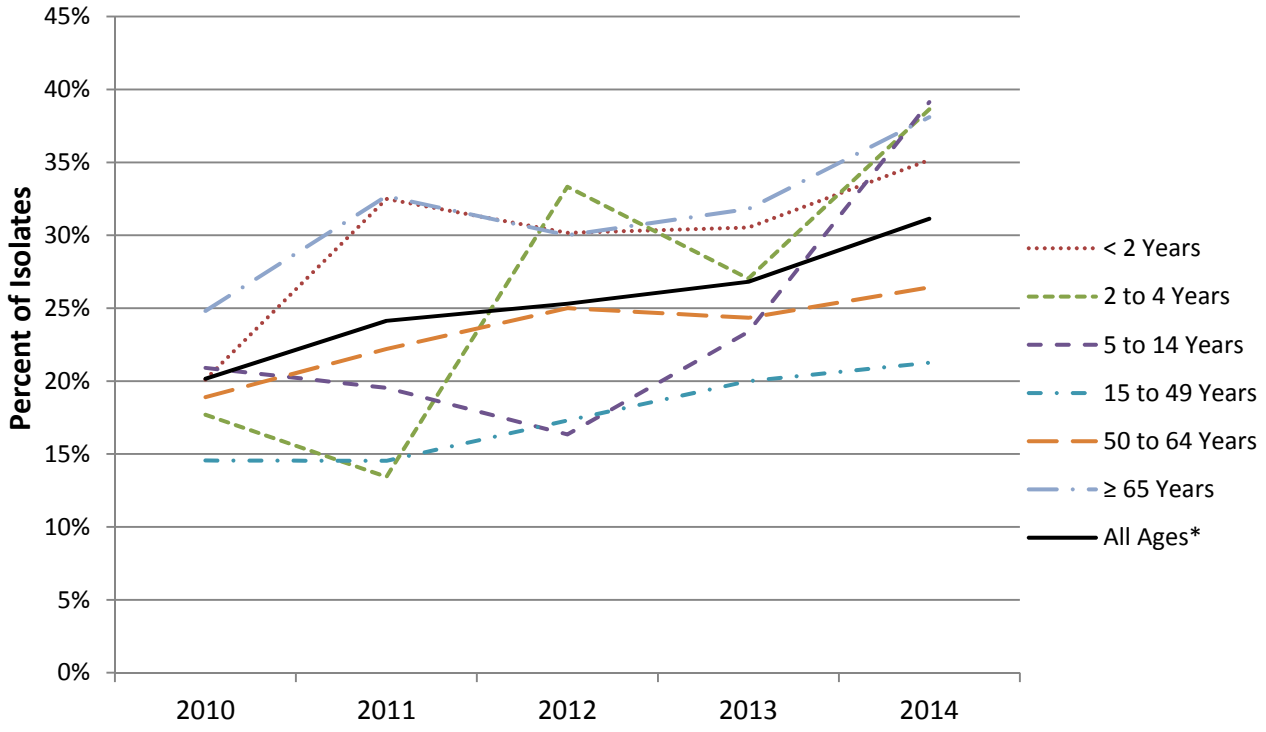


Table 7. Non-vaccine serotype isolates by age group, 2010 – 2014

Age Group (Years)	Year				
	2010	2011	2012	2013	2014
<2	20.1% (37)**	32.5% (52)	30.2% (35)	30.5% (40)	35.2% (45)
2 - 4	17.7% (26)	13.4% (18)	33.3% (41)	27.0% (20)	38.6% (34)
5 - 14	20.9% (23)	19.5% (25)	16.3% (17)	23.4% (18)	39.1% (27)
15 - 49	14.6% (85)	14.5% (91)	17.3% (106)	20.0% (107)	21.3% (108)
50 - 64	18.9% (130)	22.2% (153)	25.0% (174)	24.3% (166)	26.4% (185)
≥65	24.8% (240)	32.7% (299)	30.0% (282)	31.8% (332)	38.1% (368)
All Ages*	20.2% (546)	24.1% (646)	25.3% (660)	26.8% (689)	31.1% (770)

* Includes isolates for which an age was not available. ** Percentage of isolates (number of isolates).

Antimicrobial Resistance of *S. pneumoniae*

As part of a joint NML/CARA program called SAVE, antimicrobial susceptibility testing was performed on 1125 *S. pneumoniae* isolates collected in 2014 from any age group causing IPD submitted from 8 participating jurisdictions (Saskatchewan, Manitoba, Ontario, Québec, Nova Scotia, Prince Edward Island, New Brunswick, Newfoundland and Labrador).

Over the 4 year period from 2011 to 2014 antimicrobial resistance rates among *S. pneumoniae* have remained relatively stable or have declined slightly. The high rate of resistance were observed to clarithromycin, declining slightly from 24.8% (n=263) to 22.0% (n=248, p=0.130) from 2013 to 2014 (Figure 21, Table 8). Lower resistance rates were seen with penicillin (meningitis breakpoints) declining steadily since 2011 from 11.9% (n=135) to 8.6% (n=97, p=0.017) in 2014, and clindamycin resistance has also declined from 7.1% (n=80) in 2011 to 4.4% (n=49, p=0.006) in 2014. Resistance to doxycycline has remained relatively stable since 2010, at 7.9% (n=89) in 2014. After increasing from 5.1% (n=58) to 7.4% (n=78, p=0.030) between 2011 and 2013, trimethoprim/sulfamethoxazole resistant *S. pneumoniae* has decreased to 5.8% (n=65, p=0.137) in 2014. All isolates were susceptible to ertapenem, linezolid, tigecycline and vancomycin.

Serotypes 15A, 19A, 19F and 35B generally had the highest rates of antimicrobial resistance during 2014 (Table 9). Clarithromycin resistance was associated with serotypes 19A (62.4%, n=53); 11A (27.3%, n=21); 12F (46.0%, n=23); 15A (64.0%, n=16); 22F (28.4%, n=31), 33F (77.3%, n=34) and 35B (25.0%, n=8) (Figure 22). Cefuroxime (parenteral) resistant serotypes were predominately 15A (23.1% n=6), 19A (18.8%, n=16), 19F (33.3%, n=5) and 35B (43.8%, n=14) (Figure 23); and clindamycin resistance was seen in serotypes 15A (48.0%, n=12), 19A (15.3%, n=13), 19F (33.3%, n=5), and 33F (18.2%, n=8) (Figure 24). A relatively high proportion of isolates with doxycycline resistance were seen in serotypes 3 (12.2%, n=11), 15A (68.0%, n=17), 19A (23.5%, n=20), 19F (40.0%, n=6) and 23A (43.6%, n=17) (Figure 25). Imipenem and meropenem resistance was mainly associated with serotype 19A isolates (11.8%, n=10 for each; respectively) (Figures 26, 27). Relatively high rates of resistance to penicillin (meningitis) were evident in serotypes 6C (24.3%, n=9), 15A (42.3%, n=11), 19A (22.4%, n=19), 19F (33.3%, n=5), 23A (48.7%, n=19) and 35B (46.9%, n=15) (Figure 28). Trimethoprim/sulfamethoxazole resistance was associated with serotypes 6C (18.9%, n=7), 7C (38.5%, n=5), 11A (14.3%, n=11), and 19A (20.0%, n=17) (Figure 29).

Multidrug resistance (MDR) to 3 or more classes of antimicrobials among *S. pneumoniae* continues to decline from 7.8% (n=88) of isolates tested in 2011 to 4.9% (n=55, p=0.004) in 2014 (Figures 30, 31 and Table 10). Serotypes with the highest rates of MDR during 2014 were 15A (53.8%, n=14), 19A (17.6%, n=15) and 19F (33.3%, n=5). The major MDR pattern among serotype 15A isolates was β-lactam-macrolide-clindamycin-tetracycline; and for serotypes 19A and 19F β-lactam-macrolide-clindamycin-tetracycline-trimethoprim/sulfamethoxazole. Resistance to 6 classes of antimicrobials was seen in 1 isolate of serotype 6B, 4 isolates of 19A, and 1 isolate of 19F (Table 10).

Figure 21. Antimicrobial resistance of *S. pneumoniae* isolates, 2011 – 2014

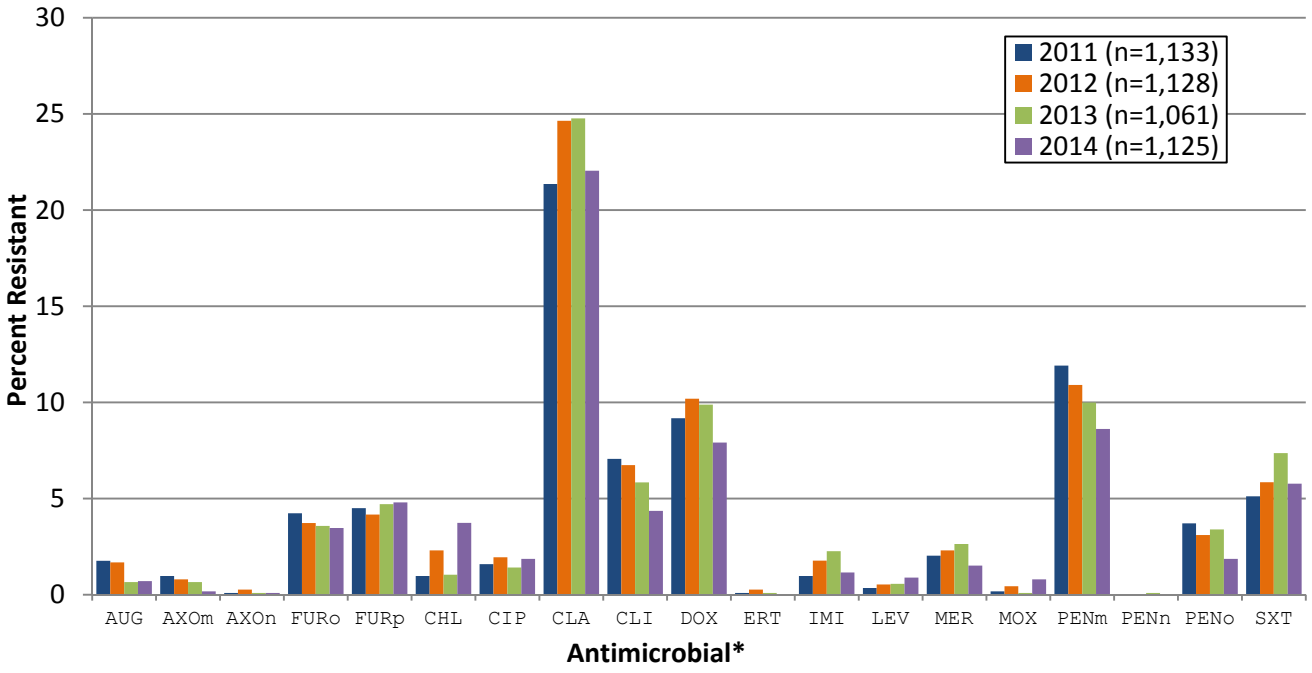


Table 8. Antimicrobial resistant *S. pneumoniae* isolates, 2011 – 2014

Antimicrobial*	Year			
	2011	2012	2013	2014
AUG	1.8% (20)**	1.7% (19)	0.7% (7)	0.7% (8)
AXOm	1.0% (11)	0.8% (9)	0.7% (7)	0.2% (2)
AXOn	0.1% (1)	0.3% (3)	0.1% (1)	0.1% (1)
FURo	4.2% (48)	3.7% (42)	3.6% (38)	3.5% (39)
FURp	4.5% (51)	4.2% (47)	4.7% (50)	4.8% (54)
CHL	1.0% (11)	2.3% (26)	1.0% (11)	3.7% (42)
CIP	1.6% (18)	2.0% (22)	1.4% (15)	1.9% (21)
CLA	21.4% (242)	24.7% (278)	24.8% (263)	22.0% (248)
CLI	7.1% (80)	6.7% (76)	5.8% (62)	4.4% (49)
DOX	9.2% (104)	10.2% (115)	9.9% (105)	7.9% (89)
ERT	0.1% (1)	0.3% (3)	0.1% (1)	0.0% (0)
IMI	1.0% (11)	1.8% (20)	2.3% (24)	1.2% (13)
LEV	0.4% (4)	0.5% (6)	0.6% (6)	0.9% (10)
MER	2.0% (23)	2.3% (26)	2.6% (28)	1.5% (17)
MOX	0.2% (2)	0.4% (5)	0.1% (1)	0.8% (9)
PENm	11.9% (135)	10.9% (123)	10.0% (106)	8.6% (97)
PENn	0.0% (0)	0.0% (0)	0.1% (1)	0.0% (0)
PENo	3.7% (42)	3.1% (35)	3.4% (36)	1.9% (21)
SXT	5.1% (58)	5.9% (66)	7.4% (78)	5.8% (65)
Total Tested	**(1,133)**	**(1,128)**	**(1,061)**	**(1,125)**

*AUG = amoxicillin/clavulanic acid; PENm = penicillin using the parenteral meningitis CLSI interpretive standard; ; PENn = penicillin using the parenteral non-meningitis interpretive standard; PENo = penicillin using the oral penicillin V interpretive standard; LEV = levofloxacin; MOX = moxifloxacin; AXOm = ceftriaxone using the parenteral meningitis interpretive standard; AXOn = ceftriaxone using the parenteral non-meningitis interpretative standard; FURo = cefuroxime using the oral interpretative standard; FURp = cefuroxime using the parenteral interpretative standard; ETP = ertapenem; IMI = imipenem; MER = meropenem; CIP = ciprofloxacin; CLA = clarithromycin; CLI = clindamycin; CHL = chloramphenicol; DOX = doxycycline; SXT = trimethoprim/sulfamethoxazole. Non susceptibility was not observed for daptomycin (no interpretative standard), linezolid, tigecycline (no interpretative standard), or vancomycin. EUCAST[EUCAST, 2015] interpretative breakpoints were used for CIP, all other according to CLSI[CLSI, 2015]. ** Percentage of isolates (number of isolates).

