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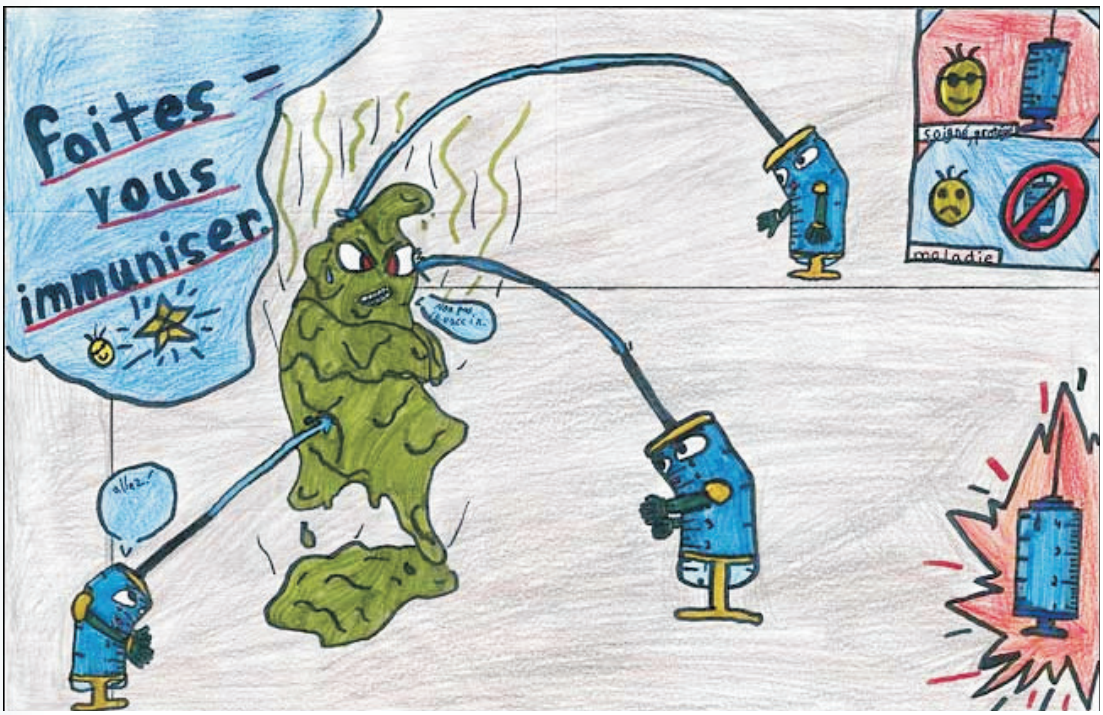

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CANADIAN NATIONAL REPORT ON IMMUNIZATION

2006

The Public Health Agency of Canada

Mission:

To promote and protect the health of Canadians through leadership, partnership, innovation and action in public health.

Vision:

Healthy Canadians and communities in a healthier world.

Immunization and Respiratory Infections Division

Mandate:

To prevent, reduce or eliminate vaccine-preventable and infectious respiratory diseases; reduce the negative impact of emerging and re-emerging respiratory infections; and maintain public and professional confidence in immunization programs in Canada. This is done in collaboration with provinces, territories, other federal departments, and other national and international stakeholders.

Acknowledgements

We acknowledge the continuing contribution of our immunization program and surveillance partners, including, but not limited to, the following groups and organizations: provincial and territorial epidemiologists, public health and immunization experts; the Canadian Nursing Coalition for Immunization; National Microbiology Laboratory, Winnipeg; National Centre for Streptococcus, Edmonton; provincial public health laboratories; members of the Immunization Monitoring Program, ACTive; the Canadian Paediatric Society and physicians contributing to the Canadian Paediatric Surveillance Program; Canadian members of the International Circumpolar Surveillance Invasive Bacterial Diseases Working Group; the FluWatch network of sentinel physicians and the College of Family Physicians of Canada.

Staff members of the Immunization and Respiratory Infections Division, Centre for Infectious Disease Prevention and Control, Public Health Agency of Canada, Ottawa, Ontario, Canada, contributed to determining the content, writing and editing of the report.

The artwork on the cover – an original drawing by Christian Morin from École Dagenais in Macamic, Quebec – was selected as the National Winner of the Canadian Immunization Poster Competition for grade 6 students. The competition was organized by the Immunization and Respiratory Infections Division and the Canadian Coalition for Immunization Awareness & Promotion, in conjunction with the sixth Canadian Immunization Conference in December 2004. The theme was “Give Us Your Best Shot”.

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PREFACE

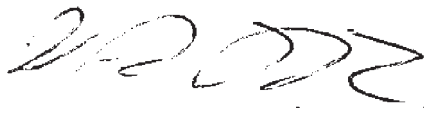
Since the publication of the 1998 *Canadian National Report on Immunization*, the landscape of public health in Canada has changed considerably, foremost with the creation of the Public Health Agency of Canada and the Pan-Canadian Public Health Network in 2004. This was preceded by the acceptance of the National Immunization Strategy (NIS) by the Conference of Federal, Provincial and Territorial (F/P/T) Deputy Ministers of Health and a commitment of $45 million over 5 years in the 2003 Federal Budget to strengthen national collaboration on immunization. In Budget 2004, the Government of Canada provided $300 million directly to the provinces and territories (P/T) to support the introduction of four new childhood and adolescent vaccines.

In the context of these significant changes, the purpose of this report is to cover progress in immunization, including current P/T programs and the results of the National Immunization Coverage Surveys, and to provide an update since 1998 on trends in select vaccine-preventable diseases and in adverse events following immunization. While major highlights of the progress of the NIS are discussed in a feature section of this report, there have been many milestones for immunization in the past several years that are worth emphasizing here:

- continued low disease rates for many vaccine-preventable diseases and limited spread of import-related measles and rubella cases, signalling the elimination of these diseases in Canada;
- the expansion of routine immunization programs to include childhood pneumococcal conjugate vaccine and adolescent acellular pertussis programs in all provinces and territories, as well as childhood meningococcal and varicella zoster vaccine programs in 12 jurisdictions;
- improvements over time in vaccine coverage estimates among 2-year-olds for a single dose of the measles, mumps and rubella vaccine and for four doses of diphtheria, pertussis, tetanus, polio and *Haemophilus influenzae* type b combination vaccines;
- a dramatic decline in the reported frequency of specific adverse events since the switch from whole-cell to acellular pertussis vaccines in childhood immunization programs in 1997-98;
- the first national consensus conference of national goals and recommendations for vaccine-preventable diseases held in June 2005;
- the first national research priorities workshops on influenza and on human papillomavirus vaccines, held in the fall of 2005, to identify knowledge gaps and ways to address these gaps;
- new collaborations forged between public health and experts in immunization, sexually transmitted diseases, and cancer prevention and management to design effective immunization strategies for the newly approved human papillomavirus vaccine;
- establishment of a pandemic influenza vaccine readiness contract with our domestic supplier in 2001, the first country to achieve this, and the Canadian Pandemic Influenza Plan, published in 2004, to facilitate national coordination in preparedness and response activities;
- the release of the 7th edition of the *Canadian Immunization Guide* in 2006;
- the provision of cutting-edge information on immunization science, policy, programs and practice and a forum for networking and knowledge-sharing among the many disciplines working in immunization through the biennial Canadian Immunization Conference. The December 2006 instalment is aptly entitled, *Celebrating Immunization in Canada: Achievements and Opportunities*.

Despite these achievements, however, there have been sporadic outbreaks of measles, mumps and rubella in several jurisdictions, which serve to remind us that Canada will experience ongoing importations of vaccine-preventable diseases and that there are pockets of non-immunized or under-immunized populations vulnerable to the introduction of such infectious agents. The spread of poliovirus to 11 previously polio-free countries in Africa and south-east Asia during late 2004 and 2005 illustrates the necessity for constant vigilance in immunization coverage and disease surveillance if we are to minimize the impact of vaccine-preventable diseases both in Canada and abroad. The outbreak of Severe Acute Respiratory Syndrome (SARS) in 2003 highlighted the need to strengthen our public health infrastructure, including immunization programs, and our capacity to conduct rapid vaccine research and development for emerging infections.

Where do we go from here? Given the current development in vaccine technology and research, it is expected that new vaccines will have a major impact on the delivery of immunization programs and the epidemiology of vaccine-preventable diseases in the coming years. A number of new vaccines are expected on the horizon, and innovative collaborative approaches are expected to continue in the future to facilitate vaccine program design and implementation, and to address security of supply. It will be important to monitor our progress closely, identify and address challenges, and report on our accomplishments.



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1. Canada's National Immunization Strategy: Progress Highlights

Developed and advocated by the Federal, Provincial and Territorial (F/P/T) Advisory Committee on Population Health and Health Security, the First Ministers' Accord on Health Care Renewal endorsed the National Immunization Strategy (NIS) in February 2003. In June 2003, the NIS was accepted by the Conference of F/P/T Deputy Ministers of Health. It was further supported in the 2003 Federal Budget through an allocation of $45 million over 5 years, to strengthen national collaboration on immunization.

The NIS is a collaborative approach to address immunization activities in Canada. The goals of the NIS are as follows:

- Provide high, achievable and measurable coverage of publicly funded immunization programs for all Canadians.
- Provide complete coverage of all children with routine childhood vaccines recommended by the National Advisory Committee on Immunization (NACI).
- Ensure that there is equitable access to routinely recommended vaccines – among jurisdictions and in special populations – while considering jurisdictional program implementation differences.
- Promote public and professional acceptance of recommended programs.
- Provide optimal vaccine safety, effectiveness and acceptance.
- Improve program coordination and efficiency.
- Provide optimal cost-effectiveness and affordability of programs.
- Establish security of vaccine supplies.
- Provide national intervention when required.

To achieve these goals, five components were identified for action, and specific objectives were developed for each component. These five components are the development of national goals and recommendations for immunization programs, immunization program planning, vaccine safety, vaccine supply and the immunization registry network. The five components are supported by interrelated activities, including immunization research, professional and public education, and vaccine-preventable disease surveillance. This section highlights the key accomplishments in each of these areas.

1.1 Development of national goals and recommendations for immunization programs

The first national consensus conference on national goals and recommendations for vaccine-preventable diseases was held in June 2005. Conference delegates included representatives from international, national, federal, P/T, non-governmental and professional agencies and organizations. The participants reviewed and assessed disease reduction and immunization coverage goals, recommendations, and targets for six vaccine-preventable diseases, namely rubella, varicella, pertussis, invasive pneumococcal disease, invasive meningococcal disease and influenza.

The Canadian Immunization Committee (CIC), which is responsible for providing advice and recommendations on the NIS implementation, will review these goals and recommendations and work with a task group to consolidate conference proceedings. A summary report of the conference will be released in 2006. Future consensus conferences are planned to review, develop and update recommendations for national goals for immunization coverage and disease reduction for all vaccine-preventable diseases.

1.2 Immunization program planning

One of the goals of the NIS is to ensure that equitable access exists to NACI-recommended vaccines. This is a challenge, considering the differences in jurisdictional program implementation. After the NIS was approved in 2003, $300 million dollars was provided to the P/T to purchase four new vaccines: acellular pertussis, meningococcal C conjugate, pneumococcal conjugate and varicella vaccines. The majority of P/Ts now offer access to these newly funded vaccines, a significant increase from 2003 (Table 1). This means that approximately twice as many Canadian children can be protected from these childhood diseases in 2006 as compared with 2003. The current P/T immunization programs are listed in Annex 1 of the report.

1.3 Vaccine safety

Vaccine safety is an integral component of the NIS. Objectives of this component are to optimize the vaccine safety system, maintain professional and public confidence in the safety of vaccines and address growing anti-immunization concerns. Several key accomplishments were identified for this component:

- The F/P/T Vaccine Safety Network was developed through on-site consultations with P/T jurisdictions to discuss priorities and develop an action plan for identified gaps, and through consultations with vaccine manufacturers to improve cooperation on and understanding of vaccine safety and obtain vaccine lot dose distribution data on a regular basis.
- Improvements have been made to the Canadian Adverse Event Following Immunization Surveillance System (CAEFISS) (previously called the Vaccine Associated Adverse Events Surveillance System, VAAES) to enhance the ability to produce timely reports from the CAEFISS database.
- The national guidelines for vaccine storage and handling for vaccine providers have been updated in collaboration with Canadian Nursing Coalition on Immunization (CNCI), the Vaccine Supply Working Group, jurisdictional representatives and manufacturers. The updated guidelines are expected to be published in late 2006.

1.4 Vaccine supply

Vaccine supply is one of the main pillars of the NIS. The goal is to establish the long-term security of high-quality vaccine supply at the best international price for Canada. To facilitate achievement of this goal, the F/P/T Vaccine Supply Working Group (VSWG) was formed. Some of the achievements of the VSWG are as follows:

Table 1. Impact of public funding on harmonized access: summary of provinces and territories with access to newly funded vaccines, 2003 vs. 2006

		Number of P/Ts with access	
Vaccine	**Age group**	**2003**	**2006**
Acellular pertussis	14-16 yrs	7 (MB,NL,NT,NU,ON,PE,SK)	13 (all jurisdictions)
Meningococcal C conjugate	≤ 12 months	4 (AB,BC,QC,PEI)	12 (AB,BC,MB [grade 4], NB,NL, NS,ON,PE,QC,SK,YT,NT)
Pneumococcal conjugate	≤ 18 months	3 (AB,BC,NU)	13 (all jurisdictions)
Varicella	≤ 18 months	5 (AB,NS,PEI,NU,YT)	12 (AB,BC,QC,MB,NB,NL,NS, NU,ON,PE,SK,NT)

Original Source: Canadian Nursing Coalition on Immunization (CNCI), updated July 2006

- Facilitated participation of almost all P/Ts in bulk purchasing for routine childhood vaccines through a centralized bulk purchasing agreement.
- Facilitated long-term contracts for the four newly funded vaccines (Table 1) introduced in Canada.
- To support security of supply, collaborated with P/Ts, other government departments and the vaccine manufacturers for split contracts for supply of vaccines.
- Provided support and facilitated distribution of the annual influenza vaccine and also provided input and feedback for the pandemic influenza vaccine contract.
- Responded to shortage issues of pertussis-containing vaccines, pneumococcal polysaccharide vaccine and botulism antitoxin, and facilitated equitable distribution of supply to P/Ts without disruption to the programs.
- Established protocols with the Special Access Program of Health Canada to permit access to diphtheria antitoxin.
- Initiated a comprehensive study to examine the feasibility of a vaccine supply strategy for Canada.

1.5 Immunization registry network

The Canadian Immunization Registry Network (CIRN) is a network of representatives from all Canadian jurisdictions committed to developing a virtual national network of immunization registries. Since its inception in 2001, it has provided a forum for the creation of national data standards and functional standards and the centralized coordination necessary to ensure that compatible electronic immunization registries are developed across Canada.

In 2002, only three jurisdictions had fully functional registries. Of fourteen jurisdictions surveyed in 2004, including the First Nations and Inuit Health Branch (FNIHB) of Health Canada:

- five have fully functioning registries, which they plan to continue using (Manitoba, New Brunswick, Saskatchewan, Prince Edward Island and British Columbia);
- four are in the process of implementing a registry (Alberta, Ontario, Newfoundland and Labrador and FNIHB);
- two are evaluating options for a new registry (Quebec and Northwest Territories);
- and three have no registry (Nova Scotia, Yukon and Nunavut).

CIRN continues to be actively involved in revising and developing tools, technology and standards for immunization registries in Canada. It is currently working with the INFOWAY Pan-Canadian Health Solution to ensure that the immunization registry module under development is compliant with existing national standards for immunization registries in Canada. By 2009, all jurisdictions will have access to immunization registry technology through this project.

CIRN also acts as the advisory group for the Automated Identification of Vaccine Products (AIVP) project, which evaluated the feasibility and user acceptance of bar coding vaccine products to improve immunization record-keeping and inventory management, as recommended by NACI in 1999. The AIVP project was implemented in collaboration with a wide range of stakeholders, including the vaccine industry, Canadian therapeutic product labelling regulators, vaccine providers, standards committees and international standard-setting organizations.

The feasibility study was completed in 2004, and the pilot evaluation was performed in 2005 in a public health unit and in a physician's office. On the basis of the positive results of the pilot evaluation, standards to label vaccine products with bar codes were proposed. The next steps in the project include working with the vaccine industry to come to agreement on bar coding standards and an implementation time-frame; establishing plans for implementing bar coding technology across all Canadian jurisdictions; and further enhancing the Vaccine Identification Database System (VIDS) used to transfer vaccine-specific data from a central Web-based repository to the client immunization record.

1.6 Immunization research

Immunization research is one of the cross-cutting activities of the NIS. Since the NIS was established, there have been notable accomplishments in a number of key areas:

- A meeting with researchers and academia was held in October 2004 to define immunization research questions, set priorities and develop mechanisms for cooperation.
- The Public Health Agency of Canada (PHAC) and Canadian Institutes of Health Research (CIHR) jointly supported an Influenza Research Priorities Workshop in August 2005. The objective was to develop recommendations on national research priorities that will enhance pandemic and interpandemic influenza prevention and control strategies. The final report identifies the top 10 priorities for influenza research. Since that time the CIHR has disseminated its first request for applications for pandemic preparedness, and further analysis of funding opportunities for identified priorities will be carried out.
- The Human Papillomavirus (HPV) Vaccine Research Priorities Workshop was held in November 2005. The objective was to develop national research priorities for optimal Canadian HPV vaccine use. Results point to the development of 49 research questions and the identification of 21 infrastructure gaps with the three most highly ranked research questions relating to program delivery issues. The final report is currently being finalized.
- The Influenza Immunization Program Evaluation Study was carried out, comparing the universal influenza program in the province of Ontario with influenza immunization programs targeting populations at high risk of complications in Canada. Phase I of the study is now complete. Phase II will be carried out in partnership with the Canadian Institutes of Health Research during 2006-09.

1.7 Professional and public education

The goal of this cross-cutting activity of the NIS is to provide high-quality educational material and information to both health professionals and the public; several initiatives have taken place to this end:

- The Professional Education Working Group was formed. A comprehensive, detailed list of core competencies for immunization was developed that is national in scope, multi-disciplinary in focus and applicable to both formal and continuing professional education. In addition, a training package in a modular format is being prepared for the education of health professionals.
- The Immunization and Respiratory Infections Division (IRID) of the PHAC, in partnership with the Canadian Paediatric Society (CPS), hosted the 6th Canadian Immunization Conference in December 2004, which had over 970 participants. The 7th conference will be held in December 2006.
- IRID, in collaboration with P/Ts and non-governmental organizations, is working on the development of public awareness through a marketing strategy for immunization. The Canadian Coalition for Immunization Awareness Program, in cooperation with IRID, developed and implemented the Annual Influenza Immunization Awareness Program and the National Immunization Awareness campaign. A public Web site was created to include immunization-related topics: http://www.immunize.cpha.ca/.

