Poster Abstract Program
Programme des résumés d’affiches
Addressing the immunization needs of Syrian Refugees in Saskatoon: An innovative community approach

Simon Kapaj, Risa Ledray

Introduction/Background: The arrival of large numbers of government-sponsored Syrian refugees beginning in late 2015 created new demands for health services in Saskatoon. These were addressed by the creation of a temporary interdisciplinary clinic which aimed to provide physical assessments, laboratory investigations and immunizations for Syrian refugees in Saskatoon Health Region (SHR). Learning gained from the design, implementation and follow-up of immunization services in this clinic model will be presented.

Methods: The Saskatoon Refugee Health Collaborative was a temporary clinic established by the collaboration of multiple community partners, private partners, and SHR. The Collaborative developed processes for initial exams, investigations, immunizations and referrals of refugee family units based on provincial and national guidelines. Clinic procedures were modified based on experience. Immunizations were recorded in Panorama, the Saskatchewan immunization registry. A formal evaluation of the clinic’s operation is underway: summarized here are key immunization findings.

Results: The clinic reached 400 Syrian refugees between January 9 and March 19, 2016. Patients included 215 males and 188 females, ranging in age from under one year to 73. 212 (52.6%) of the patients seen were under 18. Clients were assessed within two months upon arrival to Canada and linked with a family physician and Public Health office for follow-up. Eligible vaccine series were initiated with a total of 1975 immunizations administered. 11.5% of clients had immunization records from country of origin and/or a refugee camp. All patients were considered under-immunized. This period coincided with flu season and a pertussis outbreak, providing a venue to administer priority vaccines. Efforts were made to create a family-friendly, culturally sensitive environment. Patient feedback of their experience was positive.

Conclusions/Implications for immunization research and evaluation: This model of refugee health service delivery is unique in Western Canada and contributes new knowledge to the field of refugee healthcare. Specifically, important learning emerged regarding delivering immunizations to large groups of newly-arrived Canadians in a short timeframe and programing with limited resources. The interdisciplinary and inter-agency collaboration was crucial to its success. Strong relationships between partners evolved and the refugee patients, whose resilience was astounding, were connected with local public health offices.

Adverse effects of vaccination with live attenuated intranasal influenza vaccine in a pediatric cohort with cystic fibrosis

Constantina Boikos, Lawrence Joseph, Jesse Papenburg, David Scheifele, Larry Lands, Gaston De Serres, Nicholas C. Winters, Mark Chilvers, Caroline Quach

Introduction/Background: The objective of this study was to determine the effects of the live-attenuated intranasal influenza vaccine (LAIV) in subjects 2-19 years old with cystic fibrosis (CF).

Methods: During the 2012-13 and 2013-14 influenza seasons, we recruited 264 pediatric patients with CF from 4 CF clinics in Canada. Participants were followed prospectively for 2 months following vaccination with LAIV. A self-controlled risk interval study design was used in the analysis. Incidence rate ratios (IRRs) comparing risk to control periods and their 95% credible intervals (CrIs) were estimated. Further analyses will evaluate the occurrence of minor reported respiratory, gastrointestinal and systemic symptoms. We will also estimate adjusted IRRs and evaluate the robustness of results by conducting multiple sensitivity analyses.

Results: In total, 15 serious adverse events (SAEs) were reported by 15 different study participants, all of whom were hospitalized (no deaths). Of the reported SAEs, only 2 (days 16 and 30) were determined by investigators to “possibly” be causally related to LAIV based on temporality and underlying health conditions.

Conclusion: In this preliminary analysis, SAEs appeared to be more frequent in the month following LAIV administration compared to the control month, however the unadjusted IRR was not statistically significant and
causal relation to LAIV was unlikely in 87% of reported SAEs. The incidence of reported antibiotic initiation was not higher in the risk period compared to the control period.

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**Adverse event following immunization active paediatric surveillance: From case identification to reporting. Recent experience in an IMPACT hospital**

Sophie Bouchard, Marc H. Lebel, Marie-Hélène Lavergne

**Introduction/Background:** Immunization Monitoring Program-Active (IMPACT) has been conducting active AEFI surveillance in paediatric tertiary care hospitals since 1991. Since June 2013, a detailed report is generated documenting the numbers of charts reviewed and the reasons for exclusions of potential cases from reporting. The objective of this study is to describe AEFI reported and the reasons for exclusion of cases hospitalized at CHU Sainte-Justine (HSJ) in Montreal.

**Methods:** AEFI surveillance involves screening of daily admission lists, ICD-10 discharge diagnoses and individual chart review. Cases are assigned to the following categories: neurological (GBS/AFP, seizures, encephalitis/meningitis), non-neurological (thrombocytopenia, intussusception, vasculitides), complications of vaccination (anaphylaxis, cellulitis, site reaction) and others. Events are further subcategorized as irrelevant cause (obviously unrelated to immunization), immunized within specified time interval and reported as AEFI, immunized within specified interval with clear other cause, not immunized within specified interval or unknown immunization status.

**Results:** Between June 2013 and May 2016, there were approximately 25,500 hospitalizations at HSJ. 4912 cases (19.3%) met screening criteria for further review. 96% of events reviewed had either an irrelevant cause or no immunization within the specified interval. For 3% of events, immunization history was not available. The remaining 151 cases (0.6%) received a vaccine within the specified interval. Of these, 52 events were reported as AEFI. The most frequent events in children ≤6 months of age were: fever, acute life-threatening event (ALTE) and Kawasaki. In older children, these were: seizures, other neurological event, Kawasaki, thrombocytopenia/neutropenia and vaccination site reaction. The other 99 cases had a definite alternative diagnosis. In children ≤6 months of age, most frequent presentation and their causes were: for ALTE: gastroesophageal reflux and viral infection; for fever: infection; for neurological events: CNS infection, metabolic disease or brain anatomical abnormalities. Above 6 months of age, the cause was infection for seizures, meningitis, arthritis/osteomyelitis, cellulitis/abscess and thrombocytopenia.

**Conclusions/Implications for immunization research and evaluation:** Admissions for potential AEFI remain infrequent. Of events temporally associated with immunization, 66% were found to have a cause other than the vaccine. With more thorough investigation during admission, more potential AEFI may be categorized as having a proven other cause.

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**The annual disease and economic burden of seasonal influenza in Canada**

Thomas Shin, Jason Lee, Ayman Chit

**Introduction/Background:** Seasonal influenza epidemics are responsible for substantial annual morbidity and mortality in Canada. While a US study has estimated the annual economic burden of seasonal influenza to be US$87.1 billion, there has been no Canadian equivalent at the national level. To address this gap, we developed an economic model of influenza in Canada to estimate costs attributable to annual seasonal influenza epidemics in Canada.

**Methods:** A probabilistic and static model was constructed with epidemiological and economic parameters derived from Canadian sources. From the model we estimated influenza-associated outpatient visits, emergency department visits, hospitalizations, and deaths. We also estimate the associated costs of these outcomes including lost productivity from work, absenteeism, or premature death. Simulations for Canada were
constructed using national epidemiological data from the 2000-01 to 2007-08 influenza seasons. We then estimated healthcare resource utilization associated with these health outcomes as well as their direct and indirect costs using Canadian healthcare and labour cost data. A probabilistic sensitivity analysis modelled the parameter uncertainty, providing lower and upper bound estimates for each key parameter.

**Results:** We estimate that an average seasonal influenza epidemic in Canada results in 2,186 deaths, 13,177 hospitalizations, 86,983 emergency department visits, and 406,412 outpatient visits. Direct medical costs averaged C$99 million annually, while projected lost earnings due to illness and loss of life amounted to C$726 million annually. Factoring projected statistical life values associated with influenza-related deaths, the total economic burden of seasonal influenza epidemics was C$8.5 billion a year.

**Conclusions/Implications for immunization research and evaluation:** The results of this study highlight the substantial annual burden of influenza in Canada. While medical and hospitalization costs are important contributors, the main driver of the economic burden is premature death.

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**Antibody responses against antigenically drifted strains of Fluad, a seasonal mf59 adjuvanted trivalent influenza vaccine in older adults**

James Mansi, Ethan Settembre, Giuseppe Palladino, Pirada Suphaphiphat, Annette Ferrari, Ivna DeSouza, Jack Ferdman

**Introduction/Background:** Current influenza vaccines cover a limited range of strains antigenically similar to those in the vaccine. Given the low estimated vaccine effectiveness observed in the 2014/15 NH season (~23%) in part attributed to seasonal drift variants, there is a continued call for vaccines that elicit greater breadth. The immunogenicity of FLUAD™, against heterologous strains was evaluated in older adults.

**Methods:** We examined antibody responses by hemagglutination inhibition (HAI) against antigenically drifted strains using sera from subjects immunized with either FLUAD or a non-adjuvanted TIV comparator in four clinical trials in older adults conducted between 1992 and 2011. To specifically examine the heterologous antibody response against the antigenically drifted H3N2 strain during the 2014-2015 season samples we used sera samples from two 2013/14 NH seasonal licensure Phase II trials.

**Results:** In the four clinical trials FLUAD seroconversion rates were significantly higher than TIV (lower 95% CI exceeding 0), in 9 of 10 heterologous strains tested. Similarly, geometric mean titers (GMT) amongst subjects vaccinated with FLUAD were significantly greater than TIV (lower 95% CI of the GMT ratio exceeding 1) in 7 of 10 strains tested. In the smaller study analyzing the 2014/15 seasonal mismatch, 32% of subjects vaccinated with FLUAD showed seroconversion as measured by a fourfold or greater increase in antibody titers over pre-vaccination titers against the A/Texas cell version, which would have represented a strain circulating at that time. Only 13 percent of those vaccinated with TIV showed seroconversion. The A/Hong Kong strain represents an antigenically drifted H3N2 strain that predominated in the 2014-2015 season and is significantly antigenically different from A/Texas. 40% of FLUAD vaccinees seroconverted against the A/Hong Kong strain, whereas only 13% of TIV vaccinees seroconverted.

**Conclusions/Implications for immunization research and evaluation:** In clinical trials, FLUAD demonstrated increased breadth of antibody responses in comparison to non-adjuvanted comparators. A closer look at these data suggests that adjuvanted vaccine generated a higher percentage of significant titer increase against both matched and mismatched strains.
Assessing the relationship between age, medical risk factors and influenza complications: The challenges of answering policy questions with routinely collected public health data

Christina Renda, Karin Hohenadel, Bryna Warshawsky

Introduction/Problem identification: When making decisions about immunization programs, policymakers often look to public health officials for timely scientific and technical advice. However, routinely collected data and other tools available to public health practitioners can make answering these questions complex. Using the scientific review of Ontario’s Universal Influenza Immunization Program (UIIP) as a case study, the challenges of answering policy questions with routinely collected public health information are assessed.

Purpose: To describe the experience of determining the relationship between age and medical risk factors with respect to influenza complications (i.e., hospitalizations and deaths) using routinely collected reportable disease data from Ontario’s Integrated Public Health Information System (iPHIS) and published literature.

Methods/Evidence: Rates of hospitalizations and deaths among cases of laboratory-confirmed influenza in adults reported in iPHIS were compared for those with and without reported medical risk factors, stratified by age group. In addition, a literature search was conducted to examine risks of influenza-related hospitalizations or deaths in adult populations with and without medical risk factors. Data extraction and quality appraisal was performed on the 18 articles included in the final review.

Significance of Findings/Outcomes for immunization research and evaluation: Results suggest that adult influenza cases reported in iPHIS were more likely to experience complications if they had one or more medical risk factors. However, this relationship was driven by individuals under 70 years of age, implying the impact of medical risk factors on risk of complications was lower in older adulthood and age itself increased the risk of complications in older individuals. These results were supported by the literature review, which found the presence of medical risk factors to have a greater impact on hospitalizations and deaths in younger adults compared to older adults. Significant limitations were encountered when using reportable disease data and the published literature to answer this question. Limitations with reportable disease data included potential bias in influenza testing and reporting practices; published literature was limited by heterogeneity in defining medical risk groups as well as determination of rates of influenza-attributable complications. Because of the challenges faced when answering policy questions with routinely collected public health data, the findings should be interpreted with caution.

B-cell responses to 13-valent pneumococcal conjugate vaccine in patients with severe chronic kidney disease

Gabrielle N. Gaultier, Angele Desbiens, Eli B. Nix, William McCready, Marina Ulanova

Introduction/Background: In Canada, 23-valent pneumococcal polysaccharide vaccine (PPV23) is currently recommended for chronic kidney disease (CKD) patients. It has been suggested that previous immunization with PPV23 may affect responses to subsequent immunization with 13-valent pneumococcal conjugate vaccine (PCV13), as a result of depletion of the peripheral memory B-cell pool. Our study objective is to compare numbers of circulating B memory cells and antibody secreting cells (ASC) in severe (stage 4-5) CKD patients previously immunized with PPV23 and patients without previous pneumococcal vaccination.

Methods: Forty 33-89 year old severe CKD patients received one dose of PCV13; 27 participants were pneumococcal vaccine naïve, and 13 previously immunized with PPV23. Blood was collected pre- and 7 days post-immunization. Flow cytometry analysis determined proportions of total B cells (CD19+) and their subsets: naïve (IgM+CD27-), IgM memory (IgM+CD27+), class switched (IgM-CD27-), and class switched memory (IgM-CD27+) B cells, and populations of CD5+ and CD5- B cells. Absolute cell numbers were determined using lymphocyte count. ELISPOT was used to determine the number of APC specific for pneumococcal serotype 6B and 14 capsular polysaccharides, as well as total IgG secreting cells.

Results: On day 7 post-immunization with PCV13, peripheral blood B lymphocytes of severe CKD patients were composed of 50.35% naïve B cells, 9.61% class switched memory B cells, 13.21% class switched B cells,
26.83% ± 2.78 class switched memory B cells, 0.79% ± 0.12 CD5+, and 4.0% ± 0.65 CD5-cells. We found no statistically significant difference in any B cell subpopulations between PPV23-naïve patients and those who received PPV23 more than 1 year ago.

**Conclusions/Implications for immunization research and evaluation:** Based on our preliminary analysis, it does not appear that previous immunization with PPV23 has a negative effect on any specific B cell subpopulation in patients immunized with PCV13. Further analysis will be completed when sample size reaches 60 participants, i.e. 30 patients previously immunized with PPV23, and 30 pneumococcal vaccine naïve patients. Results for the study will aid in optimization of pneumococcal immunization schedules for patients with severe CKD.

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**BCG-induced granulopoiesis protects newborns from septic death**

Byron Brook, Rym Ben Othman, Bing Cai, Sheka Aloyouni, Daniel He, Tobias Kollmann, Nelly Amenyogbe

**Introduction/Background:** Human newborns vaccinated with BCG have a staggering 50% reduction in mortality compared to non-vaccinated neonates, and the mechanism involved is not yet known. We have developed a mouse model that recapitulates the same level of protection observed in human trials. Considering that in human newborns neutropenia closely correlates with risk of death from bacterial sepsis, we hypothesize that BCG-mediated granulopoiesis will affect the number, and/or function of neutrophils, and this population is responsible for the protective non-specific effect (NSE).

**Methods:** BCG was administered to mice at day of life 4-5, and sepsis was induced 3 days later by intraperitoneal injection of cecal slurry. Mice were observed for either mortality over the next four days, or bacterial burden 24 hours post-challenge.

**Results:** BCG-vaccinated neonatal mice had a ~50% reduction in mortality, and reduced bacterial burden. To explore the protective mechanism involved samples of spleen, blood, and bone marrow were analyzed by flow cytometry. A CD11b+ granulocytic population expanded in the spleen 3 days post vaccination (same day as time of challenge). Upon challenge BCG-vaccinated neonates had greater numbers of mature granulocytes released from the bone marrow into circulation. Preliminary adoptive transfer experiments of purified CD11b+ cells displayed a transfer of protection from the BCG-vaccinated mice to naïve recipients.

**Conclusions/Implications for immunization research and evaluation:** To answer the WHO’s call for an urgent identification of NSE protective mechanisms, we developed a mouse model that recapitulates the powerful protective effect of BCG. We have seen protection with BCG, a corresponding increase in G-CSF production, an expansion of CD11b+ neutrophils, and that purified CD11b+ cells can confer protection in a naïve mouse against sepsis. This data all supports the hypothesis that a BCG-mediated expansion of CD11b+ cells is at least one protective mechanism against sepsis.

Currently BCG is not commonly given in Canada because the risk of Tuberculosis infection is low. Our data, alongside human trials performed in Africa, point towards a greater benefit in BCG-vaccination than just protecting against Tuberculosis. In particular low birth weight newborns in Canada are susceptible to sepsis, and it has been shown that BCG vaccination can reduce the risk of death in this vulnerable population.

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**Bordetella pertussis strains in Canada not expressing acellular pertussis vaccine antigens**

Raymond Tsang, Michelle Shuel, Linda Hoang, Steven Drews, Greg Horsman, John Wylie, Frances Jamieson, Brigitte Lefebvre, Robert Needel

**Introduction/Background:** Global incidence rates of pertussis have increased in the past decade, making pertussis one of the most prevalent vaccine preventable bacterial diseases. Acellular B. pertussis vaccines contain between one and five components and can include pertactin (Prn), pertussis toxin (PT), filamentous haemagglutinin (Fha) and fimbriae (Fim) 2 and 3. The recent and rapid emergence of vaccine antigen deficient
isolates, most notably Prn, has been observed in several countries, including Canada, the US, Australia and several European countries.

**Methods:** The presence/absence of Prn was detected by Western blot analysis. Complete prn gene sequencing, including the promoter region, was performed to identify any mutations or insertion sequences. Presence of PT, Fha and Fim 2 and 3 were detected by indirect whole cell ELISA. Partial gene sequencing of virulence antigen genes ptxS1, prn, fim3, fhaB and ptxP was carried out to determine sequence type (ST).

**Results:** 382 isolates from seven Canadian provinces, collected between 1994 and 2015, were examined. Prn was present in 319 isolates, while 63 isolates were Prn-deficient. All of the isolates tested produced PT and Fha. The majority of isolates belonged to Fim 3 (97.9%), however Fim 2, Fim 2,3 and non-typeable isolates were also observed in small numbers. ST-1 (ptxS1A, prn2, fim3B, fhaB1, ptxP3) and ST-2 (ptxS1A, prn2, fim3A, fhaB1, ptxP3) were most common and found in 55.8% and 36.9% of the isolates, respectively. Prior to 2008, ST-1 was found in 73.5% of isolates studied, while only 14.4% belonged to ST-2. Since then, a significant shift toward ST-2 has been observed with ST-1 decreasing to 46.4% and ST-2 increasing to 48.8%.

**Conclusions/Implications for immunization research and evaluation:** In late 2000s, a genetic shift in the pertussis isolates from ST-1 to ST-2 was observed. Also the first Prn-deficient isolates were identified in Canada in 2011 in the provinces of Ontario and Manitoba. In 2011, the rate of Prn-deficient isolates was 8.3%, which increased steadily each year up to 72.7% in 2015. Prn-deficient isolates were seen in 6 provinces. This study highlights the importance of laboratory characterization of strains in our surveillance system for pertussis, and may also suggest a potential need for newer pertussis vaccines.

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**British Columbia’s Influenza Prevention Policy: Healthcare workers’ knowledge, attitudes and practices study, 2015/16 influenza season**

*Chelsea Treloar, Alexandra Nunn, David Puddicombe, Robert Balshaw, Bonnie Henry, Michael Otterstatter, Monika Naus*

**Introduction/Background:** In 2012/13, British Columbia (BC) implemented the BC Influenza Prevention Policy (the policy) which requires healthcare workers to be vaccinated against influenza or wear a mask in patient care areas during the influenza season. This study was the first survey of healthcare workers’ covered by the policy and was designed to identify factors related to vaccination or mask wearing decisions during the 2015/16 influenza season.

**Methods:** A cross-sectional knowledge, attitude and practice survey was distributed electronically in April/May 2016 to healthcare workers employed by BC health authorities. The survey contained questions on demographics, employment information, influenza vaccination status, compliance with the policy, and knowledge and attitudes about influenza immunization, influenza infection and the policy. The outcomes of interest will be influenza vaccination status and masking behavior of unvaccinated healthcare workers. Multivariable regression models will be developed to describe predictors of the outcomes of interest. The distribution of demographic variables and influenza vaccine uptake of the study sample will be compared with the overall healthcare worker population to assess the generalizability of the results to all healthcare workers in BC.

**Results:** There were 18,579 eligible survey responses included for analysis; the estimated response rate ranged from 10% to 18%, based on the number of email addresses to which the survey was sent and the active employee count from workplace health information system, respectively. The majority (85%) of HCWs reported receiving the influenza vaccine in the 2015/16 influenza season. Sixty-three percent (9,418 of 15,064) of immunized respondents agreed or somewhat agreed with the statement, “I support the [BC Influenza Prevention] Policy”. Support for the policy was lower among unimmunized respondents, 19% (473 of 2,496) of unimmunized respondents agreed or somewhat agreed with the same statement. Detailed results will be available by December 2016.
Conclusions/Implications for immunization research and evaluation: Conclusions will be presented in December. Findings from this study will inform policy makers and stakeholders on BC healthcare workers’ experiences with the policy during the 2015/16 influenza season.

Burden of influenza B in Canada: analysis of FluWatch national surveillance data 2004-2016
Heather VanSeggelen, Stephen Noorduyn

Introduction/Background: Seasonal influenza is a common respiratory illness causing significant burden of disease worldwide. Circulating viruses are identified as influenza A strains or B lineages, with a dominant strain of influenza A circulating in most seasons. This study summarizes the annual burden of influenza B in Canada as reported by national surveillance systems.

Methods: National influenza surveillance data were extracted from the annual summary or week 34 FluWatch reports for years 2004 to 2016, including incidence data from the Respiratory Virus Detection Surveillance System (RVDSS) and National Microbiology Laboratory strain characterization. Average seasonal strain incidence was calculated as a cumulative average percentage, excluding the 2009-10 pandemic season. Where available, the relative burden of influenza B disease was calculated by age group and province.

Results: Total influenza cases ranged from 7,422 in 2005-06 to 43,865 in 2014-15 as reported by the RVDSS. Influenza B accounted for 26% of overall laboratory confirmed cases. Adults over 20 years of age represented 59% of influenza B cases and 75% of influenza A cases reported in the 2010-11 through 2015-16 seasons. Influenza B hospitalizations by age were reported for two seasons: adults aged 20-64 years of age accounted for 25% and 26% and seniors (65+) accounted for 57% and 53% of influenza B related hospitalizations in 2013-14 and 2014-15, respectively. A mismatch of the trivalent vaccine to the circulating B lineage or co-circulation of both lineages occurred in 50% of seasons.

Conclusions/Implications for immunization research and evaluation: Influenza B remains a significant source of illness across all age cohorts in Canada. As such, it is prudent to examine the relative impact of influenza B across different vulnerable populations. Incidence of influenza B and frequency of mismatch between circulating lineages and trivalent vaccine-included strains may be important considerations when informing influenza vaccine use across age cohorts. Newer immunization technologies may provide additional protection in such a mismatch scenario.

Canadian healthcare providers’ perceptions of vaccine product monograph safety language and impact on use of vaccines in pregnancy
Catherine Arkell, Noni MacDonald, Heather Scott, Shelly McNeil, Jaelene Mannerfeldt, Karina Top

Background: Influenza immunization in pregnancy is recommended by WHO, NACI, and SOGC; however, vaccine uptake in Canada remains low. One barrier may be healthcare providers’ perceptions that product monograph information contradicts current immunization recommendations for pregnant women. Our objective was to determine the effect of vaccine product monograph language on Canadian and international healthcare providers’ perceptions of vaccine safety and their recommendation for use in pregnancy.

Methods: In October 2015, healthcare providers were recruited at two international maternal health conferences, and from teaching programs in Ethiopia, Ghana, Uganda, and Laos. Participants completed a ten-item online survey, with quantitative and qualitative components, capturing perceptions of vaccine safety after reading de-identified vaccine product monograph excerpts. Analysis was descriptive.

Results: 161 participants, including 26 Canadians, were recruited from 49 countries. The Canadian respondents included obstetricians (65%), midwives (12%), family physicians (19%), and a nurse (4%). 73% prescribed/administered influenza immunizations and 58% read product monographs “often” or “occasionally”. When provided with examples of influenza vaccine product monographs (e.g., “safety and effectiveness... [in pregnancy] is not
established”, use “only if clearly needed”), 23% of Canadian respondents perceived the vaccine as moderately or very unsafe, 15% would not recommend the vaccine despite national guidelines, and 65% reported that this language would affect how they counseled patients. Themes derived from content analysis of free text responses included vaccine product monographs lacking essential information, need for more research on vaccine safety and efficacy in pregnancy, concern about risks of vaccination, concerns with trust regarding monograph content, and need for more clearly worded monographs. Findings were similar between Canadian and international healthcare providers.

**Conclusions:** Vaccine product monographs are perceived by healthcare providers as ambiguous, lacking essential information on safety and use in pregnancy, and as opposing current immunization recommendations. Negative wording used in product monographs may influence whether maternal healthcare providers recommend vaccination to pregnant women. Product monograph language that clearly supports the evidence-based use of vaccines in pregnancy may help to improve maternal vaccination rates. Efforts from Health Canada and NACI are needed to address this issue.

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**Changing the landscape of immunization coverage assessment in Ontario: Methods and knowledge exchange**

*Sarah E Wilson, Chi Yon Seo, Andrean Bunko, Jill Fediurek, Stacie Carey, Lindsey Linters, Shelley Deeks*

**Introduction/Problem identification:** Prior to 2013, immunization coverage in Ontario was assessed using a ‘complete-for-age’ definition across 36 de-centralized databases, which posed several challenges. The transition to Panorama in 2013 has resulted in a transformation of business processes for immunization programs, including coverage assessment. Using Panorama, assessment at the provincial-level can now occur using individual-level data with the application of decision rules to support up-to-date (UTD) coverage. To prepare for a forthcoming coverage report which will present UTD coverage estimates for the first time in Ontario, a knowledge exchange (KE) plan was developed in parallel to the methodologic and analytic aspects of the project.

**Purpose:** Our aim was to develop decision rules to support UTD coverage assessment for all routine childhood and adolescent programs using individual-level immunization data from Panorama. Our second aim was to develop a comprehensive KE strategy to raise awareness and increase knowledge about the new methodology and its possible implications for coverage estimates, among key stakeholders.

**Methods/Evidence:** We reviewed a range of advisory committee documents, best practices and product monographs to inform the decision rules to calculate UTD coverage by antigen, for relevant age cohorts. The methodology consisted of three steps: (1) Derivation of the analytic cohort; (2) Conditions for dose validation through the application of minimum ages, minimum intervals and vaccine interactions; and (3) Determination of number of valid doses required to be UTD. We included conditions to ensure late starters and unvaccinated children with documented immunity were considered UTD, where appropriate. To raise awareness and increase knowledge about the new methodology and its implications, a comprehensive KE strategy was developed. Key stakeholders were identified, and a variety of engagement activities were planned including: report dissemination, complementary products tailored to key audiences, and educational meetings with various options for attendance (i.e. webinar).

**Significance of Findings/Outcomes for immunization research and evaluation:** The transition to Panorama and the ability to analyse individual-level immunization data at the provincial-level represent exciting developments that will greatly enhance immunization program evaluation in Ontario. The dissemination of the first UTD coverage report using Panorama data represents an important opportunity for KE and professional education within the public health community in Ontario.
Characteristics of *Haemophilus influenzae* serotype a in Canada: an emerging pathogen in the post-Hib vaccine era

Raymond Tsang, Michelle Shuel, Linda Hoang, Gregory Tyrrell, Greg Horsman, John Wylie, Frances Jamieson, Brigitte Lefebvre, David Haldane, Rita Gad, Gregory German, Jean-Francois Proulx, Kim Barker

**Introduction/Background:** In the post-*Haemophilus influenzae* serotype b (Hib) vaccine era, serotype a (Hia) has been identified as an emerging pathogen causing significant morbidity and mortality in the indigenous population. Hia causes disease similar to Hib which can manifest as meningitis, septicemia, septic arthritis, pneumonia, epiglottitis, and cellulitis, particularly in children <5 years old.

**Methods:** Isolates were serotyped by slide agglutination and PCR detection of serotype specific and capsule transport *bexA* genes. Multilocus sequence typing was carried out to determine sequence type (ST). Beta-lactamase production was detected using Dryslide Nitrocefin and antibiotic susceptibility against 14 antibiotics was done using the disk diffusion method.

**Results:** Between 1995 and 2016, 364 Hia case isolates were received at the National Microbiology Laboratory from nine Canadian provinces, and Nunavut. The source of the isolates was provided for 358 cases: 349 (97.5%) were from normally sterile body sites, and nine (2.5%) were from non-sterile sites. Age was available for 356 cases: 256 (71.9%) were from children <5 years and only 81 (22.8%) were from adults >18 years. All isolates were positive for serotype a and *bexA* genes, however, 3 were identified as non-typeable by slide agglutination. 313 isolates were determined to be Biotype II, ST-23, and an additional 43 biotype II isolates had STs closely related to ST-23 and were part of the ST-23 clonal complex. There were eight biotype I isolates, including one ST-23 and seven with STs not part of the ST-23 clonal complex (ST-4 and ST-62). Antibiotic resistance was not identified in the majority of isolates, however, five isolates were resistant to ampicillin by β-lactamase production including one with multidrug resistance.