Table 9. Antimicrobial resistance of *S. pneumoniae* serotypes, 2014

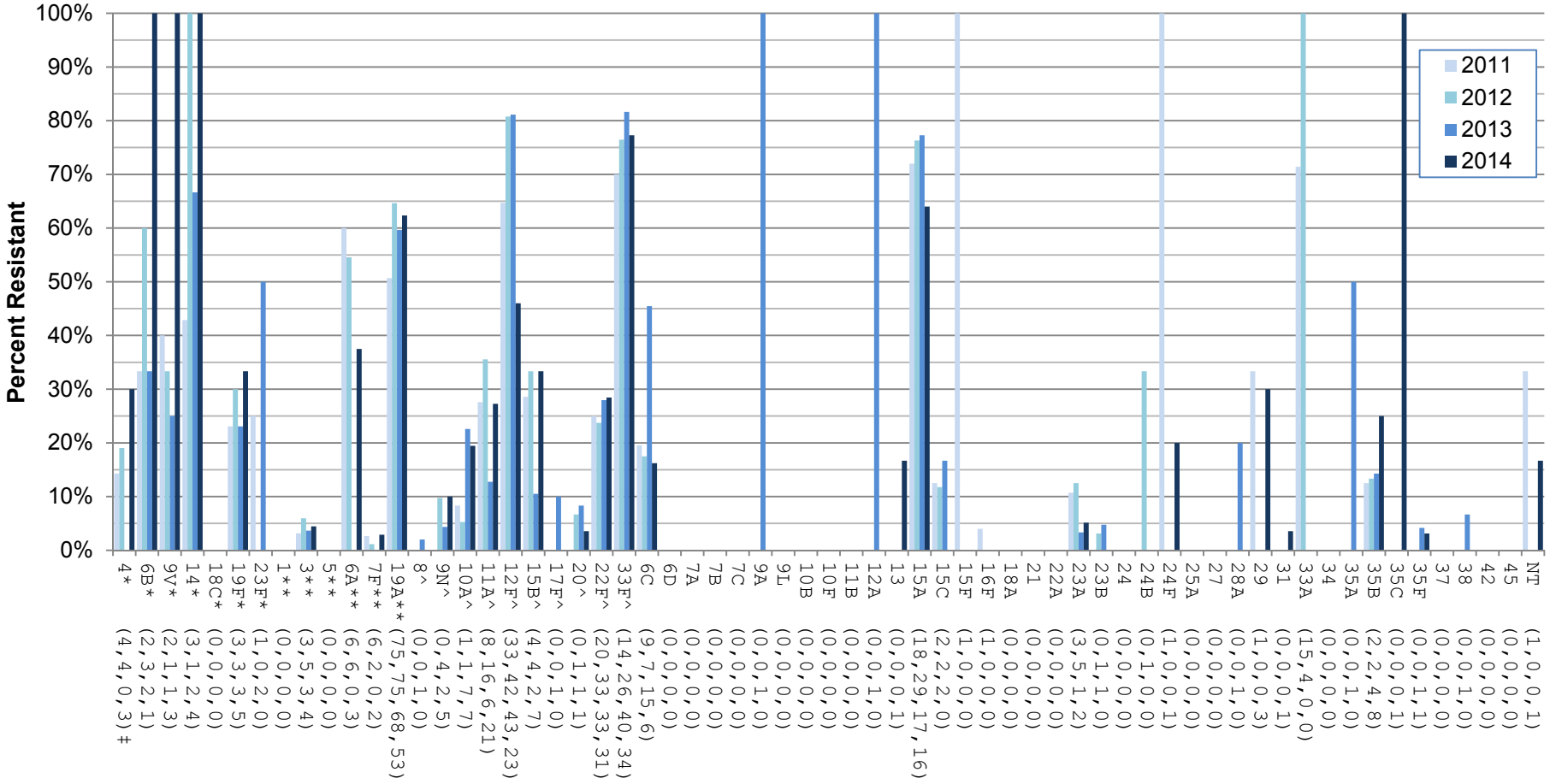
	Penicillins				Cephems				Carbapenems			Fluoro-quinolones			Other				
Serotype	AUG[a]	PENm	PENn	PENo	AXOm	AXOn	FURo	FURp	ERT	IMI	MER	CIP	LEV	MOX	CLA	CLI	CHL	DOX	SXT
1 (n=2)	-[b]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3 (n=90)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.4[c]	3.3	12.2	12.2	-
4 (n=10)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30.0	-	-	10.0	-
6A (n=8)	-	37.5	-	-	-	-	-	-	-	-	-	12.5	12.5	12.5	37.5	-	-	-	-
6B (n=1)	-	100	-	-	-	-	-	-	-	-	-	-	-	-	100	100	100	100	100
6C (n=37)	-	24.3	-	-	-	-	-	10.8	-	-	-	-	-	-	16.2	-	-	2.7	18.9
6D (n=1)	-	-	-	-	-	-	-	-	-	-	-	100	100	100	-	-	-	-	-
7B (n=1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7C (n=13)	-	-	-	-	-	-	-	-	-	-	-	7.7	-	-	-	-	-	7.7	38.5
7F (n=69)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.9	1.4	-	4.3	-
8 (n=44)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.3	6.8	-
9N (n=50)	-	2.0	-	-	-	-	-	-	-	-	-	-	-	-	10.0	-	2.0	-	2.0
9V (n=3)	-	100	-	33.3	-	-	100	100	-	-	-	-	-	-	100	-	-	-	100
10A (n=36)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19.4	-	-	2.8	2.8
10B (n=1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10F (n=1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11A (n=77)	-	1.3	-	1.3	-	-	1.3	1.3	-	-	-	3.9	-	-	27.3	2.6	1.3	1.3	14.3
11B (n=2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12F (n=50)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	46.0	-	-	-	-
13 (n=6)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16.7	-	-	16.7	-
14 (n=4)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	25.0	-	-	-
15A (n=26)	-	42.3	-	7.7	-	-	15.4	23.1	-	-	4.0	-	-	-	64.0	48.0	15.4	68.0	-
15B (n=21)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33.3	-	-	-	4.8
15C (n=9)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11.1
16F (n=45)	-	-	-	-	-	-	-	-	-	-	-	8.9	6.7	6.7	-	-	-	-	2.2
17F (n=12)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18C (n=4)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25.0	-	-
19A (n=85)	7.1	22.4	-	12.9	1.2	-	16.5	18.8	-	11.8	11.8	1.2	-	-	62.4	15.3	4.7	23.5	20.0
19F (n=15)	13.3	33.3	-	26.7	6.7	6.7	33.3	33.3	-	13.3	13.3	-	-	-	33.3	33.3	6.7	40.0	13.3
20 (n=28)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.6	-	3.6	-	-
21 (n=5)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22A (n=2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22F(n=109)	-	-	-	-	-	-	-	-	-	-	-	4.6	2.8	2.8	28.4	0.9	11.9	-	0.9
23A (n=39)	-	48.7	-	-	-	-	-	-	-	-	-	-	-	-	5.1	2.6	-	43.6	-
23B (n=29)	-	10.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.4	6.9
23F (n=3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24 (n=1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24B (n=1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24F (n=5)	-	40.0	-	-	-	-	-	-	-	-	-	-	-	-	20.0	20.0	-	40.0	-
28A (n=1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29 (n=10)	-	40.0	-	10.0	-	-	20.0	40.0	-	-	10.0	10.0	10.0	10.0	30.0	-	-	-	10.0
31 (n=28)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.6	-	-	-	-
33F (n=44)	-	-	-	-	-	-	-	-	-	-	-	2.3	-	-	77.3	18.2	4.5	2.3	13.6
34 (n=12)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35B (n=32)	-	46.9	-	3.1	-	-	31.3	43.8	-	3.1	9.4	3.1	3.1	-	25.0	-	3.1	3.1	9.4
35C (n=1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	-	-	-	100
35F (n=32)	-	-	-	-	-	-	-	-	-	-	-	6.3	-	-	3.1	-	-	-	-
37 (n=2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38 (n=12)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NT (n=6)	-	16.7	-	-	-	-	-	16.7	-	-	-	-	-	-	16.7	-	-	-	-
All(n=1125)	**0.7**	**8.6**	**0**	**1.9**	**0.2**	**0.1**	**3.5**	**4.8**	**0**	**1.2**	**1.5**	**1.9**	**0.9**	**0.8**	**22.1**	**4.4**	**3.7**	**7.9**	**5.8**

[a]AUG = amoxicillin/clavulanic acid; PENm = penicillin using the parenteral meningitis CLSI interpretive standard; ; PENn = penicillin using the parenteral non-meningitis interpretive standard; PENo = penicillin using the oral penicillin V interpretive standard; LEV = levofloxacin; MOX = moxifloxacin; AXOm = ceftriaxone using the parenteral meningitis interpretive standard; AXOn = ceftriaxone using the parenteral non-meningitis interpretative standard; FURo = cefuroxime using the oral interpretative standard; FURp = cefuroxime using the parenteral interpretative standard; ETP = ertapenem; IMI = imipenem; MER = meropenem; CLA = clarithromycin; CIP=ciprofloxacin; CLI = clindamycin; CHL = chloramphenicol; DOX = doxycycline; SXT = trimethoprim/sulfamethoxazole. Non susceptibility was not observed for daptomycin (no interpretative standard), linezolid, tigecycline (no interpretative standard), or vancomycin. EUCAST[EUCAST, 2015] interpretative breakpoints were used for CIP, all other according to CLSI[CLSI, 2015].

[b] "-" denotes no resistance (0%) to the antimicrobial.

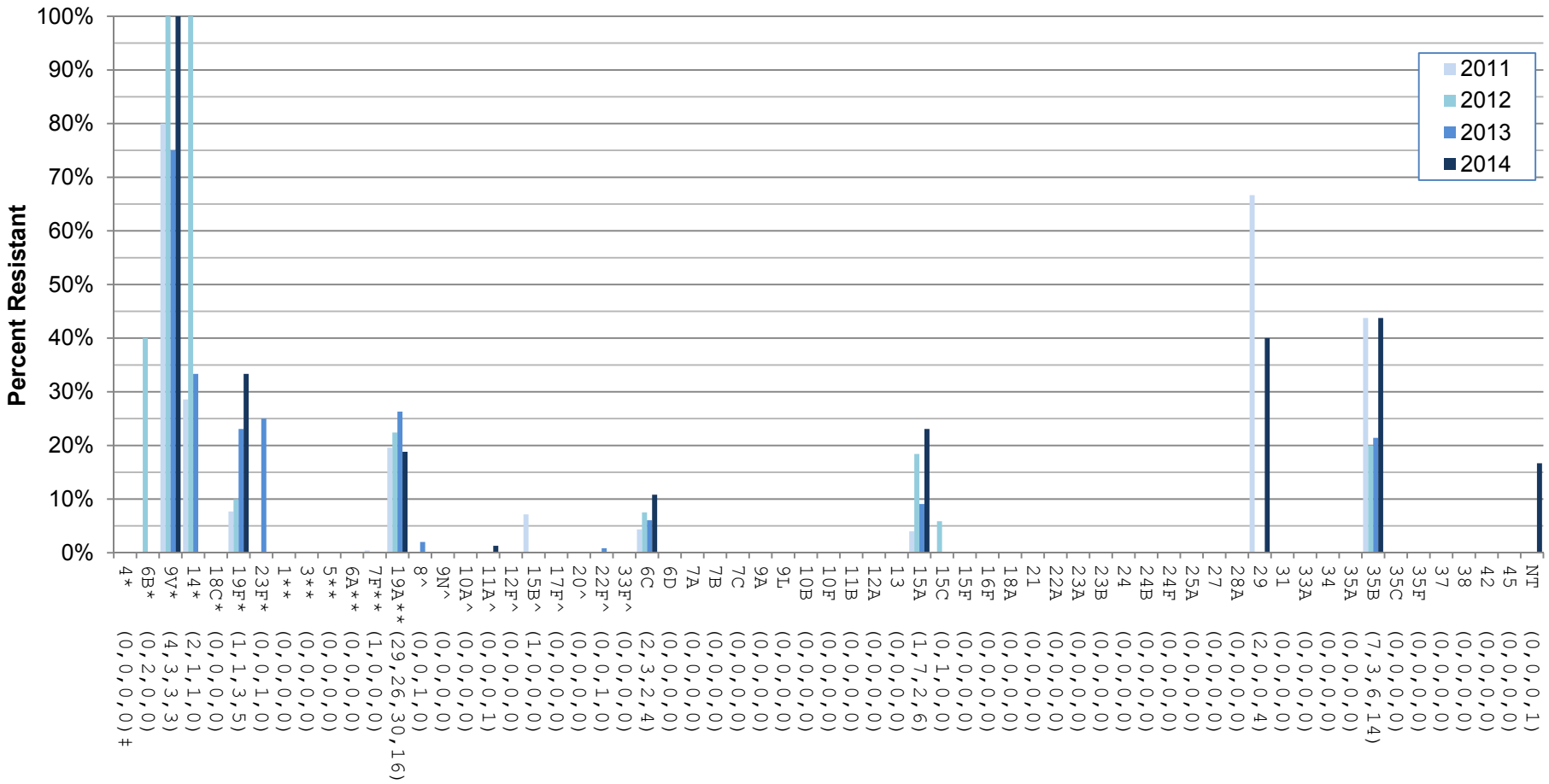
[c] Percentage of serotype total interpreted as resistant to the antimicrobial agent.

Figure 22. Clarithromycin resistance of *S. pneumoniae* serotypes collected 2011 - 2014



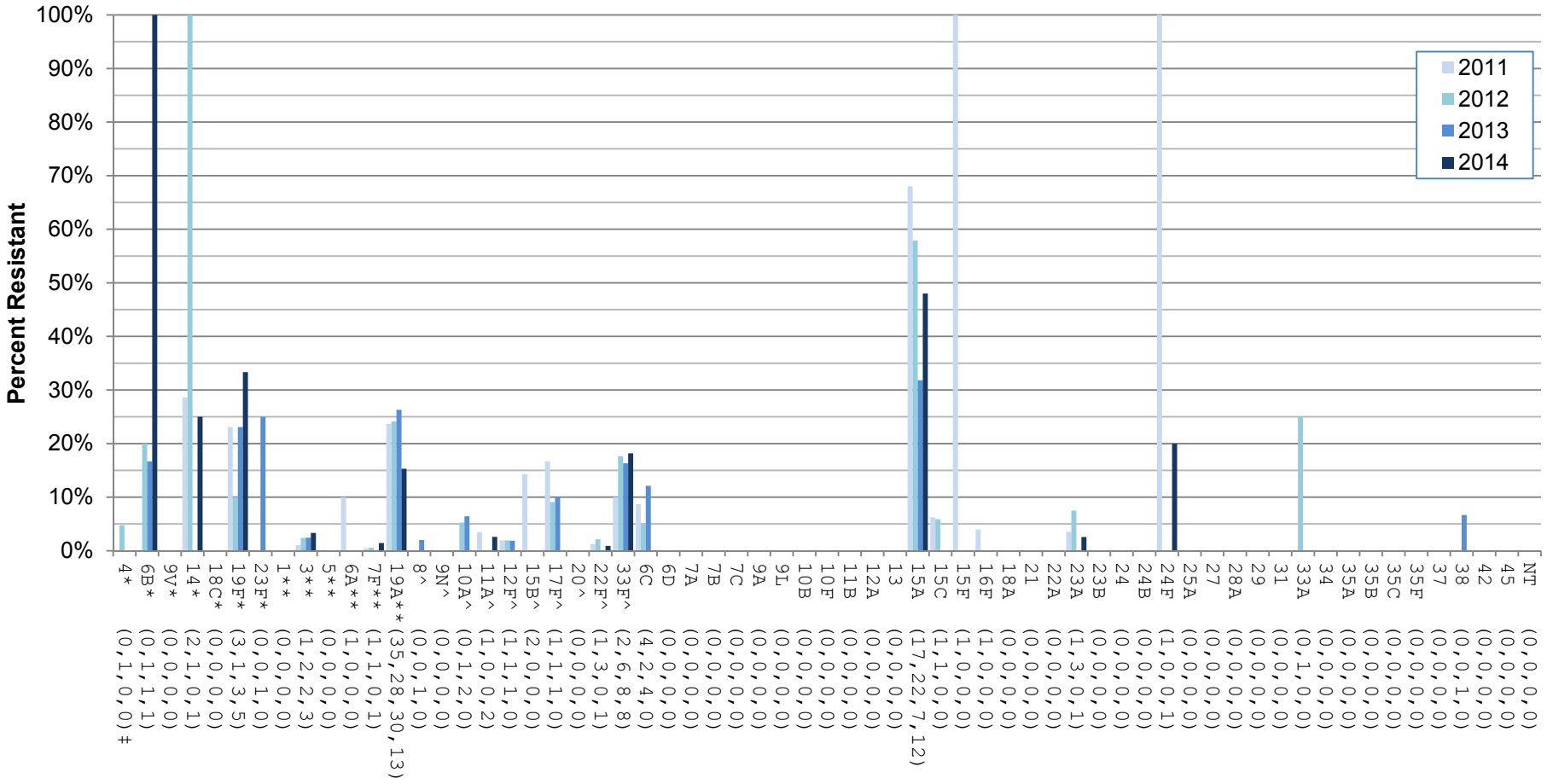
*Component of PCV7; ** Component of PCV13; ^ Component of PPV23; ‡ Number of resistant isolates for 2011, 2012, 2013 and 2014, respectively.

