National Laboratory Surveillance of *Streptococcus pneumoniae* and *Streptococcus pyogenes* In Canada Annual Summary 2011

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Background

Before the introduction of an effective vaccine, ***Streptococcus pneumoniae*** was one of the most common causes of mortality and morbidity. It is responsible for a range of infections including meningitis, septicaemia, bacterial pneumonia, otitis media, and sinusitis and children are at greatest risk of infection.

From 2001 to 2005, pneumococcal immunization programs using a 7-valent pneumococcal conjugate vaccine (PCV7) were established in all provinces which have led to dramatic decreases in invasive pneumococcal disease (IPD) caused by constituent PCV7 serotypes: 4, 6B, 9V, 14, 18C, 19F and 23F. Serotype replacement with non-PCV7 serotypes has since been observed among pneumococcal infections in Canada.

In response to a shift of serotypes away from those contained in the PCV7 vaccine, a PCV13 vaccine (includes the PCV7 serotypes as well as serotypes 1, 5, 7F, 3, 6A and 19A) was introduced in all provinces and territories in 2010. Continued monitoring of *S. pneumoniae* serotypes is important as it directly informs the potential effectiveness of vaccine formulations.

A 23-valent polysaccharide pneumococcal vaccine (PPV23) is available for adults; however this formulation is not effective in children under 2 years of age due to their poor antibody response to polysaccharide vaccines.

Streptococcus pyogenes **(Group A *Streptococcus*, GAS)** infections range in severity from mild pharyngitis to severe invasive disease of soft tissues and bacteraemia resulting in toxic shock syndrome and necrotizing fasciitis. Mortality and morbidity rates associated with Group A *Streptococcus* infections have recently been increasing and is now regarded as a re-emerging disease.

Executive Summary

- This report summarizes the characterization of 2,372 invasive *Streptococcus pneumoniae* (IPD) and 1238 invasive *Streptococcus pyogenes* (Group A Streptococcus; iGAS) isolates collected in Canada between January 1 and December 31, 2011 and submitted by provincial and territorial public health laboratories and hospitals for surveillance purposes.
- To further the national representativeness the data includes information on 453 isolates serotyped by the Laboratoire de santé publique du Québec and 419 isolates serotyped by the Toronto Infectious Bacterial Diseases Network.
- Nationally the proportion of *S. pneumoniae* strains associated with the PCV7 vaccine continues to be relatively low representing 6% of all isolates and 2% of those from the <2 and 2-4 age groups.
- The proportion of PCV13 serotypes among child isolates <2 years of age decreased from 63% to 42% from 2010 to 2011. Little change has been observed among the other age groups.
- PCV13 serotypes 7F and 19A are most prevalent in all age groups representing 9% and 21% of isolates from children <2 years of age; 10% and 43% of 2-4 year olds; 31% and 18% of 5-14 year olds, 25% and 12% of 15-49 year olds; 14% and 17% of 50-64 year olds; and 12% and 13% of ≥65 year olds, respectively.
- Regionally, 7F is the most prevalent serotype in Central (18%) and Eastern (21%) Canada, whereas 19A is the predominant serotype in Western regions (16%).
- The PPV 23 vaccine targeted to adults covers 77% of the isolates reported in people 50-64 years of age and 66% of seniors aged ≥65 years and over.
- Elevated levels of non-PCV13 serotype 22F has been observed in children aged <2 years (7%); children aged 2-4 (9%), adults aged 15-49 (7%), adults aged 50-64 (6%) and seniors aged ≥ 65 (9%).
- 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. Of the 1,241 isolates included in the study, 27% were resistant to ciprofloxacin, 22% to clarithromycin, 13% to penicillin, 10% to doxycycline, 8% to clindamycin, 6% trimethoprim/sulfamethoxazole, 1.5% to ceftriaxone, 0.3% to moxifloxacin, and 0% to vancomycin.
- Multi-drug resistance (3 or more classes of antimicrobials) was observed in 7% of the isolates tested with the highest rates seen in serotypes 9V (25%), 15A (20%), 4 (13%) and 19A (12%).
- The most prevalent *emm* types of *S. pyogenes* (Group A *Streptococcus*) in 2011 were *emm*1 (27%), *emm*3 (12%) and *emm*89 (9%).

Introduction

As of April 1, 2010, the National Microbiology Laboratory (NML), Winnipeg began offering surveillance, reference diagnostics, research activities and outbreak support on invasive *Streptococcus pneumoniae* and *Streptococcus pyogenes* (Group A *Streptococcus*). The Streptococcus and Sexually Transmitted Infections 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* and *emm* types of *S. pyogenes* isolated from sterile sites that are forwarded from Canadian provincial and territorial public health laboratories, regional health units and reference centres to the NML. Data presented in this report are of a preliminary nature and include aggregated counts of isolates received from all sources and reported by NML. To broaden the representativeness of the data presented, the aggregated counts also include data submitted by organizations that perform their own serotyping such as the Laboratorie de santé publique du Québec (LSPQ) and Toronto Invasive Bacterial Disease Network (TIBDN), Mt. Sinai Hospital.

Invasive pneumococcal infection is a common invasive bacterial disease causing bacterial meningitis and bacteraemia [1,2] with children being at greatest risk for infection [3,4]. Of the 92 distinct pneumococcal serotypes currently recognized, the majority of disease worldwide is caused by only a few serotypes.

The **PCV7** vaccine was introduced in all provincial and territorial vaccination programs by 2005 [10], which has led to dramatic a decrease in invasive disease caused by the constituent serotypes [5, 6, 7, 8, 10]. Since the introduction of vaccination programs, serotype replacement has been observed among pneumococcal infections with an increase in non-PCV7 serotype infections [5, 8]. The **PCV13** vaccine was recommended for use in Canada in 2010 [9] and introduced in British Columbia in June; Alberta, Saskatchewan, Manitoba, New Brunswick, Nova Scotia and Yukon Territories in July; Ontario in August; Prince Edward Island, Newfoundland and Labrador, Northwest Territories and Nunavut in September; and in Quebec in December. Immunization schedules vary by jurisdiction, however National Advisory Committee on Immunization (NACI) recommendations have been published [9]. Surveillance of the distribution of *S. pneumoniae* serotypes is important to inform vaccine composition and monitor for possible serotype replacement. The **PPV23** vaccine is available for adults; however it is not effective in children due to a poor T-cell-independent antibody response in immature immune systems [11].

Invasive *S. pyogenes* (Group A *Streptococcus*) 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 [12]. Surveillance of strains is important to monitor increasing virulence patterns associated with this organism [13, 14]. The M protein, encoded by the *emm* gene, is an important virulence factor and an epidemiological marker used to characterize *S. pyogenes* isolates.

Methods

S. pneumoniae and S. pyogenes strains were submitted to the NML from provincial and territorial public health laboratories for surveillance or reference purposes. Additional data was submitted by jurisdictions performing serotyping which included 453 IPD characterized by LSPQ and 419 strains from TIBDN.

Data submitted with bacterial isolates included patient age, gender, clinical source and date of collection. Multiple isolates collected from the same patient from different clinical sites within 14 days were 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 into <2 year, 2-14 year, 15-49 year, 50-64 year and ≥65 year age groups; and regionally into Western (British Columbia, 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.

All IPD isolates were screened by bile solubility and optochin (Oxoid) analyses and iGAS isolates were confirmed using PYR (pyrolidonyl arylamidase) reaction and susceptibility to bacitracin (Oxoid) and trimethoprim/sulfamethoxazole susceptibility discs (BBL; 1.25/23.75 µg/ml) [15]. Sterile clinical isolation sites include blood, cerebrospinal fluid or other nervous tissue (CSF), pleural fluid, peritoneal fluid, pericardial fluid, joint fluid, internal body sites and muscle including surgical or biopsy samples and aspirates, and any site if a case of toxic shock syndrome or necrotizing fasciitis [16, 17].

Serotyping of IPD at NML is performed by observing the Quellung reaction using pool, group, type and factor commercial antisera from SSI Diagnostica; Statens Serum Institute, Copenhagen, Denmark [18, 19]. Isolates for which a Quellung reaction is not observed are confirmed by *rpoB* gene sequencing [20, 21] as well as PCR typing as outlined at: http://www.cdc.gov/ncidod/biotech/strep/pcr.htm .

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 (*Streptococcus pneumoniae* Serotyping and Antimicrobial Susceptibility: Assessment for Vaccine Efficacy in Canada After the Introduction of PCV-13). All sterile-site isolates from any age group causing invasive pneumococcal disease submitted by the 8 participating provinces 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 [22]. MIC interpretive standards were defined according to CLSI breakpoints (M100-S21, 2011) for all antibiotics except ciprofloxacin and doxycycline for which EUCAST interpretative breakpoints were used [23]. AST results for each isolate tested are posted on CNPHI at www.cnphi-rcrsp.ca and are summarized in the following Table 3 and Figure 23. This is a preliminary analysis of the SAVE data, more complete AST analysis by CARA will be posted at www.can-r.ca as it becomes available.

Multidrug resistance was determined by classifying the antimicrobials as per CLSI into the following classes: penicillins (PEN, amoxicillin/clavulanic acid and penicillin using meninigitis breakpoints); cephems (CEP, ceftriaxone using meningitis breakpoints, cefuroxime using parenteral breakpoint); carbapenems (CAR, ertapenem, imipenem and meropenem); macrolides (MAC, clarithromycin); fluoroquinolones (FQN, ciprofloxacin, levofloxacin and moxifloxacin); tetracyclines (TET, doxycycline); folate pathway inhibitors (SXT, trimethoprim-sulflamethoxazole); phenicols (CHL, chloramphenicol); lincosamides (CLI, clindamycin); and oxazolidinones (LZD, linezolid).

The *emm* and T serotypes 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/ncidod/biotech/strep/M-ProteinGene_typing.htm. The *emm* sequences obtained are compared with the CDC (Atlanta) data bank (www.cdc.gov/ncidod/biotech/strep/strepblast.htm) and results reported to the type level, not the subtype level (*emm*4.4 is reported as *emm*4). T-typing was performed using commercial *Streptococcus* agglutination Anti-T Typing Sera purchased from TransEurope Chemicals, Czech Republic.

Table 1. Number of invasive *S. pneumoniae* isolates by age group and jurisdiction, January 1 to December 31, 2011

Province / Territory	<2 yrs	2 - 4 yrs	5-14 yrs	15-49 yrs	50-64 yrs	>65 yrs	Not Available	Total
British Columbia	16	13	20	73	90	106	-	**318**
Saskatchewan	16	6	4	36	18	49	-	**129**
Manitoba	12	7	5	33	33	36	7	**133**
Ontario	47	59	52	239	313	424	13	**1147**
Quebec	65	42	28	89	80	156	-	**460**
New Brunswick	4	-	5	20	22	31	-	**82**
Nova Scotia	2	6	7	9	21	11	-	**56**
Prince Edward Island	-	-	-	6	3	3	-	**12**
Newfoundland and Labrador	-	-	1	1	6	7	6	**21**
Yukon Territories	-	-	-	1	3	2	-	**6**
Northwest Territories	1	-	-	3	3	1	-	**8**
Canada	**163**	**133**	**122**	**510**	**592**	**826**	**26**	**2372**