**Conclusions/Implications for immunization research and evaluation:** The majority of Hia case isolates in this study caused invasive disease, were recovered from children <5 years old and exhibited clonal characteristics. Given the severity of the disease as well as the threat of recurrent infections and outbreaks, global surveillance is important for a better understanding of Hia as an emerging pathogen and the burden of disease it causes to assist in the development of a potential vaccine for the protection of vulnerable populations.

Clinical and economic impact of switching from the 13-valent to 10-valent pneumococcal conjugate vaccine in Canada

Michele Wilson, Matt Wasserman, Marie-Claude Breton, Cheryl McDade, Stephanie Earnshaw, Raymond Farkouh

**Introduction/Problem identification:** The 13-valent pneumococcal conjugate vaccine (PCV13) is part of the routine infant immunization schedule in all provinces of Canada. Use of PCV13 has reduced incidence of important serotypes, and the impact of other PCVs on relevant serotypes is uncertain.

**Purpose:** The purpose of this study is to evaluate the health and economic implications of potential disease re-emergence following a switch to a lower-valent vaccine.

**Methods/Evidence:** A decision-analytic model was developed to estimate public health and economic impacts of a change in infant vaccination schedule over a 20 year time horizon. Historical pneumococcal disease surveillance data were used to estimate disease trends and to forecast serotype re-emergence and/or reduction. Serotype-specific incidence was modeled based on serotype coverage for infants (direct vaccination effects) and for older age groups (indirect effects of infant vaccination). The model compared maintaining PCV13 use versus switching to PCV10. For each vaccination program, health outcomes (cases of invasive pneumococcal disease, pneumonia, and acute otitis media) and associated health-care costs were estimated. Costs (2016 Canadian dollars), utility weights, and risk of disease-specific sequelae were derived from available published sources. Incremental cost-effectiveness ratios were calculated based on the costs and outcomes of each
program. Costs and outcomes were discounted 3% per year. Univariate and probabilistic sensitivity analysis was undertaken to evaluate the impact of parameter uncertainty.

**Significance of Findings/Outcomes for immunization research and evaluation:** Continuing use of PCV13 resulted in fewer cases of pneumococcal disease in all age groups compared with switching to PCV10 due to the re-emergence of disease. While vaccine costs were higher for PCV13, medical costs due to disease were lower due to fewer cases of disease in the PCV13 population. The increase in disease and associated costs predicted continued use of PCV13 to remain cost-effective compared to starting a PCV10 program. Results were robust under multiple sensitivity analyses. The results demonstrate continued use of PCV13 in Canada would provide a greater public health benefit compared to switching to PCV10. It is important that policy makers consider the potential implications of disease re-emergence when considering modifications to vaccination strategies.

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**Community health aides: Augmenting the scope of nursing practice in Northern Inuit communities**

*Tina Buckle, Sylvia Doody*

**Introduction/Problem identification:** Historically there have been challenges meeting the provincial public health mandate in the Labrador Inuit communities of Nunatsiavut. These challenges include the turnover of nurses, cultural understanding and knowledge, community trust, language barriers, and the difficulties associated with living in northern remote isolated communities. All of these challenges are multilayered and thus result in difficulties in providing a high standard of care across the continuum.

**Purpose:** In response to these unique challenges a new service delivery model was explored to respond to our needs. The model that was chosen, which was adapted from the Alaska Community Health Aide Practitioner program, looked at the realities of nursing recruitment and retention in northern remote isolated communities. We also took into consideration the resources that currently existed in the communities and built on those strengths to enhance capacity. The CHA positions were introduced into our community health nursing programs to support and bridge some of the gaps and barriers in service delivery across community programs.

**Methods/Evidence:** Our community health aides are residents of the community, Inuit, and have a strong knowledge and understanding of Inuktitut. In addition, the CHA’s possess an innate cultural understanding which is specific to their home community. These qualities are the foundation for giving the programs longevity and continuity to respond to the transiency in nursing staff. The CHA’s engage families and support the nurses in program service delivery such as in the immunization program, provide health care services and facilitate linkages within the community.

**Significance of Findings/Outcomes for immunization research and evaluation:** The CHA program was implemented in the Nunatsiavut region in January of 2008. Since this time, feedback has been positive from various partner organizations, community health nurses and residents of the community. In addition, immunization coverage rates in all of the communities are greater than 95% and have been consecutively at that rate and higher for many years. Furthermore, the CHA’s have become such an integral part of our programs that even during periods when there is no nurse the community health programs continue.

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**Comparative analysis of pertussis epidemic cycles in immunizing and under-immunizing public health units in Ontario, 1991-2015**

*Amanda Shane, Kevin Brown, Sarah Wilson, Chi Yon Seo, Natasha Crowcroft*

**Introduction/Background:** An in-depth understanding of Ontario’s pertussis epidemiology is critical as there is evidence from other countries that pertussis resurgence is possible despite presence of vaccine programs. The presence of geographically-defined communities in Ontario not accepting of immunization provides an opportunity to conduct a comparative epidemiologic analysis. Our aim was to describe and compare the
epidemiology of pertussis in immunized and under-immunized public health units (PHUs) to improve our understanding pertussis disease dynamics in Ontario.

Methods: Confirmed cases of pertussis between January 1, 1991 and December 31, 2015 were extracted from Ontario’s provincial reportable disease surveillance system. Population denominators were obtained from Statistics Canada to calculate incidence rates/100,000 population. Under-immunizing PHUs were classified as those with a higher proportion of 7-year olds with religious/conscientious belief exemptions, compared to the provincial mean from 2004 to 2012. Peaks were identified visually and mean inter-epidemic period was calculated as the mean number of years between adjacent peaks. The distribution of pertussis cases by year, age, sex and inter-epidemic period was compared between immunizing and under-immunizing PHUs. Analysis was conducted in STATA 13.

Results: 20,039 confirmed cases of pertussis were reported in Ontario from 1991 to 2015 (incidence: 6.6/100,000 population). Median age at illness was 6.7 years (IQR: 2.5 to 12.1 years). There were more female than male cases (53.5 vs. 46.4%). Incidence was highest among those <1 year and decreased with age. Fifteen (42%) PHUs were classified as under-immunizing. Under-immunizing PHUs had a significantly higher incidence than immunizing PHUs (IRR 1.46 [1.42-1.51], smaller proportion of cases <1 year (12.3 vs. 17.2%), but more cases 5 to 9 years (29.2 vs. 24.4%), compared with immunizing PHUs. There was no difference in median age or sex distribution between immunizing and under-immunizing PHUs. Mean periodicity was 1.5 years longer among immunizing PHUs compared to under-immunizing PHUs.

Conclusions/Implications for immunization research and evaluation: This comparative analysis of two distinct time series suggests variation in trends between under- and immunizing PHUs in Ontario. Findings are consistent with moderate herd effects and justify further quantifications of the changes in periodicity over time in order to assess indirect effects of immunization improve our understanding pertussis disease dynamics in Ontario.

Comparing the cost-effectiveness of universal hepatitis B immunization programs: A literature review

Lauren Ramsay, Man Wah Yeung, Liane MacDonald, Shelley Deeks, Beate Sander

Introduction/Background: In Canada, guidelines recommend either an infant or adolescent hepatitis B (HB) immunization program with no stated preference. Hence program delivery schedules vary across provinces and territories. While revisiting guidelines, cost-effectiveness is an important consideration when deciding which intervention should be implemented. This work seeks to address the question: Is a publicly-funded universal pre-exposure infant HB immunization program cost-effective compared to an adolescent program in jurisdictions with low HB endemicity?

Methods: A literature search was conducted in relevant databases and grey literature for studies published between January 1, 1995 and November 10, 2015. Articles were screened by two reviewers independently for the following inclusion criteria: be a full economic evaluation; compare cost-effectiveness of universal infant and adolescent HB immunization strategies; and, be comparable to the Ontario population in terms of HB epidemiology and overall health status. Full texts were screened and included studies were critically appraised using the Critical Appraisal Skills Program Economic Evaluation Checklist. Data on patient characteristics and vaccination programs were abstracted.

Results: Of 736 articles screened, four studies were included. Studies were from the United Kingdom (n=2), Switzerland (n=1), and the United States (n=1). Studies used the healthcare payer (n=3) and societal (n=1) perspectives. All of the articles had limitations in their applicability to Ontario. When comparing universal infant and adolescent programs to a selective program, discounting was an important factor in the cost-effectiveness results: undiscounted results favoured universal infant HB programs in all three studies that reported them. When discounting was applied, two studies favoured infant programs and two studies favoured adolescent program. Discounted results found that adding infant vaccination to a selective program cost $569,085/quality-adjusted life year (QALY) gained, $141,810/life year gained (LYG), $219,533/LYG, and $37,755/LYG (2016
Conclusions/Implications for immunization research and evaluation: The present literature review found high heterogeneity in economic evaluations of universal HB immunization programs. Given the importance of cost-effectiveness data when deciding between immunization programs, further work using Ontario-specific data may be warranted.

Comparing the estimated potential health impact of two herpes zoster vaccines in Ontario, Canada

Kelly Johnson, Yiling Jiang, Alexandra Goyette, Fern DeAngelis, Jonathan Graham, Eddy Bresnitz, Thomas Weiss

Background: Health Canada approved the one-dose herpes zoster (HZ) vaccine in 2008 for adults aged ≥60 years and ages ≥50 in 2011. Our objective was to estimate the health impact of the one-dose vaccine compared to an investigational two-dose vaccine in development.

Methods: A health impact model was developed to compare the estimated number of HZ cases prevented with the one-dose vaccine compared to the investigational, two-dose vaccine in Ontario for adults aged ≥60 years. Vaccine efficacy (VE) assumptions were taken from a study in Kaiser Permanente Northern California (P024) for the one-dose HZ vaccine. VE assumptions for the investigational vaccine were taken from publications. Data on the investigational vaccine’s first dose efficacy are unavailable; we assumed a VE range of 25%-65% and a constant efficacy duration of one year. Based on adherence rates reported for Hepatitis vaccines in adults, series completion assumptions with the two-dose vaccine varied from 45%-75%. Two different VE waning scenarios were assumed for the one-dose vaccine and the two-dose investigational vaccine: a) 15 years for both vaccines, b) 15 years for the one-dose vaccine/20 years for the two-dose investigational vaccine until the efficacy of both vaccines fully wane to zero.

Results: Out of a 1,000 vaccinated individuals, the one-dose HZ vaccine prevented three more cases of HZ (22 vs. 19) than the two-dose vaccine when both vaccines were assumed to have equal time to loss of efficacy, a two-dose adherence rate of 45% and a first-dose efficacy of 65% for the investigational vaccine. Keeping these assumptions constant except changing duration of efficacy for the investigational vaccine to 20 years resulted in the two-dose vaccine preventing two more cases of HZ than the one-dose vaccine (24 vs. 22).

Conclusion: When series completion rates are <60% for the two-dose investigational HZ vaccine, the approved one-dose HZ vaccine could prevent more HZ cases. Higher adherence rates and increased duration of efficacy for the two-dose vaccine result in more HZ cases prevented. Because adherence rates and one-dose efficacy are unknown for the investigational two-dose HZ vaccine, further analyses are needed to determine its overall health impact compared to the existing one-dose HZ vaccine.

Comparison of two pneumococcal urine antigen detection tests for detection of community acquired pneumonia (CAP) in hospitalized adults

May ElSherif, Alisha Kapur, Lingyun Ye, Donna Mackinnon-Cameron, Li Li, Ardith Ambrose, Irene Martin, Todd Hatchette, Jason LeBlanc, Shelly McNeil

Introduction/Background: Diagnosis of pneumococcal community acquired pneumonia (CAP$_{Spn}$) is provisional to clinical findings and laboratory detection of $S.\ pneumoniae$. During infection, pneumococcal antigens can be excreted in urine, which in turn can be used for detection. This study compared two pneumococcal urinary antigen detection (UAD) assays for detection of CAP$_{Spn}$ in hospitalized adults.

Methods: The Serious Outcomes Surveillance (SOS) Network of the Canadian Immunization Research Network (CIRN) has been performing active surveillance for CAP in hospitalized adults since December 2010. CAP was identified by chest radiography, clinical symptoms, and laboratory testing. Sputum and blood cultures were performed as standard practice, and $S.\ pneumoniae$ isolates were serotyped using the Quellung reaction or PCR-
based serotyping. Urine was tested using a multiplexed PCV13-serotype specific urinary antigen detection assay (UAD$_{PCV13}$) or a commercial pan-pneumococcal UAD (UAD$_{Spn}$). Results were analyzed in the context of the 13-valent pneumococcal conjugate vaccine (PCV13), 23-valent pneumococcal polysaccharide vaccine (PPV23) serotypes, or non-vaccine types (NVT). Overall sensitivity and specificity was calculated against a modified gold standard where *S. pneumoniae* isolates or concordant UAD results were considered positive.

**Results:** Of 621 CAP patients with paired urine, sputum, and blood cultures, 98 were positive results for *S. pneumoniae*. Of 67 PCV13 serotypes, 42 (62.7%) were detected by UAD$_{Spn}$ and 60/67 (89.6%) by UAD$_{PCV13}$. UAD$_{Spn}$ was also able to detect 7/17 (41.2%) of PPV23 serotypes not covered by PCV13, as well as 2/6 (33.3%) NVTs. These additional serotypes could not be detected with UAD$_{PCV13}$. Both UADs had positives results that were not confirmed by other methods: 21 for UAD$_{Spn}$ and 25 for UAD$_{PCV13}$. Overall, the sensitivity and specificity of *S. pneumoniae* detection was 59/98 (60.2%) and 502/523 (96.0%) for UAD$_{Spn}$, and 61/98 (62.2%) and 498/523 (95.2%) for UAD$_{PCV13}$, respectively.

**Conclusions/Implications for immunization research and evaluation:** While UAD$_{Spn}$ and UAD$_{PCV13}$ demonstrated similar performance characteristics overall, each had its own merits and limitations. UAD$_{PCV13}$ was more sensitive for the detection of PCV13 serotypes, and UAD$_{Spn}$ could also detect NVTs and PPV23 serotypes not covered by PCV13. Development of a UAD assay coupling high sensitivity and specificity to the detection of all *S. pneumoniae* serotypes would greatly enhance surveillance of vaccine preventable pneumococcal disease.

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**Cost-effectiveness comparison of monovalent C versus quadrivalent ACWY meningococcal conjugate vaccination in Canada**

*Philippe De Wals, Zhou Zhou*

**Introduction/Background:** In Quebec, one dose of monovalent C meningococcal conjugate vaccine (Men-C-Con) is offered at 12 months and a booster dose in grade 9. In other Canadian provinces, a quadrivalent ACWY vaccine (Men-4-Con) is increasingly being used for adolescents. An economic analysis was performed to assess the value of a switch from Men-C-Con to Men-4-Con.

**Methods:** A compartmental static simulation model was developed to assess the burden of AWY invasive meningococcal disease (IMD) in a cohort of 100,000 persons under different vaccination scenarios. Univariate and multivariate sensitivity analyses were performed, including variation in vaccine price difference ($12; range $0 to $20), AWY-IMD rate (0.08/100,000 to 0.28/100,000 person-years), level of herd immunity generated by adolescent vaccination (from zero to disease elimination) and discounting rate (0%, 3% or 6%).

**Results:** In the low AWY-IMD rate base scenario, replacing Men-C-Con with Men-4-Con for adolescents would reduce disease burden by 16% (no herd effect) to 58% (moderate herd effect), with an incremental cost-effectiveness ratios (ICER) between $445,000/QALY and $167,000/QALY in a societal perspective. In the high AWY-IMD rate scenario, ICER would be in the $97,000/QALY to $19,000/QALY range.

**Conclusions/Implications for immunization research and evaluation:** Based on the epidemiological situation in Quebec and in most other Canadian provinces, the benefits of Men-4-Con in reducing the burden of disease would be low for a high cost. The switch would, however, be more economically attractive with much higher incidence rates (as observed in British Columbia) or with a reduced vaccine price.

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**Cost-effectiveness of alternative strategies for use of 13-valent pneumococcal conjugate vaccine (PCV13) in Canadian adults aged ≥65 years**

*Marie-Claude Breton, Mark Atwood, Linda Beausoleil, Craig Laferrière, Reiko Sato, Derek Weycker*

**Introduction/Problem identification:** The National Advisory Committee on Immunization (NACI) recommends broad use of the 13-valent pneumococcal conjugate vaccine (PCV13) in infants, and use of the 23-valent
pneumococcal polysaccharide vaccine (PPV23) and PCV13 sequentially (PCV13->PPV23) in adults aged ≥65 years and adults who are immunocompromised.

**Purpose:** In light of recent PCV13 efficacy results from the Community-Acquired Pneumonia Immunization Trial in Adults (CAPiTA), and new sero-epidemiology data on vaccine-type community-acquired pneumonia (CAP) in Canada, we examined the economic implications of funding an expanded PCV13 immunization program.

**Methods/Evidence:** A microsimulation model depicting expected lifetime risks, consequences, and costs of invasive pneumococcal disease (IPD) and CAP in Canadian adults was developed. PPV23 effectiveness was based on published literature; PCV13 effectiveness was based on CAPiTA. CAP rates were estimated from the Canadian Institute of Health Information Hospital Discharge Abstract Database. The proportion of CAP caused by PCV13 serotypes was estimated from the Serious Outcomes Surveillance Network using urinary antigen detection assay. Herd effects from the PCV13 pediatric program were included based on the PCV7 experience in Canada. Outcomes and costs were evaluated assuming use of PPV23 alone, and alternatively, use of PCV13->PPV23 among: (1) all adults aged ≥65 years (n=5.4M); and (2) immunocompromised and high-risk adults aged ≥65 years (n=3.0M).

**Significance of Findings/Outcomes for immunization research and evaluation:** For population #1, PCV13->PPSV23 reduced IPD cases by 1,100, CAP cases by 7,000, and disease costs by $135.8M; vaccination costs increased by $254.3M, and cost per QALY gained was $35,484. For population #2, PCV13->PPSV23 reduced IPD cases by 900, CAP cases by 6,000, and disease costs by $120.3M; vaccination costs increased by $149.8M, and cost per QALY gained was $10,728.

Expanding use of the sequential vaccination regimen (i.e., PCV13->PPV23) among Canadian adults aged ≥65 would be a cost-effective use of scarce healthcare resources.

“Crater Like Defect” following adjuvanted influenza vaccine

**Barbara Gordon, Judy MacDonald, Cora Constantinescu, Mohammed H. Mosli, Adenikay Smith**

**Introduction/Problem identification:** A 75 year old woman with multiple complex comorbidities received adjuvanted influenza vaccine for seniors in her left deltoid on November 4, 2015. The next day, her daughter noted a significant indentation in the skin at the injection site. It was non-painful at the time, so she did not seek medical attention until several months later. This case was then reported to the Calgary Communicable Disease (CD) Unit Adverse Events Following Immunization (AEFI) Team for investigation and reporting.

**Purpose:** AEFI reporting and monitoring is a key contributor to public confidence in immunization programs, is critical to vaccine safety surveillance, is used to confirm results of pre-licensure clinical trials, and provides a process to identify previously unknown concerns for vaccine products. Calgary Zone AEFI team has never seen this type of reaction following immunization and wanted to share with the broader immunization community.

**Methods/Evidence:** The AEFI reporting system in Alberta is a passive surveillance system which relies on the vaccine recipient to report AEFIs to their vaccine provider who in turn reports to Public Health. The AEFI team completes a provincial reporting form in consultation with the Medical Officer of Health, assesses the likelihood of association with vaccine, and then makes recommendations for further doses. In this case, the AEFI was submitted as “other unusual events”, as it did not meet any specific case definition, but was considered significant. The client was referred to the Calgary Special Immunization Clinic for further assessment and review.

**Significance of Findings/Outcomes for immunization research and evaluation:** A literature review revealed only one reported case of focal lipoatrophy following adjuvanted influenza vaccine. The pathogenesis of lipoatrophy following vaccination is unclear. The long term prognosis of vaccine-induced lipoatrophy is good; however esthetic concerns should not be ignored. Given the client’s age and history of multiple comorbidities, the benefit of further doses of influenza vaccine outweighs the risk of another similar AEFI. Annual influenza vaccine is recommended; an alternate injection site for further vaccines and avoidance of vaccines with “oil in water” adjuvants seems prudent in the future.
Current epidemiology of invasive *Haemophilus influenzae* disease in Northwestern Ontario

Marina Ulanova, Victoria Eton, Eli Nix, Raymond Tsang, William McCready

**Introduction/Background:** In the post-*Haemophilus influenzae* (Hi) type b vaccine era, the epidemiology of invasive Hi disease has changed, with dramatic decline in Hib and increasing prevalence of non-Hib, especially non-typeable (NT) Hi and serotype f. Serotype a (Hia) has emerged as an important cause of invasive disease in some regions with proportionally high Indigenous populations, such as the Arctic. We studied epidemiology of invasive Hi disease in a rural population of Northwestern Ontario.

**Methods:** A retrospective chart review of all cases of invasive Hi disease was conducted in a regional hospital serving a population of 29,000 (82% First Nations) between January 2010 and July 2015. All invasive and non-invasive Hi isolates were collected during November 2013-May 2016. Identification of *H. influenzae* was done using standard methods and confirmed by 16S ribosomal RNA sequencing; serotyping was performed by both bacterial agglutination test and PCR to detect the serotype-specific genes. Clonal analysis and detection of the *IS1016-bexA* partial deletion in the capsular loci were completed by multilocus sequence typing and PCR, respectively. In addition, Hi was detected and characterized in nasopharyngeal swabs from healthy 3-5 year old children.

**Results:** Ten cases of invasive Hi disease were identified; Hia was the most prevalent isolate (50%) followed by NTHi (20%). Average annual incidence of invasive Hia disease was 3.1/100,000/population. One Hia case occurred in an infant; the remaining 4 were in adults with significant co-morbidities such as diabetes, rheumatoid arthritis, and alcoholism. Invasive Hia disease presented as pneumonia and/or sepsis, or pericarditis; there was one fatality. Hia represented 6 of 92 non-invasive Hi isolates (6.5%); in all cases Hia was isolated from the middle ear of young children. Moreover, Hia was carried by 10% of healthy children.

**Conclusions/Implications for immunization research and evaluation:** In a rural Northwestern Ontario First Nations population, Hia is present as a cause of both invasive and non-invasive disease and commonly carried by healthy children. Invasive Hia disease is characterized by severe presentations. Pediatric immunization with a new conjugate Hia vaccine under development in Canada may decrease the burden of invasive disease and overall circulation of the pathogen in vulnerable populations.

Determinants of influenza vaccination among a large population in Quebec

Virginie Gosselin, Maryse Guay, Genevieve Baron, Genevieve Petit, Arnaud Gagneur

**Introduction/Background:** Very low uptake has been noted for the influenza vaccine in the Eastern Townships as well as in the Quebec Province. During the 2013-2014 season in Quebec, 57% of adults aged 60 and over and 33% of adults aged 18-59 and suffering from a chronic medical condition were vaccinated against influenza. This study aimed to identify the determinants of influenza vaccination among a large regional population.

**Methods:** A phone survey was conducted between June and October 2014 on a large random digit sample in the Eastern Townships (Quebec) by trained interviewing staff. In addition to demographic and socioeconomic questions, respondents aged between 18 and 95 were contacted to answer questions on several health topics such as knowledge and beliefs about immunization according to the Health Belief Model, medical consultations, health status and life habits. Weighted data according to age, sex and territories were analyzed. Statistically significant variables in the univariate analysis were introduced into a multivariate logistic regression model to determine independent factors of influenza vaccine receipt (OR and 95% CI).

**Results:** A total of 8,737 interviews were conducted, giving a participation rate of 48.3%. Among all respondents, 37% have received the influenza vaccine during the 2013-2014 season. Regarding target groups, 55% of adults aged 60 and over and 47% of adults with a chronic disease were vaccinated against influenza. Several determinants were significantly associated to influenza vaccination: recommendation from a healthcare professional (OR=4.79; 4.08-5.62), belief that the vaccine has few side effects (OR=2.67; 2.24-3.18), and perceived risk of catching the flu (OR=2.02; 1.72-2.37). Besides age, healthcare profession and suffering from a
chronic disease, other significant determinants were observed: having consulted a pharmacist (OR=1.32; 1.11-1.56), having a body mass index of 30kg/m² or over (OR=1.25; 1.03-1.52), and low education level (OR=0.74; 0.61-0.90 and OR=0.81; 0.65-0.99 for college and university degree, respectively).

Conclusions/Implications for immunization research and evaluation: Many determinants may influence the decision to get vaccinated against influenza. Some of them, such as the education level and the role of the pharmacist, could be dig deeper and exploited in future research.

Determinants of vaccine hesitancy in the Eastern Townships (Quebec): A large population-based survey
Virginie Gosselin, Genevieve Petit, Genevieve Baron, Maryse Guay, Arnaud Gagneur

Introduction/Background: Vaccine hesitancy is a global phenomenon that needs to be measured and addressed. Only a few studies had assessed vaccine hesitancy and its determinants on a population basis. This study aimed to identify the determinants of vaccine hesitancy among a large regional population.

Methods: A phone survey was conducted between June and October 2014 on a large random digit sample in the Eastern Townships (Quebec) by trained interviewing staff. In addition to demographic and socioeconomic questions, respondents aged between 18 and 95 were contacted to answer questions on several health topics such as knowledge and beliefs about immunization according to the Health Belief Model, medical consultations, health status and life habits. Weighted data according to age, sex and territories were analyzed. Statistically significant variables in the univariate analysis were introduced into a multivariate logistic regression model to determine independent factors of vaccine hesitancy (OR and 95% CI).

Results: A total of 8,737 interviews were conducted, giving a participation rate of 48.3%. Among all respondents, 32% were vaccine-hesitant. Regarding vaccination topic, several determinants were significantly associated to vaccine hesitancy: belief that children receive too many vaccines (OR=2.72; 2.32-3.18), belief that a healthy lifestyle can eliminate the need for vaccination (OR=2.48; 2.09-2.93), belief that the use of other alternative medicine practices can eliminate the need for vaccination (OR=1.39; 1.16-1.68), and low level of knowledge about immunization (OR=1.26; 1.04-1.51). Other determinants were: having consulted a massage therapist (OR=2.34; 1.46-3.75), non-vaccination against influenza (OR=1.80; 1.49-2.16), having a low household income (<$30,000) (OR=1.58; 1.24-2.02) or middle income ($30,000-$79,000) (OR=1.37; 1.12-1.67), not agreeing that the municipality adds fluoride in drinking water (OR=1.40; 1.21-1.63), and cigarette smoking (OR=1.22; 1.01-1.47).

Conclusions/Implications for immunization research and evaluation: Many determinants are related to vaccine hesitancy. These determinants must be taken into account when health professionals counsel vaccine hesitant patients.

Determining the impact of a medical directive on the uptake of pneumococcal polysaccharide vaccine to eligible at risk patients
Laura Bourns, David Montoya, Wendy Chong

Introduction/Background: NACI recommends pneumococcal polysaccharide vaccine-23 valent (PPSV-23) for persons aged ≥65 years and those at high risk for invasive pneumococcal disease (IPD). No Canadian data is available on the PPSV-23 immunization rate among patients < 65 years at high risk for IPD, nor how this rate compares to that of patients ≥65 years of age in a similar setting.

Our objectives were to determine and compare the proportion of patients from two groups (seniors and patients with diabetes) at risk for IPD immunized with PPSV-23. A second objective was to determine the effect of implementation of a medical directive on immunization uptake in these two groups.
Methods: A retrospective chart review was carried out at an urban community health centre, before and after implementation of a medical directive for the administration of PPSV-23.

Patients who attended the community health centre during a two-year period before or after implementation of the medical directive, were randomly selected. Participants were selected from two groups: 1) 18 – 64 years of age with a diagnosis of type 2 diabetes, and seniors 65 years of age and older with no diagnosis of diabetes. A total of 100 patients were selected across the two groups and time periods.

Outcomes measured included the number of patients in each group that had a documented PPSV-23 immunization or refusal during either of the two time periods. A Fisher’s exact test and z-statistic were used to determine if differences were statistically significant.

Results: There was a statistically significant difference in the number of seniors immunized (18/50) compared to the number of type 2 diabetics (9/50) (p=0.042). In both groups there was no statistically significant difference in the proportion immunized or refusing immunization (p>0.05) before and after implementation of the medical directive.

Conclusions/Implications for immunization research and evaluation: Despite PPSV-23 immunization being offered by an increased number of health care practitioners and being offered at no cost to patients, barriers still exist to adult immunization. Further work needs to be done to look at how the uptake of immunizations in the adult population can be optimized, and what additional barriers may exist for patients and health care professionals.

