FRASER HEALTH REPORT

Immunizations and Vaccine Preventable Diseases

2014-2015

fraserhealth

CONTENTS

A WORD FROM THE CHIEF MEDICAL HEALTH OFFICER

I am pleased to present the Chief Medical Health Officer's annual report on immunizations and vaccine-preventable diseases (VPDs), a resource for planners across health organizations and community agencies. This report will also help inform individuals from our communities with an interest in issues and trends relating to VPDs in Fraser Health.

Immunizations are one of the safest and most effective public health interventions available. Thankfully, most Fraser Health residents and healthcare providers will not experience the harmful effects of VPDs because of the strength of the provincial immunization program and the effectiveness of local efforts by public health and community providers.

Vaccines date back to 1796 when Edward Jenner used cowpox virus to prevent smallpox, a now eradicated infection. Since then we have made tremendous progress in developing vaccines that target many different communicable diseases. Despite these advances, the need for new vaccines and effective immunization programs is as present now as it was during the era of smallpox given the resurgence of VPDs such as pertussis and measles locally, nationally and globally.

2014 was a challenging year for Fraser Health – we experienced the largest measles outbreak in North America in the past 30 years. This report highlights the significance of that outbreak, and summarizes the epidemiology for VPDs in Fraser Health. The lessons that we have learned from our experiences in preventing and managing VPDs are being used to improve our immunization program and increase the level of immunization coverage in our region. Our goal by 2017 is to ensure that 80% or more of two-year olds are up-to-date for their immunizations.

To achieve this goal we need to continually improve the services that we provide in our public health units, and explore new technologies to facilitate efficient delivery of vaccines. Partnerships will also play a decisive role in achieving our goal and we will need to enhance collaboration with our primary care and community vaccine providers. Most importantly, we need to proactively dispel myths about immunizations, raise awareness and understanding about the remarkable safety and effectiveness of vaccines, and empower parents, families and communities to take action.

Together, we can protect our children, families, and communities from the threat of vaccine-preventable diseases.

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Chief Medical Health Officer and
Vice President Population and Public Health (interim)
Fraser Health Authority

ACKNOWLEDGEMENTS

I would like to acknowledge the dedicated staff for their day to day work in the prevention and control of communicable diseases within Fraser Health—the Medical Health Officers, the Communicable Diseases Committee, the Public Health Nurses and Environmental Health Officers, the Communicable Disease Nurse Coordinators and the Population Health Observatory. The production of this year's annual report would not have been possible without the efforts of Dr. Michelle Murti (MHO lead for communicable diseases) and Christina Fung (epidemiologist). I would also like to thank our regional health authority and provincial partners as well as the BC Centre for Disease Control for providing additional data for the purposes of this report.

EXECUTIVE SUMMARY

Purpose

This year's annual report from the Office of the Chief Medical Health Officer is focused on vaccine-preventable diseases (VPDs) and immunizations in Fraser Health. This information is intended to inform Fraser Health programs, health care providers, schools, non-governmental organizations, and community partners. The report contains statistics, in-depth case and outbreak summaries, a description of the immunization program and the recent work towards improving immunization coverage for children under 2 years old in the Fraser Health region.

Vaccine-preventable diseases

British Columbia (BC) has a robust immunization program and there are currently 16 VPDs that are covered by routine vaccinations. This report contains summary statistics of the incidence of select reportable VPDs in Fraser Health over the past 5 years (2009-2013), as well as descriptions of the cases reported.

- Infections from diphtheria, *Haemophilus influenzae* type b, rubella, and tetanus have become almost non-existent in Canada. In the past 5 years, there have only been 8 cases from all of these infections in Fraser Health, and all but 1 case were un-immunized or incompletely immunized.
- Cases of invasive meningococcal disease are also rare. There was only 1 case in the past 5 years due to serogroup C, the strain covered by immunizations in BC, and it was in an adult who would not have received his immunization as a child.
- Incidence of invasive pneumococcal disease have increased in recent years in Canada, BC and Fraser Health. The most recent introduction of the 13-valent pneumococcal conjugate vaccine to BC in 2010 appears to be coincident with a decline in the incidence of infection for children under 2 years of age, but an increase in cases in those 65 years of age and older in Fraser Health.
- Mumps remains endemic in BC. In Fraser Health, sporadic cases as well as periodic outbreaks of mumps infection contribute to ongoing infection.
- Measles has been eliminated in Canada; however, importations of illness from other countries lead to sporadic cases and clusters, as well as larger outbreaks.
- Pertussis is still widely prevalent in Fraser Health, along with the rest of Canada and worldwide, due to cyclical peaks of activity every few years punctuating baseline endemic rates.

Outbreaks

There have been several outbreaks of vaccine-preventable infections in recent years in Fraser Health. This report highlights three of the major outbreaks: mumps in 2011, pertussis in 2012, and measles in 2014.

- The mumps outbreak of 2011 was initially associated with a ski resort in Whistler, BC, and spread to the Lower Mainland of BC, which includes the Fraser Health region. While most cases of illness occurred in those who were unvaccinated or incompletely vaccinated, 14% of the 29 cases in Fraser Health were in those who reported having had two doses of mumps-containing vaccine.
- The pertussis outbreak of 2012 was associated with a large outbreak that spread throughout pacific North America, particularly in California and the northwest. By the end of 2012, there were 175 cases of pertussis in Fraser Health.
- The 2014 measles outbreak in the Fraser Valley resulted in the largest outbreak in BC in the past 30 years. There were 422 cases of measles associated with the outbreak, and 1% of cases resulted in severe illness. Almost all of the cases were not immunized against measles; only 2 cases had a history of 2 doses of measles vaccine.

Immunizations

There is a mixed model of delivery of the routine immunizations in Fraser Health. Early childhood vaccinations are given at 2, 4, 6, 12, and 18 months of age, with a booster at 4 to 6 years of age with school entry. Approximately two-thirds of these are delivered by Public Health Nurses with the remainder given by primary care providers. School-based immunization clinics are delivered by Public Health to children in Grades 6 and 9. Influenza vaccines are provided seasonally, and catch-up immunizations are provided at any age to ensure children are up-to-date.

Coverage assessments of how well the population is immunized are measured for children at 2 years of age and at 7 years of age (i.e. after their school-entry booster). Coverage for children receiving the Grade 6 and 9 immunizations is also routinely reported.

- The percentage of children who are up-to-date for their immunizations at 2 years of age in Fraser Health has increased from 61.5% in 2009 to 67.7% in 2013.
- Children who are not up-to-date by age 2 years are most often missing their 18 month booster doses. The percentage of children up-to-date minus the 18 month booster increased from 69.9% in 2009 to 76.5% in 2013.
- The provincial target for up-to-date coverage at 2 years old is 90% by 2023.
- In 2013, there was a change in the way school-age coverage is assessed in BC. Prior to 2013, coverage was reported as the proportion of children enrolled in Kindergarten who were up-to-date by each vaccine. Overall up-to-date coverage at 7 years of age is the new reporting statistic that is available from 2012 onwards. For Fraser Health, up-to-date at 7 years of age increased from 66% in 2012 to 68% in 2013.

- Grade 6 children receive immunizations for meningococcal (serogroup C), hepatitis B (if not previously received in infancy) and varicella (chickenpox), and girls receive HPV vaccine. Hepatitis B and meningococcal coverage remain high at 88%, and varicella coverage was 83% in 2012/13. HPV coverage has increased from 61.6% in 2008/09 to 71.0% in 2012/13.
- Grade 9 children receive their adolescent booster dose for diphtheria, pertussis, and tetanus. Coverage for being up-to-date for all doses of pertussis has declined from 86.2% in 2008/09 to 81.6% in 2012/13, and the combined coverage for diphtheria and tetanus has declined from 88.9% to 84.6% in the same time period.

Immunization Program Review

Up-to-date coverage at 2-year old is now a key performance indicator for Fraser Health with a target of 80% by 2017. Over the past year, a number of initiatives were started with the intent of assessing our current state, understanding where the gaps are, and putting forward recommendations for improving coverage in Fraser Health.

- A detailed assessment of our own immunization coverage data analyzed where children are falling off the schedule or not getting their doses in on time. We identified that 94% of children start their immunizations, but coverage and the timeliness of doses falls off with each subsequent visit. There is a need for keeping parents and children on schedule and to get all the recommended doses on time at each visit.
- Interviews with parents of children who were not up-to-date by 21 months of age identified barriers that parents face. We identified a need for enhanced reminder systems about upcoming appointments and when children are due, and a need for having clinics that accommodate busy parents to make it easier to come in.
- A survey to the ten Divisions of Family Practice in Fraser Health identified a declining workforce of general practitioners who are providing routine childhood immunizations in their practice. Their barriers to providing these immunizations included issues of not having enough time, insufficient compensation and challenges with reporting vaccine records to public health. We identified a need to support primary care providers who are providing immunizations, as well as the need for resources for all providers so they can effectively advocate for vaccines with their patients.
- Through our current state assessment, literature review, and jurisdiction scan, we identified 2 mains ares of focus to improve coverage rates including 1) ensuring that children complete the full series to 18 months of age, and 2) ensuring that immunization records accurately reflect coverage levels.
- We identified several recommendations to promote the completion of the immunization series, including developing an overall quality improvement strategy and immunization promotion plan, enhancing the use of reminders and the efficiency of clinic processes, and supporting physician-delivered immunizations. We have also identified the need to improve the accuracy of immunization records through improved technological resources and collaboration with primary care providers and parents reporting their immunizations.

INTRODUCTION

Fraser Health provides a variety of programs and services aimed at reducing and eliminating communicable diseases in our community. This includes Public Health programs that range from health promotion activities to childhood immunizations services offered by the 18 local Public Health Units (PHU) serving over 1.68 million residents throughout the Fraser Health region (Figure I).

Within Public Health, the Communicable Disease Control program follows up on all reportable diseases, including vaccine-preventable infections. Follow-up consists of case investigations and a range of public health measures to control the spread of infection, including education, isolation, contract tracing, and the use of antibiotics or vaccine products for those exposed (known as post-exposure prophylaxis). On average, over 6,500 cases of reportable communicable diseases[1], were reported and investigated by Public Health each year between 2009 and 2013. In addition to

> "As a Communicable Disease Nurse Coordinator (CDNC), I consult with Public Health Nurses working with the immunization and CD programs. On any given day, I may be asked about whooping cough, meningitis or possible measles cases. Other days it may be immunization schedules for a routine series for an infant or a complex schedule for a high risk individual (e.g. someone who is restarting a vaccine series after a bone marrow transplant). No day is the same and each day brings new challenges."
>
> - CD Nurse Coordinator

Figure I Public Health Unit Locations in Fraser Health

[1] A list of reportable communicable diseases in British Columbia is included in Appendix B

case follow-up, routine monitoring of disease and enhanced surveillance is conducted in partnership between the Population Health Observatory, the front line Communicable Disease (CD) teams, which includes nursing and environmental health staff in consultation with Medical Health Officers, and the British Columbia Centre for Disease Control (BC CDC) as required.

In addition to individual cases of diseases, it is a Public Health priority to investigate and manage communicable disease outbreaks as quickly as possible. Outbreaks may be limited to a household or a classroom, while others can be large and involve many people and areas. Public Health works in partnership with the affected community to successfully manage an outbreak response. This may include working closely with community leaders, schools, community physicians, and pharmacy partners to provide education and prophylaxis to the community as needed for disease prevention and control.

Immunization is a cornerstone of public health practice and one of the most effective health measures for protecting children and adults against vaccine-preventable diseases. Immunization services are provided within the Fraser Health region through a mixed service delivery model involving local PHUs, general physicians, and community pharmacists. Routine childhood immunizations are available through local PHUs and community physicians for the over 17,000 children born in Fraser Health each year.[2] Of the over 200,000 routine childhood immunizations provided to residents of Fraser Health in 2012, approximately two-thirds (66%) of these where administered by nurses at local PHUs.[3] Children aged 5 and over and adults can choose to receive their immunizations via Public Health, their physician, or through an immunizing pharmacist. School-based immunization services are also provided by Public Health across the region and include the review of immunization records for those entering Kindergarten as well as immunization clinics delivered in schools for those in Grade 6 and Grade 9 (see Appendix C for a list of immunizations provided to school-aged children). Immunization coverage rates are regularly reviewed with the goal of achieving target levels of immunity in the community.

> "As CDNCs we receive calls from multiple sources with various concerns ranging from simple immunization questions to complex CD follow up. Our team works together to provide support and guidance to frontline Public Health Nurses, physicians, and to our acute care partners regarding VPDs. What is reassuring to us is the strong skill set amongst many frontline Public Health Nurses that give CDNCs support in efficiently managing an outbreak of a disease. This enables us to feel confident that our community is looked well after."
>
> - CD Nurse Coordinator

[2] BC Vital Statistics Agency; prepared by the Population Health Surveillance, Engagement and Operations branch , Population and Public Health, Ministry of Health, November 2014.

[3] Immunization provider type data extracted from the integrated Public Health Information System (iPHIS) for January 1 to Dec 31,2012.

SECTION 1

VACCINE PREVENTABLE DISEASES IN FRASER HEALTH

In 2013, the Centers for Disease Control and Prevention (CDC) listed "Immunizations" first in their list of the ten great public health achievements of the 20th century.[4] Significant reductions in the burden of these communicable diseases have resulted in generations that have grown up without knowing the paralysis of polio or seeing their child unable to breathe from *Haemophilus influenzae* type b epiglottitis. Without experiencing the devastations of these diseases and the benefits of immunizations, concerns about the safety and efficacy of immunization can lead to complacency about the need to maintain a high immunization coverage rate in the population. In the Fraser Health region, ongoing cases and periodic outbreaks of vaccine-preventable diseases are a reminder of this importance.

The current routine childhood immunization schedule in BC (Appendix C) provides vaccine protection against 16 diseases including:

- Diphtheria
- *Haemophilus influenzae* type b (Hib)
- Hepatitis A
- Hepatitis B
- Human papillomavirus (HPV)
- Influenza
- Measles
- Meningitis, serogroup C
- Mumps
- Pertussis
- Pneumococcal disease
- Polio
- Rotavirus
- Rubella
- Tetanus
- Varicella

Of these vaccine-preventable diseases, rotavirus, varicella (chicken pox), and human papillomavirus (HPV) are not reportable to public health, and are therefore excluded from disease surveillance and this report. While influenza, hepatitis A, and hepatitis B are reportable, most community cases of influenza are not captured and more detailed summaries of hepatitis A and hepatitis B infections are included elsewhere in provincial reports.[5,6] In the past 5 years (2009-2013), there were no cases of polio or congenital rubella syndrome in Fraser Health. For the remaining vaccine-preventable infections, the following sections describe their 5-year epidemiology in Fraser Health, as well as more detailed reviews of recent outbreaks. The 2009 to 2013 period was selected for analysis as 2014 data was not available at time of compilation of this report and only confirmed cases are presented, unless otherwise specified.

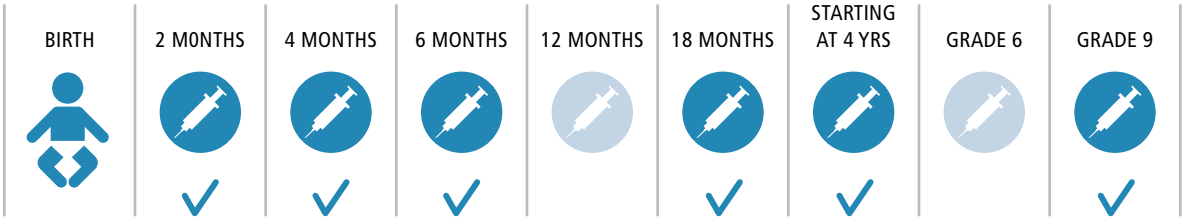
[4] Centre for Disease Control and Prevention. (2013). Ten great public health achievements in the 20th century. Retrieved from: http://www.cdc.gov/about/history/tengpha.htm

[5] BC CDC. (2014). BC CDC EHSSS Site Report 2000-2011. Retrieved from: http://www.bccdc.ca/NR/rdonlyres/76BB526B-3241-40A2-8404-5576FED076E5/0/EHSSS_BCCDC_Site_Report_200011Final_forWeb.ppt

[6] BC CDC. (2014). Hepatitis A Update – British Columbia 2012-2013. Retrieved from: http://www.bccdc.ca/NR/rdonlyres/AA5A3C07-561E-4238-89B6-807A8BEB3BA9/0/BCCDC20122013HepatitisAReportv4_formatted.pdf

1.1 DIPHTHERIA

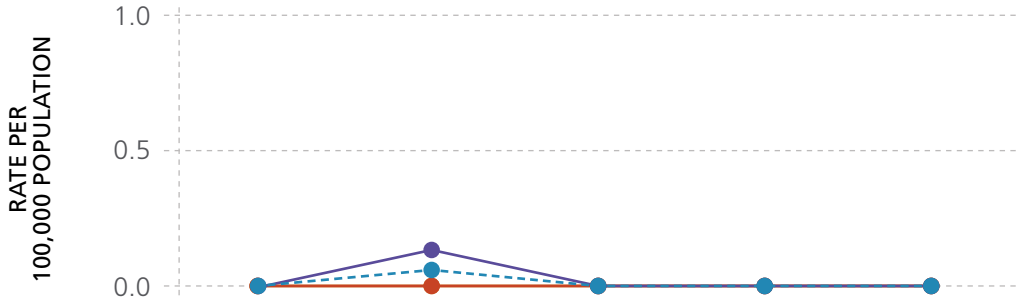
Routine Childhood Immunization Schedule



Diphtheria is caused by infection of the mucous membranes of the upper respiratory track and skin by the bacterium *Corynebacterium diphtheria*. It is commonly spread through person-to-person contact and symptoms generally include a sore throat, fever, and difficulty breathing. Prior to the introduction of routine diphtheria vaccination in the 1930's, diphtheria was a common cause of childhood illness and mortality. Currently, diphtheria is rarely observed in Canada due to widespread routine childhood immunization.[7]

Between 2009 and 2013, only 1 confirmed case of acute diphtheria was reported in Fraser Health in 2010 (Figure 1-1). The case was an adult male who was partially immunized. This case was related to travel to South Africa and was a case of cutaneous (skin infection) diphtheria that is most common in tropical regions of the world.

Figure 1-1 Confirmed diphtheria cases and rates (per 100,000) in Fraser Health by HSDA, 2009 to 2013

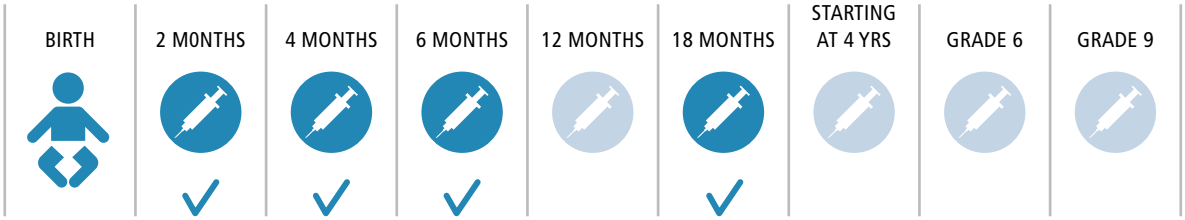


		2009	2010	2011	2012	2013
RATES	Fraser East	0.0	0.0	0.0	0.0	0.0
	Fraser North	0.0	0.0	0.0	0.0	0.0
	Fraser South	0.0	0.14	0.0	0.0	0.0
	Fraser Health	**0.0**	**0.06**	**0.0**	**0.0**	**0.0**
CASES	Fraser East	0	0	0	0	0
	Fraser North	0	0	0	0	0
	Fraser South	0	1	0	0	0
	Fraser Health	**0**	**1**	**0**	**0**	**0**

[7] Public Health Agency of Canada. (2014). Vaccine-Preventable Diseases - Diphtheria. Retrieved from: http://www.phac-aspc.gc.ca/im/vpd-mev/diphtheria-diphterie-eng.php

1.2 *HAEMOPHILUS INFLUENZAE* TYPE B

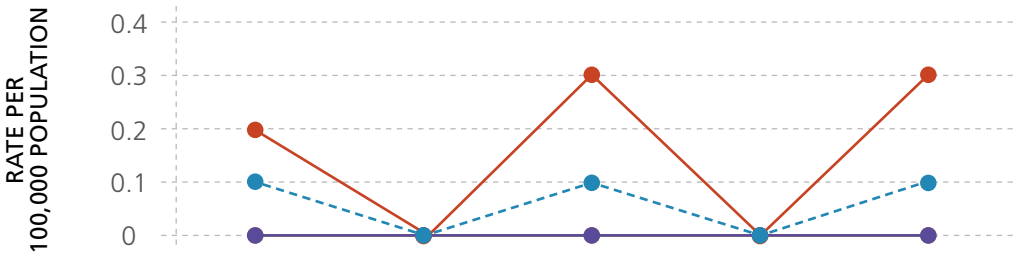
Routine Childhood Immunization Schedule



Invasive *Haemophilus Influenzae* type b (Hib) disease is caused by a bacterial infection. It can cause severe illness in children such as meningitis (inflammation of the membranes covering the brain and spinal cord), bacteremia (presence of live bacteria in the blood), and epiglottitis (inflammation of the flap which lies at the base of the tongue). Since the introduction of the first conjugate Hib vaccines in Canada in 1988, the incidence of invasive disease due to Hib has decreased by 95% compared with the pre-vaccine era to less than 0.08 cases per 100,000 between 2006 and 2012.[8]

In Fraser Health, 5 cases of Hib were reported between 2009 to 2013 from Fraser North (Figure 1-2). In 2009, there was 1 case reported in an infant less than 1-year of age who had completed a primary series of vaccine but was too young to receive a booster dose which is generally given at 18 months of age for toddlers. Between 2011 and 2013, 4 cases were reported in adults (3 males, 1 female) ranging from 38 to 53 years of age. Of the 4 adult cases, 3 had a history of drug and alcohol abuse and 2 cases experienced serious complications, including sepsis, pneumonia and endocarditis (an infection of the heart valves or lining of the heart caused by bacteria entering into the bloodstream).