1.8 Vaccine-preventable disease surveillance

The Vaccine-Preventable and Respiratory Infections Surveillance (VPRIS) working group was established in December 2005 as a national mechanism for working with stakeholders to improve surveillance systems for vaccine-preventable diseases and respiratory infections. The mandate of the VPRIS Working Group is to identify gaps and needs, set priorities and provide advice, direction and coordination on the development, ongoing enhancement and evaluation of surveillance activities/systems for respiratory infections and vaccine-preventable diseases, as well as the use of surveillance methods and/or special studies to identify and assess relevant issues. Members of the VPRIS Working Group include representatives from the PHAC (IRID, National Microbiology Laboratory, Centre for Emergency Preparedness and Response), experts from F/P/T surveillance programs, Canadian Public Health Laboratory Network and other disease-specific and epidemiology experts. One of the priorities of the VPRIS Working Group for 2006 is the completion of the surveillance annex to the Canadian Pandemic Influenza Plan.

IRID also continues to provide ongoing support to and participation in several national surveillance systems that monitor vaccine-preventable diseases. These surveillance systems are described in Section 3 of this report.

1.9 Conclusions

The NIS is a work in progress. Its development and implementation is a long-term commitment that will improve our ability nationally to ensure that new immunization programs across Canada are introduced in a timely fashion and that there is equitable access to recommended vaccines. It will help improve efficiencies of programs, affordability of vaccines, security of vaccine supply and vaccine safety monitoring and response, as well as restore public confidence in vaccines. Ultimately the NIS will enhance our ability to reduce the impact of vaccine-preventable disease. Provinces and territories will continue to be responsible for planning, funding and delivering immunization programs to their respective populations and to contribute to shared activities that support the NIS.

A full progress report on the implementation and evaluation of the NIS strategy will be published in 2007. Additional information on the NIS can be found on the PHAC Web site: http://www.phac-aspc.gc.ca/publicat/nat_immunization_03/index.html.

2. Vaccine Coverage

2.1 Background and objectives

Immunization is considered to be among the most cost-effective public health interventions available[1]. The NIS works with the jurisdictions to set national goals for vaccine coverage in order to promote the high levels of coverage that are required to prevent and control vaccine-preventable diseases, and it supports National Immunization Coverage Surveys (NICS). The measurement of immunization coverage rates is required to monitor the effectiveness of immunization programs and progress towards national goals, and these rates are a sensitive indicator of the health of a population and the capacity of a health system to deliver essential services[2].

NICS are implemented every 2 years by IRID in order to assess national coverage rates for routine childhood immunizations and for select adult immunizations during alternating years. Questions on knowledge, attitudes and beliefs (KAB) towards immunization were added to the NICS from 1998 onwards. The purpose of these surveys is to monitor immunization coverage levels over a number of years; to assess up-to-date and on-time immunization coverage levels; to evaluate changes in KAB; and to monitor progress towards national immunization coverage goals.

In 1994 and 1996, surveys were mailed to households to assess national coverage rates for routine childhood immunizations among 2-year-olds. In 1997 this method was repeated with the addition of a cohort of 7-year-olds, and parental KAB towards immunization were assessed. In 2002, the methodology of the NICS was re-designed to employ a telephone survey of households with children 2 years of age (24 to 36 months) and 7 years of age[3,4].

2.2 Methodology

In 2004, the telephone survey methodology was modified slightly from the 2002 survey: the range of the cohort of children aged 2 was broadened from 24 to 36 months to 20 to 40 months to facilitate data capture; a 17-year-old cohort was added; four new publicly funded vaccines under the NIS were added to the list of routine childhood immunizations; and the KAB section was expanded.

The primary objective of the 2004 NICS was to estimate routinely recommended childhood immunization coverage rates of children by the second birthday (i.e. on or before the child's second birthday), by the seventh birthday and by the seventeenth birthday[5]. This differs from the method used in the 2002 NICS, which assessed coverage for children aged 2 (between the second and third birthdays), 7 (between the seventh and eight birthdays) and 17 (between the seventeenth and eighteenth birthdays). The coverage assessment methodology was changed to reflect current coverage assessment standards for age[5] and to ascertain whether children had been immunized in accordance with NACI-recommended immunization schedules. The results are compared with the 1997 and 2002 NICS results.

Secondary objectives, such as assessing the circumstances surrounding immunization and parental knowledge and attitudes with respect to certain immunization issues, were also measured and the results will be published in a future Canada Communicable Disease Report (CCDR) publication.

Sample selection and data collection

Respondents were selected from the Ipsos-Reid's Canadian Household Panel and supplemented using random digit dialing. Eligible households were those that included a child between 20 and 40 months of age, 7 to 8 years or 17 to 18 years of age as of the date of survey administration. Respondents were selected from seven regions (British Columbia, Alberta, Manitoba and Saskatchewan, Ontario, Quebec, the Atlantic Provinces, and the territories).

Computer-assisted telephone interviews were performed by trained interviewers in both English and French from 22 September to 18 October, 2004. Questions were asked of the member of the household who was reported to be most familiar with the child's immunization history.

Data analysis

Data extraction and preliminary data analysis were performed by Ipsos-Reid, with further analysis done by IRID using SPSS (Statistical Package for the Social Sciences). For respondents who did not have a copy of their child's immunization record at the time of interview and who answered questions from recall, the results were excluded from the analysis. With the respondent's permission, IRID validated the information collected during the survey with records from physicians or local public health authorities. All national coverage estimates have been assessed according to the NACI-recommended schedule at the time of survey implementation. The results may vary when assessed according to provincial and territorial schedules.

2.3 Results

In total, interviews were conducted with 499 parents of children aged between 20 and 40 months, 546 parents of children 7 years of age and 552 parents of children 17 years of age. The sample was weighted using Canadian Census population proportions for each region.

The following results are based on the analysis of responses from parents reporting from immunization records only for 2004 ($N_{2\text{-year}} = 431$; $N_{7\text{-year}} = 441$; $N_{17\text{-year}} = 381$). The results are considered accurate to within 4.2%-4.4%. The margin of error will be larger within regions and for other sub-groupings of the survey population.

Table 2 compares immunization coverage results from national coverage surveys from 1997, 2002 and 2004. Caution must be taken when comparing results, as methodologies have changed over time.

Measles, mumps and rubella (MMR)

Coverage estimates for a single dose of the MMR vaccine by the 2nd birthday is 94%, which is close to the national goal of 97%. This is similar to the 2002 estimate of 93%. Coverage for the second dose of measles by the 7th birthday is 79% and 93% for one dose of mumps and rubella. Coverage for this age group is similar to the 2002 levels but falls short of the recommended national goal of 97%. Coverage for a second dose of measles is lowest in the 17-year-old group, at 62%. Rubella and mumps coverage remains relatively high for one or more doses, at 93% for both by the 17th birthday.

Diphtheria, pertussis, tetanus, polio and DTaP-polio-Haemophilus influenzae type b (Hib)

This family of pertussis-containing vaccines can be given as a single pentavalent vaccine (Pentacel™) or in combination as a quadrivalent (Quadracel™) vaccine with Hib vaccine. The variability of reported doses across the five antigens is significant, and coverage estimates for these five antigens will be presented individually.

Compared with 2002, coverage estimates by the 2nd birthday cohort in the 2004 NICS have remained approximately the same for diphtheria (2002: 77%; 2004: 78%), pertussis (2002: 75%; 2004: 74%), tetanus (2002: 74%; 2004: 73%) and polio (2002: 88%; 2004: 89%). Coverage estimates for Hib have increased the most in this group (2002: 64%; 2004: 73%); however, they still remain well below the nationally recommended target of 97% for this age group.

Coverage estimates for the sixth dose or booster by the 17th birthday of age for diphtheria and tetanus were both well below nationally recommended targets, at 47% and 44%, respectively. Coverage estimates for the acellular pertussis sixth dose booster was also low, at 23%. This result was expected, as the majority of jurisdictions introduced their adolescent programs for acellular pertussis in late 2003 and 2004, so the survey captured only those immunizations that began before 2003 through the initial programs in Nunavut, Newfoundland and the Yukon.

2.4 Discussion

Overall the results of the NICS survey are encouraging. Preliminary results using age range instead of up-to-date status by the second or seventh birthday demonstrated improvement across all antigens for the 2-year and 7-year cohorts[6]. Applying the national standard for up-to-date status by second, seventh or seventeenth birthday reduced coverage levels for most of the antigen, as children past their eligible birthday were excluded from the numerator. Despite this change in methodology, the majority of antigens still showed modest increases in coverage.

Ninety percent of parents in all age cohorts believed that their children were up to date for immunizations for their age group according to their provincial/territorial records, the most commonly cited reason/challenge for keeping their children up-to-date being "remembering to have it done/to make an appointment" (11% overall). However, further analysis shows that only 61% of 2-year-olds and 41% of 7-year-olds were up to date for the NACI-recommended number of doses for the combination of DTaP-IPV-Hib and MMR vaccinations by their second and seventh birthdays, respectively.

Other new vaccines, including those recently introduced through NIS funding, were added to the NICS questionnaire in 2004. Considering the variability of jurisdictional schedules and the time required to roll out new programs, 2004 coverage estimates for influenza, meningococcal C conjugate, pneumococcal conjugate and varicella vaccines, shown in Table 2, should be considered as a baseline for comparison with future coverage estimates.

There are two potential limitations of the NICS. First, responses may be subject to errors of reporting or recording on immunization records. The validation component of the 2004 NICS will assess accuracy of parental reporting from immunization records compared with medical records. Second, the household panel used in both the 2002 and 2004 NICS surveys is a convenience sample. Although it is nationally representative, the sample may underrepresent special populations, including First Nations persons living on reserves, single-parent families, households in which the first language is not an official language, those without telephones or those with only cellular phones. Immunization coverage surveys, with their limitations, will continue to be used to assess national and jurisdictional coverage rates until electronic immunization registries (the "gold standard" for coverage assessment) are consistently used to record and store immunization records across the country.

A full report of the 2004 NICS, including the validation component and analysis of parental KAB, will be published in CCDR in 2006. The adult NICS has been implemented in the spring of 2006.

Table 2. Routine childhood immunization coverage, National Immunization Coverage Survey, 1997, 2002 and 2004

	2 years old*				7 years old				17 years old	
Antigen	# of doses	1997† (%)	2002 (%)	2004‡	# of doses	1997† (%)	2002 (%)	2004‡ (%)	# of doses	2004‡ (%)
Diphtheria	≥ 4	84	77	78	≥ 5	79	71	71	≥ 6	47
Pertussis	≥ 4	83	75	74	≥ 5	75	65	68	≥ 6	23
Tetanus	≥ 4	83	74	73	≥ 5	77	66	65	≥ 6	44
Polio	≥ 3§	85	88	89	≥ 4	85	66	80	≥ 4	65
Hib	≥ 4	72	64	70	≥ 4	—	65	71	—	3
Measles	≥ 1	95	95	94	≥ 2	50	76	79	≥ 2	62
Mumps	≥ 1	95	94	94	≥ 2	—	74	—	—	—
					≥ 1	—	—	93	≥ 1	93
Rubella	≥ 1	95	94	94	≥ 2	—	76	—	—	—
					≥ 1	97	—	93	≥ 1	93
Hep B	≥ 3	—	5	14	≥ 3	—	—	4	≥ 3	60
									≥ 2	69
Varicella	≥ 1	—	—	32	≥ 1	—	—		≥ 1	1
Pneumococcal conjugate	Up to date dependent on age at first dose	—	11	7	—	—	—	—	—	—
Meningococcal C conjugate	Up to date dependent on age at first dose	—	32	28	≥ 1 dose between 1 and 7 yrs or ≥ 3 doses between 0 and 1 yr	—	—	—	≥ 1 dose between 1 and 17 yrs	41
Influenza	≥ 1 dose between Oct 2003 and 2004	—	—	4	≥ 1 dose between Oct 2003 and 2004	—	—		≥ 1 dose between Oct 2003 and 2004	2

*The data presented for the 2-year age group was calculated using an age range of 24 to 36 months in the 2002 NICS. NICS 2004 results assess coverage by the 2nd birthday (i.e. on or before the child's 2nd birthday), by the 7th birthday and by the 17th birthday.

†Data from the 1997 immunization survey were based on different methodologies from those used in NICS 2002 and 2004, and may not be appropriate for comparison.

‡The margin of error for the 2004 NICS is estimated to be from 4.2% to 4.4%.

§According to the NACI schedule for routine childhood immunizations, dose 3 of inactivated polio vaccine (IPV), given at 6 months, is given for convenience because of its combined administration in the form of Pentacel™. Since children at age 2 years require only 3 doses of IPV, the coverage estimate for this vaccine is calculated for 3 doses.

3. Vaccine-preventable Disease Surveillance Systems

Surveillance is the systematic, ongoing collection, collation and analysis of data and the timely dissemination of information to those who need to know so that action can be taken[7]. Surveillance may be established to assess the public health status of a health event, establish public health priorities, evaluate programs and contribute to hypothesis generation and research[8]. A number of criteria can be used to determine conditions that should be under surveillance, such as incidence, severity, changing epidemiologic patterns, socio-economic burden, risk perception and preventability[9]. In Canada, most vaccine-preventable diseases are under surveillance by one or more national systems. This section describes the national surveillance systems that monitor vaccine-preventable diseases, including enhanced disease-specific systems coordinated by IRID.

3.1 Notifiable Diseases Reporting System (NDRS)

The NDRS is the passive surveillance system coordinated by PHAC that is used to monitor more than 40 nationally notifiable infectious diseases. The objectives of disease surveillance by the NDRS are to

1. facilitate the control of the disease under surveillance by identifying
    a) prevailing incidence levels, impacts and trends to assist in the development of feasible objectives for prevention and control of the disease and the evaluation of control programs;
    b) epidemiologic patterns and risk factors associated with the disease to assist in the development of intervention strategies;
    c) outbreaks, for the purpose of timely investigation and control;
2. satisfy the needs of government, health care professionals, voluntary agencies and the public for information on risk patterns and trends in the occurrence of communicable diseases.

Case definitions for diseases under national surveillance were published as a CCDR supplement in 2000[10]. Physicians, hospitals and/or laboratories report cases of specific diseases to P/T departments of health as mandated by P/T legislation. P/T health authorities determine whether the case meets the surveillance case definition and, if so, gather the necessary epidemiologic data on it. Non-nominal data on notifiable cases are submitted to the NDRS using a "core set" of variables. Data entry and analysis occur at PHAC. Provisional data are published quarterly in the CCDR, and finalized numbers of cases and incidence rates are published in annual surveillance summaries and on-line at: http://dsol-smed.phac-aspc.gc.ca/dsol-smed/ndis/index_e.html.

3.2 Enhanced measles surveillance

The enhanced measles surveillance system was modified in 1998 to an email-based reporting system. Every week, when prompted, P/T reply by email to IRID. If there are no cases, then they reply with no comment; if there is a case that meets the national case definition, a case report is completed and attached. The variables collected include demographic data, immunization history and exposure history. The weekly response rates for 13 provinces and territories averaged around 70% for 2004 and 62% for 2005.

3.3 Enhanced invasive meningococcal disease (IMD) surveillance

Enhanced case-based surveillance has been conducted by IRID since 1985. P/T departments of health report non-nominal epidemiologic data on all IMD meeting the national case definition, at a minimum, on a yearly basis. P/T public health and/or hospital laboratories send most *Neisseria meningitidis* isolates

to the National Microbiology Laboratory in Winnipeg for confirmation of serogroup and further bacteriologic studies (serotyping and subtyping for all isolates and multilocus enzyme electrophoresis for all serogroup C isolates). Probabilistic matching on P/T, date of birth (or age), sex, onset date and serogroup (when available) is conducted to retrospectively link epidemiologic and laboratory data for those P/T not able to pre-link the data[11].

3.4 FluWatch

IRID maintains a national influenza surveillance network through the FluWatch program. Each week, IRID collects, collates and analyzes national influenza and influenza-like illness (ILI) data provided by its surveillance partners. The primary objectives of FluWatch, first initiated in 1996-97, are early detection and monitoring of influenza outbreaks; provision of timely updates on influenza activity in Canada and abroad to public health professionals as well as the public; rapid detection and monitoring of circulating strains of influenza viruses, including new sub-types; and contribution to global information on circulating virus strains to assist decision-making concerning vaccine composition for the following season. FluWatch has five main components:

1. Laboratory-confirmed influenza detections: approximately 33 sentinel laboratories across Canada report the total number of laboratory tests conducted each week and the number of specimens positive for influenza by virus type to the Respiratory Virus Detection Surveillance System (RVDSS).
2. Influenza virus characterization: the National Microbiology Laboratory analyzes a proportion of positive influenza specimens tested by provincial laboratories and provides strain information on circulating influenza viruses.
3. ILI consultation rates: each year, approximately 250 sentinel physicians are recruited through the National Research System of the College of Family Physicians of Canada (from seven provinces and three territories) and by independent sentinel provincial programs (in British Columbia, Alberta and Saskatchewan). Between 70% and 90% of sentinels report weekly during the regular influenza season (September to April), and participation declines during the summer months. A standard case definition for ILI is used, and patients meeting the definition are determined as a proportion of all patient consultations for all reasons during 1 day of each week. These numbers are then aggregated, and an average national ILI consultation rate is produced.
4. Influenza activity level assessment: P/T epidemiologists assess regional influenza activity levels based on ILI data, laboratory detections and outbreaks in long-term care facilities, schools and hospitals. Regional activity levels are classified as no activity, sporadic, localized or widespread.
5. Sentinel monitoring of pediatric hospitalizations due to influenza: beginning in the 2003-2004 influenza season, a pilot study was initiated with the Immunization Monitoring Program, ACTive (IMPACT) network of pediatric hospitals to determine the feasibility of hospital-based surveillance of laboratory-confirmed influenza admissions and mortality in children. The pilot was incorporated into the FluWatch surveillance system as a key indicator of severity of influenza in children in autumn 2003[12].

3.5 IMPACT

The IMPACT network has been actively monitoring vaccine-preventable diseases since 1991 and vaccine-associated adverse events since 1993. The network currently includes 12 pediatric tertiary care centres in eight provinces that receive referrals from all P/T. IMPACT centres account for approximately 90,000 admissions every year and represent about 90% of all tertiary care pediatric beds in Canada. Nurse monitors at each IMPACT site review laboratory reports and admission and discharge records to identify cases, and they complete detailed case report forms. The nurse monitor is assisted by team members such as infection control nurses, emergency and unit nurses, physicians, laboratory

personnel and medical records staff. Each centre also communicates with the local public health department and the provincial epidemiologist to report cases, distribute IMPACT news, and collect immunization histories and other data specific to each centre. Information on each case reported through the IMPACT network is sent to the Vaccine Evaluation Centre in Vancouver, BC, where data are entered, cleaned and analyzed. IMPACT is administered by the Canadian Paediatric Society (CPS) with 11 centres receiving funding from IRID[13].