Figure 23. Cefuroxime (parenteral) resistance of *S. pneumoniae* serotypes collected 2011 – 2014



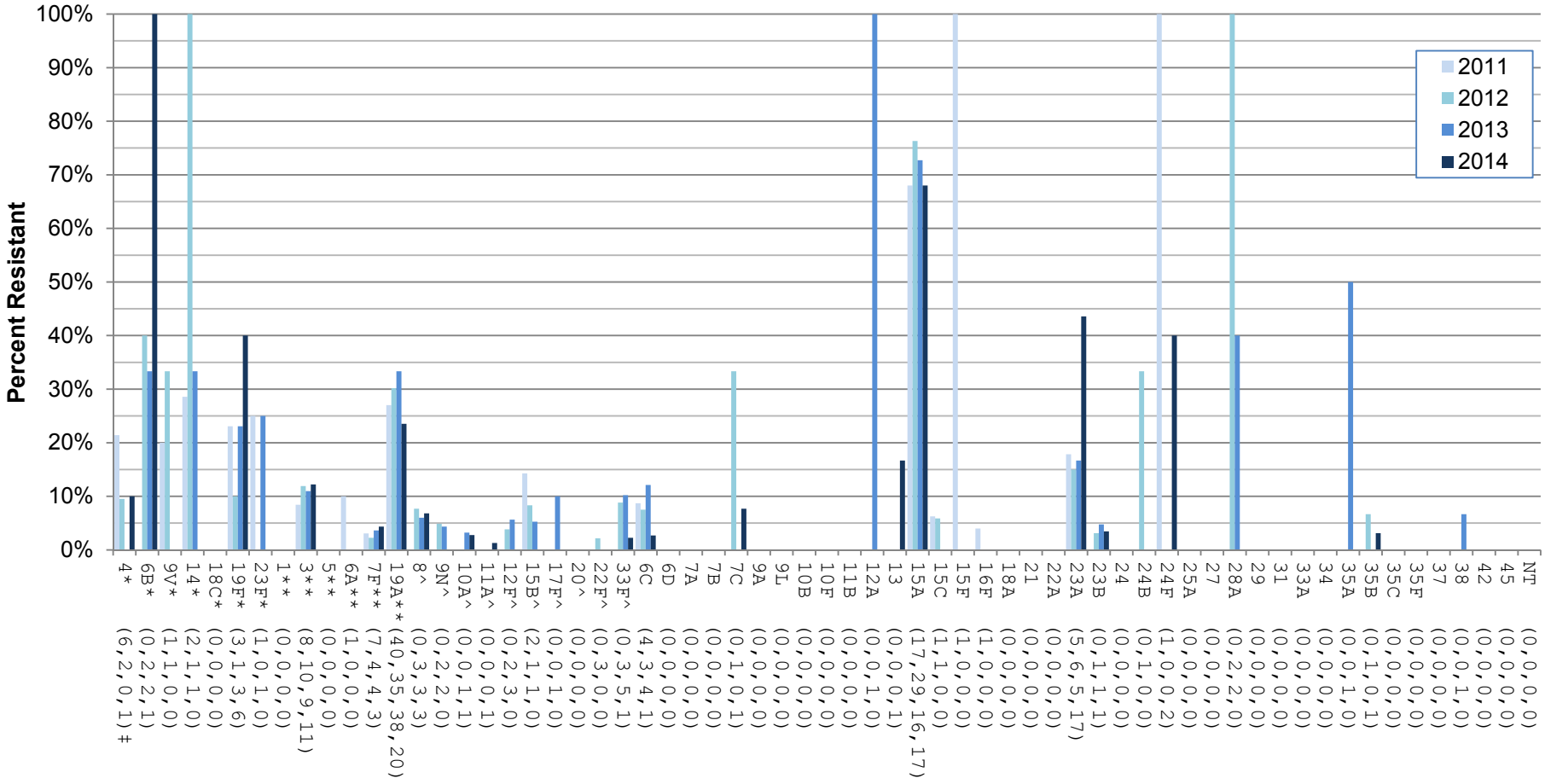
*Component of PCV7; ** Component of PCV13; ^ Component of PPV23; ‡ Number of resistant isolates for 2011, 2012, 2013 and 2014, respectively.

Figure 24. Clindamycin resistance of *S. pneumoniae* serotypes collected 2011 – 2014



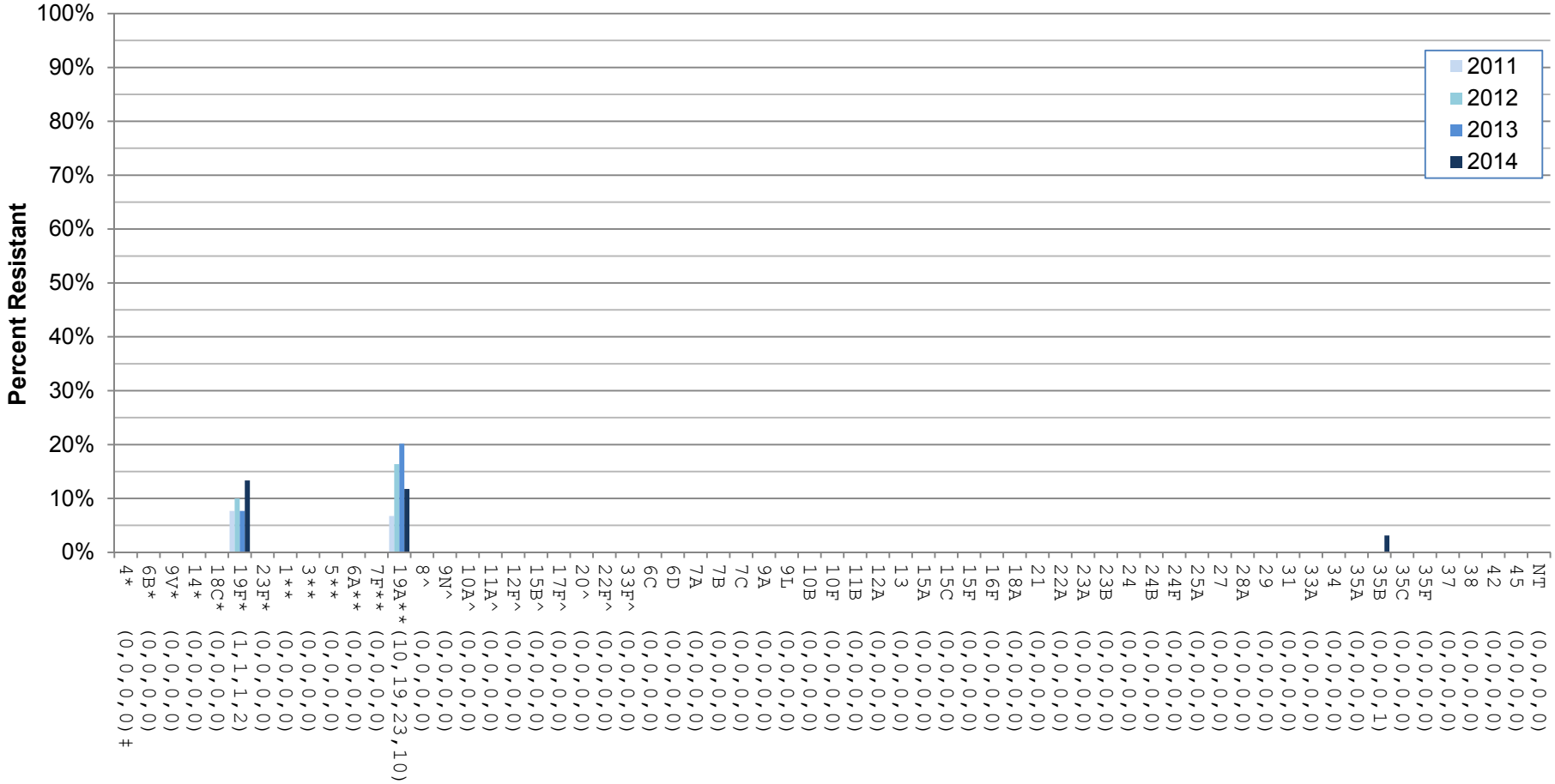
*Component of PCV7; ** Component of PCV13; ^ Component of PPV23; ‡ Number of resistant isolates for 2011, 2012, 2013 and 2014, respectively.

Figure 25. Doxycycline resistance of *S. pneumoniae* serotypes collected 2011 – 2014



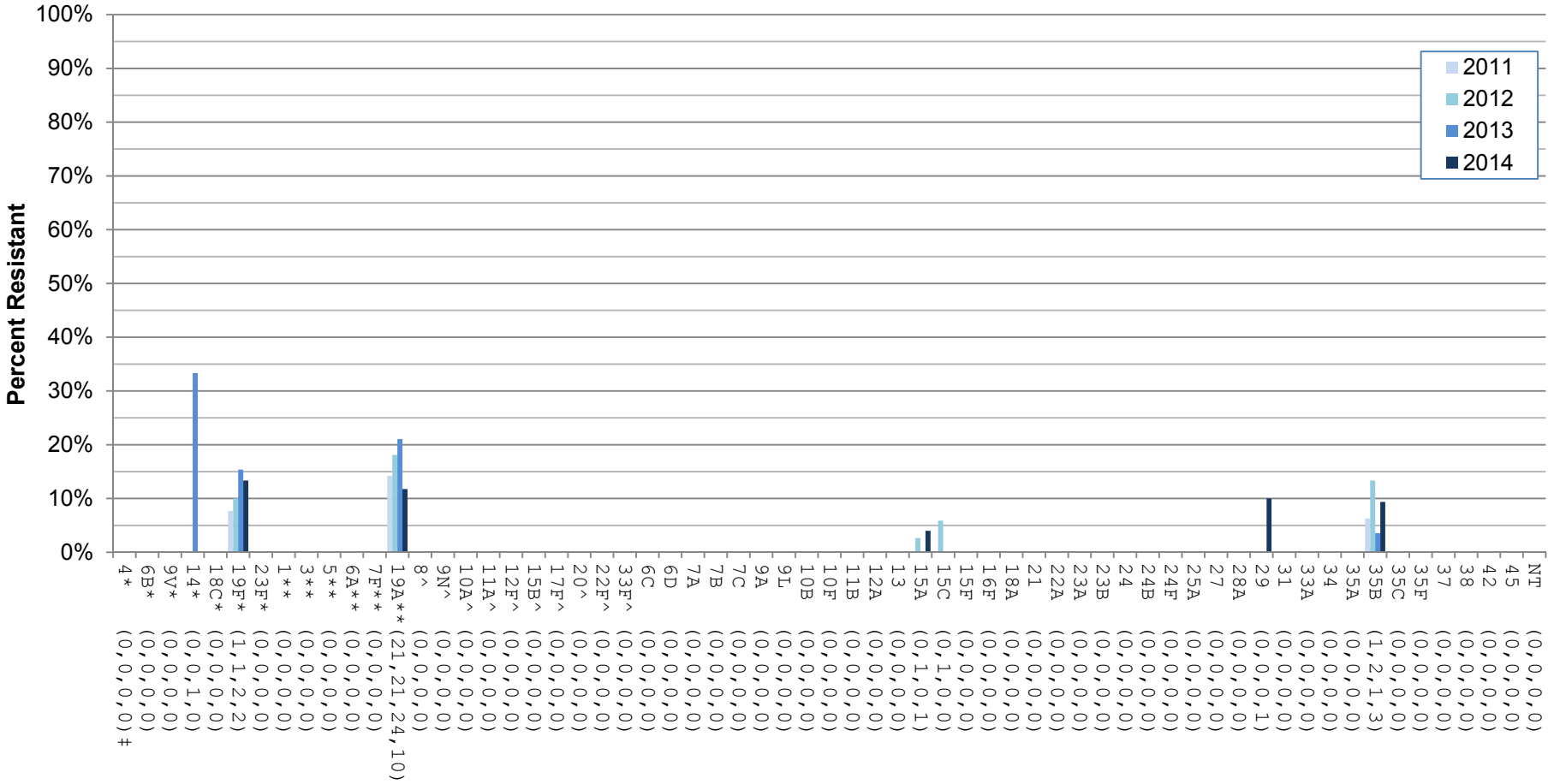
*Component of PCV7; ** Component of PCV13; ^ Component of PPV23; ‡ Number of resistant isolates for 2011, 2012, 2013 and 2014, respectively.