Developing new standards for building trust with pharmaceutical companies: A reflection on GlaxoSmithKline’s (GSK’s) journey in Canada

Leonard Friedland, Shehzad Iqbal, David Willer, Shireen Khaliq

Introduction/Problem identification: Common healthcare goals for patients, healthcare professionals (HCP) and payers are higher quality care, lower costs and better outcomes. In achieving this, the relationship of trust between patient and doctor is absolutely crucial. That includes patients trusting their doctors to prescribe in their best interests. The pharmaceutical industry has an important part to play in supporting doctors with information about our medicines and vaccines, and supporting professional skills development, so that doctors have the information to make the right decisions for each patient – fully understanding the advantages and disadvantages of the many treatments available. At GSK, we believe that the industry’s current established way of operating would benefit from evolution.

Purpose: GSK has introduced ways of working to put the relationship of trust between industry and HCP beyond doubt, so that patients can be confident that industry has no undue influence over doctors’ decisions. GSK is committed to changing the pharmaceutical industry’s operating model in the interests of patients and healthcare professionals.

Methods/Evidence: This session will review GSK’s activities to build trust, including supporting medical education in new ways, no longer paying external HCP’s to promote or speak about our medicines and vaccines on our behalf, changing the sales force compensation model and opening access for all clinical trial data. The progress on enacting these reforms in Canada will be discussed and reflect on both positive feedback as well as significant challenges we continue to face from our internal and external environment.

Significance of Findings/Outcomes for immunization research and evaluation: Using novel approaches, GSK is changing the standard ways of working that industry uses with its academic and public health customers. With a goal of becoming a trusted partner in the scientific and public health community, these changes have broad reaching implications for delivering the best quality of healthcare to patients.
Development of a glycoconjugate vaccine to combat disease caused by Haemophilus influenzae type A
Andrew Cox, Chantelle Cairns, Dean Williams, Wei Zou, Frank St. Michael, Josee Plamondon, Melanie Arbour, Teffanie Le Francois, Hafida Aomari, Luke Masson, Perry Fleming, Raymond Tsang

Background: Glycoconjugate vaccines are relative newcomers as vaccine strategies but have been tremendously successful in the eradication of a number of important bacterial pathogens. The Haemophilus influenzae type B (Hib) glycoconjugate vaccine, based upon the capsular polysaccharide, was the first commercial glycoconjugate vaccine. Following its introduction in the late 1980’s it has almost eliminated disease caused by Hib wherever it has been used. In Canada alone there were approaching 1000 cases of invasive disease reported per year at the peak of the Hib epidemic, but since vaccination was initiated with the glycoconjugate vaccine, invasive disease due to Hib has all but disappeared. Epidemiological monitoring has however recently revealed that infections due to Haemophilus influenza type A (Hia) are on the increase in Canada’s northern communities and could become an emerging disease.

Methods: This presentation will detail the vaccine development work we have carried out in order to isolate, purify, conjugate and establish the immunogenicity of the capsular polysaccharide produced by Hia.

Results: We have optimised growth and isolation methodologies, conjugation techniques and investigated the utility of several carrier proteins in order to evaluate the immune response in rabbits and mice following immunisation with the glycoconjugates. We established the specific recognition of the immunising carbohydrate antigen and a geographically distinct set of Hia strains by the derived sera and also employed a serum bactericidal assay to illustrate the functional capacity of the sera to kill all Hia strains we tested.

Conclusions: This research has established a proof of concept that a glycoconjugate vaccine approach based on the capsular polysaccharide of Hia can, in the same way as the commercial Hib glycoconjugate vaccine, elicit functional antibodies capable of facilitating killing in a bactericidal assay. Our current efforts are to engage industry in order to produce clinical lots and commence clinical trials.

Economic analysis of pneumococcal vaccination for elderly adults in Canada
Zhou Zhou, Philippe De Wals, Geneviève Deceuninck, Caroline Quach, Brigitte Lefebvre, Maryse Guay, Bruce Tapiero, Louis Valiquette

Introduction/Background: In Canada, the current recommendation for 23-valent pneumococcal polysaccharide vaccine (PPV23) is one dose at age 65 years. The 13-valent pneumococcal conjugate vaccine (PCV13) is now licensed for adults. The objective of the present study was to evaluate the cost-effectiveness of different strategies: 1)PPV23 at age 65 years, 2)PCV13 at age 65 years, 3)PCV13 at age 65 years and PPV23 at 66 years, and 4)PPV23 at age 65 years and 70 years.

Methods: A static model derived from previous studies was used to simulate invasive pneumococcal disease (IPD) and non-invasive pneumococcal community-acquired (NlPCAP) epidemiology. Epidemiological parameters were extracted from published studies as well as surveillance and administrative databases. Future trends in IPD and NlPCAP incidence and serotype distribution were modelled. Clinical trials, epidemiologic studies and meta-analyses were reviewed to estimate vaccine effectiveness against vaccine-types IPD and NlPCAP, supplemented by expert opinion on the duration of protection while assuming that 10% of the population would not respond to vaccination. In the base model, it was assumed that PCV13 was effective against serotype 3 while PPV23 was not. Economic and utility parameters were derived from published studies. Estimated vaccine prices were approximately $11 for PPV23 and $66 for PCV13. All benefits and costs were discounted at a 3% annual rate.

Results: In the base model, PPV23+PPV23 was the most effective strategy for IPD prevention, PCV13+PPV23 effective against NlPCAP generating a higher QALY gain but at higher cost. Incremental CE ratios against PPV23 were similar for the two options $67,000/QALY and $63,000/QALY, respectively. Vaccine price was an important factor influencing results.
Conclusions/Implications for immunization research and evaluation: PPV23 as currently recommended remains the best option in terms of cost-effectiveness. PCV13+PPV23 one year apart is the most effective strategy to reduce pneumococcal disease burden but also the most expensive one. Revaccination with PPV23 five years after the primary vaccination is an interesting alternative to cheaply reduce the disease burden at lower cost.

Effect of human papillomavirus vaccination on cervical cancer screening in Alberta

Jong Kim, Christopher Bell, Maggie Sun, Gordon Kiewer, Linan Xu, Maria McInerney, Lawrence Svenson, Huiming Yang

Introduction/Background: A school-based program with quadrivalent human papillomavirus (HPV) vaccination was implemented in Alberta in 2008. We assessed the impact of this program on Pap test cytology results using databases of province-wide vaccination and cervical cancer screening.

Methods: We conducted a nested case–control study involving a cohort of women in Alberta born between 1994 and 1997 who had at least 1 Pap test between 2012 and 2015. Women with negative cytology results were controls. Women with low-grade (atypical squamous cells of undetermined significance or low-grade squamous intraepithelial lesion) and high-grade (atypical squamous cells, cannot rule out a high-grade lesion; or high-grade squamous intraepithelial lesion) cervical abnormalities were cases. Exposure status was assigned according to records of HPV vaccination. Odds ratios (ORs) for abnormal cytology results by vaccination status were adjusted for neighbourhood income, laboratory service, rural versus urban residency, and age.

Results: The total study population was 10,204. Adjusting for age, vaccinated women had a higher screening rate than unvaccinated women (13.0% v. 11.4%, p < 0.001). Among women who received full vaccination (≥ 3 doses), the adjusted OR for cervical abnormalities was 0.72 (95% confidence interval [CI] 0.63–0.82). For high-grade lesions, the adjusted OR was 0.50 (95% CI 0.30–0.85).

Conclusions/Implications for immunization research and evaluation: Quadrivalent HPV vaccination significantly reduced high-grade cervical abnormalities in females completing 3-dose schedule. Vaccination against HPV was associated with screening uptake. Population-based vaccination and screening programs should work together to optimize cervical cancer prevention.

The effect of latent cytomegalovirus and Epstein-Barr virus infections on responses to MenC and Hib conjugate vaccines in children

Manish Sadarangani, Andrew J Pollard, Katie Jeffrey

Introduction/Background: Cytomegalovirus (CMV) and Epstein-Barr virus (EBV) infect most people worldwide, usually during childhood. Latent CMV infection significantly perturbs the immune system and influences vaccine responses in adults, but there are no data on the effect of latent CMV infection on vaccine responses in school-aged children. In Gambian infants, CMV-positivity was associated with a reduction in measles-specific CD4+ T cell responses and one study showed that measles antibody response was lower in infants latently infected with EBV if they were also CMV-positive. The aim of this study was to investigate the effect of latent CMV and EBV infection on the response to the Haemophilus influenzae type b-meningococcal capsular group C (Hib-MenC) conjugate vaccine in 6-12 year-old children.

Methods: 250 healthy 6-12 year-old children who had previously received Hib and MenC conjugate vaccines were immunized with a single booster dose of Hib-MenC conjugate vaccine. MenC serum bactericidal antibody (SBA) titers and Hib anti-polyribosyl ribitol phosphate (anti-PRP) IgG antibody levels were measured before vaccination and 1 month and 1 year post-vaccination. Specific IgG antibodies to CMV and EBV (viral capsid antigen) were measured at time of vaccination by Liaison chemiluminescence immunoassays, as a marker of latent infection. Statistical analyses were performed using R.
Results: Overall, 58/250 (23%) of children were CMV-positive and 73/172 (42%) were EBV-positive at time of the Hib-MenC booster immunization. 2 children had an equivocal CMV IgG, and these were excluded from the analyses. EBV-positive children had a lower Hib anti-PRP IgG than EBV-negative children at 1 month post-vaccination (127 µg/ml vs 230 µg/ml, p = 0.0134), which persisted to 1 year post-vaccination (13 µg/ml vs 21 µg/ml, p = 0.0253). CMV serostatus did not influence Hib anti-PRP IgG, and neither CMV status or EBV status had an effect on MenC SBA titers.

Conclusions/Implications for immunization research and evaluation: Latent infection with EBV was associated with a lower antibody response to Hib conjugate vaccine, although protective levels of antibody were present in EBV-positive and EBV-negative children. Further work is required to assess the influence of other herpesviruses on vaccine responses, and to investigate the mechanism by which latent EBV infection influences responses to vaccination.

Effectiveness of live zoster vaccine in preventing postherpetic neuralgia (PHN)

Roger Baxter, Joan Bartlett, Bruce Fireman, Morgan Marks, John Hansen, Edwin Lewis, Laurie Aukes, Yong Chen, Eddy Bresnitz, Nicola Klein, Patricia Saddier

Introduction/Background: Zostavax™, a live attenuated zoster vaccine, is licensed in >50 countries for the prevention of herpes zoster and PHN. Duration of protection is being evaluated in a long-term observational study. We previously reported that vaccine effectiveness (VE) to prevent zoster tended to decline over time and was on average 45-50% over the first 5 years following a single dose of vaccine in all 60+ age groups. We present here VE against PHN from 2006 through 2013.

Methods: The study is conducted in a large US healthcare plan as an open cohort that members enter when they become age-eligible for the vaccine. PHN cases were identified in the databases within a year of zoster onset as having a PHN-specific diagnosis code >90 days after the first zoster diagnosis code, either (1) for both a visit and a prescription (positive predictive value [PPV] ~96%) or (2) as a primary code for a visit (PPV ~89%). VE against PHN by age at vaccination and by year since vaccination was estimated using Cox regression adjusted for sex, year of birth, race/ethnicity, and several time-varying variables, including healthcare use, comorbid conditions and immune-compromise status.

Results: From Jan-2007 to Dec-2013, over 1.3 million study individuals 50+, including >300,000 who received one dose of Zostavax, contributed ~4.9 million person-years of follow-up and experienced ~42,000 zoster episodes and 1,720 PHN episodes. As of 2013, vaccine coverage was >40% in 60+. VE against PHN was 83% (95% CI 73-90%) in the first year for all ages combined, decreased in the second year, and then remained relatively stable through year 5, with an overall VE of ~70% in all 60+ age groups (60-69, 70-79, and 80+ years at vaccination). Among people vaccinated at 80+, overall VE against PHN was 71% (54-82%).

Conclusion/Implications for immunization research and evaluation: Overall VE of live zoster vaccine against PHN was ~70% in all 60+ age groups, with less waning over time than seen with VE against zoster. VE against PHN and zoster in people vaccinated at 80+ was similar to younger 60+ groups, supporting vaccination of all eligible people, including the elderly who are at increased risk of zoster and PHN.

Equity-based childhood immunization policy-making in urban centres across the Canadian Prairies: A comparative analysis

Thilina Bandara, Cory Neudorf

Introduction/Background: One key indicator of health inequities in a population is childhood immunization coverage rates. Equitable immunization coverage overall ensures that vulnerable populations, who are more likely to be exposed to pathogens and less likely to have access to preventative services, will have long-term protection against disease. As equity is one of the main goals of the public health enterprise in Canada, it is
important to assess which programming and policy practices allow local public health units to deliver equitable immunization coverage to Canadians. Despite growing interest among practitioners, equity-related public health practice has not been studied to a great extent in the literature, especially in Canada. Public health system and service research literature, in general, is nascent and requires further attention. It is also largely unknown to what extent inequities may exist in childhood immunization coverage, and how public health can address these inequities.

Methods: Utilizing the Urban Public Health Network to directly engage public health practitioners as research partners, I am investigating 5 large urban prairie health. There are two phases of the study. Firstly, I will conduct health-inequalities-over-time measurements on 10 years of MMR immunization coverage data from each region. Secondly, upon observing the inequity trends, I will conduct a policy-based inquiry to assess which programs and policies these urban public health units employed over those 10 years to reduce immunization inequities in their jurisdictions. Based on this evidence, I will then provide insights into where equity-based considerations fit into modern public health practice.

Results: Results are forthcoming and will be in a presentable form by December.

Conclusions/Implications for immunization research and evaluation: My study will provide valuable insights into how public health can utilize equitable immunization public health practices to improve population health as a whole. I will also provide a portrait of inequities in MMR coverage across the prairies, and demonstrate the blended use of epidemiology and policy-analysis in health inequities research. Additionally, my use of CIHR’s integrative knowledge translation principles ensure that, by involving the Urban Public Health Network, the evidence generated will be translated effectively into practice.

Evaluating the cost-effectiveness of targeted vaccination campaigns for the containment of pandemic influenza in Canadian metropolitan area

Patrick Saunders-Hastings, Bryson-Quinn Hayes, Daniel Krewski

Introduction/Problem identification: In the past hundred years, a novel strain of influenza has emerged to produce a global pandemic four times. The timing of these occurrences is unpredictable, and their consequences are uncertain. These pandemics have tended to be associated with a shift in mortality risk towards younger population. Further, their genetic novelty reduces the effectiveness of vaccinations in preventing infection, while development and distribution constraints may delay access to a more effective vaccine until later in the pandemic. As such, it is important to consider policies to optimize the use of vaccines of low-to-moderate effectiveness as a means of interrupting community transmission and reducing the health consequences of future pandemic influenzas.

Purpose: This project seeks to evaluate the relative impact of three vaccination strategies in reducing the number of influenza infections and hospitalizations associated with a future pandemic of unknown severity. These strategies are: no prioritization, prioritization of groups at high risk of adverse outcomes, and prioritization of groups with traditionally high attack rates.

Methods/Evidence: A new integrated stochastic model has been developed, combining predictive transmission dynamics with insights from past pandemics on hospitalization, economic burden, and pharmaceutical interventions. Evidence suggests that prioritization of high-risk groups is preferable early in a pandemic, as this generated the greatest reduction in expected hospitalizations, deaths, and costs. Meanwhile, a “no prioritization” strategy is likely to cause problems in maintaining a sufficiently high vaccination rate to achieve desired coverage. While targeting high attack rate groups was found to produce the greatest reduction in total infections, these tended to be linked with self-limiting infections which smaller associated costs and health burdens.

Significance of Findings/Outcomes for immunization research and evaluation: Outbreaks of pandemic influenza are inherently uncertain events. However, by studying patterns relating to vaccine characteristics of
Evaluation of a brief training on motivational interviewing adapted to vaccination

Stéphanie Lanthier-Labonté, Amin Mesbahi, Nina Nguyen, Ginette Sika, Judith Archambault, Maryse Guay

Introduction/Background: Vaccinators might feel helpless with vaccine-hesitant individuals. In Quebec, vaccinating nurses expressed the need to improve their counselling to hesitant clients. Therefore, based on prior Quebec studies on motivational interviewing (MI) with parents of newborn children that showed an increase in vaccine coverage, a brief training on MI adapted to vaccination was developed and evaluated.

Methods: A quasi-experimental, one group pretest-post-test design was conducted on 35 nurses in different public health care settings. The 90-minute training on MI was given 5 times in August 2015. Starting with a short theoretical part on 4 MI principles (ambivalence exploration, open-ended questions, argumentation avoidance and an "elicit-provide-elicit" strategy to inform), the workshop used mainly trio role-plays (hesitant parent – vaccinator – observer). Data come from a pre/post questionnaire developed from the Ajzen and Fishbein Theory (1975) and from Briss et al. (2000). The pre-test was administered at the beginning of the training while the post-test was filled immediately at the end. The questionnaire measured: 1) knowledge and intention to apply MI principles and confidence to be competent in doing MI according to each of the four MI principles; and 2) socio-demographic variables. Also, a satisfaction questionnaire assessed the training. Descriptive and comparative non-parametric analyses were performed.

Results: For each MI principle, average pre-post scores all showed statistically significant improvement (p < 0.01), except for knowledge on exploring ambivalence (p = 0.08). The average score on perception of readiness in doing MI in their counselling went from 2.2/4 to 3.3/4 (p < 0.001). Improvement in pre-post scores was not influenced by any of the sociodemographic variables. The training was highly appreciated and met expectations.

Conclusions/Implications for immunization research and evaluation: The brief training on MI helped to improve vaccinator knowledge, intention and confidence in being able to do MI in their practice. These results are promising despite the inherent limits of the design. These findings pave the way for a sustainable training to better prepare vaccinators to vaccine hesitancy. This training could be enhanced by including a more robust assessment and an impact evaluation on immunization acceptance.

Evaluation of Public Health Ontario’s Annual Report on Vaccine Safety

Diane Lu, Lauren Ramsay, Tara Harris, Stacie Carey, Jill Fediurek, Shelley Deeks

Introduction: Public health surveillance of adverse events following immunization (AEFIs) is essential to monitor vaccine safety and inform immunization program planning and evaluation. The “Annual Report on Vaccine Safety in Ontario” was initiated in 2013 by Public Health Ontario (PHO) as a core component of public health vaccine safety surveillance in the province. Each annual report includes a comprehensive AEFI assessment and is accompanied by an “Immunization Overview” (a one-page summary for health professionals). Our evaluation objective was to assess whether the Annual Report on Vaccine Safety and related resources helped public health professionals improve their knowledge and communication about vaccine safety.

Methods: This was a mixed methods evaluation using a combination of an online survey of public health unit (PHU) stakeholders, assessment of email dissemination of the report using the Stakeholder Relations Management (SRM) system, and web metrics for PHO’s vaccine safety webpage. The target audience was PHU staff including: medical and associate medical officers of health, vaccine preventable disease/immunization program managers, and program staff.
**Results:** A total of 31 individuals completed the survey, representing 21 of 36 PHUs. Almost all survey participants (97%) read the report, and 65% read the Immunizer Overview. The most commonly cited uses were to improve knowledge, reference in daily work, share with colleagues or stakeholders and to develop educational resources. Overall, there was high satisfaction with the design and content of both products. The open rate for the email dissemination of these resources was 40%. Two-thirds of survey participants accessed the webpage in the last year, expressing satisfaction with the content and usefulness of the information. Themes for improvement included: reducing the length of the report with increased focus on key messages and data visualization, tailoring communication resources for specific audiences, expanding resource dissemination methods, and improving promotion and navigation of the vaccine safety webpage.

**Conclusions/Implications for immunization research and evaluation:** This is the first evaluation of PHO’s vaccine safety knowledge products. The findings demonstrate high satisfaction with the Annual Report on Vaccine Safety and related resources. Recommended actions for improvement were made, and plans are underway to implement these actions to better meet the needs of our stakeholders.

**Excluding pupils in a pertussis outbreak to increase immunization coverage**

*Bill Sherlock, Morgan Harnest, Shawna Hoskin*

Ontario’s Immunization of School Pupils Act (ISPA) allows for the exclusion of exempted students from school in the event of an outbreak of the relevant vaccine-preventable disease. In the past, this power to exclude has been used as an outbreak control measure, even though ISPA does not allow exclusion of students over age 17 or school staff. Because exclusion is likely to be of limited effectiveness in controlling a pertussis outbreak, the usual practice has been to not exclude.

In response to a pertussis outbreak in two schools in Bancroft in May 2016, Hastings Prince Edward Public Health (HPEPH) used the exclusion provision as a strategy for promoting immunization. The 29 students at these schools who were exempt from suspension because they had completed the required statement of religious or conscientious objection were served with an exclusion order for one incubation period after last contact unless they updated their pertussis immunization. 15 out of 29 pupils complied and were immunized at the school immunization clinics.

Outbreak exclusion is consistent with the purpose of ISPA and appears to be an effective tool for promoting immunization in some students.

**Exploring knowledge and attitudes in a low-immunization Saskatchewan First Nation community**

*Nnamdi Ndubuka, Carrie Gardipy, Janet Yang, Katie Armstrong, Meaghan Ryan, Norma Rabbitskin, Daren Skibinsky, Karen Miller, Bonnie McLeod*

**Introduction/Background:** While immunization has been one of the most important preventive health developments, some populations do not see the same benefits due to lower immunization rates, an example being First Nations populations in Canada. Our study was completed in a First Nations community in northern Saskatchewan with a low immunization rate of 54% as part of the immunization program evaluation. The purpose was to determine knowledge, attitudes and behaviours of community members and health care workers surrounding immunization.

**Methods:** The evaluation was completed through a quasi-experimental design using mixed methods questionnaires. Questionnaires were distributed by the Community Health Representative to parents of young children (n=76), Community Health Nurses (n=3) and Nurse Manager/Health Director (n=2) from the low-immunization community. Community Health Nurses (n=3) from two high immunization communities in northern Saskatchewan completed questionnaires for comparison. Additionally, childhood immunization...
records for children whose parents participated were examined. Data analysis was done using descriptive statistics and trend analysis.

Results: The major findings of this evaluation were that parents were most concerned about vaccine side-effects and reactions, immunizations were not a priority amongst community members, the health centre staff did not have adequate access to information, and the staff needed to delegate duties to their community health representatives in order to manage time and resources. Ultimately, 19 evidence-based program improvement suggestions were developed that focused on increasing awareness and education in the community, reminding parents about upcoming immunizations, increasing access to immunization appointments, and improving surveillance and access to information within the health centre.

Conclusions/Implications for immunization research and evaluation: This evaluation provides insights from both the perspective of community members and health care workers that reveal a lack of knowledge and efficient use of resources when it comes to the community immunization program. Although the results may not be generalizable to all First Nations communities, they contribute towards the improvement of immunization coverage in the community. Further research should continue to identify barriers and possible solutions to low immunization rates in First Nations communities throughout the country.

Exploring the potential use of mobile health (mhealth) digital technologies for healthcare worker communicable disease prevention in England: a survey focussed on influenza immunization among healthcare workers

Robyn Harrison, Heidi Larson, Pauline Paterson, Richard Pebody

Introduction/Background: Mobile health (mhealth) technologies have demonstrated effectiveness as behavioural change tools in some clinical care models, but have not yet been explored in the context of immunization provision for healthcare workers (HCWs). This study examines whether mobile phone technologies such as text messaging or an app would be well received by healthcare workers (HCWs) working in the National Health Service (NHS) in England as a means of improving voluntary immunization.

Methods: All healthcare trusts in England (n=267) were invited to participate in this observational study by advertisement from an employer organisation for the National Health Services (“NHS Flu Fighters”). Participating trusts (n=2) invited HCWs to complete a web-based survey administered via web-based platform (SurveyMonkey®) between August – September 2015. Themes relating to vaccine confidence, influenza immunization history, and receptiveness toward mhealth technologies were surveyed by closed and open-ended questions. Mixed methods analyses were performed. In-depth interviews of vaccine hesitant HCWs were offered.

Results: Two trusts participated in the study yielding 301 respondents in trust A, and 15 respondents in trust B across a range of HCW specialties. 100% reported owning a mobile phone. 80% carry their phone at work. Self-reported influenza immunization rates were 63.6% and 64.0%, as compared with 41.7% and 74.3% reported officially for each trust. In the larger trust, 91/301 (30%) reported never or rarely obtaining influenza vaccine, but of those, 31/91 (34%) expressed interest in receiving information about vaccine clinics via text, or app (48/89, 54%). The most common reason cited for not obtaining vaccine was fear of side effects. 50% of all surveyed indicated they would be receptive to vaccine information by text; 64% reported they would be interested in an app. Themes raised in both survey and in-depth interviews (n=3) included privacy, message volume, education, and convenience.

Conclusions/Implications for immunization research and evaluation: 64% of HCWs surveyed would be interested in a vaccine app and half of all HCWs surveyed would be receptive to receiving vaccine information via text message illustrating the potential of mobile phone technologies as a means of improving voluntary immunization. Among those who communicated vaccine hesitance, analysis revealed receptiveness toward education and immunization schedule information via vaccine app.
fHBP variant diversity and level of surface expression among invasive neisseria meningitidis serogroup B isolates from Canada (2006-2012)

Julie Bettinger, Wendy Vaudry, Raymond Tsang, David Scheifele, Scott Halperin, Nathaniel Lambert, Paul Liberator, Li Hao, Kathrin Jansen, Annaliesa Anderson

Background: The Canadian Immunization Monitoring Program Active (IMPACT) is a population-based sentinel surveillance network and includes over 50% of adults and children in Canada. Meningococcal serogroup B (MenB) is endemic in Canada, accounting for 50%-80% of invasive meningococcal disease depending upon age and region. Factor H binding protein (fHBP), a meningococcal outer membrane protein and virulence factor, is an antigen component of two MenB vaccines (bivalent rLP2086 and 4CMenB). Two subfamilies of fHBP variants (designated A and B), grouped based on amino acid sequence similarity, elicit subfamily-restricted immune responses. The correlate of protection from meningococcal disease is antibody-mediated, complement-dependent serum bactericidal activity measured using human complement (hSBA) and the level of antigen expression at the surface of invasive disease isolates can impact strain susceptibility in hSBA.

Methods: A total of 258 invasive MenB strains collected through the Canadian IMPACT surveillance network from 2006-2012 were typed for fHBP and other epidemiological markers. Comparative analysis to a MenB reference collection of isolates from Europe and the US (n=1814, 2000-2006) was conducted. The level of fHBP expressed at the surface of 101 MenB isolates collected from 2010-2012 was determined using the validated flow cytometry based MEASURE assay.

Results: Each of the Canadian MenB isolates contained the gene that codes for fHBP, with sequence diversity that includes 50 unique fHBP variants. Approximately 38% of the fHBP variants were assigned to subfamily A and 62% to subfamily B, consistent with the MenB reference collection. The distribution of Canadian strains expressing subfamily A and B differed as a function of patient age. Compared with adolescents and young adults, considerably more meningococcal disease in infants < 1 year and adults > 65 years of age was due to MenB isolates expressing subfamily A fHBP variants. While the ten most prevalent variants in the MenB reference collection (76.6% of 1814 strains) account for 76.4% of the Canadian strains, some differences are noted. For example, fHBP variant B44, the most abundant variant among Canadian MenB disease-causing strains (accounting for 32% of the total), is the fifth most abundant variant detected in the MenB reference collection. Using the validated MEASURE assay, fHBP expression was detected on the surface of >95% of strains in the MnB reference collection including consistently high levels on the surface of fHBP variant B44 strains. Levels of surface expression for the Canadian MenB isolates from 2010-2012 will be presented.

Conclusions: Routine surveillance of circulating invasive MenB isolates is critical to predict and then monitor the effectiveness of prophylactic vaccines. Preclinical and clinical studies have demonstrated that the bivalent rLP2086 vaccine induces antibodies that kill MenB isolates that express diverse subfamily A or B fHBP variants. fHBP variants that are prevalent in the MenB reference collection are also prevalent in Canadian disease isolates. Analysis of MenB epidemiology and fHBP variant distribution predicts that these Canadian isolates will be susceptible to bivalent rLP2086 immune sera and suggests that the vaccine will provide broad coverage against serogroup B disease in Canada.

Haemophilus influenza type A invasive infections at the Montreal Children Hospital and infection rates in Quebec

Andrée-Anne Boisvert, Dorothy Moore, Brigitte Lefebvre

Introduction/Background: In recent years, increasing numbers of invasive infections due to H. influenza type a (iHia) have been reported in the Canadian north. In Nunavik, Quebec, iHia infection was first reported in 2010, with numbers peaking in 2013. In November 2013, the Institut national de santé publique du Québec (INSPQ) made interim recommendations for Nunavik to provide chemoprophylaxis to household and other close contacts (Flash Vigie Dec. 2013). The objectives of this study are to describe epidemiologic and clinical features
of patients with iHia infection admitted to the Montreal Children’s Hospital, and to determine iHia infection rates in Quebec.