3.6 Canadian Paediatric Surveillance Program (CPSP)

In January 1996, the CPSP was initiated to look for rare childhood conditions, including congenital rubella syndrome and acute flaccid paralysis. The CPSP uses a two-tiered reporting process to ascertain and investigate cases. Approximately 2,400 practising pediatricians and pediatric sub-specialists are asked to complete monthly initial report forms regardless of whether they see a case or not. Participants who report cases are asked to submit detailed report forms. Case ascertainment is monitored and verified by investigating duplicate reports and comparing data with relevant programs and centres, including IMPACT and the NDRS. Once the detailed report has been returned to the CPSP, it is forwarded to the investigator for analysis. The overall response rate for the initial report forms has remained stable at 81% to 83% since 1999, with completion rates of detailed questionnaires for reported cases higher, at approximately 95%[14].

3.7 International Circumpolar Surveillance (ICS)

ICS is a population-based invasive bacterial disease surveillance network of circumpolar countries (Canada, Finland, Greenland, Iceland, Norway, Sweden and United States). Within Canada, five regions (Yukon, Northwest Territories, Nunavut, and the northern regions of Labrador and Quebec) and a network of 14 laboratories, including three references laboratories (the Laboratoire de santé publique du Québec, the National Streptococcus Centre and the National Microbiology Laboratory), participate in the ICS initiative. Communicable disease consultants located in the five regions gather clinical and demographic information on reported cases. Laboratory and clinical data are forwarded in "real-time" to the ICS coordinator at the Arctic Investigations Program of the United States Centers for Disease Control and Prevention in Anchorage, Alaska. ICS data contribute to the understanding of the epidemiology of invasive bacterial diseases among northern populations, and this assists in the formulation of prevention and control strategies for these populations, including immunization recommendations. Canada, through IRID, has been a partner since 1999[15].

The vaccine-preventable diseases under surveillance by these systems are shown in Table 3.

Table 3. National surveillance systems monitoring vaccine-preventable diseases in Canada

Disease	NDRS	Disease-specific enhanced surveillance	IMPACT	CPSP	ICS
Diphtheria	X				
Hepatitis A	X	X			
Hepatitis B	X	X			
Haemophilus influenzae type b disease, invasive	X		X		X
Influenza	X*	X*	X		
Measles	X	X			
Meningococcal disease, invasive	X	X	X		X
Mumps	X				
Pertussis	X		X		
Pneumococcal disease, invasive	X		X		X
Poliomyelitis/acute flaccid paralysis	X	X	X	X	
Rubella	X	X†			
Congenital Rubella Syndrome (CRS)	X		X‡	X§	
Tetanus	X				
Varicella	X‖		X		

* For the purposes of NDRS surveillance, laboratory-confirmed influenza is not reportable in all jurisdictions. However, through the RVDSS, all jurisdictions are represented by sentinel laboratories.

† Under development.

‡ Until 31 March, 2005.

§ Until 31 December, 2004.

‖ Varicella reporting by jurisdictions is incomplete.

4. Update on the Epidemiology of Selected Vaccine-Preventable Diseases

The purpose of this section is to provide an update on the epidemiology of selected vaccine-preventable diseases since the 1998 *Canadian National Report on Immunization*[16]. Influenza and invasive pneumococcal disease were not discussed in previous immunization reports; summaries of the recent trends of these diseases now under national surveillance have been included in the current report. The information presented in this section summarizes surveillance data from the national systems described in Section 3 of the report and other recent significant disease activity. Data on the vaccine-preventable disease indicators shown in Table 4 are from the NDRS, except where noted. NDRS data are complete and finalized up to 2001. NDRS data for 2002 to 2004 are provisional and subject to change.

4.1 Invasive *Haemophilus influenzae* type b (Hib) disease

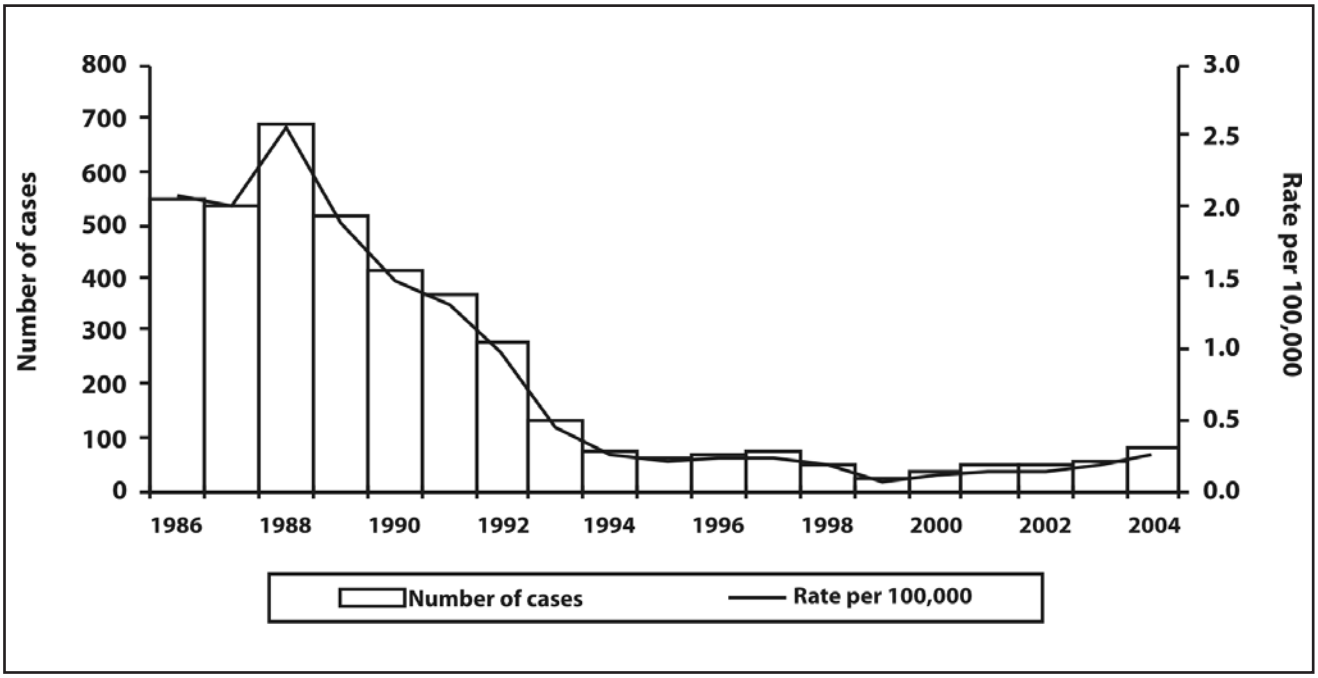
The incidence of invasive Hib disease has declined significantly since 1986, when the first generation of Hib vaccines became available and the disease became nationally notifiable. Further decline has occurred since 1992, when the newer conjugate Hib vaccines were introduced into all routine infant immunization programs. As shown in Figure 1, the average annual incidence during the period 1986-1992 was 1.8 per 100,000 (mean 475 cases per year), compared with 0.15 per 100,000 (mean 47 cases per year) between 1998 and 2004. A decreasing trend is also supported by data from the Canadian Institute for Health Information's Hospital Morbidity Database (HMDB). Although Hib was recognized as the most common cause of bacterial meningitis in Canada until the early 1990s, only 5% of bacterial meningitis hospitalizations captured in the HMDB between 1994 and 1995 and 2000 and 2001 were attributable to Hib[17].

Table 4. Disease indicators for selected vaccine-preventable diseases, Canada 1997 to 2004*

	1997		1998		1999		2000		2001		2002		2003†		2004†‡	
Disease	**Cases**	**Rates**	**Cases**	**Rates**	**Cases**	**Rates**	**Cases**	**Rates**	**Cases**	**Rates**	**Cases**	**Rates**	**Cases**	**Rates**	**Cases**	**Rates**
Diphtheria§	1	0.003	0	0.0	1	0.003	0	0.0	0	0.0	1	0.003	1	0.003	1	0.003
Invasive Hib disease	70	0.2	51	0.2	21	0.07	33	0.1	46	0.2	45	0.1	54	0.2	81	0.3
Measles‖	581	1.9	12	0.04	29	0.1	199	0.7	35	0.1	7	0.02	15	0.05	8	0.03
IMD¶	265	0.9	174	0.6	214	0.7	240	0.8	350	1.1	233	0.7	191	0.6	–	–
Mumps	264	0.9	117	0.4	90	0.3	87	0.3	102	0.3	205	0.7	20	0.06	16	0.05
Pertussis	4,280	14.3	8,910	29.5	5,847	19.2	4,751	15.4	2,946	9.5	3,217	10.2	3,229	10.2	3,120	9.7
IPD**	ND		ND		ND		1,350††	4.4	1,734	5.6	2,270	7.2	2,720	8.6	2,903	9.1
Poliomyelitis	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Rubella	4,002	13.3	63	0.2	24	0.08	29	0.09	27	0.09	15	0.05	14	0.04	10	0.03
CRS‡‡	1	0.3	1	0.3	1	0.3	2	0.6	0	0.0	2	0.6	1	0.3	3	0.9
Tetanus	4	0.01	2	0.007	6	0.02	4	0.01	8	0.03	1	0.003	1	0.003	3	0.009

*Statistics Canada annual population estimates (CANSIM table 051-001) were used to calculated incidence rates per 100,000 population.
†NDRS data are provisional for 2003 and 2004.
‡Data from enhanced disease-specific systems are provisional for 2004.
§NDRS reported as diphtheria-like; upon follow-up, cases did not meet case definition of diphtheria.
‖Based on data from the Enhanced Measles Surveillance System.
¶Based on data from the Enhanced IMD Surveillance System.
**IPD became nationally notifiable in 2000; ND = no data.
††IPD was not reportable in Ontario until November 2001; Ontario did not submit data to NDRS for 2000.
‡‡CRS incidence rates are per 100,000 live births.

Figure 1. Reported cases of invasive *Haemophilus influenzae* type b disease, Canada, 1986 to 2004



The reduction in the number of reported cases has mostly been among young children. Between 1986 and 1992, 75% of nationally reported cases were children < 5 years of age, compared with 30% of cases reported to NDRS between 1998 and 2004. The number of Hib cases in children < 16 years of age admitted to IMPACT pediatric tertiary care hospitals decreased from 485 cases at 10 centres in 1985 to < 16 cases seen annually between 1996 and 2003 (mean 8.4 cases) at 12 centres. A historic annual low of only three cases was reported by the IMPACT network in 2003. During this latter period, the majority of pediatric cases occurred in children too old to have received vaccination, in unimmunized children or in children too young to have received their primary series. As well, the annual number of vaccine failures after age-appropriate vaccination has been nearly constant, ranging from 1 to 4 cases[18].

Although not covered by the Hib vaccine, non-b typeable and non-typeable H. influenzae can rarely cause invasive disease. Of the national surveillance systems, only the ICS monitors invasive disease due to any type of *H. influenzae*. Between 2000 and 2004, 51 cases of invasive *H. influenzae* were detected in northern Canada by ICS. Of these, only five cases (11% of 47 with serotype information) were due to serotype b; 55% of cases were caused by serotype a, and 28% of invasive disease involved non-typeable isolates. Serotypes c, d and e were each isolated in one case of invasive disease.

4.2 Hepatitis B

Interpretation of hepatitis B virus (HBV) incidence rates in Canada has been confounded by inconsistencies in reporting acute versus prevalent (chronic) infections[19]. To address this issue, in 1998, an Enhanced Hepatitis Strain Surveillance System (EHSSS) was initiated to provide a more accurate estimate of infection levels of hepatitis. Eight sites across Canada representing approximately 27% of the Canadian population collect data on acute and chronic hepatitis B and C infections, risk factors associated with infection and viral genotype information[19].

Data from seven of the eight EHSSS sites show that overall incidence rates for acute hepatitis B declined significantly from 2.05 per 100,000 in 1999 to 0.93 per 100,000 in 2004. The decline in incidence was seen in most age groups. There was a 75% decrease in the number of cases in the 30 to 39 year age group, a 72% decrease in those aged 10 to 19 years and a 64%

decrease in the number of cases in the 20 to 29 year age group. Rates were 2.8 times higher among males[20].

The reported cases likely represent an underestimate of the true incidence of infection as a result of under-reporting and subclinical infections. Likewise these factors may affect the annual incidence estimates, but should not affect the incidence trend over time.

Since the EHSSS covers only 27% of the Canadian population, data may not be representative of all of Canada, as certain cities with a high density of immigrant populations (e.g. Montreal and Toronto) did not contribute to the system.

4.3 Influenza

Laboratory data

Over the past 9 years, the number of laboratory tests for influenza conducted by sentinel laboratories has risen substantially, from 26,991 tests in 1996-1997 to 101,258 tests in 2004-2005. The 3.8-fold increase in testing is likely related to multiple factors unrelated to seasonal severity, including an increase in testing by clinicians and an increase in the number of sentinel laboratories participating in the FluWatch program, from 25 in 1996 to 33 in 2005. The number of tests positive for influenza has risen 5.5-fold from 2,347 in 1996-1997 to 12,879 in 2004-2005. The three seasons with the highest percentage of positive influenza tests were 1999-2000, 2003-2004 and 2004-2005 (12% to 13%). The three seasons with the lowest percentage were 1996-1997 (8.7%), 2000-2001 (7.6%) and 2002-2003 (5.8%). In addition to the severity of the season, the increase in percentage of positive influenza tests over the years may be related to improved clinician swabbing technique with greater experience and more appropriate testing of only those persons meeting the case definition for ILI.

As shown in Figure 2, six of the past nine seasons (1997-1998, 1998-1999, 1999-2000, 2001-2002, 2003-2004, 2004-2005) have been characterized as predominantly influenza A seasons (86% to 99% of laboratory detections being influenza A). Two seasons (1996-1997 and 2002-2003) were mixed seasons, and one season (2000-2001) was characterized as a predominantly influenza B season. Strains with the H3N2 subtype of influenza A evolve more rapidly and cause more frequent and intense seasonal outbreaks than those belonging to the influenza A H1N1 subtype or to influenza B. Influenza A is also typically associated with greater morbidity and mortality than influenza B and usually affects the elderly, whereas influenza B is more often seen in young children. In four of the six predominantly influenza A seasons, 41% to 46% of laboratory-confirmed influenza cases were in persons ≥ 65 years of age, whereas children < 5 years of age accounted for < 20% of laboratory-confirmed cases. In the mixed seasons and the predominantly influenza B season, children < 5 years of age accounted for 24% to 32% of laboratory- confirmed cases, whereas persons ≥ 65 years of age accounted for 7% to 19%.

Three influenza seasons (1996-1997, 1998-1999 and 2000-2001) saw known circulating strains match well with those in the available influenza vaccine. In one season (1997-1998) there was a mismatch in the A(H3N2) component of the vaccine. This was the first season that the A/Sydney/5/97(H3N2)-like virus was known to circulate in Canada, and the season was assessed as being a severe epidemic season. In the 2003-2004 season, there was a mismatch in all components of the vaccine [A(H3N2), A(H1N1) and B]; this season was considered to be of moderate severity. In the 2004-2005 season, a relatively severe season characterized by large numbers of outbreaks in long-term care facilities (LTCFs), the emergence of the A/California/7/2004 H3N2 strain resulted in a vaccine mismatch. There were mismatches in the vaccine and circulating strains for 2001-2002 and 2002-2003; however, these seasons were considered relatively mild.

ILI consultation rates

Expected rates (mean and 95% confidence interval [CI]) were calculated for each season (October through May) based on the other eight seasons from 1996-1997 through 2004-2005. Three influenza seasons (1996-1997, 1997-1998 and 1999-2000) had 50% or more weeks with ILI consultation rates exceeding these expected rates. One season (1998-1999) saw 33% of weeks exceeding expected ILI consultation rates, and the remaining five seasons

(2000-2001 through 2004-2005) saw 0% to 15% of weeks exceeding expected values for ILI consultation rates.

Influenza activity levels

The FluWatch program has been collecting data on influenza activity level for provincially/territorially assigned surveillance regions on a weekly basis since 1997-1998. Using the number of times that widespread influenza activity was reported in a season as a measure of severity, the seasons with the highest percentage of widespread activity levels were 1997-1998 (50%), 1998-1999 (31%) and 1999-2000 (31%). The seasons with the lowest percentages were 2001-2002 (8%), 2002-2003 (14%) and 2000-2001 (20%). Caution must be used when comparing seasonal influenza activity levels because of (1) increases in the number of surveillance regions (10 provinces and two territories reporting in 1997-1998, which were subsequently subdivided into > 50 regions beginning in 2000) and the number of weeks of influenza activity level reporting per season; (2) decreases in incomplete reporting from 11% to 18% of surveillance regions in the late 1990s to between 0.2% and 8% of surveillance regions during the early to mid-2000s; and (3) the substantial variation in the application or interpretation of activity levels by P/T, despite the provision of standard definitions set in 1997.