Figure 1-2 Confirmed invasive *Haemophilus Influenzae* type b cases and rates (per 100,000) in Fraser Health by HSDA, 2009 to 2013

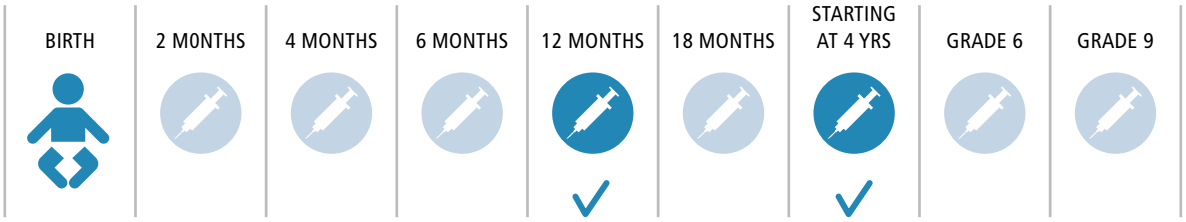


		2009	2010	2011	2012	2013
RATES	Fraser East	0.0	0.0	0.0	0.0	0.0
	Fraser North	0.2	0.0	0.3	0.0	0.3
	Fraser South	0	0.0	0.0	0.0	0.0
	Fraser Health	**0.1**	**0.0**	**0.1**	**0.0**	**0.1**
CASES	Fraser East	0	0	0	0	0
	Fraser North	1	0	2	0	2
	Fraser South	0	0	0	0	0
	Fraser Health	**1**	**0**	**2**	**0**	**2**

[8] Public Health Agency of Canada. (2014). Vaccine-Preventable Diseases - *Haemophilus influenzae* disease. Retrieved from: http://www.phac-aspc.gc.ca/im/vpd-mev/hib-eng.php

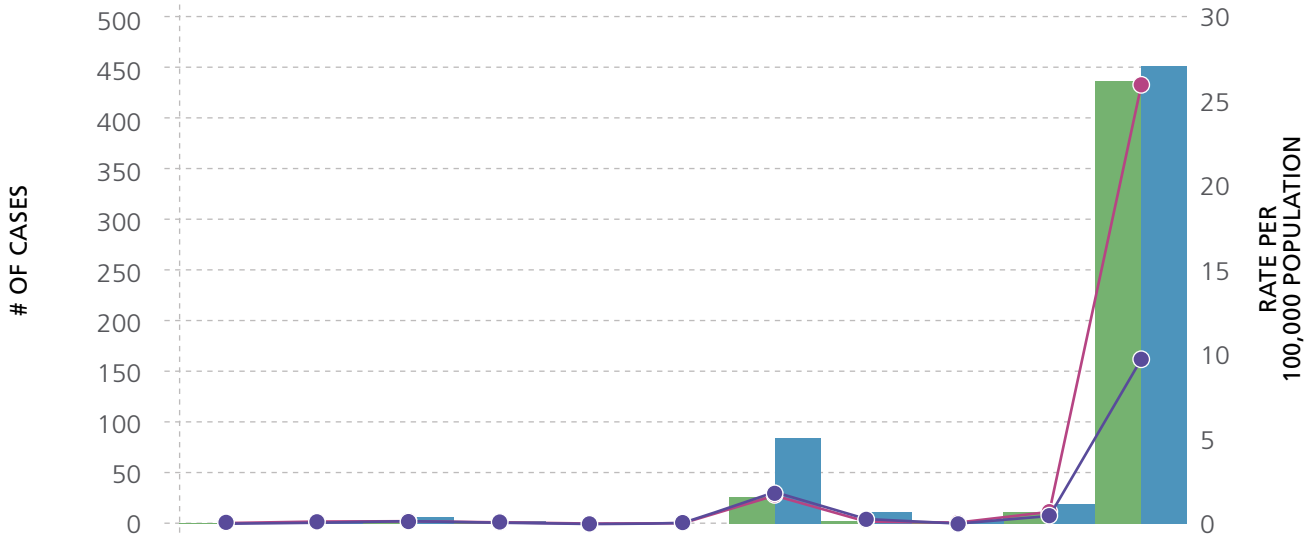
1.3 MEASLES

Routine Childhood Immunization Schedule



Measles is a highly contagious viral illness that causes fever, rash, and symptoms of cough, runny nose, and conjunctivitis. It is transmitted from one person to the next by sharing the same airspace and by direct contact with droplets from nasal or throat secretions. The disease is more severe in infants and those with immune compromising conditions, and complications include encephalitis (inflammation of the brain), pneumonia, seizures, hearing loss, and death.[9] As a result of the introduction of childhood immunization programs, measles is considered eliminated in Canada[10], although sporadic cases do occur due to importations from endemic countries. While historical levels of measles have been low, Fraser Health has recently experienced increased measles activity due to outbreaks in 2010 (associated with the 2010 Olympics) and in 2014 (Figure 1-3).

Figure 1-3 Reported confirmed and clinical cases and rates of measles (per 100,000), Fraser Health and BC, 2004 to 2014*.



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014*
Fraser Health Rate	0.07	0.14	0.13	0.07	0.00	0.00	1.62	0.12	0.06	0.66	25.79
BC Rate	0.02	0.05	0.14	0.05	0.00	0.00	1.88	0.24	0.04	0.41	9.60
Fraser Health Cases	1	2	2	1	0	0	26	2	1	11	438
BC Cases	1	2	6	2	0	0	85	11	2	19	456

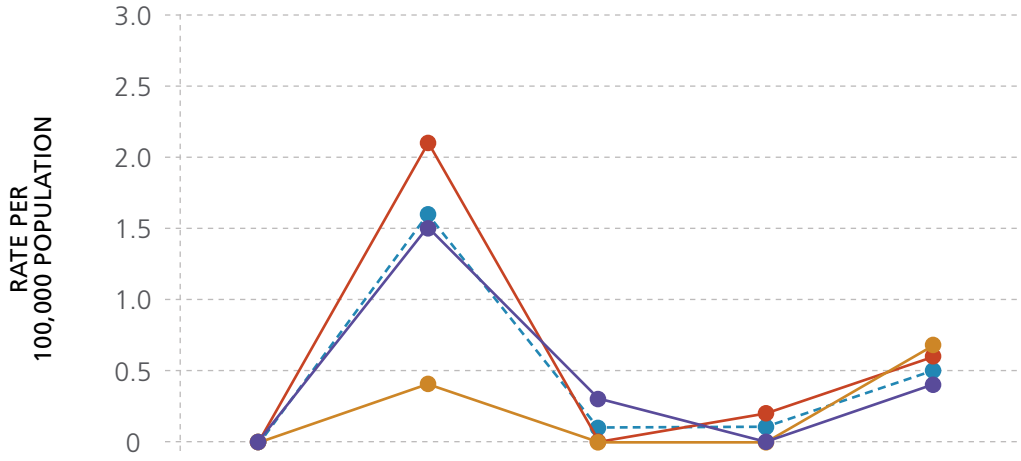
Source: Cases extracted from iPHIS. Population data extracted from BC Stats, 2013 PEOPLE estimates.
*2014 YTD total includes cases reported in iPHIS up to September 21, 2014

[9] Public Health Agency of Canada. (2014). Canadian Immunization Guide - Measles Vaccine. Retrieved from: http://www.phac-aspc.gc.ca/publicat/cig-gci/p04-meas-roug-eng.php

[10] Public Health Agency of Canada. (2013). Elimination of measles, rubella and congenital rubella syndrome in Canada: Documentation and Verification Report. Retrieved from: http://www.phac-aspc.gc.ca/im/vpd-mev/measles-rougeole-mrer-eng.php

Figure 1-4 illustrates the rates of confirmed cases of measles in Fraser Health between 2009 and 2013. During this period, rates of measles peaked at 1.6 cases per 100,000 in 2010 and 25 cases of confirmed measles were reported that year. All cases with the exception of one were associated with the 2010 Winter Olympics in BC. The non-outbreak related case had no documented doses of MMR, but claimed he was fully vaccinated as a child. The infection was likely acquired abroad in Zambia and no secondary transmission was associated with this case. In 2011, two confirmed cases of measles were reported in unimmunized twin infants (<1 year old) from Fraser South. The two cases were linked to travel in India where they likely acquired the virus (genotype D8) and did not result in any known transmission of disease within BC. In 2012, a confirmed case of measles was reported in an adult male and was linked to travel abroad. In 2013, 9 cases of measles were reported involving 3 known clusters imported from endemic areas. One cluster was identified in early 2013 involving an adult case who traveled to Thailand and resulted in secondary transmission to a sibling who shared the same household. Both cases were conscientious objectors and therefore unimmunized. A second cluster was identified in the summer involving an importation of measles from the Netherlands. A third cluster in the late summer involved 3 laboratory confirmed cases with the same genotype (B3), but none of the 3 had traveled abroad, been exposed to measles, or had any exposure to each other. One of the cases was less than 1 year of age (too young to be immunized), but the other two self-reported a history of measles immunization. Of over 300 contacts followed with this third cluster, only 1 case of secondary transmission was identified in an unimmunized 3 year old child.

Figure 1-4 Confirmed measles cases and rates (per 100,000) by HSDA, 2009 to 2013



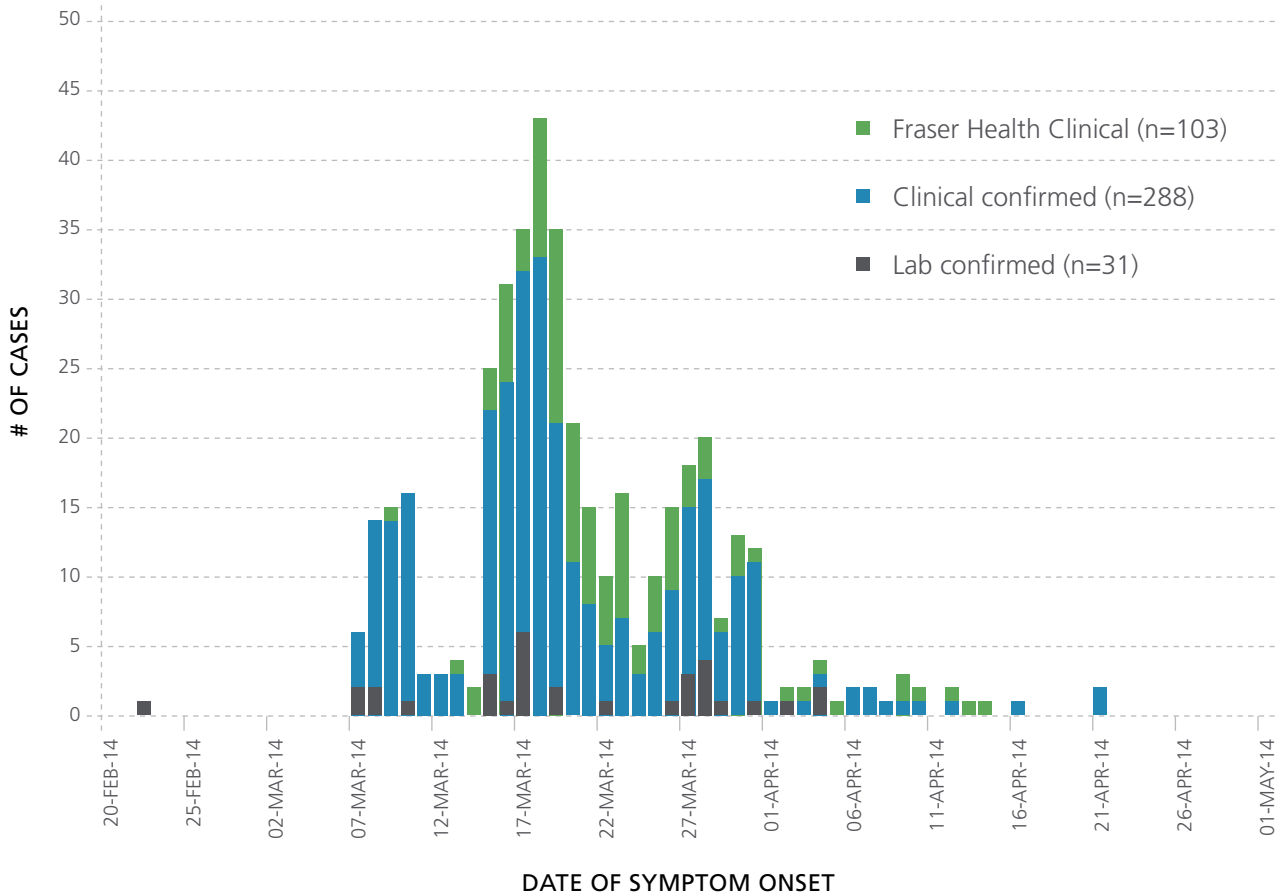
		2009	2010	2011	2012	2013
RATES	Fraser East	0.0	0.4	0.0	0.0	0.7
	Fraser North	0.0	2.1	0.0	0.2	0.6
	Fraser South	0.0	1.5	0.3	0.0	0.4
	Fraser Health	**0.0**	**1.6**	**0.1**	**0.1**	**0.5**
CASES	Fraser East	0	1	0	0	2
	Fraser North	0	13	0	1	4
	Fraser South	0	11	2	0	3
	Fraser Health	**0**	**25**	**2**	**1**	**9**

Measles outbreak in 2014

In March 2014, an outbreak of measles began in a religious school in Fraser East. Public health officials were notified by the principal of a number of measles cases in the school and community. Over the next several weeks, measles had spread through the community, led to closure of the school, and resulted in the largest measles outbreak in BC in almost 30 years.

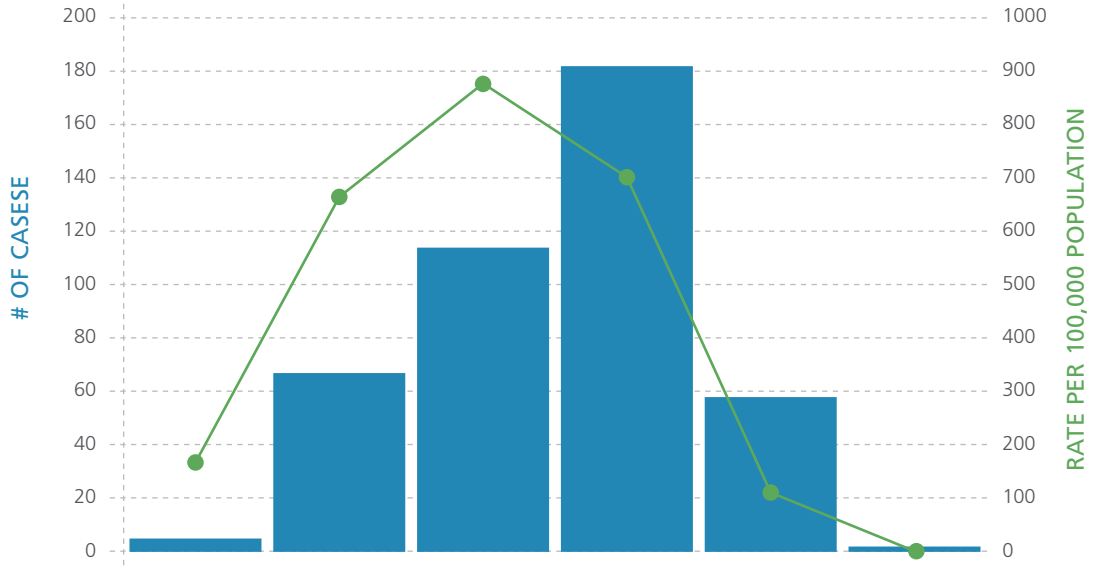
By the end of April, there were 422 reported cases of measles associated with the outbreak, including 31 laboratory confirmed, 288 epidemiologically-linked (clinical confirmed) cases, and 103 "Fraser Health Clinical cases". Most cases did not present for laboratory testing to be able to confirm their case status. However, the close connections of the contacts affiliated with the school and church necessitated the creation of the outbreak case definition "Fraser Health Clinical cases". These were members of the community who did not have a direct epidemiological link to a laboratory-confirmed case, but were affiliated with the community where measles was spreading and had clinically compatible symptoms of measles. The epidemic curve of the measles outbreak is shown in Figure 1-5. The majority of cases (294, 70%) were school-aged (5 to 19 years) with a median age of 10 years (range: <2 months to 43 years). With the outbreak spread starting from the school, case identification was focused on school class lists. Subsequently, the identified case attack rate was highest for children 5 to 9 years of age at a rate of 877.7 cases per 100,000 population (Figure 1-6). Of the reported cases, more severe illness was reported in 5 cases (1%) including 1 case with encephalitis, 1 case of febrile seizure, and 3 cases of pneumonia. There were a total of 3 cases hospitalized during the outbreak, including 2 children who were less than 5 years of age.

Figure 1-5 Epidemic curve of 2014 measles outbreak in Fraser Health by date of illness onset.



Note: Onset date based on rash or, if unavailable, prodrome onset date.

Figure 1-6 Age distribution and attack rates (per 100,000) among reported measles cases.



	<1	1-4	5-9	10-19	20-39	40+
Rate per 100,000	166.4	662.4	877.7	703.2	108.6	0.9
Cases	4	66	113	181	57	1

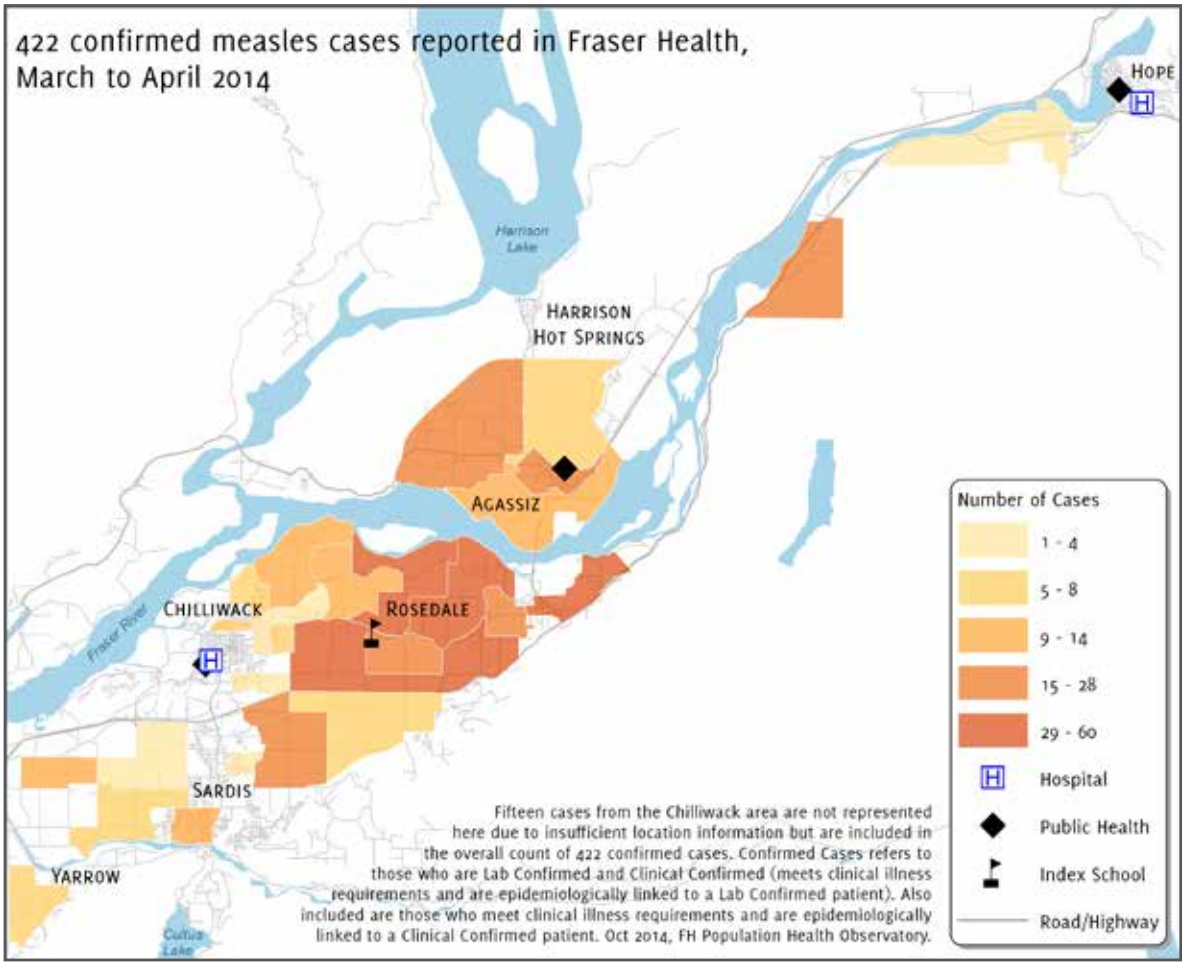
Sources: Cases include those reported between Feb 1 and April 30, 2014. Population data from BC Stats PEOPLE 2013 Projections for Chilliwack, Agassiz and Hope Local Health Areas.