Methods: We conducted a retrospective observational study of cases of iHia infection admitted between 2006 and 2015. Children who had Hia isolated from a normally sterile site (blood, cerebrospinal fluid, joint fluid) were identified from laboratory records. Data on iHia infections in Quebec were obtained from the INSPQ. Population data were obtained from Statistics Canada and the Institut de la statistique du Québec.

Results: Between January 2009 and December 2015, 19 children with invasive Hia infection were admitted. All were aboriginal children from Northern Quebec. Median duration of hospitalization was 7 days. Five patients were transferred to the pediatric intensive care unit (PICU), for a median duration of 4 days. The median age at admission was 14 months and for those transferred to the PICU was 9 months. There were 9 cases of meningitis, 9 of osteoarticular infection and one of bacteremic pneumonia. Two patients with meningitis died. For 2013, rates of iHia infection per 100 000 persons were 82.7, 21.2 and 0.05 for Nunavik, James Bay Cree territory and the whole province, respectively. For the same year, Nunavik and James Bay Cree territory rates were 364.5 for children less than one year of age and 235.2 for those aged 1 to 4 years.

Conclusions/Implications for immunization research and evaluation: Invasive Hia infection is a significant health threat to aboriginal children living in Northern Quebec, with infection rates similar to those reported for Haemophilus influenza b in the pre-vaccine era. A vaccine is needed. Meanwhile, information about carriage and secondary infection rates could help inform recommendations for antibiotic prophylaxis.

The health and economic burden of pertussis in Canada: A microsimulation study

Ashleigh McGirr, Beate Sander, David Fisman

Introduction/Background: This study was undertaken to estimate age-specific quality-adjusted life years (QALYs) lost, life years (LYs) lost, and costs associated with pertussis to evaluate the health and economic burden of pertussis in Ontario and Canada.

Methods: A microsimulation model was designed in TreeAge Pro. We simulated disease progression through a natural history model and compared results to a model with only susceptible and dead health states. Daily probabilities of pertussis complications, hospitalizations, and disease sequelae as well as utilities and costs for the health states were derived from the literature. A healthcare payer perspective was used with a lifetime time horizon. QALYs lost, LYs lost, and costs were discounted at 5% per annum. Probabilistic sensitivity analysis was used to assess parameter uncertainty. Budget impact was assessed by multiplying average case cost estimates by annual age-specific incidence. Using 1 and 3x GDP per capita for a cost-effectiveness threshold, we quantified the QALY loss to assess the net monetary impact of pertussis.

Results: Infants showed the greatest QALY loss (0.123 QALYs). QALY loss was smallest in seniors (0.018 QALYs). Pertussis costs in Ontario generally decline with age with infants having a mean (sd) cost per case of $8,946 ($25,886) and seniors $2,479 ($10,087). Based on current age-specific incidence, pertussis costs the Canadian healthcare system approximately $34.1M annually ($8.4M in Ontario) and as much as $110.9M ($28.2M in Ontario) in an outbreak year. When QALYs were included at 1x GDP per capita for a cost-effectiveness threshold, we quantified the QALY loss to assess the net monetary impact of pertussis.

Conclusions/Implications for immunization research and evaluation: The health and economic consequences of pertussis persistence in Canada are substantial and highlight the need for improved strategies for the use of existing vaccines.
**Hepatitis B immunization in pediatric solid organ transplant recipients**

*Helena Evangeliou, Léna Coïc, Adela Barbaros, Bruce Tapiero, Chantal Buteau, Fernando Alvarez*

**Hepatitis B Immunization in Pediatric Solid Organ Transplant Recipients**

**Background:** Pediatric solid organ transplant (SOT) recipients represent a vulnerable population with respect to vaccine-preventable illnesses (VPI). Both the underlying medical condition and the transplant itself result in significant delays in the administration of routine immunizations, as well as inadequate seroprotection due to the loss of immunologic memory. We sought to describe the pre-transplant immunization status and post-transplant humoral immunity against hepatitis B in a cohort of SOT recipients.

**Methods:** We performed a retrospective chart review of all actively followed liver, kidney and cardiac transplant recipients in a tertiary-care pediatric hospital (1997 to 2015). We included all children ≤18 years who had data available on: (1) pre-transplant hepatitis B immunization status; (2) post-transplant residual hepatitis B serology at 1 year post-transplant.

**Results:** Of 114 actively followed SOT recipients, 96 children had information on pre-transplant immunization status. Median (range) age at SOT was 3.1 (0.1-18.5) years, and 49 (51%) children had complete hepatitis B immunization (3 or more doses) before transplant. In the post-SOT analysis, we had to exclude 12 patients. At a median of 12 (6.4-21.1) months post-transplant, residual hepatitis B serology was available for 61 of 102 (60%) children who had not received any booster dose since transplant. Of these, 33 (54%) had an anti-HBs titer greater than 10 IU/L. Of 32 children who had complete hepatitis B vaccination pre-transplant, 11 (34.4%) had an anti-HBs titer below 10 IU/L at a median of 12 months post-SOT.

**Conclusion:** Pediatric SOT candidates are poorly immunized against hepatitis B before transplant. Among those adequately immunized before SOT, seroprotection was low after transplant. Reasons for this may include a non-response to the primary hepatitis B vaccine series, or loss of anti-HBs as a result of immunosuppression. These findings highlight the importance of a systematic approach to immunization both before and after SOT in pediatric patients.

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**Hospitalized pneumonia in the Nunavik Region of Quebec from 1997-2013**

*Jean-Baptiste Le Meur, Philippe De Wals, Jean-François Proulx*

**Introduction/Background:** Respiratory infections are a major public health problem in Nunavik. In 2002, in order to control an outbreak of serotype 1 pneumococcal infections, a mass immunization campaign was implemented targeting persons ≥ 5 years of age and using PPSV23. At the same time, the PCV7 was introduced into the routine immunization program of infants (3+1 doses). PHI-D-CV10 replaced PCV7 in 2009 and PCV13 is used since 2011. The objective of this study was to describe the burden of pneumonia in relation to pneumococcal vaccines use.

**Methods:** Time-series analysis of hospitalized pneumonia cases (main diagnosis) identified in the provincial Med-Echo database during the period 1997-2013.

**Results:** Annual incidence rates are shown in Figure 1. Following the serotype 1 outbreak and the PPSV23 mass campaign and introduction of PCV for children, hospitalized pneumonia rates in people > 5 years of age decreased steadily starting in 2002. In children < 5 years, rates were not much lower in the 2004-2013 PCV era than in the 1997-2000 pre-PCV period (724/10,000 vs 762/10,000, p-value=0.39).

**Conclusions/Implications for immunization research and evaluation:** In Nunavik, slight downward trends were observed in pneumonia incidence but rates remain much higher than in the overall population of Quebec. The relative contribution of pneumococcal vaccines, improved ambulatory treatments and changes in criteria for hospital admission merits further investigation.
How do we measure vaccine hesitancy? A comparison of qualitative and quantitative measures in a Victoria-based sample of mothers

*Clara Rubincam, Julie Bettinger, Constance Haselden, Devon Greyson, Robin Saunders*

**Introduction/Background:** Immunization rates in British Columbia are below the level required to mitigate outbreaks of some infectious diseases. This can be partly explained by some parents’ doubts and concerns about pediatric vaccinations, termed ‘vaccine hesitancy’. The Parental Attitudes about Vaccines (PACV) scale was developed as a diagnostic tool for health care providers to ascertain parents’ confidence about vaccinations. To our knowledge, no study to date in British Columbia has compared mothers’ PACV score with qualitative reflections on their decision-making about vaccinations.

**Methods:** This mixed method study employed in-depth interviews with pregnant women and new mothers (n=19) from the Greater Victoria, B.C. area to explore mothers’ decision-making processes about pediatric vaccination. At the conclusion of the post-natal interview, all mothers completed the PACV survey. Responses to the survey and data from qualitative interviews are in the process of being compared and contrasted to ascertain how accurately the PACV survey represents each mothers’ beliefs and practices about pediatric vaccinations.

**Results:** At the time of the second interview, the majority of women in the study had chosen to fully vaccinate their young children; some mothers reported persistent doubts or concerns but had nonetheless chosen to vaccinate. Mothers’ scores on the PACV survey are still being tabulated and preliminary findings suggest higher levels of vaccine hesitancy than were presented in the qualitative data. This appears to be due, at least in part, to the methodological differences of qualitative and quantitative methods; the fixed answers on the survey encourage mothers to make a decisive choice whereas qualitative interviews allow for more nuance. Once analysis is complete, data from these mixed methods will indicate whether different methods of assessing vaccine hesitancy yield different estimates about parents’ vaccine confidence.

**Conclusions/Implications for immunization research and evaluation:** Preliminary results suggest that for some study participants, the PACV survey indicated higher levels of vaccine hesitancy than would have been indicated through qualitative conversation. Those using the PACV survey as a diagnostic tool for vaccine hesitant parents should be mindful of how different methodologies used with the same population can yield diverse responses.

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I Boost Immunity

*Ian Roe*

**Introduction/Problem identification:** Vaccines are a victim of their own success. Public discourse in traditional and social media has turned to anti-vaccine sentiment, focused on inaccurate information and fear-mongering. Vaccination also presents a unique challenge to public health because for immunization to work anywhere, it has to be present everywhere. This nexus between local and global responsibility stretches our intuitive understanding of “community immunity;” not only do we have a duty to protect vulnerable children from disease wherever they may be, it is also in our best self-interest to do so.

**Purpose:** I Boost Immunity is tackling this public health challenge by rewarding individual knowledge and learning with a practical outcome that can lead to healthier lives for children around the world.

**Methods/Evidence:** The website uses quizzes, stories and articles to raise local literacy around immunization in a fun, engaging way, and pairs it with a global reward: vaccines for kids through UNICEF. ‘Boosters’ can do over 500 quiz questions, earning one vaccine for every correct answer. Quizzes start easy, but get more challenging as you ‘level up’ - like a game - with badges and rewards at each level. Recent research in social marketing and immunization also supports the IBI approach. The journal Pediatrics published a 2013 study titled “The Impact of Social Networks on Parents’ Vaccination Decisions.” The results strongly suggest that social networks, and particularly parents’ people networks, play an important role in parents’ vaccination decision-making.
Significance of Findings/Outcomes for immunization research and evaluation: To our knowledge, IBI is the only platform of its kind in world. Using social media, elements of gamification and social rewards, IBI represents a new approach to counter anti-vaccine voices that pervade the internet. The design and implementation of over 25 achievement badges, article curation, story submission, teams and a Booster Leaderboard are innovative features of the platform.

Since the newest site was launched in March 2016, highlights include:
- 100,000 vaccines earned for UNICEF during National Immunization Week
- 3,500 registrations from Canada & around the world including teams from Germany, Russia and Israel
- Tens of thousands questions answered about vaccination
- 190,000 vaccines earned for UNICEF
- 500,000 page views

Identified barriers to the uptake of the human papilloma virus vaccine program in Ontario

Anierhe Joan Abohweyere, Natasha Johnson, Fatima Bhetasi, Trish Tuloch, Hirotaka Yamashiro

Introduction: The Human Papilloma Virus (HPV) Vaccine has been publicly funded in Ontario and administered through the school system for female adolescents in Grade 8 since the fall of 2007. As of the fall of 2016, the HPV vaccination program will expand to include boys and the timing shifted from Grade 8 to 7. In the years since its inception, the program has had variable success with vaccine uptake rates ranging from 65 – 80 % against the expected Provincial target of 90%. This study aimed to identify barriers to the uptake of the HPV vaccine in Ontario resulting in lower than utimal vaccination rates.

Methods: For health care providers, a two-step process involving anonymous online surveys and in-person focus group discussions was utilised. Adolescents and their parents completed surveys in 2 paediatric office settings. Survey respondents included Paediatricians, Family Physicians adolescents and parents .

Results: Surveys: One hundred and eighteen (118) Paediatricians and 12 Family Physicians responded. Sixty (60%) percent of surveyed Paediatricians worked in the community with office practices. All twelve family Physicians had office practices. One hundred and twenty-three (123) adolescents and fifty-one (51) parents responded.

Focus Groups: The group consisted of thirty –six physicians comprising 23 Paediatricians, 3 Paediatric sub-specialists 9 Family Physicians and 1 Internal Medicine physician.

Identified Barriers:
- Lack of knowledge of HPV related diseases amongst patients.
- Inadequate patient and parental Education on HPV
- Need for parental consent for vaccine administration
- Misinformation on HPV vaccine safety.
- Religious objections; equating HPV vaccine with license for promiscuity.
- Difficulty obtaining the HPV vaccine from Public Health Units by physicians to provide “catch-up”

Conclusions/Implications for immunization research and evaluation: Barriers were identified from both the surveys and focus groups. Potential solutions were proposed to address the barriers identified and thus improve the uptake of the HPV vaccine by all adolescents.
Illness absenteeism rates in primary and secondary schools in 2013-2014 in England: was there any impact of vaccinating all children of primary school age against influenza? An ecological study

Nicholas Brousseau, Helen K Green, Nick Andrews, Laura Selby, Richard Pebody

Introduction/Background: A phased introduction of routine vaccination of healthy children against influenza with a live attenuated vaccine was recommended in the United Kingdom in 2012, with the aim of protecting both vaccinated children and the wider population through reducing transmission. In the first year of the program in 2013-2014, 4-11 year olds were targeted in six pilot areas across England. The availability of national school level absenteeism data in England allowed us to assess if the vaccination programme had an impact on illness absenteeism in children, an important societal burden of influenza.

Methods: During the spring 2014 term when influenza predominantly circulated, the proportion of absence sessions due to illness was compared between vaccination pilot and non-pilot areas for primary schools (to measure overall impact) and secondary schools (to measure indirect impact). A linear multilevel regression model was applied, adjusting for clustering within schools and potential school-level confounders, including past absenteeism, deprivation, ethnicity, number of pupils, urban/rural status and special education needs.

Results: Low levels of influenza activity were reported in the community in 2013-2014. Vaccine uptake reached 56% in 4-11 year olds in the pilot sites with school delivered programmes. Of the 16,755 primary schools included in the study, five percent (n=809) were in vaccine pilot sites. A significantly adjusted decrease in illness absenteeism of 0.05% was seen in primary schools in pilot areas relative to non-pilot schools (95%CI -0.10% to 0.003%, p=0.036). This is equivalent to an average of four days per school and translates to 20 children needing to be vaccinated to avert a day of illness absence. In secondary schools, there was no significant indirect impact of being located in a pilot area on illness absenteeism.

Conclusions/Implications for immunization research and evaluation: Observations during the first year of the childhood influenza vaccination programme in England suggest a modest but significant reduction in illness absenteeism in primary schools where children were offered vaccine. However there was no significant indirect effect and thus impact on illness absenteeism in secondary schools. These insights and future findings as the programme is further rolled out in England will be of use to jurisdictions considering influenza vaccination for healthy children.

The immune response of adult patients with severe chronic kidney disease to 13-valent pneumococcal conjugate vaccine

Angèle Desbiens-Forget, Gabrielle N. Gaultier, Eli B. Nix, Kylie Williams, William McCready, Marina Ulanova

Introduction/Background: Adult patients with chronic kidney disease (CKD) are immunocompromised and more susceptible than the general population to invasive pneumococcal disease and pneumococcal pneumonia. The effectiveness of the pneumococcal polysaccharide vaccine (PPV23) in this group remains controversial, and there is currently insufficient evidence to recommend the use of the 13-valent pneumococcal conjugate vaccine (PCV13). Recent data suggest that (1) in immunocompromised adults, PCV13 may be more immunogenic than PPV23, and (2) immunization with PPV23 may affect the subsequent response to PCV13. Our goal is to study the immune response to PCV13 in adults with severe CKD.

Methods: Fifty seven individuals aged 33-89 years with CKD stage 4-5 undergoing hemodialysis, were administered one dose of PCV13. The concentration of serotype-specific IgG, IgM, and IgA antibody against 7 individual pneumococcal serotypes were quantified at baseline, one month, and 1 year post-immunization using the standard ELISA. The antibody response was compared between the individuals who had or had not previously received PPV23 as part of standard care.

Results: One month following vaccination with PCV13, the concentrations of IgG antibody significantly increased for serotypes 6B, 9V, 14, 19A, 19F, and 23F (P<0.05) but not for serotype 3. The IgM antibody response was significant for serotypes 6B, 19A and 19F (P<0.05). The IgA antibody response was significant for all serotypes.
A higher serotype-specific IgM antibody response to PCV13 was found in individuals previously vaccinated with PPV23, compared to those who are PPV23-naïve; no significant difference in IgG or IgA antibody response between these two groups was found.

Conclusions/Implications for immunization research and evaluation: We found that adult patients with severe CKD are able to respond to PCV13 with significant increase in most serotype-specific antibody concentrations one month post-immunization. Based on the preliminary data, previous PPV23 immunization does not appear to have a negative effect on antibody response to PCV13. Participant recruitment will continue until January 2017, for a target of 120 participants; analysis of antibody levels and functional activity one year post-immunization will be added. The anticipated results of this study will provide essential evidence to guide vaccine policy for adults with CKD.

Impact and effectiveness of the quadrivalent human papillomavirus vaccine: A review of 10 years of real-world experience in Canada

Caroline Rodier, Marc Steben, Voica Racovitan, Nathalie Mallette, Mattea Thompson, Fern DeAngelis

Background: Human papillomavirus (HPV) vaccines to prevent cervical cancer, pre-cancer and other HPV related diseases have been licensed since 2006. Canada has had high vaccine coverage rates and success in the launch of its HPV vaccination public programs. Despite that, there has been limited awareness of the effectiveness of the Canadian public programs. The purpose of this review is to synthesize the available data and to quantify the reported impact and effectiveness of the quadrivalent vaccination on HPV prevalence, genital warts, cervical abnormalities and Juvenile onset of Recurrent Respiratory Papillomatosis (JoRRP).

Methods: Pubmed and Embase databases were searched for articles published from September 1ST 2006 to July 1ST 2016 including conference abstracts which describe the impact of the quadrivalent HPV vaccine in Canada. Only publications after the initiation of the public immunization programs were included.

Results: A total of 9 articles were identified: 3 reported on decreased genital warts (GWs), 1 published on reduced abnormal cytology and GWs, 1 reported on reduced HPV prevalence, 2 published on decreased abnormal cytology, 1 published on decreased rates of cervical intraepithelial neoplasia(CIN), and 1 abstract reported a national decline of JoRRP incidence and prevalence. Two articles reported on impact before the initiation of the public program, and were thus excluded. Publications/abstracts were retrieved from 4 provinces (Quebec, Ontario, Alberta and British Colombia). All reported substantial reduction in their respective outcomes mainly for the eligible vaccinated cohorts of young girls. The observed decrease ranged from 50% to 44% in relative reduction of dysplasia, 40% to 45% in relative reduction of GW. In BC, the incidence rate ratio for CIN2+ was significantly reduced as well (0.14; 95% CI: 0.04–0.47; p<0.01). In Quebec, vaccine strain prevalence is now virtually absent in the vaccinated cohort.

Outcomes for immunization research and evaluation: In Canada, over the last decade, the impact of the quadrivalent HPV vaccine in real-world settings has become evident in 4 provinces. HPV vaccination programs constitute a major public health initiative and their impact on the reduction of genital warts, HPV infection and cervical abnormalities is an important advancement in Canadian public health.

The impact of repeated vaccination on influenza vaccine effectiveness: A systematic review

Lauren Ramsay, Sarah Buchan, Jeff Kwong, Robert Stirling, Lennon Li, Bryna Warshawsky

Introduction/Background: Recent influenza vaccine effectiveness (VE) studies have suggested that VE may be lower in persons with a history of frequent prior vaccination. While a number of studies have assessed VE by vaccination status across two or more seasons, no systematic review has been completed on this topic. This study explores the impact of repeated vaccination on influenza VE based on a systematic review of studies that assess vaccination across two seasons by influenza type/subtype, age group, and season.
Methods: We searched MEDLINE, Embase, PubMed, and Cumulative Index to Nursing and Allied Health Literature from database inception to April 27, 2016. Eligible observational studies reported VE against laboratory confirmed influenza for mutually exclusive vaccination status groups: vaccinated in the current season only, vaccinated in a prior season only, vaccinated in both seasons, and not vaccinated in the current or prior season. Two reviewers independently screened titles and abstracts to identify articles for full text review and conducted data extraction. Differences in VE between the vaccination groups will be assessed by influenza season, age group, and influenza type/subtype.

Results: We identified 3281 unique publications, selected 599 for full text review, and included 26 articles in the review. There was excellent agreement between reviewers for the title and abstract screen (kappa, Κ=0.94) and for the full text review (Κ=0.98). The majority of articles included one year prior vaccination status, and three articles reported vaccination status for varying prior seasons (e.g. any vaccination in the prior two seasons). Full results will be available for presentation.

Conclusions/Implications for immunization research and evaluation: This systematic review will consolidate the knowledge to date on this topic in order to support policy decisions regarding regular influenza vaccination and communication to patients. Future VE studies should continue to include analyses on repeated vaccination in order to further understand this phenomenon.

Impacts de l’utilisation de Panorama sur les pertes de vaccins du Programme québécois d’immunisation (PQI)

Sylvie Bastien, Danielle Auger, Nadine Sicard

Introduction/Définition du problème : Le suivi des pertes annuelles des vaccins d’un programme de vaccination est un indicateur à suivre dans une perspective d’amélioration de la gestion de ces produits. L’introduction du volet sur la gestion des produits immunisants du système d’information Panorama tant au niveau régional que local depuis 2013 a permis de mieux soutenir les opérations de gestions des inventaires de vaccins dans la province. Après 3 années d’usage du système d’information, il apparaît opportun de documenter l’impact sur les pertes de vaccins du PQI.

But : Démontrer l’impact de l’utilisation du système d’information Panorama, volet GPI sur les pertes de vaccins.

Méthode/Données probantes : Les données sur les pertes annuelles de vaccins du PQI en fonction de différentes raisons (date de péremption échue, bris de chaîne de froid, etc...) sont colligées chaque année. Les données seront présentées sur plusieurs années incluant une analyse des tendances observées. Par exemple, le pourcentage de pertes avant Panorama se situait entre 2 et 3% sur les doses totales distribuées dans le programme mais ont baissé à moins de 0,30% suite à l’implantation du volet GPI, ce qui correspond à une valeur de près d’un million de dollars en produits immunisants. L’effet est visible tant au niveau du retour des doses pour cause de péremption que des bris de chaîne de froid. Les résultats permettent de supposer que les produits sont mieux utilisés chronologiquement en fonction de leurs dates de péremption.

Impact of conjugate vaccines on *Haemophilus influenzae* type b (Hib) and *Streptococcus pneumoniae* in children with cancer: A report from the Canadian Immunization Monitoring Program Active (IMPACT)

Joanne McNair, Alyssa Smith, Julie Bettinger, Otto Vanderkooi, Ben Tan, Shalini Desai, Wendy Vaudry, Scott Halperin, Karina Top

**Introduction:** Children undergoing cancer treatment are at increased risk of invasive *Haemophilus influenzae* type b (Hib) and invasive pneumococcal disease (IPD). The epidemiology of these diseases in children with cancer has not been described in the post-Hib vaccine and pneumococcal conjugate vaccine (PCV) era. The Canadian Immunization Monitoring Program Active (IMPACT) conducts active surveillance for Hib and IPD at 12 pediatric tertiary care centres. Our objective was to describe clinical features and outcomes of invasive Hib and IPD among children with cancer reported to IMPACT from 1991 to 2014.

**Methods:** We analyzed IMPACT reports of invasive Hib and IPD among children with cancer 0–16 years of age who were receiving cancer treatment or post-hematopoietic stem cell transplant (1991–2014). Demographic and clinical data were extracted from IMPACT databases for analysis.

**Results:** Fourteen cases of invasive Hib and 307 cases of IPD were reported among children with cancer. Age distribution of invasive Hib cases was: 1/14 (7%) <2 years of age, 4 (29%) 2–4 years, and 9 (64%) ≥5 years of age. Age distribution of IPD cases was: 22/307 (7%) <2 years of age, 115 (38%) 2–4 years, 169 (55%) ≥5 years of age. Five patients with Hib (36%) were age-appropriately immunized and 4 (29%) were incompletely immunized for age. Among patients presenting after PCV licensure (2001), 34/169 (20%) were age-appropriately immunized and 31 (18%) were incompletely immunized. 7% of Hib and 20% of IPD cases had unknown vaccination history. Bacteremia was the most common presentation of Hib and IPD (57% and 67%, respectively). ICU admission was required in 29% of Hib and 8% of IPD cases. One child died of Hib and 4 died of IPD.

**Conclusions/Implications for immunization research and evaluation:** Invasive Hib and IPD occurred predominantly in children with cancer ≥5 years of age and were associated with morbidity and mortality. Preliminary results suggest that less than 40% of patients were fully immunized for age; however, the vaccine coverage analysis is ongoing. The findings suggest a need for further research into the effectiveness of Hib and PCV immunization in this high-risk population to optimize immunization strategies.

Implementation of British Columbia’s Influenza Prevention Policy, 2015/16 influenza season

Alexandra Nunn, Chelsea Treloar, David Puddicombe, Robert Balshaw, Bonnie Henry, Michael Otterstatter, Monika Naus

**Introduction/Background:** In 2012/13, British Columbia (BC) introduced the BC Influenza Prevention Policy, requiring healthcare workers (HCWs) to be vaccinated against influenza or wear a mask in patient care areas during the influenza season. This study was designed to address how the policy was implemented in the 2015/16 season from the perspective of HCWs and front-line managers.

**Methods:** A cross-sectional knowledge, attitudes and practices survey was distributed electronically in April/May 2016 to HCWs employed by BC health authorities. The questionnaire contained questions about implementation of the Policy, including how the Policy was communicated, the availability of influenza vaccination and masks in the workplace to support policy compliance, and respondents’ experience with policy enforcement. Managers completed an additional set of questions regarding their responsibility to monitor and enforce staff compliance. The representativeness of respondents compared to the HCW population will be assessed. Analyses include descriptive and bivariate statistics, and qualitative content analysis of text responses.

**Results:** There were 18,579 valid responses to the survey; the response rate is estimated to be 10-18% based on the number of email invitations sent and the number of eligible HCWs. Of the respondents, 1700 (9%) were managers responsible for monitoring their staff compliance with the policy.
Preliminary results are presented here; detailed results are forthcoming. The majority of respondents (89%) reported that influenza vaccine was accessible at work, and 79% of unvaccinated staff reported that masks were always or often available in patient care areas. Policy enforcement was supported by an online self-reporting system enabling HCWs to inform their employer of their decision to be vaccinated or wear a mask, which was used by 90% of respondents and was easy to use according to 97% of those who used it. The majority of managers agreed or somewhat agreed that the policy was successfully implemented (89%) and that the policy was becoming easier to implement each season (75%).

**Conclusions/Implications for immunization research and evaluation:** Conclusions will be available by December 2016. Findings from this study will inform policy makers and stakeholders of successes and challenges with policy implementation, enforcement and compliance during the 2015/16 season. Findings will be relevant to other Canadian jurisdictions implementing similar policies.

**Improving pediatric experience of pain during vaccinations at the North Bay Nurse Practitioner-led clinic**

*Shawna Meloch, Terri MacDougall*

**Introduction/Problem identification:** Quality improvement is based in real world analysis of clinical practice data “the noise of practice” with patients centred in the flow of care. It is well known fact that it takes 15 to 17 years for research to permeate into practice. There are very good clinical practice guidelines that address assessment and mitigation of vaccination pain in the pediatric population. Most clinicians will acknowledge they implement some best practices to mitigate pain during vaccinations when they see their pediatric patients. Addressing pain during vaccination is important to prevent suffering and the risk of vaccine hesitancy and health care avoidance.

**Purpose:** What this poster does, is outline how the North Bay Nurse Practitioner-Led Clinic implemented use of a validated tool to assess pain in the pediatric population (rFLACC) and how the team deliberately planned improvements according to best practice to optimize use of strategies to mitigate pain during vaccinations. (Reducing Pain during Vaccine Injections: Clinical Practice Guideline, Taddio, A. et al, 2015).

**Methods/Evidence:** Quality improvement tools and adaptive leadership skills that were learned at Health Quality Ontario IDEAS (Improving and Driving Excellence across Sectors) were utilized to improving pediatric experience of pain during vaccinations. (Model for Improvement, PDSA cycles). Cost analysis of some strategies will be presented in the context of low income families’ ability to access topical anesthetic cream prior to their appointments.

**Significance of Findings/Outcomes for immunization research and evaluation:** An exploration of the value of pain prevention in the pediatric population will be touched on in the context of our cultural expectations of pain. Experience of pain may relate to vaccine hesitancy. Addressing pain in the vaccine hesitant population is an important strategy. Quality improvement tools, lessons learned and suggestions for clinicians to take back to their practices will be outlined. Pain mitigation should become part of all immunization programs.