Figure 1. Clinical isolation sites of *S. pneumoniae*

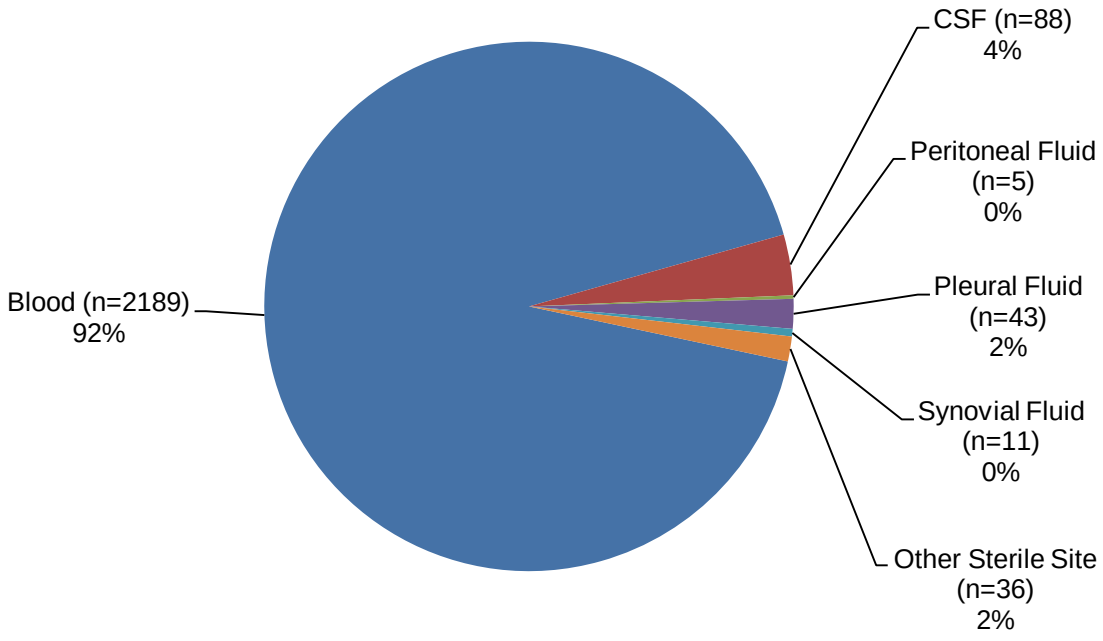
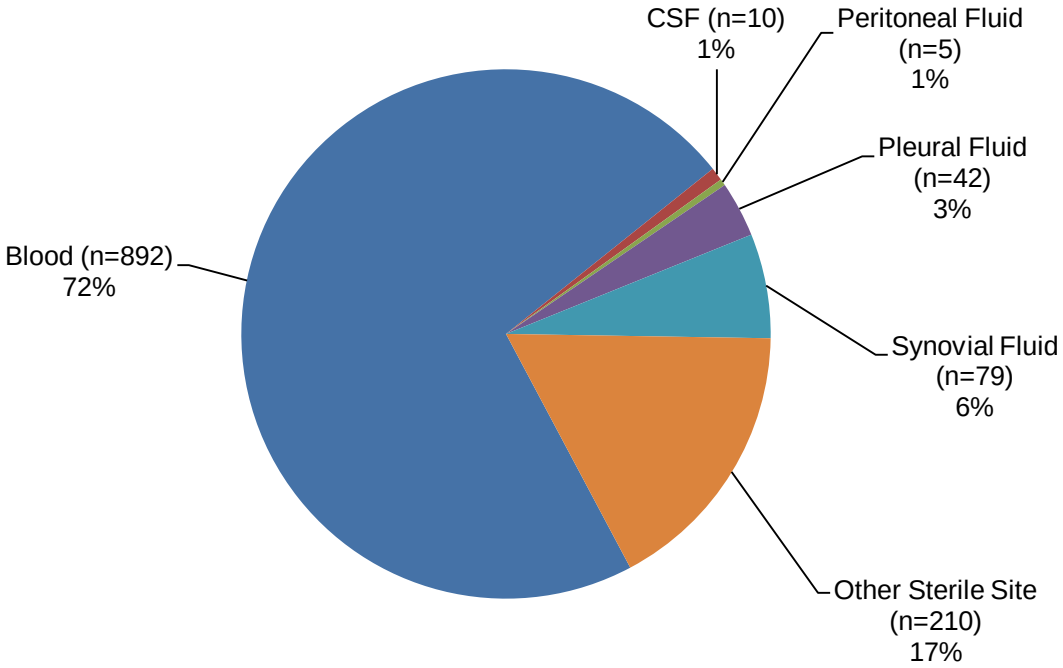


Table 2. Number of invasive *S. pyogenes* isolates by age group and jurisdiction, January 1 to December 31, 2011

Province / Territory	<2 yrs	2 - 4 yrs	5-14 yrs	15-49 yrs	50-64 yrs	>65 yrs	Not Available	Total
British Columbia	4	4	17	53	41	42	-	**161**
Saskatchewan	1	2	5	34	18	9	-	**69**
Manitoba	5	7	11	34	19	26	9	**111**
Ontario	15	17	31	203	114	190	24	**594**
Quebec	10	17	24	103	47	52	9	**262**
New Brunswick	1	1	1	9	6	7	-	**25**
Nova Scotia	1	-	-	-	-	2	-	**3**
Prince Edward Island	-	-	1	2	1	3	-	**7**
Newfoundland and Labrador	-	-	1	1	-	3	1	**6**
Canada	**37**	**48**	**91**	**439**	**246**	**334**	**43**	**1238**

Figure 2. Clinical isolation sites of *S. pyogenes*



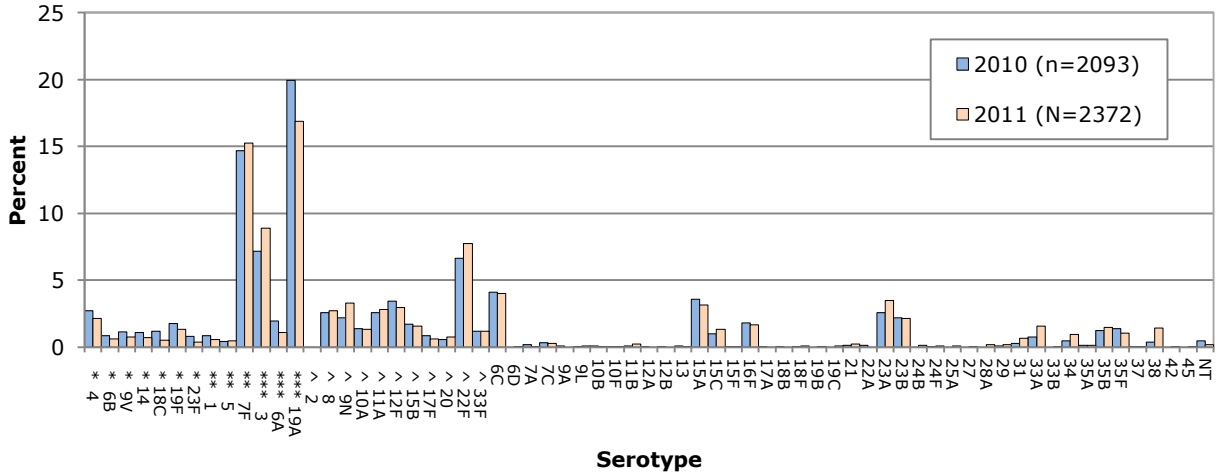
Results and Discussion

Streptococcus pneumoniae

Of the 2,372 IPD isolates reported, **patient age** was provided for 98% (n=2,346) of which 7% (n=163) were isolated from children <2 years of age, 6% (n=133) from children aged 2 to 4, 5% (n=122) from children aged 5 to 14, 22% (n=510) from adults aged 15 to 49, 25% (n=592) from adults aged 50 to 64, and 35% (n=826) from seniors aged ≥65 years (Table 1). **Blood** was the most frequent **clinical isolation site** accounting for 92% (n=2189) of all isolates. Of the 2322 isolates with **gender** information specified, 53% were from male patients.

The most predominant serotypes in 2011 included 19A, 7F, 3, 22F and 6C, together accounting for 53% (n=1254) of IPD in Canada. Serotype 19A, a constituent of the PCV13 vaccine, continues to be the most predominant serotype among isolates from the <2, 2-4, 50-64 and ≥65 year olds, whereas 7F continues to be predominant in the 5-14 and 15-49 year old age groups. Serotype 19A has decreased in children <2 years of age to 23% (38/163) of the isolates, down from 41% (75/183) in 2010. No appreciable decreases have been observed in the other age groups where levels are relatively consistent in 2011 at 44% (58/133) in the 2 to 4, 18% (22/122) in the 5 to 14, 12% (62/510) in the 15 to 49, 17% (102/592) in 50-64 and 14% (117/826) in ≥65 year olds. The relative proportion of serotype 7F has increased in the 5-14 year old age group from 20% (15/74) of the strains in 2010 to 30% (36/122) in 2011, and in the 15 to 49 year old age group, 7F has remained at 23% (118/510).

Figure 3. Proportion of *S. pneumoniae* serotypes in Canada, 2010-2011



*Component of PCV7 vaccine, ** additional component of the PHiD10 vaccine, *** additional components of the PCV13 vaccine, ^ additional components of the PPV23 vaccine.

Figure 4. Proportion of *S. pneumoniae* serotypes in children <2 years of age

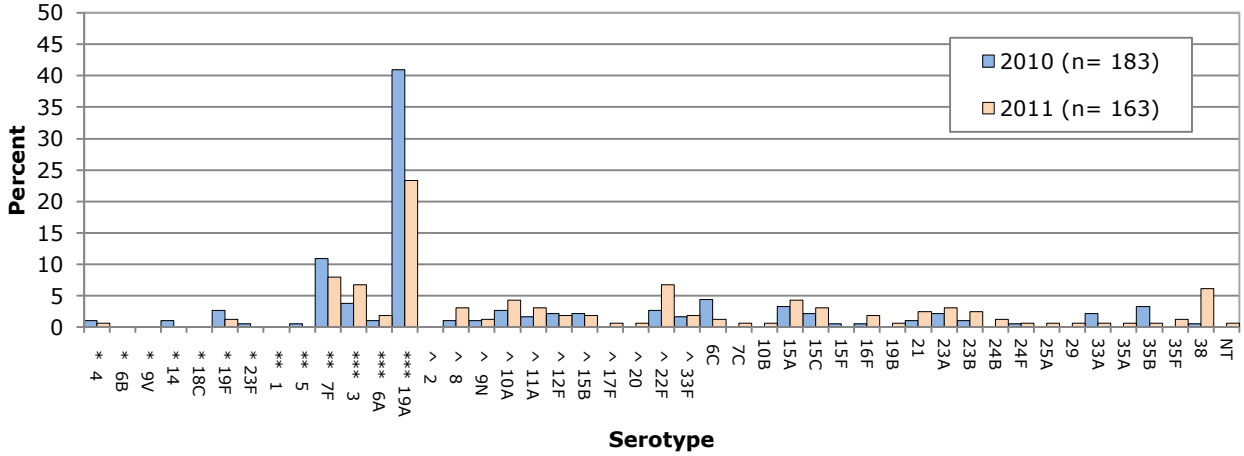


Figure 5. Proportion of *S. pneumoniae* serotypes in children 2 - 4 years of age

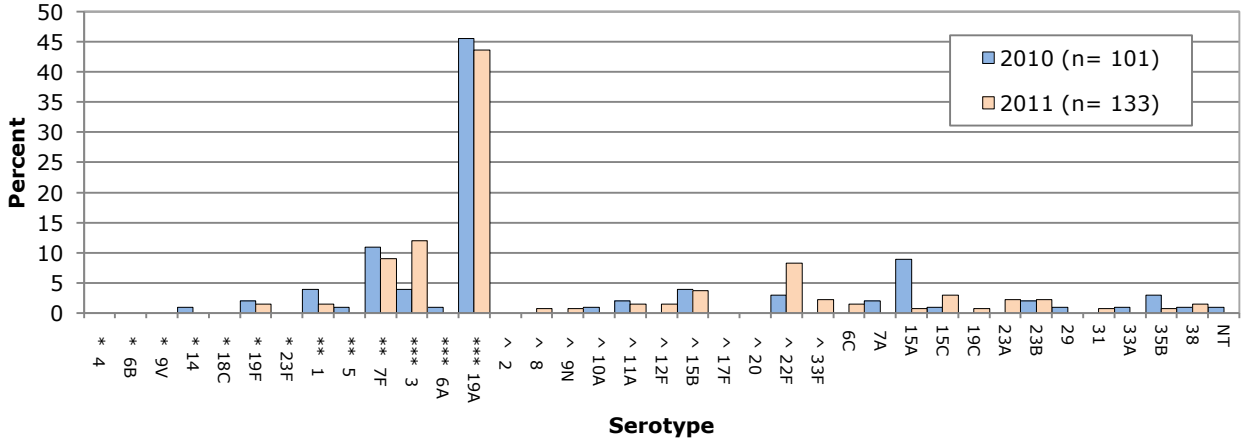


Figure 6. Proportion of *S. pneumoniae* serotypes in children 5 - 14 years of age