Outbreaks in LTCFs

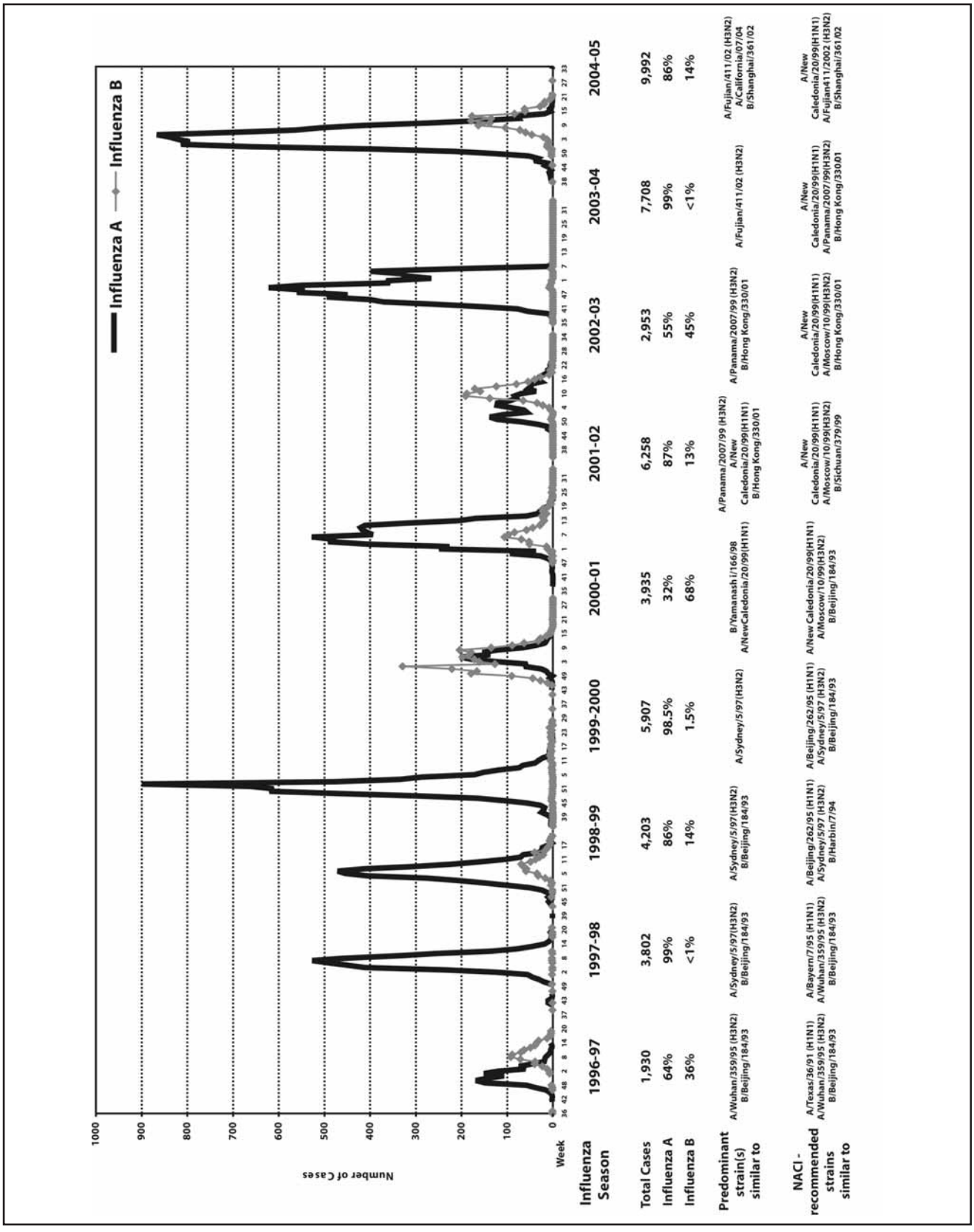
Since the 1999-2000 influenza season, P/T have been reporting the number of laboratory-confirmed influenza outbreaks in LTCFs to PHAC. The number of reported outbreaks has increased each year, from three outbreaks in 1999-2000 to 793 in 2004-2005. In addition to any annual variations in epidemiologic impact, this increase is likely also an artefact related to improved reporting over the years. Interestingly, in the late 1990 seasons when the numbers of reported outbreaks were lowest, the ratios of widespread to localized influenza activity levels were highest. These findings suggest that outbreaks were substantially underreported in the early years of the FluWatch Program.

IMPACT data

IMPACT implemented a pilot program to collect data on pediatric hospital admissions with laboratory-confirmed influenza from nine sites in 2003-2004 and, in 2004-2005, these data were collected from all 12 IMPACT sites. During the 2003-2004 influenza season, IMPACT reported 505 pediatric hospital admissions with laboratory-confirmed influenza: 500 (99%) were influenza A and 5 (1%) were influenza B. Three deaths were reported (0.6% case fatality). Fifty-seven percent of cases were < 2 years of age. Previously healthy children admitted with influenza infections were approximately three times more likely to be < 2 years of age than aged ≥ 2 years (odds ration [OR] = 3.0, 95% CI 2.0-4.4, $p < 0.0001$). In the 2004-2005 influenza season, IMPACT reported 391 pediatric hospital admissions with laboratory-confirmed influenza: 271 (61%) were influenza A and 120 (39%) were influenza B. Two deaths were reported (0.5% case fatality). Fifty-five percent of cases were < 2 years of age. Previously healthy children admitted with influenza infections were approximately four times more likely to be < 2 years of age than aged ≥ 2 years (OR = 4.5, 95% CI 2.9-7.2, $p < 0.0001$)[21]. Although it is not possible to determine trends in pediatric morbidity and mortality with only 2 years of data, preliminary findings support the recent NACI recommendation that all healthy children aged 6 to 23 months receive influenza immunization.

Overall, surveillance data appear to indicate that the influenza seasons in the early to mid-2000s were relatively milder than the seasons in the late 1990s when the A/Sydney/5/97(H3N2)-like viruses were circulating. Influenza surveillance has improved substantially in the past 9 years, both in terms of the quality of data and the addition of important indicators. These indicators, when assessed in combination, provide a good description of national influenza activity each season. However, the addition of real-time data on influenza-related severe morbidity (hospital admissions) and mortality in adults would provide a better description of influenza severity by season and allow for more informative evidence-based policy decisions.

Figure 2. Seasonal distribution of case-by-case influenza data by type and week of onset, Canada, 1996-1997 to 2004-2005



Influenza Season	1996-97	1997-98	1998-99	1999-2000	2000-01	2001-02	2002-03	2003-04	2004-05
Total Cases	1,930	3,802	4,203	5,907	3,935	6,258	2,953	7,708	9,992
Influenza A	64%	99%	86%	98.5%	32%	87%	55%	99%	86%
Influenza B	36%	<1%	14%	1.5%	68%	13%	45%	<1%	14%
Predominant strain(s) similar to	A/Wuhan/359/95 (H3N2) B/Beijing/184/93	A/Sydney/5/97(H3N2) B/Beijing/184/93	A/Sydney/5/97(H3N2) B/Beijing/184/93	A/Sydney/5/97(H3N2)	B/Yamanash i/166/98 A/NewCaledonia/20/99(H1N1)	A/Panama/2007/99 (H3N2) A/New Caledonia/20/99(H1N1) B/Hong Kong/330/01	A/Panama/2007/99 (H3N2) B/Hong Kong/330/01	A/Fujian/411/02 (H3N2)	A/Fujian/411/02 (H3N2) A/California/07/04 B/Shanghai/361/02
NACI - recommended strains similar to	A/Texas/36/91 (H1N1) A/Wuhan/359/95 (H3N2) B/Beijing/184/93	A/Bayern/7/95 (H1N1) A/Wuhan/359/95 (H3N2) B/Beijing/184/93	A/Beijing/262/95 (H1N1) A/Sydney/5/97 (H3N2) B/Harbin/7/94	A/Beijing/262/95 (H1N1) A/Sydney/5/97 (H3N2) B/Beijing/184/93	A/New Caledonia/20/99(H1N1) A/Moscow/10/99(H3N2) B/Beijing/184/93	A/New Caledonia/20/99(H1N1) A/Moscow/10/99(H3N2) B/Sichuan/379/99	A/New Caledonia/20/99(H1N1) A/Moscow/10/99(H3N2) B/Hong Kong/330/01	A/New Caledonia/20/99(H1N1) A/Panama/2007/99(H3N2) B/Hong Kong/330/01	A/New Caledonia/20/99(H1N1) A/Fujian411/2002 (H3N2) B/Shanghai/361/02

4.4 Measles

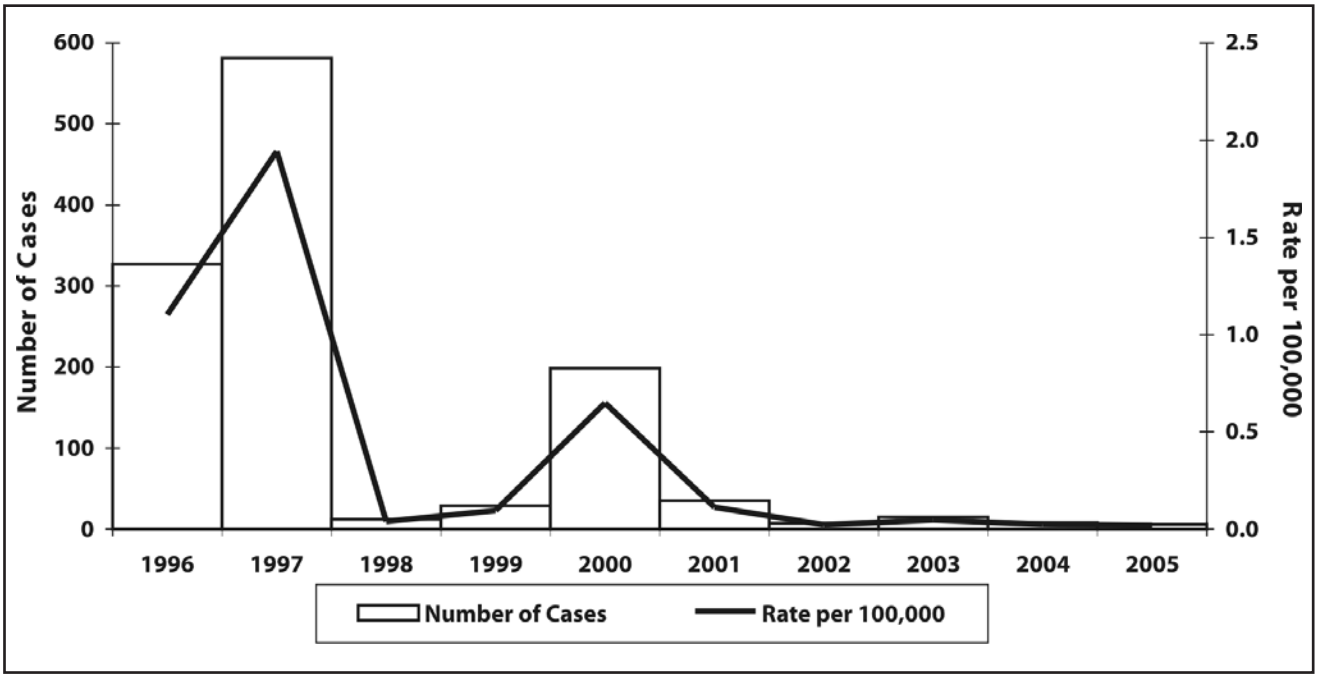
The epidemiology of measles in Canada and progress towards elimination has been discussed in detail in recent publications[3,16,22]. King et al. summarized the current situation in Canada and outlined progress towards measles elimination up to 2004[23]. The latter publication highlighted a 96% decline in the average annual incidence of measles since the introduction of routine two-dose immunization and catch-up campaigns in 1996-1997 (Figure 3). The dramatically reduced number of measles cases reported in Canada and the lack of sustained transmission from sporadic importations are attributed to the success of these immunization initiatives.

In recent years, measles cases reported in Canada have been limited to sporadic importations linked to endemic countries, with occasional outbreaks. In recent years, larger outbreaks consisting of more than 10 cases have been associated with undervaccinated communities[22]. Since the last *Canadian National Report on Immunization*, when a new low of 12 cases was reported for 1998, the number of cases reported annually has remained under 35 except for the year 2000. In 2000, a total of 199 cases were reported, all of which were either sporadic imported cases (3%) or imported cases and their associated outbreak cases (97% involving 2, 6, 30 and 155 cases in Ontario, Alberta, Quebec and British Columbia/Alberta, respectively)[23].

The lowest number of cases reported for any year to date in Canada was six cases reported in 2005. Four of the six cases were imported or import-related following exposure in the United States (source not identified). The remaining two cases identified in 2005 were sporadic cases with no travel history and no identified source of exposure in Canada. Similarly, all but one of eight cases identified the previous year occurred secondary to travel or contact with a traveler outside of Canada.

The 2004 NICS indicated that 94% of children received one dose of MMR by their second birthday and approximately 78% received two doses by their seventh birthday (see section on 2004 NICS). While these achievements are below the recommended 97% targets for these age groups, coverage has so far been sufficiently high in the general population to prevent re-establishment of endemic transmission. Nevertheless, the goal of measles elimination will be achievable only if two-dose vaccine coverage is maintained at very high levels[23] .

Figure 3. Reported cases of measles, Canada, 1996 to 2005



4.5 Invasive Meningococcal Disease (IMD)

IMD is endemic in Canada with periods of increased activity occurring roughly every 10 to 15 years but with no consistent pattern. The incidence rate varies considerably with different serogroups, age groups, geographic locations and time. IMD has been a nationally reportable disease in Canada since 1924 through the NDRS. Since 1985, additional data elements have been collected through enhanced surveillance from all P/T.

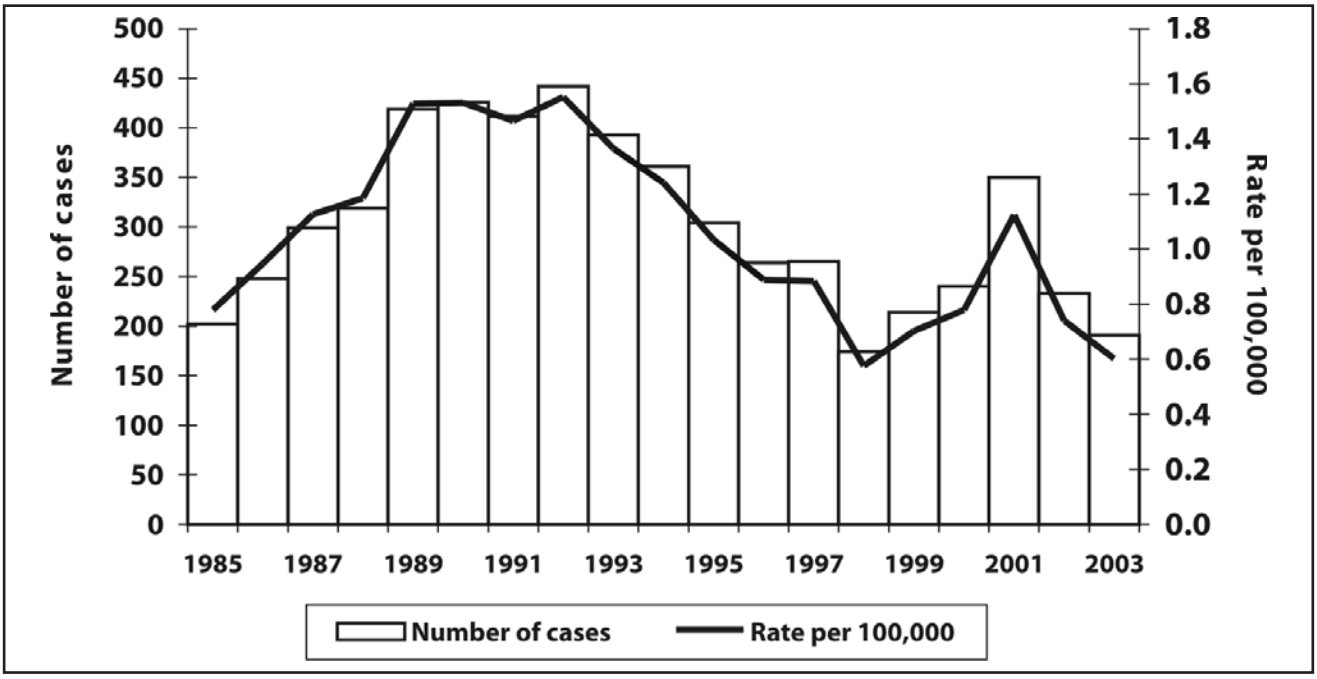
As shown in Figure 4, the overall annual incidence of IMD has remained at or below 2 per 100,000 (range 0.5 to 2.1) since 1985. Overall, the incidence rate has been highest among children < 1 year of age, and then declines as age increases except for a smaller peak in the 15 to 19 year age group. An average of 303 cases of meningococcal disease were reported annually between 1995 and 2003. Disease occurs year-round; however, there is seasonal variation, the majority of cases occurring in the winter months.

Serogroups A and C *Neisseria meningitidis* were the groups most frequently identified from 1971 to 1974. From 1975 to 1989, serogroup B predominated, the majority being serotypes 2b, 4 and 15 and the most common subtype P1.2. In 1986, a new clone of serogroup C, serotype 2a, characterized as electrophoretic type 15 (ET-15), was identified in Canada for the first time and is currently responsible for most of the serogroup C disease reported in Canada.

Since 1993, serogroups B and C have been responsible for most of the cases of endemic disease in Canada (incidence rates ranging between 0.13 and 0.65 per 100,000 for serogroup C and 0.2 and 0.44 per 100,000 for serogroup B). However, there has been less fluctuation in the incidence of serogroup B than of serogroup C disease over time. Serogroup C isolates have almost exclusively been responsible for outbreaks; there were sporadic localized outbreaks and periods of elevated incidence of serogroup C disease during 1989 to 1993 (mean 1.49 cases per 100,000 per annum) and 1999 to 2001 (mean 0.87 cases per 100,000 per annum). During these years, incidence increased in particular among persons aged 15 to 19 years[11]. Immunization campaigns for serogroup C IMD using polysaccharide and conjugate vaccines were implemented in some regions during that period.

Since 2001, NACI has recommended meningococcal conjugate C vaccine for all Canadian children < 5 years of age, adolescents and young adults. The extent to which the NACI recommendations have

Figure 4. Reported cases of IMD, Canada, 1985 to 2003



been implemented varies throughout the country. By July 2005, 12 of 13 P/T had implemented a universal meningococcal C conjugate vaccination program at various ages. Initial surveillance data indicate that vaccination against serogroup C disease may be having an impact on the epidemiology of IMD in Canada; however, because of the cyclical nature of the disease, ongoing surveillance is essential.

4.6 Mumps

Since the *Canadian National Report on Immunization, 1998*, the number of mumps cases reported to the NDRS has continued to decline, except for the number in 2002. As illustrated in Figure 5, the average annual incidence dropped by 74%, from 1.2 per 100,000 (354 cases per year) during 1990 to 1997 to 0.3 per 100,000 (99 cases per year) during 1998 to 2001. In 2002, the annual incidence rose to 0.7 per 100,000 (205 cases), largely as a result of an outbreak in an under-vaccinated community in northern Alberta, which declined vaccination for philosophical reasons.