**Incidence of adult invasive pneumococcal disease post pneumococcal conjugate vaccines in Toronto/Peel, Canada, 2001-2015**

*Karen Green, Jeff Li, Wallis Rudnick, Agron Plevneshi, Sylvia Pong-Porter, Allison McGeer, Toronto Invasive Bacterial Diseases Network*

**Introduction/Background:** In 2001, the first pneumococcal conjugate vaccine (PCV7) was authorized in Ontario, Canada. Publicly funded PCV7 was introduced in 1/2005, PCV10 in 10/2009 and PCV13 in 11/2010. TIBDN performs population-based surveillance for invasive pneumococcal disease (IPD) in Toronto/Peel (population 4.3 million in 2015) and describes trends in pneumococcal serotypes prior to and post introduction of conjugate vaccines.
Methods: IPD cases are reported to a central office and one isolate/case is serotyped at a central lab. Demographic and clinical data are collected by chart review and patient/physician interview. Residence in Toronto/Peel is defined by a patient’s postal code (based on Statistics Canada 2011 census data).

Results: From 2001 to 2015, 5514 adult (≥15 years) IPD cases were identified. 48% of adult cases were ≥65 years. In 2014-2015, 553 (74%) adults had a chronic underlying illness predisposing them to IPD and 205 (37%) were immunosuppressed either as a result of an underlying medical condition or treatment with immunosuppressive medications; pneumonia was diagnosed in 530 (71%) cases, bacteremia without focus in 107 (14%), and meningitis in 42 (6%).

Among older adults (≥65 years), the overall IPD rate decreased from 30.34/100,000/year in 2001-2003 to an average of 26/100,000/year from 2005-2009 to 3.1/100,000/year in 2015.

Since 2009, the IPD rate due to PCV13/nonPCV7 serotypes decreased (2.3 to 0.9/100000/year in adults <65 years and from 8.9 to 3.5/100000/year in adults ≥65 years). IPD due to nonPCV serotypes remained constant (all adults, about 3.4/100000/year) and IPD due to PCV7 serotypes continued to decrease (all adults, 5.9 in 2001 to 0.3/100000/year in 2013).

In 2015, serotype was available for 303 (92%) adult IPD cases. Serotypes 22F (12%), 19A (10%), 3 (9%), 23A (7%), and 11A (6%) were most common. NonPCV serotypes comprised 63% of adult cases.

Conclusions/Implications for immunization research and evaluation: Since 2009, in both adult age categories, the rate of IPD due to NPCV serotypes has remained constant (all adults, 4/100,000/year) and IPD due to PCV7 serotypes has continued to fall (6/100,000/year in 2001 to 0.5/100,000/year in 2014-2015).

Influenza burden, risk factors for severe disease and influenza vaccine effectiveness among patients with chronic obstructive pulmonary disease (COPD) admitted to hospital with lab-confirmed influenza: A study from the Serious Outcomes Surveillance (SOS) Network of the Canadian Immunization Research Network (CIRN)


Introduction/Background: International guidelines recommend annual influenza vaccination for patients with COPD to reduce exacerbations and associated influenza-related complications. Despite this, vaccination coverage among COPD patients remains suboptimal. To enhance our understanding of influenza burden and morbidity in the COPD population, we examined risk factors for serious influenza outcomes in hospitalized adults with COPD, and assessed influenza vaccine effectiveness (VE) in preventing hospitalization in this vulnerable group.

Methods: We conducted prospective active surveillance for influenza among hospitalized adult between 2011-2015 (November - April annually). In a subgroup of patients with COPD and PCR-confirmed influenza, we determined risk factors for death and intensive care unit (ICU) admission. VE against influenza-associated hospitalization was assessed using a test-negative design in a separate cohort of influenza cases and test-negative controls. VE was estimated as (1 - odds ratio (OR) of influenza in vaccinated versus unvaccinated) X 100. Crude VE estimates were adjusted using multivariable logistic regression.

Results: Among 1847 COPD patients with PCR-confirmed influenza, mean age was 74.4 years. 30.8% (n=568) and 52.4% (n=967) of the cohort had co-morbid diabetes and heart disease, respectively. 82.1% of the cohort were past or current smokers, while 10.3% (n=191) used home oxygen. Of those with known vaccination status, 59% (887/1504) received influenza vaccine. 18.1% (n=335) were admitted to ICU, 9.6% (n=177) required mechanical ventilation.
ventilation, 11.2% (n=206) died within 30 days after hospital admission. Significant risk factors for death included, increasing age, cardiac disease (OR 2.0; 95% CI 1.3-3.1), admission from long-term-care (OR 2.4; 95% CI 1.4-4.0), and baseline home oxygen use (OR 3.0; 95% CI 1.7-5.1). Risks for ICU admission included diabetes with complications (OR 3.3; 95% CI 1.7-6.2), current or past smoking (OR 2.1; 95% CI 1.4-3.4), home oxygen (OR 1.7; 95% CI 1.1-2.6) and receipt of antivirals prior to outcome (OR 0.1; 95% CI 0.1-0.1). Overall adjusted VE for the prevention of influenza-associated hospitalization in patients with COPD was 39.6% (95% CI 28.8-48.8).

Conclusions/Implications for immunization research and evaluation: Despite guideline recommendations, only 59% of hospitalized influenza cases with underlying COPD had received influenza vaccine. The demonstrated VE suggests that increasing influenza vaccination rates in COPD patients could significantly reduce hospitalization rates and subsequent health care costs.

Informed consent by mature minors in BC

Stephanie Meier

Introduction/Problem identification: Historically, parents/guardians in BC have been given the opportunity to consent to or refuse immunizations for their school aged children, including those children in grade 9 (14 years of age). Consent for school-based immunizations has been sought inconsistently from students at the school clinic setting and only if the consent form has not been returned or signed by the parent/guardian. Concerns have been raised as to whether this process provides an opportunity for grade 9 students to give consent on their own behalf as mature minors as per the Infants Act in British Columbia. Furthermore, anecdotal evidence suggests that a variety of practices related to obtaining mature minor consent are utilized across the province.

Purpose: Describe current practices across all five BC regional health authorities for obtaining informed consent for grade 9 school immunization, including the frequency and consistency of obtaining consent from the students themselves and to determine the need for a provincial best practice guideline.

Methods/Evidence: Information was collected through a variety of methods:
- A national scan was conducted through interviews with senior nursing administrators identified by the Canadian Nurses Coalition on Immunization representing eight Canadian jurisdictions.
- Interviews were conducted with key informants from each of the five regional health authorities in BC, including public health program leaders and risk management staff.
- Frontline public health nurses in BC participated in an online qualitative survey.

Significance of Findings/Outcomes for immunization research and evaluation: The findings indicate that grade 9 students in BC have varying opportunities to consent to immunization on their own behalf. In general, public health focuses efforts on obtaining parental consent, and mature minor consent is only offered when efforts to contact the parent have not been successful. Participants identified lost opportunities for immunization as a result. Participants also identified the lack of clear practice standards and resources as barriers to implementing ‘mature minor consent’ more consistently. As a result, the Informed Consent section in the BC Immunization Manual was revised to include clear and consistent direction to public health nurses about the use of mature minor consent in school-based immunization clinics. Accompanying training materials were updated accordingly.

To address the information needs of public health nurses, parents, students, and schools, and to bridge the knowledge gap between these stakeholder groups, a new HealthLinkBC file titled “The Infants Act, Mature Minor Consent and Immunization” was developed.

Integration of public health unit practice and immunization research within Fraser Health

Alison Orth, Shovita Padhi, Anup Samra, William Fisher, James A. Mansi

Introduction/Problem identification: Research conducted in a real world setting can help address important questions related to implementation that cannot easily be studied in a controlled environment. A Health Unit
The clinic can provide a valuable mechanism through which researchers can connect with parents regarding their opinions and beliefs on vaccines and immunization practice. However, implementing a research study within a Public Health Unit setting can be challenging due to additional impact on the time and resources of staff and day to day clinic operations.

**Purpose:** To examine the methods implemented to facilitate running a successful collaborative research study on parental acceptance of a novel adjuvanted seasonal influenza (aTIV) vaccine for infants through three local Public Health Units within Fraser Health Authority.

**Methods/Evidence:** Fraser Health participated in a pan-Canadian collaborative research study to assess parental concerns, intention to vaccinate, and determinants of intention to vaccinate their infant with novel aTIV vaccine. A Fraser Health team was formed that included a Medical Health Officer site investigator, research nurses paired with public health nurses, in collaboration with a research coordinator and each health unit manager to complete this study just prior to the start of the 2015/2016 seasonal influenza immunization campaign. The research protocol required ethics approval by the Fraser Health Research Ethics Board. The target enrollment within Fraser Health was 30 parents between September 1 and October 15.

**Significance of Findings/Outcomes for immunization research and evaluation:** A total of 71 parents were enrolled in the study during the recruitment period, exceeding recruitment targets by 135%. Three public health units were selected to participate in this research representing 9 public health nurses. A variety of tactics were utilized to varying degrees of success. Examining these methods and making this knowledge available to public health researchers, public health nurses and their associated networks will help provide tools that could be useful when considering a similar undertaking. Successful collaboration between clinicians, researchers (from academia and industry), and public health practitioners is essential to creating an environment that can foster and promote research to support public health decision making and health care implementation.

**Interventions to increase routine childhood immunizations in low socioeconomic populations: A systematic review**

*Sarah Edwards, Vineet Saini, Shaan Lally, Deborah McNeil*

**Introduction/Background:** Immunization rates for children have not reached targeted levels and evidence indicates that there is lower coverage for children with low socioeconomic status (SES) compared to high SES. Effective interventions to increase immunization rates in children have been identified including patient-oriented interventions (e.g. reminders for parents), provider interventions and system interventions. However, interventions that have been shown to work specifically for low SES populations have not been explored. A systematic review was conducted to identify effective interventions for increasing routine childhood immunizations in low SES populations.

**Methods:** A three stage strategy was used to conduct a search of the literature including five electronic databases (MEDLINE, EMBASE, CINAHL, EBMR, and PsycInfo), hand searches of the reference lists of all relevant articles and reviews and a gray literature search. Searches included combinations of terms for vaccination, including specific terms for routine childhood vaccines, and low SES. Limitations of being published in English, between 1990 and 2016, and from developed countries were used. Each relevant study was critically appraised using the Effective Public Health Practice Project Quality Assessment tool (EPHPP) by two assessors.

**Results:** A total of 41 intervention studies designed to increase routine childhood immunization rates in low SES populations were identified. A majority (90%) were conducted in the US and in urban settings (73%). Various types of effective interventions were reported including multi-component (56%), reminder/recall (17%), incentive/restriction (20%), outreach/tracking (5%) and support (2%). In total, 22% of the intervention studies were rated weak using the EPHPP quality assessment tool. Inter-rater reliability was excellent (intra-class correlation coefficient: 0.96, \( P < 0.0001 \)).
Conclusions/Implications for immunization research and evaluation: The quality of evidence for interventions to improve immunization rates for routine childhood vaccines in low SES populations is good. The interventions examined in low SES populations are similar to those explored in general populations and range from simple, low cost interventions such as letter/phone/text reminders to more complex, resource-intensive, multi-component interventions. There are a variety of effective interventions to significantly increase childhood immunization rates in vulnerable populations.

Invasive meningococcal disease in Canada, 2012 to 2014

Jenny Rotondo, Shalini Desai, Raymond Tsang

Introduction/Background: A variety of routine childhood and adolescent meningococcal vaccination programs using monovalent (serogroup C) and quadrivalent (A, C, Y, W) conjugate vaccines have been implemented in Canada since 2002, resulting in a decrease in invasive meningococcal disease (IMD) incidence, particularly in serogroup C. Meningococcal vaccines have also been used for outbreak response, including the multicomponent vaccine (4CMenB) in parts of Québec recently. This study describes the epidemiology of IMD in Canada from 2012 to 2014.

Methods: Case data were obtained from the National Enhanced IMD Surveillance System. Isolates were sent to the National Microbiology Laboratory for confirmation of serogroup and further studies including phenotype and clonal complex identification. Epidemiologic and laboratory data were linked retrospectively by probabilistic matching. Incidence rates (IRs) were calculated per 100,000 population.

Results: Reports of IMD continue to decrease, with a total of 379 cases reported from 2012 to 2014, corresponding to an annual average of 126 cases and an average annual IR of 0.36. Cases were most likely to occur in the winter (39%). Average IRs were highest among infants <1 (4.19), 1 to 4 (1.13), and 15 to 19 (0.92) year olds. Among the 48 cases reported in infants <1, 65% occurred before six months of age. Forty-one deaths were reported, with case fatality ratios ranging from 10% to 14% depending on serogroup. Infants <2 years accounted for 37% of cases that resulted in death. Serogroup B accounted for the majority of the 360 cases with serogroup information (68%), followed by Y (20%), C (8%), and W (4%). An average of 81 serogroup B cases were reported annually (average annual IR = 0.23). The median age of serogroup B cases was 17 years. Among cases with phenotype information (74%), the most common were B:17:P1.19 (21%), Y:14,19:P1 (9%), and B:4:P1.4 (7%). Among cases with clonal complex information (56%), the most common were ST-269 (36%), ST-23 (17%), and ST-41/44 (16%), occurring exclusively among serogroup B, Y, and W cases.

Conclusions/Implications for immunization research and evaluation: IMD is a rare but severe infection in Canada that mostly affects the very young and young adults. Serogroup B continues to account for the greatest proportion of disease.

Invasive pneumococcal disease (IPD) by serotypes 3/6A/19A in children after 13-valent (PCV13) and 10-valent (PCV10) pneumococcal conjugate vaccination in the United States and Finland

Jose A. Suaya, Raymond Farkouh, Heather L Sings, James Wassil, David L Swerdlow, Raul Isturiz, Luis Jodar

Background: The US routine infant PCV program (3+1 schedule) started with PCV7 in 2000 and was followed by PCV13 in February 2010. Finland’s program has used PCV10 (2+1 schedule) since September 2010. PCV13 contains 3 more serotypes (3, 6A, and 19A antigens) than PCV10. We compared IPD cumulative incidence trends between countries for these 3 serotypes in children because both countries have had similar implementation year, high vaccination rates, and clinical studies supporting licensure.

Methods: Annual serotype-specific IPD-cases/100,000 population for 2005–2014 in children aged 0–4 years was assessed. Data sources included publications from the US Active Bacterial Core surveillance, the Census Bureau, and the National Infectious Disease Register of Finland.
Results: In the United States, serotype-3 incidence has had a downward trend starting pre-PCV13; serotype-6A decreased post-PCV7 and was not seen post-PCV13. Serotype-19A dropped markedly by 93.6% (9.4 to 0.6) post-PCV13. In Finland, post-PCV10 incidence caused by serotype-3 increased by 400% and, except for 2012, serotype-19A incidence was overall similar to years pre-PCV10; serotype-6A continued to drop, a marked trend starting pre-PCV10 (Figure).

Conclusions: Continuation of robust surveillance systems for pneumococcal diseases monitoring worldwide, in the context of epidemiologic environment, vaccination schedules, and uptakes, will provide further clarification regarding direct effect against these 3 serotypes by the 2 PCVs currently licensed.

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Investigation of an excess of injection site reactions following immunization with measles, mumps, rubella and varicella (MMRV) vaccine in Quebec

Marilou Kiely, Marie-Noelle Billard, Eveline Toth, Joseline Zafack, Monique Landry, Gaston De Serres

Background: In Quebec, the MMRV vaccine is scheduled at 18 months of age and infants born since April 2013 received Infanrix hexa® at 2, 4 and 18 months. In January 2015, Proquad® replaced Priorix tetra® at 18 months. An excess of injection site reactions (ISR) following the administration of MMRV was reported in 2015 to the Quebec passive surveillance system of adverse events following immunization (AEFI) (43 cases in 2015 vs 4 cases annually on average for 2011-2014). Quebec was the only Canadian province to observe this type of excess and to have this schedule at 18 months. The aim of this study was to identify factors associated with this excess.

Methods: In Quebec, reporting AEFI is mandatory for health-care workers. All cases of ISR associated with an MMR±V or a DTaP-IPV-Hib±VHB vaccine received at 16-23 months of age from January 2015 to March 2016 were extracted from the provincial database. Large local reactions were defined as ISR that extended beyond the nearest joint or persisted for ≥4 days. Cellulitis had to be diagnosed by a physician with antibiotics prescription. The report comments were used for case validation and additional information on immunization history was obtained from the regional public health departments and the provincial vaccine registry.

Results: After validation, 52 cases were retained for analysis including 28 large local reactions (54%) and 24 cellulitis (46%). Four of them (8%) received Proquad® alone, 3 (6%) received Infanrix-hexa® alone and 41 (79%) received both vaccines with 66% (27/41) injected on the same limb. Most cases (71%) had a medical consultation following the event and 8% were hospitalized. Cases occurred in different regions and were not associated with specific lot numbers.

Conclusion: Preliminary analysis confirmed the excess of ISR associated with 18 months vaccines observed in 2015, which persists in 2016 and is associated with an increase of medical consultation compared with past years. However, no specific cause for this excess was confirmed. A case-control study will be conducted to test if co-administration of Proquad® and Infanrix hexa® at the same visit or in the same limb increases the risk of large local reactions and cellulitis.

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Is there evidence in the scientific literature to support the indirect effect of influenza immunization?

Anne Winter, Christina Renda, Bryna Warshawsky

Introduction/Background: Influenza continues to be a significant cause of morbidity and mortality in Canada. Populations at the greatest risk of severe complications from influenza infection are least likely to benefit from direct immunization due to their poor immunologic response. Vulnerable populations, in particular the elderly and those living in long-term care facilities, may benefit from indirect protection afforded by immunizing healthy populations (e.g., health care workers, school children, healthy adults).

Methods: A literature search was conducted using the MEDLINE and Embase databases for studies that explored the effect of immunizing healthy populations in order to provide indirect protection to populations at high-risk of complications from influenza infection. A total of 2068 articles were identified. Reference lists from relevant
systematic reviews were also searched for possible articles. A total of 44 articles were selected for final inclusion. A single reviewer determined if the articles met inclusion and exclusion criteria and the data was extracted by the same reviewer; extractions were then evaluated by a second reviewer. All articles were critically appraised by both reviewers.

Results: The majority of articles showed an indirect benefit of vaccinating children and/or adults on vulnerable populations such as the elderly and residents in long term care facilities. However, the validity and magnitude of the effect is difficult to assess due to the different vaccinated populations and coverage rates achieved, different study designs and outcomes, variability in influenza seasons and influenza vaccine effectiveness, as well as methodologic weaknesses of the studies. Additional results will be available for the presentation.

Conclusions/Implications for immunization research and evaluation: The literature demonstrated evidence of an indirect effect of vaccinating healthy children and adults, including health care workers. It is important to understand this indirect benefit as vaccinating healthy school age children and healthy adults distinguishes universal influenza vaccination programs from programs that target high risk groups. Given the methodologic limitations of the existing body of literature it is difficult to determine the magnitude of the indirect effect. Future studies should attempt to measure the indirect effect at achievable vaccination coverage rates and use laboratory confirmed outcomes in a number of intervention and control communities over a number of influenza seasons.

Knowledge, attitudes, beliefs and behaviors of college students and staff during a meningococcal B outbreak vaccination program: A Canadian Immunization Research Network (CIRN) study

Donna MacDougall, Joanne Langley, Shelly McNeil, Karina Top, Beth Halperin, Li Li, Donna MacKinnon-Cameron, Ann Swain, Julie Bettinger, Eve Dube, Gaston De Serres, Scott Halperin

Introduction: In February, 2015, an outbreak of Neisseria meningitidis type B was identified at a Nova Scotia university (~3500 students) and a mass Public Health-delivered vaccination program was implemented with the 4CMenB vaccine. Using an online survey, we explored the knowledge, attitudes, beliefs, and behaviors of members of the university community in relation to the disease, the vaccine, and the vaccination program.

Methods: All students, faculty, and staff eligible for the vaccination program were invited by email to participate in an anonymous, 71 item survey comprising 10 demographic, 1 awareness, 4 behavior, 7 knowledge, and 49 attitude and belief questions. The survey was distributed after completion of the first-dose clinics and reminders sent after completion of the second-dose clinics. Point estimates for each item were analyzed. Items significant at the p<0.05 in the univariate analysis were entered into the multivariate analysis.

Results: A total of 404 individuals responded to the survey; 75.8% of respondents who provided gender information were female. 306 (75.7%) respondents were students (response rate approximately 9% of the student body), with equal distribution from first to fourth year (20.6%-24.1% of those who provided their year of study); 9.8% were graduate students. 60.8% of respondents were science affiliated majors. Knowledge about meningococcal disease and the 4CMenB vaccine were generally high; 70.8%-96.8% correct responses were received on each knowledge question except for a question exploring the different serotypes of meningococci (49.0%). There were no significant differences between students and faculty or staff members in the responses to the knowledge questions. Being immunized or intending to be immunized was significantly (p<0.05) associated with gender (78% female vs 22% male) and higher knowledge scores (90.8% ≥4 vs. 9.2% <4 correct answers). In the univariate analysis, positive attitudes about immunization, concern about the infection, a sense of community responsibility and trust in public health advice also correlated with being vaccinated or intending to be vaccinated (p<0.05). A family physicians’ recommendation did not play a significant role in the decision whether or not to be immunized.
Conclusion/Implications: A successful mass vaccination program in a Nova Scotia University (vaccine uptake of 84.8% for dose 1 and 70% for dose 2) was associated with high levels of student knowledge, positive attitudes towards vaccination, and positive attitudes towards public health recommendations.

Life after ACCA: Causality assessment for serious adverse events following immunization (AEFI) in British Columbia and Manitoba

Monika Naus, Meena Dawar, Mark Bigham, Joselito Montalban, Tim Hilderman

Introduction/Problem identification: The National Advisory Committee on Causality Assessment (ACCA) sunset in 2010, and causality assessment for serious AEFI is now conducted by some provinces in Canada. British Columbia (BC) and Manitoba, supported by a federal project in vaccine safety, have each developed causality assessment processes.

Purpose: We aim to describe the process of development of the causality assessment schemes, as well as early experience with their use.

Methods/Evidence: Causality assessments developed by other bodies including ACCA, the Clinical Immunization Safety Assessment (CISA) Project, and the World Health Organization were reviewed. Relevance to the Canadian context, available diagnostic services, access to medical specialist services, and other resources required to support a standardized expert review of serious AEFI were considered. Criteria for events that warrant review were developed. Estimates of the number of events warranting review annually using historical reporting through the passive surveillance system were developed. Background rates of events (e.g., select neurological and autoimmune diagnosis, sudden unexpected death) due to any cause in the provincial population were obtained from administrative data bases to provide estimates of expected frequencies by age group and sex.

While the BC process incorporates components of all three source processes and the Manitoba process is more closely aligned with the CISA and WHO processes, both processes include consideration of the certainty of the diagnosis, association with vaccine versus injection/the act of immunization, potential sepsis, errors and anxiety, evidence for alternate causes, temporal relationship to vaccine receipt, prior occurrence of the event in the recipient with or without antecedent vaccine, and evidence from the literature of known or suspected association to vaccine and the highest strength of that evidence.

Both processes classify events as consistent, inconsistent or indeterminate. The BC process will conduct assessment at the regional level with central support, while the Manitoba process is conducted centrally with regional participation. Ten causality assessments have been completed in Manitoba and a pilot project has been completed in BC with provincial implementation in progress.

Significance of Findings/Outcomes for immunization research and evaluation: The experience of BC and Manitoba in development and implementation of causality assessment processes for serious AEFI will be of interest to Canadian jurisdictions contemplating similar processes to replace the national review process.

A literature review of strategies to increase uptake of the influenza vaccine among health care workers in hospitals

Anne Winter, Christina Renda, Bryna Warshawsky

Introduction/Background: Influenza is a significant cause of morbidity and mortality in Canada. To reduce influenza transmission to vulnerable populations, Canada’s National Advisory Committee on Immunization (NACI) and the Advisory Committee on Immunization Practices (ACIP) in the United States recommend annual influenza vaccination for health care workers (HCWs). Various strategies have been used to increase HCW influenza immunization rates, including implementing ‘vaccinate or mask policies’.
**Methods:** We conducted a literature review of strategies to promote uptake of influenza vaccine in HCWs. Articles were included in the final review if they were primary studies conducted in hospitals or were systematic reviews of publications that explored the effect of various strategies on hospital HCW rates. Twenty-five articles were selected for inclusion. A single reviewer determined if the articles met inclusion and exclusion criteria and the data was extracted by the same reviewer; extractions were verified by a second reviewer.

**Results:** The literature suggests that success of initiatives to increase HCW immunization vary and are influenced by factors including hospital size and patient population served. In addition, many studies implement more than one strategy at a time and thus it is difficult to discern the exclusive effect of each initiative. Overall, promotional strategies alone are less effective and require consistent, sustained efforts to maintain. Higher rates are achieved when multiple strategies are implemented simultaneously, with the highest uptake achieved following the implementation of a mandatory immunization policy, which achieved HCW immunization rates over 90%. ‘Vaccine or mask policies’ achieved vaccination rates ranging from mid-80% to high 90%. In several studies, these HCW immunization rates were sustained over time. Use of declination forms was found to result in modest increases in immunization rates in some articles but not others.

**Conclusions/Implications for immunization research and evaluation:** Evaluating strategies to achieve high HCW immunization rates is challenging. Published systematic reviews of the various strategies often exclude the majority of relevant studies due to methodologic weaknesses. Study methods were often heterogeneous and thus precluded meta-analyses that could provide more robust estimates. It was noted that many initiatives required significant and sustained investment of resources to maintain their success.

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**Maternal perceptions of childhood vaccination: Reasons for and against**

**Melissa Mueller, Deborah A. McNeil, Shannon MacDonald, Sheila McDonald, Vineet Saini, James D. Kellner, Suzanne Tough**

**Introduction/Background:** Understanding reasons for and against vaccination from the parental perspective is a critical component for designing vaccination campaigns and informing other interventions to increase vaccination uptake. The objective of this study was to understand maternal vaccination decision making for children.

**Methods:** Mothers participating in the longitudinal community-based pregnancy cohort study, the All Our Babies study in Calgary, Alberta, completed open-ended survey questions on reasons for vaccinating or delaying/not vaccinating their child by 24 months postpartum. One team member, using content analysis, identified codes and categories and the remaining team developed sub-themes and themes. Qualitative responses were also linked to administrative vaccination records to examine survey responses and recorded vaccination status (none, partial, complete, missing).

**Results:** Open-ended responses were available from 1560 women at 24 months postpartum; 89% (n=1391) provided reasons for vaccinating, 5% (n=79) provided reasons for not vaccinating/delaying, and 6% (n=90) provided reasons for both. All three major themes and most sub-themes were the same regardless of a mother’s vaccination decision, however; interpretation was different depending upon a mother’s decision. Three broad themes were: 1) Influencers on decision making which included personal, family, and external experiences. 2) Reasons common to both perspectives were risk, research, effectiveness, and balancing risks and benefits. Responsibility was a reason for those vaccinating; while choice, instrumental/practical, and health issues were the reasons for those not vaccinating or delaying. 3) Context of decision making encompassed a mother’s level of conviction and motivation. External or internal motivation was evident in 40% of respondents while a strong level of conviction either for or against vaccination was evident in approximately 50% of respondents. Of those who provided reasons for vaccinating (n=1391), the majority (81%) were completely vaccinated.

**Conclusions/Implications for immunization research and evaluation:** Immunization decision making is complex and can be impacted by interplay of many factors that are similar but contribute to different decisions.
depending on mothers’ perspectives. The results of this study can help inform nuanced strategies to target interventions or strategies. Examples include: addressing maternal knowledge gaps related to risks and benefits; enhancing paradigms of collective responsibility; and addressing instrumental barriers through vaccine delivery systems or approaches.

**Mind the gender gap: Assessing sex-specific differences in adverse event following immunization reporting in Ontario, 2012-15**

*Tara Harris, Kenny Wong, Jyotsna Nair, Jill Fediurek, Shelley L Deeks*

**Introduction/Background:** Female predominance in adverse events following immunization (AEFIs) reporting is consistently observed in passive vaccine safety surveillance systems. Reasons for this may include differences between males and females in vaccine uptake and healthcare-seeking behaviour, as well as growing evidence suggesting that sex-specific responses to vaccines may play an important role. Our objective was to assess sex-specific trends in AEFI reporting within the provincial AEFI surveillance system.

**Methods:** AEFIs reported in Ontario following vaccines administered between January 1, 2012 and December 31, 2015 were extracted from the integrated Public Health Information System on May 1, 2016. The female-only human papillomavirus vaccine program was excluded. Events were grouped by provincial surveillance AEFI definitions. Reporting rates were calculated using provincial population estimates as the denominator. The standard World Health Organization serious AEFI definition was used.