Figure 26. Imipenem resistance of *S. pneumoniae* serotypes collected 2011 – 2014



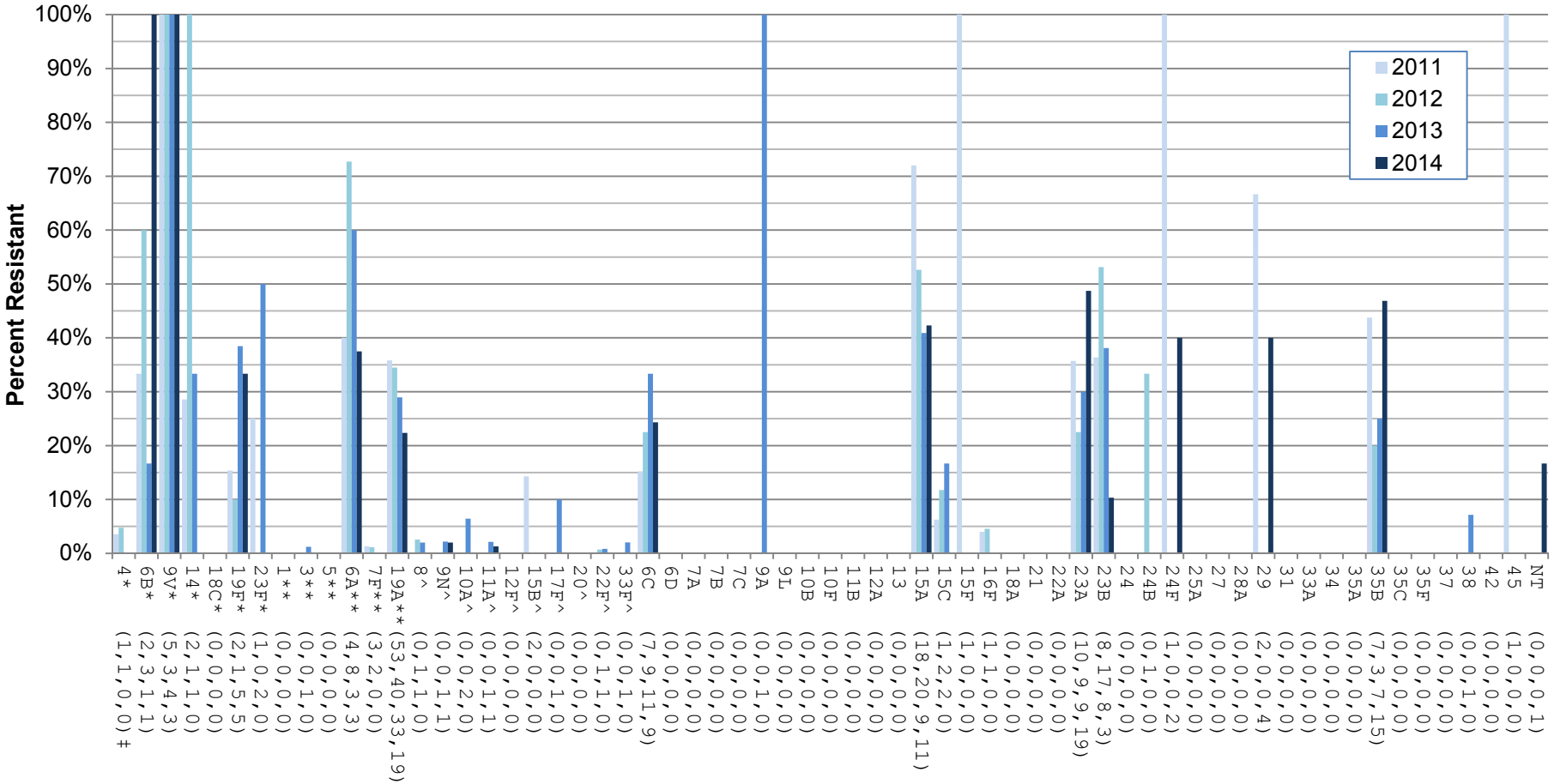
*Component of PCV7; ** Component of PCV13; ^ Component of PPV23; ‡ Number of resistant isolates for 2011, 2012, 2013 and 2014, respectively.

Figure 27. Meropenem resistance of *S. pneumoniae* serotypes collected 2011 – 2014



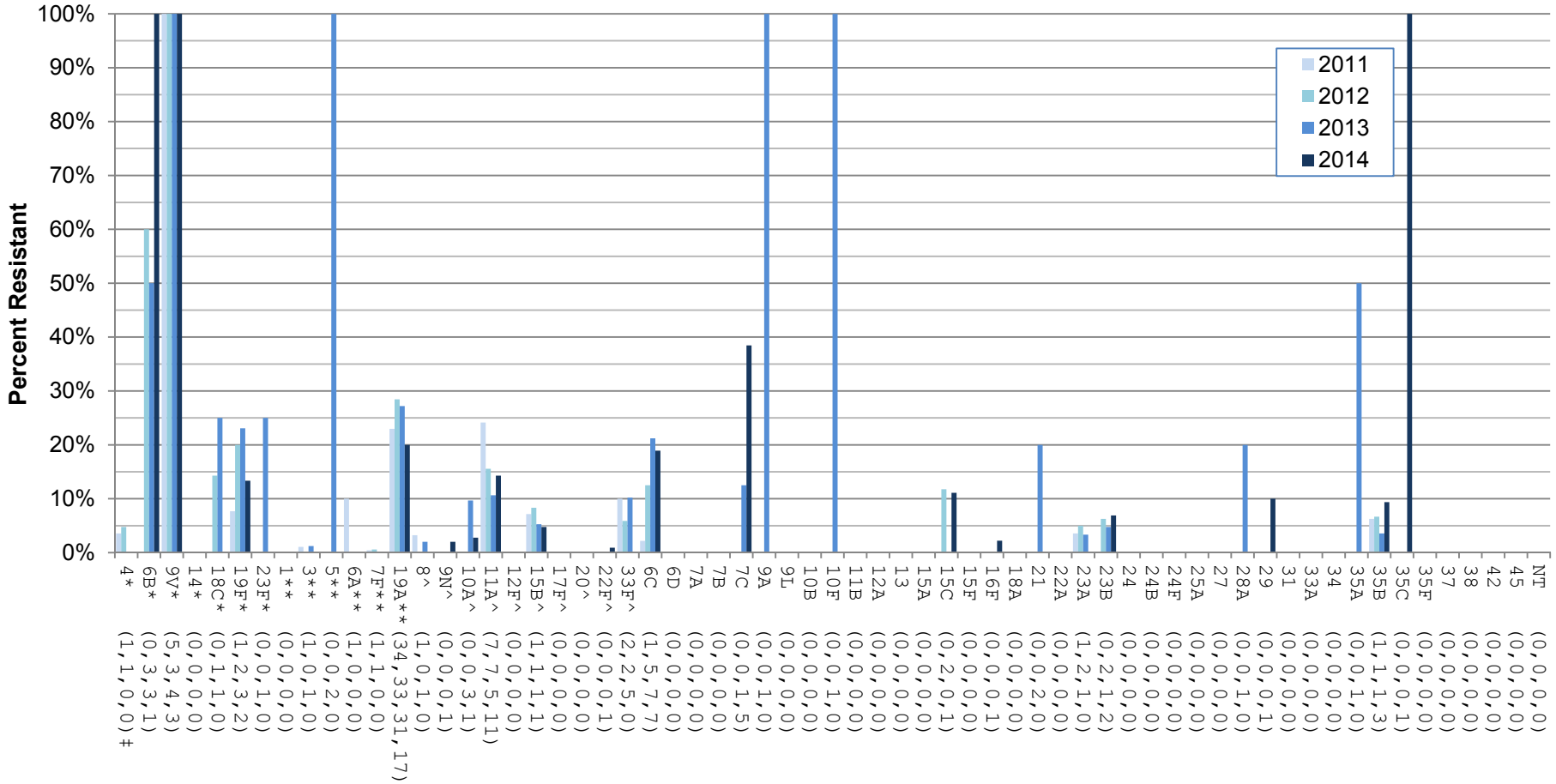
*Component of PCV7; ** Component of PCV13; ^ Component of PPV23; ‡ Number of resistant isolates for 2011, 2012, 2013 and 2014, respectively.

Figure 28. Penicillin resistance (meningitis breakpoints) of *S. pneumoniae* serotypes collected 2011 – 2014



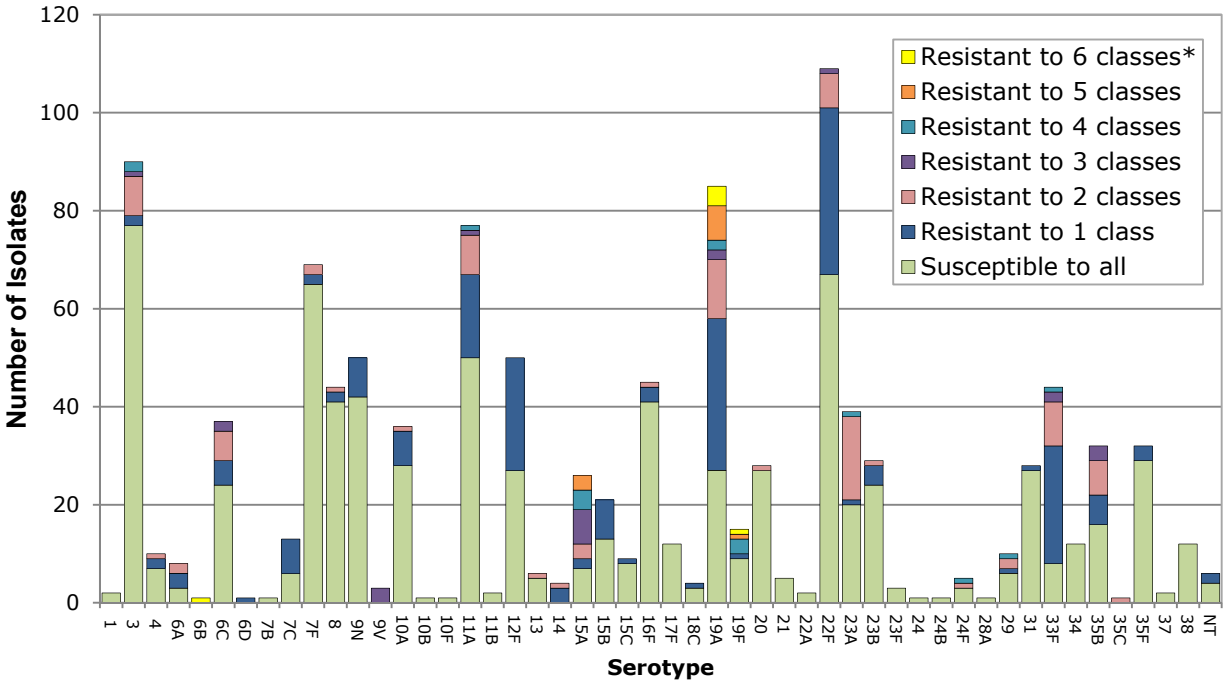
*Component of PCV7; ** Component of PCV13; ^ Component of PPV23; ‡ Number of resistant isolates for 2011, 2012, 2013 and 2014, respectively.

Figure 29. Trimethoprim/Sulfamethoxazole resistance of *S. pneumoniae* serotypes collected 2011 – 2014



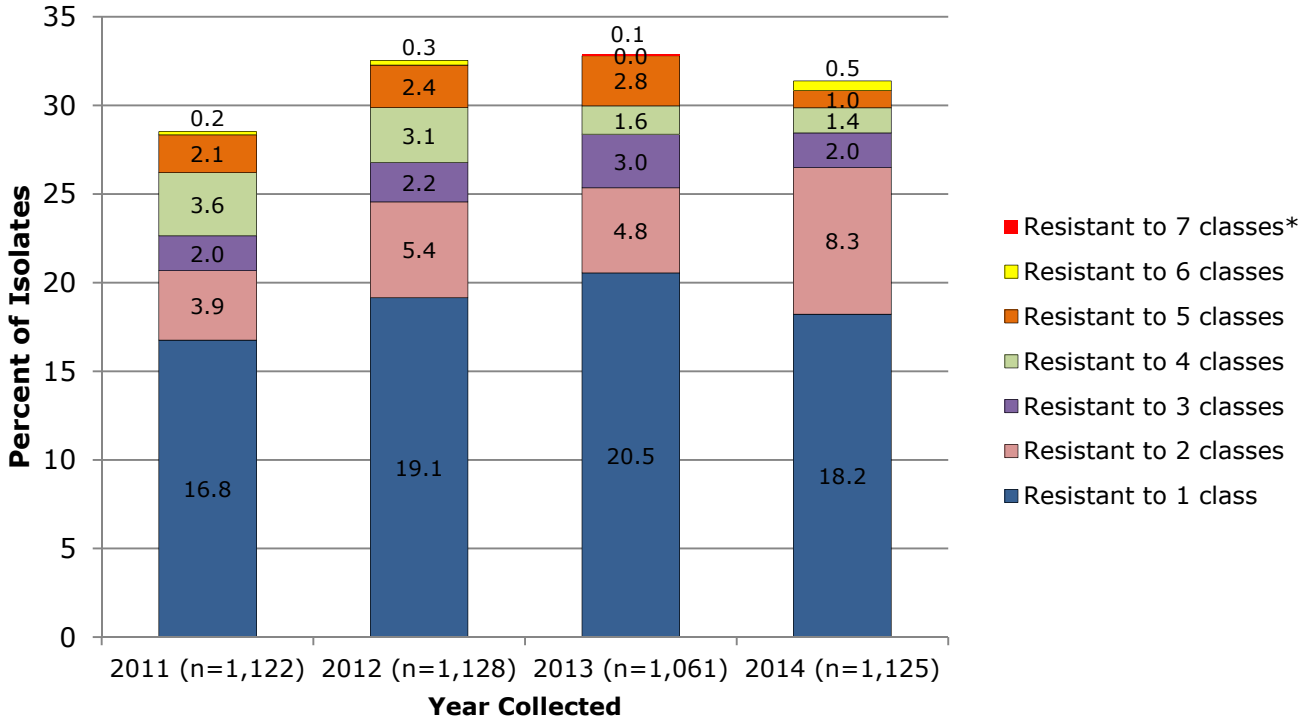
*Component of PCV7; ** Component of PCV13; ^ Component of PPV23; ‡ Number of resistant isolates for 2011, 2012, 2013 and 2014, respectively.

Figure 30. Multi-drug resistance of *S. pneumoniae* serotypes, 2014



*Antimicrobial classes include: β-lactams (amoxicillin/clavulanic acid, penicillin using meningitis breakpoints, ceftriaxone using meningitis breakpoints, cefuroxime using parenteral breakpoint, ertapenem, imipenem and meropenem); macrolides (clarithromycin); fluoroquinolones (levofloxacin and moxifloxacin); tetracyclines (doxycycline); folate pathway inhibitors (trimethoprim-sulfamethoxazole); phenicols (chloramphenicol); lincosamides (clindamycin); oxazolidinones (linezolid).

Figure 31. Multi-drug resistance of *S. pneumoniae*, 2011 - 2014



*Antimicrobial classes include: β-lactams (amoxicillin/clavulanic acid, penicillin using meningitis breakpoints, ceftriaxone using meningitis breakpoints, cefuroxime using parenteral breakpoint, ertapenem, imipenem and meropenem); macrolides (clarithromycin); fluoroquinolones (levofloxacin and moxifloxacin); tetracyclines (doxycycline); folate pathway inhibitors (trimethoprim-sulfamethoxazole); phenicols (chloramphenicol); lincosamides (clindamycin); oxazolidinones (linezolid).

