



## Epidemiology of invasive pneumococcal and *Haemophilus influenzae* diseases in Northwestern Ontario, Canada, 2010–2015



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### ABSTRACT

**Introduction:** North American indigenous populations experience a high burden of invasive bacterial infections. Because *Streptococcus pneumoniae* and *Haemophilus influenzae* have multiple antigenic variants, the existing vaccines cannot prevent all cases. This study addresses the current epidemiology of invasive *H. influenzae* and pneumococcal disease (IPD) in a region of Northwestern Ontario, Canada with a relatively high (82%) indigenous population.

**Methods:** Data were retrieved from a retrospective chart review at a hospital servicing a population of 29 000 (82% indigenous), during January 2010–July 2015.

**Results:** Ten cases of invasive *H. influenzae* disease and 37 cases of IPD were identified. The incidence of both in the study population (6.3 and 23.1/100 000/year, respectively) exceeded national rates (1.6 and 9.0/100 000/year). *H. influenzae* serotype a (Hia) was the most common (50%), followed by non-typeable *H. influenzae* (20%). In adults, 77% of IPD cases were caused by serotypes included in the 23-valent pneumococcal polysaccharide vaccine. All paediatric IPD cases were caused by serotypes not included in the 13-valent pneumococcal conjugate vaccine. The case-fatality rate was 10% for invasive *H. influenzae* and 2.7% for IPD. Most cases exhibited substantial co-morbidity.

**Conclusions:** In Northwestern Ontario, the incidence of invasive Hia disease exceeds that of *H. influenzae* type b (Hib) in the pre-Hib vaccine era. This provides strong support for the development of a new Hia vaccine. Improved pneumococcal vaccination of high-risk adults in the region is warranted.

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### Introduction

Northwestern Ontario, in central Canada, is a largely rural area of over half a million square kilometres. The unique geographic, socioeconomic, and demographic characteristics of the region pose numerous challenges to the distribution of comprehensive health services and maintenance of optimal resident health. Approximately 20% of the Northwestern Ontario population is indigenous (First Nations, Métis, or Inuit) (Statistics Canada, 2011a; Statistics Canada, 2011b; Statistics Canada, 2011c). In contrast, 4.3% of the total Canadian population is indigenous (Statistics Canada, 2013). Notably, many indigenous communities face enormous barriers to

equitable care, in addition to distinct geographic and socioeconomic circumstances (e.g., systemic racism, continuing colonialism, poverty, remote fly-in communities, inadequate access to potable water, overcrowded living conditions) (Shah et al., 2003; Waldram et al., 2006; Waldram et al., 2006).

The Meno Ya Win Health Centre (SLMHC), located in the town of Sioux Lookout, Northwestern Ontario, is a 60-bed hospital with a 20-bed extended care facility. It serves the residents of Sioux Lookout as well as the populace of an expansive geographic area, including the northern Nishnawbe Aski Nation areas, Lac Seul First Nation of Treaty 3, and the communities of Hudson, Pickle Lake, and Savant Lake. The total catchment population for the hospital is approximately 29 000; 82% are indigenous (Poling et al., 2014).

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## Haemophilus influenzae

*Haemophilus influenzae* is a Gram-negative human-restricted pathogen categorized based on the presence or absence of a polysaccharide capsule (Musher, 1996). There are six serotypes per the capsule composition (a, b, c, d, e, and f), while non-encapsulated strains are considered non-typeable (NTHi). *H. influenzae* colonizes the nasopharynx and can cause bacteraemia by infiltration of the epithelium and capillary endothelium (Musher, 1996). *H. influenzae* type b (Hib) is the most virulent serotype. It can cause septicaemia and meningitis, mainly in children <2 years of age. *H. influenzae* type a (Hia) is the second most virulent serotype (Whyte et al., 2015). NTHi most commonly cause respiratory tract infections (Musher, 1996).

Before the introduction of the Hib conjugate vaccine in the late 1980s and early 1990s, Hib was the most common cause of paediatric bacterial meningitis (Ulanova and Tsang, 2009). Following the introduction of routine childhood immunization against Hib in Canada in 1991, the incidence of invasive Hib decreased from a peak of 3.6 cases per 100 000 population in 1989 to 0.1 cases per 100 000 in 2013 (Public Health Agency of Canada, 2017). In contrast, the incidence of invasive non-Hib increased from 0.6 per 100 000 in 2007 to 1.5 per 100 000 in 2013, with the majority of cases caused by NTHi (Public Health Agency of Canada, 2015). This is a trend seen in several other countries (Ulanova and Tsang, 2009). Various specific indigenous North American populations experience higher rates of Hia (e.g., 18/100 000/year in Alaska Native children <5 years of age, 2002–2011) compared to the general North American population (e.g., 0.5/100 000/year in non-native children <5 years of age in Alaska, 2002–2011) (Tsang et al., 2014; Bruce et al., 2013).