**Results:** There were 1,632 AEFI reports over the four year period, 66.2% were female. The annualized sex-specific reporting rates for females and males were 5.9 and 3.0 per 100,000 population, respectively. Female to male reporting rate ratio (RRR) varied by age and was highest among adults 18-64 years (6.8), whereas no differences were observed in children <10 years. Within routine, publicly funded vaccines, RRRs were highest for tetanus-diphtheria (10.0), tetanus-diphtheria-acellular pertussis (4.0) and influenza (2.9) vaccines. RRRs for adverse events were highest for allergic events (2.2) and injection site reactions (2.1). The RRR for serious AEFIs was lower at 1.3 and the proportion of male AEFIs reported that were serious (5.7%) was higher than among females (4.0%). Male AEFIs were also slightly more likely to have had medical consultation, an ER visit or hospitalization (77.7% vs. 73.2%, 23.0% vs. 19.7% and 5.6% vs. 4.2%, respectively). Self-reported AEFIs were predominantly female (81.1%) compared to other reporting sources.

**Conclusions/Implications for immunization research and evaluation:** Female predominance in AEFI reports is observed primarily in adults and within specific events and vaccines typically targeted to adult age groups. We found disproportionate reporting of non-serious AEFIs and those that did not require medical attention among females. Further analysis is needed to understand the relationship between AEFI reporting and sex.
auprès du personnel en vaccination ; comptes rendus ; feuilles de route remplies par les participants (responsables des programmes et services de vaccination) ; notes de terrain et fiches de suivi colligées par l’équipe de recherche. Des analyses de contenu et une triangulation des données ont été réalisées.

**Résultats** : Les éléments favorables à l’élaboration et à l’implantation du modèle sont la rigueur des travaux, les liens de confiance tissés, les diverses rencontres et techniques d’animation employées, la mobilisation générée par la révision des façons de faire. Ils ont permis de donner un souffle nouveau aux services de vaccination chez tous les acteurs. Les participants ont développé leurs connaissances ou expertise afin de réfléchir aux meilleures pratiques organisationnelles en vaccination. Les membres des équipes se sont sentis partie prenante au projet, suscitant une mobilisation et une sensibilisation accrues par rapport à la vaccination. Les parents sont davantage sensibilisés au respect du calendrier. La contribution des agents administratives au processus de vaccination a été reconnue. Les vaccinatrices ont émis un besoin de formation en entretien motivationnel. Finalement, une culture d’amélioration continue dans les équipes de vaccination s’est développée (ex : qualité de l’acte vaccinal).

**Conclusions/Conséquences pour la recherche et l’évaluation en immunisation** : Si la dimension recherche a permis de disposer d’un portrait des activités de vaccination et d’un modèle éprouvé d’organisation des services de vaccination aux 0-5 ans, la partie action, soit le processus de l’étude, a aussi été porteur de changements.

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**Monitoring medication errors following vaccination**

*Battouli Said Salim, Jhona Rose, Jim Gallivan, Duc Vu*

**Introduction/Problem identification** : Millions of vaccine doses are administered safely every year. However, errors may occur during the production, prescribing, dispensing and/or administration of vaccines. These types of errors may or may not cause adverse events following immunization (AEFIs).

Information on patterns of medication errors (MEs) and potential MEs are relevant to the interpretation of the safety and overall benefit-risk evaluation of vaccines. However, there has been little systematic analysis of the reporting rates and outcomes of MEs for vaccines marketed in Canada.

**Purpose** : To analyze reports of MEs for vaccines marketed in Canada to provide an overview of reporting rates, causes and outcomes.

**Methods/Evidence** : Health Canada reviewed reports of MEs presented in Periodic Safety Update Reports (PSURs) and reports submitted to the Canada Vigilance (CV) database from January 2011 to December 2014. Search terms were included in the MedDRA High Level Group Terms for MEs under the System Organ Class of “Injury, poisoning and procedural complications”.

The reporting rate for MEs in PSURs was 1 to 28 cases/100,000 doses. For vaccines reporting ≥ 6 MEs/100,000 doses, a single ME, such as mixing error, tended to dominate. For non-human errors, manufacturers described corrective measures to address the problem. The most common ME reported was “drug administration to patient of inappropriate age”. Most ME reports (79-97%) were without other AEFIs. Of the reports with other AEFIs, 0.1 to 5% were serious. The most frequently reported serious AEFIs were pyrexia and vaccination site reactions.

There were 390 reports of MEs in the CV database. Of these, 79% were without other AEFIs. The most commonly reported MEs were: drug administration to patient of inappropriate age, inappropriate schedule of drug administration and expired product administered. These terms were also most likely to have other AEFIs reported. Among the ME reports with other AEFIs, 65% were serious. The most commonly reported serious AEFIs were pyrexia, vaccination site pain, headache, and myalgia.

**Significance of Findings/Outcomes for immunization research and evaluation** : The reporting rate for MEs was 1-28 cases/100,000 doses. Most reported MEs were human errors with no other side effects. Pyrexia and local reactions were the most common serious AEFIs.
Monitoring of lack of effectiveness/vaccination failure

Gloria Giraldo, Jhona Rose, Jim Gallivan, Duc Vu

Introduction/Problem identification: Millions of doses of vaccines are administered annually for the prevention of diseases. However, vaccines are not 100% efficacious or effective. Lack of effectiveness (LoE)/vaccination failure (VF) may have public health consequences. Monitoring LoE/VF is an ongoing challenge, but is essential for the evaluation of the safety and benefit-risk of vaccines marketed in Canada.

Purpose: To analyze reporting rates (RRs), causes and outcomes in spontaneous reports of LoE/VF for vaccines marketed in Canada to assess the utility of spontaneous reports of adverse events following immunization (AEFIs) in monitoring LoE/VF.

Methods/Evidence: Health Canada reviewed reports of LoE/VF presented in Periodic Safety Update Reports (PSURs), and in AEFI reports submitted to the Canada Vigilance (CV) database from January 2011 to December 2014. Search terms included MedDRA preferred terms (PTs) for LoE/VF, as well as PTs indicative of LoE specific vaccine-preventable diseases. Data from these two sources were assessed using criteria defined by manufacturers or CIOMS/WHO to identify cases of confirmed or suspected VF.

The reporting of LoE/VF in PSURs was variable. Only 3 of 38 PSURs included a specific definition of LoE, and only 14 reported confirmed cases. RRs of confirmed VF ranged from 0.013-2.73/1,000,000 doses, and from 0.22-15.55/1,000,000 doses for non-confirmed VF. Vaccines with high efficacy for rare diseases (i.e. MMR) had higher reporting rates than those vaccines with low efficacy for common diseases (i.e. influenza). Waning of immunity was an identified problem (i.e Tdap).

There were 208 reports of LoE submitted to the CV database; about 10% of the AEFI reports submitted during the period. For the LoE reports, 69% of were “reported” cases with limited information, 20% were “failure to vaccinate,” 10% were suspected vaccine failure, and 1% were confirmed vaccine failure that resulted in a vaccine-preventable disease.

There was no correlation between the number of reports of LoE/VF received by CV and the RRs in the PSURs.

Significance of Findings/Outcomes for immunization research and evaluation: The RR for LoE/VF was low, and most reports lack sufficient information to confirm LoE/VF. Spontaneous reports provide limited information for the monitoring of LoE/VF.

New vaccine storage and handling resources for British Columbia (BC) health professionals

Shaila Jiwa

Introduction/Problem identification: Vaccines are sensitive biological products that must be stored and handled appropriately. Failure to do so can compromise vaccine integrity and result in vaccine wastage. In BC, a wide variety of health professionals are responsible for storing and handling vaccines. These professionals are expected to follow cold chain principles and provincial vaccine management guidelines outlined in the BC Immunization Manual. In an effort to improve knowledge on storage and cold chain guidelines, the BC Centre for Disease Control (BCCDC) identified the need for simpler vaccine management resources that appealed to the broad spectrum of individuals who handle vaccines. As a result, the BCCDC developed the Vaccine Storage and Handling Quick Reference Guide as well as the Vaccine Storage and Handling Online Course.

Purpose: The purpose of the Vaccine Storage and Handling Quick Reference Guide as well as the Vaccine Storage and Handling Online Course is to:

- Consolidate provincial and national vaccine management guidelines.
- Present information in an easy to read and engaging format.
- Provide guidance to all health care professionals who handle vaccines.
Methods/Evidence: Upon completion of the Vaccine Storage and Handling Online Course, users can complete a voluntary and anonymous online survey to assess whether the course meets their needs. Results compiled from July 8 2015 to May 31 2016 indicate that the majority of users found the online course to be an appropriate learning tool, time efficient, and helpful in their practice.

While there is no formal evaluation for the Quick Reference Guide, initial feedback has been positive.

Significance of Findings/Outcomes for immunization research and evaluation: The positive feedback on BC’s new vaccine storage and handling resources demonstrates the need for health professionals to have immunization related information presented in a consolidated and user-friendly way. These resources support the continued success and uptake of vaccines.

An outbreak of mumps in a population of young adults left susceptible by Canada’s evolving vaccination schedules

Althea Hayden, Margot Smythe, Sarah Forsting, Monika Naus, Alex Nunn

Introduction/Problem identification: In British Columbia (BC), the incidence of mumps has been low since routine immunization with a single dose of MMR was introduced in 1981. A second dose of MMR was not added until 1996, leaving a large under-vaccinated age cohort. A similar susceptible cohort exists throughout much of the developed world.

In 2011, there was a large outbreak of mumps in this cohort in Whistler, BC and the surrounding area, which primarily falls within Vancouver Coastal Health (VCH). Whistler is a popular tourist destination that attracts visitors and seasonal employees from around the world; it also hosts a variety of events and festivals. In 2016, a second outbreak of mumps was seen in the VCH region.

Purpose: Describe the outbreak and identify opportunities to prevent future outbreaks in this susceptible population.

Methods/Evidence: An outbreak of mumps was identified through routine surveillance with initial cases in the Vancouver area, and subsequent spread to Whistler. Outbreak response included targeted vaccination, communication to health care providers, business leaders in Whistler, and the general public.

In 2016 there were 74 cases of mumps in VCH. Cases resided in Vancouver (42%), Whistler (43%), and throughout the region (15%). The median age was 30 years (range 16-70). Nearly all cases (97%) reported being immunized, but documentation was highly incomplete. Most cases (85%) were in the age cohort offered one dose of mumps vaccine in childhood. Fifty-four percent were Canadian, 26% from outside of Canada, and 19% of unknown nationality. The outbreak strain was genotype G, typified by sequence variant MMR 16-0155, MuVs/BC. CAN/13.16.

Significance of Findings/Outcomes for immunization research and evaluation: Early transmissions were identified following a mass gathering event in Vancouver and the outbreak was propagated by multiple events in Whistler. This mirrored the 2011 mumps outbreak. Within Whistler transmission occurred among young adults working in tourism/hospitality who live in congregate settings. These same factors facilitated subsequent regional spread.

These outbreaks highlight the consequences of our evolving immunization schedules, which left a large age cohort with incomplete immunity. Since 2009, BC has recommended a second dose of mumps containing vaccine for this age cohort, but no catch up campaign was implemented. Regular vaccine campaigns targeted at seasonal workers in Whistler, BC as well catch up of this young adult cohort may prevent future outbreaks.
Paediatric invasive pneumococcal disease (IPD) post pneumococcal conjugate vaccines in Toronto/Peel Region, Canada, 2001–2015

Karen Green, Ms Wallis Rudnick, Jeff Li, Agron Plevneshi, Sylvia Pong-Porter, Allison McGeer, Toronto Invasive Bacterial Diseases Network

Introduction/Background: In 2001, the first pneumococcal conjugate vaccine (PCV) was authorized in Ontario, Canada. Publicly funded PCV7 was introduced in Jan/2005, PCV10 in Oct/2009 and PCV13 in Nov/2010. TIBDN performs population-based surveillance for invasive pneumococcal disease (IPD) in Toronto/Peel and describes changes in incidence and serotype distribution.

Methods: IPD cases are reported to a central office and one isolate/case is serotyped at a central lab. Demographic and clinical data are collected by chart review and patient/physician interview. Residence in Toronto/Peel is defined by a patient’s postal code (Statistics Canada 2011 census data).

Results: From 2001–2015, 1083 IPD cases were identified in children (<15 years). Among children <5 years, IPD due to PCV13 serotypes decreased from 15/100000/year in 2009 to 2/100000/year in 2015. Among children ≥5 years, the rate of PCV13 IPD remained between 1 and 2/100000/year between 2009 and 2012 and then decreased to 0.3–0.8/100000/year in 2013–2015. NonPCV IPD has remained constant (between 1 and 2/100000/year from 2009-2015).

In 2015, 39 IPD cases were reported in children: no cases of meningitis, two cases requiring ICU admission, and no deaths. Serotype was available for 39 (100%) isolates. Serotypes associated with ≥3 episodes were: 19A(6), 3(6), 22F(5), 15C(4), 15B(4), and 23A(3). 26 (67%) cases were due to nonPCV serotypes. No cases were due to a PCV7 serotype. One IPD case was due to a serotype included in PCV10 (7F); this case occurred in a four-year old child with atrial septic defect, who was incompletely immunized (three doses of PCV13 at 2, 5 and 6 months of age).

Twelve cases of IPD were due to serotypes included in PCV13/notPCV10. Of these, three were not eligible to have received PCV13 (two were aged >35 months when the vaccination program with catch-up was implemented in Ontario and one was 17 days old). One vaccine failure was identified in an apparently healthy four-year old who developed pneumonia due to serotype 19A after vaccination with three PCV13 doses at 5, 7 and 16 months.

Conclusions/Implications for immunization research and evaluation: Since PCV13-program implementation, the IPD rate due to PCV13 serotypes has decreased among children. NonPCV IPD has remained constant.

Partnering to improve Influenza vaccine uptake in the Labrador Inuit communities of Nunatsiavut

Sylvia Doody, Tina Buckle

Introduction/Problem identification: Within the Nunatsiavut region health care delivery falls under the jurisdiction of two separate service providers. The mandate for public health and home care rests with the Nunatsiavut Government Department of Health and Social Development (DHSD) and primary care is provided by the province of Newfoundland and Labrador through Labrador Grenfell Regional Health Authority (LGH). To ensure seamless healthcare services for residents throughout the region strong partnerships across providers is essential. A huge undertaking each fall is the Influenza vaccination clinics which require continuous commitment and partnership between both organizations. Given the remoteness and limited resources within these isolated communities the need for prevention through immunization is even more critical because of the social determinants of health present in these communities and the potential for disease to become widespread.

Purpose: Each year within the province of Newfoundland and Labrador there are deaths associated with Influenza. The Labrador Inuit communities of Nunatsiavut are situated in the remote and isolated area of Northern Labrador. Due to geography, availability of acute care services in these communities are limited and residents have to be flown out of their community to access tertiary care. Given that clients with suspected or
confirmed Influenza are generally very ill and require acute respiratory services the goal is to focus on prevention and health promotion within the communities through vaccination and promotion of handwashing.

**Methods/Evidence:** The partnership starts from planning right through to implementation and after the clinics have been completed. During the planning phase both partners are engaged to ensure the necessary planning and preparation is in place to roll out the Influenza clinic. During the implementation phase, again staff are engaged and actively involved in the community Influenza clinics. Finally, even after community Influenza clinics have been completed, staff continue to be vigilant in health promotion and vaccine administration for those who may have missed this scheduled clinics.

**Significance of Findings/Outcomes for immunization research and evaluation:** Through our partnership with LGH, Influenza coverage rates throughout Nunatsiavut have remained comparable to the regional average and in some communities rates have been higher.

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**Perceptions of human papilloma virus related disease among adolescents and parents in Ontario**

_Anierhe Joan Abohweyere, Fatima Bhetasi, Trish Tulloch, Natasha Johnson, Hirotaka Yamashiro_

**Introduction/Background:** The human papilloma virus (HPV) is a well-established cause of many diseases in both males and females. The causal link between HPV and female cervical cancer is perhaps best known among the general public. Its causal relationship to other health issues as well as its mode of transmission may be less well known. The HPV vaccine has been administered to adolescents in many developed countries including Canada for more than a decade. This study aimed to ascertain the knowledge and perceptions of Ontario adolescents and their parents regarding HPV related diseases.

**Methods:** Anonymous paper surveys were administered to adolescents and their parents attending two healthcare facilities in Southern Ontario. The first was a Community Health Centre for Youth and the second, a Paediatric Group Practice.

In addition, paediatricians completed anonymous online surveys with minor variations from the paper one.

**Results:** One hundred and twenty-three (123) adolescents were surveyed of whom, 70% were female. Forty-two percent (42%) reported that they knew what the human papilloma virus was; 68% believed it caused female genital cancer and 37% male genital cancer. Only 23% and 18% identified it as a cause of oropharyngeal and anal cancers respectively. Over one third of respondents (35%) believed transmission only occurred through vaginal intercourse.

Fifty-one parents responded of whom, eighty-six (86%) percent had children aged 11 – 19 years. Forty-seven percent (47%) reported that they knew what the Human papilloma virus was. Whilst 86% of parents identified the virus as a cause of female genital cancer, only 35% knew it caused male genital cancer. Only 25% thought the virus was a cause of oropharyngeal cancers and 15% for anal cancers.

**Conclusions/Implications for immunization research and evaluation:** Significant gaps in the knowledge of Ontario adolescents and parents about the Human Papilloma Virus have been identified. Further education of adolescents and parents about HPV, its transmission, and the various diseases associated with the virus is warranted.

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**Pertussis in Ontario: age-specific trends with suggestion of waning immunity among tweens**

_Ch Yon Seo, Jill Fediurek, Sarah Wilson, Shelley Deeks_

**Introduction/Background:** Pertussis is endemic with cyclical peaks occurring every two to five years. Acellular pertussis vaccine is administered as part of routine immunization schedules and given over the lifespan; however, there is suggestion of decreased vaccine effectiveness in the acellular compared with the whole cell pertussis vaccine. Our objective is to describe the epidemiology of pertussis in Ontario.
Methods: We extracted confirmed and probable pertussis cases reported between January 1, 2010 and December 31, 2015 from the integrated Public Health Information System (iPHIS) on May 27, 2016. We calculated incidence rates using population estimates (2010-14) and projections (2015) obtained through IntelliHealth Ontario. We included pertussis-containing vaccines received at least 42 days after birth date and 14 days before disease onset in the immunization status assessment.

Results: Between 2010 and 2015, 2,708 cases of pertussis were reported in Ontario. The annual incidence was highest in 2012 and lowest in 2010 (7.8 and 0.9 cases/100,000 population, respectively). Cases ranged in age between <1 week to 91 years (median 10 years). Annualized age-specific incidence was highest among infants <1 year (50.2 cases/100,000 population) and lowest among those ≥65 years (0.5 cases/100,000 population). Among all cases under surveillance, 7.1% were hospitalized; in which 79.1% were among infants <1 year. Two-thirds of cases had a known immunization status and of those, 53.0% (957/1807) were unimmunized. Among the 850 immunized cases, 48.5% had received ≥5 doses. For cases 7-13 years of age, 78.9% had a known immunization status and of those, 34.5% (164/476) were unimmunized. Among the 312 immunized 7-13 year olds, 74.0% had received ≥5 doses and 54.5% of those had disease onset ≥6 years after the receipt of last dose.

Conclusions/Implications for immunization research and evaluation: Despite routine immunization programs, pertussis remains endemic in Ontario with infants at the highest risk of disease and hospitalization. Cases among 7-13 year olds immunized with ≥5 doses of pertussis-containing vaccine and considered up-to-date are suggestive of waning immunity associated with acellular pertussis vaccines. Continuous improvements in immunization data quality is essential in further evaluating vaccination status of pertussis cases and supporting surveillance activities in the province.

Pertussis outbreak in a large health region in Saskatchewan
Olanrewaju Medu, Maureen Anderson, Andrea Enns, Judith Wright, Terry Dunlop, Rosalie Tuchscherer, Simon Kapaj, JohnMark Opondo

Introduction: In early September 2015, Saskatoon Health Region (SHR) disease control department detected an increase in pertussis cases in Saskatoon with subsequent increases in rural communities. A health region wide outbreak was declared to facilitate the redistribution of resources for enhanced clinical and population health management.

Purpose: To describe the epidemiology of the current outbreak and identify possible predictors of the outbreak. We also reviewed the interventions implemented to address the outbreak.

Methods: Confirmed pertussis cases in Saskatoon Health Region from 2010 to 2016 were extracted from the integrated Public Health Information System (iPHIS) database. Descriptive data analysis and a comparison between 2010 and 2015/16 outbreaks was conducted. A Poisson regression model was used to determine the incidence rate ratios (IRR) of factors associated with pertussis infection. In addition, the health region’s response to address the outbreak is described.

Outcomes: Between 2010 and 2016, SHR experienced two pertussis outbreaks (2010; n=6 (rural) n=69 (urban) and 2015/16; n=74 (rural); n=39 (urban). Risk factors for disease were similar between the two outbreak years. Factors associated with 2015/16 infection include adults (IRR = 1.30; 95% CI: 1.22 - 1.40) and teenagers (OR = 1.25; 95% CI: 1.14 - 1.31) compared to children. Other statistically significantly factors include: residency in specific rural communities (p<0.0001) and unsure immunization status (p<0.0001). Targeted communication, enhanced contact tracing, and immunization clinics were conducted in various locations; cocooning vaccination strategy was also employed.

Significance: Pertussis is a cyclical disease. Several risk factors were statistically significantly associated with the recent outbreak in SHR, including, age, location and immunization status. Adults and teenagers were at increased risk compared to children younger than five years of age; possibly indicative of waning immunity. A known pool of susceptibles in a specific rural community of conscientious objectors had a higher incidence rate.
A phase 1 randomized, placebo controlled clinical trial assessing the safety and immunogenicity of a recombinant vesicular stomatitis virus Ebola vaccine in healthy adults

May ElSherif, Catherine Brown, Donna MacKinnon-Cameron, Shelly McNeil, Joanne Langely, Scott Halperin

Introduction/Background: The 2013/14 Ebola virus disease (EVD) outbreak in West Africa was the most widespread in history. After demonstration of protection in non-human primates (NHP), a live attenuated recombinant vesicular stomatitis virus (rVSV) vaccine expressing the Zaire Ebolavirus glycoprotein (ZEOV-GP) warranted evaluation in humans. Preliminary safety data from other studies offered the opportunity to design a phase 1 trial without staggered dosing to evaluate three vaccine doses.

Methods: In a phase 1 randomized, dose-ranging, double-blind, placebo-controlled trial, 40 healthy adults aged 18 – 65 years were randomly allocated in 4 groups of 10 to receive a single injection of one of three dose levels of rVSV Ebola vaccine (1x10^5 plaque forming units (pfu), 5x10^5 pfu, and 3x10^6 pfu per 1ml injection volume) or normal saline placebo administered intramuscularly. Eight follow-up visits spanned 180 days post-vaccination for safety and tolerability monitoring, immunogenicity testing, and presence of rVSV vaccine virus in blood, urine and saliva by polymerase chain reaction (PCR). Safety monitoring included Physician Safety Monitor and Data Safety Monitoring Board (DSMB) reviews.

Results: The majority of adverse events (AEs) were mild or moderate, no severe AEs were identified. Transient hematologic changes consistent with live attenuated virus vaccination were observed. With all three doses, there was no PCR evidence of virus shedding. Viremia was 80% among the highest dose group at day 3; by day 7, it was 0% across all groups. Seroconversion (4-fold increase) by ELISA and neutralization assays reached 100% and 78%, respectively.

Conclusions/Implications for immunization research and evaluation: No safety concerns were observed with administration of the rVSV ZEOV-GP vaccine. The three doses that were tested demonstrated consistent immune responses. Study data supports further evaluation of this vaccine in phase 2 trials.

Pneumococcal conjugate vaccines’ (PCVs) effect against invasive pneumococcal disease (IPD) related to serotype 19A: Evidence from national surveillance programs


Background: To assess the effect on serotype (ST) 19A following the introduction of PCVs containing the 19A ST in its formulation (PCV13) vs the cross-reactive 19F ST (PCV7/PCV10), we review the post-introduction IPD data from publically available surveillance systems.

Methods: Publically available data for 12 countries with robust surveillance for IPD were analyzed.

Results: The number of cases of serotype 19A IPD increased after PCV7 or PCV10 introduction in children eligible for vaccines in Brazil, Chile, New Zealand, the United States, and Norway (see Table). In Finland, a decrease in 19A IPD cases was observed during the first 2 years after vaccine introduction among children aged <5 years and has since risen to pre-vaccine levels. In those aged >5 years, the number of 19A IPD cases has steadily increased since PCV10 introduction in each country examined except for the Netherlands. In contrast, since the introduction of PCV13 in the United States, France, Norway, and the United Kingdom, immediate reductions in 19A IPD have been observed in all age groups.
Conclusions: Data from surveillance programs around the world suggest that the introduction of PCVs containing ST 19F, but not 19A, may induce short-lived benefits in children aged <5 years, but not in individuals aged >5 years. In contrast, the introduction of PCV13, which includes ST19A in its formulation, has shown to substantially reduce the number of cases in all age groups.

Post hoc analysis of the 13-valent polysaccharide conjugate vaccine efficacy against vaccine-serotype pneumococcal community acquired pneumonia in at-risk older adults

Jose A Suaya, Qin Jiang, Marc Bonten, Scott Patterson, Cornelis H van Werkhoven, Daniel Scott, William C Gruber, Chris Webber, Beate Scmoele-Thoma, Cassandra Hall-Murray, Gregg Sylvester, Luis Jodar, Raul Isturiz

Background: The Community-Acquired Pneumonia Immunization Trial in Adults, a randomized, double-blind, placebo-controlled clinical trial involving 84,496 adults, demonstrated that vaccination of adults ≥65 years with 13-valent pneumococcal polysaccharide conjugate vaccine (PCV13) is efficacious in preventing vaccine-type pneumococcal community-acquired pneumonia (VT-CAP) and VT invasive pneumococcal disease.

Methods: To address requests from public health authorities such as the U.S. Advisory Committee on Immunization Practices, we used similar definitions, analyses (per-protocol of first episode), statistical method (calculation for vaccine efficacy (VE) and confidence interval (CI)), and data from this trial, to perform a post-hoc sub-analysis to assess vaccine efficacy against VT-CAP and Streptococcus pneumoniae CAP (Sp-CAP) in at-risk individuals. At-risk classification was based on at least one of the following self-identified medical conditions reported prior to vaccination: heart or lung disease, asthma, diabetes with or without insulin use, liver disease, and smoking. No medical record verification was performed.

Results: Of the 84,496 adults in this study, 41,630 or 49.3% were at-risk, (20,804 in PCV13 and 20,826 in placebo groups). VT-CAP was identified in 43 and 72 at-risk subjects in the PCV13 and placebo groups, respectively, implying a VE of 40.3%; (95.2% CI: 11.4-60.2); Sp-CAP was identified in 81 and 116 at-risk subjects in the PCV13 and placebo groups, respectively, implying a VE of 30.2% (95%CI: 6.5-48.1).

Conclusions: In this post-hoc exploratory analysis of individuals at-risk, we observed statistically significant estimates of PCV13 efficacy against VT-CAP and Sp-CAP that were overall similar to those estimates for the entire study population (i.e., 45.6% and 30.6%, respectively) previously published.

Predicting the efficacy of the adjuvanted trivalent influenza vaccine based on haemagglutination-inhibiting antibody titers and clinical protection in adults 65 years of age and older

Van Hung Nguyen, James Mansi

Background: A number of studies have shown higher antibody responses of the adjuvanted trivalent influenza vaccine (aTIV) versus standard unadjuvanted split virus and subunit trivalent influenza vaccines (TIV). Evidence suggests that aTIV in older adults results in enhanced protection against influenza infection. Despite their pivotal role in the assessment of influenza vaccines, limited attempts have been made to use immunogenicity data from haemagglutination inhibition (HI) titers to predict vaccine efficacy. Understanding the relationship between HI titers and vaccine efficacy would be important for public health vaccination decision making. Here we present the results from an application of a bayesian random-effects model comparing aTIV to TIV.

Methods: We constructed the predicting model estimating the level of protection against laboratory-confirmed influenza from HI titres by using the published research from Coudeville et al. (BMC Med Res Methodol. 2010 Mar 8;10:18.). Vaccine efficacy and differences in vaccine efficacy were then predicted using results of clinical trials in adults 65 years of age and older, providing comparative information on the immune response generated by aTIV and TIV. The predicted efficacy increases were then compared to results of vaccine efficacy trials to validate the model.
Results: Pooling available immunogenicity data in adults aged 65 years and older, the HI protection model predicted a relative increase in vaccine efficacy for the adjuvanted product. In public health terms, compared to a theoretical TIV only strategy, switching to aTIV could reduce the remaining number of cases by 33.53 % [95 % CI 22.70 %; 42.58 %], 45.39 % [95 % CI 37.01 %; 52.88 %], and 12.78 % [95 % CI 1.04 %;18.12 %] for A/H1N1, A/H3N2, and B lineages respectively.

Conclusion: This analysis confirms that the higher immune response elicited by aTIV, is predicted to translate into greater vaccine efficacy compared to standard TIV. This efficacy increase could translate into substantial reductions in influenza related disease and related complications in this vulnerable segment of the population.