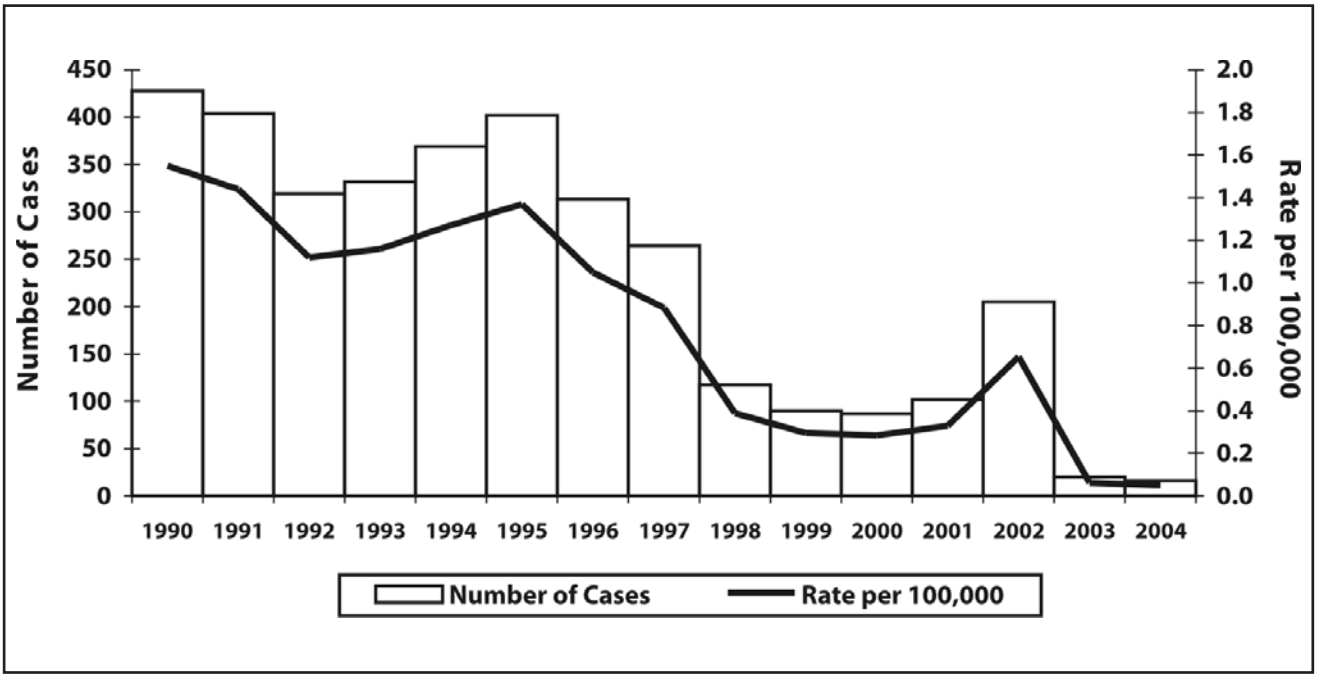
The Alberta outbreak began in September 2001, peaking in March 2002 and ending in August 2002 with a total of 193 cases. The index case was an imported case involving an unimmunized child whose family had moved from Bolivia while the child was acutely ill. Following the initial importation, the outbreak spread through area schools (152/193 or 79% of cases were students) and to a lesser extent the surrounding community (41/193 or 21% of cases). Just over half (54%) of those affected were females, and the average age of the cases was 12.2 years (range 8 months to 47 years; median 10 years). With immunization rates in the affected community significantly below the provincial average for Alberta (< 43% of individuals had been immunized with two doses of mumps vaccine), the majority of cases (155/193 or 80%) occurred in unimmunized individuals (A. Honish, Alberta Health and Wellness: personal communication, 2005).

Previous outbreaks had been reported in 1997 and 1998. The 1997 outbreak of 51 cases occurred in teenagers and young adults and was related to attendance at a rave party in British Columbia[24,25]. The 1998 outbreak of 37 cases occurred in school children from families in Quebec who had recently emigrated from countries where mumps vaccine was not included in the routine childhood immunization program[26].

Preliminary data for 2003 and 2004 indicate that fewer than 30 cases were reported annually during this period, the lowest incidence ever recorded in Canada. No outbreaks were reported. However, in 2005 two outbreaks were reported in Nova Scotia. In the spring of 2005, the first of these involved 13 cases, ages 13 to 19 years (mean 14 years). This was followed by a second outbreak occurring between September 2005 and January 2006 and involving 19 cases in university students, ages 20 to 27 years (mean 23 years). This second outbreak led to three secondary cases reported in Ontario. While most cases (9/13) in the first cluster had received two or more doses of MMR, only one of the 19 cases in the second outbreak had received two doses of MMR.

As with other vaccine-preventable diseases that are uncommon in the highly vaccinated general population, occasional outbreaks may still affect under-immunized pockets of the population. Importation from countries with low vaccine coverage rates presents an ongoing risk to under-vaccinated individuals and communities. With sustained high coverage rates, these sporadic importations are not expected to result in any sustained transmission in the general population.

Figure 5. Reported cases of mumps, Canada, 1990 to 2004



4.7 Pertussis

As shown in Figure 6, after a historic low incidence rate of 4.1 per 100,000 in 1988, the national incidence of reported pertussis increased between 1989 and 1998, peaking in 1994 at 34.8 per 100,000. There was a series of large outbreaks in several provinces during that period. The outbreaks occurred in progressively older age groups, the 1988-1992 birth cohorts being most susceptible to illness[27-29]. The resurgence in pertussis has been attributed to the low efficacy of the combined adsorbed diphtheria-tetanus-pertussis whole cell vaccine used in children in Canada between 1980 and 1997, waning of vaccine-induced immunity among older adolescents and adults, increased physician awareness and improved diagnosis and reporting of pertussis disease.

Since the replacement of adsorbed whole cell vaccine with the more efficacious and less reactogenic acellular pertussis vaccine in all P/T during 1997-1998, the national incidence of pertussis has declined. According to preliminary data for 2004, the crude incidence rate was 9.7 per 100,000 (3,120 cases). Children < 1 year old continue to have the highest age-specific incidence at 92.2 per 100,000 (309 cases). Ten- to 14-year olds, who would have only received whole cell pertussis vaccine, had the second highest incidence, of 50.7 per 100,000 (1,074 cases). Younger children who have lived through the acellular period and have been exposed to a greater number of acellular vaccine doses had lower pertussis rates, at 21.6 per 100,000 (295 cases) in the 1 to 4 year age group and 19.5 per 100,000 (373 cases) in the 5 to 9 year age group.

Pertussis is most severe among children < 1 year of age. Thirteen deaths due to pertussis were reported to the Statistics Canada Deaths Registry between 1995 and 2000, and 85% of these occurred in children < 4 months of age. Children in this age group would have been too young to receive immunization protection or would have received only one dose of the vaccine. Similarly, of 16 deaths reported by pediatric tertiary care centres of the IMPACT network between 1991 and 2001, 13 were < 2 months of age, and three deaths were in children between 2 and 6 months of age[30].

Pertussis has been increasingly recognized as a cause of prolonged cough illness among adults and adolescents, but it is often under-diagnosed in these age groups because of nonspecific symptoms[31]. In September 2003, NACI recommended that all pre-adolescent and adolescent children should receive a single dose of the adult formulation of

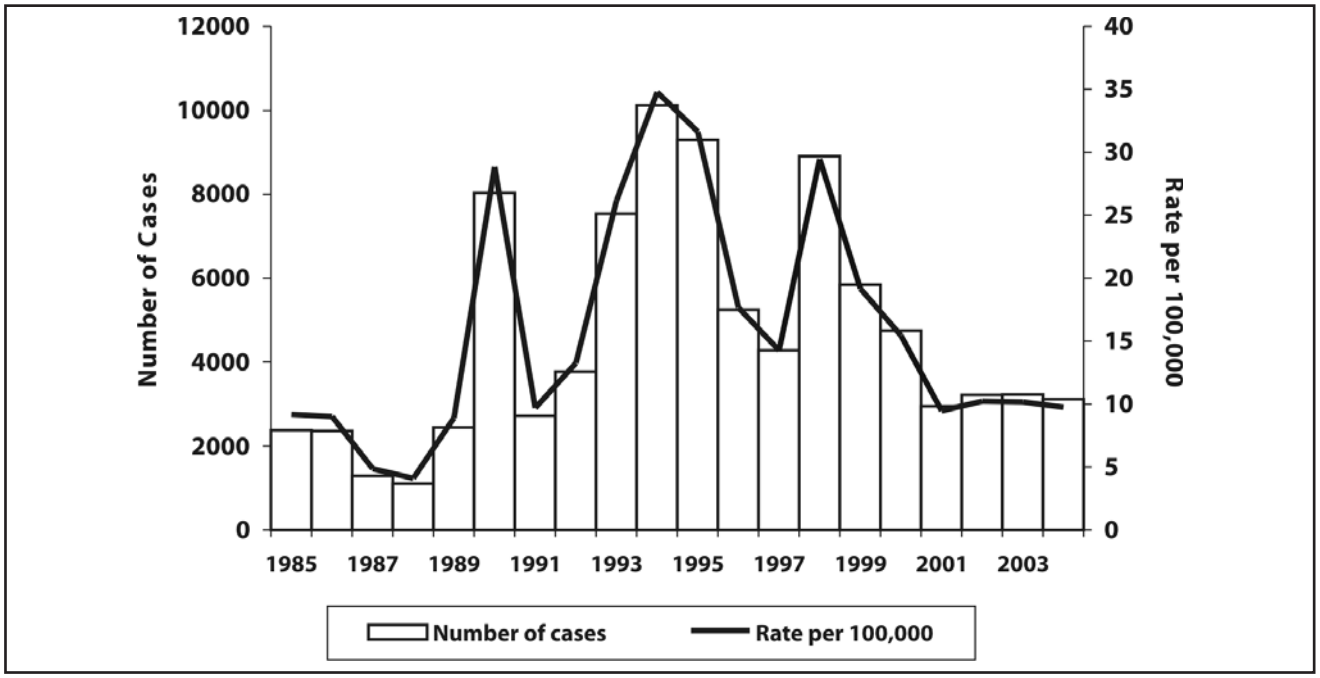
acellular pertussis vaccine, and that adults who had not previously received a dose of acellular vaccine receive the combined diphtheria-tetanus-acellular pertussis (Tdap) vaccine rather than a single diphtheria-tetanus (Td) booster dose. The immunization of adults and adolescents may also indirectly protect infants[32]. By September 2004, all P/T had implemented adolescent acellular pertussis vaccine programs. Although it is too early to assess the national impact of these programs, an overall decrease has been observed in the Northwest Territories, which was the first jurisdiction to implement an adolescent pertussis program in October 2000. The average incidence per 100,000 for the territory decreased from 7.5 between 1993 and 1996 (whole-cell vaccine era) to 7.2 between 1997 and 2000 (after introduction of the child formulation of acellular pertussis vaccine) to 1.1 between 2001 and 2004 (after introduction of the adolescent Tdap program)[33]. Continued close monitoring will help to determine whether these reductions will be seen across the country over time.

4.8 Invasive pneumococcal disease

Streptococcus pneumoniae is an important cause of morbidity and mortality in adults and children worldwide. Invasive pneumococcal disease (IPD) is most common in the very young, the elderly and persons with certain underlying illnesses, including asplenia; HIV infection and other conditions causing immunosuppression; diabetes; cerebral spinal fluid leak; alcohol abuse; and chronic cardiovascular, pulmonary or liver diseases.

Between 1979 and 1999, only pneumococcal meningitis was nationally notifiable; the overall annual incidence rates during this period ranged from 0.05 to 0.50 per 100,000. However, meningitis accounts for only a small proportion of all invasive disease due to *S. pneumoniae*. Population-based studies conducted during the mid-1990s estimated that the annual incidence rate for IPD was between 11.6 and 17.3 per 100,000[34]. IPD became nationally notifiable in 2000 and includes laboratory-confirmed pneumococcal meningitis, pneumonia with bacteremia, and bacteremia without a known site of infection. Although well below original estimates, national rates of IPD have increased from 4.4 per 100,000 (1,350 cases) in 2000 to 9.1 per 100,000 (2,903 cases) in 2004, indicating improved reporting

Figure 6. Reported cases of pertussis, Canada, 1985 to 2004



over time. In 2004, the age-specific incidence rates were highest among children < 1 year of age, at 42.1 per 100,000 (141 cases), followed by children 1 to 4 years of age at 31.2 per 100,000 (426 cases). The incidence rate of IPD was lower among adolescents and younger adults, increasing among adults 60 years of age and older to 20.6 per 100,000 (1,158 cases).

Elevated rates of IPD have been detected in northern Canada by the ICS. Between 1999 and 2004, the crude annual incidence ranged from 21.8 to 38.4 per 100,000, with age-specific incidence rates for the entire period highest among children < 2 years, at 147.8 per 100,000. The crude incidence rate was higher among Aboriginals during 1999-2004, at 38.0 per 100,000, than non-Aboriginals, at 9.6 per 100,000 (ICS, unpublished data, 2006).

The 23-valent polysaccharide vaccine (Pneu-P-23), which is recommended for adults ≥ 65 years of age and persons > 5 years who are at greater risk of disease, has been available in Canada since 1983. In January 2002, NACI recommended the use of 7-valent pneumococcal conjugate vaccine (Pneu-C-7) in routine infant immunization programs; all 13 provinces and territories had implemented Pneu-C-7 programs by January 2006.

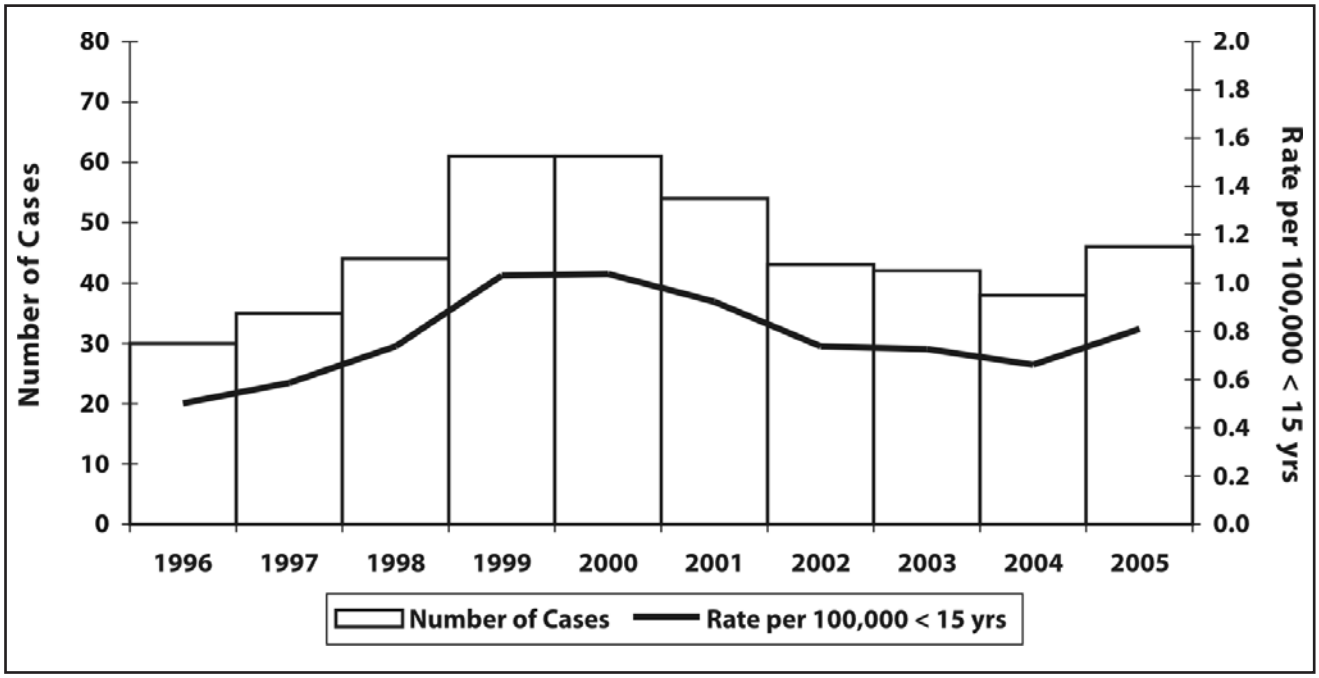
Recent data from the IMPACT network suggest a shift towards *S. pneumoniae* serotypes that are not included in Pneu-C-7. Of the 1,774 cases of IPD seen in inpatients and outpatients < 16 years of age at IMPACT pediatric tertiary care centres between January 1998 and January 2004, the proportion of serotypes matching those in Pneu-C-7 decreased from 81.2% between 1998 and 2000 to 77.1% between 2001 and 2004 ($p = 0.04$). However, this shift appears unrelated to vaccine use, as most jurisdictions did not implement their routine infant Pneu-C-7 programs until 2004-2005. Overall, 59% of cases reported during this period occurred in children < 2 years of age, 30% in children with underlying conditions or other risk factors for IPD, and 2.7% of cases resulted in death[35].

It is too early to assess the impact of these infant Pneu-C-7 programs nationwide. However, a prompt and large decline in the incidence of IPD among children < 2 years of age has been observed in population-based surveillance in the Calgary Health Region. Alberta was one of the first jurisdictions to introduce a universal infant Pneu-C-7 program, in September 2002. Compared with the combined IPD rate of 53.0 per 100,000 among children < 2 years old between 1998 and 2001, the rate in 2004 decreased by 81.6% to 11.7 for all serotypes ($p = 0.02$), by 92.6% to 3.9 for Pneu-C-7 serotypes ($p < 0.001$) and by 93.4% to 3.9 for Pneu-C-7 and related serotypes ($p < 0.001$); there was no change for non-Pneu-C-7 serotypes. There was also a significant decline in the incidence of IPD among adults ≥ 65 years, which was likely due to the indirect effect of Pneu-C-7 rather than a direct effect of Pneu-P-23 programs in older adults[36]. The national incidence of IPD is expected to similarly decline across Canada because more infants are now being immunized against the disease (Table 1).

4.9 Poliomyelitis and acute flaccid paralysis (AFP) surveillance

The last case of wild paralytic poliomyelitis in Canada was an imported case reported in 1988 (the last indigenous case was reported over a decade earlier, in 1977). Maintaining vigilance in the absence of disease is a challenge; however, until global eradication is achieved the risk of importation of wild poliovirus remains. Therefore, syndromic surveillance and follow-up investigation of AFP in children < 15 years of age continues to be used to monitor for potential cases of paralytic poliomyelitis. The expected background rate of AFP in the absence of wild poliovirus transmission according to the World Health Organization (WHO) is 1 per 100,000 of the population aged < 15 years. This equates to approximately 60 cases per year in Canada. However, since 1996, an average of only 0.77 per 100,000 or 45 cases (range 0.50 to 1.04 per 100,000 or 30 to 61 cases) of AFP have been reported each year in Canada. The AFP reporting rate initially increased following the introduction of enhanced surveillance in the early 1990s, reaching the 1 per 100,000 target rate in 1999 and 2000, then fell again to < 45 cases per year in 2002 to 2004 (Figure 7). The reasons for not meeting this target are not entirely clear, given current active enhanced surveillance systems,

Figure 7. Non-polio AFP reporting rate, Canada, 1996 to 2005



including the CPSP network of pediatricians and the IMPACT network of pediatric tertiary care centres across Canada.

4.10 Rubella

Despite occasional outbreaks, the most recent of which occurred in south-western Ontario in 2005, the incidence of rubella has maintained a steady decline in Canada over the past two decades. In particular, following the introduction of routine infant immunization programs for MMR across Canada in 1983, the average number of reported cases per year decreased from approximately 5,300 per year (1971 to 1982) to < 30 cases per year (1998 to 2004) (Figure 8). Further, following the introduction of two-dose MMR schedules introduced in 1996-1997, the average incidence decreased from 0.08 per 100,000 in 1999 to 0.03 per 100,000 in 2004 (range 0.03 to 0.09 per 100,000), and the previously observed peaks in incidence have become less apparent. Nevertheless, outbreaks have occurred, because of either gaps in overall population coverage (pre-1983 selective immunization programs) or under-vaccination of individuals and communities (due to emigration from areas of low MMR coverage or refusal of MMR vaccination for philosophical reasons).

In 1997, a large outbreak in Manitoba affected mostly non-immunized males aged 15 to 24 years and was attributed to gaps in vaccination coverage that resulted from early selective immunization programs targeting pre-adolescent females in some jurisdictions. This outbreak resulted in incidence rates approximating 350 cases per 100,000. This is reflected as a sharp increase in the national incidence rate for 1997 (Figure 8), wherein 98% of the total reported cases for Canada were associated with the Manitoba outbreak.