Table 10. Antimicrobial* resistance profiles of *S. pneumoniae* serotypes, 2014

Multidrug Resistance Profile																																			
BLA*	-	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
FQN	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-	+	-	-	+	-	-	+	+	-	-	-	+	-	-	-	-	-	-	
MAC	-	-	-	+	+	+	+	+	+	+	-	-	-	-	+	+	-	+	+	+	+	-	-	-	+	+	+	+	+	+	+	-	-	-	
CLI	-	-	-	-	+	+	-	-	-	-	-	-	-	-	+	+	-	-	+	+	+	-	-	-	-	+	+	+	-	-	-	-	-	-	
TET	-	-	-	-	+	+	-	-	+	+	-	+	+	-	+	+	-	-	-	-	+	+	-	-	-	-	+	+	-	-	+	-	+	+	
SXT	-	-	-	-	-	+	+	+	-	+	+	-	+	-	-	+	-	-	-	-	-	-	+	-	-	-	+	+	-	+	-	+	-	+	
CHL	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	
ST**	**Number of Isolates**																																		**Total**
1	2																																		2
3	77													1							2	8			1		1								90
4	7																								2						1				10
6A	3	1		2																			1		1										8
6B																1																			1
6C	24	2		2				2			3														2							1		1	37
6D																							1												1
7B	1																																		1
7C	6																						1									5	1		13
7F	65																									1					1		2		69
8	41																					1											2		44
9N	42	1												1											5							1			50
9V								3																											3
10A	28																								7									1	36
10B	1																																		1
10F	1																																		1
11A	50										1								1				2		12			1	1	6		3			77
11B	2																																		2
12F	27																								23										50
13	5																														1				6
14																									3	1									4
15A	7	1			4				2			1		1	3												5				2				26
15B	13																								7							1			21
15C	8																															1			9
16F	41																						3	1											45
17F	12																																		12
18C	3													1																					4
19A	27			3	1	7			1	1	2		1			4							1		29	1				1	5	1			85
19F	9				3	1										1																1			15
20	27																	1																		28
21	5																																		5
22A	2																																		2
22F	67													6			1	5	1				4		24					1					109
23A	20	1		1	1							16																							39
23B	24	3																														1		1	29
23F	3																																		3
24	1																																		1
24B	1																																		1
24F	3				1							1																							5
28A	1																																		1
29	6	1		2			1																												10
31	27																								1										28
33F	8																		1	1					22	5	1			4		2			44
34	12																																		12
35B	16	5	1	5				2	1		1			1																					32
35C																														1					1
35F	29																						2		1										32
37	2																																		2
38	12																																		12
NT	4	1																							1										6
All	772	16	1	15	10	8	1	7	4	1	7	18	1	11	3	6	1	6	3	1	2	9	15	1	141	8	7	1	1	13	10	16	6	3	1125

*Antimicrobial classes: BLA= β-lactams (amoxicillin/clavulanic acid, penicillin and ceftriaxone (meningitis breakpoints), cefuroxime (parenteral breakpoint),ertapenem, imipenem and meropenem); MAC=macrolides (clarithromycin); FQN=fluoroquinolones (levofloxacin and moxifloxacin); TET=tetracyclines (doxycycline); SXT=folate pathway inhibitors (trimethoprim-sulfamethoxazole); CLI=lincosamides (clindamycin); CHL=phenicols (chloramphenicol).

** ST = Serotype.

Streptococcus pyogenes (Group A *Streptococcus*)

Overall incidence of invasive GAS cases in Canada has increased significantly ($p<0.001$) from 2009 to 2014. The average annual rate of 4.5 cases per 100,000 population (range: 4.0-4.9) (Table 11). The average annual incidence rate per 100,000 population was highest in infants <1 year of age (9.2 cases, range: 8.2-9.7), followed by the 60+ age group (7.3 cases, range: 6.8-7.8), and lowest among the 10-24 age groups (Figure 32, Table 11).

Figure 32. Annual incidence of invasive *S. pyogenes* cases in Canada, by age group, 2009 – 2013

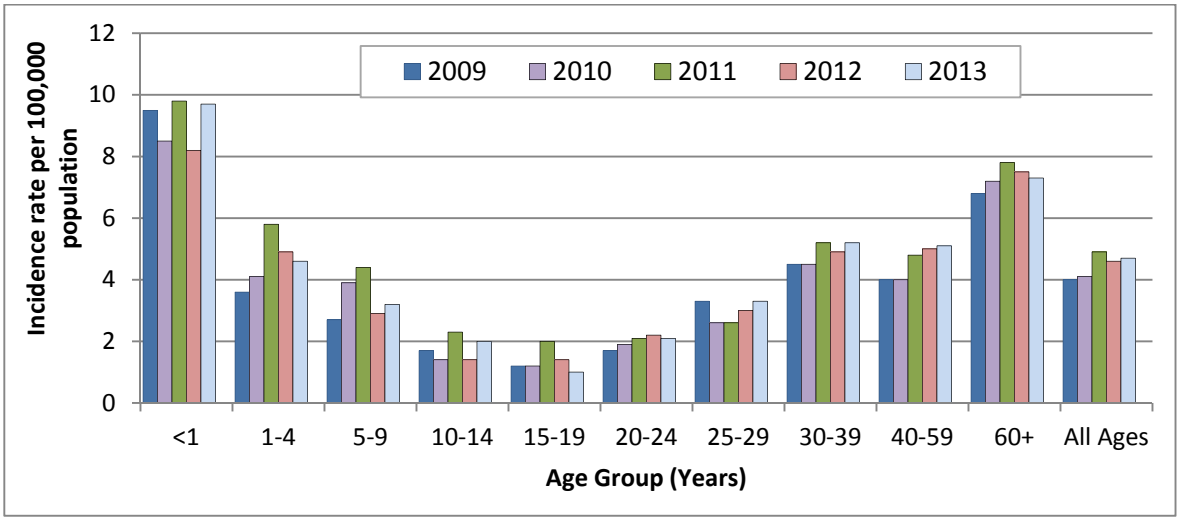


Table 11. Annual incidence rates of invasive *S. pyogenes* cases per 100,000 in Canada, 2009 – 2014

Year	Age Group (Years)										
	<1	1-4	5-9	10-14	15-19	20-24	25-29	30-39	40-59	60+	All Ages
2009	9.5	3.6	2.7	1.7	1.2	1.7	3.3	4.5	4	6.8	4
2010	8.5	4.1	3.9	1.4	1.2	1.9	2.6	4.5	4	7.2	4.1
2011	9.8	5.8	4.4	2.3	2	2.1	2.6	5.2	4.8	7.8	4.9
2012	8.2	4.9	2.9	1.4	1.4	2.2	3	4.9	5	7.5	4.6
2013	9.7	4.6	3.2	2	1	2.1	3.3	5.2	5.1	7.3	4.7

In 2014, of the 1,457 *Streptococcus pyogenes* isolates tested at the NML by *emm* typing, 159 (11.0%) were isolated from children <15 years of age; 1,449 (89.0%) from adults ≥15 years of age; and no age was available for 8 isolates. Isolates from male patients represented 53.0% (n=766) of the 1,444 isolates for which gender information was available (Table 12).

There were no major differences observed in the relative proportions of clinical isolation sites between adults and children other than slightly more CSF and pleural fluid isolations sites observed among child isolates (1.3%, n=2; and 3.8%, n=6; respectively) than in the adults (0.5%, n=6; and 1.4%, n=18; respectively) (Figures 33-34).

Regionally, *emm*1 represented a greater proportion of isolates in Central Canada (33.2%, n=324) than in Western (15.0%, n=64) or Eastern (24.5%, n=13) regions; whereas *emm*89 was more prevalent in Eastern regions (17.0%, n=9). *Emm* types associated with Western regions included *emm*41 (n=14), *emm*53 (n=30), and *emm*80 (n=28); those predominantly in Central Canada include *emm*6 (n=47), *emm*29 (n=66) and *emm*91 (n=10); and in Eastern regions *emm*4 (n=8), *emm*93 (n=1) and *emm*94 (n=2) and *emm*114 (n=1) (Figure 35).

Proportions of individual *emm* types have remained relatively stable since 2010, with *emm*1 continuing to be the most prevalent in Canada during 2014 accounting for 36.5% (n=58) of isolates collected from children <15 years of age and 26.4% (n=341) of isolates from those ≥15 years of age (Figures 36-37). In children <15 years of age, *emm* types 4, 6 and 12 were next most prevalent accounting for 11.9% (n=19), 12.6% (n=20) and 10.7% (n=17), respectively; and in adults ≥15 years of age *emm* types 89, 28, and 12 were next most predominant with 10.4% (n=134), 6.4% (n=82) and 6.0% (n=78), respectively.

Table 12. Number of invasive *S. pyogenes* (GAS) isolates by province, 2014

Province	Age Group (Years)						Not Given	Total
	< 2	2 – 4	5 – 14	15 – 49	50 – 64	≥ 65		
British Columbia	3	3	4	72	48	30	1	161
Saskatchewan	2	5	9	65	28	29	-	138
Manitoba	7	3	5	53	27	28	1	124
Ontario	18	21	28	201	130	214	6	618
Québec	13	13	20	136	76	101	-	359
New Brunswick	-	-	1	10	5	5	-	21
Nova Scotia	-	1	1	7	2	8	-	19
Prince Edward Island	-	-	-	1	1	-	-	2
Newfoundland and Labrador	-	-	2	2	4	3	-	11
Yukon Territories	-	-	-	-	1	1	-	2
Northwest Territories	-	-	-	1	-	-	-	1
Nunavut	-	-	-	-	-	1	-	1
Canada	**43**	**46**	**70**	**548**	**322**	**420**	**8**	**1,457**

Figure 33a. Clinical isolation sites of *S. pyogenes* from children <15 years of age (N=159)

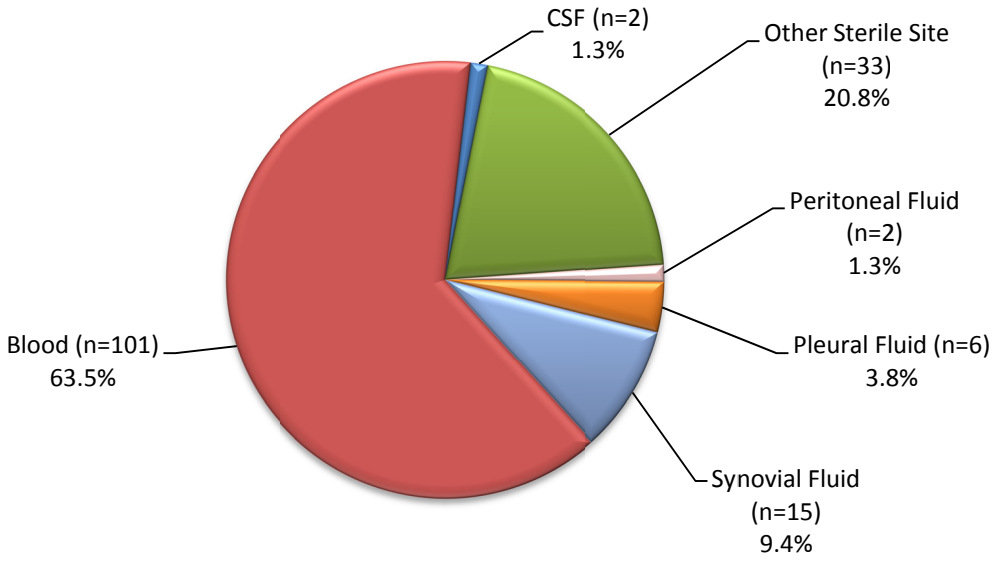
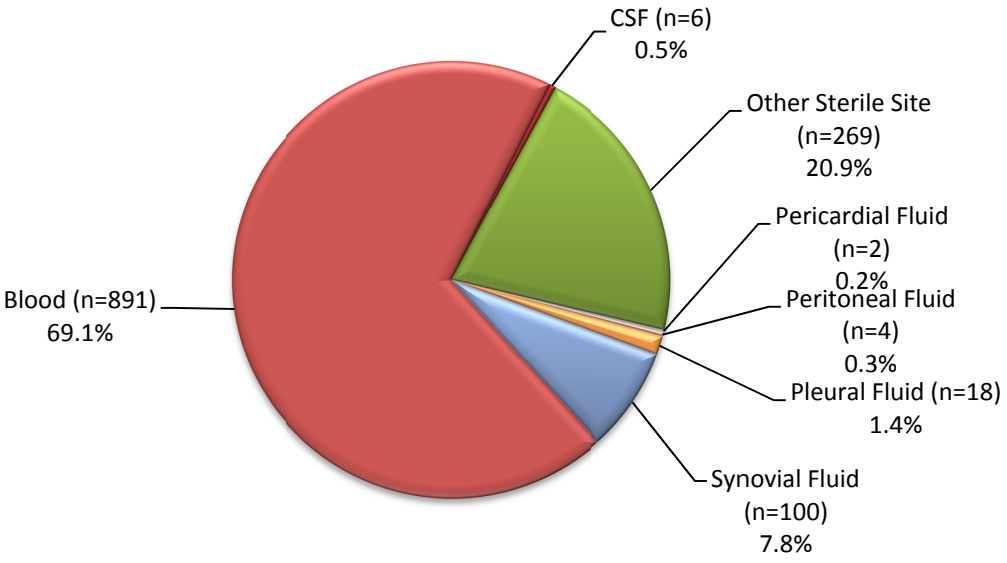


Figure 33b. Clinical isolation sites of *S. pyogenes* from adults ≥15 years of age (N=1,290)



Other sterile sites include: deep tissue, biopsy and surgical samples, bone, mastoid and any clinical sources associated with necrotizing fasciitis. Patient age was not available for 8 isolates.

