Pneumococcal disease burden and vaccination in older adults: where does Canada stand?

Sharifa Nasreen, PhD1,2; Gebremedhin Beedemariam Gebretekle, PhD3,4

1 Dalla Lana School of Public Health, University of Toronto, Toronto, Ontario
2 ICES, Toronto, Ontario
3 Institute of Health Policy, Management and Evaluation, University of Toronto, Toronto, Ontario
4 Toronto Health Economics and Technology Assessment (THETA) Collaborative, University Health Network, Toronto, Ontario

Abstract
Prevention of vaccine-preventable infectious diseases in aging adult population is imperative for healthy aging. Here we reflect on where Canada stands with regard to vaccine-preventable pneumococcal diseases in older adults, specifically the continuing high disease burden, current evidence on effectiveness and observed impact of pneumococcal vaccines, and suboptimal vaccine uptake in older adults. The need for ongoing strong disease surveillance is emphasized, and the implications of a lack of adult vaccine registry are also discussed.

Aging Canadian population
As of July 1, 2021, more than 7 million Canadians were aged ≥65 years (12,822 centenarians), representing 18.5% of total population (Statistics Canada, 2021). It was estimated that by 2030, older adult population will exceed 9.5 million, accounting for 23% of the population (“Action for Seniors report”, 2014). Currently, the average 65-year-old Canadian can expect to live an additional 19.5 years for males and 22.2 years for females, (Statistics Canada, 2021) and life expectancy is projected to increase to 86.5 years for males and 88.8 years for females by 2036 (“Action for Seniors report”, 2014). Increased longevity also means an increase in the prevalence of chronic diseases, and immune senescence resulting in an increase in susceptibility and severity of infectious diseases, as well as more severe disease outcomes.

Pneumococcal disease burden
Pneumococcal disease is caused by the anaerobic gram-negative bacterium Streptococcus pneumoniae (pneumoccus) that has 100 serotypes as of 2020 (Hall et al, 2021). Disease spectrum spans from asymptomatic carriage (20–60% school-age children and 5–10% adults) to invasive pneumococcal disease (IPD) that is characterized by the isolation of bacteria from normally sterile body fluids, and non-invasive disease without bacterial isolation from sterile sites; pneumonia can present as both (Figure 1A) (Hall et al, 2021). The case fatality ratios of pneumococcal bacteremia and meningitis are 12% and 14%, respectively (Hall et al, 2021).

IPD became nationally notifiable in 2000 (Public Health Agency of Canada, 2020). The incidence rate of IPD in older adults remains considerably high (Public Health Agency of Canada, 2020; Nasreen et al, 2021). The incidence of IPD among ≥65 year-olds was 23.6 per 100,000 during 2011–2015 and 24 per 100,000 in 2017 (Government of Canada, 2021). Consequently, Canada is not on track of the IPD incidence reduction target of less than 23.5 cases per 100,000 population per year by 2025 among individuals aged ≥65 years (NACI, 2018; Public Health Agency of Canada, 2020). While there has been an emerging burden of IPD caused by unique-PPV23 and non-vaccine serotypes in recent years, (Desai et al, 2016; Wijayasri et al, 2019; Nasreen et al, 2021) 61% of the IPD cases among ≥65 year-olds were potentially preventable by PCV13 and PPV23 (Government of Canada, 2021). Additionally, the proportion of IPD caused by penicillin-resistant and multi-drug resistant (MDR) S. pneumoniae has increased by 49% and 26%, respectively between 2013 and 2017 in all ages in Canada, and IPD caused by MDR serotypes (e.g., 19A and 19F) present in current pneumococcal vaccines could be potentially prevented through vaccination (“Canadian Antimicrobial Resistance Surveillance System Report”, 2020).

However, IPD represents only the tip of the iceberg reflecting a much larger burden of noninvasive disease (Figure 1B) (LeBlanc et al, 2017; Goldblatt & Miller, 2019). The overall annual incidence rate of pneumococcal pneumonia among Canadian older adults ≥65 year-olds was 131.7 per 100,000 in 2015 with the highest rate among ≥85 year-olds at 249.4 per 100,000; during 2010–2015, 26.6% of the ≥65 year-old pneumococcal pneumonia cases required ICU admission, 18.2% required mechanical ventilation, and had a 12% 30-day mortality rate (Leblanc et al, 2020). The burden of pneumococcal pneumonia not requiring hospitalization is expected to be much higher than the burden of hospitalized...
cases. There are limited data on the burden of acute otitis media and sinusitis in Canadian older adults.