Genotyping of the virus strains from lab-confirmed cases found they were the same as the circulating strain from the measles outbreak in the Netherlands that caused over 2,600 cases between May 2013 to March 2014. While the initial case from this Fraser Health outbreak was never identified, it was presumed that it was a travel-related importation from the Netherlands. While several communities reported cases of measles during the outbreak, the majority were affiliated with communities that have close links to the Netherlands. The school where the outbreak was first identified has a student population with less than 5% measles immunization coverage. Without vaccine protection, measles spread rapidly through the community to all those who were not previously immune from measles illness. To control the outbreak and further spread, Fraser Health worked closely with religious and school leaders to ensure those who

were ill were self-isolating while infectious. The school closed early for spring break and remained closed for 3 weeks. As a result of this partnership, there was very limited spread of measles outside of the religious community.

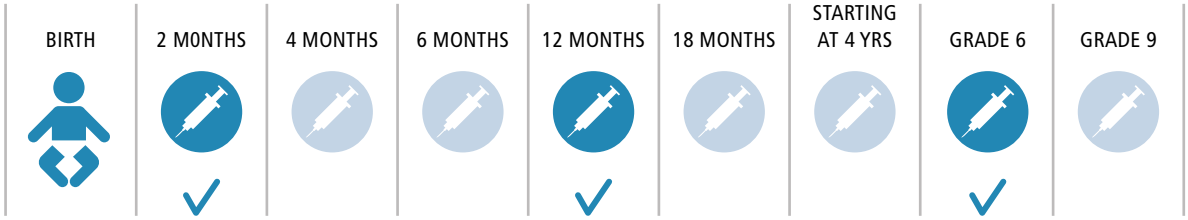
The geographical spread of the outbreak is illustrated in Figure 1-7. Only 5 cases were identified in individuals not affiliated with the religious community, including 3 cases from the same family cluster (with 2 unvaccinated children) and 2 cases who reported having received two doses of MMR. Further spread beyond the religious community was also limited by surrounding communities with higher rates of measles vaccine coverage. For Fraser Health, the Kindergarten 2-dose measles coverage estimate was 87.7% in 2013. Control measures also focused on increasing measles immunity in the surrounding areas. Immunization clinics for the public were established in at-risk areas, and all Fraser Health staff were required to have proof of measles immunity to work in a patient care setting.

Figure 1-7 Geographical distribution of reported measles cases, Fraser East, 2014.



1.4 INVASIVE MENINGOCOCCAL DISEASE

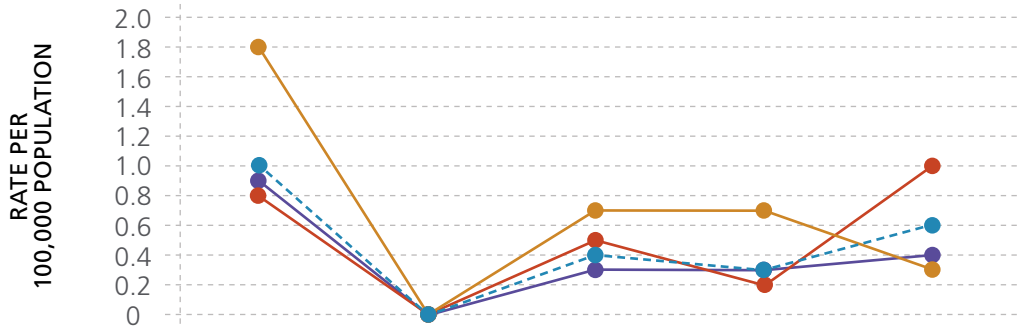
Infant and Childhood Immunization Schedule



Invasive meningococcal disease (IMD) is a serious illness caused by the bacterium *Neisseria meningitidis*. IMD can be spread through direct contact with respiratory secretions of an infected person and infection can result in meningitis, septicemia (blood poisoning) and pneumonia. The meningococcal bacteria can be classified into at least 12 different serogroups based on differences in the polysaccharide capsule, of which 5 (A, B, C, W-135 and Y) are most frequently associated with disease. IMD remains endemic in Canada and infants under 1 year of age are at the greatest risk for infection. The meningococcal conjugate C (Men-C) vaccine prevents against one of the most common strains of meningococcal bacteria, serogroup C,[11] and has been offered as part of the routine childhood immunization in BC since 2003. A meningococcal quadrivalent conjugate vaccine against serotypes A, C, Y and W-135 (Men A/C/Y/W-135) is not part of the routine immunization in BC but is provided to those children and adults who are at increased risk of IMD.

Between 2009 and 2013, an average of 7.6 cases of confirmed IMD[12] was reported annually in Fraser Health and incidence rates of IMD were highest in 2009 at 1.0 cases per 100,000 population (Figure 1-8).

Figure 1-8 Confirmed invasive meningococcal disease cases and rates (per 100,000) in Fraser Health by HSDA, 2009 to 2013

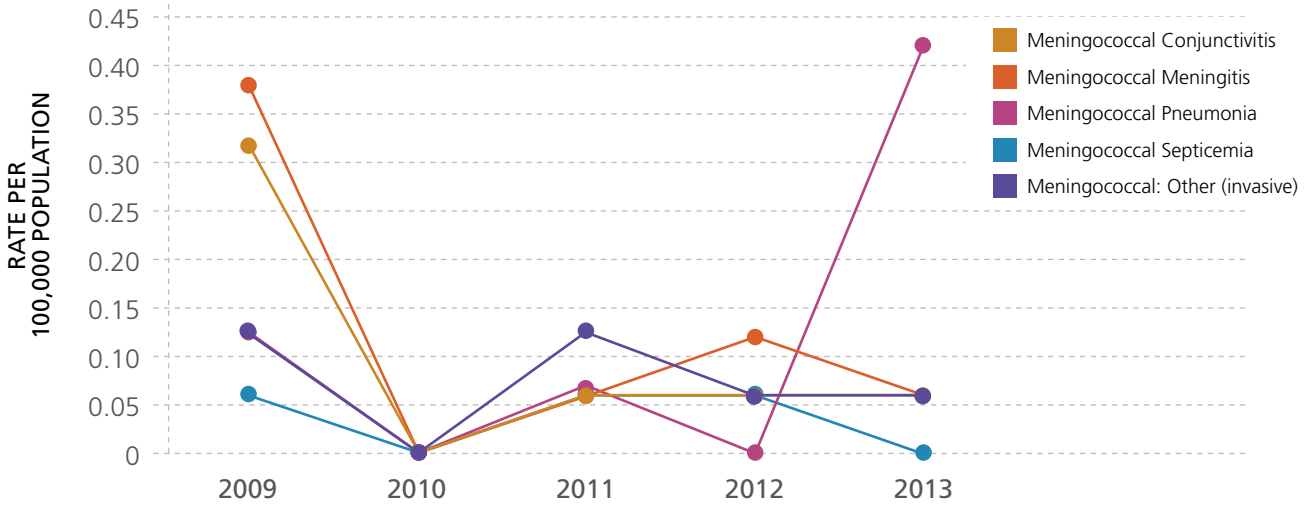


		2009	2010	2011	2012	2013
RATES	Fraser East	1.8	0.0	0.7	0.7	0.3
	Fraser North	0.8	0.0	0.5	0.2	1.0
	Fraser South	0.9	0.0	0.3	0.3	0.4
	Fraser Health	**1.0**	**0.0**	**0.4**	**0.3**	**0.6**
CASES	Fraser East	5	0	2	2	1
	Fraser North	5	0	3	1	6
	Fraser South	6	0	2	2	3
	Fraser Health	**16**	**0**	**7**	**5**	**10**

[11] Public Health Agency of Canada. (2014). Canadian Immunization Guide - Meningococcal Vaccine. Retrieved from: http://www.phac-aspc.gc.ca/publicat/cig-gci/p04-meni-eng.php

[12] Includes all reportable meningococcal disease which is comprised of meningococcal conjunctivitis, meningococcal meningitis, meningococcal pneumonia, meningococcal septicaemia, and meningococcal: other (invasive).

Figure 1-9 Rates of confirmed cases of invasive meningococcal disease (per 100,000) by reportable type, 2009 to 2013

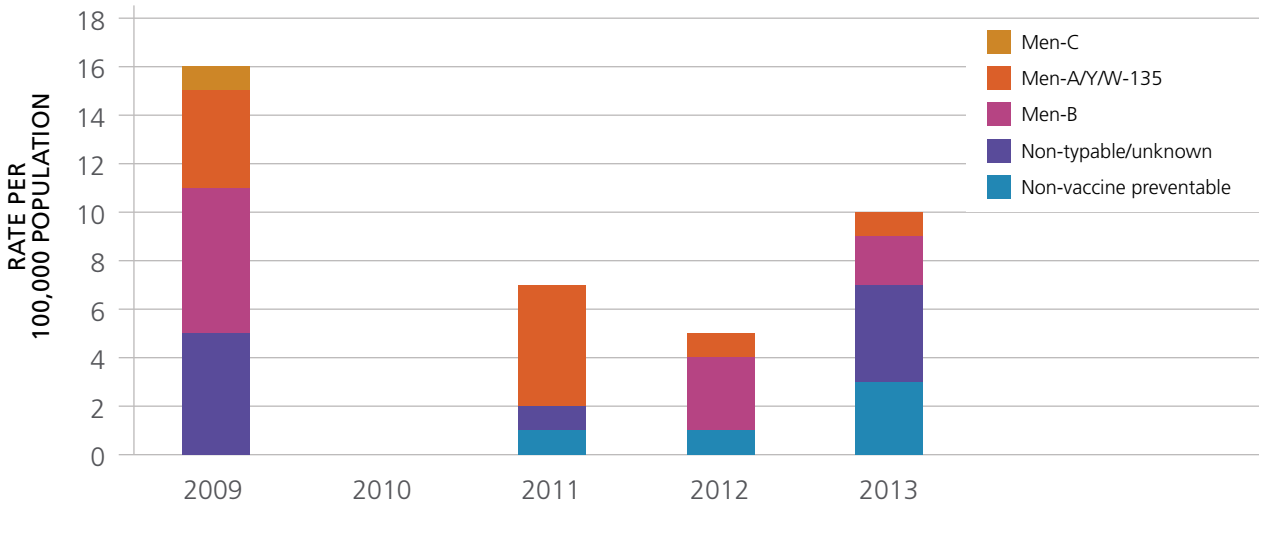


Sources: Cases extracted from iPHIS. Population data extracted from BC Stats, 2014 PEOPLE.

The median age of all reported IMD cases was 52 years, of which 5 cases (13%) were less than 1 years of age. In 2009, meningococcal meningitis was the most commonly reported (n=6) presentation of IMD, followed by meningococcal conjunctivitis (n=5). In 2013, the most common presentation was meningococcal pneumonia (n=7) (Figure 1-9).

Of the 38 cases of IMD between 2009 to 2013, there has been only 1 case where serogroup C was identified as the strain type. This was reported in an adult male in 2009 who would have not been immunized through the routine immunization program as this was only introduced to infants and children starting in 2003 (Figure 1-10). The decline in serogroup C disease is attributable to vaccination of infants and children in Grade 6 and is consistent with that observed elsewhere in BC.[13] The most commonly identified serogroup identified in reported IMD cases from 2009 to 2013 was due to serogroup B (11/38, 29%). A new vaccine against serogroup B has recently been approved by Health Canada, but is not currently part of the routine childhood schedule.

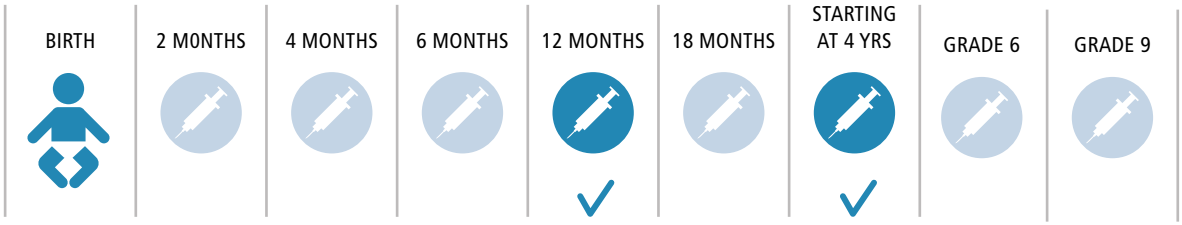
Figure 1-10 Confirmed cases of reportable invasive meningococcal disease in Fraser Health by vaccine serogroups, 2009 to 2013



[13] BC CDC. (2014). British Columbia Annual Summary of Reportable Diseases 2013. Retrieved from: http://www.bccdc.ca/NR/rdonlyres/D8C85F70-804C-48DB-8A64-6009C9FD49A3/0/2013CDAnnualReportFinal.pdf

1.5 MUMPS

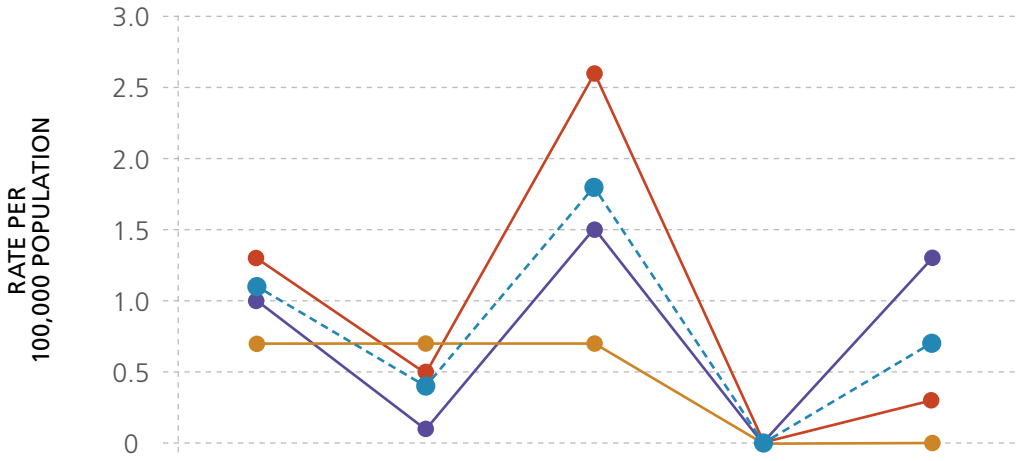
Infant and Childhood Immunization Schedule



Mumps is a viral infection that is characterized by fever, cold-like symptoms and swelling of the parotid gland on the sides of the face (parotitis). Some cases of mumps may remain asymptomatic, while others can lead to complications of hearing loss, orchitis (inflammation of the testes), meningitis or encephalitis. Mumps is highly infectious and is spread through saliva and respiratory droplets. It remains endemic in Canada and globally.[14]

In BC, mumps activity had begun to decline after the introduction of the 2nd dose of MMR as part of the routine immunization schedule in 1996. Between 2009 and 2013, there has been ongoing mumps activity in Fraser Health, with as many as 29 cases reported in 2011 (associated with a provincial outbreak) (Figure 1-11). In 2013, there were 12 confirmed cases of mumps reported in Fraser Health, including both travel-related and locally-acquired infections.

Figure 1-11 Confirmed mumps cases and rates (per 100,000) in Fraser Health by HSDA, 2009 to 2013



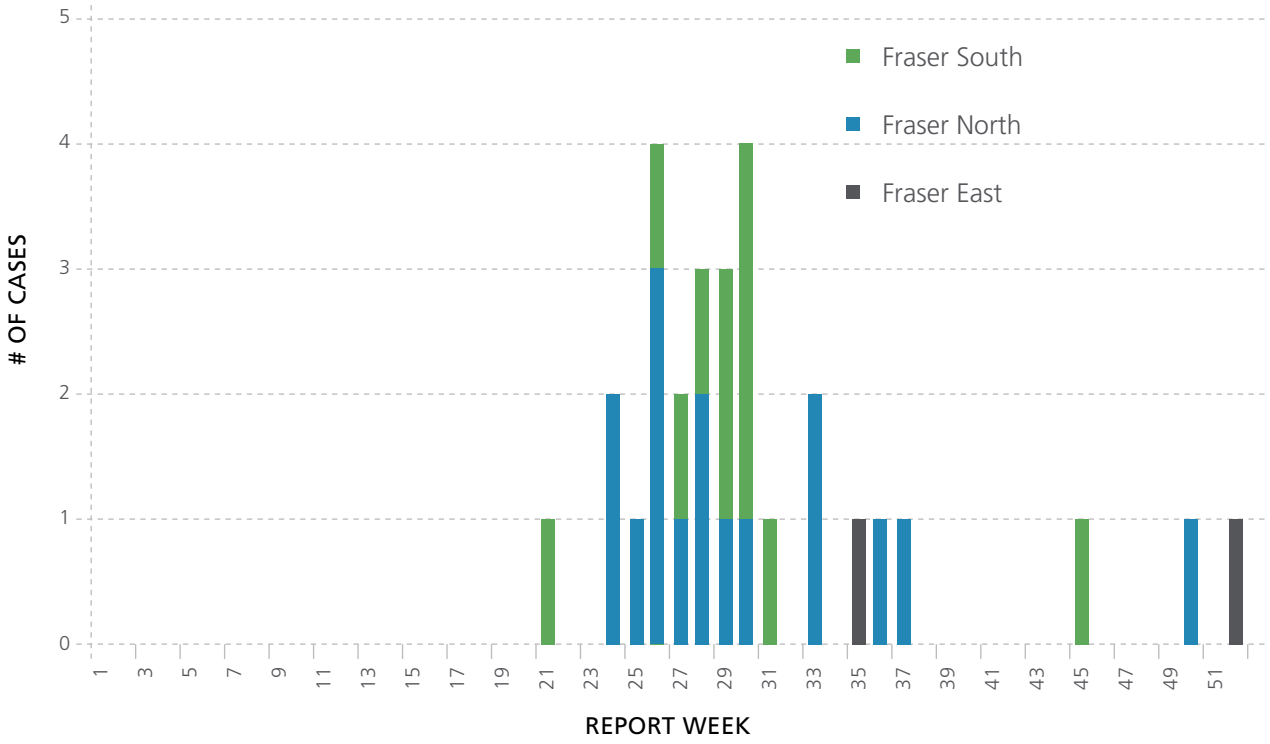
		2009	2010	2011	2012	2013
RATES	Fraser East	0.7	0.7	0.7	0.0	0.0
	Fraser North	1.3	0.5	2.6	0.0	0.3
	Fraser South	1.0	0.1	1.5	0.0	1.3
	Fraser Health	**1.1**	**0.4**	**1.8**	**0.0**	**0.7**
CASES	Fraser East	2	2	2	0	0
	Fraser North	8	3	16	0	2
	Fraser South	7	1	11	0	10
	Fraser Health	**17**	**6**	**29**	**0**	**12**

[14] Public Health Agency of Canada. (2014). Canadian Immunization Guide Mumps Vaccine. Retrieved from: http://www.phac-aspc.gc.ca/publicat/cig-gci/p04-mump-orei-eng.php

Mumps Outbreak in 2011

In 2011, an outbreak of mumps began in January at a ski resort in Whistler, BC, which later spread to the Fraser Health region in May. A total of 132 confirmed cases were reported in this BC-wide outbreak of which 29 cases were Fraser Health residents (Figure 1-12). The individuals from Fraser Health were predominately young adults, with a median age of 29 years and a range from 13 to 66 years. The majority of the cases associated with the outbreak were unimmunized (no record of mumps vaccine) or under-immunized (did not receive 2 doses of mumps vaccine required for protection). Among the 29 cases in Fraser Health, there were 3 cases (10%) with no record of mumps immunizations, 6 cases (21%) who had received one dose of mumps vaccine, 4 cases (14%) who had received two doses of mumps vaccine, and 16 cases (55%) who had an unknown immunization history. No deaths were associated with this outbreak.

Figure 1-12 Epidemic curve of confirmed mumps cases in Fraser Health reported between Jan 1, 2011 to Dec 31, 2011 by HSDA

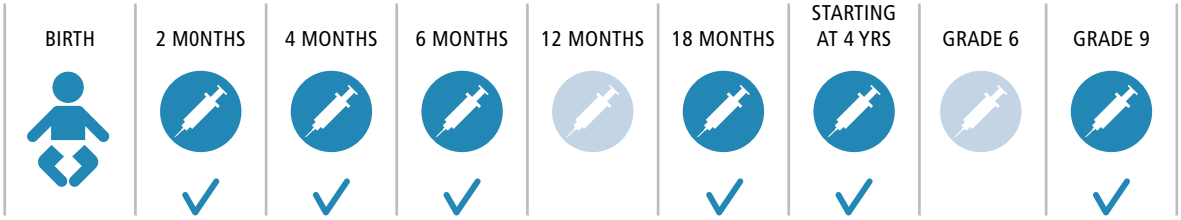


Note: Confirmed cases extracted from iPHI5 with report dates between Jan 1, 2011 to Dec 31, 2011.

The outbreak is consistent with the current epidemiological evidence that suggests a changing age distribution of mumps over the past few decades with increases in the number of reported cases in the post-secondary and young adult populations. Most people born in Canada before 1970 would have naturally acquired immunity to mumps during childhood when the virus was circulating prior to the introduction of immunization programs whereas those born after 1996 in BC would have been offered two doses of MMR as part of the routine schedule. As a result, a cohort of individuals born between 1970 and 1996 in BC would have been under-immunized (offered one dose of MMR vaccine), underexposed (not assumed to have natural immunity to mumps), and therefore susceptible to disease.