Preparedness for and response to meningococcal outbreaks: preliminary safety results of a Canadian Immunization Research Network (CIRN) randomized controlled trial of two schedules of 4CMenB vaccination in adolescents and young adults

Joanne Langley, Soren Gantt, Caroline Quach, Joenel Alcantara, Julie Bettinger, Scott Halperin, Brian Ward, Shelly McNeil, Jill Mutch, Donna MacKinnon-Cameron, Kim Marty, David Scheifele

Introduction: Emergency vaccination programs are often needed when outbreaks of Meningococcal B (MenB) disease in young adults attending university occur. The four component MenB vaccine (4CMenB, Bexsero®, Novartis, GlaxoSmithKline) is authorized for persons 2 months through 17 years of age in Canada, but there is limited data on safety and immunogenicity in persons >17 years or on various dosing schedules.

Methods: A randomized, controlled, observer-blinded trial comparing an accelerated 4CMenB schedule (0, 21 days) compared to a standard schedule (0, 60 days) was conducted during the academic year (Sept 2015-April 2016) in persons 17-25 years of age, in stable health and attending school, at three sites. The first dose in both groups was 4CMenB vaccine. Solicited local and systemic adverse events (AE) days 0-6 post vaccine and unsolicited events days 0-21 were collected on memory aids. Analysis of immune responses on Days 0, 21, 42, 81 and 180 is underway.

Results: Among 121 participants the mean age was 21.4 years (range 17.0, 26.0); 69.4% (n=84) were female. Any solicited AE occurred in 100%, 73.7 and 78.0% post doses 1, 2 and 3 respectively. One serious AE (fractured patella) occurred. The most common solicited AE Day 0-6 was local: pain at the injection site in 99.2%, 64.4% and 71.2% after doses 1, 2 and 3 respectively, followed by systemic muscles aches in 52.9%, 33.1%, and 35.6% respectively. Drowsiness Day 0-6 occurred in in 38%, 27.1%, and 29.7% and nausea in 18.2%, 17.8% and 16.9% of participants after doses 1, 2 and 3 respectively. Fever was only reported in 2 participants (1.7%), after dose 2. Overall, a Grade 1 AE occurred in 33.9%, 32.2% and 30.5%, any Grade 2 AE in 30.6%, 11.9% and 13.6%, and a Grade 3 AE in 5.8%, 5.9% and 6.8% of participants after doses 1, 2 and 3.

Conclusions: A multicenter rapid clinical trial of a 4CMenB vaccine was conducted by the Clinical Trials Network of CIRN. Pain at the injection site and muscles aches were highest after the first (unblinded) dose. Systemic muscle aches, drowsiness and nausea were common after all doses. Fever was not common and AEs did not interfere with study completion (120/121 participants received three doses). The safety profile in this age group and using this schedule is similar to that observed in younger adolescents.

Promoting vaccination in a healthy lifestyle program for dyads of seniors and their companions: A randomized controlled trial

Maryse Guay, Gina Bravo, Lise Trottier, Marcel Arcand, Danièle Blanchette, Anne-Marie Boire-Lavigne, Marie-France Dubois, Paule Hottin, Julie Lane

Introduction/Background: Vaccination is seldom included in interventions promoting healthy lifestyle. The Healthy Duo Program (HDP) tested in the Eastern Townships (Quebec) changed this situation. Consisting of three 150-minute workshops, the HDP was tested as the control intervention in a randomized trial assessing the
efficacy of an advance care planning (ACP) intervention. The HDP targeted dyads made up of a senior aged ≥ 70 years and of a self-selected companion. It aimed at fostering healthy habits through discussions facilitated by a trained nurse. Topics addressed included vaccination, physical activity and diet.

**Methods:** The trial involved 235 dyads (117 HDP; 118 ACP) from 2011 to 2014. The data come from 1) pre and 6-month post-intervention questionnaires that included items on participants’ influenza, pneumococcal and zoster vaccine status; 2) evaluation questionnaires filled out by participants after each workshop; 3) the workshop nurses’ logbook.

**Results:** At baseline, the proportions of seniors who had received influenza, pneumococcal or zoster vaccines did not differ between the HDP and ACP groups for both seniors and companions. The pre-intervention proportions of seniors who had received the influenza, pneumococcal or zoster vaccines were 64%, 66% and 2%, respectively. Figures for companions were 59%, 43% and 3%. None of the Group-by-Time interactions were significant (all ps>0.20). None of the pre-post comparisons were significant except for the proportions of seniors vaccinated against influenza in the HDP group (from 63% to 69%; p=0.040) and the proportions of companions vaccinated against pneumococcus in the ACP group (from 39% to 46%; p=0.046).

The workshops were appreciated. Some participants mentioned they did not know that pertussis or tetanus boosters were recommended for them. The nurses found that vaccine hesitancy was present in many seniors and companions.

**Conclusions/Implications for immunization research and evaluation:** These data suggest that only negligible gains had been made with the HDP. The HDP should be reviewed if vaccine coverage improvement is targeted.

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**Protection against vaccine preventable diseases after chemotherapy for Acute Lymphoblastic Leukemia**

Isabel Garcia de la Fuente, Léna Coïc, Jean-Marie Leclerc, Caroline Laverdière, Céline Rousseau, Philippe Ovetchkine, Bruce Tapiero

**Background:** After chemotherapy, children are more susceptible to infections. We assessed the level of protection against VPD in children treated for ALL.

**Methods:** Clinical characteristics of the children who completed chemotherapy for ALL were collected. Antibodies against VPD were measured after completion of chemotherapy.

**Results:** 50 children with a median age of 4 years (0-16) at diagnosis of ALL were included. 84% were up to date with their vaccination prior to chemotherapy. VPD antibodies were measured 13 months (1-147) after the end of chemotherapy.

**Conclusion:** Protection against VPD is suboptimal in children with ALL. Our findings support the need for a systematic booster vaccination after chemotherapy.

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**Quality improvement in clinical services delivered by public health**

*Mohammed Mosli, Nicholas Etches, Leanne Finstad, Leslie Fioretto*

**Introduction/Problem identification:** The Vaccination Clinic at the Sheldon M. Chumir Health Centre in Calgary was launched in October of 2013. The main focus of the clinic was to provide vaccination services to special populations such as Health Care Workers/Health care students (HCW/HCS). Since it’s opening, wait times for HCW/HCS at the clinic progressively increased from two weeks in 2013 to over 24 weeks in 2015. Additionally, the number of clients waiting to be immunized grew to reach a high of 1014 clients in September 2015.

**Purpose:** A Quality Improvement (QI) team was created in August 2015 to initiate the project with a purpose of improving wait time for immunizations to HCW/HCS. The team consisted of the clinic’s active staff members, Public Health managers from Alberta Health Service, the QI project sponsor, and the QI project lead.
Methods/Evidence: Numerous QI methodologies have been previously studied in healthcare with varying levels of success. In our project, we applied the Alberta Health Services Improvement Way (AIW) which is a common organization-wide approach for solving problems, making improvements and managing change based on the LEAN and Six Sigma principles. The AIW follows four main steps: Defining an opportunity, building understanding, acting to improve, and sustaining results.

Significance of Findings/Outcomes for immunization research and evaluation: By closely following the AIW approach, the QI team was able identify multiple process steps that could be targeted for improvement. By following the AIW methodology, a new process was developed and a pilot to test this process was carried out in August 2015. Due to promising results from the trial, the new process was implemented in October 2015. By April 2016, the wait list at the clinic dropped from 1014 clients to 243 clients and the wait time from over 24 weeks to under 15 weeks. These results demonstrate the potential for QI projects to produce significant impacts in healthcare when carried out in an organized, systematic manner.

A randomized controlled trial of the effect of two injection speeds on infant distress during vaccination
Anna Taddeo, Horace Wong, Ben Welkovics, Angelo Ilerich, Mara Cole, Morton Goldbach, Moshe Ipp

Introduction/Background: Evidence-based recommendations exist regarding how to perform intramuscular injections with respect to needle length and angle of injection; however, there is little evidence to guide recommendations regarding the speed of injection. This study compared the pain caused from fast vs. slow vaccine injections.

Methods: Infants 2-6 months receiving primary immunizations were randomized to fast (2-4 seconds/ml) or slow (5-10 seconds/ml) injections during routine Diphtheria, Tetanus, acellular Pertussis, Inactivated Polio Virus, Haemophilus influenza type b vaccine (DTaP-IPV-Hib) injections. Two-and 4-month olds additionally received Pneumococcal Conjugate Vaccine (PCV) injections. A research assistant and parent unaware of treatment allocation and hypothesis assessed pain using validated tools, including; the Modified Behavioural Pain Scale (MBPS, range 0-10), cry duration, and Numerical Rating Scale (NRS, range 0-10). The primary outcome was infant pain score using the MBPS.

Results: Altogether, 119 infants participated; 61 were randomized to fast injections and 59 to slow injections. There were no differences in infant characteristics, including; age (p=0.994) and sex (p=0.540). The mean MBPS score (standard deviation) during DTaP-IPV-Hib injection was lower in the fast injection group: 6.4 (2.7) vs. 7.4 (2.5), respectively; p=0.046. Regression analysis demonstrated a positive correlation between injection speed and pain. There were no other differences between groups.

Conclusions/Implications for immunization research evaluation: Fast injection reduced injection-induced pain in infants receiving DTaP-IPV-Hib but not PCV vaccine. Fast injections are recommended when administering vaccines because of the potential for a reduction in pain and feasibility.

Reactogenicity of high versus standard dose trivalent inactivated influenza vaccine for use in healthcare workers
Cheryl Volling, Brenda Coleman, Kevin Katz, Andrew Simor, Matthew Muller, Jeff Powis, Janet McElhaney, Allison McGeer

Introduction/Background: Influenza vaccination of HCWs has been associated with decreased patient morbidity and all-cause mortality. Potential impact of this strategy is limited by efficacy of standard dose (SD) trivalent inactivated influenza vaccines (TIV), which in a good year prevent 60% of infections. A high dose (HD) TIV has been shown to have greater immunogenicity in older and immunocompromised subjects, and efficacy in older subjects. This trial was designed to assess immunogenicity and reactogenicity of HD v SD TIV in younger healthy adults for potential use in HCWs.
Methods: We conducted a prospective randomized controlled, observer blind trial of HD (High dose antigen/strain) v SD (Standard dose antigen/strain) TIV in generally healthy adults 18-64 years of age over two influenza seasons in 2014 and 2015. The primary outcome was seroconversion to vaccine strains, and secondary outcomes were rates of local and systemic reactions and acceptability.

Results: 167 adults were enrolled; 47 in 2014, 120 in 2015; 32 in both years. 124 were female; median age 47 (range 22-65) years. 97% reported good to excellent baseline health. 86 received HD and 81 SD TIV. Subjects who received HD reported more site pain (by day 1 mean 2.73 v 1.5 on a numeric [0-10] pain scale, p= 0.0004), and a greater number and severity of local and systemic reactions, though between-group differences and rates of reactions waned by day 2 to 3. In 2015 there were 49 v 17 moderate or extreme reactions reported on day 0, and 5 v 5 on day 3 in the HD v SD groups, respectively. None led subjects to seek medical attention in the 7 days following vaccination. Most common reactions were warmth, swelling, muscle aches, fatigue, headache and malaise. There was no difference in the rate of those who on day 21 reported they would accept the same vaccine again (HD 78/86 v SD 77/81, p=0.37) based on side effects, and half of those expressing reluctance would accept the same vaccine if proven more effective.

Conclusions/Implications for immunization research and evaluation: HD TIV was associated with a greater number and severity of early local and systemic reactions, though this appeared not to influence acceptability. Further study of the efficacy of HD TIV in HCWs is warranted.

Reducing the numbers of adolescent students who were not in compliance with immunization legislation using a combined strategy of school-based and community evening vaccination clinics

Lilian Yuan, Andrea Main, Debeka Navaranjan

Introduction/Problem identification: Ontario’s Immunization of School Pupils Act (ISPA) requires that parents of children attending primary or secondary school provide their local medical officer of health with proof of their child’s immunization against tetanus, diphtheria, poliomyelitis, measles, mumps, rubella, meningococcal disease, pertussis, and varicella. In the spring of 2016, York Region Public Health (YRPH) assessed the immunization records of 17 year old students attending Catholic and public high schools. There were 13,726 17 year old students, of which, 5,839 (42%) had incomplete immunization records. Five weeks prior to suspension, there were 2,860 (21%) of students who were still not in compliance. Thus, YRPH explored additional strategies to reduce the number of students at risk of suspension.

Purpose: Based on the literature, school-based vaccination (SBV) programs are an effective strategy to increase immunization coverage among school-aged children. YRPH offered school-based catch-up clinics only in Catholic high schools while continuing to offer evening catch-up (CEV) clinics to students in both Catholic and public schools. This evaluation will assess the effect of applying the SBV program.

Methods/Evidence: Compliance rates for eight mandatory vaccines were compared between the Catholic school board (mixed-method approach) and public school board (only the CEV clinic). Daily numbers of students at risk of suspension due to noncompliance were extracted from the Panorama immunization information system. In addition, the costs and resources associated with the combined strategy were assessed.

Significance of Findings/Outcomes for immunization research and evaluation: Our findings indicate that the rate of decline in noncompliant students was greater when the combined strategy was implemented than the rate of decline among students who were only offered CEV clinics. When comparing the costs of the two strategies, there was no difference since a small group of full time nurses was able to staff SBV at no additional cost. Based on these results, school-based catch-up clinics were an effective way to ensure adolescents are up-to-date with their immunizations.
Reductions in antibody production to the 2014/15 seasonal influenza vaccine in highly active young men aged 18-35

Andrew Stewart, Otto Vanderkooi, Raylene Reimer, Patricia Doyle-Baker

Introduction/Background: In Canada there is a clear trend towards increasing adiposity and sedentary behavior. Research indicates that adiposity may modify immune response to influenza vaccines. The purpose of this study was to determine the immune response of young men (aged 18-35) to the 2014/15 seasonal influenza vaccine and the potential role of adiposity and physical activity on antibody production to vaccine.

Methods: 125 participants were recruited, 76 attended the first data collection session and 45 participants returned to complete the study (remainder lost to follow up). This study followed a prospective cohort design with two data collections. Demographic information, serum for influenza serology, Dual X-Ray Absorptiometry (DXA) scanning (% body fat) and self-reported physical activity (Godin Leisure Time Physical Activity Questionnaire) was collected prior to vaccination. Participants were vaccinated at Alberta Public Health clinics with the 2014/15 trivalent influenza vaccine. Four weeks later, serum was collected. The Canadian Centre for Vaccinology (Halifax, N.S.) completed hemagglutinin inhibition assays for the three strains in the annual trivalent vaccine for quantification of seroconversion rates. Statistical comparisons were made using the Mann-Whitney U Test.

Results: Median % body fat was 15.9 (IQR 13.7-19.0). No differences in body fat were associated with seroconversion rates in participants. Self-reported physical activity scores ranged from 9-127 (median 47). Participants who did not seroconvert reported higher physical activity scores. Significant differences were found for the A/Texas strain (p<0.01) with a mean physical activity score for non-seroconverters of 71 versus 40 in the seroconverting group. A similar trend of lower magnitude was observed for A/California and B/Massachusetts (63 vs 50 and 58 vs 52 respectively).

Conclusions/Implications for immunization research and evaluation: The high levels of physical activity and the corresponding decrease in seroconversion rates seen in participants provides support that a high level of physical activity may be detrimental to immune response to vaccine. Additional work is required to elucidate the full impact of lifestyle on current vaccine responses, which will guide immunization practice.

Reporting and identification of adverse events following immunization (AEFI) in pregnancy, Canada, 01 Jan 2000 to 31 December, 2015

Ania Kemp, Helen Anyoti, Christina Bancej

Background: Selected inactivated vaccines are recommended for pregnant women in Canada, including influenza vaccine and others if indicated (hepatitis B, tetanus/diphtheria/pertussis polio, meningococcal, pneumococcal and certain travel vaccines).¹

Internationally, attention is being focused on establishing standards for monitoring the safety of immunization in pregnant women.² Canada currently does not have a reporting standard for recording pregnancy status at time of immunization, nor is this information systematically collected (e.g., through a checkbox) on the national AEFI reporting form.

AEFI reports received nationally are entered into the Canadian Adverse Events Following Immunization Surveillance System (CAEFISS) and relevant free text information is coded using the Medical Dictionary for Regulatory Activities (MedDRA).

The objective is to highlight limitations in the reporting and identification of vaccinated pregnant women in CAEFISS, and to provide recommendations to enhance vaccinovigilance.

Methods: CAEFISS was searched for reports with vaccination date between January 1, 2000 and December 31, 2015. A total of 76,737 reports were identified; three sections of those reports (known medical conditions,
reported events (AEFI) and comments) were searched for pregnancy related terms (pregnancy, pregnant, abortion, miscarriage, and stillbirth) using SAS EG 5.1.

Results: A total of 102 AEFI reports were identified; for 17 (17%) pregnancy status was coded under known medical conditions; for 13 (13%), pregnancy status at time of immunization was determined based on the reported AEFI; and for 72 (70%), pregnancy status was found in free text and had not been coded.

Conclusion: In CAEFISS it is difficult to identify AEFI reports of women immunized while pregnant, and to measure the degree of underascertainment of AEFI reports on pregnant women in Canada, as pregnancy status is not systematically collected at time of immunization.

Lack of systematic capture of pregnancy status and possible underreporting creates a challenge for vaccinovigilance in pregnant women. It represents an important gap in Canada given the identification of pregnant women as a special population for coverage and uptake of certain vaccines.

We recommend reporting standards for pregnancy status be adopted in alignment with evolving international best practices, by building systematic capture of pregnancy information into the national AEFI reporting form and CAEFISS.

Reverse vaccinology – The catalyst for a new Renaissance period in vaccine development

David Willer, Shehzad Iqbal, Leonard Friedland, Shireen Khaliq, Rino Rapuolli

Introduction/Problem identification: In the millennia since the first descriptions of inoculation against smallpox in China, highlighted by the efforts of Hilleman, Jenner, and Pasteur, the field of vaccinology has transitioned through a number of eras which have benefited from advances in technology. Currently, the field is profiting from pioneering advancements of the modern “omics” era, where developments in genomics, proteomics, bioinformatics, structural biology/immunology are all supporting multifaceted approaches to vaccine discovery and development.

Purpose: Although there has been unprecedented success in the development of vaccines, there remains an even longer list of human diseases which have remained refractory to traditional empirical approaches. By highlighting how Reverse Vaccinology was applied to the development of a novel menB vaccine (4CmenB), we will look to how lessons learned stand to shape the future of vaccine development.

Methods/Evidence: Reverse Vaccinology represents a rationale approach to vaccine design, which relies on initial knowledge of the genetic blueprint of an organism to subsequently predict appropriate vaccine antigens. Starting from >2100 predicted proteins in the genome of Neisseria meningitidis group B, and by applying bioinformatic tools, Rapuolli and colleagues were able to predict 570 putative surface proteins, of which 350 could be cloned with resultant expression in E. Coli. Subsequent confirmation of surface expression in the murine system and evaluations of bactericidal activity, allowed for 28 proteins to be assessed further for conservation across the menB serogroup. Three principal candidates were selected for vaccine development, ultimately leading to the generation of the novel menB vaccine (4CmenB).

Significance of Findings/Outcomes for immunization research and evaluation: Applications of Reverse Vaccinology are not limited to infectious diseases, or even to bacterial pathogens, with adaptations of this approach being used to develop vaccines for any number of elusive targets. Moreover, this revolutionary approach, partnered with tremendous multifaceted technological advancements has even broader implications for the development of preventative or therapeutic measures in such disparate fields including cancer and allergy. As such, we are firmly enjoying a Renaissance period in the development of preventative measures against human diseases.
A review of cost-utility analyses of vaccines

Jason Lee, Thomas Shin, Ayman Chit

Introduction/Background: Economic evaluations are a major component of public health decision making on vaccination programs. Given the rapid growth in the number of published economic evaluations of vaccines, we sought to better understand global trends in these studies by describing growth, quality and result trends in the published literature over time. We also examine factors correlated with quality and the results.

Methods: We reviewed published economic evaluation of vaccines using the Tufts CEA Registry, a comprehensive database of 5,000 published health care related cost-utility analyses. Descriptive data from eligible publications were screened and summarized by reviewers, who also perform an assessment of the quality of each study. We described: the studied vaccines, their geographic distribution, author affiliation, funding sources, quality and results. We also conducted multivariate regression analysis to examine the correlation between study attributes and vaccine cost-effectiveness.

Results: From 1980-2014, there has been a steady growth of publications examining the cost-utility of vaccines, with a total of 320/5000 articles in the CEA registry. The United States (n=109), Canada (n=31), the Netherlands (n=29) and the United Kingdom (n=24) were the largest publishers, accounting for 53% of total publications. Overall, 14 types of vaccines were reported, with 30% of articles (n=96) addressing pediatric vaccines. While the majority of study authors reported academic affiliations (n=27), most studies were funded by industry (n=101) and government (n=93). Most studies reported favourable findings, with 29% of articles (n=94) reporting a dominant incremental cost-utility ratios (ICURs) against comparator interventions. The mean ICUR of all vaccine articles was approximately $21,575 USD/quality-adjusted life year. The mean quality rating of all vaccine articles was 4.7/7, and was consistent over time, funding sources, and vaccine type.

Conclusions/Implications for immunization research and evaluation: The publication of cost-utility analyses of vaccines has steadily increased over time. Given the increasing impact of these studies on public health policy and practice, more trained researchers and better peer-review processes are needed to utilize this information, especially in jurisdictions that do not have a formal health technology assessment process for vaccines.

Review of encephalitis and encephalopathy cases following immunization reported to the Canadian Immunization Monitoring Program ACTive (IMPACT) from 1992 to 2012

Jennifer Tam, Dat Tran, Julie Bettinger, Dorothy Moore, Laura Sauvé, Taj Jadavji, Ben Tan, Wendy Vaudry, Scott Halperin, Karina Top

Introduction/Background: Neurological adverse events following immunization (AEFI) remain poorly understood. The Canadian Immunization Monitoring Program ACTive (IMPACT) is a national pediatric hospital-based network that conducts active surveillance for select AEFI, including neurological events. Our objective was to characterize encephalopathy/encephalitis cases following immunization reported to IMPACT (1992-2012).

Methods: We analyzed encephalopathy/encephalitis cases reported to IMPACT from 1992 to 2012. Cases were reported if symptom onset occurred 0-7 days after tetanus or pertussis-containing vaccines, 0-15 days after other inactivated vaccines, or 5-30 days after live vaccines. Descriptive statistics were used to describe clinical characteristics, temporally associated vaccines, and outcomes. Clinical investigations and the final diagnosis were analyzed to identify possible causes for encephalopathy/encephalitis other than vaccination.

Results: Sixty-one cases of encephalopathy/encephalitis following immunization were reported to IMPACT. The median age at admission was 4.7 years (range 0.2-16.4); 52.5% were male. The majority were previously healthy (85.2%), without any underlying neurologic disease (83.6%). The most common temporally associated vaccines were diphtheria-tetanus-pertussis (32.8%) and measles-mumps-rubella (32.8%), with or without other vaccines administered concomitantly. Median length of hospital stay was 15 days (range 1-106), with 49.2% requiring intensive care. At discharge, 29.5% of patients had returned to neurologic baseline, 47.6% had an abnormal neurological exam, and 19.7% required seizure medications. Three patients (4.9%) died; in two cases, there was
an alternate cause besides vaccination. The final diagnosis was acute encephalopathy/encephalitis in 65.6% of cases, chronic encephalitis in 6.6% of cases, and another neurological condition, such as acute disseminated encephalomyelitis, in 27.9%. Symptoms suggestive of concomitant infection, such as fever, cough, coryza, sore throat, or vomiting, were present in 82.0% of patients. A positive microbiology test for a non-vaccine infectious cause was found in 36.1% of patients. A non-infectious and non-vaccine-related cause of encephalopathy/encephalitis (e.g., anti-NMDA receptor encephalitis) was established in 8.2% of cases.

**Conclusions/Implications for immunization research and evaluation:** Encephalopathy/encephalitis following immunization remains a rare but serious adverse event. Most cases reported to IMPACT via active surveillance had another more likely etiology than vaccination. Continued diligent monitoring and analysis of AEFI is paramount to reassure vaccine providers and the public about the safety of immunization programs.

**Risk of recurrence of adverse events following immunization: A systematic review**

Joseline Zafack, Gaston De Serres, Marilou Kiely, Marie-Claude Gariepy, Karina Top

**Introduction:** Persons who experience an adverse event following immunization (AEFI) are at risk of vaccination cessation or delay because of the fear that the AEFI might recur. For patients who need additional doses of the vaccine(s) associated with the AEFI, recommendations on revaccination are frequently based on expert opinion. We conducted a systematic review of the literature to assess the safety of revaccination in this population. Our objective was to determine the risk and predictors of AEFI recurrence.

**Methods:** We included articles in English or French available before April 30th, 2015 in Medline via PubMed, EMBASE and the Cochrane library. Articles were selected if they estimated the risk of recurrence of AEFI in at least 5 individuals. Risk of recurrence was calculated as: number of patients with recurrence/ total number of patients revaccinated.

**Results:** Of 3726 articles retrieved from the search, 29 met the criteria of our review. Included studies were frequently small (N<30) or heterogeneous (variability in vaccines and age groups). Among patients with a history of hypotonic hyporesponsive episode (HHE, n=530), anaphylaxis (n=133) or seizures (n=60) who were revaccinated, the AEFI recurred in 0-0.6%. Overall, 31 (5%) of the 591 patients with a history of allergic-like event had a recurrence. Fever recurred in 0-84% of 836 vaccinees, depending on the vaccine and rank of the dose. Compared to children without a history of fever, children who had fever at a previous immunization were more likely to develop fever at subsequent immunizations especially if they received acellular pertussis vaccine (risk ratios after dose 2 and 3 ranging from 2.6-4.7 for DTaP and 1.5-1.8 for DTwP). Among children with extensive limb swelling after the 4th dose of DTaP, the recurrence after dose5 was higher after DTaP (78%) compared to the reduced antigen formulation Tdap (53%, p=0.02).

**Conclusion:** Despite vaccines being administered to millions of people annually, few studies have evaluated the risk of AEFI recurrence. Published data suggests that revaccination is usually safe. However, in these studies we could not exclude the fact that severe cases were less often revaccinated.

**Risk of recurrence of adverse events following immunization: Results of 18 years of surveillance in Quebec**

Joseline Zafack, Gaston De Serres, Eveline Toth, Monique Landry, Karina Top

**Introduction:** Patients who experience adverse events following immunization (AEFI) often require additional doses of vaccine. Recommendations regarding revaccination of these patients are frequently based on expert opinion and supported by limited scientific data. Our objective was to evaluate the risk of recurrence of AEFIs and identify predictors of recurrence.

**Methods:** Since 1998, the Quebec AEFI surveillance system (ESPRI) has followed up patients with a history of AEFI using phone calls to determine if they were revaccinated and if the AEFI recurred. We included AEFI cases reported to ESPRI between January 1st, 1998 and December 31st, 2015 following administration of
DTaP±Polio±HepB±Hib, rotavirus, PCV, MMR/MMRV, hepatitis B±A and HPV vaccines. Information on revaccination was extracted from comments attached to the AEFI reports. Risk of recurrence was calculated as: number of cases with recurrence/ total number of cases revaccinated.

**Results:** Among the 5274 AEFI cases eligible to receive further doses of vaccine, information on revaccination status was available in 1686 (32%) cases, of which 1316 (78%) were revaccinated. Compared to mild cases, moderate/severe AEFIs were less likely to be revaccinated (Risk Ratio 0.8 [0.77-0.89]). Among the 1316 cases revaccinated, 210 (16%) had a recurrence, of which 83% were less or equally severe compared to the initial AEFI. The risk of recurrence was 22%, 21%, 13%, 12% and 8% following hepatitis B±A, HPV, DTaP±Polio±HepB±Hib, rotavirus, PCV and MMR/MMRV respectively. The AEFI recurred in 10% (40/387) of patients with a history of allergic-like event (ALE) and 22% (44/200) of those with a history of large local reaction (LLR). Fever recurred in 15% (11/71) of cases; the risk of recurrence in patients with temperature ≥40.5°C was 8% (1/12). Seizures recurred in 6% (3/48) of cases, all recurrences were in patients with febrile seizures and none had a history of seizures prior to their initial AEFI. Eight patients with anaphylaxis were revaccinated and none experienced a recurrence.

**Conclusion:** Patients with moderate/severe AEFIs were less likely to be revaccinated. The risk of recurrence of common AEFIs (ALE, fever, LLR) ranged from 10% to 22% with recurrences being usually less or equally severe compared to the initial episode.

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**Sample-size analysis: Can an observational study successfully assess the historical association between influenza vaccination rates of health care workers (HCW) on the probability of influenza outbreaks in long-term care facilities (LTCF) in BC?**

Robert Balshaw, Chelsea Treloar, Sandra Allison, Meena Dawar, Bonnie Henry, Dee Hoyano, Michelle Murti, Sue Pollock, Monika Naus

**Introduction/Background:** In 2012, British Columbia (BC) enacted a policy requiring healthcare workers (HCW) to be vaccinated against influenza or wear a mask in patient care areas during the influenza season. While published studies have examined the impact of HCW vaccination on LTCF resident mortality and infection rates, our analysis examined the feasibility of finding a statistically significant association between HCW vaccination rates and laboratory-confirmed influenza outbreaks in LTCFs using pre and post-policy routinely collected data. Analysis was conducted at the level of the facility, as province-wide, HCW vaccination rates ranged from low to high throughout this time period.