Figure 34a. Invasive *S. pyogenes emm* types from blood, 2014

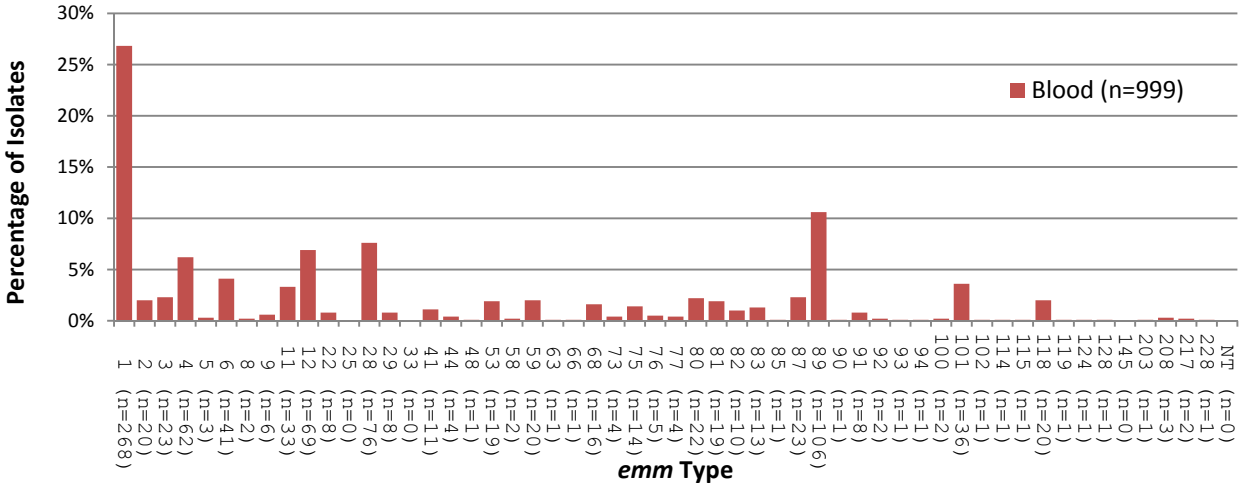


Figure 34b. Invasive *S. pyogenes emm* types from synovial fluid, 2014

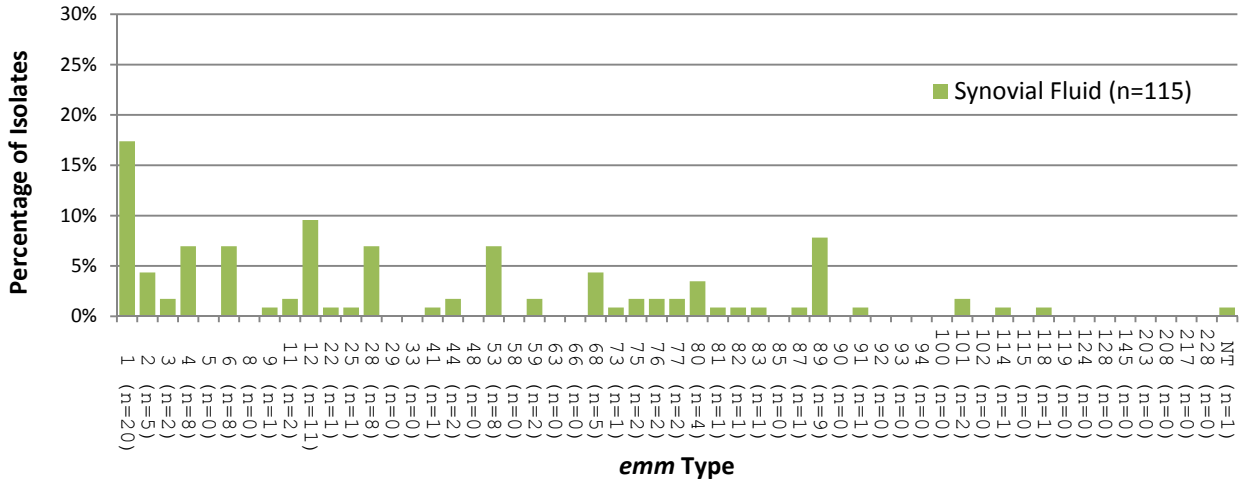
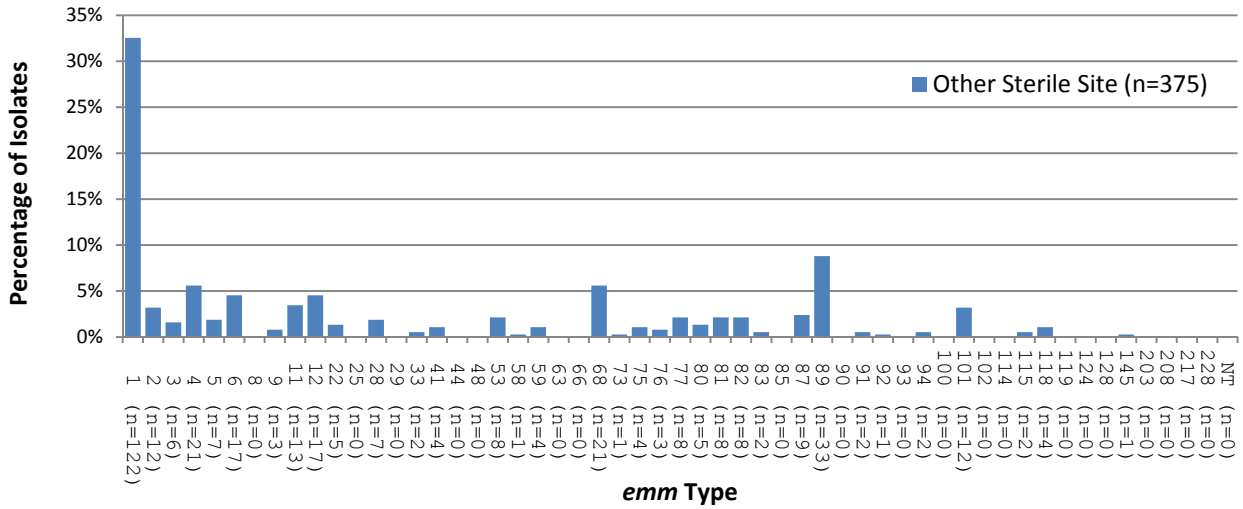
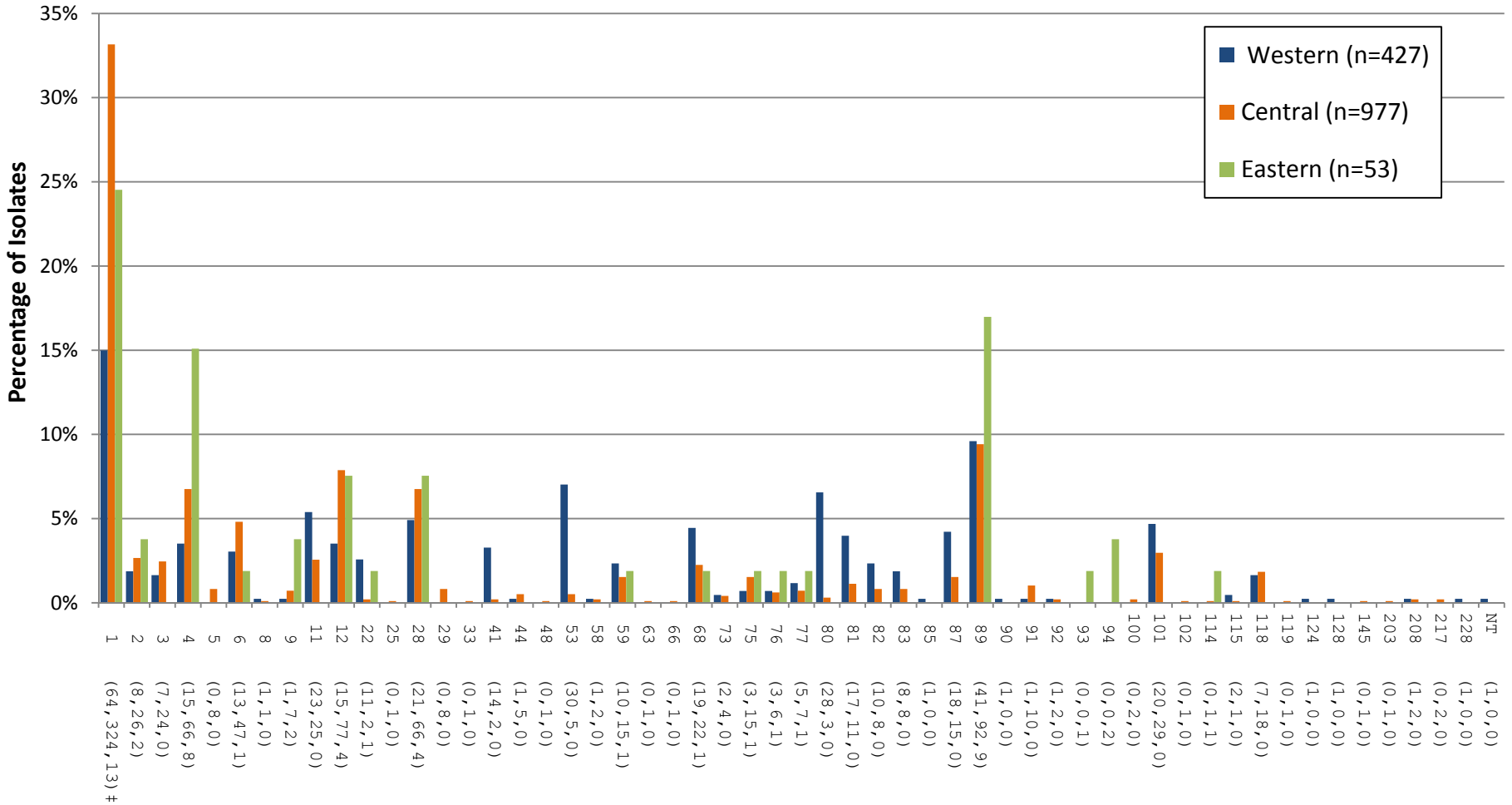


Figure 34c. Invasive *S. pyogenes emm* types from other clinical sources, 2014



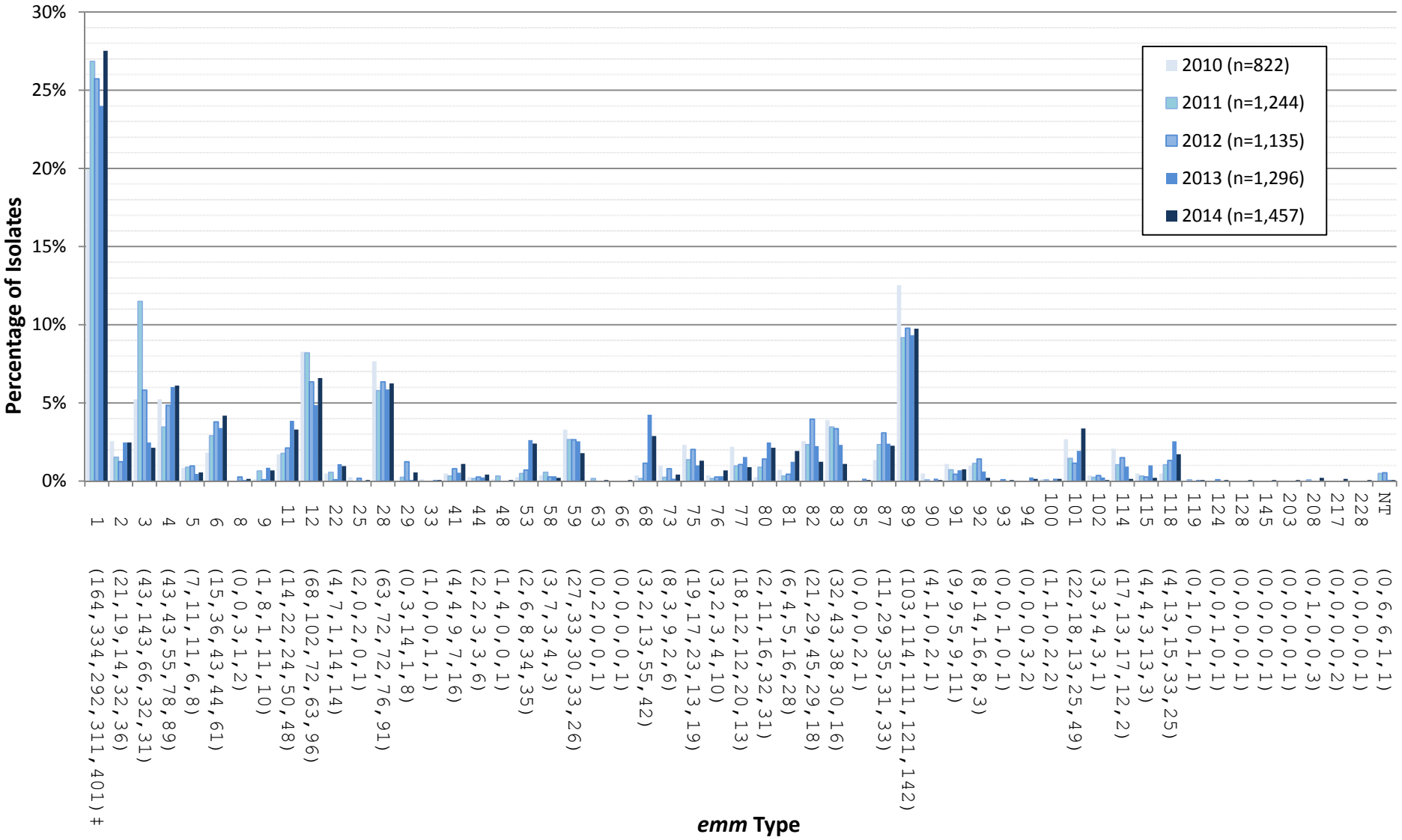
Other sterile sites include: CSF, pericardial fluid, peritoneal fluid, deep tissue, biopsy and surgical samples, bone, mastoid and any clinical sources associated with necrotizing fasciitis.

Figure 35. Regional Distribution of Invasive *S. pyogenes emm* Types, 2014



‡ Number of resistant isolates for Western, Central and Eastern regions, respectively.

Figure 36. Invasive *S. pyogenes emm* types in all combined age groups, 2010 – 2014



‡ Number of resistant isolates for 2010, 2011, 2012, 2013 and 2014, respectively.

Figure 37a. Invasive *S. pyogenes emm* types in children <15 years of age, 2010 – 2014