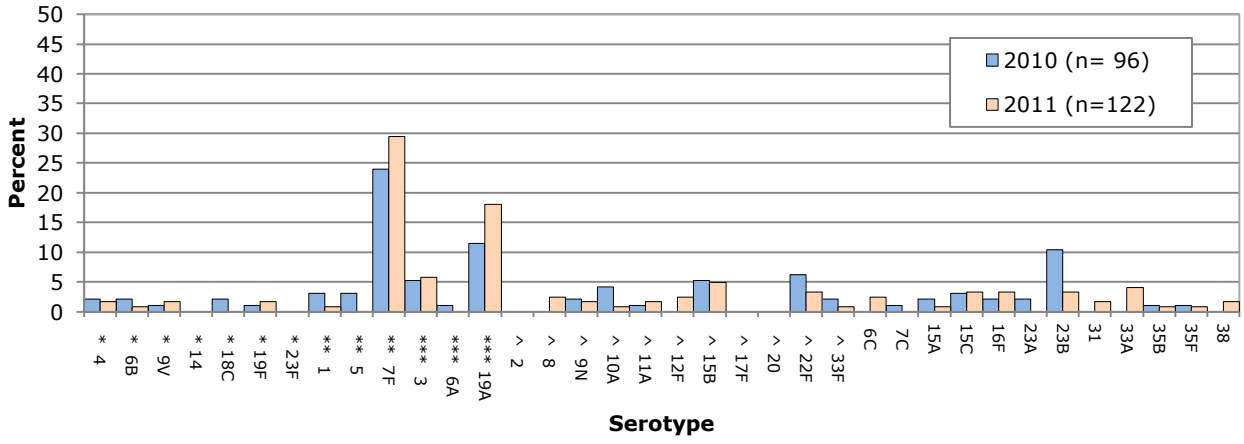


Figure 7. Proportion of *S. pneumoniae* serotypes in adults 15 - 49 years of age

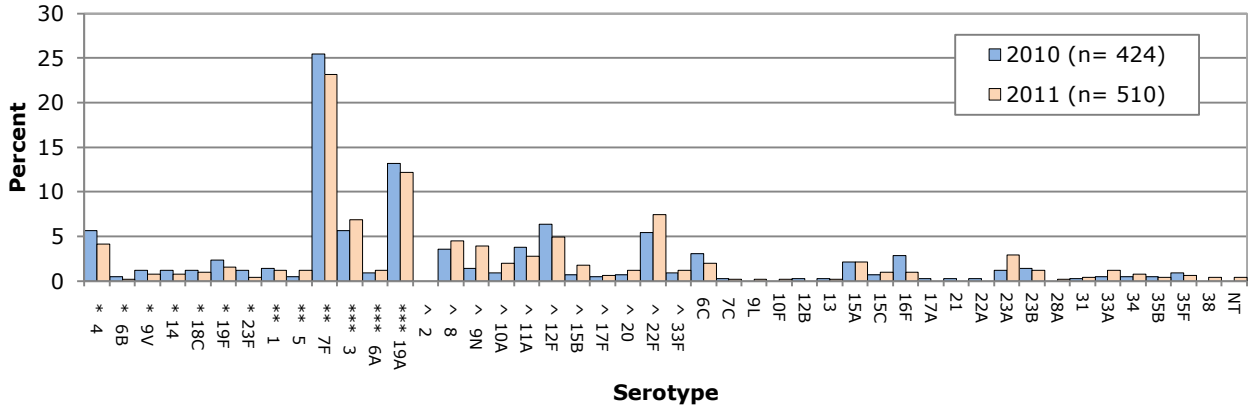


Figure 8. Proportion of *S. pneumoniae* serotypes in adults 50 - 64 years of age

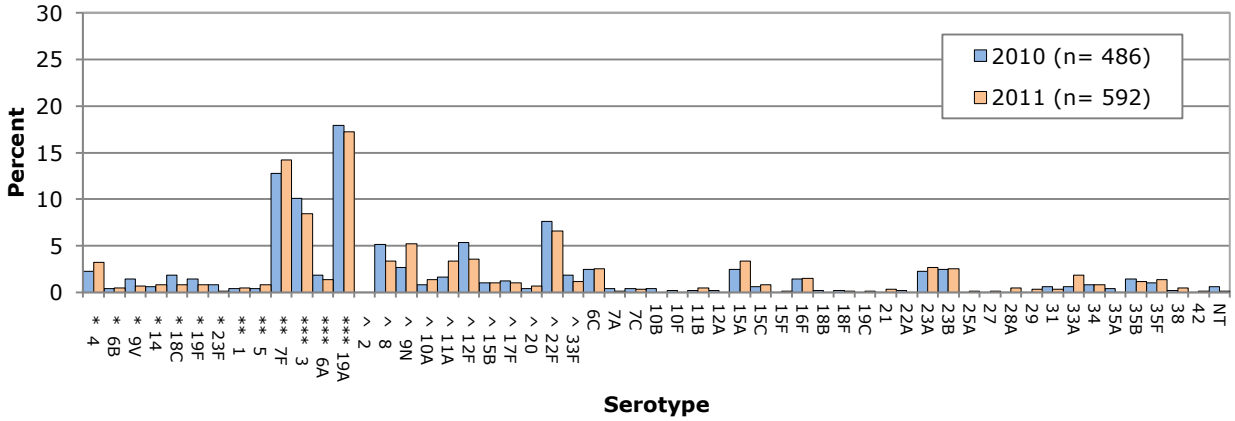
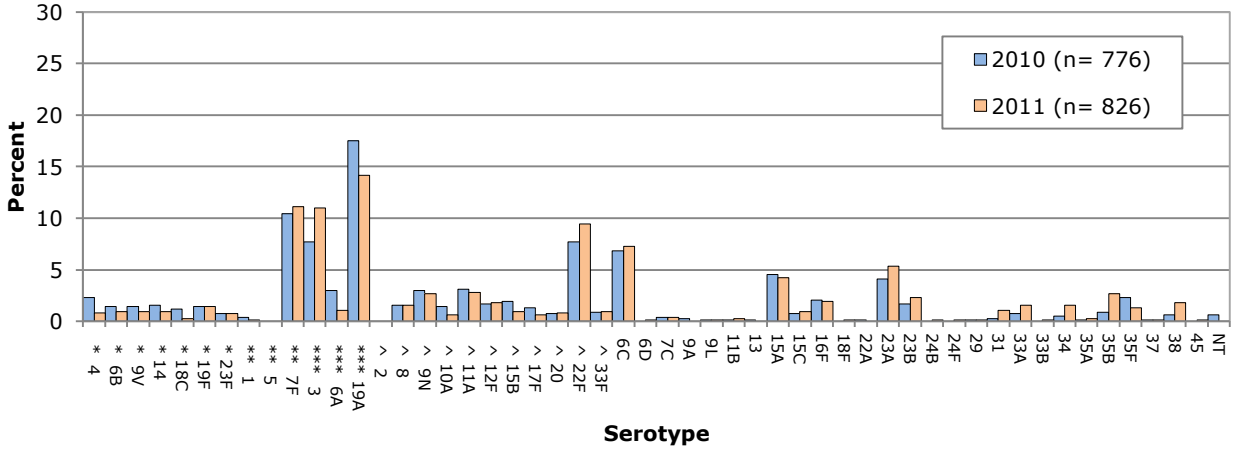


Figure 9. Proportion of *S. pneumoniae* serotypes in seniors ≥65 years of age



Regional Distribution of *Streptococcus pneumoniae* Serotypes

Of the PCV7 serotypes, only serotype 4 is of note being highest in Eastern Canada with 5% (8/171). PCV13 serotype 7F was the most prevalent serotype Eastern (21%; 35/171) regions, whereas PCV13 serotype 19A was most prevalent in the West (16%; 96/594). In Central Canada, levels of serotypes 7F and 19A were relatively equivalent at 16% (263/1607) and 17% (278/1607), respectively. Other serotypes of note include 3 and 22F representing about 8% of the isolates in all regions and 11A was elevated in Western regions with 6% (n=19/594).

In the <2 year old age group (Figure 4) serotype 19A was the most predominant serotype in all regions, representing 33% (n=2/6) of Eastern, 26% (n=29/112) of Central and 15% (n=7/45) of Western isolates.

Serotype 19A was also the most prevalent serotype in the 2–4 year old age group 19A in all regions with 50% (n=3/6), 45% (n=45/101) and 39% (n=10/26) of East, Central and Western isolates.

In the 5 – 14 year old age group, serotype 7F was the most predominant serotype in all regions representing 35% (n=10/29) of the isolates in Western, 28% (n=22/80) of Central and 31% (n=4/13) of Eastern Canada. Relatively high levels of 23B and 33A have also been observed in the East with each at 15% (n=2/13).

Serotype 7F was also most predominant in the 15-49 year old age group in Central (25%, 83/328) and Eastern (42%, 15/36) regions. Levels of 19A were relatively low in all areas ranging from 10% (34/328) in Central areas to 15% (23/146) in the West.

Serotype 7F was predominant in the 50-64 year old age group in Central Canada (17%, 67/393) whereas 19A was predominant in Western (20%, 30/147) and Eastern (21%, 11/52) regions. In the East, a relatively high proportion of serotype 11A was seen in this age group with 12% (6/52).

In the ≥65 year old age group, serotype 7F was most predominant in Eastern Canada (19%, 10/52) and 19A was most predominant in Central (16%, 94/580) and Western (9%, 18/194).

Other serotypes of note include:

Serotype 22F was prevalent in a number of age groups and regions including <2 year olds in Central Canada (9%, 10/111); the 2-4 year old age group in the West (12%, 3/26); and in the ≥65 year old age group representing about 10% of the isolates from this age group in each region. Serotype 8 was also prevalent in 15-49 year olds in Eastern Canada (14%, 5/36) and in 5-14 year olds in Western regions (10%, 3/29).

Figure 10. Regional distribution of *S. pneumoniae* serotypes

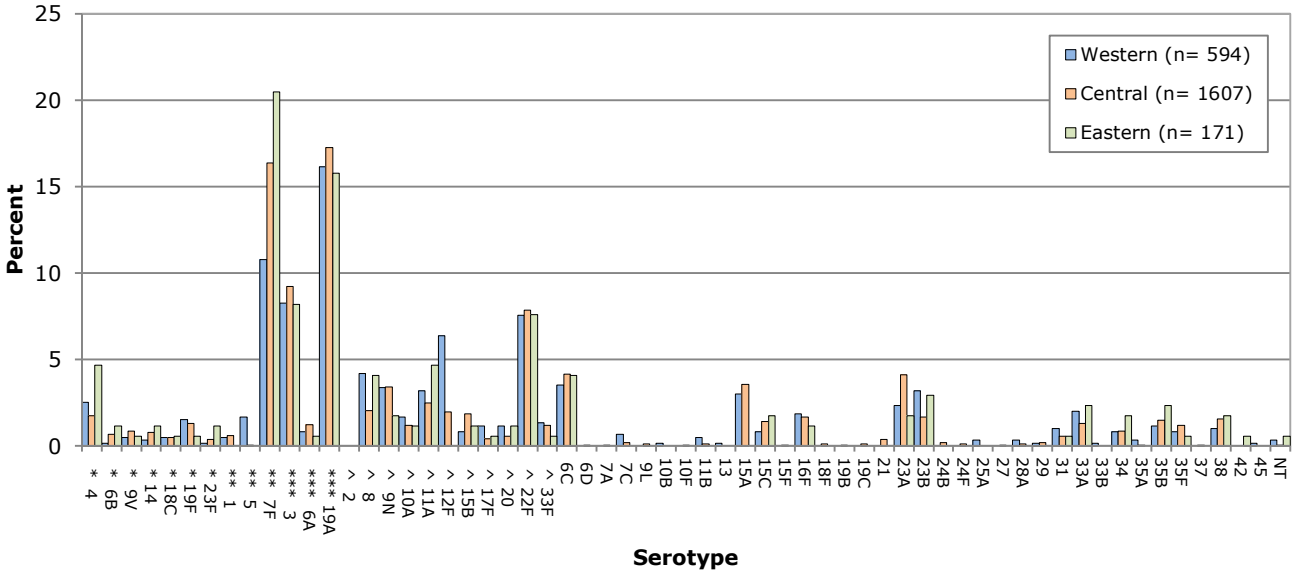


Figure 11. Regional distribution of *S. pneumoniae* serotypes in children <2 years of age

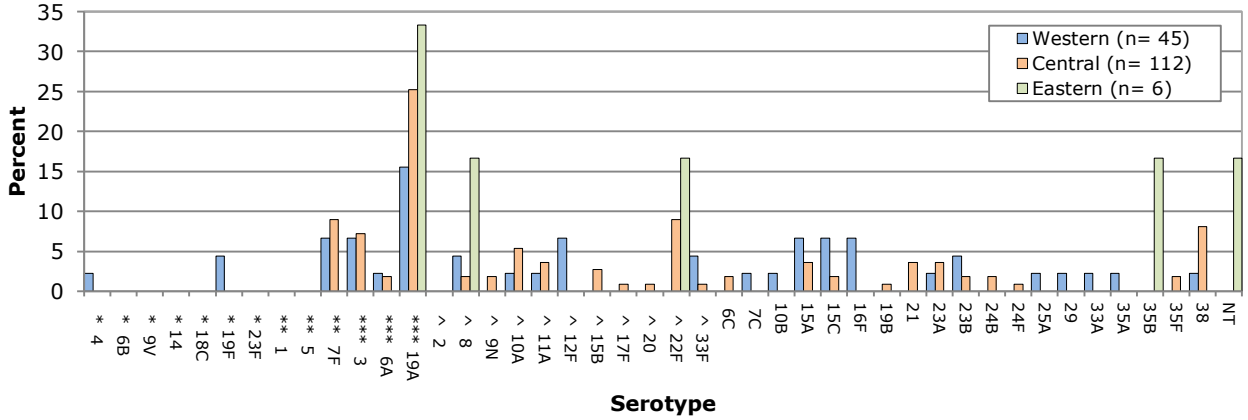


Figure 12. Regional distribution of *S. pneumoniae* serotypes in children 2 - 4 years of age