**Effectiveness and impact of pneumococcal vaccines in older adults**

Two pneumococcal vaccines are available for older adults in Canada to prevent pneumococcal disease: 23-valent pneumococcal polysaccharide vaccine (PPV23) containing 23 pneumococcal serotypes and 13-valent pneumococcal conjugate vaccine (PCV13) containing 13 pneumococcal serotypes. Publicly funded PPV23 is recommended for use in all adults aged ≥65 years regardless of risk factors or prior pneumococcal vaccination, while PCV13 is recommended on an individual basis (Kaplan et al, 2019). PPV23 has direct protective effect against both IPD (pooled vaccine effectiveness: 73% from clinical trials, 45% from cohort studies and 59% from case-control studies) and pneumococcal pneumonia (pooled vaccine effectiveness: 64% from clinical trials and 48% from cohort studies) in older adults (Falkenhorst et al, 2017). PCV13 is moderately effective in preventing PCV13-type IPD and pneumococcal pneumonia in older adults (ACIP, 2019). Albeit limited, some indirect impact of publicly funded pediatric PCV13 immunization program on PCV13 type IPD in older adults have been reported from early PCV13 periods (Morre et al, 2015; Ciruela et al, 2019). When compared to non-pneumonia illnesses, substantial reduction of all-cause pneumonia hospitalization and hospitalization-associated costs was observed in older adults during the early years of PCV13 program implementation ( Luca et al, 2018). The economic implications of funding pneumococcal vaccines in older Canadians has not been thoroughly investigated, however, one study showed that sequential use of PCV13 and PPV23 for older adults was cost-effective with an incremental cost-effectiveness ratio of $35,484/Quality-adjusted life years (QALY) (Atwood et al, 2018).

**Low pneumococcal vaccine coverage in older adults**

During 2020–2021, Only 55% of Canadian older adults aged ≥65 years reported receiving a pneumococcal vaccine as an adult (60% females vs. 48% males), which is well below the national vaccination coverage goal of 80% for pneumococcal vaccine in this population (“Vaccine uptake in Canadian adults”, 2021). The primary reason reported for not receiving a pneumococcal vaccine was the perception that pneumococcal vaccine was not necessary. Vaccine offered by a healthcare provider was strongly associated with pneumonia vaccine uptake in older Canadian adults (Schneeeberg et al, 2014). A lack of recommendation from health care professionals has been reported as one of the main reasons for older adults not receiving pneumococcal vaccination in other settings (Ipsos Healthcare, 2017). This underscores the critical role healthcare professionals should play to improve pneumococcal vaccine uptake in older adults. Measures to facilitate healthcare professionals’ knowledge on pneumococcal disease burden and prevention by vaccines could encourage healthcare professionals to offer pneumococcal vaccines to this population. Nevertheless, a lack of adult vaccine registries across Canadian jurisdictions is a major setback to improve vaccination rates as it is often difficult to ascertain pneumococcal vaccination status in adults before advising or recommending pneumococcal vaccination (Ludwig et al, 2012). A lack of individual-level pneumococcal vaccination data also precludes assessing pneumococcal vaccine effectiveness in Canadian adults in real-world settings and identifying trends in vaccine uptake (Kobayashi, 2021).

**Conclusions/recommendations**

More actions are warranted to reduce pneumococcal diseases burden in older adults to promote healthy aging. The rising burden of unique-PPV23 and non-vaccine serotype IPD underscores the need for continuing strong surveillance to better understand pneumococcal disease epidemiology, including trends in antimicrobial resistance. Concentrated efforts are needed to improve vaccination coverage in older adults. Improved vaccination coverage will reduce not only the disease burden but also reduce the use of antibiotics and antimicrobial resistance. Establishing vaccine registries across provinces and territories is critical in tracking trends in vaccine uptake and determining vaccine effectiveness to guide vaccination policy for Canadian adults. The COVID-19 pandemic has shown us the invaluable role of vaccine registries in timely assessment of vaccine uptake and vaccine effectiveness to help guide vaccination policy.
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References

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