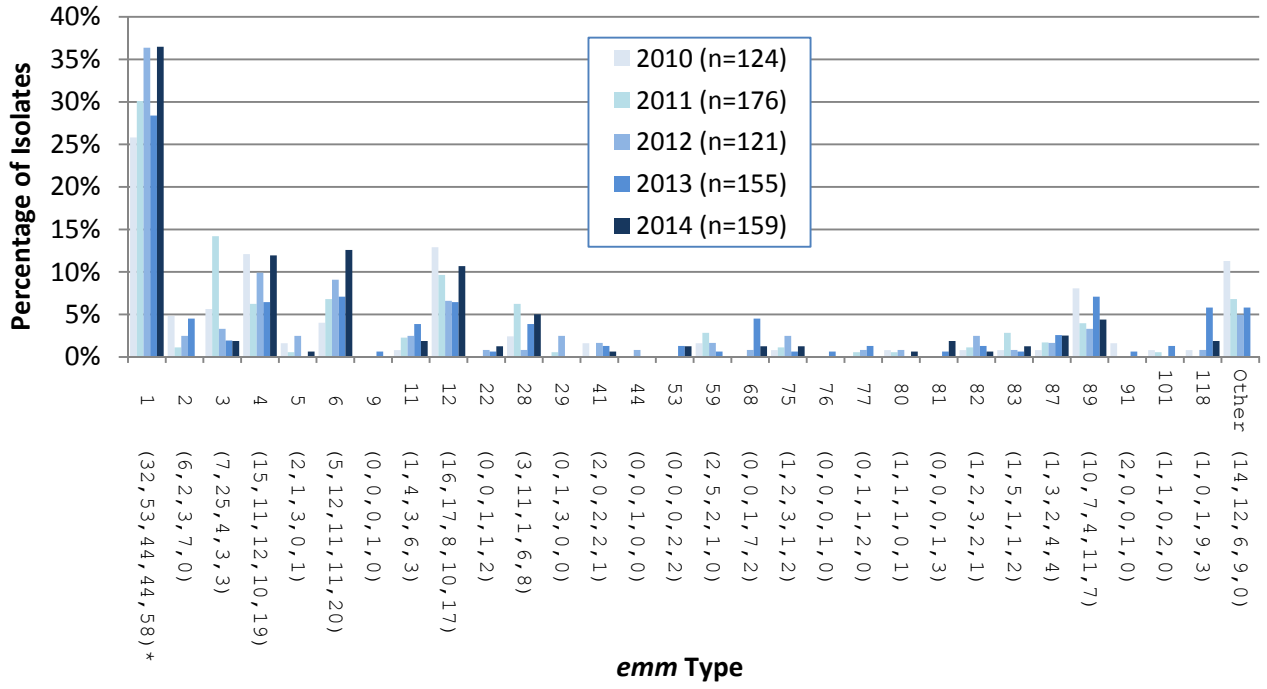
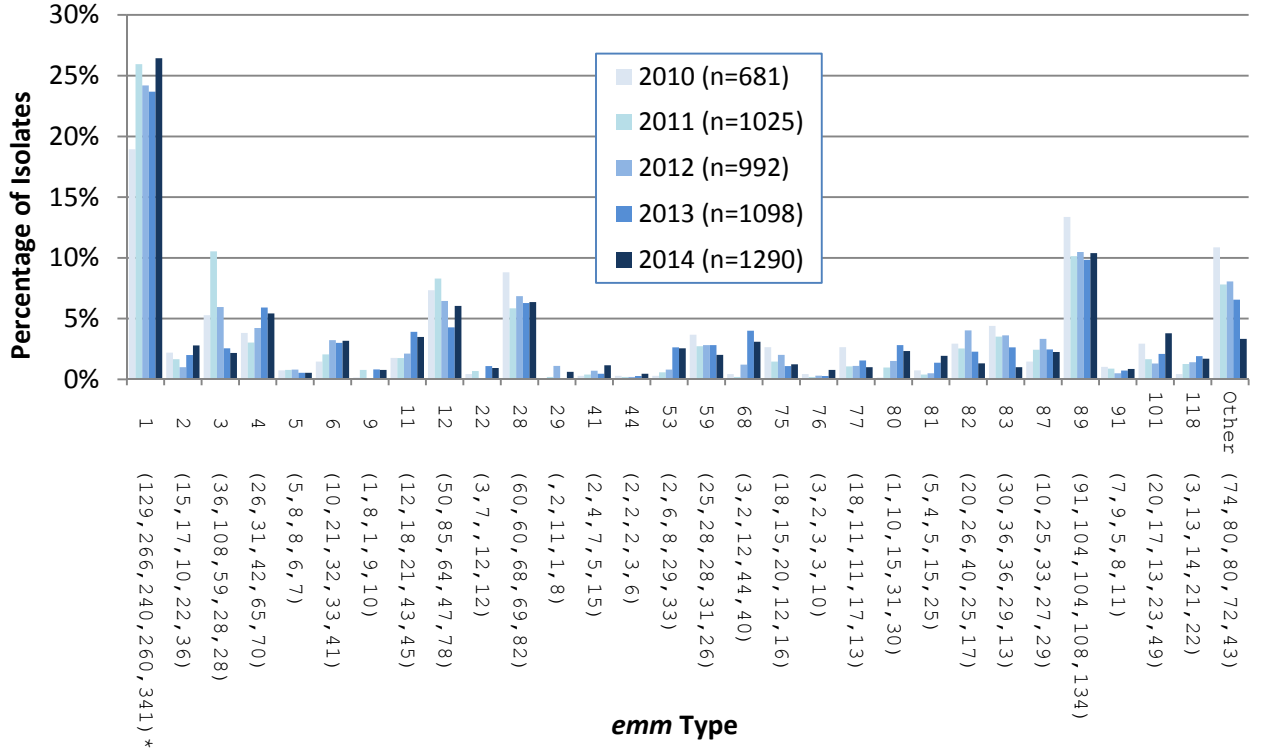


Figure 37b. Invasive *S. pyogenes emm* types in adults ≥15 years of age, 2010 – 2014



*Number of isolates in 2010, 2011, 2012, 2013 and 2014, respectively.

Antimicrobial Resistance of *Streptococcus pyogenes*

Of the 1,443 invasive *S. pyogenes* isolates tested by disc diffusion in 2014, only 2 isolates were non-susceptible to chloramphenicol (1 resistant *emm*92 and 1 intermediate *emm*82), down from 36 (9.4%) in 2010.

Erythromycin resistance has continued to decrease from 14.4% (n=55) to 6.9% (n=100, p<0.001) from 2010 to 2014; whereas resistance to clindamycin has remained relatively unchanged at 2.8% (n=40) in 2014 (Figure 38, Table 13). Relatively high macrolide (erythromycin) resistance was observed among *emm*9 (60.0%, n=6), *emm*11 (81.8%, n=27), *emm*76 (90.0%, n=9), *emm*77 (38.5%, n=5), and *emm*83 (31.3%, n=5) (Figure 39). Induced resistance to clindamycin was observed in a further 3.7% (n=53) of the isolates. No resistance was observed to penicillin or vancomycin.

Figure 38. Antimicrobial resistance of invasive *S. pyogenes* (GAS) 2010 - 2014

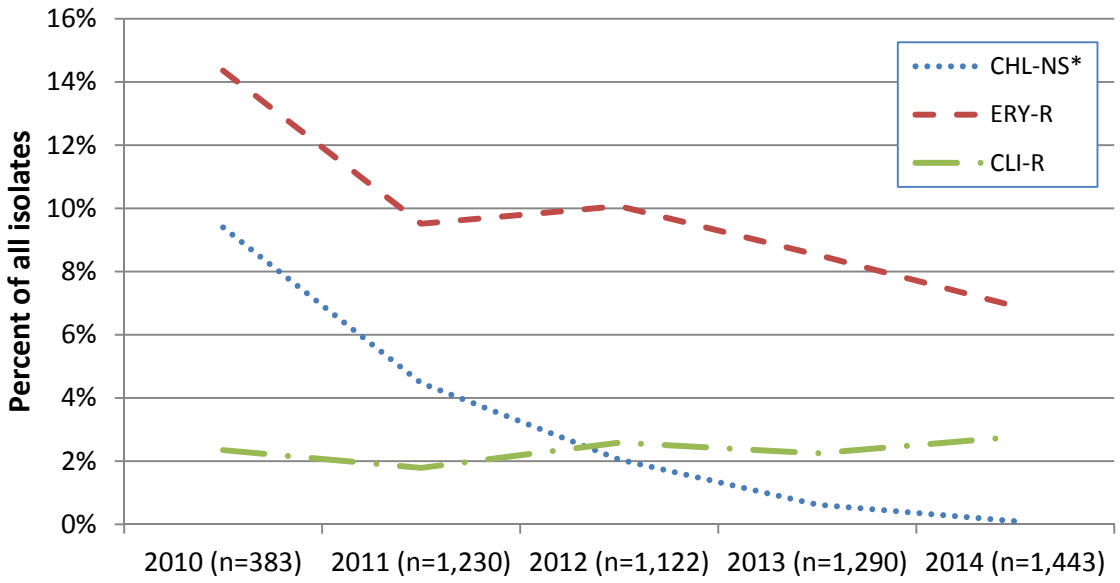
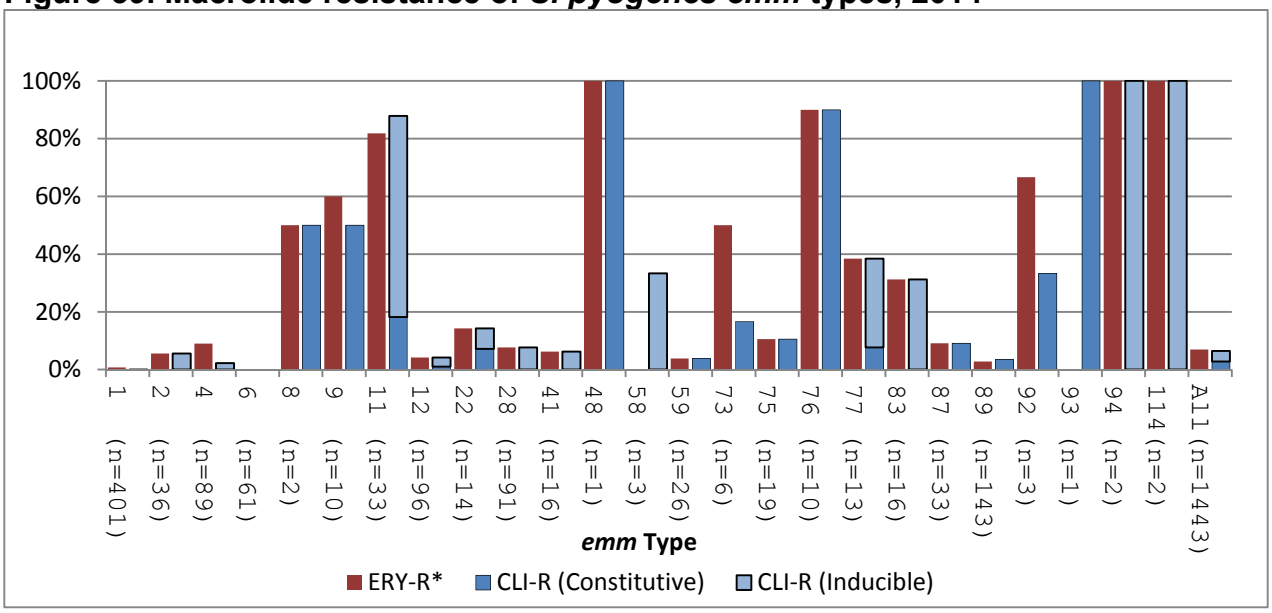


Table 13. Antimicrobial resistance of invasive *S. pyogenes* (GAS) isolates 2010 – 2014

Antimicrobial	Year				
	2010	2011	2012	2013	2014
CHL-NS*	9.4% (36)	4.5% (55)	2.0% (23)	0.6% (8)	0.1% (2)
ERY-R	14.4% (55)	9.5% (117)	10.1% (113)	8.5% (110)	6.9% (100)
CLI-R	2.3% (9)	1.8% (22)	2.6% (29)	2.2% (29)	2.8% (40)
Total Tested	**(383)**	**(1,230)**	**(1,122)**	**(1,290)**	**(1,443)**

*CHL-NS = Chloramphenicol non susceptible (resistant or intermediate); ERY-R = Erythromycin resistant; CLI-R = constitutively clindamycin resistant.

Figure 39. Macrolide resistance of *S. pyogenes emm* types, 2014



*ERY-R = Erythromycin resistant; CLI-R = clindamycin resistant. (Constitutive or Inducible)

Invasive *Streptococcus agalactiae* (Group B *Streptococcus*)

Of the 249 *Streptococcus agalactiae* isolates tested at the NML during 2014, 7 cultures (2.8%) were early onset isolates from infants <8 days old; 7 cultures (2.8%) were late onset from infants 8-31 days old; 10 cultures (4.0%) were from children 1 month to 14 years old, 111 (44.6%) were from adults 15-64 years old, and 103 (41.4%) were from seniors ≥65 years of age, and no age was available for 11 isolates (Table 14). Isolates from male patients accounted for 54.4% (n=111) of the 204 isolates for which gender information was available.

Serotype V was most prevalent overall representing 23.3% (n=58) of all isolates tested in 2014 (Table 14), an increase from 19.8% (n=85, p=0.286) in 2013 (Figure 40, Table 15). An increase of serotype IV was also seen from 9.1% (n=39) to 17.7% (n=44, p=0.001) from 2013 to 2014.

The majority of GBS were isolated from blood, representing 60.2% (n=150) of all isolates, followed by synovial fluid with 25.7% (n=64) of the isolates. Serotype III accounted for 24.0% (n=36) of blood and 20.8% (n=5) of the synovial fluid isolates; whereas serotype V accounted for the majority of synovial fluid (41.7%, n=10) and serotype IV was most predominant from of other sterile site isolates (32.8%, n=21) (Figure 41, Table 16).

Table 14. Invasive *S. agalactiae* serotypes by age group, 2014

Serotype	Age Group*					Not Given	Total
	Infant Early Onset	Infant Late Onset	Child	Adult	Senior		
Ia	14.3% (1)**	14.3% (1)	-	12.6% (14)	14.6% (15)	9.1% (1)	12.7% (32)
Ib	14.3% (1)	-	20.0% (2)	14.4% (16)	17.5% (18)	-	14.7% (37)
II	-	-	-	9.9% (11)	4.9% (5)	9.1% (1)	6.8% (17)
III	57.1% (4)	57.1% (4)	60.0% (6)	14.4% (16)	15.5% (16)	63.6% (7)	21.1% (53)
IV	14.3% (1)	14.3% (1)	10.0% (1)	23.4% (26)	14.6% (15)	-	17.5% (44)
V	-	14.3% (1)	10.0% (1)	22.5% (25)	28.2% (29)	18.2% (2)	23.1% (58)
VI	-	-	-	2.7% (3)	-	-	1.2% (3)
VIII	-	-	-	-	1.0% (1)	-	0.4% (1)
IX	-	-	-	-	1.0% (1)	-	0.4% (1)
NT	-	-	-	-	2.9% (3)	-	1.2% (3)
Total	**(7)**	**(7)**	**(10)**	**(111)**	**(103)**	**(11)**	**(249)**

*Infant Early Onset ≤7days, Infant Late Onset = 8-31 days, Child = 1 month-14 years, Adult = 15-64 years, Senior ≥65 years, NT = Non-typeable.
**Percentage of age group isolates (number of isolates).

Figure 40. Invasive *S. agalactiae* serotypes, 2010 to 2014

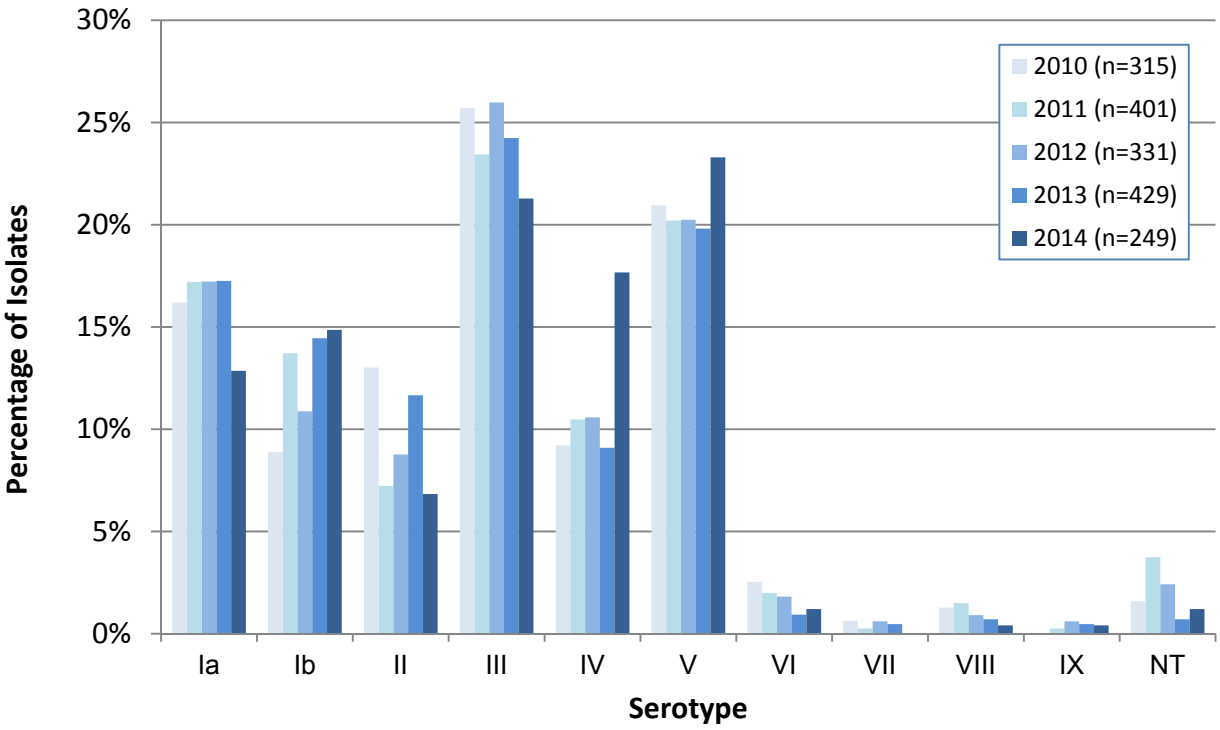


Table 15. Invasive *S. agalactiae* serotypes, 2010 – 2014

Serotype	Year				
	2010	2011	2012	2013	2014
Ia	16.2% (51)*	17.2% (69)	17.2% (57)	17.2% (74)	12.9% (32)
Ib	8.9% (28)	13.7% (55)	10.9% (36)	14.5% (62)	14.9% (37)
II	13.0% (41)	7.2% (29)	8.8% (29)	11.7% (50)	6.8% (17)
III	25.7% (81)	23.4% (94)	26.0% (86)	24.2% (104)	21.3% (53)
IV	9.2% (29)	10.5% (42)	10.6% (35)	9.1% (39)	17.7% (44)
V	21.0% (66)	20.2% (81)	20.2% (67)	19.8% (85)	23.3% (58)
VI	2.5% (8)	2.0% (8)	1.8% (6)	0.9% (4)	1.2% (3)
VII	0.6% (2)	0.2% (1)	0.6% (2)	0.5% (2)	0.0% (0)
VIII	1.3% (4)	1.5% (6)	0.9% (3)	0.7% (3)	0.4% (1)
IX	0.0% (0)	0.2% (1)	0.6% (2)	0.5% (2)	0.4% (1)
NT	1.6% (5)	3.7% (15)	2.4% (8)	0.7% (3)	1.2% (3)
All	**(315)**	**(401)**	**(331)**	**(429)**	**(249)**

*Percentage of age group isolates (number of isolates).