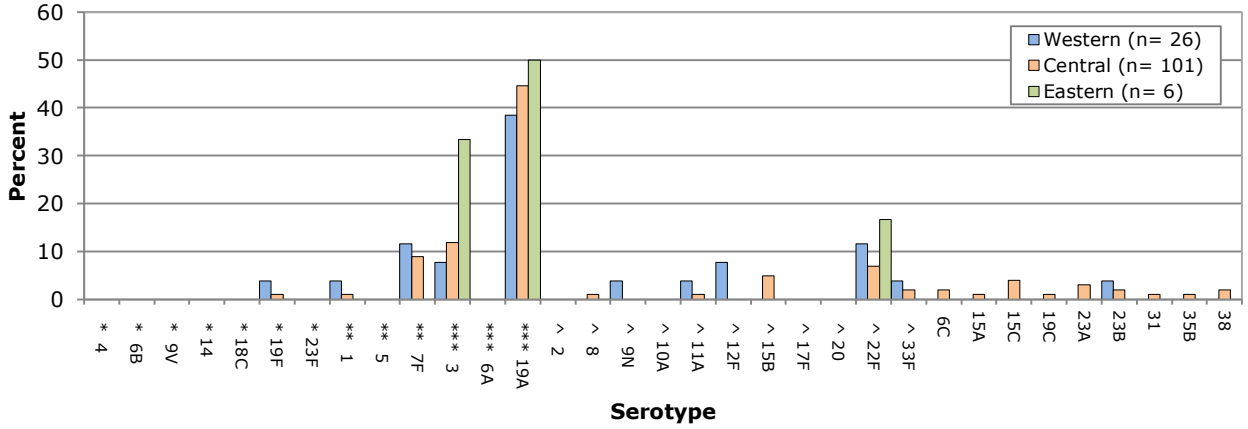


Figure 13. Regional distribution of *S. pneumoniae* serotypes in children 5 - 14 years of age

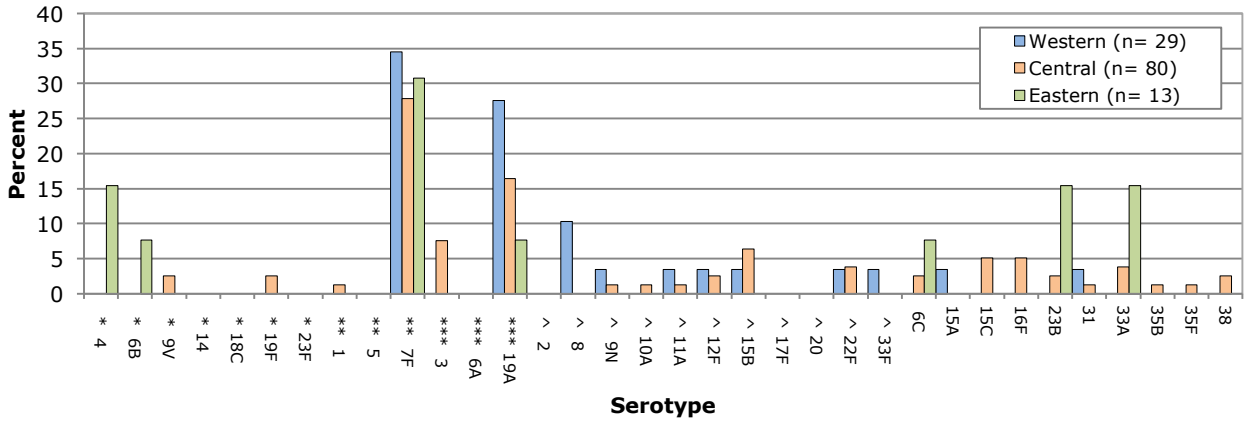


Figure 14. Regional distribution of *S. pneumoniae* serotypes in adults 15 - 49 years of age

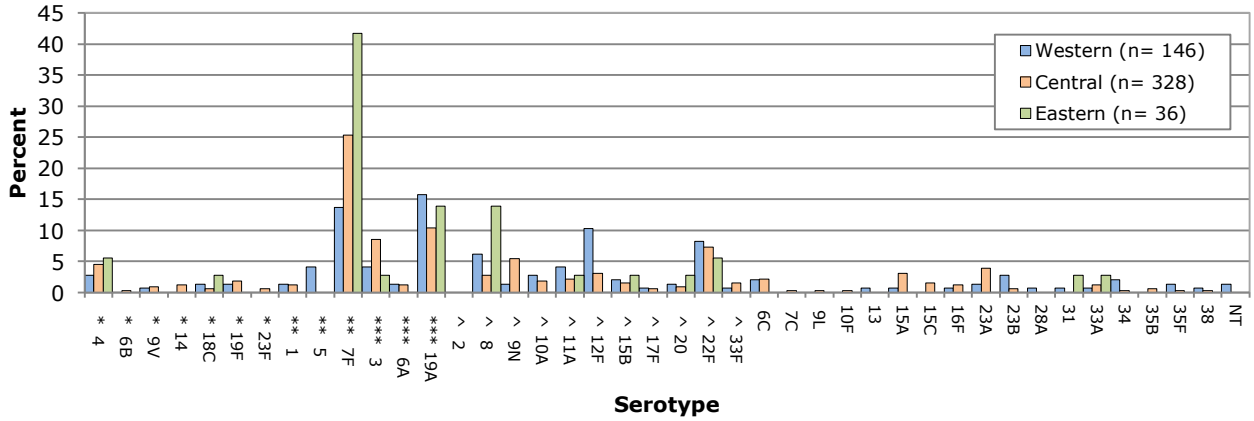


Figure 15. Regional distribution of *S. pneumoniae* serotypes in adults 50 - 64 years of age

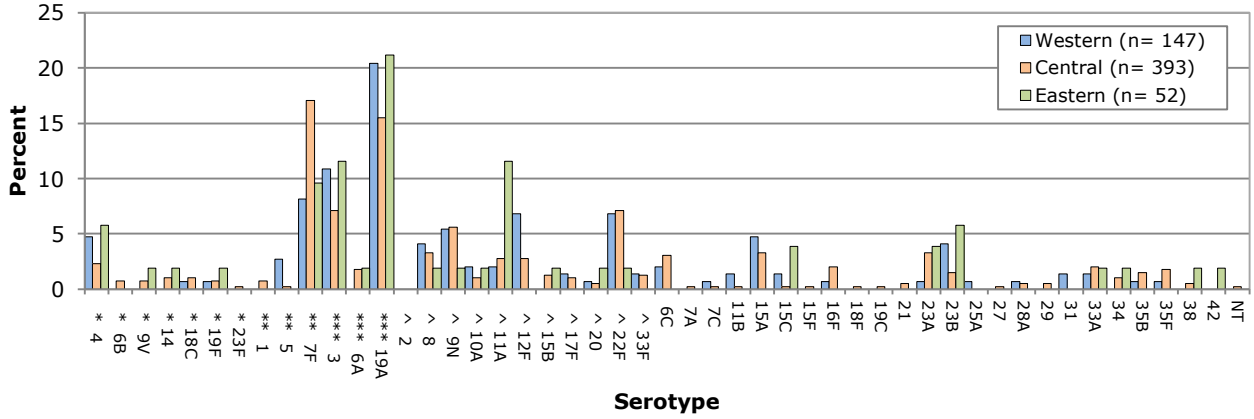
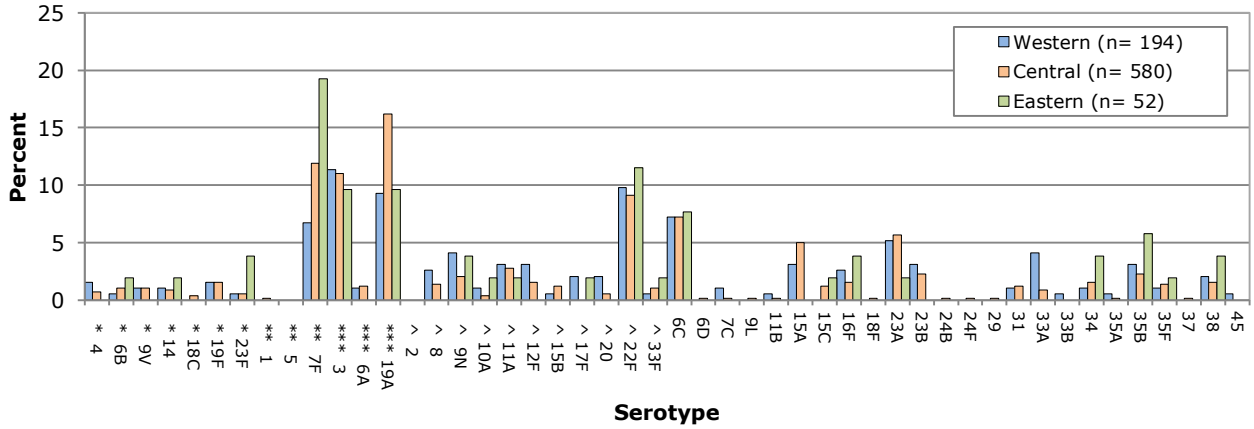


Figure 16. Regional distribution of *S. pneumoniae* serotypes in seniors ≥65 years of age



Coverage of Serotypes by Vaccines

Since the introduction of the **PCV7** vaccine (serotypes 4, 6B, 9V 14, 18C 19F, 23F) in 2005, the proportion of these serotypes circulating in Canada **among children continues to be low** representing 2% of the isolates from the <2 (3/162) and the 2-4 (2/133) year old age groups during 2011. The PCV13 vaccine was implemented across Canada in 2010 and consists of all the PCV7 serotypes plus serotype 1, 3, 5, 6A, 7F and 19A. The proportion of **PCV13** serotypes among child isolates **<2 years** of age **decreased** from 63% (115/183) in 2010 to 42% (68/163) in 2011. Proportions of PCV13 serotypes in other age groups remained relatively unchanged from 2010 to 2011.

The PPV 23 vaccine serotypes in Canada account for 85% (432/510) of the pneumococcal infections in adults aged 15-49 years, 77% (456/592) of the 50-64 year old age group and 66% (545/826) of those in seniors aged ≥65 years.