1.6 PERTUSSIS

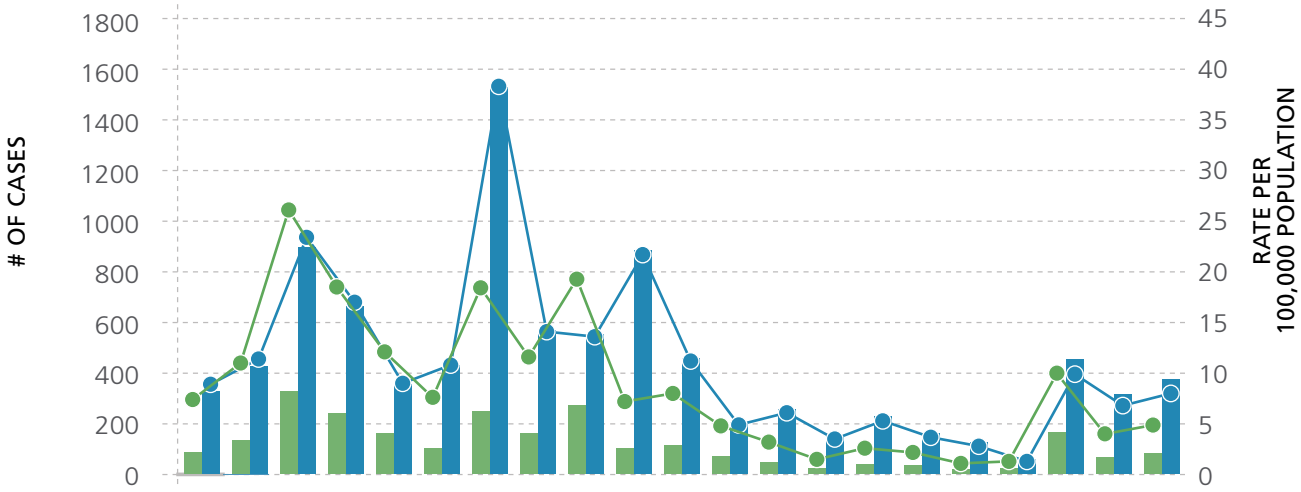
Routine Childhood Immunization Schedule



Pertussis, also known as whooping cough, is caused by the bacterium *Bordetella pertussis*. It starts like a common cold, but then the cough gets worse, leading to severe, repeated, and forceful coughing spells that often end with a 'whoop' sound. Complications of pertussis include pneumonia, seizures, brain damage, or even death. Young infants less than 1 year of age are particularly at risk of complications from pertussis. Routine immunization for pertussis does not begin until 2 months of age, and most deaths due to pertussis in Canada are in babies less than 3 months of age.[15]

Pertussis is endemic worldwide and peaks in activity have been observed every few years in Canada. Epidemic levels were experienced in BC in 1996, 2000, and 2003[16] (Figure 1-14). In 2011, BC had experienced a 20-year historic low in pertussis activity. While there has been decreased activity over the past decade, levels of pertussis in the Lower Mainland region had resurged beginning 2012.

Figure 1-14 Reported confirmed cases and rates (per 100,000) of pertussis in Fraser Health and BC, 1994 to 2014*



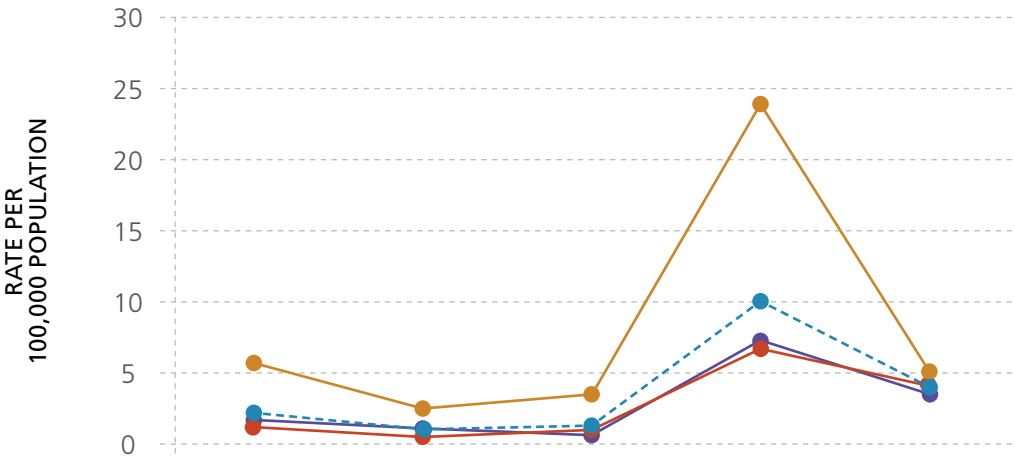
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Fraser Health Rate	7.4	11.0	26.1	18.5	12.1	7.6	18.4	11.6	19.3	7.2	8.0	4.8	3.2	1.5	2.6	2.2	1.1	1.3	10.0	4.0	4.9
BC Rate	8.9	11.4	23.4	17.0	9.0	10.8	38.3	14.1	13.6	21.7	11.2	4.9	6.1	3.5	5.3	3.7	2.8	1.3	9.9	6.8	8.0
Fraser Health Cases	87	135	329	241	161	102	252	162	274	103	116	71	47	22	40	35	18	21	165	67	84
BC Cases	329	429	906	670	357	435	1548	575	557	894	464	205	258	149	231	163	125	58	457	317	379

[15] Public Health Agency of Canada. (2014). Canadian Immunization Guide Pertussis Vaccine. Retrieved from: http://www.phac-aspc.gc.ca/publicat/cig-gci/p04-pert-coqu-eng.php

[16] Chambers C et al. (2014). Pertussis surveillance trends in British Columbia, Canada, over a 20-year period: 1993-2013. *CCDR 2014*, 40(3). Retrieved from: http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/14vol40/dr-rm40-03/dr-rm40-03-bc-eng.php

There were 18 to 165 confirmed cases of pertussis reported each year in Fraser Health between 2009 and 2013 (Figure 1-15). In 2012, incidence rates of pertussis peaked at 10.0 per 100,000 population and this was attributable to widespread pertussis activity in the Lower Mainland (more details below). Within Fraser Health, there is regional variation in pertussis incidence rates, with higher levels of activity occurring in Fraser East. This is typically linked with localized outbreaks that occur at schools and areas with low immunization coverage rates.

Figure 1-15 Confirmed pertussis cases and rates (per 100,000) in Fraser Health by HSDA, 2009 to 2013

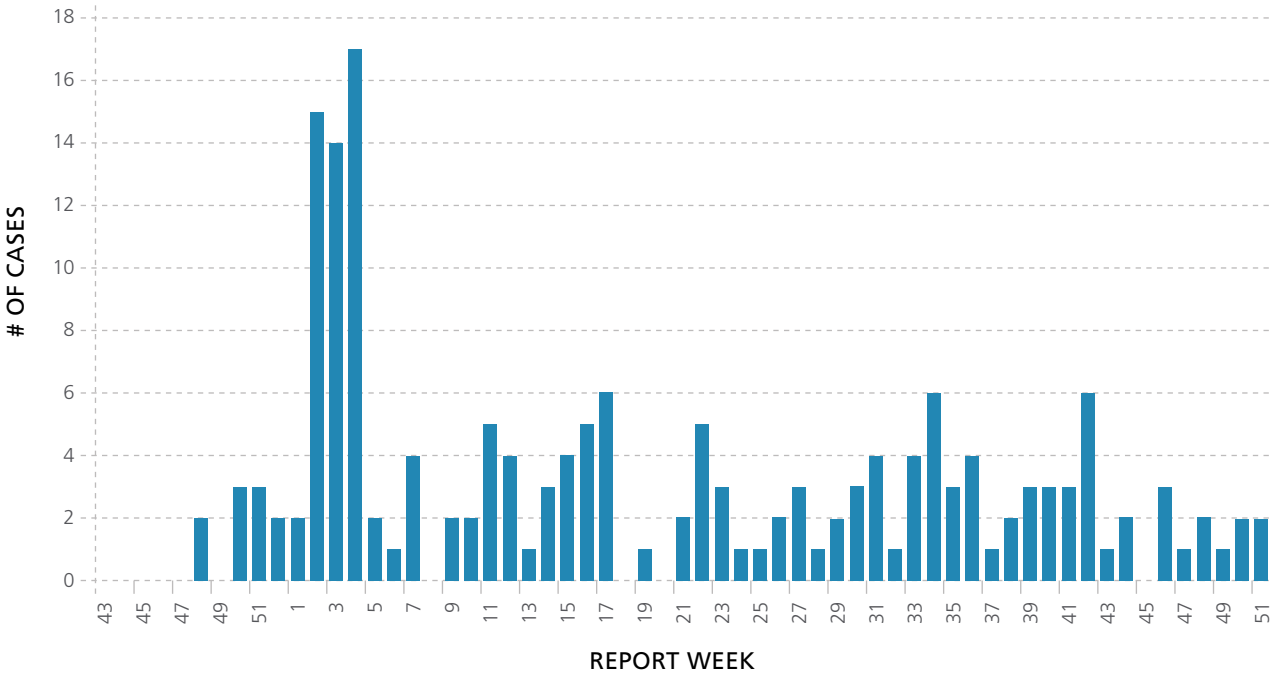


		2009	2010	2011	2012	2013
RATES	Fraser East	5.7	2.5	3.5	23.9	5.1
	Fraser North	1.2	0.5	1.0	6.7	4.1
	Fraser South	1.7	1.1	0.7	7.3	3.5
	Fraser Health	**2.2**	**1.1**	**1.3**	**10.0**	**4.0**
CASES	Fraser East	16	7	10	69	15
	Fraser North	7	3	6	42	26
	Fraser South	12	8	5	54	26
	Fraser Health	**35**	**18**	**21**	**165**	**67**

Pertussis outbreak in 2012

In fall of 2011, Fraser Health experienced a notable increase in pertussis activity in Hope. In response to this, the Fraser Health Office of the Chief Medical Health Officer declared a pertussis outbreak on November 13, 2011. Outbreak levels of pertussis were also detected by neighbouring health regions in Vancouver Coastal Health, Vancouver Island Health, and Washington State. Increased pertussis activity had continued into 2012 and when the outbreak was declared over by the end of 2012, a total of 175 confirmed cases were reported in Fraser Health (Figure 1-16).

Figure 1-16 Epidemic curve of confirmed cases of pertussis in Fraser Health reported between Oct 23,2011 to Dec 31,2012.



Source: Confirmed cases extracted from iPHIS cases with report dates between Oct 16, 2011 to Dec 31, 2012

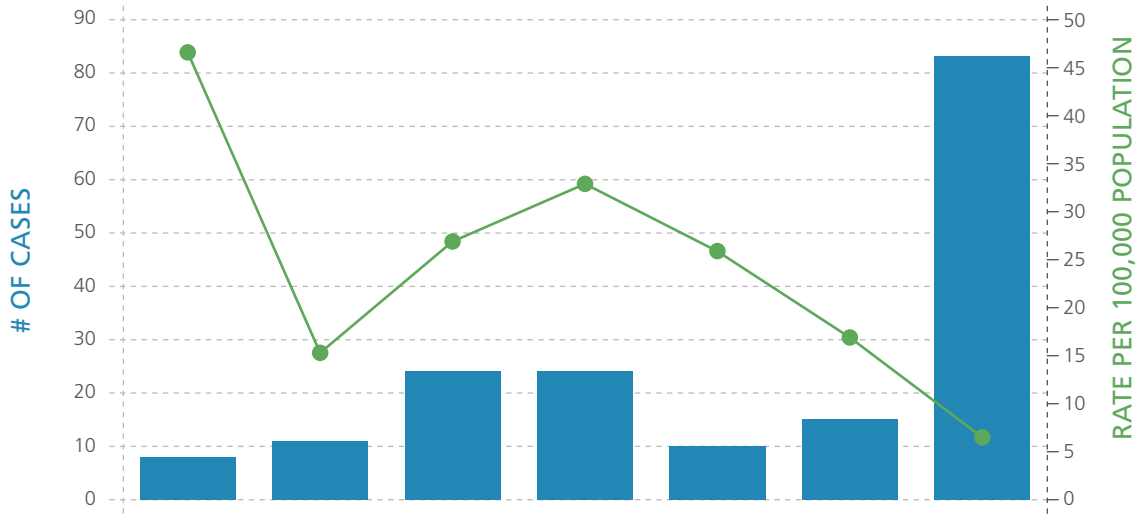
The median age among reported cases was 19 years (range: 2 weeks to 72 years). Attack rates were highest among infants less than one year of age at 46.6 cases per 100,000 population; no deaths were reported (Figure 1-17). The geographical spread of the outbreak is shown in Figure 1-18, with the majority of cases in Fraser East. Due to the high burden of illness in infants from this outbreak, routine immunization of all pregnant women with pertussis vaccine was offered during the outbreak, as recommended by the Canadian National Advisory Committee on Immunization.[17] Other control measures included intensive case and contact follow-up, offering post-exposure prophylaxis of antibiotics to eligible high risk contacts, and raising awareness amongst the community and health care workers about pertussis.

[17] National Advisory Committee on Immunizations. (2014). Update on pertussis vaccination in pregnancy. Retrieved from: http://www.phac-aspc.gc.ca/naci-ccni/acs-dcc/2014/pvip-vcpg_0214-eng.php

"The 2012 pertussis outbreak in BC was also seen in the US, where they had 20 pertussis-related deaths, and most of these in infants under three months old. We know that infants under 4 months of age are at greatest risk of severe outcomes, including death, from pertussis (whooping cough) infection. As a way of protecting these newborn infants prior to their first pertussis immunization at two months, there has been increasing evidence that suggests immunizing pregnant women against pertussis may help. We participated in a 2013 serosurvey of pregnant woman from Fraser Health and Halifax Nova Scotia and found that almost 80% of pregnant women are likely vulnerable to pertussis infection. This means they would not pass on protective antibodies to their babies. We hope these data will help inform future pertussis immunization recommendations in Canada to better protect infants."

- Medical Health Officer, Fraser Health

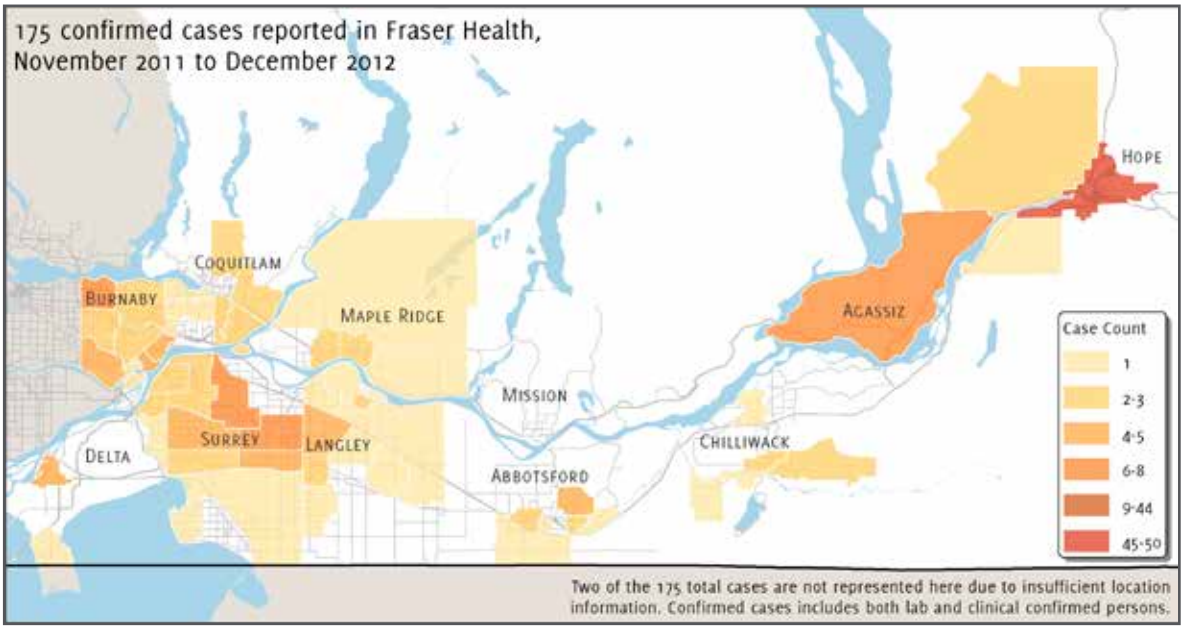
Figure 1-17 Attack rates (per 100,000) of reported pertussis cases in Fraser Health during 2012 outbreak



	<1	1 - 4	5 - 9	10 - 13	14 - 15	16 - 19	20+
Rate per 100,000	46.6	15.3	26.9	32.9	25.9	16.9	6.5
Cases	8	11	24	24	10	15	83

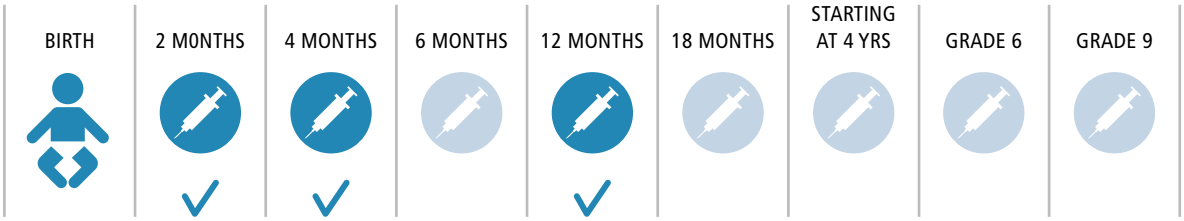
Sources: Cases extracted from iPHIS between Nov 1, 2011 and Dec 31, 2012. Population data extracted from BC Stats, 2013 PEOPLE estimates.

Figure 1-18 Geographical distribution of reported pertussis cases during 2012 outbreak



1.7 INVASIVE PNEUMOCOCCAL DISEASE

Routine Childhood Immunization Schedule

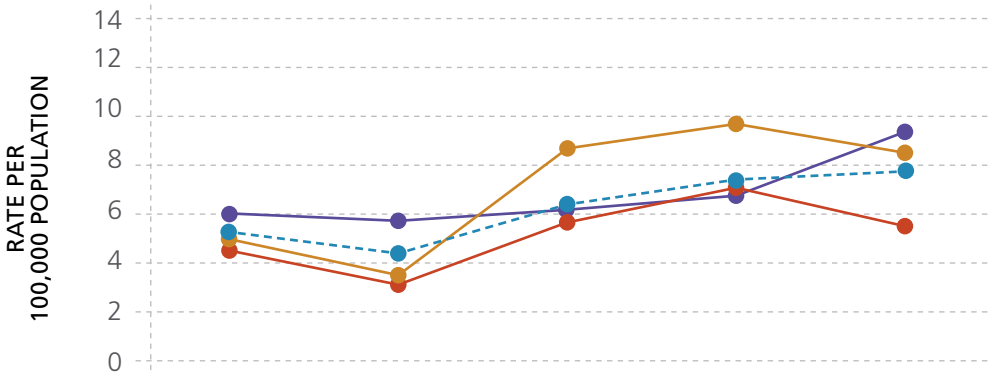


Invasive pneumococcal disease (IPD) is a serious infection caused by the bacterium *Streptococcus pneumoniae* that can lead to pneumonia, bacteremia, and meningitis. It is most common among infants (ages 2 years and under) and elderly persons (ages 65 years and older). While there are 92 known serotypes of *Streptococcus pneumonia* worldwide, invasive disease caused by 24 serotypes can be prevented by vaccination.[18] In Sept 2003, a publicly funded 7-valent pneumococcal conjugate vaccine (PCV-7) was introduced in BC for all infants starting 2 months of age (i.e. born on or after July 1, 2003). The vaccine protects against 7 serotypes (4, 9V, 6B, 14, 18C, 19F, and 23F) and was replaced in June 2010 by the 13-valent pneumococcal conjugate vaccine (PCV-13) which offers protection against 6 additional serotypes (1, 5, 7F, 3, 6A, and 19A). In June 2012, the first cohort of 2-year old children in BC completed their 3-dose series of PCV 13 pneumococcal vaccine. The 23-valent pneumococcal polysaccharide vaccine is available for adults 65 years and older and those with high risk conditions.[19]

[18] Public Health Agency of Canada. (2014). Canadian Immunization Guide Pneumococcal Vaccine. Retrieved from: http://www.phac-aspc.gc.ca/publicat/cig-gci/p04-pneu-eng.php

[19] BCCDC. Immunization Manual. (2014). Retrieved from. http://www.bccdc.ca/NR/rdonlyres/528C4C20-F2F8-4333-9927-E8DC455A5E76/0/SectionVII_BiologicalProducts_October2014.pdf

Figure 1-19 Confirmed invasive pneumococcal disease cases and rates (per 100,000) by HSDA, 2009 to 2013

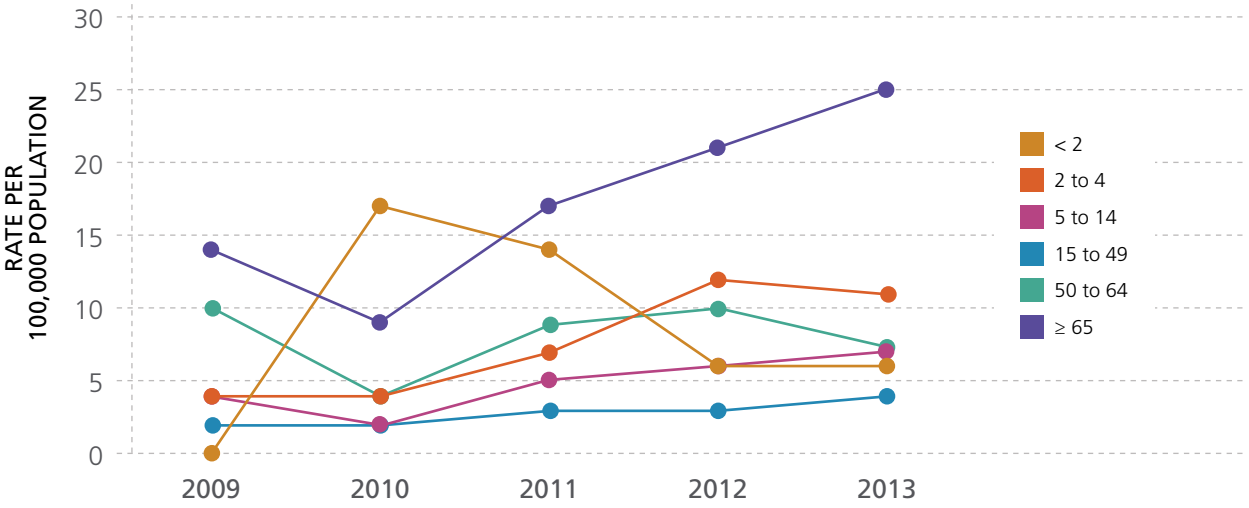


		2009	2010	2011	2012	2013
RATES	Fraser East	5.0	3.5	8.7	9.7	8.5
	Fraser North	4.5	3.1	5.7	7.1	5.5
	Fraser South	6.0	5.7	6.2	6.8	9.4
	Fraser Health	**5.3**	**4.4**	**6.4**	**7.4**	**7.8**
CASES	Fraser East	14	10	25	28	25
	Fraser North	27	19	35	44	35
	Fraser South	42	41	45	50	70
	Fraser Health	**83**	**70**	**105**	**122**	**130**

IPD is one of the most common vaccine preventable diseases in Fraser Health. Between 2009 and 2013, an average of 102 confirmed cases of IPD were reported annually in Fraser Health with a high of 130 confirmed cases reported in 2013 (Figure 1-19). Over the years, the incidence of IPD in Fraser Health had increased by 47% from 5.3 per 100,000 in 2009 to 7.8 per 100,000 population in 2013.