Figure 41. Invasive *S. agalactiae* serotypes by clinical isolation site, 2014

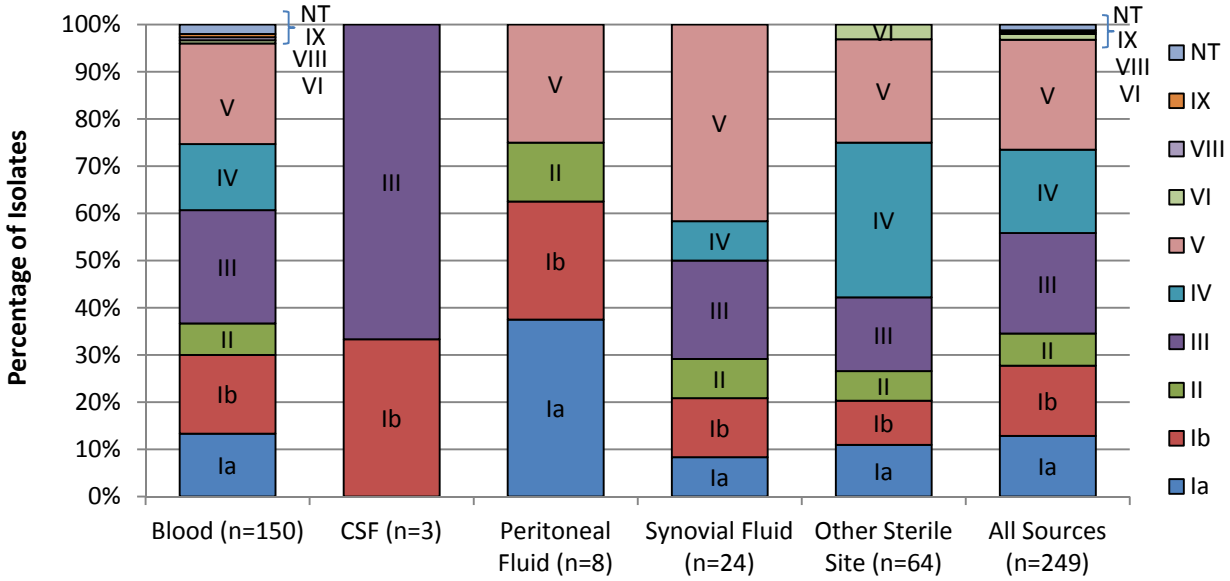


Table 16. Invasive *S. agalactiae* isolates by clinical isolation site, 2014

Serotype	Isolation Site					Total
	Blood	CSF	Peritoneal Fluid	Synovial Fluid	Other Sterile Site	
Ia	13.3% (20)	-	37.5% (3)	8.3% (2)	10.9% (7)	12.9% (32)
Ib	16.7% (25)	33.3% (1)	25.0% (2)	12.5% (3)	9.4% (6)	14.9% (37)
II	6.7% (10)	-	12.5% (1)	8.3% (2)	6.3% (4)	6.8% (17)
III	24.0% (36)	66.7% (2)	-	20.8% (5)	15.6% (10)	21.3% (53)
IV	14.0% (21)	-	-	8.3% (2)	32.8% (21)	17.7% (44)
V	21.3% (32)	-	25.0% (2)	41.7% (10)	21.9% (14)	23.3% (58)
VI	0.7% (1)	-	-	-	3.1% (2)	1.2% (3)
VIII	0.7% (1)	-	-	-	-	0.4% (1)
IX	0.7% (1)	-	-	-	-	0.4% (1)
NT	2.0% (3)	-	-	-	-	1.2% (3)
Total	**60.2% (150)**	**1.2% (3)**	**3.2% (8)**	**9.6% (24)**	**25.7% (64)**	**(249)**

Antimicrobial Resistance of *Streptococcus agalactiae*

Of the 249 invasive *S. agalactiae* isolates tested by disc diffusion in 2014, one isolate was resistant to chloramphenicol (serotype V). Erythromycin and clindamycin resistance has remained relatively stable accounting for 49.4% (n=123) and 27.3% (121) of the isolates tested in 2014 (Figure 42, Table 17).

Relatively high macrolide (erythromycin) resistance was observed among serotypes Ia (50%, n=16), II (58.8%, n=10), III (49.1%, n=26), IV (77.3%, n=34), and V (41.4%, n=24) (Figure 43).

Figure 42. Antimicrobial resistance of invasive *S. agalactiae*, 2010 – 2014

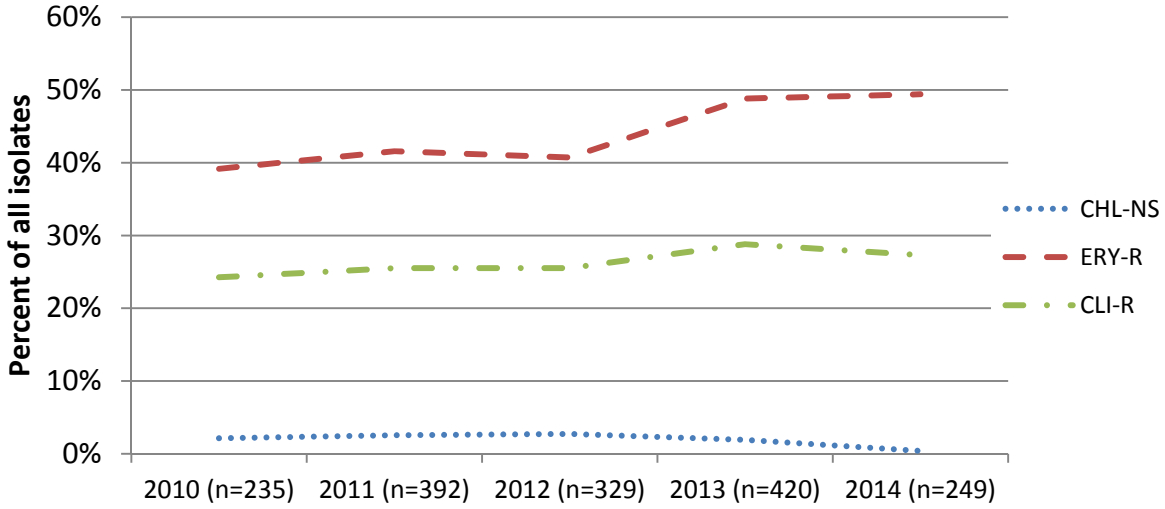
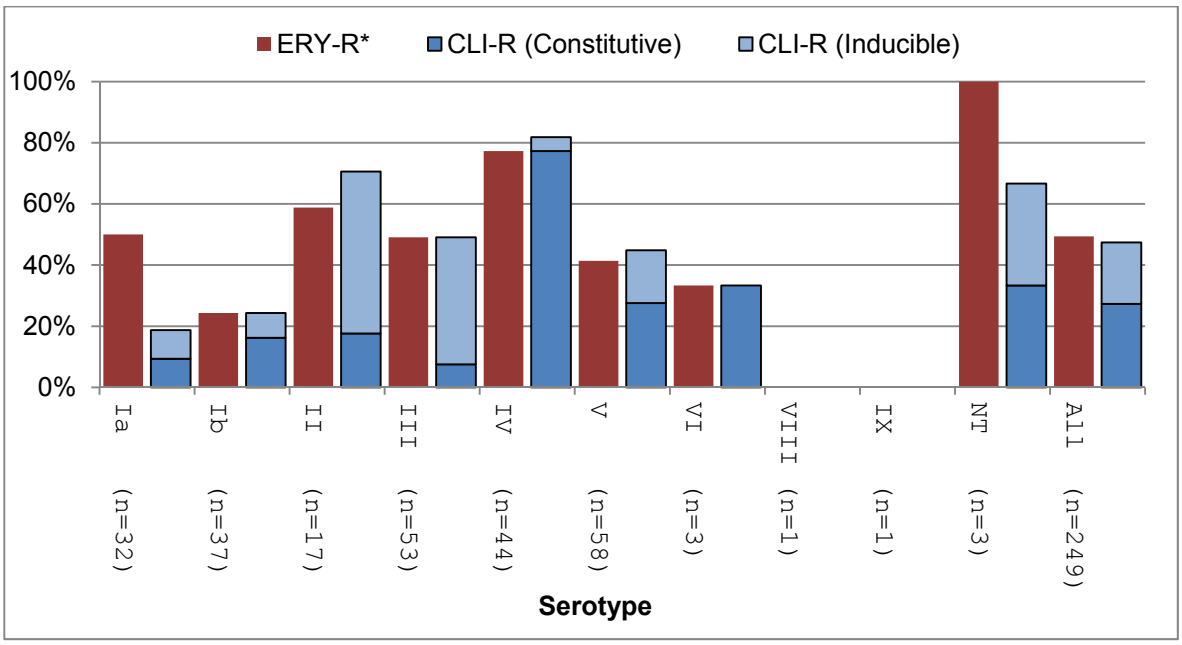


Table 17. Antimicrobial resistance of invasive *S. agalactiae*, 2010 – 2014

Antimicrobial	Year				
	2010	2011	2012	2013	2014
CHL-NS*	2.1% (5)	2.6% (10)	2.7% (9)	1.9% (8)	0.4% (1)
ERY-R	39.1% (92)	41.6% (163)	40.7% (134)	48.8% (205)	49.4% (123)
CLI-R	24.3% (57)	25.5% (100)	25.5% (84)	28.8% (121)	27.3% (68)
Total Tested	**(235)**	**(392)**	**(329)**	**(420)**	**(249)**

*CHL-NS = Chloramphenicol non susceptible (resistant or intermediate); ERY-R = Erythromycin resistant; CLI-R = constitutively clindamycin resistant.

Figure 43. Macrolide resistance of *S. agalactiae* serotypes, 2014



*ERY-R = Erythromycin resistant; CLI-R = clindamycin resistant. (Constitutive or Inducible)

CONCLUSION

The proportion of PCV7 serotypes among *S. pneumoniae* in Canada remains low in 2014 and continuing decreases in the predominant PCV13 serotypes 7F and 19A have been observed. The decrease of PCV13 serotypes, in addition to continuing decreases in incidence of disease in children, provides evidence of the impact of the PCV13 vaccination programs in Canada. Continued vigilance however, is required to recognize possible increases in other non-PCV13 serotypes circulating in Canada, such as serotypes 22F, 23A, 23B and 15A. Although a component of the PCV13 vaccine, serotype 3 has not decreased at the rate of other constituent serotypes, raising concerns of the virulence, the immunogenicity of this serotype and the efficacy of this component of the vaccine. The continued monitoring of the relative frequency of serotypes circulating in Canada will help inform and guide the development and composition of new vaccines which will lower the total burden of disease.

Antimicrobial resistance among isolates of *S. pneumoniae* is generally declining, mainly due to the decline of highly resistant serotype 19A, but resistance to penicillins, macrolides, tetracyclines, sulfonamides and fluoroquinolones and multi-drug resistance is still common. Current antimicrobial resistance levels in Canada are relatively low, however monitoring the antimicrobial susceptibility patterns of the common *S. pneumoniae* serotypes is essential to guide empiric and directed treatments.

*S. pyogenes emm*1 and *emm*89 continue to be the dominate strains in Canada, whereas annual variability of the other *emm* types continue. Antimicrobial resistance in Group A *Streptococcus* has declined since 2010, however, due to the severity, high risk of infection and heightened public awareness of Group A *Streptococci*, the continued monitoring and surveillance of circulating serotypes and antimicrobial resistance levels are important to help identify outbreaks of disease and to inform and guide public health interventions.

S. agalactiae serotypes V, III and IV are the predominate strains in Canada, and macrolide resistance is stabilized in 2014. Group B *Streptococci* cause severe outcomes in neonatal groups; however there is an increasing burden of disease among adults. Monitoring shifts in the distribution of serotypes, levels of antimicrobial resistance as well as collecting additional enhanced epidemiological information, is important to help identify potential risk factors, spread of invasive strains, and to raise awareness of future prevention and treatment options.

APPENDIX

Table A. Proportion of invasive *Streptococcus pneumoniae* cases serotyped in Canada, 2014

Age group	Total number of isolates serotyped	Total number of illnesses reported to CNDSS**	Percent serotyped
<1 years	61	65	93.8%
1 - 4 years	151	170	88.8%
5 – 39 years	335	425	78.8%
40 – 59 years	666	872	76.4%
≥60 years	1,212	1,625	75.8%
All Ages	**2,438***	**3,157**	**74.6%**

*Includes 13 isolates with no patient age, 35 pleural fluid isolates excluded. ** Preliminary data from Canadian Notifiable Diseases Surveillance System, PHAC.

Table B. Proportion of invasive *Streptococcus pyogenes* cases typed in Canada, 2014

Age group	Total number of isolates tested	Total number of illnesses reported to CNDSS**	Percent serotyped
<1 years	21	Available Feb. 2016	
1 - 4 years	68		
5 – 39 years	417		
40 – 59 years	413		
≥60 years	530		
All Ages	**1,457***		

*Includes 8 isolates with no patient age. ** Canadian Notifiable Diseases Surveillance System, PHAC.

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