Figure 17. Proportion of PCV7 serotypes by age group in Canada

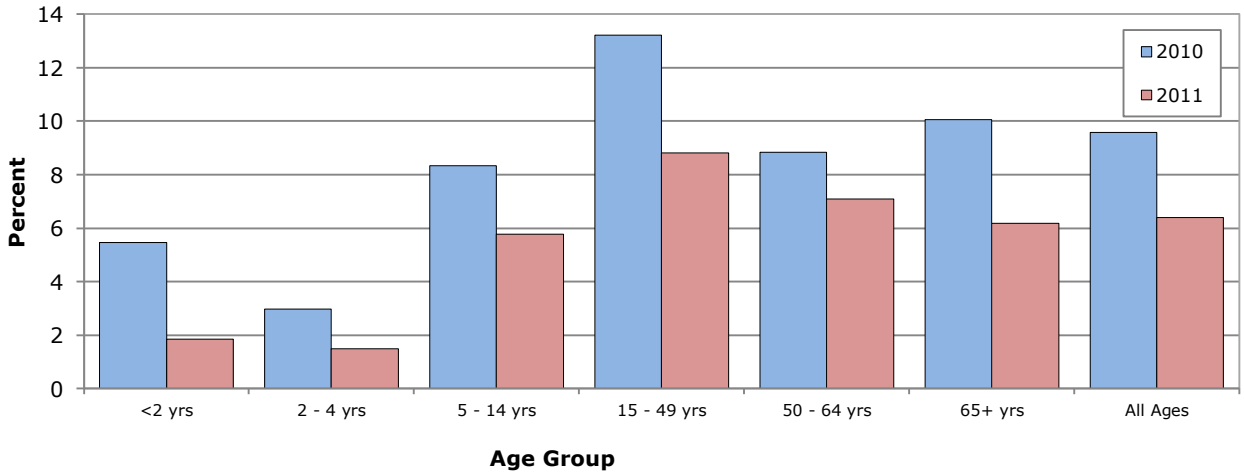


Figure 18. Proportion of PCV13 serotypes by age group in Canada

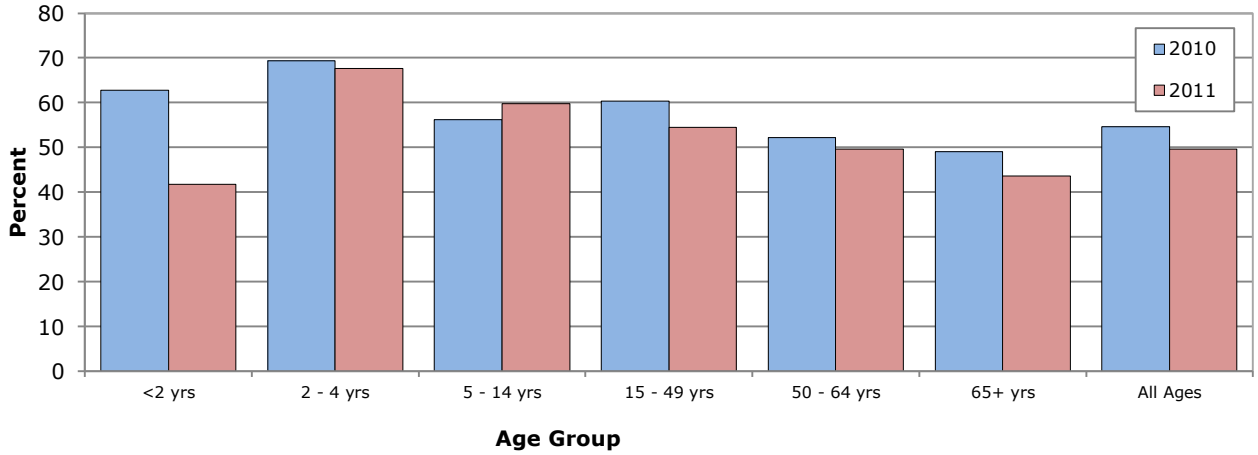


Figure 19. Proportion of PCV13 serotypes by age group in Western Canada

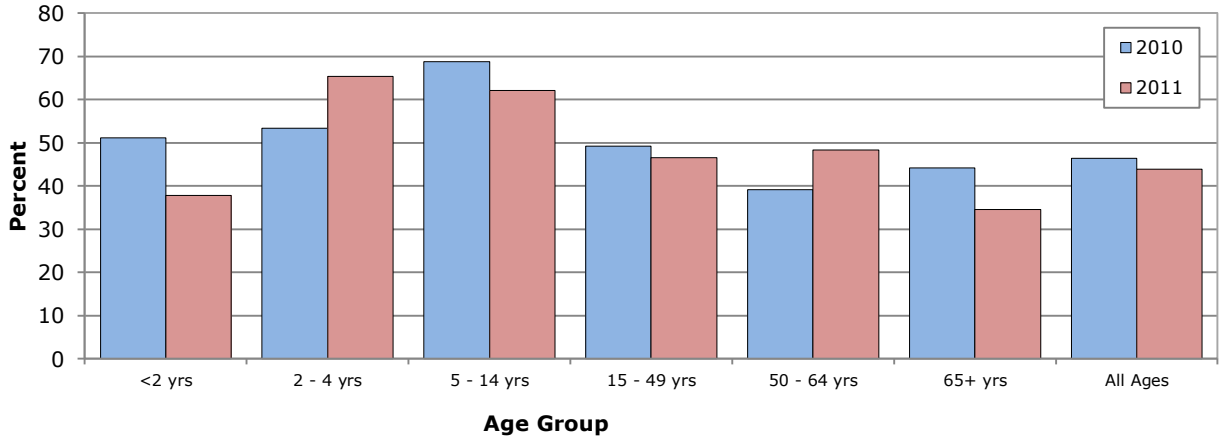


Figure 20. Proportion of PCV13 serotypes by age group in Central Canada

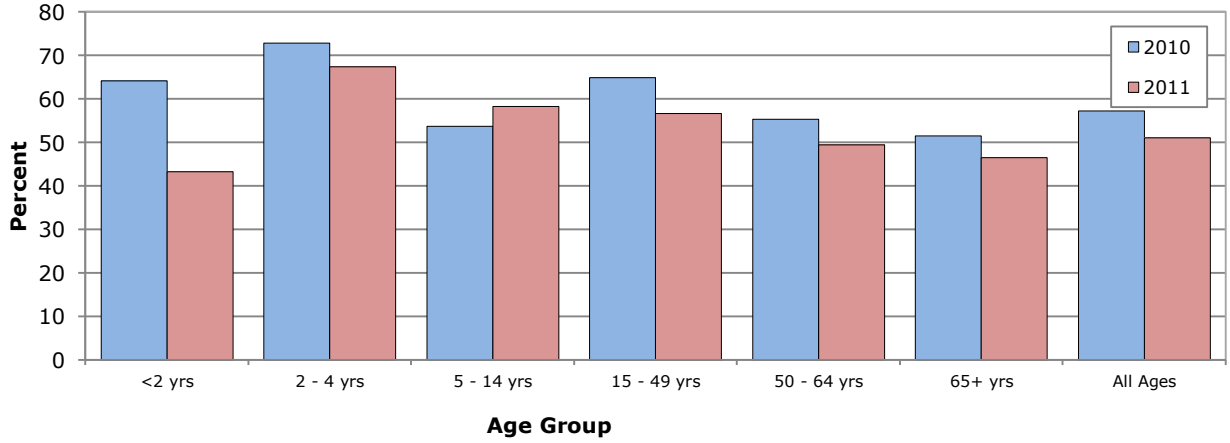


Figure 21. Proportion of PCV13 serotypes by age group in Eastern Canada

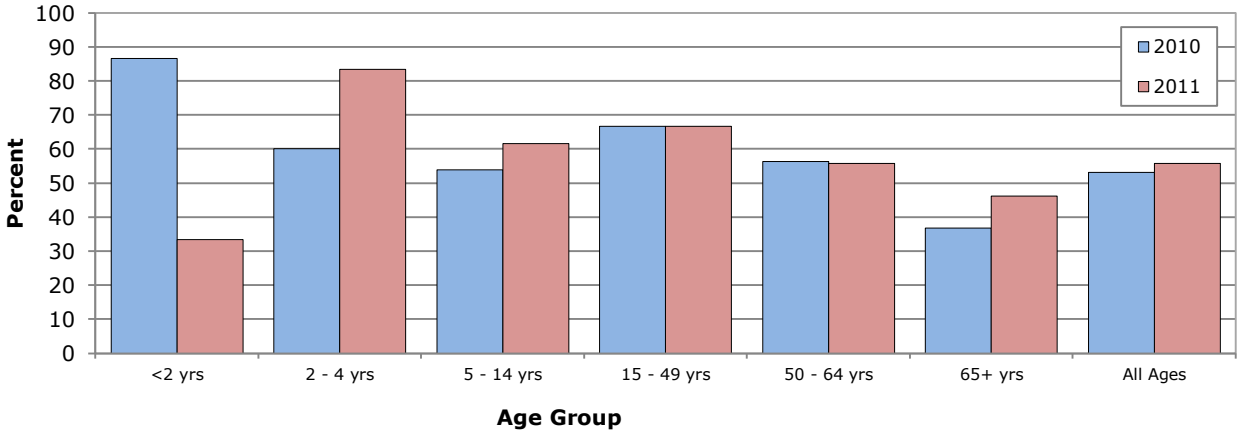
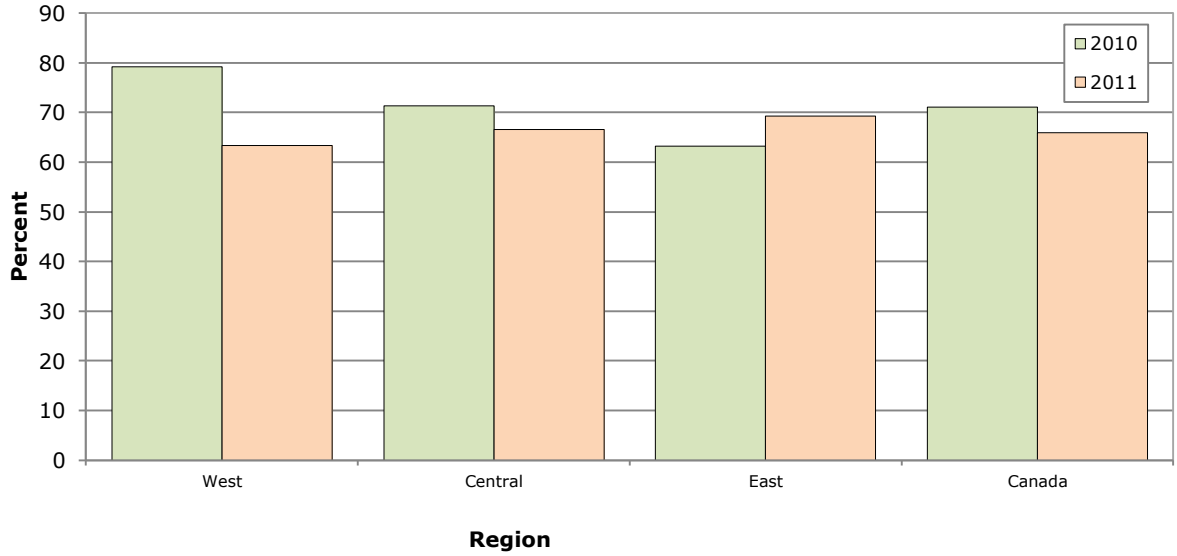


Figure 22. Regional distribution of PPV23 serotypes in seniors ≥65 years of age



Antimicrobial Resistance

Of the 1,241 *S. pneumoniae* isolates tested, the high rates of resistance to ciprofloxacin (27%, n=334) and clarithromycin (22%, n=271) were observed. Lower rates were seen with penicillin using meningitis breakpoints (13%, n=161), doxycycline (10%, n=117), clindamycin (8%, n=102), and trimethoprim/sulfamethoxazole (5.5%, n=68), ceftriaxone using meningitis breakpoints (1.5%, n=18), and moxifloxacin (0.3%, n=3). No resistance to daptomycin, linezolid, penicillin with non-meningitis breakpoints, tigecycline, doripenem or vancomycin was found.

Ciprofloxacin resistance was most evident in serotypes 11A, 15A, 15B, 15C, 19A and 20; with rates of resistance ranging from 52% of the 19A isolates to 73% of serotype 20 isolates (Table 4). High levels of clarithromycin resistance were observed in serotypes 6A, 14, 15A, 19A, 33A and 33F; and relatively high rates of penicillin resistance (meningitis) was seen among serotype 15A, 35B, 19A, 23A and 23B. Other notable serotype-specific resistances include cefuroxime resistance in serotypes 9V and 35B, clindamycin in 15A, doxycycline in 19A and trimethoprim/sulfamethoxazole in serotype 11A.

Resistance to 3 or more classes of antimicrobials was observed in 7% (n=132) of the *S. pneumoniae* tested, with highest rates seen with serotypes 9V (25%, n=5), 15A (20%, n=31), 4 (13%, n=5), and 19A (12%, n=56). The major resistance pattern with the 9V was at least PEN-CEP-SXT; for 15A PEN-MAC-CLI-TET-FQN; for serotype 4 MAC-TET-FQN and 19A PEN-CEP-MAC-CLI-TET-FQN-SXT. Resistance to all 8 classes of antimicrobials was seen in 23 isolates of serotype 19A (5%) and one 19F isolate (3%).

Table 3. Percentage of *S. pneumoniae* serotypes resistant to antimicrobials, 2011