Most cases of IPD occur among the very young (those under 2 years) and the elderly (those 65 years and older). Between 2010 and 2013, there has been in an overall decrease in all types of IPD among those under 2 years of age compared to a steady increase in those over 65 (Figure 1-20). The decrease in the incidence of IPD for infants under 2 years of age may be related to the increase in vaccine serotype coverage by the routine childhood immunization program. Between 2009 and 2013, 15 cases of IPD were reported among those under 2 years of age, of which 6 cases (40%) were caused by non-vaccine serotypes (3 cases were fully immunized, 1 case was partially immunized, and 2 cases were unimmunized) and only 2 cases (13%) were caused by serotypes included in PCV-7 (one case was a conscientious objector and the other child was fully immunized) .

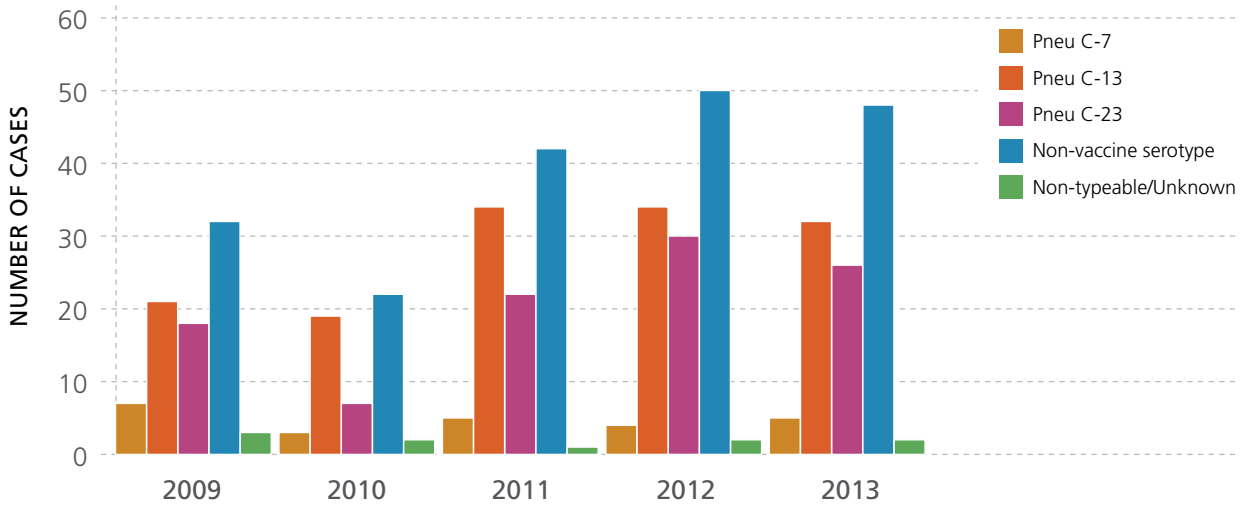
Figure 1-20 Age-specific incidence rate of IPD cases, 2009 to 2013



Serotyping was available for 461 of 510 cases (90%) reported in Fraser Health between 2009 and 2013. In 2013, the majority of IPD cases in Fraser Health were caused by serotypes that were not included in a vaccine. The incidence of non-vaccine serotype cases has increased slightly from 2.0 per 100,000 (n=32) in 2009 to 2.8 per 100,000 population (n=48) in 2013 (Figure 1-21) whereas IPD cases covered by PCV-7 serotypes have remained low.

Between 2009 and 2013, 3 fatal cases of IPD were reported among children under 18 years of age. One death was reported in a newborn as a result of vertical transmission from mother to child. Two cases were among children ages 5 to 14 who were both hospitalized and admitted to the ICU. One child had no records of immunization and while the other was fully immunized, invasive disease was caused by a serotype that was not included in the PCV-7 vaccine.

Figure 1-21 Confirmed cases of IPD by associated vaccine serotype*, 2009 to 2013

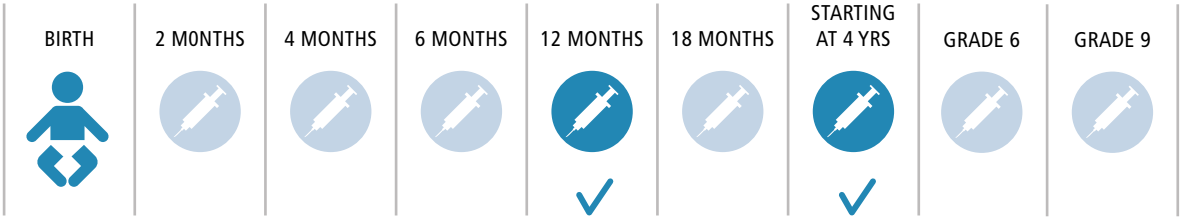


Source: BC CDC Enhanced Surveillance Database for Invasive Pneumococcal Disease.

* Serotypes are grouped by their associated vaccine type as follows:
Pneu C-7 refers to serotypes 4, 6B, 9V, 14, 18C, 19F, and 23F.
Pneu C-13 refers to serotypes not covered by Pneu C-7 and includes serotypes 1, 3, 5, 6A, 7F, and 19A.
Pneu C-23 refers to serotypes not covered by Pneu C-7 and Pneu C-13 and includes 2, 8, 9N, 10A, 11A, 12F, 15B,17F, 20, 22F, and 33F.
Non-vaccine serotype refers to any other serotype not listed above.

1.8 RUBELLA

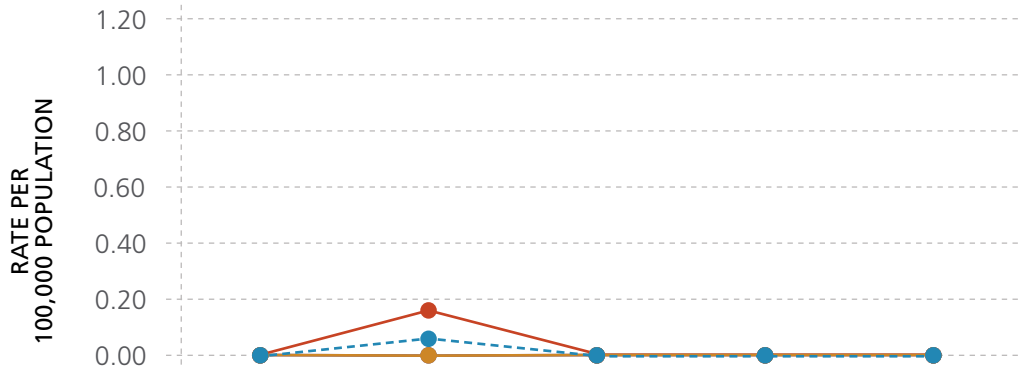
Routine Childhood Immunization Schedule



Rubella (also known as German measles) is a viral illness that results in a low grade fever and rash. It is spread by direct contact with the respiratory secretion of an infected person through coughing or sneezing. If infected during pregnancy, the virus can lead to congenital rubella syndrome, resulting in miscarriage or causing infection in the fetus that can result in birth defects. Due to widespread immunization programs, indigenous rubella has been eliminated in Canada.

Between 2009 and 2013, only one case of rubella was reported in Fraser Health (Figure 1-13). The case was linked to an outbreak of rubella at a workplace located in the Lower Mainland involving 9 confirmed cases, with one adult male case from Fraser North.

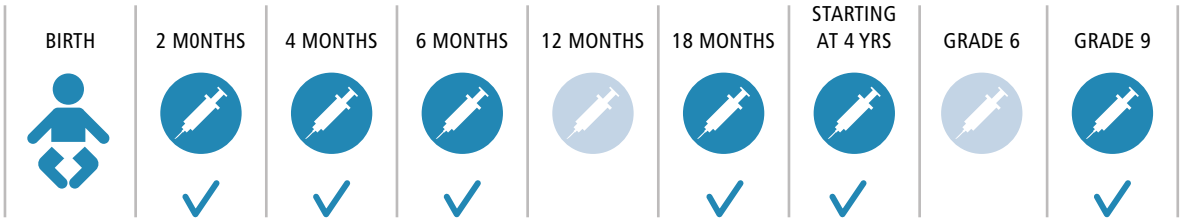
Figure 1-13 Confirmed rubella cases and rates (per 100,000) in Fraser Health by HSDA, 2009 to 2013



		2009	2010	2011	2012	2013
RATES	Fraser East	0.0	0.0	0.0	0.0	0.0
	Fraser North	0.0	0.16	0.0	0.0	0.0
	Fraser South	0.0	0.0	0.0	0.0	0.0
	Fraser Health	**0.0**	**0.06**	**0.0**	**0.0**	**0.0**
CASES	Fraser East	0	0	0	0	0
	Fraser North	0	1	0	0	0
	Fraser South	0	0	0	0	0
	Fraser Health	**0**	**1**	**0**	**0**	**0**

1.9 TETANUS

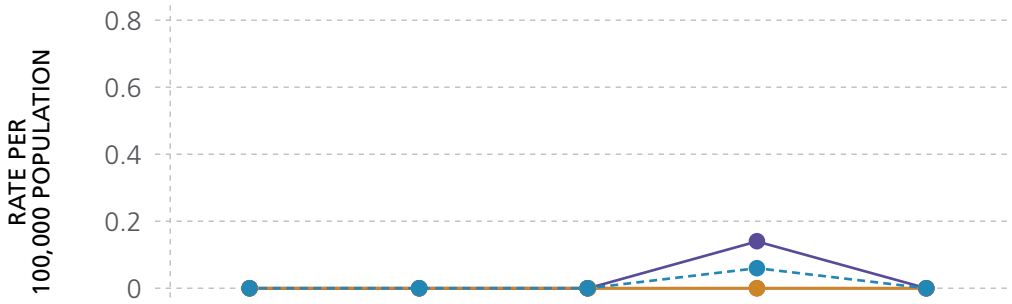
Routine Childhood Immunization Schedule



Tetanus (also known as lockjaw) is a disease caused by bacteria that is commonly found in soil, dust, and manure. It affects the nervous system and causes painful muscle contractions that begin in the jaw and neck and then continues down to the rest of the body. The disease can lead to death and affects all age groups. Unlike other vaccine-preventable diseases, tetanus does not spread by person to person but rather enters the body through cuts or breaks in the skin caused by contaminated objects such as a nail or needle. In 1940, a tetanus toxoid–containing vaccine was introduced in Canada and today tetanus is considered rare, with a national average of 3 cases reported per year between 2000 and 2013.[20]

One case of tetanus was reported in Fraser Health between 2009 and 2013 (Figure 1-22). The case was in an elderly female who sustained a laceration to her leg from falling into a garden, and she had not previously received a complete primary series of tetanus toxoid-containing vaccine. She was hospitalized for over 3 weeks, received a total of 3 doses of tetanus immunoglobin given in 1 week intervals in hospital, and survived the infection.

Figure 1-22 Confirmed tetanus cases and rates (per 100,000) by HSDA, 2009 to 2013



		2009	2010	2011	2012	2013
RATES	Fraser East	0.0	0.0	0.0	0.0	0.0
	Fraser North	0.0	0.0	0.0	0.0	0.0
	Fraser South	0.0	0.0	0.0	0.14	0.0
	Fraser Health	**0.0**	**0.0**	**0.0**	**0.06**	**0.0**
CASES	Fraser East	0	0	0	0	0
	Fraser North	0	0	0	0	0
	Fraser South	0	0	0	1	0
	Fraser Health	**0**	**0**	**0**	**1**	**0**

[20] Public Health Agency of Canada. (2014). Epidemiology of tetanus in Canada. Retrieved from: http://www.phac-aspc.gc.ca/im/vpd-mev/tetanus-tetanos/professionals-professionnels-eng.php

SECTION 2

IMMUNIZATION COVERAGE IN FRASER HEALTH

Immunization is the most effective health measure for protecting children and adults from vaccine preventable diseases. Recent outbreaks in Fraser Health over the past few years remind us of the need to remain vigilant in maintaining high immunization coverage rates in the community to ensure protection through vaccination. Immunization coverage is defined as the proportion of people in the population who have received one or more vaccine(s) of interest. It is a measure of how many people are protected against vaccine-preventable infections within the overall population. Determining immunization coverage rates is important to identify susceptible groups that are at increased risk of contracting vaccine-preventable diseases, to allocate public health efforts and resources to increase coverage rates, and to evaluate immunization programs. In BC, immunization coverage rates are routinely assessed for 2-year olds and school aged-children in Kindergarten (replaced by 7-year old cohort in 2013), Grade 6, and Grade 9.[21]

BC has one of the most comprehensive childhood immunization programs in Canada. Significant additions have been made to the recommended immunization schedule over the past few decades. In the early 1980s, the routine childhood immunization schedule included vaccines that protect a child against 7 infectious diseases. Today, the routine childhood immunization schedule covers 16 diseases by 2 years of age (Table 2-1).

Table 2-1 Number of diseases included in childhood immunization schedule, 1980 to 2014

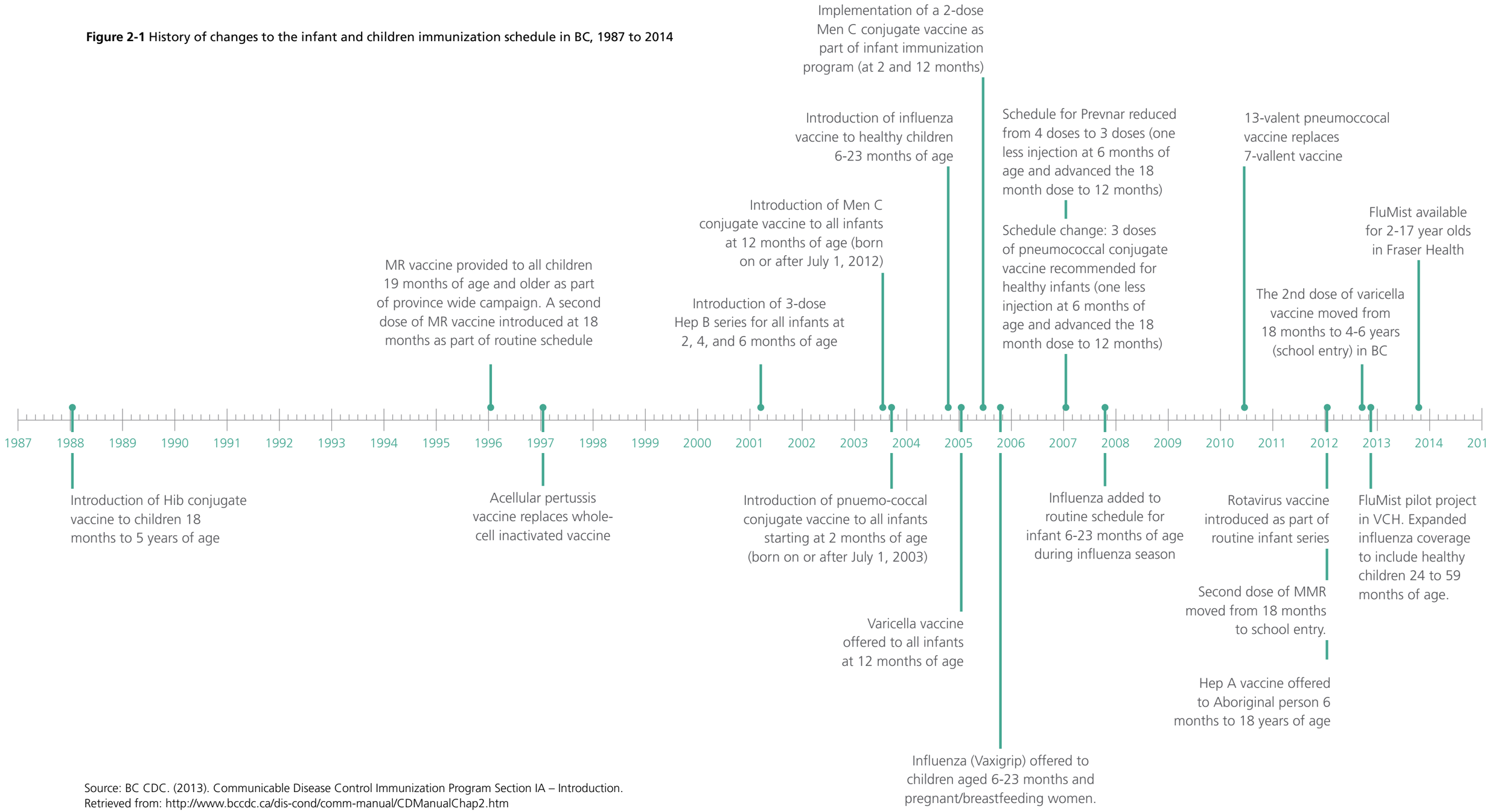
	1980	2000	2014
Disease included in routine childhood immunization schedule	Diphtheria Pertussis Tetanus Polio Measles Rubella Mumps	Diphtheria Pertussis Tetanus Polio Measles Rubella Mumps *Haemophilus influenza B* (Hib) Hepatitis B	Diphtheria Pertussis Tetanus Polio Measles Rubella Mumps *Haemophilus influenza B* (Hib) Hepatitis B Invasive pneumococcal disease Invasive meningococcal disease Varicella Human papillomavirus Rotavirus Hepatitis A* Influenza

* Offered to Aboriginal children living both on-reserve and off-reserve.