## Streptococcus pneumoniae

*Streptococcus pneumoniae* (pneumococcus) is an encapsulated Gram-positive bacterium that frequently colonizes the nasopharynx and upper airway. Dissemination to the sinuses or middle ear, aspiration into the lung, or entry into the systemic circulation causes pneumococcal disease. Ninety-two *S. pneumoniae* capsular types have been identified; the polysaccharide capsule, which resists phagocytosis, is the major virulence factor (Kalin, 1998;

Weinberger et al., 2008). Pneumococcal nasopharyngeal carriage is distinctly common in young children, especially those living in crowded environments—frequent conditions for Canada's indigenous populations (Waldram et al., 2006; Kalin, 1998).

Invasive pneumococcal disease (IPD), when *S. pneumoniae* is isolated from normally sterile sites such as blood or cerebrospinal fluid, is a major health concern in Northern Canadian populations, particularly among indigenous infants (Cléophat et al., 2014; Li et al., 2006). However, recent studies in Nunavik (northern Quebec, Canada) found that uptake rates of pneumococcal vaccines were similar to those measured in other regions of Quebec (Cléophat et al., 2014).

In Canada, two pneumococcal vaccines are currently available: a conjugate vaccine (PCV-13) and a polysaccharide vaccine (PPV-23). A case-control study found PCV-13 has 86% efficacy in preventing IPD in children (Moore et al., 2016). Since November 2010, it has been included (at 2, 4, and 12 months of age) in the publicly funded childhood immunization programme in Canada (Government of Canada, 2017). PPV-23 is more than 80% effective against IPD in healthy adults; its efficacy ranges from 50% to 80% in high-risk groups, including aging populations. It is recommended for all adults >65 years of age, as well as for individuals in high-risk groups >2 years of age (Government of Canada, 2017).

Depending on community, health circumstances, and immunization type, people in Northwestern Ontario may receive immunizations at family physician offices, pharmacies, nursing stations (on-reserve), schools, district health units, and/or hospitals. In the province of Ontario, no immunization uptake data are currently available. In 2013, Hib coverage was estimated at 72.1% at 17 years of age and PCV-13 at 79.3% at 2 years of age for Canada (Public Health Agency of Canada, 2016). Canadian adult uptake estimates in 2012 for PPV-23 were 38% in those >65 years of age and 19% in those with chronic medical conditions (Public Health Agency of Canada, 2012).

Due to their heightened potential to cause invasive disease in Canadian indigenous populations, *S. pneumoniae* and *H. influenzae* are of concern in Northwestern Ontario. The aim of this study was to describe the epidemiology of invasive pneumococcal and *H. influenzae* diseases in the SLMHC catchment population over a 5.5-year period.

**Table 1**  
Characteristics of individuals with invasive *Haemophilus influenzae* and *Streptococcus pneumoniae* diseases in the Meno Ya Win Health Centre catchment area, January 1, 2010 to June 30, 2015.

Characteristic	<i>H. influenzae</i> (%) n = 10	<i>S. pneumoniae</i> (%) n = 37
Age, median (years)	37	42
Children <5 years	3 (30)	6 (16.2)
Male	6 (60)	22 (59.5)
Indigenous (confirmed)	9 (90)	34 (91.9)
Residency		
On-reserve	7 (70)	28 (75.7)
Urban	2 (20)	7 (18.9)
Semi-rural (township)	1 (10)	1 (2.7)
Rural	0 (0)	1 (2.7)
Smoking (adults, past or current)	1 (16.7)	3 (9.7)
Co-morbidity (general)	7 (70)	28 (75.7)
Alcohol and other substance abuse (adults, past or current)	2 (33.3)	7 (33.3)
Type 2 diabetes mellitus	3 (30)	11 (29.7)
Length of hospital stay, median (days)	4.5	5
Outcome		
Discharge	4 (40)	23 (62.2)
Transfer	2 (20)	5 (13.5)
Death	1 (10)	1 (2.7)
Unknown	3 (30)	8 (21.6)

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