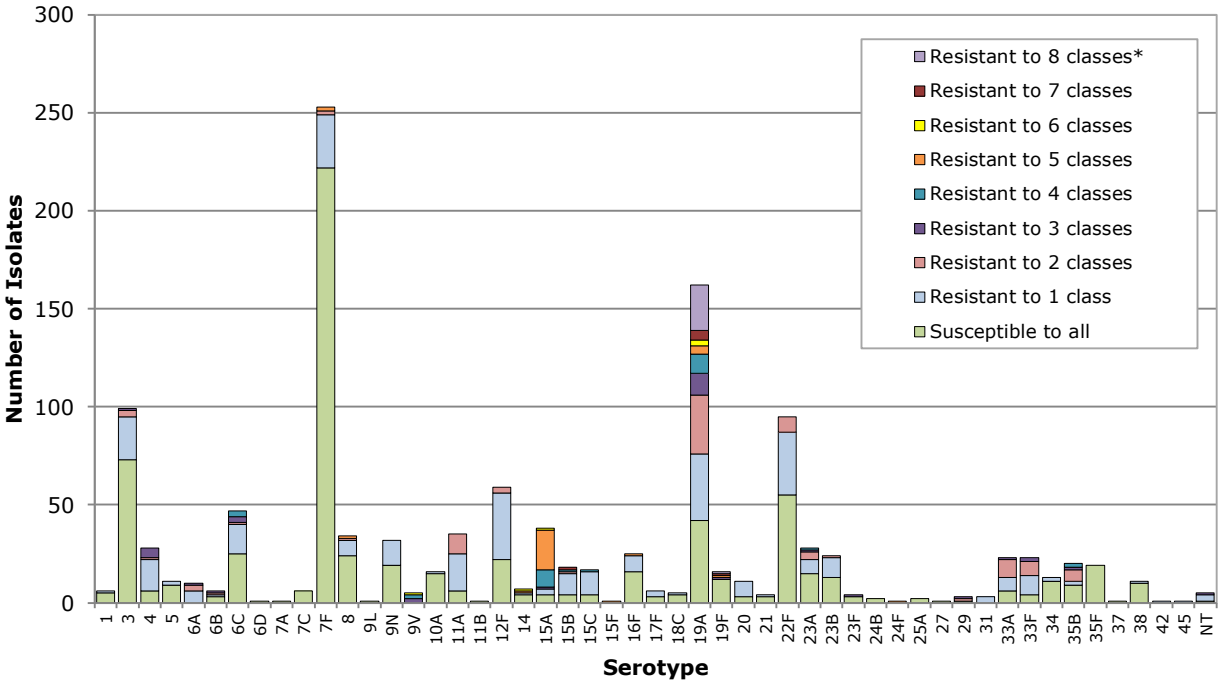
Class	Penicillins			Fluoroquinolones			Cephems				Carbapenems			Other				
Serotype	AUG[1]	PENm	PENo	CIP	LEV	MOX	AXOm	AXOnm	FURo	FURp	ETP	IMI	MER	CLA	CLI	CHL	DOX	SXT
1 (n=6)	-[2]	-	-	16.7[3]	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3 (n=99)	-	-	-	19.2	-	-	-	-	-	-	-	-	-	3.1	1.1	8.1	6.1	2.1
4 (n=28)	-	3.6	-	75	-	-	-	-	-	-	-	-	-	14.3	-	-	21.5	3.6
5 (n=11)	-	-	-	18.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6A (n=10)	-	40.0	-	20.0	-	-	-	-	-	-	-	-	-	60.0	10.0	-	10.0	10.0
6B (n=6)	-	33.4	-	33.4	-	-	-	-	-	-	-	-	-	33.4	-	-	-	-
6C (n=47)	-	14.9	2.2	23.5	-	-	-	-	2.2	4.3	-	-	-	19.2	8.6	-	6.4	2.2
6D (n=1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7A (n=1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7C (n=6)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7F (n=253)	-	1.2	-	9.5	-	-	-	-	0.4	0.4	-	-	-	2.4	0.4	-	2.0	0.4
8 (n=34)	-	3.0	-	29.5	-	-	-	-	-	-	-	-	-	3.0	3.0	-	3.0	3.0
9L (n=1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9N (n=32)	-	-	-	40.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9V (n=5)	-	100	80.0	60.0	-	-	-	-	80.0	80.0	-	-	-	40.0	-	-	20.0	100
10A (n=16)	-	-	-	-	-	-	-	-	-	-	-	-	-	6.3	-	-	-	-
11A (n=35)	-	-	-	57.2	-	-	-	-	-	-	-	-	-	25.8	2.9	-	-	20.0
11B (n=1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12F (n=59)	-	-	-	5.1	-	-	-	-	-	-	-	-	-	61.1	1.7	1.7	-	-
14 (n=7)	-	28.6	14.3	28.6	-	-	-	-	14.3	28.6	-	-	-	42.9	28.6	-	14.3	-
15A (n=38)	-	81.6	5.3	55.3	-	-	-	-	7.9	10.6	-	-	-	81.6	79.0	-	79.0	-
15B (n=18)	-	11.2	5.6	66.7	-	-	-	-	5.6	5.6	-	-	-	22.3	11.2	5.6	11.2	5.6
15C (n=17)	-	5.9	-	64.8	-	-	-	-	-	-	-	-	-	11.8	5.9	-	5.9	-
15F (n=1)	-	100	-	100	-	-	-	-	-	-	-	-	-	100	100	-	100	-
16F (n=25)	-	4.0	-	36.0	4.0	4.0	-	-	-	-	-	-	-	4.0	4.0	-	4.0	-
17F (n=6)	-	-	-	33.4	-	-	-	-	-	-	-	-	-	-	16.7	-	-	-
18C (n=5)	-	-	-	20.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19A (n=162)	15.5	38.3	21.0	51.9	1.3	-	9.9	1.9	21.7	22.3	0.7	8.7	16.7	51.3	26.0	0.7	29.1	25.4
19F (n=16)	12.5	18.8	12.5	18.8	-	-	12.5	-	12.5	12.5	-	12.5	12.5	25.0	25.0	-	18.8	12.5
20 (n=11)	-	-	-	72.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21 (n=4)	-	-	-	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22F (n=95)	-	1.1	-	26.4	1.1	1.1	-	-	-	-	-	-	-	22.2	1.1	-	-	-
23A (n=28)	-	35.8	-	7.2	-	-	-	-	-	-	-	-	-	10.8	3.6	-	17.9	3.6
23B (n=24)	-	37.5	-	12.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23F (n=4)	-	25.0	-	-	-	-	-	-	-	-	-	-	-	25.0	-	-	25.0	-
24B (n=2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24F (n=1)	-	100	-	100	-	-	-	-	-	-	-	-	-	100	100	-	100	-
25A (n=2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
27 (n=1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29 (n=3)	-	66.7	-	-	-	-	-	-	66.7	66.7	-	-	-	33.4	-	-	-	-
31 (n=3)	-	-	-	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
33A (n=23)	-	-	-	8.7	-	-	-	-	-	-	-	-	-	69.6	-	-	-	-
33F (n=23)	-	-	-	13.1	-	-	-	-	-	-	-	-	-	74.0	21.8	-	-	8.7
34 (n=13)	-	-	-	15.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35B (n=20)	-	45.0	35.0	15.0	5.0	5.0	-	-	45.0	45.0	-	-	5.0	10.0	-	-	-	5.0
35F (n=19)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
37 (n=1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38 (n=11)	-	-	-	9.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42 (n=1)	-	-	-	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45 (n=1)	-	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NT (n=5)	-	20.0	-	40.0	-	-	-	-	-	-	-	-	-	20.0	-	-	20.0	20.0
ALL (n=1241)	2.2	13	4.2	27	0.5	0.3	1.5	0.3	4.8	5.1	0.1	1.3	2.5	21.9	8.3	0.9	9.5	5.5

[1]AUG = amoxicillin/clavulanic acid; PENm = penicillin using the parenteral meningitis interpretive standard; PENo = penicillin using the oral penicillin V interpretive standard; CIP = ciprofloxacin; LEV = levofloxacin; MOX = moxifloxacin; AXOm = ceftriaxone using the parenteral meningitis interpretive standard; AXOnm = 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; CLI = clindamycin; CHL = chloramphenicol; DOX = doxycycline; SXT = trimethoprim/sulfamethoxazole. No resistance was observed for penicillin using the parenteral non-meningitis interpretive standard, daptomycin (no interpretative standard), linezolid, tigecycline (no interpretative standard), or vancomycin. EUCAST[23] interpretative breakpoints were used for CIP and DOX, all other according to CLISI[22].

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

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

Figure 23. Multi-drug resistance of *S. pneumoniae* serotypes in Canada, 2011



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

Streptococcus pyogenes (Group A *Streptococcus*)

Of the 1238 *Streptococcus pyogenes* isolates tested at the NML by *emm* typing and T serotyping no differences was observed in the relative proportions of clinical isolation sites between adults and children and 54% of the isolates were collected from male patients.

The most prevalent *emm* type in Canada during 2011 continues to be *emm*1 accounting for 29% of child, 24% of adult and 30% of senior strains. *Emm*3 is next most prevalent in children (16%) and seniors (13%), followed by *emm*12 in both age groups (10% and 12%, respectively). In the adult age group, *emm*89 ranks 2nd most prevalent (13%) and *emm*3 ranks 3rd (9%).

Among blood isolates *emm*1 accounted for 27% (242/892) of the isolations, followed by *emm*3 with 14% (n=120). The predominant types isolated from synovial fluid was *emm*1 (19%, 15/79) and *emm*89 (14%, n=11). Isolates from other clinical sites (mainly deep tissue and necrotizing fasciitis specimens) were largely represented by *emm*1 (27%, 73/267) and *emm*89 (8%, n=21) and *emm*83 (13%).

Figure 24. Regional Distribution of *S. pyogenes* *emm* Types

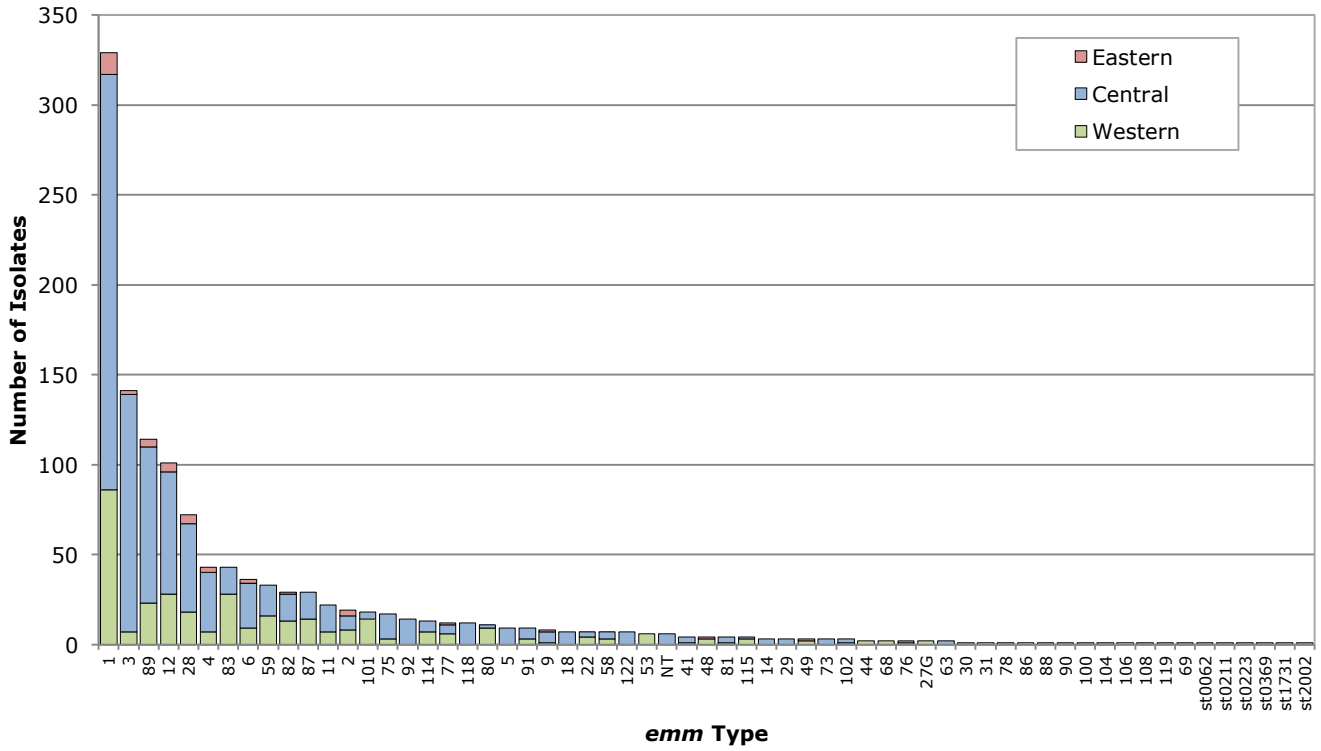


Figure 25. Proportion of *S. pyogenes* *emm* types in children 0 - 14 years of age

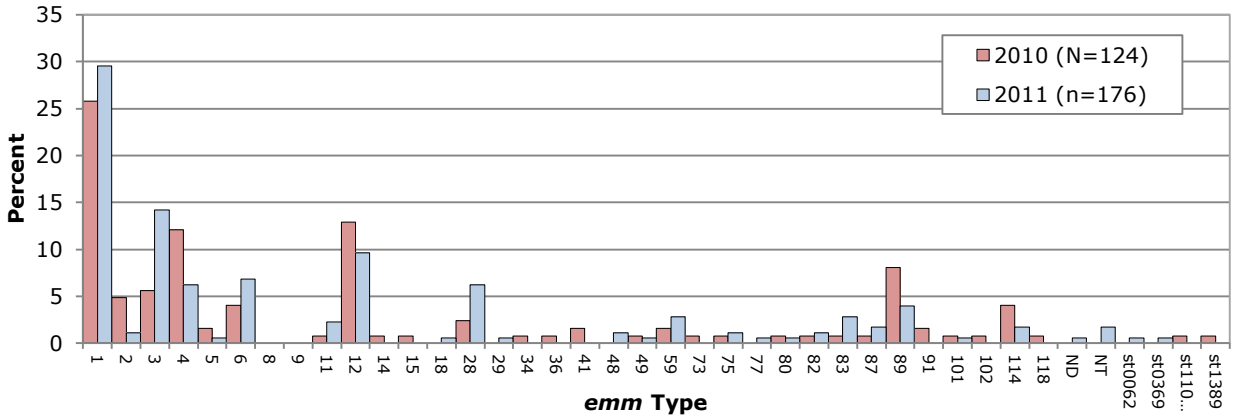


Figure 26. Proportion of *S. pyogenes* *emm* types in adults 15 - 64 years of age