[21] BC CDC. (2013). Immunization Coverage. Retrieved from: http://www.bccdc.ca/imm-vac/BCImmunizationCov/default.htm

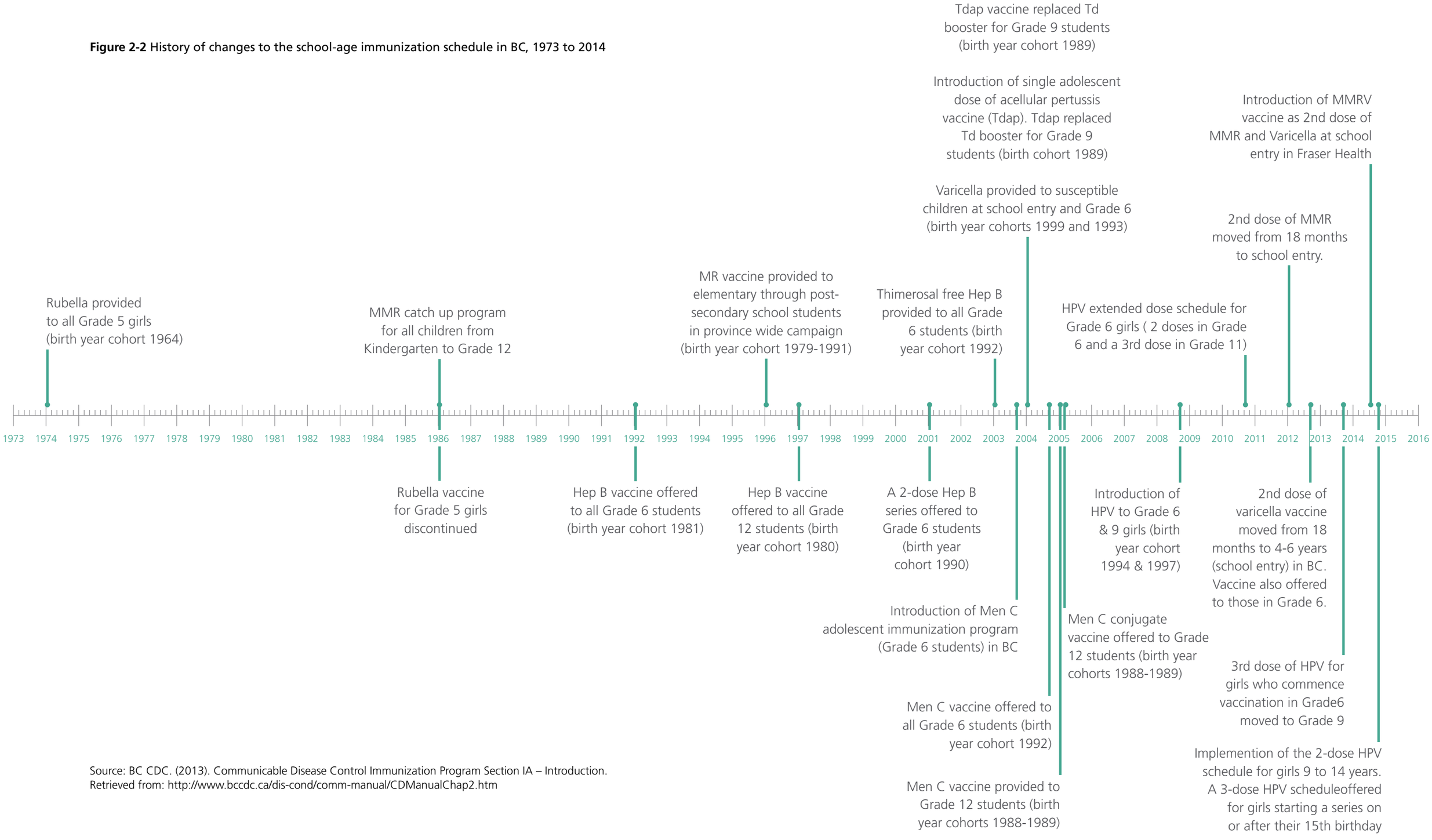
Introduction of new vaccines into the immunization schedule, such as the combination measles/mumps/rubella/varicella vaccine (MMRV), has resulted in changes to the timing of primary series doses, specifically, the second dose of measles/mumps/rubella vaccine (MMR) was moved from 18 months to school entry in 2012. In addition to new vaccines, there are multiple routes of vaccine administration, such as an oral dose for rotavirus and an intranasal spray for influenza. While the additional protection from the expanding immunization program has significant benefits, the increasing complexity of the schedule can be challenging for both practitioners and parents to become familiar and up-to-date with current immunization practices. This also means that comparison of immunization coverage rates over time should be interpreted with the changes in immunization policies and practices in mind as it may result in shifts in coverage rates. Figure 2-1 illustrates the history of changes to the infant immunization schedule, and Figure 2-2 shows the history of changes to the school-age immunization schedule in BC.

Figure 2-1 History of changes to the infant and children immunization schedule in BC, 1987 to 2014



Source: BC CDC. (2013). Communicable Disease Control Immunization Program Section IA – Introduction. Retrieved from: http://www.bccdc.ca/dis-cond/comm-manual/CDManualChap2.htm

Figure 2-2 History of changes to the school-age immunization schedule in BC, 1973 to 2014



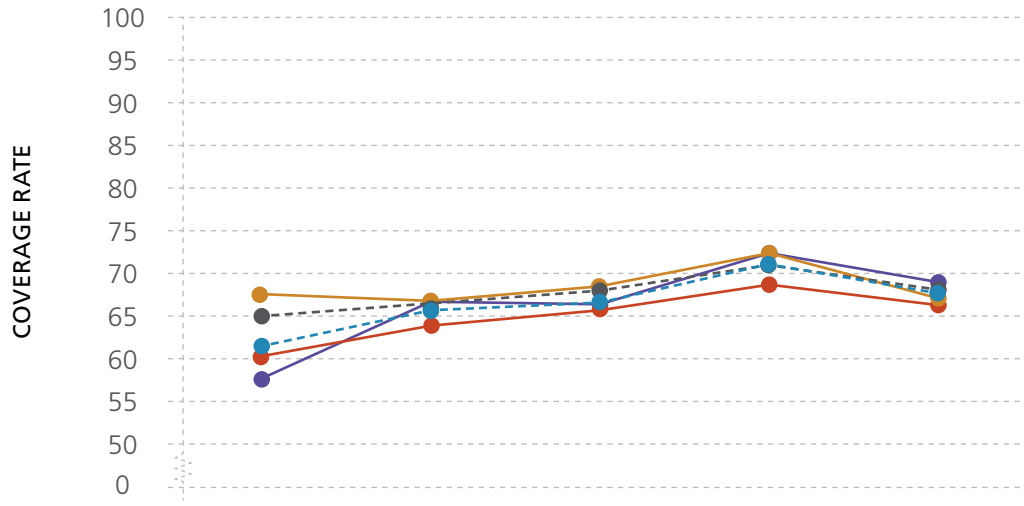
Source: BC CDC. (2013). Communicable Disease Control Immunization Program Section IA – Introduction. Retrieved from: http://www.bccdc.ca/dis-cond/comm-manual/CDManualChap2.htm

2.1 INFANT IMMUNIZATION COVERAGE RATES

Up-to-date for 2-year olds

"Up-to-date for age" is a term used to assess an individual's immunization status against the recommendations by immunization schedule. By the age of 2, infants in BC should have received 14 vaccines protecting against 14 diseases and administered over 5 visits. Children who have completed all of their routine childhood immunization schedule by 2 years of age would be considered as being up-to-date (UTD) with their immunization status for their age.[22]

Figure 2-3 Percent of 2-year olds with up-to-date immunization, 2009 to 2013



RATES	2009	2010	2011	2012	2013
Fraser East	67.6	66.8	68.5	72.4	67.1
Fraser North	60.3	63.9	65.7	68.7	66.3
Fraser South	57.7	66.7	66.4	72.4	69.0
Fraser Health	61.5	65.7	66.6	71.1	67.7
BC Excluding VCH	65.0	66.0	68.0	71.0	68.1

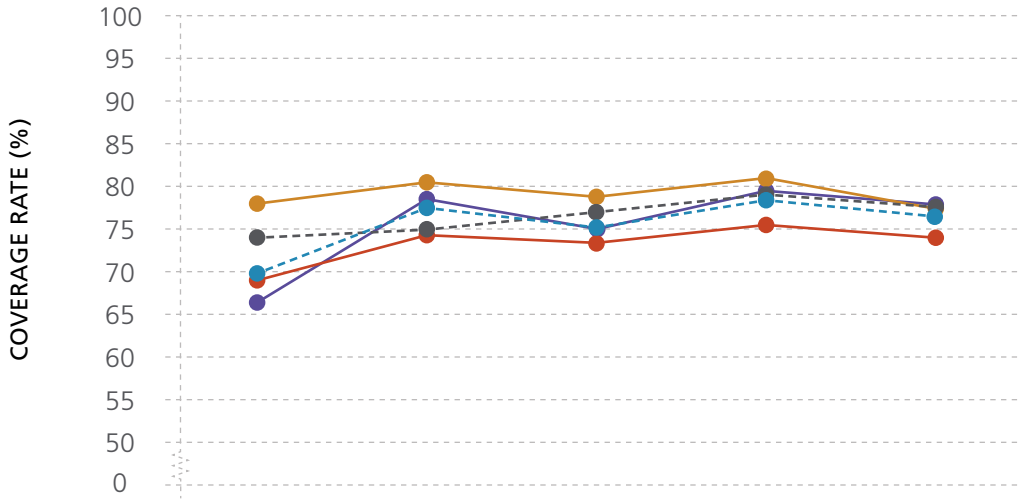
In 2013, over two-thirds of children in Fraser Health were fully immunized before their 2nd birthday (Figure 2-3). While Fraser Health coverage rates are similar to provincial rates, 2-year old UTD immunization rates are generally higher in Fraser East than Fraser North. Based on the data analysis from the immunization review (see Section 4 -Review of Immunization Program in Fraser Health), this is likely due to missing immunization reports of vaccines not delivered by public health. Over time, UTD immunization coverage rates for 2-years olds have increased in both Fraser Health and BC over the past 5 years. The increase in 2012 may be reflective of the change in schedule that moved the second dose of MMR from 18 months to Kindergarten, resulting in only one dose of MMR required for UTD coverage. In 2013, rates begin to slightly decline and this may be attributable to the conversion of immunization records from the integrated Public Health Information System (iPHIS) database to the Panorama database in June 2013. More details at the municipal level are available in Appendix D.

[22] According to the BC Routine Immunization Schedule for Infants & Children, up-to-date for 2 year-olds include 4 doses of diphtheria/tetanus/pertussis, 3 doses of hepatitis B, 1 dose of measles/mumps/rubella, 3 doses of polio (at 2,4, and 18 months), at least 1 dose of Haemophilus influenza type b after 15 months of age, 1 dose of varicella (or recorded exemption for varicella due to previous disease or protective antibody levels), 3 doses of pneumococcal conjugate and at least 1 dose of meningococcal C conjugate as defined by age of first dose.

Up-to-date for 2-year olds minus booster

The recent changes in the immunization schedule mean that only a single booster dose of diphtheria, tetanus, pertussis, polio and Hib is given at the 18 month visit. Therefore, the primary series is essentially complete without this dose, and "up-to-date minus booster" is an additional measure of immunization coverage for the primary infant series. There is significant drop-off in coverage for this dose, and therefore up-to-date minus booster may be more reflective of protection levels in the population. In Fraser Health, 76.5% of 2-year olds were up-to-date minus booster in 2013 (Figure 2-4). More details at the municipal level are available in Appendix D.

Figure 2-4 Percent of 2-year olds with up-to-date immunizations minus the booster, 2009 to 2013



		2009	2010	2011	2012	2013
RATES	Fraser East	78.0	80.5	78.8	81.0	77.4
	Fraser North	69.0	74.3	73.4	75.5	74.0
	Fraser South	66.4	78.6	75.0	79.5	77.9
	Fraser Health	69.9	77.5	75.2	78.4	76.5
	BC Excluding VCH	74.0	75.0	77.0	79.0	77.6

2.2 SCHOOL-AGE IMMUNIZATION COVERAGE RATES

While a single dose of some vaccines may offer lifelong immunity, protection from some infant immunizations can wear off over time as children get older. Booster shots are therefore given to maintain protection against vaccine-preventable diseases. In Fraser Health, school-aged children can receive booster doses that are offered in Kindergarten, Grade 6 and Grade 9 through school-based immunization clinics. The hepatitis B, meningococcal C, varicella, and HPV (girls only) vaccines are offered to Grade 6 students. In Grade 9, a combined tetanus/diphtheria/acellular pertussis vaccine (TdaP) is offered. Girls in Grade 9 during the three school years of 2008/09, 2009/10, and 2010/11 were offered HPV vaccination as the Grade 6 program was introduced. More details regarding the school-aged immunization schedule are available on Appendix C.

Through strong partnership with local school boards and staff, Public Health Nurses begin delivering immunizations programs in the fall of each school year. Consent forms are sent home to all eligible students and are required to be signed by parents/guardians prior to immunization. Efforts are first made to obtain parental/guardian consent. However, those students in Grade 9 presenting without parental/guardian consent also have the option of self-consenting to immunization as a mature minor if they demonstrate the capability of understanding the benefits and risks of immunizations.

Each year, school vaccination data is collected locally by nurses who run the school immunization programs. This allows for the assessment of school-based immunizations for students who are enrolled as of June 30th of the school year for their up-to-date for age immunization status.

Immunizations starting at 4 years (Kindergarten entry)

Immunization coverage rates among Kindergarten children reflect the proportion of students enrolled in Kindergarten as of June 30 who have received valid doses of all routine childhood immunizations. Currently, the recommended vaccines due at Kindergarten include the diphtheria/tetanus/acellular pertussis/polio vaccine (DTaP-IPV) and measles/mumps/rubella/varicella vaccine (MMRV). Assessment of Kindergarten immunization coverage rates was available until 2012/13 as they have been replaced by assessment of immunization coverage rates of 7-year olds in 2012. Immunizations administered at Kindergarten are recommended for children 4 to 6 years old. Therefore, this recent change in the measure of up-to-date status was prompted by a desire to capture all children who had received their immunization at the appropriate time (before 7 years of age). While Kindergarten coverage assessments from before 2013 cannot be directly compared with the new 7-year old coverage rates, preliminary results show that immunization coverage rates among 7-year olds have increased from 66% in 2012 to 68% in 2013 within Fraser Health, similar to provincial trends. More details on the new immunization coverage rates among 7-year olds can be found elsewhere on provincial reports.[23]

[23] BC CDC. (2013). Immunization Uptake in Children by the Seventh Birthday 2012-2013. Retrieved from: http://www.bccdc.ca/NR/rdonlyres/60740019-8581-4428-B5D6-73DA44AF737E/0/7_Year_Old_Coverage_2005_Birth_Cohort_updated.pdf

In Fraser Health, the proportion of Kindergarten students who received their fourth or fifth dose of diphtheria/acellular pertussis/tetanus/polio-vaccine (DaPTP) after their fourth birthday declined by 9.0 percentage points from 79.0% in 2008/09 to 70.0% 2012/13 (Table 2-2). As a complete series of DaPTP includes 5 doses, the decline in coverage rates may be indicative of children incomplete for their last few doses of the series due at 18 months and Kindergarten entry. This may also suggest difficulties with catching up missed doses if children had not received a complete series by 2 years of age. The measles vaccine and hepatitis B vaccine coverage among Kindergarten students had remained stable at 87-88% and 88-90% respectively between 2008/09 to 2011/12, reflective of high immunization rates during infancy. However, these rates had recently declined to 84.7% for measles and 86.2% for hepatitis in 2012/13 (Note: This may be due in part to the conversion of immunization records from iPHIS to Panorama and the change in MMR schedule from 18 months to Kindergarten in 2012 for measles). Over time, mumps coverage appeared to decline from 92.2% in 2008/09 to 84.7% in 2012/13 and may be attributable to the change to a more stringent up-to-date for age definition from one to two doses in 2009. Varicella vaccine and meningococcal vaccine coverage have gradually increased over time to 88.7% and 89.4% respectively in 2011/12, although coverage rates begin to decline in 2012/13 (again, this may be due to the conversion of immunization records from iPHIS to Panorama). More details on immunization coverage rates among Kindergarten at the HSDA can be found in Appendix E.

Table 2-2 Up-to-date for age immunization coverage rates among Kindergarten in Fraser Health, 2008/09 to 2012/13 school year

ANTIGENS	2008/09	2009/10	2010/11	2011/12	2012/13
DaPTP	79.0%	75.3%	75.7%	73.8%	70.0%
Measles	87.2%	87.8%	87.7%	86.6%	84.7%
Mumps	92.2%	87.4%	87.7%	86.2%	84.7%
Rubella	92.2%	89.8%	89.8%	89.0%	87.6%
Hepatitis B	88.4%	88.9%	89.8%	88.9%	86.2%
Varicella	79.2%	86.9%	89.6%	88.7%	86.8%
Meningococcal C	86.3%	88.0%	89.7%	89.4%	87.0%

Kindergarten students with up-to-date for age immunization coverage rates measure the proportion of students enrolled in Kindergarten as of June 30 who received:

- **DaPTP:** the fourth or fifth dose of diphtheria/acellular pertussis/tetanus/polio containing vaccine after their fourth birthday and by June 30.
- **Measles:** 2 valid doses of measles-containing vaccine by June 30.
- **Mumps:** 2 valid doses of mumps-containing vaccine by June 30. The definition of up-to-date for age for mumps had changed from 1 to 2 valid doses of mumps-containing vaccine in 2009.
- **Rubella:** at least 1 valid dose of rubella-containing vaccine by June 30.
- **Hepatitis B:** a completed series of 3 doses of hepatitis B vaccine by June 30.
- **Varicella:** 1 valid dose of varicella vaccine by June 30 or reported previous history of varicella disease.
- **Meningococcal C:** 1 dose of meningococcal C conjugate vaccine on or after 12 months of age.

Grade 6 Immunizations

Among Grade 6 students, hepatitis B coverage rates declined from 2008/09 to 2010/11, but have since increased to 87.5% in 2012/13 (Table 2-3). The 2012/13 cohort of Grade 6 students were the first infants to be offered a 3-dose series of publicly funded hepatitis B vaccine beginning in 2001. The high coverage rates may be in part due to changes in the 2001 childhood immunization program.

Meningococcal C coverage rates among Grade 6 students in Fraser Health had declined by 1.8 percentage points between 2008/09 to 2009/10. This may be attributable to changes in the definition of up-to-date for meningococcal C vaccine for the 2009/10 school year that specified that the vaccines must have been received on or after 10 years of age, rather than after 12 months of age.

Overall, the proportion of Grade 6 students protected against varicella (either through previous disease or vaccination) decreased in Fraser Health from 88.2% in 2008/09 to 82.6% in 2012/13. The decrease in 2012/13 may be in part due to a change to a more stringent up-to-date definition from one dose received on or after 1st birthday (prior to 2012/13) to 2 doses of varicella vaccine (2012/13 and later). This is reflective of changes in immunization policy where a second dose of varicella was offered to susceptible students in Grade 6. It is important to note that the proportion of students protected through varicella immunization alone (i.e. excluding those who reported previous history of varicella disease) had increased every year from 37.3% in 2008/09 to 64.6% in 2012/13 (data not shown).

A school-based HPV vaccine program for girls was introduced in September 2008 for Grade 6 and 9 students. In the 5 years of the program, HPV coverage rates increased from 61.6% in 2008/09 to 71.0% in 2012/13. Part of the increase may be attributable to the change in up-to-date for age definition from 3 doses to 2 doses of HPV vaccine for females. On September 2013, the 3rd dose of HPV vaccine was revised to be offered earlier in Grade 9 (see next section). More details on immunization coverage rates among Grade 6 students at the HSDA level can be found in Appendix F.

Table 2-3 Immunization coverage rates among Grade 6 students in Fraser Health, 2008/09 to 2012/13 school year

ANTIGEN	2008/09	2009/10	2010/11	2011/12	2012/13
Hepatitis B	86.2%	82.5%	81.0%	83.5%	87.5%
Meningococcal C	90.2%	88.4%	86.8%	87.9%	87.9%
Varicella	88.2%	81.8%	84.6%	83.1%	82.6%
HPV	61.6%	59.3%	68.4%	68.7%	71.0%

Grade 6 Students with up-to-date for age immunization coverage rates measure the proportion of students enrolled in Grade 6 as of June 30 who received:

- **Hepatitis B:** a completed series of hepatitis B vaccine by June 30 (3 doses if series was started before 11 years of age or 2 doses if series was started on or after 11 years of age).
- **Meningococcal C:** 1 dose of meningococcal C conjugate vaccine a) on or after 12 months of age(prior to 2009/10) or b) on or after 10 years of age (2009/10 and later). A more stringent definition of up-to-date for age used starting 2009/10 school year specifying that the vaccine must have been received on or after 10 years of age may result in artifactual decreases in coverage rates.
- **Varicella:** 1 (prior to 2013) or 2 (2013 or later) valid dose(s) of varicella vaccine by June 30 or reported previous history of varicella disease. The definition for up-to-date for age for varicella reflects a change in immunization policy that was implemented during the 2012/13 school year when a second dose of varicella vaccine was offered to susceptible students in Grade 6.
- **HPV (for female students only):** 3 doses of HPV vaccine (prior to 2010/11) or 2 doses of HPV vaccine (2010/11 and later). The change in definition for up-to-date for age for HPV from 3 to 2 doses starting in 2010/11 school year may result in artifactual increases in coverage rates.

Grade 9 Immunizations

While rates have fluctuated over the years, Grade 9 coverage rates for acellular pertussis and tetanus/diphtheria administered through school-based programs remain high at 83.5% and 85.4% respectively in 2011/12. The decline in rates in 2012/13 maybe attributable to the conversion of immunization records from iPHIS to Panorama in June 2013. In September 2008, the first cohort of Grade 6 and 9 girls in BC were offered HPV vaccine. The program for Grade 9 girls continued for two more school year only until 2010/11. Grade 9 HPV coverage rates in Fraser Health ranged from 54.2% to 60.4% during this period. This is lower than the HPV coverage rates for Grade 6 students (ranging from 59.3% to 68.4 % between 2008/09 to 2010/11).

Table 2-4 Immunization coverage rates among Grade 9 students in Fraser Health, 2008/09 to 2012/13 school year.

ANTIGENS	2008/09	2009/10	2010/11	2011/12	2012/13
Acellular Pertussis	86.2%	84.2%	85.1%	83.5%	81.6%
Tetanus/Diphtheria	88.9%	85.4%	88.3%	85.4%	84.6%
HPV	59.2%	54.2%	60.4%	*Please see note below	

Grade 9 Students with up-to-date for age immunization coverage rates measure the proportion of students enrolled in Grade 9 as of June 30 who received:

- **Pertussis:** a completed primary series of pertussis-containing vaccine and received an acellular pertussis booster in the form of tetanus/diphtheria/acellular pertussis within the past 5 year by June 30
- **Tetanus/diphtheria:** a completed primary series of tetanus/diphtheria-containing vaccine and received any tetanus/diphtheria-containing vaccine within the past 5 years by June 30.
- **HPV(females only):** ever completed a 3-dose series of HPV by June 30. *Girls who were in Grade 9 in 2011/12 and 2012/13 were offered 3 doses of HPV vaccine when they were in Grade 6 in 2008/09 and 2009/10. Please refer to Grade 6 coverage rates for results.

