



The impact of the universal infant varicella immunization strategy on Canadian varicella-related hospitalization rates



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ABSTRACT

Introduction: Varicella vaccine was introduced to the infant immunization schedule in each province or territory between 2000 and 2007 as a result of the Canadian Immunization Strategy. The impact of vaccinating children against this disease is potentially far reaching, as immunization may also benefit those segments of the population not immunized. The objective of this paper is to examine the effects of varicella vaccine on related hospitalizations across the entire Canadian population.

Methods: This study is an ecological study using annual hospitalization rates in all ten provinces between 1990 and 2010.

Results: There were decreased varicella-related hospitalization rates for all ages across Canada following the introduction of varicella vaccination programs. The majority of changes in hospitalization rates were greater than 70% across all ages less than 40. Statistically significant declines in hospitalization were found for children aged 1–4 (ranges from 65 to 93%), and children less than 1 (ranges from 48 to 100%). Adults aged 20–39 and 40–59 also experienced statistically significant declines (55–100%, and 39–76% respectively).

Conclusion: Results suggest that decreased circulation of varicella appears to significantly contribute to declines in varicella-related hospitalizations for infants <1, as well as adults aged 20–39.

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1. Introduction

Varicella, commonly known as chicken pox, is a highly infectious disease caused by the varicella-zoster virus (VZV). Prior to the introduction of varicella vaccine, the Public Health Agency of Canada estimated the annual incidence of uncomplicated chicken-pox to be 350,000 across all ages, and of these cases more than 1550 were hospitalized. Children are highly susceptible to varicella, with 50% of children contracting the disease by age five and 90% by age twelve [1]. Adults are more likely to have contracted the disease at a young age and are therefore immune to the disease. As a result, adult varicella incidence rates are estimated to be lower – approximately 20 per 100,000 in adults aged less than 30, and 2–5 per 100,000 in adults over 40 prior to vaccine introduction [2].

The first vaccine to protect against varicella was approved in Canada in 1998. Since 2010, three vaccines have been available to protect against varicella: Merck's VarivaxTM-III and Glaxo-SmithKline's (GSK's) univalent vaccine, VarilrixTM and quadrivalent

(MMRV) vaccine, Priorix-TetraTM. In 1999, Canada's National Advisory Committee on Immunization (NACI) recommended single-dose routine varicella vaccination for children at 12–18 months, and catch-up immunizations for susceptible individuals, including a two-doses for people over the age of 12 [3]. A one-dose varicella program for children was maintained in Canada until 2010, at which point NACI released a new 2-dose recommendation for children 12–18 months [3].

NACI's recommendations do not necessarily translate into publicly funded immunization programs. Therefore, at the time the varicella vaccines were introduced, they were only acquired through private sale. Funding for universal vaccine programs is the responsibility of individual Canadian provinces and territories. The result of this autonomy has been a staggered introduction of universal varicella vaccination across the country. Two provinces and a territory introduced varicella vaccinations between 2000 and 2002 – Prince Edward Island (PEI), Alberta (AB), and the Northwest Territories (NWT).

The federal government provided \$45 million in 2003 to develop the National Immunization Strategy to address the growing disparity in public immunization between Canadian provinces and territories [4]. In 2004, an additional per capita

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Table 1
ICD9, ICD9CM and ICD10 codes and disease classification descriptions.

Description	ICD9	ICD9CM	ICD10	Description
Postvaricella encephalitis	052	052.0	B011	Varicella encephalitis Postchickenpox encephalitis Varicella encephalomyelitis
Varicella (hemorrhagic) pneumonitis	052	052.1	B012	Varicella pneumonia
Chickenpox with other specified complications	052	052.7	B018	Varicella with other complications
Chickenpox with unspecified complication	052	052.8		
Varicella without complication	052	052.9	B019	Varicella without complication
Notes	Used by Newfoundland, PEI, QU, ON, MB, SK, BC	Used by PEI, NS, NB, ON, MB, SK, AB, BC	Introduced in 2001 by MB, SK, PEI, NS, AB, BC Introduced in 2003 NB, 2006 in QU, and 2002 in ON	

allocation of \$400 million was delivered to the provinces under the Public Health Immunization Trust [4]. By 2007 all remaining provinces and territories have instituted public varicella programs.