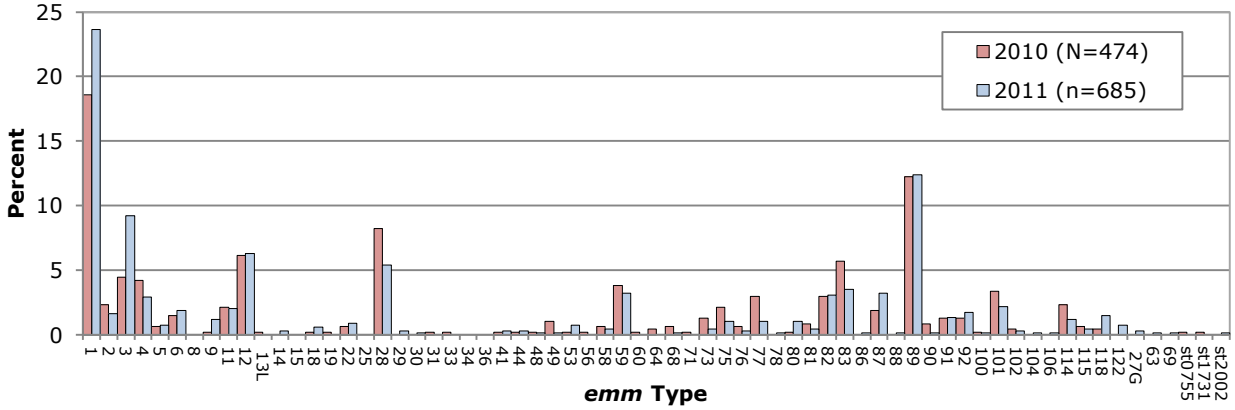


Figure 27. Proportion of *S. pyogenes* *emm* types in seniors ≥65 years of age

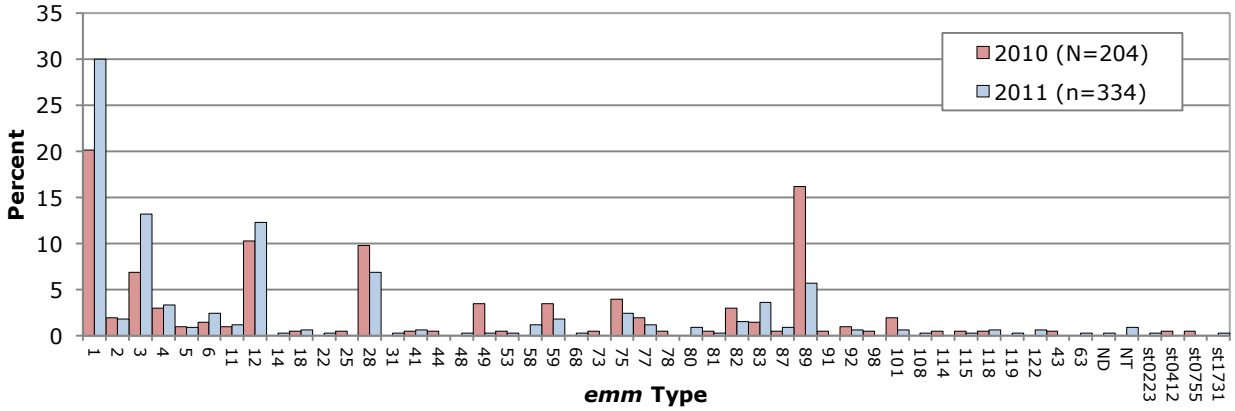
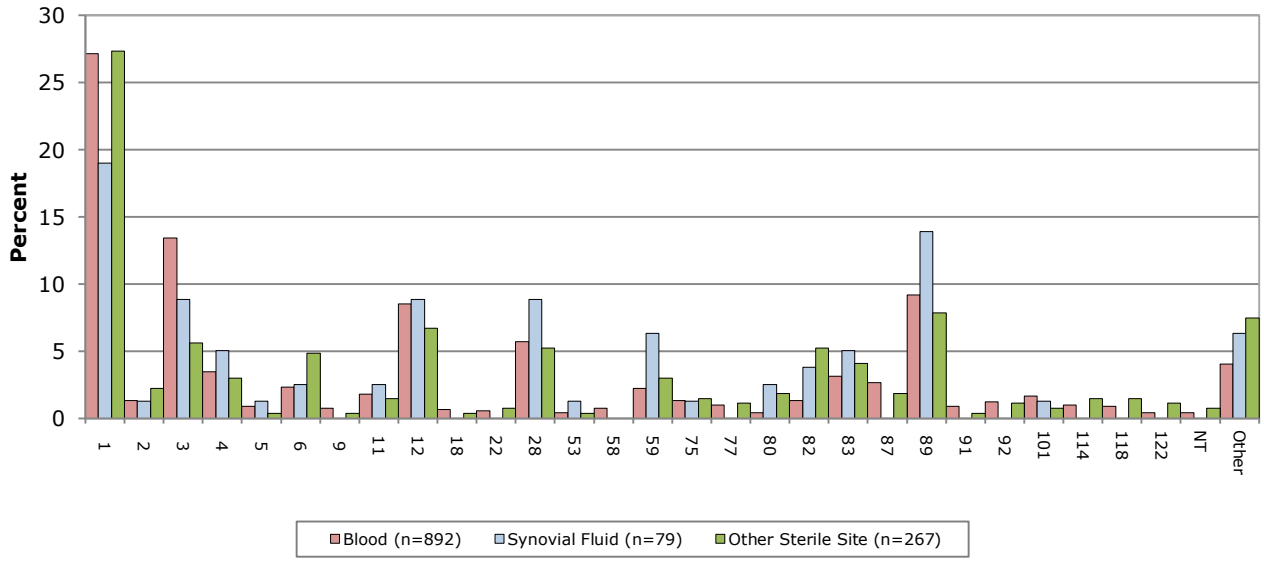


Figure 28. Proportion of prevalent *S. pyogenes* *emm* types by clinical isolation site



*Other sterile sites include CSF, biopsy tissue, necrotizing fasciitis tissue, internal/deep body tissue or surgical sites.

Outbreaks:

Seventeen isolates associated with 6 outbreaks of *S. pyogenes* where submitted to the NML for testing during 2011. Two isolates in February from a British Columbia outbreak were characterized as *emm*1 – T1; 3 isolates in March from Ontario as *emm*82 – T5/27/44; 5 isolates in May from Ontario as *emm*122 – T non-typable; 2 isolates also in May from Ontario as *emm*1 – T1; 4 isolates in August from Ontario as *emm*6 – T6 and 1 isolate from Saskatchewan during December as *emm*101 – T3,13,B3264.

Conclusion

The prevalence of serotypes associated with the 7-valent vaccine remains low, and with the introduction of the 13-valent vaccine, a decrease in the prevalent serotypes 7F and 19A in children has been observed. Continued vigilance however, is required to recognize possible increases in the prevalence of other non-PCV13 serotypes circulating in Canada. Although eradication of disease caused by *S. pneumoniae* may not be a realistic goal, the continued monitoring of the relative prevalence 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.

Isolates of *S. pneumoniae* are commonly resistant to penicillins, macrolides, tetracyclines, sulfonamides and fluoroquinolones and multi-drug resistance is a growing global concern. Monitoring the antimicrobial susceptibility patterns of the common *S. pneumoniae* serotypes is essential to guide empiric and directed treatments.

Due to the severity, high risk of infection and heightened public awareness of Group A *Streptococci*, the continued monitoring and surveillance of circulating serotypes is important to help identify outbreaks of disease and to inform and guide public health interventions.

Appendices

Appendix A. Serotypes of invasive *Streptococcus pneumoniae* in 2011

Serotype	Age Group	Western	Central	Eastern	Canada
1	2 - 4 yrs	1	1	-	**2**
	5 - 14 yrs	-	1	-	**1**
	15 - 49 yrs	2	4	-	**6**
	50 - 64 yrs	-	3	-	**3**
	>=65 yrs	-	1	-	**1**
	Subtotal	3	10	-	**13**
3	<2 yrs	3	8	-	**11**
	2 - 4 yrs	2	12	2	**16**
	5 - 14 yrs	-	7	-	**6**
	15 - 49 yrs	6	28	1	**35**
	50 - 64 yrs	16	28	6	**50**
	>=65 yrs	22	64	5	**91**
	Not Given	-	2	-	**2**
	Subtotal	49	149	14	**212**
4	<2 yrs	1	-	-	**1**
	5 - 14 yrs	-	-	2	**2**
	15 - 49 yrs	4	15	2	**21**
	50 - 64 yrs	7	9	3	**19**
	>=65 yrs	3	4	-	**7**
	Not Given	-	-	1	**1**
	Subtotal	15	28	8	**51**
5	15 - 49 yrs	6	-	-	**6**
	50 - 64 yrs	4	1	-	**5**
	Subtotal	10	1	-	**11**
6A	<2 yrs	1	2	-	**3**
	15 - 49 yrs	2	4	-	**6**
	50 - 64 yrs	-	7	1	**8**
	>=65 yrs	2	7	-	**9**
	Subtotal	5	20	1	**26**
6B	5 - 14 yrs	-	-	1	**1**
	15 - 49 yrs	-	1	-	**1**
	50 - 64 yrs	-	3	-	**3**
	>=65 yrs	1	6	1	**8**
	Not Given	-	1	-	**1**
	Subtotal	1	11	2	**14**
6C	<2 yrs	-	2	-	**2**
	2 - 4 yrs	-	2	-	**2**
	5 - 14 yrs	-	2	1	**3**
	15 - 49 yrs	3	7	-	**10**

Serotype	Age Group	Western	Central	Eastern	Canada
	50 - 64 yrs	3	12	-	**15**
	>=65 yrs	14	42	4	**60**
	Not Given	1	-	2	**3**
	Subtotal	21	67	7	**95**
6D	>=65 yrs	-	1	-	**1**
7A	50 - 64 yrs	-	1	-	**1**
7C	<2 yrs	1	-	-	**1**
	15 - 49 yrs	-	1	-	**1**
	50 - 64 yrs	1	1	-	**2**
	>=65 yrs	2	1	-	**3**
	Subtotal	4	3	-	**7**
7F	<2 yrs	3	10	-	**13**
	2 - 4 yrs	3	9	-	**12**
	5 - 14 yrs	10	22	4	**36**
	15 - 49 yrs	20	83	15	**118**
	50 - 64 yrs	12	67	5	**84**
	>=65 yrs	13	69	10	**92**
	Not Given	3	3	1	**7**
	Subtotal	64	263	35	**362**
8	<2 yrs	2	2	1	**5**
	2 - 4 yrs	-	1	-	**1**
	5 - 14 yrs	3	-	-	**3**
	15 - 49 yrs	9	9	5	**23**
	50 - 64 yrs	6	13	1	**20**
	>=65 yrs	5	8	-	**13**
	Subtotal	25	33	7	**65**
9L	15 - 49 yrs	-	1	-	**1**
	>=65 yrs	-	1	-	**1**
	Subtotal	-	2	-	**2**
9N	<2 yrs	-	2	-	**2**
	2 - 4 yrs	1	-	-	**1**
	5 - 14 yrs	1	1	-	**2**
	15 - 49 yrs	2	18	-	**20**
	50 - 64 yrs	8	22	1	**31**
	>=65 yrs	8	12	2	**22**
	Subtotal	20	55	3	**78**
9V	5 - 14 yrs	-	2	-	**2**
	15 - 49 yrs	1	3	-	**4**
	50 - 64 yrs	-	3	1	**4**
	>=65 yrs	2	6	-	**8**
	Subtotal	3	14	1	**18**
10A	<2 yrs	1	6	-	**7**
	5 - 14 yrs	-	1	-	**1**
	15 - 49 yrs	4	6	-	**10**
	50 - 64 yrs	3	4	1	**8**
	>=65 yrs	2	2	1	**5**
	Subtotal	10	19	2	**31**

Serotype	Age Group	Western	Central	Eastern	Canada
10B	<2 yrs	1	-	-	**1**
10F	15 - 49 yrs	-	1	-	**1**
11A	<2 yrs	1	4	-	**5**
	2 - 4 yrs	1	1	-	**2**
	5 - 14 yrs	1	1	-	**2**
	15 - 49 yrs	6	7	1	**14**
	50 - 64 yrs	3	11	6	**20**
	>=65 yrs	6	16	1	**23**
	Not Given	1	-	-	**1**
	Subtotal	19	40	8	**67**
11B	50 - 64 yrs	2	1	-	**3**
	>=65 yrs	1	1	-	**2**
	Subtotal	3	2	-	**5**
12F	<2 yrs	3	-	-	**3**
	2 - 4 yrs	2	-	-	**2**
	5 - 14 yrs	1	2	-	**3**
	15 - 49 yrs	15	10	-	**25**
	50 - 64 yrs	10	11	-	**21**
	>=65 yrs	6	9	-	**15**
	Not Given	1	-	-	**1**
	Subtotal	38	32	-	**70**
13	15 - 49 yrs	1	-	-	**1**
14	15 - 49 yrs	-	4	-	**4**
	50 - 64 yrs	-	4	1	**5**
	>=65 yrs	2	5	1	**8**
	Subtotal	2	13	2	**17**
15A	<2 yrs	3	4	-	**7**
	2 - 4 yrs	-	1	-	**1**
	5 - 14 yrs	1	-	-	**1**
	15 - 49 yrs	1	10	-	**11**
	50 - 64 yrs	7	13	-	**20**
	>=65 yrs	6	29	-	**35**
	Subtotal	18	57	-	**75**
15B	<2 yrs	-	3	-	**3**
	2 - 4 yrs	-	5	-	**5**
	5 - 14 yrs	1	5	-	**6**
	15 - 49 yrs	3	5	1	**9**
	50 - 64 yrs	-	5	1	**6**
	>=65 yrs	1	7	-	**8**
	Subtotal	5	30	2	**37**
15C	<2 yrs	3	2	-	**5**
	2 - 4 yrs	-	4	-	**4**
	5 - 14 yrs	-	4	-	**4**
	15 - 49 yrs	-	5	-	**5**
	50 - 64 yrs	2	1	2	**5**
	>=65 yrs	-	7	1	**8**
	Subtotal	5	23	3	**31**