SECTION 3

REVIEW OF THE IMMUNIZATION PROGRAM IN FRASER HEALTH

In 2014, improving immunization rates became a priority area in Fraser Health's strategic plan, as one of the key indicators under Public Health Measures.[24] Recent outbreaks of vaccine-preventable diseases highlight the importance of maintaining high immunization coverage to protect against illness. Coverage rates in Fraser Health have been and continue to be similar to current provincial rates, but they are significantly lower than the provincial target of 90% by 2023. In the 2013 Ministry of Health Report, *Promote, Protect, Prevent: Our Health Begins Here*, the target for immunization coverage rates up-to-date by second birthday in accordance with the routine childhood immunization schedule was set at 90% by 2023, from a baseline of 70% in 2012.[25] Within Fraser Health, interim targets have been set to improve the immunization program to reach 80% coverage by 2017.

To identify strategies to reach this target, Population and Public Health conducted a multi-pronged review of the immunization program. This review included several components to assess the current state, identify where the gaps are, and make recommendations for improving coverage in Fraser Health. First, we conducted a detailed assessment of our own data to see where children were falling off the schedule, or not getting their doses in on time. We received feedback from parents through client interviews on what kinds of barriers they experience for coming in to appointments on time, and how we could address those barriers. We then surveyed and engaged physicians, our partners in immunization, to understand how we could support them better to continue providing childhood immunizations. We also conducted a literature review and jurisdictional scan to identify best and promising practices that could be implemented in Fraser Health. Finally, we assessed our current state and used the findings from the literature review and jurisdictional scan for a gap analysis to put forward recommendations on areas of improvement.

[24] Fraser Health Strategic Plan. (2014). Retrieved from: http://fraserhealth.ca/about_us/strategic_plan/ten_priorities/10_Priority_Actions_for_Fraser_Health#publichealth

[25] Ministry of Health. (2013). Promote, protect, prevent: our health begins here. Retrieved from: http://www.health.gov.bc.ca/library/publications/year/2013/BC-guiding-framework-for-public-health.pdf

Here are some highlights of what we have learned.

What do the immunization records show?

Immunization coverage is an important aggregate measure of how much of the population is protected from vaccine-preventable infections. Up-to-date status as a measure of immunization coverage shows what percentage of children are fully protected at those ages. However, it does not reflect whether those children received their immunizations on time, or how many children are missing one or two doses versus missing most or all of their immunizations. Up-to-date status is also only as good as the records entered into the provincial database (iPHIS); when children move into or out of the province and health authority, their immunization and address records may not get updated which impacts measures of immunization coverage.

In order to better understand Fraser Health's immunization coverage for children in their first 2 years of infancy, we looked at two important questions:

- Do immunization records in the provincial database accurately reflect coverage for Fraser Health residents?
- Are children getting immunizations on time and completely in the first two years of life?

To answer the first question, Fraser Health conducted a survey in 2011 asking parents of children born in 2009 about their child's immunization history and compared it to the records available in the provincial database. The purpose of the survey was to determine the impact of missing records on the reported immunization coverage rate. Overall for Fraser Health, provincial records of immunization coverage may underestimate actual coverage by 4% based on the survey results. The largest difference was noted in Fraser North, where the survey found coverage rates of 77.3%, whereas the provincial database reported 65.7%, a difference of 11.6 percentage points. The proportion of children immunized outside of the Public Health Unit is significantly higher in Fraser North compared to Fraser South and Fraser East, which may explain this difference in coverage rates. The difference between survey coverage and iPHIS coverage for Fraser East and Fraser South were 2.1 and -1.3 percentage points, respectively, suggesting provincial records in those areas more accurately reflect actual coverage rates. While parents/guardians who responded to the survey may be more likely to have been interested in immunizations compared to the general population, this survey suggests that provincially reported immunization coverage rates underestimate actual coverage rates in Fraser Health.

Improved reporting of immunizations records to public health will provide more accurate measures of coverage rates.

To answer the second question, we conducted an in-depth examination of iPHIS records for the timeliness and completeness of infant immunizations from birth to 2 years of age for children born between 2008 to 2010 in Fraser Health.[26] The purpose of this was to identify issues that arise around the routine visits at 2, 4, 6, 12, and 18 months that may contribute to overall lower coverage by 2 years of age. Results of this analysis revealed several important findings.

i) Most kids start their immunizations

While there are concerns about individuals and groups who refuse immunizations for various reasons, only 6% of children had no immunizations on record.

This means the vast majority of parents and guardians in Fraser Health are willing to receive at least some immunizations.

ii) Keeping on track

Coverage decreases with each successive routine visit between 2 months and 18 months of age. However, the largest drop-offs in coverage are for immunizations given at the 12 months and 18 months visits. Where 94% of children had a first dose of pertussis-containing vaccine at 2 months, only 76% had their fourth routine dose at 18 months.

Ensuring that all children who begin immunizations complete the entire infant series, especially for visits between the first and the second year of life, would significantly improve two-year old immunization coverage.

iii) Getting in on time

Over 80% of children get their first doses at 2 months of age on time (within the month that the child is 2 months old). This timely receipt of immunization also drops with each successive routine visit, until only about 40% of children are getting their immunizations on time at 18 months of age. Children who are initially late on their immunizations have some opportunities for catching up in the schedule while still maintaining the required minimum time between doses. However, children who were initially late in the schedule were more likely to continue to be late and not complete the schedule. For children who started the schedule on time, there was a 13% decline between the number of children who received immunizations at 18 months compared to at 4 months. In comparison, children who were late for their first immunizations had a 51% decline between those who received immunizations at 18 months compared to 4 months of age.

Making sure that children start the schedule on time and come in for all their visits on time is necessary for children to be fully protected.

[26] Newhouse E and Murti M. (2014). 2-year old immunization coverage in Fraser Health, British Columbia: Beyond up-to-date status. Canadian Immunization Conference. Oral abstract. Ottawa, 2014.

iv) Sticking to the recommended schedule

The routine schedule in BC requires 5 visits to achieve complete vaccination by 2 years of age. Most children in Fraser Health (69%) had 5 visits on record, but 18% has less than 5 visits and 13% had more than 5 visits. Some children will have valid reasons for requiring more than 5 visits, such as if they started their immunizations in another country or had an invalid dose that needed to be repeated. However, some parents specifically request different schedules where not all immunizations are given at once. "One-at-a-time" dosing and other variations to the schedule results in two significant problems: i) children are less likely to be up-to-date by 2 years of age, and ii) additional visits create additional workload for immunizers. While children who had exactly 5 visits had a 95% likelihood of being up-to-date at 2 years old, children who had 6 or more visits had only a 77% likelihood of being up-to-date. Over 9% of all children had extra visits that were not accounted for by valid reasons – resulting in taking up 13% of the total visits – an excess of 4%. Children living in the Burnaby, Newton and New Westminster areas had particularly high proportions of children receiving extra visits.

Children are more likely to be up-to-date if they get all doses in the recommended number of visits

v) Getting all of the recommended immunizations

Parents/guardians may have specific hesitation towards certain vaccines resulting in their children receiving some but not all of their immunizations. At the first 2 month visit, children in this analysis should have received their (i) diphtheria/tetanus/pertussis/hepatitis B/polio/Haemophilus influenzae type b (DTap-HB-IPV-Hib) vaccine (93.8%), (ii) pneumococcal vaccine (93.0%) and (iii) meningococcal C vaccine (92.5%). Small differences (1.3%) were noted between immunizations received at this visit. However, at the 12 month visit, children in this analysis should have received their (i) measles/mumps/rubella (MMR) vaccine (87.3%), (ii) varicella vaccine (83.8%), (iii) third dose pneumococcal vaccine (83.6%), and (iv) second dose meningococcal C vaccine (83.1%). Children with a history of varicella disease do not require varicella immunization, but this accounted for only 0.2% of children, and does not explain the 3% difference compared to MMR. Some children in this cohort may have preferentially and differentially received a MMR dose due to the Olympics-related outbreak of measles in 2010, resulting in higher coverage for that vaccine compared to other vaccines due at 12 months. Overall, the differences in coverage for immunizations due at the same visit suggest that preferential receipt of some vaccines may be a concern, but contributes a small amount to overall up-to-date coverage at two years old.

Getting all of the recommended immunizations at each visit ensures children are fully protected against vaccine-preventable diseases

What do parents say?

In an effort to understand how to make public health unit delivered immunization services more client-oriented, we interviewed 15 parents of children who were not up-to-date by 21 months of age to assess what barriers they faced in keeping up with the schedule.[27] Parents had a variety of reasons for their child not being up-to-date. There were parent-driven delays, such as choosing an alternative schedule, being out-of-town, procrastination about booking an appointment, and not wanting to immunize their child when ill (but well enough to receive the immunizations). Other parents were not aware that their child was behind in the schedule, or had their child immunized at their doctors office and their records were not updated.

Parents talked about the need to "juggle" everything in their life – their other children, work/school responsibilities – and how immunizations sometimes became a lower priority. They generally liked coming to the public health unit, trusted the staff, and appreciated the information received, but as one parent said, "as far as my public health appointments, those don't go on my list of things that are that important." Parents said it was easier coming in for the earlier visits when they were still off of work, but that this got harder at the 12 and 18 month visits.

Findings from these interviews have highlighted the need to explore new technological options for booking and reminding parents about appointments, such as online booking platforms, and text/email reminder systems. The results also suggest the need for immunization education and promotion about the importance of sticking to the immunization schedule and the safety and efficacy of new vaccines.

[27] Newhouse E, Hashim A and Murti M. (2014). Improving client-oriented service through interviews of parents receiving recall reminders. Canadian Immunization Conference poster. Ottawa.

What do physicians think?

Fraser Health has a mixed model of immunization delivery, with both public health units and primary care physicians providing childhood immunizations. General practitioners (GPs) are important partners in improving immunization coverage rates in Fraser Health; however, the number of childhood immunizations delivered by primary care providers has been declining over time. The proportion of children immunized by physicians dropped from 94% in 1999 to 71% in 2011.[28]

To assess the validity and current state of this trend within Fraser Health, we partnered with the ten Divisions of Family Practice to administer a survey to their members, asking questions on whether they were providing childhood immunizations 5 years ago, currently, and whether they will be providing these immunizations 5 years from now. While 82.7% of the surveyed physicians who said they were currently immunizing would continue to do so 5 years from now, others were unsure or sure that they were not going to be continuing in the future. Some physicians, particularly those who had been in practice for less than 5 years, were interested in providing this service 5 years from now, even if they were not currently immunizing. Overall, there was a declining trend in the number of GPs offering childhood immunizations. Barriers to providing immunizations included: the time it takes, insufficient remuneration, not having adequate office supports, having to report back to public health, not wanting to be remembered as the "needle doctor", and the increasing complexity of the schedule. Physicians suggested more public education campaigns around immunizations were needed to raise awareness, as well as the need for information products for immunizers and parents.

[28] Omura J et al. (2014). Immunization delivery in British Columbia, perspectives of primary care physicians. *Can Fam Phys* ;60:e187-93.

What are best and promising practices?

Findings from the literature review and the jurisdictional scan identified a number of best and promising practices for trying to improve immunization coverage. These ranged from technological solutions, such as online booking platforms and connected immunization record registries, to equity-based solutions, such as targeted outreach services. Other health authorities and regions have worked on building strong partnerships with physicians, governments, and daycares to promote immunizations. In the U.S. and New Zealand, the use of audit feedback tools to measure and monitor immunization coverage at a practice level have been effective ways in encouraging increased immunization uptake.[29,30]

Many innovative approaches to improving coverage have been tried in various jurisdictions. In the same way we give multiple vaccines and multiple doses to be fully vaccinated, we also need to have multiple strategies done in multiple ways to effectively increase the overall immunization coverage. There is no 'magic bullet' solution, except for a strong commitment to ensure that as many children as possible are fully protected from vaccine-preventable illnesses.

Quality Initiatives supporting Immunization Practice:

Providing safe, quality care is a cornerstone of public health practice. A number of quality based strategies/initiatives are in place to support immunization practices. These include:

- Best Practice Statement for Mass Immunization Clinics.
- Staff training and support to complete and maintain immunization competency certification.
- Use of provincial and locally developed guidelines to support documentation standards for school based immunization consent forms.

[29] Centers for Disease Control and Prevention. (2014). AFIX (Assessment, Feedback, Incentives, and eXchange). Retrieved from: http://www.cdc.gov/vaccines/programs/AFIX/index.html.

[30] New Zealand. (n.d.). Achieving the immunisation Health Target. Retrieved from: http://www.immune.org.nz/sites/default/files/conferences/Tuohy%2C%20Challenge%20of%20the%208%20month%20target%20and%20summary%2C%20NIW%2020120906.pdf

SECTION 4
FUTURE DIRECTIONS

Fraser Health is committed to making sure that as many children as possible are fully up-to-date for immunization by 2 years of age. Over the past year, in addition to analyzing where we can be improving, we have already begun implementing changes. We have increased the number of evening and weekend appointments available at our public health units. We have been offering additional appointment slots when wait times for the next available appointment gets too long. And we are reviewing immunization records to make sure they are complete and accurately reflect the coverage of 2-year olds in Fraser Health.

Ongoing engagement with the ten Divisions of Family Practice in Fraser Health is aimed at identifying innovative ways to collaborate with our immunization partners. While not all of the barriers identified by physicians can by addressed within Fraser Health, we are reviewing and improving how we can share information with providers, deliver vaccines and make reporting on immunizations easier. We are working to find ways to support all physicians and health care providers to be champions and advocates for immunization.

From the 2-year old immunization review, we have also identified a number of short, medium and long term recommendations for ways we can continue to improve our immunization coverage and prevent vaccine-preventable illnesses. One of the first steps is putting everything we have learned into a quality improvement plan. That plan will include strategies to promote immunizations to parents, our partners, providers and others. This plan will be our guide to putting into action the ways we can close the gap on our immunization coverage.

We will also be taking a close look at how we can improve the efficiency and reach of the immunization appointments we provide. This includes how we can introduce technological solutions to book appointments, remind parents about appointments, and recall children who are not up-to-date. It also includes looking at how we can make clinic visits as client-oriented and efficient as possible. We will be repeating the coverage assessment that we conducted in 2011 to identify demographic factors associated with children who are unimmunized or under-immunized. This will inform how we can best target our immunization outreach services.

In addition to ensuring protection through immunizations, we also need to continue to build and support our capacity to respond to cases, clusters and outbreaks of vaccine-preventable diseases. This means ensuring our front-line staff continue to have the resources they need to respond quickly and effectively to notifications of illness, and work with our partners to control disease spread.

APPENDIX A

GLOSSARY AND DATA NOTES

Attack rate	The proportion of the population at risk who develops illness during an outbreak.
Booster dose	Additional dose(s) of vaccine administered after completion of a primary series to ``boost`` the immune system.
CD	Communicable Disease.
CDNC	Communicable Disease Nurse Coordinator.
Endemic	The continual occurrence of a disease within a specific geographical area or population.
Fraser Health	Fraser Health Authority. This includes the geographical area that is north of the Fraser River and West of Mission, and is comprised of the three health service delivery areas of Fraser East, Fraser North, and Fraser South.
Fraser East	This geographical area includes the municipalities of Mission, Abbotsford, Chilliwack, Agassiz-Harrison, Hope.
Fraser North	This geographical area includes the municipalities of Burnaby, New Westminster, Coquitlam, Port Coquitlam, Port Moody, Belcarra, Anmore, Pitt Meadows and Maple Ridge.
Fraser South	This geographical area includes the municipalities of Langley, Delta, Surrey, and White Rock.
IMD	Invasive meningococcal disease. This includes all reportable meningococcal disease which is comprised of meningococcal conjunctivitis,meningococcal meningitis, meningococcal pneumonia, meningococcal septicaemia, and meningococcal: other (invasive).
Immunization coverage	The proportion of people in the population who had received one or more vaccine(s) of interest. It is a measure of how many people are protected against vaccine-preventable infection within the overall population.
Incidence rate	The rate at which new disease occur in a population over a specified time period.
Index case	The first case of illness in a group or population.
IPD	Invasive pneumococcal disease. This includes reportable cases of pneumococcal meningitis (invasive) and pneumococcal other (invasive) disease.
iPHIS	integrated Public Health Information System – a database system used by public health units to report cases of reportable diseases to provincial and federal health authorities and document the administration of immunizations.
Panorama	The new public health surveillance information system which replaced iPHIS in June 2013 for immunization documentation.
Prophylaxis	The use of antibiotics or vaccine products for those exposed to a disease to prevent the disease from occurring.

Secondary transmission	Cases of illness that arise among contacts of the known cases infecting at risk individuals.
Up-to-date for age	Includes assessment of: 4 doses of diphtheria/tetanus/pertussis, 3 doses of hepatitis B, 1 dose of measles/mumps/rubella, 3 doses of polio, at least 1 dose of Haemophilius influenza type b after 15 months of age, 1 dose of varicella (or recorded exemption for varicella due to previous disease or protective antibody levels), up-to-date for pneumococcal conjugate and meningococcal C conjugate as defined by age of first dose.
Up-to-date for age minus booster	Includes assessment of: 3 doses of diphtheria/tetanus/pertussis, 3 doses of hepatitis B, 1 dose of measles/mumps/rubella, 2 doses of polio, 1 to 3 doses of Haemophilis influenza type b (depending on age at first dose), 2 to 3 doses of pneumococcal conjugate (depending on age at first dose), at least 1 dose of meningococcal C conjugate, 1 dose of varicella or past disease.
VPD	Vaccine-preventable disease.

Data notes

- Clinical and confirmed case reports are reported from the local health units through the integrated Public Health Information System (iPHIS). Diseases are classified based on the date it was reported to the health authority.
- Data included in this report was extracted in August 2014.
- Additional data for invasive pneumococcal disease was collected through enhanced surveillance system obtained from BC CDC.
- Population estimates used for denominators and rate calculations are obtained from BC Stats, P.E.O.P.L.E 2013.