The benefit of mass public immunizations such as varicella potentially extends beyond those who are immunized. Specifically, those not vaccinated will also be indirectly protected against the disease – a concept known as herd immunity [5,6]. Herd immunity has been theorized to eliminate varicella outbreaks [7], and prevent illness for individuals across all age groups and levels of susceptibility [8]. This public benefit is especially significant as it has been found that cases are more likely to be complicated among older cohorts [8–15]. In particular, adults over the age of 20 were found to be thirteen times more likely to be hospitalized and twenty five times more likely to die from VZV as compared to children under the age of 12 years [8].

Direct evidence of herd immunity is difficult to attain as it is necessary to provide individual-level coverage rates of vaccination, natural immunity from previous infection, and incidence rates. Nonetheless, a number of studies have gathered indirect evidence of herd immunity through the effect of varicella vaccination on disease prevalence and varicella-related hospitalizations. This evidence has been assessed in several countries with routine varicella vaccination programs [8,16,17]. These studies largely support the hypothesis that disease prevalence and varicella related hospitalizations will decline across the population following a public infant varicella immunization program. To date there has been limited published Canadian evidence of the impact of publicly funded varicella vaccination programs on varicella-related incidence or hospitalizations. A study of Canadian children examined the effect of varicella immunization programs on varicella-related hospitalizations and found that child hospitalizations have declined [18]. Similarly, a provincial study of the effect of a universal varicella immunization program on hospitalizations in Ontario has suggested decreased circulation of varicella, as evidenced by declines in varicella-related hospitalizations, ER, and doctor's visits across all ages [19]. The objective of this study is to determine the impact of Canada's publicly-funded varicella infant immunization programs on the entire population. Specifically, this research will examine whether there is evidence to suggest decreased circulation of varicella as indicated by decreased varicella-related hospitalization rates for all ages across Canada.

2. Methods

This study is an ecological study examining the effects of varicella vaccine on varicella-related hospitalization rates in the 10 Canadian provinces (British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, Newfoundland, Prince Edward Island, Nova Scotia, and New Brunswick). Data from the three territories were not available for the time period studied.

2.1. Case definition and study population

The study population consisted of annual provincial cases hospitalized for varicella between 1994 and 2010. These were identified by searching the Canadian Institute of Health Information Discharge Abstract database [20,21]. Varicella hospitalization admissions are identified according to ICD-9 code 052, ICD-9CM code 052.X, and ICD-10 code B01 (Table 1). Consistent with other analyses [19] dual codings for varicella and herpes zoster were excluded from this analysis, admissions were included only if varicella was listed as the most responsible diagnosis. This dataset has been validated elsewhere as containing detailed diagnostic data on all hospital admissions [22].

2.2. Statistical analysis

Varicella hospitalization rates for both years prior to universal vaccination program and years following the intervention were calculated using person-years of follow-up based on annual population estimates from Statistics Canada [23]. Due to the staggered introduction of vaccination across the provinces, the pre-vaccine and post-vaccine periods differ by province (Table 2). The calculation of person-years allowed for comparison of vaccine impacts across provinces. All provinces implemented a one-dose vaccination strategy up to 2010, and all except 2 provinces also implemented a catch-up program for susceptible children aged 12 and under (Table 2) [24].

Rate ratios were calculated by province, year of hospitalization, and age. The year of vaccination is included in the pre-vaccination period. Patient's age was aggregated into 7 categories: less than 1 year; 1–4 years; 5–9 years; 10–19 years; 20–39 years; 40–59 years and 60+ years. Two-sided Chi-squared tests were performed at the 5% level of significance, and confidence intervals were calculated

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