Serotype	Age Group	Western	Central	Eastern	Canada
15F	50 - 64 yrs	-	1	-	**1**
16F	<2 yrs	3	-	-	**3**
	5 - 14 yrs	-	4	-	**4**
	15 - 49 yrs	1	4	-	**5**
	50 - 64 yrs	1	8	-	**9**
	>=65 yrs	5	9	2	**16**
	Not Given	1	2	-	**3**
	Subtotal	11	27	2	**40**
17F	<2 yrs	-	1	-	**1**
	15 - 49 yrs	1	2	-	**3**
	50 - 64 yrs	2	4	-	**6**
	>=65 yrs	4	-	1	**5**
	Subtotal	7	7	1	**15**
18C	15 - 49 yrs	2	2	1	**5**
	50 - 64 yrs	1	4	-	**5**
	>=65 yrs	-	2	-	**2**
	Subtotal	3	8	1	**12**
18F	50 - 64 yrs	-	1	-	**1**
	>=65 yrs	-	1	-	**1**
	Subtotal	-	2	-	**2**
19A	<2 yrs	7	29	2	**38**
	2 - 4 yrs	10	45	3	**58**
	5 - 14 yrs	8	13	1	**22**
	15 - 49 yrs	23	34	5	**62**
	50 - 64 yrs	30	61	11	**102**
	>=65 yrs	18	94	5	**117**
	Not Given	-	2	-	**2**
	Subtotal	96	278	27	**401**
19B	<2 yrs	-	1	-	**1**
19C	2 - 4 yrs	-	1	-	**1**
	50 - 64 yrs	-	1	-	**1**
	Subtotal	-	2	-	**2**
19F	<2 yrs	2	-	-	**2**
	2 - 4 yrs	1	1	-	**2**
	5 - 14 yrs	-	2	-	**2**
	15 - 49 yrs	2	6	-	**8**
	50 - 64 yrs	1	3	1	**5**
	>=65 yrs	3	9	-	**12**
	Subtotal	9	21	1	**31**
20	<2 yrs	-	1	-	**1**
	15 - 49 yrs	2	3	1	**6**
	50 - 64 yrs	1	2	1	**4**
	>=65 yrs	4	3	-	**7**
	Subtotal	7	9	2	**18**
21	<2 yrs	-	4	-	**4**
	50 - 64 yrs	-	2	-	**2**
	Subtotal	-	6	-	**6**

Serotype	Age Group	Western	Central	Eastern	Canada
22F	<2 yrs	-	10	1	**11**
	2 - 4 yrs	3	7	1	**11**
	5 - 14 yrs	1	3	-	**4**
	15 - 49 yrs	12	24	2	**38**
	50 - 64 yrs	10	28	1	**39**
	>=65 yrs	19	53	6	**78**
	Not Given	-	1	2	**3**
	Subtotal	45	126	13	**184**
23A	<2 yrs	1	4	-	**5**
	2 - 4 yrs	-	3	-	**3**
	15 - 49 yrs	2	13	-	**15**
	50 - 64 yrs	1	13	2	**16**
	>=65 yrs	10	33	1	**44**
	Subtotal	14	66	3	**83**
23B	<2 yrs	2	2	-	**4**
	2 - 4 yrs	1	2	-	**3**
	5 - 14 yrs	-	2	2	**4**
	15 - 49 yrs	4	2	-	**6**
	50 - 64 yrs	6	6	3	**15**
	>=65 yrs	6	13	-	**19**
	Subtotal	19	27	5	**51**
23F	15 - 49 yrs	-	2	-	**2**
	50 - 64 yrs	-	1	-	**1**
	>=65 yrs	1	3	2	**6**
	Subtotal	1	6	2	**9**
24B	<2 yrs	-	2	-	**2**
	>=65 yrs	-	1	-	**1**
	Subtotal	-	3	-	**3**
24F	<2 yrs	-	1	-	**1**
	>=65 yrs	-	1	-	**1**
	Subtotal	-	2	-	**2**
25A	<2 yrs	1	-	-	**1**
	50 - 64 yrs	1	-	-	**1**
	Subtotal	2	-	-	**2**
27	50 - 64 yrs	-	1	-	**1**
28A	15 - 49 yrs	1	-	-	**1**
	50 - 64 yrs	1	2	-	**3**
	Subtotal	2	2	-	**4**
29	<2 yrs	1	-	-	**1**
	50 - 64 yrs	-	2	-	**2**
	>=65 yrs	-	1	-	**1**
	Subtotal	1	3	-	**4**
31	2 - 4 yrs	-	1	-	**1**
	5 - 14 yrs	1	1	-	**2**
	15 - 49 yrs	1	-	1	**2**
	50 - 64 yrs	2	-	-	**2**
	>=65 yrs	2	7	-	**9**

Serotype	Age Group	Western	Central	Eastern	Canada
	Subtotal	6	9	1	**16**
33A	<2 yrs	1	-	-	**1**
	5 - 14 yrs	-	3	2	**5**
	15 - 49 yrs	1	4	1	**6**
	50 - 64 yrs	2	8	1	**11**
	>=65 yrs	8	5	-	**13**
	Not Given	-	1	-	**1**
	Subtotal	12	21	4	**37**
33B	>=65 yrs	1	-	-	**1**
33F	<2 yrs	2	1	-	**3**
	2 - 4 yrs	1	2	-	**3**
	5 - 14 yrs	1	-	-	**1**
	15 - 49 yrs	1	5	-	**6**
	50 - 64 yrs	2	5	-	**7**
	>=65 yrs	1	6	1	**8**
	Subtotal	8	19	1	**28**
34	15 - 49 yrs	3	1	-	**4**
	50 - 64 yrs	-	4	1	**5**
	>=65 yrs	2	9	2	**13**
	Subtotal	5	14	3	**22**
35A	<2 yrs	1	-	-	**1**
	>=65 yrs	1	1	-	**2**
	Subtotal	2	1	-	**3**
35B	<2 yrs	-	-	1	**1**
	2 - 4 yrs	-	1	-	**1**
	5 - 14 yrs	-	1	-	**1**
	15 - 49 yrs	-	2	-	**2**
	50 - 64 yrs	1	6	-	**7**
	>=65 yrs	6	13	3	**22**
	Not Given	-	1	-	**1**
	Subtotal	7	24	4	**35**
35F	<2 yrs	-	2	-	**2**
	5 - 14 yrs	-	1	-	**1**
	15 - 49 yrs	2	1	-	**3**
	50 - 64 yrs	1	7	-	**8**
	>=65 yrs	2	8	1	**11**
	Subtotal	5	19	1	**25**
37	>=65 yrs	-	1	-	**1**
38	<2 yrs	1	9	-	**10**
	2 - 4 yrs	-	2	-	**2**
	5 - 14 yrs	-	2	-	**2**
	15 - 49 yrs	1	1	-	**2**
	50 - 64 yrs	-	2	1	**3**
	>=65 yrs	4	9	2	**15**
	Subtotal	6	25	3	**34**
42	50 - 64 yrs	-	-	1	**1**
45	>=65 yrs	1	-	-	**1**

Serotype	Age Group	Western	Central	Eastern	Canada
NT	<2 yrs	-	-	1	**1**
	15 - 49 yrs	2	-	-	**2**
	50 - 64 yrs	-	1	-	**1**
	Subtotal	2	1	1	**4**
All	**All Groups**	**594**	**1607**	**171**	**2372**

Appendix B. *Emm* and T-Types of invasive *Streptococcus pyogenes*, 2011

Emm Type	T-Type	Western	Central	Eastern	Canada
1	NT	-	2	-	**2**
	T1	86	230	12	**328**
	Subtotal	86	232	12	**330**
2	T2	5	6	3	**14**
	T2/28	3	2	-	**5**
	Subtotal	8	8	3	**19**
3	NT	-	16	-	**16**
	T3/13/B3264	7	117	2	**126**
	Subtotal	7	133	2	**142**
4	NT	-	4	-	**4**
	T4	6	28	3	**37**
	T8/25/Imp.19	1	1	-	**2**
	Subtotal	7	33	3	**43**
5	NT	-	6	-	**6**
	T5/27/44	-	5	-	**5**
	Subtotal	-	11	-	**11**
6	NT	-	2	-	**2**
	T6	9	23	2	**34**
	Subtotal	9	25	2	**36**
9	NT	-	-	1	**1**
	T9	1	6	-	**7**
	Subtotal	1	6	1	**8**
11	NT	2	5	-	**7**
	T11	5	10	-	**15**
	Subtotal	7	15	-	**22**
12	NT	-	6	1	**7**
	T12	28	63	4	**95**
	Subtotal	28	69	5	**102**
14	NT	-	1	-	**1**
	T14	-	2	-	**2**
	Subtotal	-	3	-	**3**
18	NT	-	7	-	**7**
22	NT	2	-	-	**2**
	T12	2	3	-	**5**
	Subtotal	4	3	-	**7**
27G	T5/27/44	2	-	-	**2**
28	NT	4	2	1	**7**
	T28	11	38	3	**52**
	T28/8	2	7	1	**10**
	T3/13/B3264	-	1	-	**1**
	T8/25	1	-	-	**1**
	T8/28	-	1	-	**1**
	Subtotal	18	49	5	**72**
29	NT	-	2	-	**2**
	T28	-	1	-	**1**

Emm Type	T-Type	Western	Central	Eastern	Canada
	Subtotal	-	3	-	**3**
30	NT	-	1	-	**1**
31	T8/25/Imp.19	1	-	-	**1**
41	NT	1	-	-	**1**
	T1/3/13/B3264	-	1	-	**1**
	T8	-	2	-	**2**
	Subtotal	1	3	-	**4**
44	NT	2	-	-	**2**
48	NT	-	-	1	**1**
	T22	1	-	-	**1**
	T4/28	2	-	-	**2**
	Subtotal	3	-	1	**4**
49	NT	1	-	1	**2**
	T14	1	-	-	**1**
	Subtotal	2	-	1	**3**
53	NT	3	-	-	**3**
	T2/8/25/Imp.19	1	-	-	**1**
	T8/25/Imp.19	2	-	-	**2**
	Subtotal	6	-	-	**6**
58	NT	1	-	-	**1**
	T1	1	-	-	**1**
	T2	1	4	-	**5**
	Subtotal	3	4	-	**7**
59	NT	9	8	-	**17**
	T11	6	9	-	**15**
	T12	1	-	-	**1**
	Subtotal	16	17	-	**33**
63	T4	-	1	-	**1**
	T6	-	1	-	**1**
	Subtotal	-	2	-	**2**
68	T12	2	-	-	**2**
69	T3/13/B3264	-	1	-	**1**
73	T3/13/B3264	-	3	-	**3**
75	T25	3	14	-	**17**
76	T12	1	1	-	**2**
77	NT	2	3	1	**6**
	T13/28/9	1	2	-	**3**
	T2/8/25/Imp.19	2	-	-	**2**
	T3/13/B3264	1	-	-	**1**
	Subtotal	6	5	1	**12**
78	NT	-	1	-	**1**
80	NT	1	-	-	**1**
	T14	5	-	-	**5**
	T8/14/25/Imp.19	-	1	-	**1**
	TB3264/14	3	1	-	**4**
	Subtotal	9	2	-	**11**
81	NT	1	1	-	**2**

Emm Type	T-Type	Western	Central	Eastern	Canada
	T3/13/B3264	-	2	-	**2**
	Subtotal	1	3	-	**4**
82	NT	1	1	-	**2**
	T11	1	-	-	**1**
	T5/12/27	-	-	1	**1**
	T5/27/44	11	14	-	**25**
	Subtotal	13	15	1	**29**
83	NT	2	1	-	**3**
	T3/13/B3264	17	9	-	**26**
	T8/25/Imp.19	9	5	-	**14**
	Subtotal	28	15	-	**43**
86	NT	1	-	-	**1**
87	NT	3	-	-	**3**
	T28	11	15	-	**26**
	Subtotal	14	15	-	**29**
88	NT	-	1	-	**1**
89	NT	1	4	-	**5**
	T11	2	3	-	**5**
	T3/13/B3264	20	80	4	**104**
	Subtotal	23	87	4	**114**
90	T3/13/B3264	-	1	-	**1**
91	NT	-	2	-	**2**
	T8/25/Imp.19	3	4	-	**7**
	Subtotal	3	6	-	**9**
92	TImp.19	-	14	-	**14**
100	NT	-	1	-	**1**
101	NT	2	1	-	**3**
	T3/13/B3264	11	3	-	**14**
	T8/25/Imp.19	1	-	-	**1**
	Subtotal	14	4	-	**18**
102	T3/13/B3264	1	1	-	**2**
	T8/25	-	1	-	**1**
	Subtotal	1	2	-	**3**
104	NT	-	1	-	**1**
106	NT	1	-	-	**1**
108	NT	-	1	-	**1**
114	NT	3	2	-	**5**
	T3/13/B3264	4	4	-	**8**
	Subtotal	7	6	-	**13**
115	NT	3	1	-	**4**
118	NT	-	3	-	**3**
	T3/13/B3264	-	8	-	**8**
	T3/13/B3264/9	-	1	-	**1**
	Subtotal	-	12	-	**12**
119	T8/25/Imp.19	-	1	-	**1**
122	NT	-	7	-	**7**
st0062	NT	-	1	-	**1**

Emm Type	T-Type	Western	Central	Eastern	Canada
st0211	T11	-	1	-	**1**
st0223	NT	-	1	-	**1**
st0369	T3/13/B3264	-	1	-	**1**
st1731	T4	-	1	-	**1**
st2002	T3/13/B3264	-	1	-	**1**
NT	NT	-	1	-	**1**
	T12	-	1	-	**1**
	T3/13/B3264	-	1	-	**1**
	T6	-	3	-	**3**
	Subtotal	-	6	-	**6**
Total		**341**	**856**	**41**	**1238**

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