In 2005, a total of 309 laboratory-confirmed cases were reported in association with an outbreak of rubella in south-western Ontario. This outbreak, which ended in late July 2005, affected both sexes roughly equally (male:female ratio 1.07), as well as all age groups. However, children aged 5 to 14 years were the most affected age group, accounting for over 60% of cases. In addition, 10 of the cases were pregnant women. At the time of writing this report, all of the pregnant women had delivered, and no cases of congenital rubella syndrome or congenital rubella infection had been reported in association with the outbreak. Unlike the 1997 Manitoba

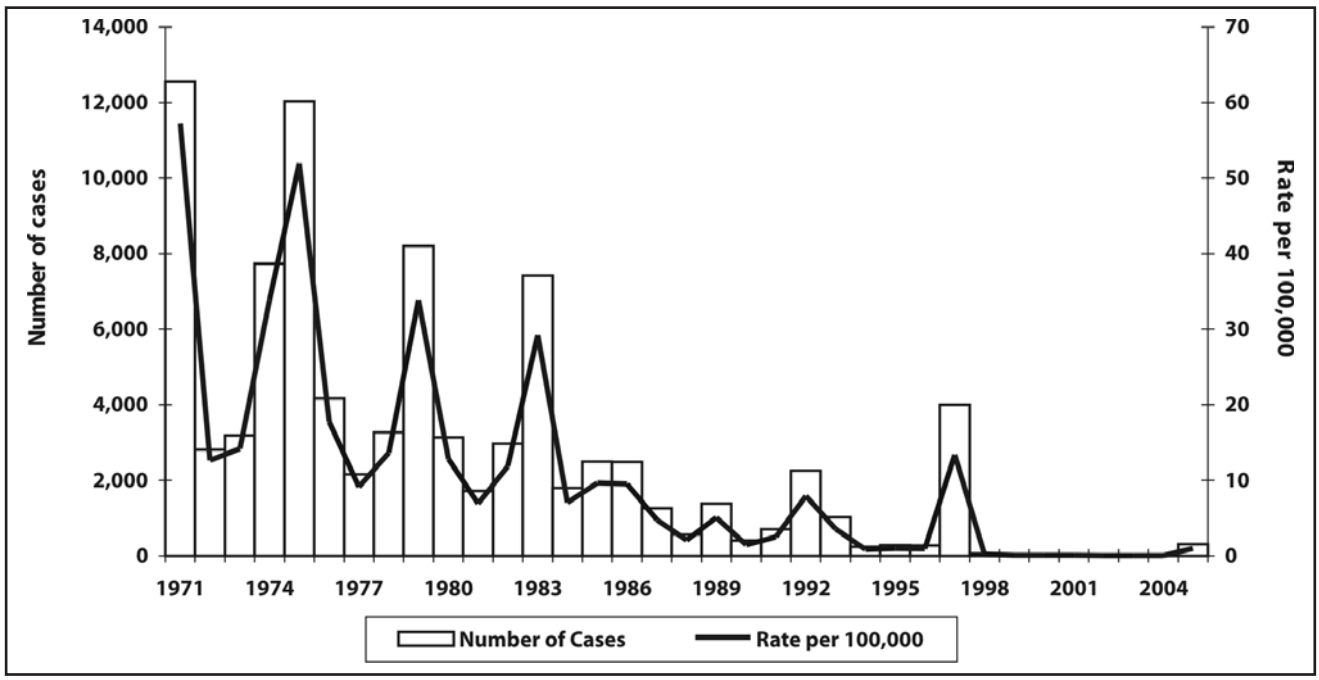
outbreak, the Ontario outbreak has been attributed to under-vaccination of persons within a defined religious community (over 98% of cases were unvaccinated) who are philosophically opposed to immunization. Preliminary laboratory evidence has linked the Ontario outbreak to an earlier outbreak in the Netherlands, which began in September 2004 and continued through to July 2005. The Netherlands outbreak resulted in 387 laboratory-confirmed cases in an unimmunized religious community. The Ontario community where the outbreak occurred has historical and social links with the affected community in the Netherlands, including frequent travel of individuals between the two communities (S. Hahné, Centre for Infectious Disease Control, the Netherlands: personal communication, 2005)[37,38].

As demonstrated by these recent outbreaks, rubella cases in Canada are increasingly limited to under-immunized individuals or groups within the general population. With established and maintained high MMR coverage rates, these outbreaks have not resulted in sustained transmission outside of the affected groups. However, unimmunized individuals, including those philosophically opposed to immunization as well as those immigrating to Canada from countries where rubella vaccine coverage is inadequate, will continue to pose a risk for future outbreaks.

4.11 CRS and congenital rubella infection

The primary goal of rubella immunization is to prevent infection in pregnancy and thereby eliminate the sequelae, namely CRS and congenital rubella infection (CRI), which can occur in infants born to infected mothers. Enhanced surveillance of CRS/CRI was initiated through the Canadian Paediatric Surveillance Program (CPSP) in 1996 with the aim of supplementing pre-existing surveillance activities to increase case finding and to initiate surveillance for CRI. While the CPSP has been a valuable means of increasing the profile of CRS and CRI through regular communications with pediatricians across Canada and annual reports on surveillance findings, after 9 years it has been decided that parallel reporting mechanisms, such as NDRS and enhanced P/T reporting, are best suited for the future of CRS/CRI surveillance in Canada. During the period of reporting through the CPSP, 1996-2004, no cases of CRI and just 10 cases of CRS were reported, most of which were reported to the NDRS in parallel. The lack of CRI reports and rarity of CRS reports over 9 years can be largely attributed to the low incidence of

Figure 8. Reported cases of rubella, Canada, 1971 to 2005



rubella in Canada but may also be due to under-reporting and/or under-diagnosis of the various manifestations of mother-to-child rubella infection, including CRI, CRS with severe manifestations and CRS with late-onset manifestations.

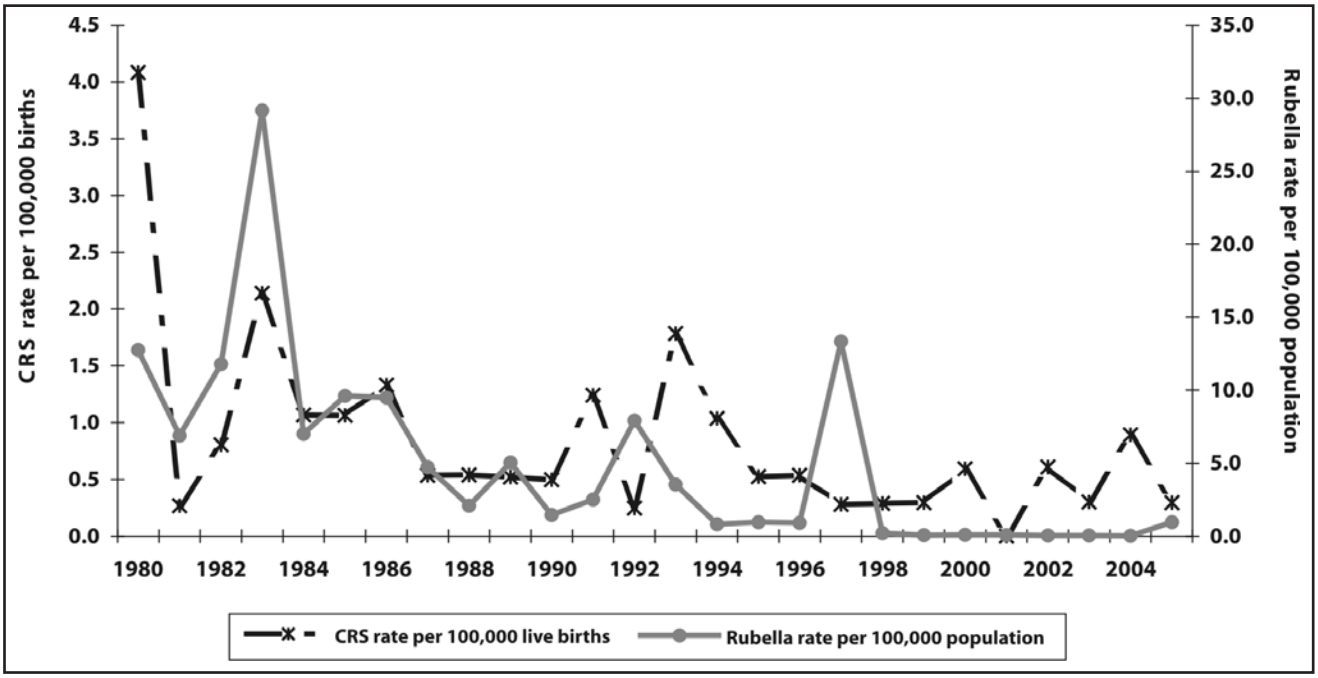
Between 1980 and 2004, the incidence of CRS appeared to follow the same trend as that of rubella (Figure 9), with the exception of the 1997 Manitoba outbreak, which involved mainly young males aged 15 to 24 years (86%). Of the 10 CRS cases reported through the CPSP between 1996 and 2004, eight had information available: five were born to immigrant women, one to an Aboriginal woman and two to non-Aboriginal women. In 2005, a single case of CRS was reported in British Columbia; the mother of the case immigrated to Canada 1 month before the infant's birth. To date, no cases of CRS or CRI have been reported in association with the 2005 outbreak of rubella in south-western Ontario, which involved 10 pregnant women, all of whom had delivered at the time of writing this report.

In Canada, routine infant and childhood catch-up immunization programs, aimed at increasing MMR coverage, have resulted in sustained high rates of immunity in the general population[4]. Together with CRS-specific policies to screen 100% of pregnant women for rubella and to offer immunization to all women who are susceptible postpartum (implemented in six provinces and one territory), Canada is making progress towards elimination of indigenous rubella infection in pregnancy. Yet while the rarity of CRS/CRI in Canada is a reflection of the impact of these rubella elimination strategies, the risk of importation and limited transmission remains, for the reasons discussed earlier (see rubella section).

4.12 Varicella

Varicella (chickenpox) infections are significantly under-reported in Canada. It is estimated that 90% of the population will have had chickenpox by the time they are 12 years of age and as many as 350,000 cases are expected to occur each year[39,40]. However, < 10% of these infections are reported to the Notifiable Diseases Reporting System (NDRS) in any given year. While varicella is a notifiable disease, only laboratory-confirmed cases or clinical cases linked to laboratory-confirmed cases are captured by the case definition and not all P/T participate in routine reporting at the national level. Furthermore, herpes zoster (shingles) cases or latent reactivation of varicella virus infections are not nationally notifiable in Canada. Given that the estimated lifetime risk of experiencing at least one

Figure 9. Incidence rates of CRS and rubella, Canada, 1980 to 2005



reactivation of primary varicella infection to herpes zoster is 15% to 20%, there are likely a significant number of these infections unaccounted for at the national level[40].

Supplementary surveillance data are available for paediatric varicella and herpes zoster hospitalizations through IMPACT. The first period of surveillance ran from 1990 to 1996 and was re-initiated in 1999 after a 3-year hiatus. Results for the first period of surveillance have been published previously[41]. For the most recent period to date, 1999 to 2005, a total of 2,358 hospitalizations due to varicella or herpes zoster were reported from the 12 sites across Canada, averaging 335 hospitalizations each year (range 246 to 455) (IMPACT, unpublished data, 2006). Of these cases, just over half were male (55%), and the most affected age groups were 1 to 4 years (45% of hospitalizations) and 5 to 9 years (30% of hospitalizations). As noted for the previous surveillance period, the majority of hospitalizations occurred in previously healthy children[41]. Pediatric deaths due to varicella are relatively uncommon; case fatality rates are highest among adults (30 deaths per 100,000 cases), followed by infants (seven deaths per 100,000 cases) and children aged 1 to 19 years (one to 1.5 deaths per 100,000 cases)[39,40,42]. In Canada, of the 53 reported varicella deaths from 1987 to 1996, 70% occurred in those > 15 years of age[39]. Since 1999, a total of seven deaths due to varicella were reported by IMPACT, ranging from 0 to three deaths per year. During the same time period, IMPACT reported one death due to herpes zoster.

Given that varicella is mainly a childhood disease, with healthy children < 12 years of age accounting for approximately 90% of all varicella cases[39] and the majority of hospitalizations, sentinel data from the IMPACT surveillance system provide important information on varicella and herpes zoster complications and trends in disease severity. However, the absence of adequate population-based surveillance presents a challenge for both a description of current trends in varicella and herpes zoster infections and for ongoing monitoring of disease incidence trends. Given that nearly all P/T have now implemented routine infant immunization programs for varicella, surveillance data will be important in monitoring the impact of these programs on varicella incidence in Canada and likewise on the incidence and potential shifting age patterns of herpes zoster reactivation.

5. Vaccine Safety: Surveillance of Adverse Events Following Immunization

5.1 Introduction and historical background

Postmarketing surveillance of drugs, including vaccines, was started by the Bureau of Epidemiology of the Laboratory Centre for Disease Control (LCDC), following the thalidomide embryopathy epidemic in the early 1960s. In 1987, postmarketing surveillance of drugs was transferred to the Drugs Directorate (now Marketed Health Products Directorate), and surveillance of vaccine safety remained with LCDC, now the Centre for Infectious Disease Prevention and Control within PHAC. Spontaneous adverse event reporting (known as passive surveillance) by health care providers, manufacturers and consumers is the cornerstone of Canadian postmarketing surveillance of vaccine safety. In addition, 12 pediatric hospitals across Canada perform active surveillance for adverse events following immunization (AEFI) under IMPACT (Section 3.5). The Canadian adverse event reporting form is available on-line (http://www.phac-aspc.gc.ca/dird-dimr/pdf/hc4229e.pdf), as well as in the *Compendium of Pharmaceuticals and Specialties*, all health centres, clinics and hospitals. Most reports are submitted first to P/T jurisdictions for public health action and follow-up, and then transferred to the national level, where all reports are aggregated and stored in a computerized, Web-enabled database. However, some reports are submitted directly to the national level (for a more complete description, see http://www.phac-aspc.gc.ca/im/vs-sv/caefiss_e.html). An expert Advisory Committee on Causality Assessment (ACCA), operative since 1994, systematically reviews selected reports on a case-by-case basis to evaluate the likelihood that an event is causally related to a vaccine (http://www.phac-aspc.gc.ca/im/vs-sv/acca_e.html).

The primary objective of this report is to present 2004 vaccine safety surveillance data, but since it is the first summary published since 1998, temporal trends are also discussed.

5.2 Methodology

This report focuses on reported adverse events following vaccines with an immunization date from 1 January, 2004, through 31 December, 2004. Reports with no immunization date were excluded. Descriptive analyses were done, using SAS statistical programs, to characterize case reports in terms of age, sex, vaccines administered, medical attention sought, adverse events reported, time from immunization to adverse event onset, causality assigned by ACCA and reporting timeliness. The results are presented for all reports regardless of vaccine(s) given.

Where appropriate, the data for 2004 have been compared with those gathered for previous years in order to examine temporal trends in adverse event reporting frequency and rate, age distribution, vaccines administered and adverse event profile. For these analyses, published data were used for the years preceding 1997[43-48], and data were retrieved and analyzed from the existing Canadian Adverse Events Following Immunization (CAEFI) database for 1997 through 2004.

Reporting rates were calculated using total doses of distributed vaccines in each year from 1992 to 2004. The dose distribution information was not available for some vaccines given from 1999 through 2004, and therefore the corresponding adverse event reports were excluded from the rate calculation, which should then be considered an approximation of the actual rate.

Before 1997, no distinction was made for seniors as opposed to other adults, and the upper and lower limits for pre-school and school-age respectively were < 5 and ≥ 5 years, whereas they were < 7 and ≥ 7 years from 1997 onwards. Otherwise the age categories are the same across all reporting years.

Table 5. Profile of reported adverse events following immunization, 2004

	Frequency*	% (*n* = 3,625)
Frequently reported adverse events (≥ 1%)		
Local reaction	1,175	32.4
Severe pain and/or swelling at injection site	630	17.0
Other	545	15.0
Allergic reaction	1,148	31.7
Serious allergic reaction (anaphylaxis)	38	1.0
Rashes	641	18.0
Other	469	13.0
Fever	835	23.0
≥ 39° C	367	10.0
< 39° C, or not recorded	468	13.0
Conjunctivitis	160	4.4
Arthralgia/arthritis	132	3.6
Screaming episode/persistent crying	120	3.3
Irritability	116	3.2
Headache	80	2.2
Chest pain	68	1.9
Nausea	56	1.5
Oculo-respiratory syndrome (ORS)†	50	1.4
Anorexia	50	1.4
Somnolence	50	1.4
Hypokinesia	46	1.3
Myalgia	45	1.2
Dyspnea	43	1.2
Cough	40	1.1
Convulsion/seizure	37	1.0
Selected less frequently reported adverse events of public health interest (< 1%)		
Hypotonic-hyporesponsive episode (HHE)	21	0.6
Localized anesthesia/paresthesia	17	0.5
Thrombocytopenia	12	0.3
Guillain-Barré syndrome (GBS)	10	0.3
Facial or cranial paralysis (Bell's palsy)	5	0.1
Encephalopathy, meningitis and/or encephalitis	4	0.1

*The event total exceeds submitted reports since more than one adverse event may be included in a single report.

†ORS definition: red eyes AND ≥ 1 respiratory symptom (cough, wheeze, chest tightness, difficulty breathing, sore throat, dysphagia, hoarseness) with or without facial edema, occurring within 24 hours of immunization.

Causality assessments carried out by ACCA for the serious cases with an immunization date from 1997 to 2004 were summarized. ACCA assigns causality using one of six terms derived from those originally described by WHO: very likely, probable, possible, unlikely, unrelated and unclassifiable[49]. For the purposes of this report, the terms very likely/probable and unlikely/unrelated have been combined and presented as "probably related" and "unlikely related", respectively.

Reporting timeliness was analyzed for the period 1997 to 2004 using the date of immunization, date of CAEFI form completion and the date the CAEFI report was received at the national level.

5.3 Results

As of 1 March, 2006, a total of 3,625 AEFI reports were received for vaccines given in 2004. On the basis of analyses of reporting timeliness over the last 5 years it is expected that > 95% of AEFI reports for vaccines administered during a given calendar year will be captured in an analysis done 1 year after the end of the calendar year.

A total of 8,409 adverse events were identified in the 3,625 reports for 2004. Table 5 shows the total number reported, by specific adverse event, and the respective proportion of all case reports. The three most commonly reported adverse events were local reactions (32.4% of 3,625), allergic reactions including rash (31.7%) and fever (23%).