APPENDIX B

REPORTABLE COMMUNICABLE DISEASES IN BC

March 2013

Schedule A: Reportable by All Sources

Acquired Immune Deficiency Syndrome

Anthrax

Botulism

Brucellosis

Cholera

Congenital infections:
- Toxoplasmosis, Rubella, Cytomegalovirus, Herpes Simplex, Varicella-zoster, Hepatitis B Virus, Listeriosis and any other congenital infection

Creutzfeldt-Jacob Disease

Cryptococcus neoformans

Cryptosporidiosis

Cyclospora Infection

Diffuse Lamellar Keratitis (DLK)

Diphtheria:
- Cases
- Carriers

Encephalitis:
- Post-infectious
- Subacute sclerosing panencephalitis
- Vaccine-related
- Viral

Foodborne illness:
- All causes

Gastroenteritis epidemic:
- Bacterial
- Parasitic
- Viral

Genital Chlamydia Infection

Giardiasis

H5 and H7 strains of the Influenza virus

Haemophilus Influenzae Disease,
- All Invasive, by Type

Hantavirus Pulmonary Syndrome

Hemolytic Uremic Syndrome

Hemorrhagic Viral Fevers

Hepatitis Viral:
- Hepatitis A
- Hepatitis B
- Hepatitis C
- Hepatitis E
- Other Viral Hepatitis

Human Immunodeficiency Virus

Invasive Group A Streptococcal Disease

Invasive Streptococcus Pneumoniae Infection

Leprosy

Lyme Disease

Measles

Meningitis: All causes
- (i) Bacterial:
  - Hemophilus
  - Pneumococcal
  - Other
- (ii) Viral

Meningococcal Disease:
- All Invasive
- Including Primary Meningococcal Pneumonia and
- Primary Meningococcal Conjunctivitis

Mumps

Neonatal Group B Streptococcus Infection

Paralytic Shellfish Poisoning (PSP)

Pertussis (Whooping Cough)

Plague

Poliomyelitis

Rabies

Reye's Syndrome

Rubella:
- Congenital Rubella Syndrome

Severe Acute Respiratory Syndrome

Smallpox

Tetanus

Transfusion Transmitted Infection

Tuberculosis

Tularemia

Typhoid Fever and Paratyphoid Fever

Venereal Disease:
- Chancroid
- Gonorrhea - all sites
- Syphilis

Waterborne Illness:
- All causes

West Nile Virus Infection

Yellow Fever

Schedule B: Reportable by Laboratories Only

All specific bacterial and viral stool pathogens:

(i) Bacterial:
- Campylobacter
- Salmonella
- Shigella
- Yersinia

(ii) Viral

Amoebiasis

Borrelia burgdorferi Infection

Cerebrospinal Fluid Micro-organisms

Chlamydial Diseases, including Psittacosis

Creutzfeldt-Jacob Disease

Cryptococcus neoformans

Herpes Genitalis

Human Immunodeficiency Virus

Influenza virus, including the H5 and H7 strains

Legionellosis

Leptospirosis

Listeriosis

Malaria

Q Fever

Rickettsial Diseases

Severe Acute Respiratory Syndrome

Smallpox

Tularemia

West Nile Virus Infection

Source: Public Health Act, Health Act Communicable Disease Regulation.
Retrieved from: http://www.bclaws.ca/civix/document/id/complete/statreg/4_83#ScheduleA

APPENDIX C

BC ROUTINE IMMUNIZATION SCHEDULE

	2 MONTHS	4 MONTHS	6 MONTHS	12 MONTHS	18 MONTHS	starting at 4 YEARS OF AGE (kindergarten entry)	GRADE 6	GRADE 9	ADULT	65 YEARS and over
Diphtheria, Tetanus, Pertussis, Hepatitis B, Polio and Haemophilus influenzae type b (DTaP-HB-IPV-Hib) Vaccine	✓	✓	✓							
Diphtheria, Tetanus, Pertussis, Polio, Haemophilus influenzae Type b (DTaP-IPV-Hib) Vaccine					✓					
Pneumococcal Conjugate (PCV 13) Vaccine	✓	✓		✓						
Rotavirus Vaccine	✓	✓								
Hepatitis A Vaccine			✓ Aboriginal infants only		✓ Aboriginal infants only	✓ Aboriginal infants only				
Hepatitie B Vaccine							✓ if eligible		✓ if eligible	
Measles, Mumps Rubella (MMR) Vaccine				✓					✓ if susceptible	
Meningococcal C Conjugate (Men-C) Vaccine	✓			✓			✓		✓ if eligible	
Chickenpox [Varicella] Vaccine				✓			✓ if eligible		✓ if susceptible	
Measles, Mumps, Rubella and Varicella (MMRV) Vacine						✓				
Human Papillomavirus (HPV) Vaccine							✓			
Diphtheria, Tetanus, Pertussis, Polio (DTap-IPV) Vaccine						✓				

Continued on next page

	2 MONTHS	4 MONTHS	6 MONTHS	12 MONTHS	18 MONTHS	starting at 4 YEARS OF AGE (kindergarten entry)	GRADE 6	GRADE 9	ADULT	65 YEARS and over
Tetanus, Diphtheria, Pertussis (Tdap) Vaccine								✓	✓	
Tetanus and Diphtheria (Td) Vaccine									✓ Every 10 years	✓ Every 10 years
Inactivated influenza (Flu) Vaccine Live Attenuated Influenza (Flu) Vaccine			Annually for infants 6 months to 4 years of age							✓ Annually
Pneumococcal Polysaccharide Vaccine										✓ 1 time only

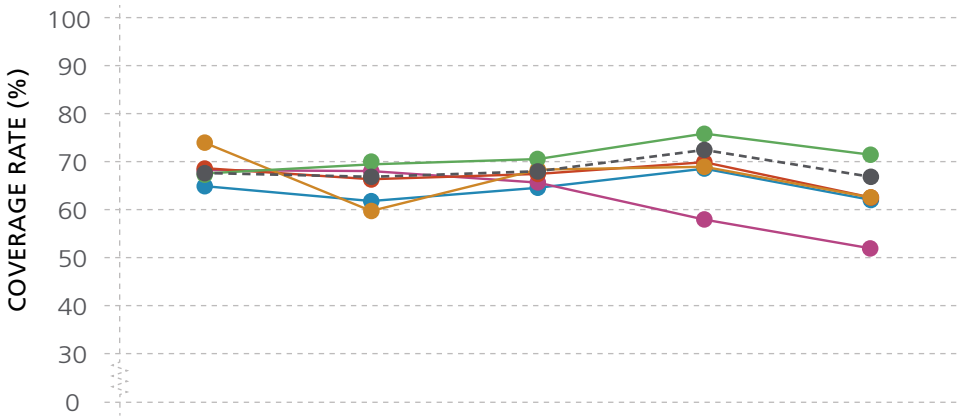
Note: This schedule is for healthy individuals. For those with chronic illness or weakened immune systems, please contact your health care provider for more information about your immunization needs. You may also be provided with other vaccines free of charge.

APPENDIX D

2-YEAR OLD IMMUNIZATION COVERAGE RATES BY LHA

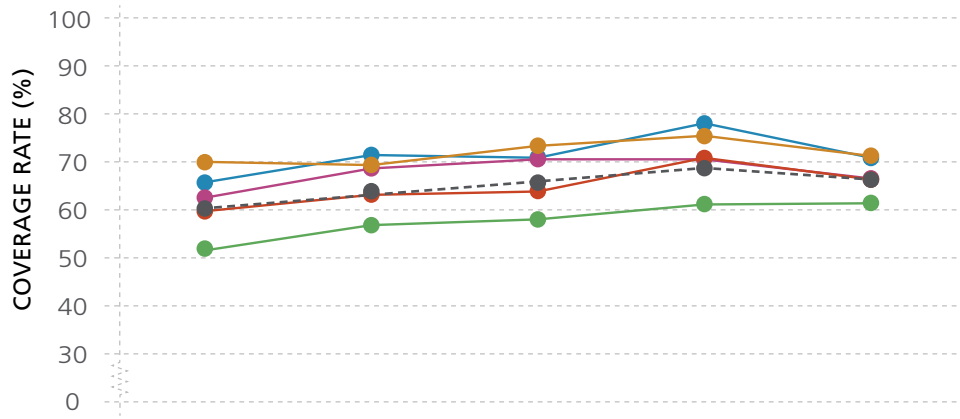
Note: Within each HSDA, and particularly for Fraser East, Local Health Area (LHA) level data should be interpreted with caution due to the small number of children in each birth cohort

Figure D-1 Percent of 2-year olds with up-to-date immunization in Fraser East, 2009 to 2013



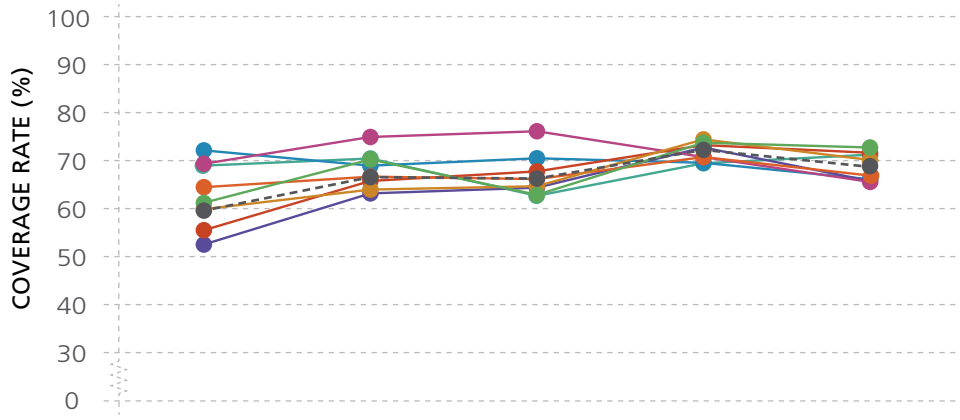
	2009	2010	2011	2012	2013
Abbotsford	67.5	69.4	70.7	75.8	71.4
Agassiz	73.9	59.7	68.4	68.9	62.5
Chilliwack	68.6	66.3	67.4	69.9	64.2
Hope	68.2	68.0	65.6	57.9	41.9
Mission	65.0	61.8	64.4	68.5	62.0
Fraser East	**67.6**	**66.8**	**68.5**	**72.4**	**67.1**

Figure D-2 Percent of 2-year olds with up-to-date immunizations in Fraser North, 2009 to 2013



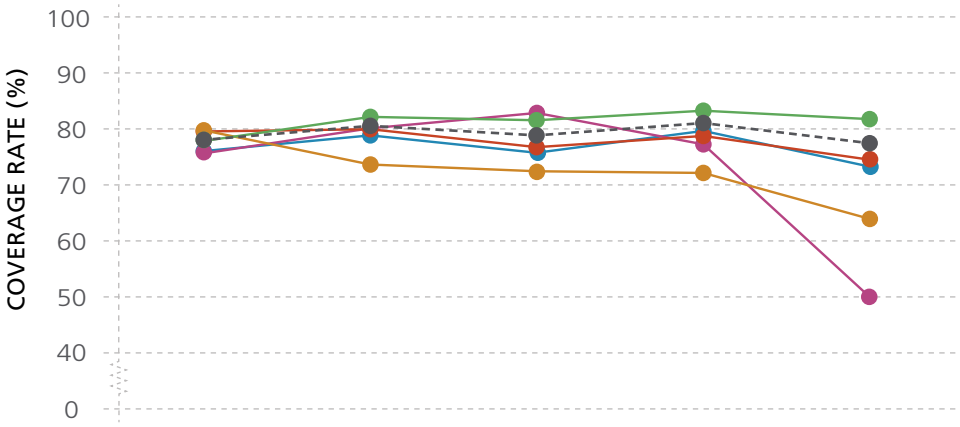
	2009	2010	2011	2012	2013
Burnaby	51.7	56.8	58	61.1	61.4
Maple Ridge	70.2	69.3	73.3	75.4	71.2
New Westminster	59.7	63.1	63.8	70.8	66.6
Newport	62.5	68.6	70.5	70.5	68.1
Port Coquitlam	65.7	71.4	71	78	71
Fraser North	**60.3**	**63.9**	**65.7**	**68.7**	**66.3**

Figure D-3 Percent of 2-year olds with up-to-date immunization in Fraser South, 2009 to 2013



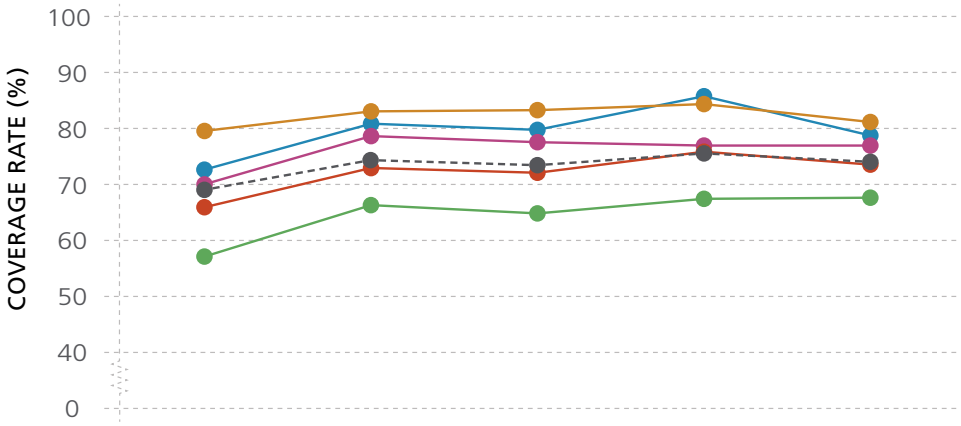
	2009	2010	2011	2012	2013
Cloverdale	61.1	70.4	66.0	73.9	72.9
Guildford	60.0	64.1	64.8	74.6	70.2
Langley	64.6	66.8	66.3	70.9	67.0
Newton	55.6	65.9	67.9	73.4	71.8
North Delta	69.5	75.1	76.3	70.9	65.7
North Surrey	52.6	63.3	64.5	72.9	65.9
South Delta	72.3	69.1	70.8	69.7	66.5
White Rock	69.1	70.6	62.8	69.6	71.4
Fraser South	**59.7**	**66.7**	**66.4**	**72.4**	**69.0**

Figure D-4 Percent of 2-year olds with up-to-date immunizations minus the booster in Fraser East, 2009 to 2013



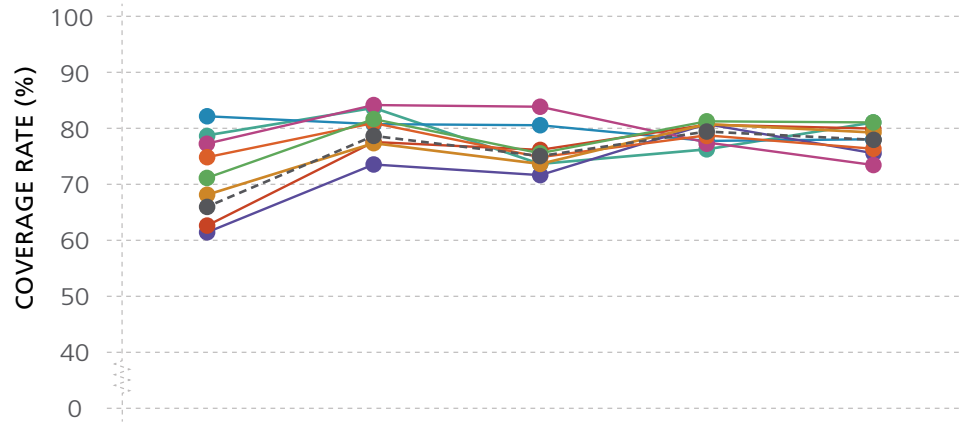
	2009	2010	2011	2012	2013
Abbotsford	77.8	82.1	81.5	83.2	81.7
Agassiz	79.7	73.6	72.4	72.1	63.9
Chilliwack	79.5	79.9	76.7	78.7	74.5
Hope	75.8	80.0	82.8	77.2	50.0
Mission	76.0	78.8	75.7	79.6	73.2
Fraser East	**78.0**	**80.5**	**78.8**	**81.0**	**77.4**

Figure D-5 Percent of 2-year olds with up-to-date immunizations minus the booster in Fraser North, 2009 to 2013



	2009	2010	2011	2012	2013
Burnaby	57.1	66.3	64.8	67.4	67.6
Maple Ridge	79.5	83.0	83.2	84.3	81.1
New Westminster	65.9	72.9	72.0	75.8	73.5
Newport	70.0	78.6	77.5	76.9	76.9
Port Coquitlam	72.6	80.8	79.7	85.7	78.7
Fraser North	**69**	**74.3**	**73.4**	**75.5**	**74**

Figure D-6 Percent of 2-year olds with up-to-date immunizations minus the booster in Fraser South, 2009 to 2013



	2009	2010	2011	2012	2013
Cloverdale	71.1	81.6	75.5	81.2	81.0
Guildford	68.1	77.3	73.6	80.7	79.2
Langley	74.8	80.9	74.8	78.7	76.3
Newton	62.6	77.5	76.1	80.6	79.9
North Delta	77.2	84.1	83.8	77.2	73.4
North Surrey	61.4	73.5	71.6	80.7	75.5
South Delta	82.1	80.7	80.5	77.7	78.0
White Rock	78.7	83.6	73.6	76.2	81.0
Fraser South	**66.4**	**78.6**	**75.0**	**79.5**	**77.9**

APPENDIX E

SCHOOL-AGE IMMUNIZATION COVERAGE RATES BY HSDA

Table E-1 Up-to-date for age immunization coverage rates among Kindergarten in Fraser Health by HSDA, 2008/09 to 2012/13 school year

		SCHOOL YEAR				
ANTIGENS	HSDA	2008/09	2009/10	2010/11	2011/12	2012/13
DaPTP	Fraser East	79.5%	74.1%	74.3%	75.4%	73.0%
	Fraser North	79.1%	74.6%	76.8%	72.4%	70.0%
	Fraser South	78.8%	76.2%	75.5%	74.1%	68.9%
MEASLES	Fraser East	88.6%	87.8%	88.9%	88.1%	87.7%
	Fraser North	86.0%	87.2%	87.5%	84.9%	85.4%
	Fraser South	87.6%	88.3%	87.3%	87.2%	83.1%
MUMPS	Fraser East	91.7%	87.9%	88.9%	88.1%	87.7%
	Fraser North	91.6%	86.0%	87.4%	84.9%	85.3%
	Fraser South	92.8%	88.3%	87.4%	86.3%	83.1%
RUBELLA	Fraser East	91.7%	90.1%	89.5%	88.9%	90.4%
	Fraser North	91.6%	88.1%	90.1%	88.8%	88.4%
	Fraser South	92.8%	90.8%	89.6%	89.3%	86.1%
HEPATITIS B	Fraser East	89.7%	88.2%	90.2%	89.9%	89.5%
	Fraser North	86.5%	88.4%	89.6%	86.9%	86.1%
	Fraser South	89.2%	89.5%	89.8%	89.9%	85.0%
VARICELLA	Fraser East	81.6%	87.5%	89.7%	88.7%	86.7%
	Fraser North	78.3%	85.4%	89.4%	87.2%	87.8%
	Fraser South	78.9%	87.7%	89.7%	89.7%	86.3%
MENINGOCOCCAL C	Fraser East	89.2%	86.6%	91.8%	91.2%	92.2%
	Fraser North	85.0%	86.6%	88.9%	87.1%	87.3%
	Fraser South	85.9%	89.4%	89.4%	90.2%	85.0%

Kindergarten students with up-to-date for age immunization coverage rates measure the proportion of students enrolled in Kindergarten as of June 30 who received:

- **DaPTP:** the fourth or fifth dose of diphtheria/acellular pertussis/tetanus/polio-containing vaccine after their fourth birthday and by June 30.
- **Measles:** 2 valid doses of measles-containing vaccine by June 30.
- **Mumps:** 2 valid doses of mumps-containing vaccine by June 30. The definition of up-to-date for age for mumps had changed from 1 to 2 doses of mumps-containing vaccine in 2009.
- **Rubella:** at least 1 valid dose of rubella-containing vaccine by June 30.
- **Hepatitis B:** a completed series of 3 doses of hepatitis B vaccine by June 30.
- **Varicella:** 1 valid dose of varicella vaccine by June 30 or reported previous history of varicella disease.
- **Meningococcal C:** 1 dose of meningococcal C conjugate vaccine on or after 12 months of age.

Table E-2 Grade 6 students with up-to-date immunization in Fraser Health by HSDA, 2008/09 to 2012/13 school year

		SCHOOL YEAR				
ANTIGENS	HSDA	2008/09	2009/10	2010/11	2011/12	2012/13
HEPATITIS B	Fraser East	80.6%	74.7%	76.7%	78.7%	86.9%
	Fraser North	86.2%	82.2%	79.6%	80.6%	82.9%
	Fraser South	88.4%	85.6%	83.6%	87.2%	91.0%
MENINGOCOCCAL C	Fraser East	85.9%	84.2%	83.3%	85.4%	85.2%
	Fraser North	90.0%	87.8%	87.3%	86.7%	86.0%
	Fraser South	92.1%	90.4%	87.8%	89.7%	90.3%
VARICELLA	Fraser East	82.4%	77.0%	84.8%	80.5%	80.9%
	Fraser North	87.2%	82.1%	79.9%	79.3%	80.0%
	Fraser South	91.2%	83.4%	87.7%	86.7%	85.1%
HPV	Fraser East	55.5%	52.2%	60.9%	62.5%	63.6%
	Fraser North	62.1%	60.8%	66.9%	66.7%	70.9%
	Fraser South	63.8%	61.0%	72.4%	72.6%	74.0%

Grade 6 Students with up-to-date for age immunization coverage rates measure the proportion of students enrolled in Grade 6 as of June 30 who received:

- **Hepatitis B:** a completed series of hepatitis B vaccine by June 30 (3 doses if series was started before 11 years of age or 2 doses if series was started on or after 11 years of age).
- **Meningococcal C:** 1 dose of meningococcal C conjugate vaccine a) on or after 12 months of age (prior to 2009/10) or b) on or after 10 years of age (2009/10 and later). A more stringent definition of up-to-date for age used starting 2009/10 school year specifying that the vaccine must have been received on or after 10 years of age may result in artifactual decreases in coverage rates.
- **Varicella:** 1 (prior to 2013) or 2 (2013 or later) valid dose(s) of varicella vaccine by June 30 or reported previous history of varicella disease. The definition for up-to-date for age for varicella reflects a change in immunization policy that was implemented during the 2012/13 school year when a second dose of varicella vaccine was offered to susceptible students in Grade 6.
- **HPV** (for female students only): 3 doses of HPV vaccine (prior to 2010/11) or 2 doses of HPV vaccine (2010/11 and later). The change in definition for up-to-date for age for HPV from 3 to 2 doses starting in 2010/11 school year may result in artifactual increases in coverage rates.

Table E-3 Grade 9 students with up-to-date immunization in Fraser Health by HSDA, 2008/09 to 2012/13 school year

		SCHOOL YEAR				
ANTIGENS	HSDA	2008/09	2009/10	2010/11	2011/12	2012/13
ACELLULAR PERTUSSIS	Fraser East	83.6%	82.3%	81.4%	78.5%	74.0%
	Fraser North	86.9%	82.5%	84.5%	82.9%	80.2%
	Fraser South	86.8%	86.1%	86.9%	85.8%	85.5%
TETANUS/ DIPHTHERIA	Fraser East	90.1%	82.7%	87.5%	80.3%	83.7%
	Fraser North	88.6%	84.3%	84.6%	85.2%	81.1%
	Fraser South	88.5%	87.3%	91.3%	87.6%	87.5%
HPV	Fraser East	52.1%	41.3%	50.4%	*Please see note	
	Fraser North	62.3%	61.3%	60.8%		
	Fraser South	59.8%	54.3%	64.0%		

Grade 9 Students with up-to-date for age immunization coverage rates measure the proportion of students enrolled in Grade 9 as of June 30 who received:

- **Pertussis:** a completed primary series of pertussis-containing vaccine and received an acellular pertussis booster in the form of tetanus/diphtheria/acellular pertussis within the past five year by June 30.
- **Tetanus/diphtheria:** a completed primary series of tetanus/diphtheria-containing vaccine and received any tetanus/diphtheria-containing vaccine within the past five years by June 30.
- **HPV** (females only): ever completed a 3-dose series of HPV by June 30. *Girls who were in Grade 9 in 2011/12 and 2012/13 were offered 3 doses of HPV vaccine when they were in Grade 6 in 2008/09 and 2009/10. Please refer to Grade 6 coverage rates for results.