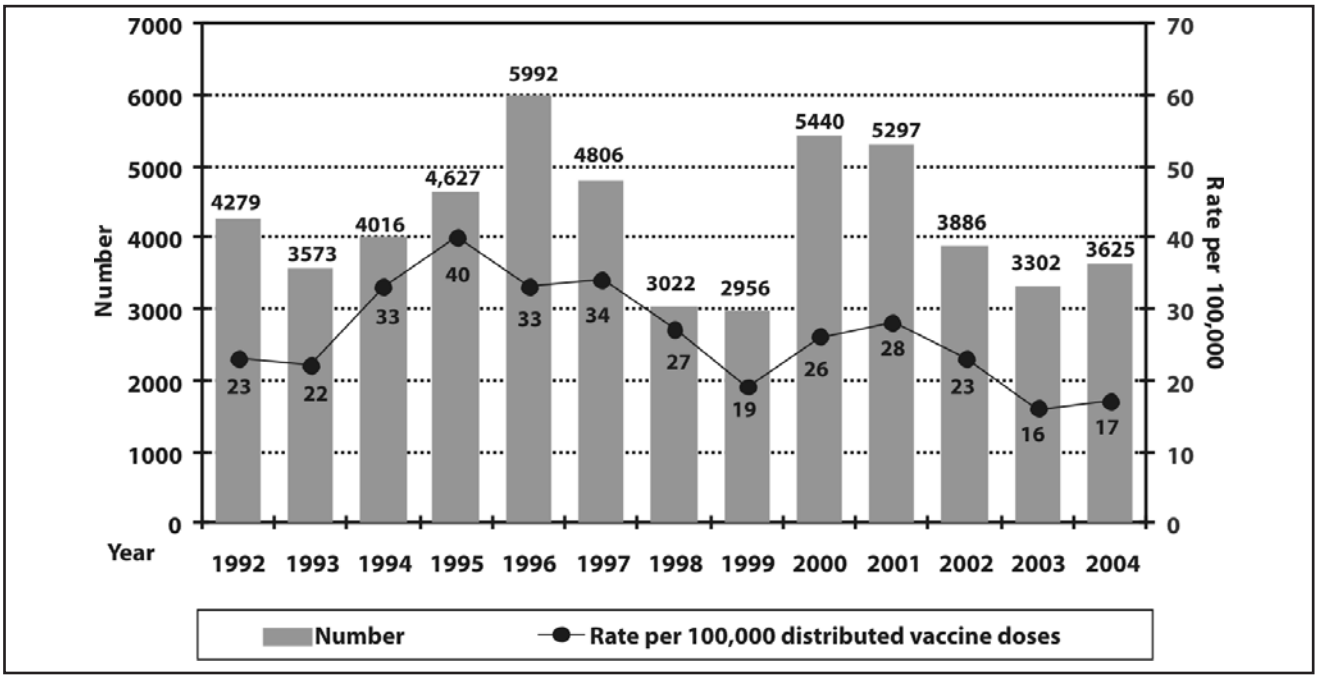
Trends in the reported occurrence of adverse events meeting the case definition for ORS (see footnote, Table 5) following influenza vaccine have been analyzed and previously described in detail for the 1997-1998 through 2003-2004 influenza seasons[50]. For the 2004-2005 season, the ORS reporting rate was 0.4 per 100,000 doses of distributed influenza vaccine.

An interval from immunization to onset was specified for 7,160 adverse events (85.2%). Cumulatively, 49% of reported events occurred within 1 day, 89.4% within 1 week and 99.3% within 1 month of immunization.

Figure 10 shows the total number of adverse event reports received and the associated reporting rates per 100,000 doses of distributed vaccines by year from 1992 to 2004.

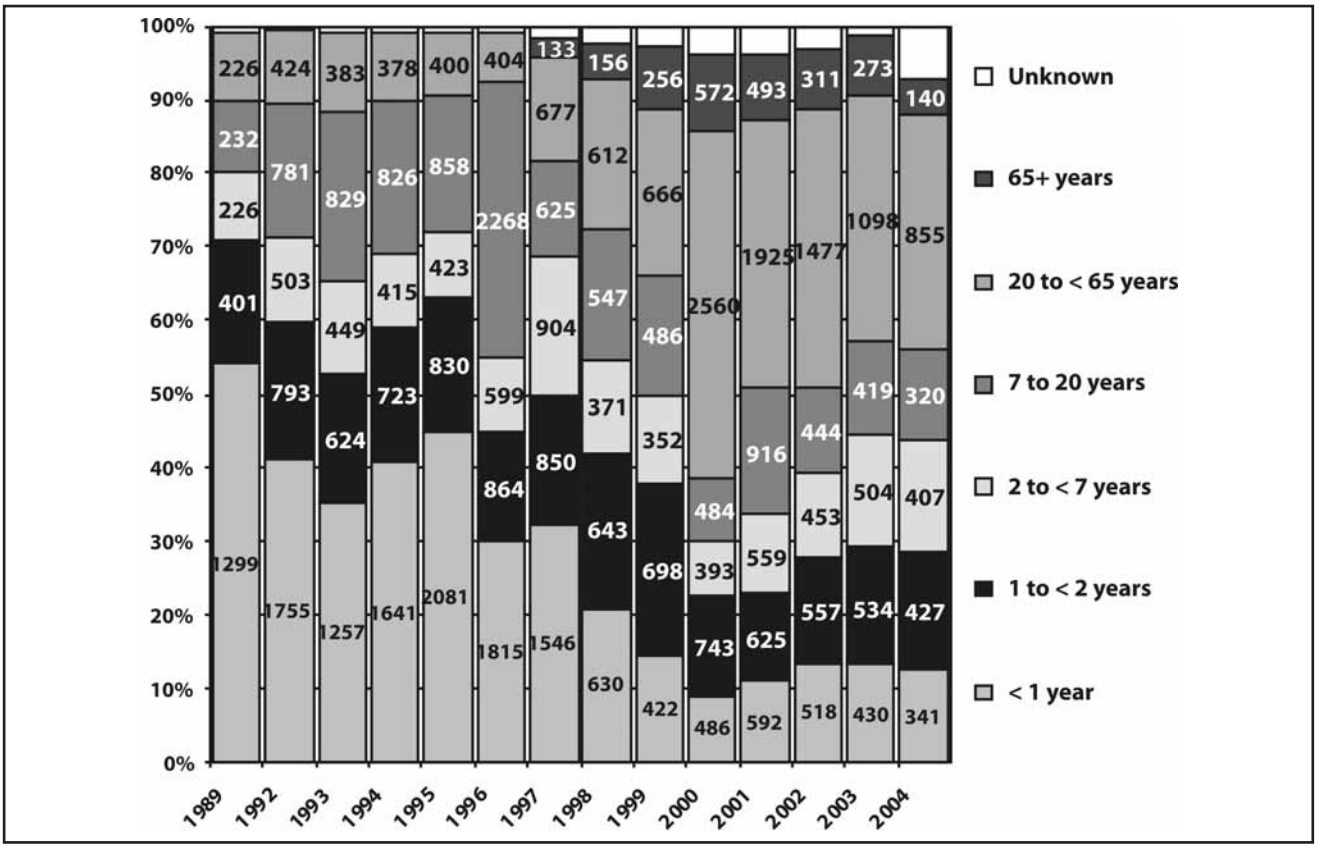
Age could be calculated for 3,584 (95%) of vaccinees with a reported adverse event following vaccine(s) given in 2004. The age distribution was as follows: < 1 year, 12.3% (*n* = 447); 1 to < 2 years, 17.2% (*n* = 623); 2 to < 7 years, 14.5% (*n* = 524); 7 to < 20 years, 12.5% (*n* = 453); 20 to < 65 years, 31.5% (*n* = 1,146); and > 65 years, 6.8% (*n* = 248). The mean and median age, respectively, were 23 and 10 years (range, birth to 101 years). Figure 11 shows the trends in age distribution from 1989 and 1992 to 2004, and includes the proportion of reports with missing data for age.

Figure 10. Number of AEFI reports and reporting rates per 100,000 doses of distributed* vaccines, 1992 to 2004



* Net number of doses distributed (doses distributed minus doses returned)

Figure 11. Age distribution of reported AEFI, 1989, 1992 to 2004*



*Numbers in the graph columns indicate the total reports received for each age group.
Before 1997, 5 years was the limit for pre-school/school-age children rather than 7 years; 65+ years was included with the 20 to < 65 year age group.
Published data on age groups were not available for 1990 and 1991.

Overall, 60% of the 3,625 reports involved females, although distribution by sex varied with age. Among children aged < 7 years there was a predominance of males (54% male), whereas females predominated after age 7, with specific proportions by age group as follows: 7 to < 20 years, 55% female; 20 to < 65 years, 81% female; 65+ years, 76% female.

For 2004, a total of 4,905 separate vaccine events were named in the 3,625 adverse event reports following immunization. Figure 12 shows trends in vaccine types in AEFI reports between 1992 and 2004.

Figure 12. Vaccines types in AEFI reports by year of immunization, 1992 to 2004

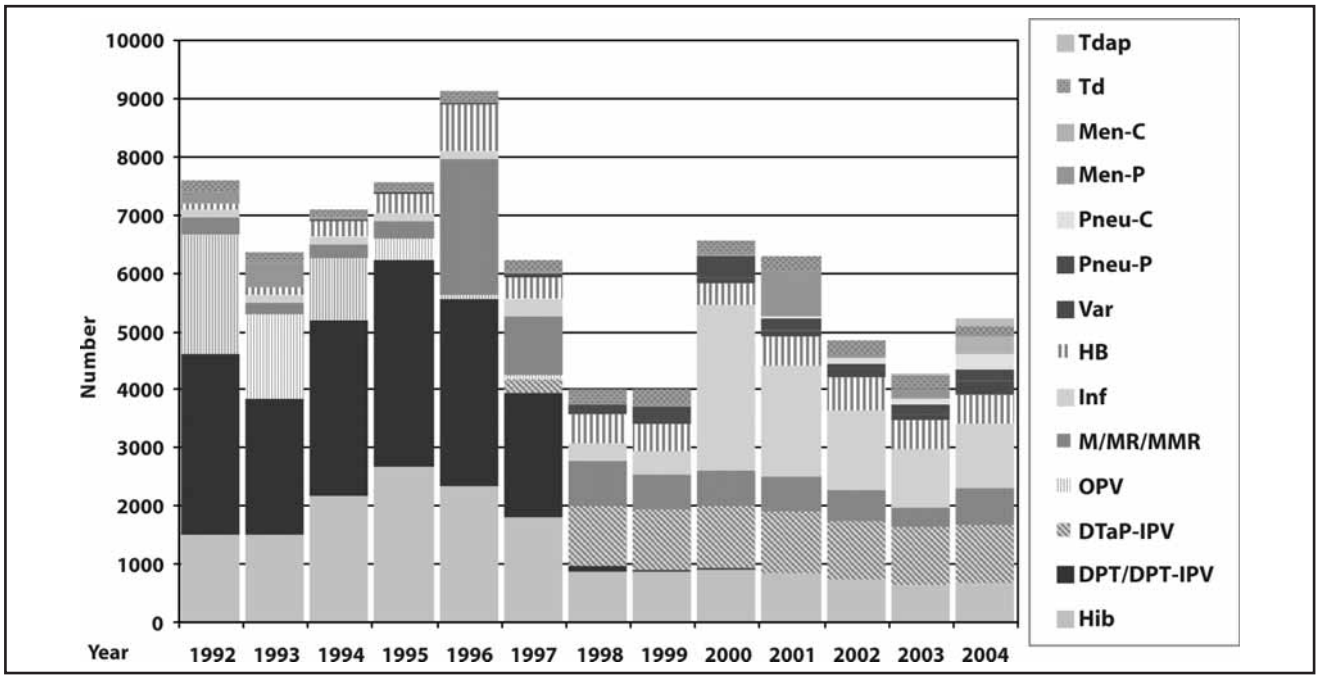
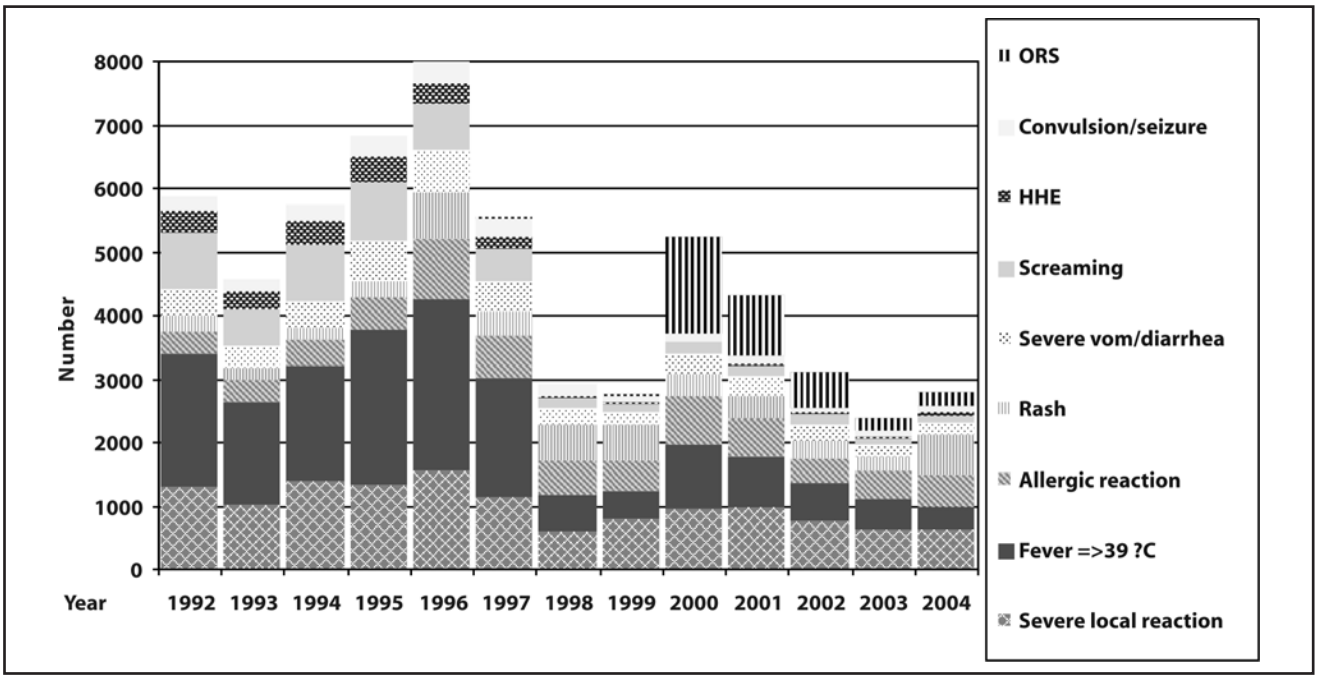


Figure 13 shows the temporal trend, from 1992 to 2004, for relatively frequent adverse events, specifically those that accounted for ≥ 5% of all events reported for at least one of the years shown.

Medical attention associated with the AEFI reports for 2004 was as follows: hospital admission for 5% (*n* = 173), emergency department assessment for 7% (277), non-urgent outpatient visit for 31% (1,113),

Figure 13. Distribution of relatively frequent* AEFI, 1992 to 2004



*Accounted for ≥ 5% of all events reported for at least one of the years shown.

no medical attention for 28% (1,021) and not indicated for 28% (1,020).

Outcome data were specified in 2,947 (81%) of the reports, of which 2,488 (84%) had full recovery, 272 (9%) were recovering and 179 (6%) had residual effects at the time of reporting. There were eight reports of deaths (0.3%).

Table 6 shows the results of causality assessment by ACCA for 502 of the serious events reported from 1997 to 2004. Deaths assigned as probably related to immunization were First Nations infants who received BCG and died of disseminated BCG due to underlying, but undiagnosed, severe combined immune deficiency syndrome[51].

Reporting timeliness was calculated for all reports received from 1997 through 2004. The median interval from vaccine administration date to completion of an adverse event report was15 days (range 0 days to 7 years). The median interval from completion of the adverse event report to receipt at the national level was 2.2 months (range 0 days to 8 years).

5.4 Discussion

It must be remembered that the results reported here reflect surveillance, not research data. The type of information requested and the coding conventions have changed over time and will continue to do so. The vast majority of reports in the CAEFI system are submitted on a voluntary basis, and there is marked variability in both the quantity and quality of information provided. The total number of reports received fluctuates from year to year for a variety of reasons, related not only to changes in immunization programs (e.g. changes in the type and number of vaccines provided through publicly funded programs; mass immunization programs in response to an outbreak; catch-up programs) but also to adverse event reporting/data entry practices and capacity (e.g. changes in personnel at the level of federal, P/T and local health departments; changes in emphasis on the types of reports sent for inclusion in the national database; changes in computer systems leading to a backlog in forwarding reports that could last 4 to 6 years). It is also important to remember that a primary purpose of the voluntary reporting system is to detect signals of concern, for which capture of all events is not essential. Despite these limitations a number of interesting trends are apparent.

Table 6. ACCA causality assessment for serious AEFI, 1997 to 2004 (*n* = 502)

Causality assessment	Not likely	Possible	Probable
Adverse event (total reviewed)			
Anaphylaxis (22)	2	3	17
Thrombocytopenia (61)	19	21	21
Neurological (200)			
■ Encephalopathy	7	3	0
■ Encephalitis/meningitis	23	3	2
■ GBS	14	12	7
■ Bell's palsy	11	7	2
■ HHE	1	4	6
■ Convulsions	53	22	23
Hospitalized ≥ 3 days (90)	54	16	20
Death (20)	16	1	3
Other (109)	61	15	33

The annual total number of adverse event reports has varied by a factor of approximately 2-fold, from a low of 3,022 to a high of 5,992, with no consistent upward or downward trend over time. The reporting rate per 100,000 distributed vaccine doses has also varied by about 2-fold (range 16 to 40) with no consistent pattern, but clearly the two variables are independent of each other. This is a good example of why it is dangerous to rely on the absolute number of reports alone when considering vaccine safety surveillance data.

There have been some dramatic and consistent age-specific changes in AEFI reporting patterns for infants aged < 1 year, school-aged children and adults (Figure 11). Much concern has been voiced about the increasing number and complexity of vaccines given to infants over the last decade. Yet it is clear that there has been a steady decrease in both the absolute and relative number of AEFI reports submitted for infants aged < 1 year. Since vaccine coverage in this group has not changed dramatically, it is likely that the change is explainable largely by the shift from whole cell to acellular pertussis vaccines in infant vaccination programs in all jurisdictions during 1997-1998. The fact that both absolute and relative numbers of reports for toddlers and pre-school children have not changed as much over the same time frame suggests that the infant trend is not due simply to variation in reporting practice or the degree to which reports are forwarded to the national level.

Among school-aged children and adolescents (5 to 7 years through < 20 years), there has been a nearly 10-fold variation in total number of annual reports (range 232 in 1989 to 2,268 in 1996). Similarly, the proportion of all reports involving this age group has varied from 10% to 40%. Several factors may account for this variation, including meningococcal vaccine campaigns focused on school-aged children in several jurisdictions; introduction of universal hepatitis B immunization in schools across Canada during the mid to late 1990s; and adoption of 2-dose measles vaccine programs with catch-up campaigns involving school-aged children in 1996. Since 2002, the total number of reports involving school-aged children and adolescents has levelled off to approximately 400 per year, which represents just over 10% of all submitted AEFI reports.

Among adults there has been a marked increase in report frequency starting in 2000, primarily as a result of ORS associated with the influenza vaccine used in 2000 and subsequent increased reporting through a combination of heightened public and provider awareness and enhanced P/T surveillance. Ontario's adoption of universal influenza immunization may also have played a role. While the proportion of AEFI reports involving adults has remained high, at just under 40% of all reports received, the total number of reports has decreased dramatically over the last 3 years, again largely related to the drop in ORS case reporting. There have been few changes in age distribution for AEFIs over the last 2 years, and the total number of reports has remained under 4,000 despite the fact that a steadily increasing number of jurisdictions have added universal infant/toddler programs against varicella, *S. pneumoniae* and *N. meningitidis*. This trend has to be interpreted with caution since some jurisdictions temporarily stopped sending reports for technical reasons.

Figure 12 is a clear reflection of the marked changes in Canada's immunization programs over the last 17 years. The increasing number and proportion of reports involving influenza vaccine reflect not only the occurrence of ORS in 2000 but also the marked increase in vaccine coverage over the last 5 years. The variation in reports associated with measles-containing vaccines, peaking in 1996, reflects the move from one- to two-dose measles and catch-up campaigns initiated in that year. Aside from that, the total number of reports involving MMR vaccines has remained very similar throughout the period shown. The figure also charts, since 1997, the cessation of whole cell pertussis and oral polio vaccine use and introduction of new vaccines in Canada: first, pediatric acellular pertussis vaccine combinations followed by live attenuated varicella zoster vaccine, conjugate pneumococcal and meningococcal vaccines and, most recently, adult formulations of acellular pertussis vaccine with Td toxoids. It is clearly important to critically examine any changes in AEFI reporting for several years after the introduction of new vaccines. Aside from the sheer number of new

vaccines added to the schedule over the last few years, the fact that many are given in combination adds to the challenge of monitoring vaccine safety. Vaccine-specific AEFI data analyses are currently under way (starting with hepatitis B, MMR and influenza vaccines) and will be published on the Web in 2006 and in CCDR in the future.

In terms of specific adverse events, the most dramatic temporal trend observed for children has been the marked drop in the frequency of reports involving fever $\geq 39^{\circ}$ C and screaming/persistent crying since the 1997 introduction of acellular pertussis vaccines. Despite the introduction of several new vaccines for universal use in Canada over the last 5 years, with accelerated adoption of these vaccines by P/T jurisdictions during 2003 and 2004, the distribution of relatively commonly reported AEFI, as shown in Figure 13, has changed little since 2000, with the single exception of ORS. While the 2004 data do not reveal any worrying trends regarding AEFI following newly introduced vaccines, it is much too early to draw any firm conclusions other than the need for continued surveillance.

The degree of medical attention associated with AEFI reports has not been consistently provided in previously published reports, and thus temporal trends in medical attention were not calculated for this report. The figure of 5% for hospitalization observed for AEFIs related to immunizations given in 2004 is similar to what was reported for both 1989 (5.2%) and 1992 (3.0%)(45,48).

An innovation for this vaccine safety report is an analysis of regional and national AEFI reporting timeliness. The vast majority of reported AEFI occur within 30 days of immunization. How quickly an AEFI is identified and reported, however, depends on many factors, including the degree of severity, the vaccinee's own or his/her caretaker's concern regarding the event and recognition by a health care professional that an event may be related to a prior vaccine. As a rule, written AEFI reports are first sent to the local health unit, then to the central P/T health departments and then onto PHAC for entry into the CAEFI database. Thus, there are many stages at which delays in reporting can occur, often for good reason, for example, delays caused by investigation into an accurate medical diagnosis or a search for etiologies other than the vaccine that may have caused the AEFI. Nevertheless, receiving reports in a timely fashion is clearly important for the rapid detection of any safety signals of concern. Collecting and analyzing AEFI reports at the national level increases the likelihood of earlier detection of rare or unusual AEFI, since it is possible to examine trends across multiple jurisdictions that might not be noticeable in a single region. It is not uncommon for P/T jurisdictions to contact the national office regarding a possible new AEFI or increased frequency of AEFI. The validity of national data analyses to address such concerns clearly depends on the timely forwarding of reports by all jurisdictions. Thus we have chosen to examine year-to-year trends in reporting timelines as one measure of the quality and utility of vaccine safety surveillance in Canada. Over the coming year, efforts to improve the timeliness of national reporting of serious adverse events will be made in collaboration with our P/T partners and the IMPACT network.

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ANNEX 1:

PROVINCIAL AND TERRITORIAL IMMUNIZATION PROGRAMS

This annex provides a summary of routine childhood immunization programs and special immunization activities relating to those programs, as well as immunization programs that are offered to special target groups.

Routine childhood immunization programs

Surveys conducted by the Canadian Nursing Coalition on Immunization (CNCI) on immunization programs available in each P/T show that the majority of routine immunization schedules are similar across jurisdictions and conform to NACI recommendations (Table 7).

Since 2003, new childhood programs have been launched or expanded in almost all P/T. In 2003, British Columbia, Alberta and Nunavut offered a publicly funded routine pneumococcal program (pneumococcal conjugate vaccine, Pneu-C-7); as of January 2006, all jurisdictions have a routine program in place. In 2003, only one-third of the P/T offered a publicly funded routine meningococcal conjugate (Men C) program; as of November 2005, 12 P/Ts have a program available. For varicella zoster vaccine, the number of P/Ts offering a publicly funded routine program has more than doubled, rising from five in 2003 to 12 in 2006. In 2003, seven P/T had incorporated a routine adolescent acellular pertussis program, and by September 2004 this program was available in all P/Ts.

Table 7. Publicly funded immunization programs in Canada, routine schedule for infants and children by P/T

	DTap	IPV	Hib	Td, Tdap or Td-IPV	HB	MMR	Var	Men-C	Pneu-C-7	Inf
NACI recommendation	**2, 4, 6,18 mths, 4-6 yrs**	**2, 4, 6, 18 mths, 4-6 yrs**	**2, 4, 6, 18 mths**	**14-16 yrs**	**Infancy (3 doses) OR Pre-teen/ teen**	**12 mths, 18 mths/4-6 yrs**	**Children between 12 & 18 mths**	**2, 4, 6 mths OR 12 mths, if not yet given OR 14-16 yrs, if not yet given**	**2, 4, 6, 12/15 mths**	**6-23 mths (1-2 doses)**
Province/ territory										
BC	2, 4, 6, 18 mths, 4-6 yrs	2, 4, 6, 18 mths, 4-6 yrs	2, 4, 6, 18 mths	dTap, gr 9	2, 4, 6 mths	12, 18 mths	12 mths	2, 12 mths	2, 4, 6, 18 mths	6-23 mths
AB	2, 4, 6, 18 mths, 4-6 yrs	2, 4, 6, 18 mths, 4-6 yrs	2, 4, 6, 18 mths	dTap, gr 9	Gr. 5	12 mths, 4-6 yrs	12 mths	2, 4, 6 mths	2, 4, 6, 18 mths	6-23 mths
SK	2, 4, 6, 18 mths, 4-6 yrs	2, 4, 6, 18 mths, 4-6 yrs	2, 4, 6, 18 mths	dTap, gr 8	Gr. 6	12, 18 mths	12 mths	12 mths	2, 4, 6, 18 mths	6-23 mths
MB	2, 4, 6, 18 mths, 4-6 yrs	2, 4, 6, 18 mths, 4-6 yrs	2,4,6,18 mths	dTap, gr 9	Gr. 4	12 mths, 4-6 yrs	12 mths	Gr. 4	2,4,6,18 mths	6-23 mths
ON	2, 4, 6, 18 mths, 4-6 yrs	2,4,6,18 mths, 4-6 yrs	2,4,6,18 mths	dTap, 14-16 yrs	Gr. 7 (2 doses)	12, 18 mths	15 mths	12 mths	2,4,6,15 mths	≥6 mths
QC	2, 4, 6, 18 mths, 4-6 yrs	2,4,6,18 mths, 4-6 yrs	2,4,6,18 mths	dTap, gr 10	Gr. 4	12, 18 mths	12 mths	12 mths	2,4,12 mths	6-23 mths
NB	2, 4, 6, 18 mths, 4-6 yrs	2,4,6,18 mths, 4-6 yrs	2,4,6,18 mths	dTap, gr 9	0, 2, 6 mths	12, 18 mths	12 mths	12 mths	2, 4, 6, 18 mths	6-23 mths
NS	2, 4, 6, 18 mths, 4-6 yrs	2, 4, 6, 18 mths, 4-6 yrs	2, 4, 6, 18 mths	dTap, gr 10	Gr. 4	12 mths, 4-6 yrs	12 mths	12 mths	2, 4, 6, 18 mths	6-23 mths
PE	2, 4, 6, 18 mths, 4-6 yrs	2, 4, 6, 18 mths, 4-6 yrs	2, 4, 6, 18 mths	dTap, gr 9	2, 4, 15 mths	15, 18 mths	12 mths	12 mths	2, 4, 6, 18 mths	
NL	2, 4, 6, 18 mths, 4-6 yrs	2, 4, 6, 18 mths, 4-6 yrs	2, 4, 6, 18 mths	dTap, gr 9	Gr. 4	12, 18 mths	12 mths	12 mths	2, 4, 6, 18 mths	6-23 mths
NT	2, 4, 6, 18 mths, 4-6 yrs	2, 4, 6, 18 mths, 4-6 yrs	2, 4, 6, 18 mths	dTap, gr 9	0, 1, 6 mths	12, 18 mths	12 mths	2, 4 mths	2, 4, 6, 18 mths	6-23 mths
YT	2, 4, 6, 18 mths, 4-6 yrs	2, 4, 6, 18 mths, 4-6 yrs	2, 4, 6, 18 mths	dTap, gr 9	2, 4, 12 mths, ≤ 19 yrs and not previously immunized	12, 18 mths		2, 6 mths	2, 4, 6, 18 mths	6-23 mths
NU	2, 4, 6, 18 mths, 4-6 yrs	2, 4, 6, 18 mths, 4-6 yrs	2, 4, 6, 18 mths	dTap, gr 9	0, 1, 9 mths	12, 18 mths	12 mths		2, 4, 6, 15 mths	≥ 6 mths to 5 yrs

Original Source: Canadian Nursing Coalition on Immunization, 2004, updated July 2006

Special immunization programs

Table 8 summarizes information regarding immunization programs offered to certain target groups. With regard to the newly funded programs, all P/Ts, except one, offer a publicly funded pneumococcal program to NACI-recommended "high risk groups", and some also offer their program to NACI-defined "presumed high risk groups". A high-risk meningococcal program consistent with NACI recommendations is in place in almost all P/T. For varicella, a high-risk program has been implemented in 11 of 13 P/T.

The Immunization and Respiratory Infections Division has received notification of several special activities focusing mainly on meningococcal conjugate and varicella vaccine activities (Table 9). However, those mentioned in this report do not necessarily represent the complete efforts of all provinces and territories.

Table 8. Publicly funded immunization programs in Canada, high-risk groups by P/T

Province/ territory	Hepatitis B	Varicella	Meningococcal conjugate	Pneumococcal conjugate
BC	Selected criteria	High risk	High-risk people of all ages, contacts of cases	High risk < 5 yrs, children with asplenia < 17 yrs
AB	Selected criteria	High-risk susceptible individuals, susceptible individuals aged 13 years and older	Contacts of cases, high risk, laboratory workers	High risk and presumed high risk 2-59 mths, healthy Aboriginal children up to 59 mths, children with asplenia aged 2 mths-16 yrs
SK	Selected criteria	Selected high-risk susceptible people	High risk, close contacts	High risk < 5 yrs
MB	Selected criteria (3 doses)	High-risk, susceptible household contacts	High risk ≥ 2 mths	High risk < 5 yrs
ON	Selected criteria	Susceptible high-risk people of all ages	High risk all ages, close contacts of cases	High risk < 5 yrs
QC	Selected criteria	High risk	Contacts of cases, high risk	High risk, non-immunized children < 5 yrs
NB			High risk all ages, contacts of cases	High risk < 5 yrs
NS	Selected criteria	High risk	High risk	High risk
PE	Selected criteria	High risk	High risk, contacts of cases	High risk, presumed high risk
NL	Selected criteria	Selected high-risk susceptible people	Contacts of cases, outbreak control	High risk < 9 yrs
NT		High risk	High risk	High risk < 2 yrs
YT	Selected criteria	High risk ≥ 12 mths (1 dose)	High risk	High risk
NU	Selected criteria		Household contacts, outbreak control	

Original Source: Canadian Nursing Coalition on Immunization, 2004, updated July 2006

Table 9. Current special immunization programs in Canada by P/T

Province/ territory	TdaP	Hepatitis B	Varicella	Meningococcal conjugate
BC		Gr 6 catch-up (2 doses)	Catch-up of susceptible children aged 18-48 mths for 2005 only, 4-6 yr old catch-up, gr 6 catch-up, catch-up of susceptible women of child-bearing age (15-45 yrs)	Gr 6 catch-up, gr 9 catch-up, gr 12 catch-up (2005/06 and 2006/07 school years only)
AB			Gr 5 catch-up, 4-6 yr old catch-up	
SK			Gr 6 catch-up	4-6 yr old catch-up, gr 6 catch-up
MB			4-6 yr old catch-up, gr 4 catch-up	
ON			5-yr old catch-up	12-yr old catch-up, 15-19 yr old catch-up
QC	1 dose dTap for ≥ 7 yrs		4-6 yr old catch-up, gr 4 catch-up, heath professional non-immune	
NB			Catch-up for those born in 2003, 4 yr old catch-up	Catch-up for those born in 2003, gr 9 catch-up, gr 11 and 12 catch-up for 2005-06
NS			1-6 yr old catch-up for those who are non-immune	14-16 yr old catch-up, gr 4 catch-up until 2011
PE				Gr 9 (14-16 yrs) catch-up
NL			4-6 yr old catch-up	Gr 4 catch-up, gr 9 catch-up, gr 11 & 12 catch-up
NT			Catch-up for children < 5 yrs old	1-5 yr old catch-up
YT	dTap, gr 12 catch-up for 03/04, 04/05 and 05/06 school years			16-19 yr old (leaving school) catch-up, catch-up for all children under 5 yrs
NU		Gr 4 catch-up		

Original Source: Canadian Nursing Coalition on Immunization, 2004, updated July 2006

Several P/Ts have recently implemented meningococcal conjugate C (Men C) catch-up programs. Saskatchewan, New Brunswick, Northwest Territories and Yukon have catch-up programs for pre-schoolers; British Columbia, Saskatchewan, Ontario, Nova Scotia and Newfoundland offer a catch-up for school-aged children; and British Columbia, Ontario, New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland and Yukon target adolescents.

Varicella catch-up programs are offered in 10 of 13 P/T, many initiated during 2004 or 2005. Targeted groups include pre-schoolers and school-aged children.

As for adolescent acellular pertussis, Quebec currently (2006) has a catch-up program for children ≥ 7 years. As well, Yukon has a grade 12 catch-up program in place, expected to be completed at the end of the 2005/06 school year.

For more up-to-date information on immunization programs across all Canadian jurisdictions visit the PHAC Web site at http://www.phac-aspc.gc.ca/im/ptimprog-progimpt/index.html or your provincial/territorial ministry of health's Web site.

ANNEX 2:

List Of Abbreviations and Acronyms

ACCA . . . . Advisory Committee on Causality Assessment
AEFI . . . . . Adverse event following immunization
AFP . . . . . Acute flaccid paralysis
AIVP. . . . . Automated Identification of Vaccine Products
CAEFISS . . Canadian Adverse Event Following Immunization Surveillance System
CCDR . . . . Canada Communicable Disease Report
CDC. . . . . US Centers for Disease Control and Prevention
CIHR . . . . Canadian Institutes of Health Research
CIRN . . . . Canadian Immunization Registry Network
CIC . . . . . Canadian Immunization Committee
CNCI . . . . Canadian Nursing Coalition on Immunization
CPS . . . . . Canadian Paediatric Society
CPSP . . . . Canadian Paediatric Surveillance Program
CRI . . . . . Congenital rubella infection
CRS . . . . . Congenital rubella syndrome
DTaP . . . . Diphtheria, tetanus, acellular pertussis infant vaccine
EHSSS. . . . Enhanced Hepatitis Strain Surveillance System
F/P/T . . . . Federal/Provincial/Territorial
FNIHB. . . . First Nations and Inuit Health Branch
GBS . . . . . Guillain-Barré syndrome
HB. . . . . Hepatitis B vaccine
HBV . . . . . Hepatitis B virus
HHE . . . . . Hypotonic-hyporesponsive episode
Hib . . . . . *Haemophilus influenzae* type b
HMDB . . . Hospital Morbidity Database
HPV . . . . . Human papillomavirus
ICS. . . . . International Circumpolar Surveillance
ILI . . . . . Influenza-like illness
IMD . . . . . Invasive meningococcal disease
IMPACT. . . Immunization Monitoring Program, ACTive
Inf . . . . . Influenza vaccine
IPD . . . . . Invasive pneumococcal disease
IPV. . . . . Inactivated poliovirus vaccine
IRID . . . . . Immunization and Respiratory Infections Division
KAB . . . . . Knowledge, attitudes and beliefs
LTCF . . . . Long-term care facility
Men-C . . . Meningococcal conjugate vaccine
Men-P . . . Meningococcal polysaccharide vaccine
MMR . . . . Measles/mumps/rubella vaccine
NACI . . . . National Advisory Committee on Immunization
NDRS . . . . Notifiable Diseases Reporting System
NICS. . . . . National Immunization Coverage Survey
NIS . . . . . National Immunization Strategy
OPV . . . . . Oral poliovirus vaccine
ORS . . . . . Oculo-respiratory syndrome
PAHO . . . . Pan-American Health Organization
PHAC . . . . Public Health Agency of Canada
Pneu-C-7. . 7-valent pneumococcal conjugate vaccine
Pneu-P-23 . 23-valent pneumococcal polysaccharide vaccine
RVDSS . . . Respiratory Virus Detection Surveillance System
SARS . . . . Severe Acute Respiratory Syndrome
Td . . . . . Tetanus, diphtheria adult vaccine
Tdap . . . . Tetanus, diphtheria, acellular pertussis adult vaccine
UNICEF . . . United National Children's Fund
VAAES . . . Vaccine Associated Adverse Events Surveillance System
Var . . . . . Varicella vaccine
VIDS. . . . . Vaccine Identification Database System
VPRIS . . . . Vaccine-Preventable and Respiratory Infections Surveillance working group
VSWG. . . . Vaccine Supply Working Group
WHO . . . . World Health Organization
WPV. . . . . Wild polio virus