The objective was to evaluate the sample size required to have adequate statistical power to detect an association between HCW vaccination rates at LTCFs and the occurrence of reported influenza outbreaks.

**Methods:** We simulated data using a logistic regression model for the probability of an outbreak at a LTCF by the HCW vaccination rate (VR). Our simulations covered a range of scenarios reflecting historical data on VR and vaccine effectiveness (VE). We also varied the association between the probability of an outbreak and VR from very weak to very strong. Each scenario was simulated 4,000 times resulting in power estimates accurate to within 0.013 (19 times in 20).

**Results:** With VE of 50%, only the scenarios with the strongest association ($\beta_{\text{VR}}=-4$) achieved a power of 80% for sample sizes of 200 to 400 LTCF. For a more realistic association ($\beta_{\text{VR}}=-1$), a sample size of 2,500 facilities would be required. Lower VE would attenuate the power further; higher VE would improve it. With VE=85%, adequate power could be achieved with sample sizes greater than 200 facilities provided the association was quite strong ($\beta_{\text{VR}}=-2$). Power was higher with higher probabilities of outbreak (i.e., higher $\beta_0$ values).

**Conclusions/Implications for immunization research and evaluation:** With approximately 350 LTCFs in BC, any analysis of the relationship between HCW VR and reported influenza outbreaks would be underpowered. Even a national study would be statistically feasible only under nearly ideal conditions. Multi-year studies may mitigate...
sample size problems, but annual seasonal variation in circulating influenza strains, VE, and vaccination coverage of LTCF residents would add substantial additional challenges.

Seroprevalence of measles, mumps, rubella, varicella-zoster and hepatitis A-C in Emirati medical students

Introduction/Background: The aims of this study were to assess the seroprevalence of vaccine-preventable infections in Emirati medical students, and to provide scientific evidence for implementation of a cost-effective immunization guideline and policy for medical school admission

Methods: This prospective cohort study involved 261 (61% female) Emirati medical students (preclinical and clinical) attending the College of Medicine and Health Sciences at UAE University. Data on vaccination and history of infectious diseases were collected from participants. Blood samples were collected between July 1, 2011 and May 30, 2012 for serological testing and QuantiFERON®-TB assay.

Results: All students tested negative for infection with hepatitis C virus and human immunodeficiency virus. The prevalence of seropositivity to rubella virus was 97%, varicella-zoster virus 88%, mumps virus 84%, measles virus 54%, hepatitis B virus (HBV) 48%, and hepatitis A virus 21%. The QuantiFERON®-TB test was positive in 8% and indeterminate in 2%. Forty percent of students received HBV vaccine at birth; their HBV titers (mean ± SD) were 17.2 ± 62.9 mIU/mL (median = 1.64). The remaining 60% received it at school and their titers were 293.4 ± 371.0 mIU/mL (median = 107.7, p = 0.000).

Conclusions/Implications for immunization research and evaluation: About 50% of students were susceptible to HBV and measles virus; therefore, pre-matriculation screening for antibodies against these viruses is highly recommended. Moreover, tuberculosis screening is necessary because of the high influx of expatriates from endemic areas. Students with inadequate protection should be reimmunized prior to contact with patients.

Shifts in distribution of invasive pneumococcal PCV13 serotypes and antimicrobial susceptibilities in Canada: 2011-2014
Averil Griffith, Walter Demczuk, Irene Martin, Brigitte Lefebvre, Allison McGeer, Gregory Tyrrell, George Zhanel, Susan Squires, Michael R. Mulvey, the Canadian Public Health Laboratory Network

Introduction/Background: The 13-valent pneumococcal conjugate vaccine (PCV13) was introduced from 2010 to 2011 in the childhood immunization program across all Canadian jurisdictions. We describe changes in the distribution of the PCV13 serotypes and antimicrobial susceptibilities of invasive Streptococcus pneumoniae (IPD) in Canada over a 4 year period from 2011 to 2014.

Methods: IPD isolates and data were submitted to the National Microbiology Laboratory between January 2011 and December 2014 by provincial public health laboratories in Canada. A total of 10,328 isolates were serotyped (2011, N=2,677; 2012, N=2,608; 2013, N=2,570; 2014, N=2,473) by Quellung reaction using commercial pool, group, type and factor antisera (Statens Serum Institute, Denmark). Susceptibility testing was performed on 4,434 PCV13 isolates (2011, N=1,120; 2012, N=1,128; 2013, N=1,061, 2014, N=1,125) with custom-designed broth microdilution panels in accordance with Clinical and Laboratory Standards Institute methods. Results: Over the study period, there has been an overall decrease in the proportion of isolates with PCV13 associated serotypes from 49.5% (n=1326) in 2011 to 30.9% (n=764) in 2014. Between 2011 and 2014, the overall proportions of PCV13 serotypes 7F and 19A have decreased from 15.2% (n=406) to 7.5% (n=185); and from 16.1% (n=430) to 8.9% (n=220), respectively. Serotype 3 has remained constant at approximately 8%. Non-PCV13 vaccine serotype 22F was the predominant serotype in 2014, increasing from 7.8% (n=208) in 2011 to 11.4% (n=282) in 2014. Ceftriaxone resistance (using meningitis breakpoints) has declined from 1.0% (n=8) in 2011 to 0.2% (n=2) in 2014. Clindamycin resistance has declined from 6.7% (n=75) to 4.4% (n=49). Doxycycline
resistance has declined from 8.8% (n=99) to 7.9% (n=89). Penicillin resistance (using meningitis breakpoints) has declined from 11.6% (n=130) to 8.6% (n=97). Trimethoprim/sulfamethoxazole resistance has remained relatively constant at approximately 6%. Multidrug resistance (resistance to 3 or more classes of antibiotic) has decreased from 7.7% (n=86) in 2011 to 4.9% (n=55).

**Conclusions:** Continued surveillance of serotypes is imperative to evaluate current vaccine effectiveness and identify possible emergent replacement serotypes to inform future vaccine development. In this study, the proportion of PCV13 associated IPD serotypes identified has declined concurrently with a general decrease in levels of antimicrobial resistance.

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**Show us the data! Improving data quality in Ontario**

*Jill Fediurek*

**Introduction/Problem identification:** Designated vaccine preventable diseases (VPDs) in Ontario are reported through the integrated Public Health Information System (iPHIS). VPD surveillance at a provincial level has been conducted by Public Health Ontario since 2012. Ongoing monitoring of iPHIS VPD data demonstrated the need for a more comprehensive continuous quality improvement strategy to develop collaborative partnerships, build capacity and support knowledge translation for local public health colleagues who are responsible for entry of VPD surveillance data.

**Purpose:** We wanted to assess the impact of a number of resources and tools developed to address VPD iPHIS data quality. We looked at data quality over time to determine whether there were improvements and whether further strategies were required.

**Methods/Evidence:** Since 2012, new data cleaning activities, resources and tools have been developed and implemented over time to address the quality of key VPD data elements, including: specific VPD case report forms and guidance documents, a new provincial iPHIS VPD user guide with quick reference data entry algorithms, online VPD resources, workshops, teleconferences, targeted data quality reports and iPHIS electronic referrals flagging specific data concerns. In addition, training webinars were conducted in 2015 with online posting of the webinar materials to ensure ongoing access.

We assessed data quality by evaluating field completion and nonsensical data fields. From 2011 to 2015, the following were assessed: immunization status and deaths (all VPDs), hospitalization (invasive VPDs only: meningococcal, pneumococcal, *Haemophilus influenzae* b) and laboratory specification (all VPDs excluding tetanus and pertussis). Improvements in data quality over time was demonstrated for immunization (51% to 93%). Improvements in field completion was demonstrated for deaths (66% to 93%), hospitalization (69% to 91%) and laboratory specification (51% to 93%).

**Significance of Findings/Outcomes for immunization research and evaluation:** A number of complementary, yet labour intensive, strategies have been developed over the past four years to improve VPD data quality, with success. Maintenance of accurate VPD surveillance data is essential to the planning, implementation and evaluation of immunization programs. Further knowledge translation activities to ensure the ongoing adoption, implementation of tools and resources and sustainability of interventions is under discussion in order to improve and maintain data quality.
The Special Immunization Clinics Network: Immunizing patients with adverse events following immunization (2013-2016)

Karina A. Top, Marie-Noëlle Billard, Donna MacKinnon-Cameron, Jeffrey M. Pernica, Anne Pham-Huy, Caroline Quach, Dat Tran, Wendy Vaudry, Simon Dobson, François D. Boucher, Athena McConnell, Shelly A. McNeil, Scott A. Halperin, Gaston De Serres

Introduction/Background: Although immunization is considered safe, adverse events following immunization (AEFI) do occur, and occasionally patients require medical attention. In such cases, there is limited evidence to guide management regarding future immunizations. The Special Immunization Clinics (SIC) Network was established in 2013 to standardize management of patients with AEFI and assess outcomes after re-immunization. We describe the first three years of the network’s implementation.

Methods: Twelve SICs were established by infectious diseases specialists and allergists in six Canadian provinces. Referrals are accepted from physicians and public health. Inclusion criteria are: injection-site reaction ≥10 cm, allergic symptoms <24h post-immunization, neurological symptoms, and other AEFI of concern. Eligible patients undergo a standardized evaluation, expert physicians perform a causality assessment and make immunization recommendations, and patients are followed up after re-immunization to capture AEFI recurrence. Recommendations are transmitted to clinicians and public health. Following individual consent, data are transferred to a central database for analysis.

Results: From June 2013 to May 2016, 472 patients were referred to a SIC and 395 met eligibility criteria. Data have been collected on 267 patients with prior AEFI, of whom 88% were children <18 years of age and 12% were adults. Patients presented with the following types of AEFI: allergic-like events (28%), injection-site reactions (21%), neurological events (12%), and other systemic AEFI (37%) (e.g., fever, persistent crying). Re-immunization was recommended for 178 (67%) patients, 89 of whom have been re-immunized and followed up to date. Seventeen patients (19%) experienced recurrent AEFI, including 8 injection-site reactions and 5 allergic-like events. Six patients (7%) experienced recurrent AEFI severe enough to limit daily activities (1 injection-site reaction, 2 allergic-like events, 1 neurological event, 2 other). No recurrent AEFI were serious (e.g., resulting in hospitalization, permanent disability, death).

Conclusions/Implications for immunization research and evaluation: The most frequent reasons for referral to a SIC were allergic-like events and injection-site reactions. Most patients with AEFI can be safely re-immunized. A larger sample of patients with severe AEFI is needed to evaluate the safety of re-immunizing that population. By providing support to physicians and public health officials faced with patients with prior AEFI, SICs are helping to strengthen Canada’s immunization programs.

Strength in numbers: Vaccine safety in Ontario in 2015

Tara Harris, Alexandra Piatkowski, Kenny Wong, Jyotsna Nair, Jill Fediurek, Shelley Deeks

Introduction/Background: Public health surveillance of adverse events following immunization (AEFIs) is a core component of vaccine safety surveillance in Ontario. AEFI surveillance is essential to monitor vaccine safety, provide relevant and timely information to health professionals and build confidence in immunization. Our objective was to summarize AEFIs reported in Ontario following vaccines administered in 2015.

Methods: AEFI reports were extracted from the integrated Public Health Information System (iPHIS) on May 1, 2016. Adverse events were grouped using provincial surveillance definitions. AEFI reporting rates were estimated using provincial population projections or vaccine doses distributed. The World Health Organization definition of serious was used. Analyses were conducted in SAS version 9.3, SAS Enterprise Guide 7.1 and Microsoft Excel 2010.

Results: There were 678 AEFIs reported following vaccines administered in 2015. The overall provincial AEFI reporting rate was 4.9 per 100,000 population; with a significant increasing trend in the reporting rate since 2011 (p<0.05). The median age was 18.5 years (range: one month-93 years), and children 1- to 3-years of age
had the highest age-specific reporting rate (24.9 per 100,000 population). Females comprised 66.0% of reports, and female predominance was most notable in adults 18- to 64-years of age (female to male reporting rate ratio: 5.8). Most AEFIs were mild and the majority (73.9%) were completely resolved at the time of reporting. The most common reported events were pain, redness or swelling at the injection site (28.9% of reports); rash (24.7%); and allergic skin reactions (17.3%). Serious AEFIs were rare (5.0%; n=34). The serious reporting rate was 2.5 per 1,000,000 population and the most frequent serious AEFIs were febrile illnesses (n=10) including 5 with rash and 2 Kawasaki disease. The reporting rate of anaphylaxis was 1.6 per 1,000 000 population; 60%(9/15) met Brighton case definition.

Conclusions/Implications for immunization research and evaluation: Overall, there was a low reporting rate of AEFIs in Ontario during 2015. Most reported events were mild (i.e. injection site reactions) and resolved completely. No unexpected safety issues were identified. Under-reporting continues to be an issue in Ontario relative to other jurisdictions; however the modest but increasing trend in the provincial AEFI reporting rate is encouraging.

Tetanus hospital admissions in Canada, 1995 to 2010

Tiffany Smith, Jenny Rotondo, Shalini Desai, Susan Squires

Introduction/Background: Although tetanus is ubiquitous in nature it is preventable through immunization. Immunization coverage is approximately 77% in children less than two, and approximately 50% of adults report having received a tetanus booster in the past 10 years. This study describes the epidemiology of hospitalized tetanus cases in Canada with the aim of informing targeted prevention methods.

Methods: Acute care hospital admissions with a primary diagnosis of tetanus between 1995 and 2010 were extracted from the Canadian Institute of Health Information’s Hospital Morbidity Database (ICD codes: 037, 7713, A35, A34, A33). Neonatal tetanus cases not meeting the World Health Organization case definition were excluded.

Results: A total of 114 hospital admissions occurred between 1995 and 2010 with an average of 7 admissions per year (range: 3-10). Admissions occurred year round but were least common in the winter (11%). Approximately 54% of cases were male. The highest number of admissions were among those ≥ 70 years old (26%) and 30 to 39 year olds (26%). Approximately 38% of admissions were from rural areas, an almost 2-fold greater representation than rural residency in the Canadian population. Among admissions with data on: wound type (n=20), 75% were open wounds; anatomical location (n=26), 77% occurred in the extremities; cause (n=24), 33% were due to accidents with hand tools and 33% a fall; and, location (n=11), 64% occurred at home. The median length of stay in hospital was 14 days. A median length of stay less than 5 days was observed in all age groups except 60 to 69 year olds (median: 28 days) and ≥ 70 years olds (median: 15 days). A total of 8 admissions resulted in death. The mean age of in-hospital deaths was 81 years old (range: 61-93 years).

Conclusions/Implications for immunization research and evaluation: Tetanus hospitalizations are rare in Canada but continue to occur year round, generally among adults with longer stays and all deaths occurring in the elderly. Given low national immunization coverage among adults, admissions may have occurred due to a missed booster. Investigation into immunization status and injury details of admissions would be helpful in determining targeted prevention methods for further reducing tetanus in Canada.

Two-year efficacy of the quadrivalent human papillomavirus vaccine in a cohort of HIV-positive females

Elisabeth McClymont, Marette Lee, Erin Moses, Sandra Blitz, François Coutlée, Sharon Walmsley, Deborah Money, The CTN 236 HPV in HIV Study Team

Introduction/Background: HIV-positive women experience higher rates of HPV infection and cervical cancer than their HIV-negative counterparts. HPV vaccination has proven efficacious in young HIV-negative females;
however, its efficacy is less well understood in older HIV-positive females. Other vaccines have shown reduced immunogenicity in HIV-positives.

**Methods:** HIV-positive Canadian females received three doses (0, 2, and 6 months) of quadrivalent HPV (qHPV) vaccine in a multi-centre study. Participants provided demographic and health data and underwent pelvic examination including cervical cytology and HPV DNA sampling (0, 6, 12, 18, and 24 months). Cervical cytology was reported by Bethesda criteria and HPV DNA samples were tested by Linear array assay. Persistent cases of qHPV were defined as newly acquired HPV 6, 11, 16, or 18 present in samples starting 1 day post-vaccination dose 1 and persisting for 2 or more consecutive visits or as qHPV present in the last available sample. Data up to 2.5 years post-vaccination dose 1 was considered.

**Results:** 254 females received at least one dose of vaccine and underwent follow-up pelvic examination, providing 436.89 person-years of follow up. Median age of participants was 39 years (IQR: 34-45), median CD4 count at first vaccination was 494/mm$^3$ (IQR: 371-680), median CD4 nadir was 230/mm$^3$ (IQR: 116-333), and 72% had a suppressed HIV viral load (<50 copies/mL) at first vaccination. With a median follow up time of 1.9 years, the incidence rate of newly acquired persistent qHPV was 1.8 per 100 person-years (95% CI: 0.8-3.6). The incidence rate of HSIL+ was 0.9 per 100 person-years (95% CI: 0.2-2.3) and the incidence rate of genital warts was 3.4 per 100 person-years (95% CI: 1.9-5.7). While none of the 4 HSIL+ cases were associated with newly acquired qHPV types, 2/15 genital wart cases may have been caused by newly acquired HPV 6 and 1/15 may have been caused by newly acquired HPV 11.

**Conclusions/Implications for immunization research and evaluation:** The rate of persistent qHPV within this HIV-positive cohort was 2.25 times greater than the rate within an HIV-negative cohort (Villa et al., 2005). However, as none of the HSIL+ cases were associated with newly acquired qHPV, this suggests good short-term vaccine efficacy although further follow up is required. It is important to recognize that despite vaccination, these women appear to be at higher risk for HPV infection and cervical dyskariosis than HIV-negative cohorts. This may help to inform screening and vaccine recommendations for HIV-positive women.

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**Understanding factors influencing infant rotavirus vaccination in British Columbia: A survey of parents**

*Alexandra Nunn, David Puddicombe, Monika Nauss*

**Introduction/Background:** A publicly funded rotavirus vaccination program was implemented in British Columbia in January 2012 as a 2-dose series given at 2 and 4 months of age. Data from 2014 for the first vaccinated cohort indicated this vaccine had the lowest uptake of all infant immunizations (70%) by the second birthday, compared to other vaccines which ranged from 72% - 85%. By 2015, rotavirus vaccination coverage had increased to 75% across 4 regional health authorities in BC but continues to have comparatively low uptake.

**Methods:** Using a case-control study design, a random sample of respondents was selected from the provincial immunization registry to participate in a telephone survey. Respondents were parents or caregivers of infants born during a 5-month period in 2013 whose record indicated either series completion or no rotavirus vaccine receipt. Responses were compared between the two groups. Analyses included descriptive and bivariate statistics and logistic regression.

**Results:** The survey was completed by 876 respondents, with a response rate of 50%. Parents of immunized infants were significantly more likely to agree that rotavirus vaccination is important to protect their child’s health (83% vs. 10%, p<0.01). The main reasons for accepting rotavirus vaccine were acceptance of all vaccines (37%) and to protect their child’s health (30%). Among those unvaccinated against rotavirus, 74% had received other routine childhood vaccinations, however less than half (45%) of respondents recalled a healthcare provider (HCP) recommending rotavirus vaccine. The most common reason for declining rotavirus vaccine was safety or side effect concerns (41%). Of the unvaccinated group, only 51% of respondents reported receiving enough information about rotavirus vaccination, and 28% would have been more likely to vaccinate had they received more information.
Conclusions/Implications for immunization research and evaluation: The relatively low uptake of rotavirus vaccination may be attributed to insufficient information provided to parents and inconsistent offer and recommendation of rotavirus vaccine by HCPs. Public health nurses and physicians have an important role in increasing rotavirus vaccination coverage by promoting trust in the healthcare system and the routine immunization schedule, addressing safety and side effect concerns and by consistently offering and recommending rotavirus vaccine.

Understanding non-vaccination against influenza in Canadian adults: Findings from the 2015-2016 Influenza Coverage Survey
Eve Dubé, Noushon Farmanara

Introduction/Background: The uptake of seasonal influenza vaccine in Canada remains sub-optimal, even in groups at increased risk of influenza-related complications. A better understanding of the factors behind non-vaccination is needed. The objective of this analysis was to identify potential determinants of non-vaccination among adults: aged ≥18 years, aged 18-64 years with and without chronic medical conditions (CMCs), and aged ≥65 years.

Methods: A random-digit dialing telephone survey of Canadian adults was conducted in January and February 2016. Logistic regression models were used to calculate unadjusted odds ratios (OR) and adjusted ORs (aOR). All rates and ORs were weighted. Reasons for non-vaccination and place of vaccination were documented to identify potential barriers to immunization and target areas for improving vaccine uptake.

Results: A total of 2000 adults aged ≥18 years were included in the study. Rates of non-vaccination were 65.7% in adults ≥18 years, 75.6% in adults 18-64 years without CMCs, 62.8% in adults 18-64 years with CMCs, and 35.4% in adults ≥65. In adults with CMCs, age group was a significant determinant of non-vaccination with the age group 18-44 being more likely to not get vaccinated compared to the group aged 45-64 (OR 2.85, 95% CI 1.70-4.79). In adults ≥65 years, age group (65-70 vs. >70, aOR 2.04, 95% CI 1.36-3.04) and lower education (aOR 1.72, 95% CI 1.06-2.80) were significant determinants of non-vaccination. In the general population, the most commonly reported reasons for non-vaccination were lack of perceived risk/need (43.4%) and not believing in vaccine effectiveness (23.4%). Doctors’ offices (33.1%) and pharmacies (29.6%) were the most frequently reported places of vaccination. Commonly reported reasons for non-vaccination and places of vaccination were consistent across all groups.

Conclusions/Implications for immunization research and evaluation: Results of this analysis show that increasing influenza vaccine coverage in Canadian adults may require tailored promotional strategies for different age groups. Furthermore, strategies that communicate risk of disease and effectiveness of the influenza vaccine may encourage vaccine uptake, particularly in high-risk groups including adults 18-64 years with CMCs, and adults ≥65. Physicians and pharmacists are key points of interaction with these at-risk groups, and may be important collaborators for addressing under-immunization in these adults.

Using mobile apps to facilitate reporting of vaccination status. Results of a pilot study with ImmunizeCA and Ottawa Public Health
Katherine Atkinson, Geoffrey Barnum, Cameron Bell, Alicia St Hill Nassir, Marie Claude Turcotte, Mari Teitlebaum, Pranesh Chakraborty, Kumanan Wilson

Introduction/Background: An augmented version of the ImmunizeCA mobile app was released on April 27, 2015 which permitted mobile reporting of immunization status. This project was a partnership between The Ottawa Hospital, the Better Outcomes Registry and Network (BORN) and Ottawa Public Health (OPH). The scope was restricted to individuals in Ottawa, reporting immunizations for children aged 15 and under, via iOS devices. All data submitted as a part of this pilot was disclosed to BORN by OPH and entered into the BORN information
Methods: The objective of this study was to characterize participant use of mobile immunization reporting as a proxy for feature acceptability by parents and usability by public health. Pilot data was extracted from the BIS on June 22nd, 2016. Final unique records were identified by determining each child’s last transmission. All data from this transmission was retained as “number of doses”. The remaining were classified as “duplicate doses”. Children’s age was calculated based on the date they received their most recent immunization.

Results: A total of 4117 users were in the Ottawa area and had iOS devices. 41,125 immunization doses (21,066 duplicate) were transmitted between April 27th, 2016 and June 22nd, 2016, representing 1,596 individual children. 818(51.3%) were male and 778(48.7%) were female. 70% of children were aged 0-5 years old, 17% were aged 6-10 and the remaining 13% were 11-15 years old. 49% of records were submitted on time, with no subsequent updates. The average number of vaccination doses submitted per child was 12.5(SD 4.21). Thirty different SNOMED codes were reported, the most frequent representing the DTaP-IPV-Hib vaccine followed by the Pneumococcal vaccine Pneu-C-13.

Conclusions/Implications for immunization research and evaluation: Our findings suggest that parental reporting of immunizations to public health via mobile devices may be acceptable. The potential to collect data on children aged 0-5 suggests that this data could enable more accurate assessments of vaccine coverage. However, several considerations should be made regarding user interface design, use of data standards and public communication in order to maximize the potential of mobile reporting.

Utilisation du programme de fidélisation d’une entreprise privée afin d’accélérer l’administration de la vaccination post exposition dans une élosion d’hépatite A

Danielle Auger, Monique Landry, Nadine Sicard

Introduction/Définition du problème : Le vendredi 15 avril 2016, un rappel de petits fruits congelés distribués par Costco dans ses magasins au Québec était annoncé en raison d’une contamination par le virus de l’Hépatite A. Plus de 25,000 unités de ce produit avaient été vendus au Québec durant la période visée, entre décembre 2015 et avril 2016. Puisqu’il s’agissait d’un produit congelé et en grosse quantité (sac de 1kg), une possibilité de consommation récente de moins de 14 jours était possible. Une vaccination en post-exposition était donc indiquée.

But : Le but de la présentation est de mettre en lumière les enjeux, les difficultés et les succès dans l’organisation rapide d’une offre de service de vaccination contre l’hépatite A lors d’un rappel de produit contaminé largement distribué au Québec.

Méthode/Données probantes : Les autorités de santé publique ont convenu avec Costco de la pertinence d’une intervention de vaccination post-exposition pour les personnes ayant consommé le produit dans les 14 jours précédents. Costco avait la capacité de rejoindre rapidement tous les membres ayant acheté le produit rappelé durant la période visée. L’enjeu était donc d’organiser rapidement (en moins de 72 heures) des cliniques de vaccination contre l’hépatite A dans toutes les régions du Québec pour répondre à la demande de vaccination de personnes ayant consommé le produit depuis moins de 14 jours suite à la communication de Costco.

Importance des constatations/résultats pour la recherche et l’évaluation en immunisation : Il s’agissait d’une première situation au Québec où les consommateurs éventuels d’un produit rappelé et largement distribué pouvaient être rejooints personnellement et rapidement pour les informer de la possibilité d’une vaccination en post-exposition. De plus en plus de détaillants de produits d’alimentation ont la capacité de rejoindre leurs clients rapidement par différents moyens de communication. Ce genre de situation pourra donc se reproduire. La collaboration étroite, rapidement établie entre les autorités de santé publique du Québec et Costco a été un élément déterminant pour l’organisation de cliniques de vaccination contre le VHA et l’ajustement de celles-ci en fonction de la demande.
Vaccination under the Midnight Sun, an audit of the Northwest Territories Immunization Registry

Marc Arseneau, Julia Young, Shannon Leblanc, Heather Hannah

**Introduction/Background:** Immunizations became reportable to the Chief Public Health Officer under the Northwest Territories Public Health Act in 2012. In the absence of an information system, monthly summaries of vaccine events were submitted by every health center and consolidated into a system of spreadsheets which make up the NWT Immunization Registry. In preparation of populating an eventual information system to manage immunization events, an audit of the existing system of data spreadsheets was conducted. The audit aimed to determine data quality and completeness of the existing spreadsheets.

**Methods:** The audit covered vaccination events conducted from 2012 - 2014 inclusive, of all children born in 2012 - 2014 inclusive. All community health centers provided copies of original vaccine events from the paper medical record of each child with a birthdate in 2012-2014. These were compared to the original monthly community spreadsheets submitted to the Registry. Errors and missing information were quantified for all vaccination events occurring in 2012-2014. In addition, validation against NWT’s Health Management Information System was conducted for names and dates of birth.

**Results:** Over 22,000 vaccination records were audited for children born between in 2012 - 2014. Approximately 1800 (28%) of the vaccine events from the paper medical record were missing from the monthly electronic submissions. Approximately 31% of vaccination events reported on the monthly summaries were contained an error or a blank field. The most common fields with errors or missing data were the Health Card Number, Vaccine Brand and Manufacturer.

**Conclusions/Implications for immunization research and evaluation:** The current audit demonstrates that the existing Immunization Registry system is incomplete and error prone. It provides further rationale that a territorial immunization information system is a necessary tool for public health practice. An integrated immunization information system will not only improve in Registry completeness and quality, it will also improve service delivery and vaccine coverage for NWT residents.

Vaccinating children against influenza in Hutterite colonies: Follow up of a randomized trial

Biao Wang, Margaret Russell, Lorraine Moss, Kevin Fonseca, Julie Fox, David Earn, Fred Aoki, Gregory Horsman, Paul Van Caeseele, Khani Chokani, Mark Vooght, Lorne Babiuk, Richard Webby, Stephen Walter, Mark Loeb

**Background:** We conducted a cluster randomized controlled trial (RCT) in Hutterite colonies during the 2008-2009 flu season, demonstrating a significant herd effect in non-vaccinated participants. We report here the results of follow up during additional influenza seasons.

**Objective:** To assess herd effect over multiple influenza seasons in a cluster randomized controlled trial.

**Methods:** In a cluster randomized controlled trial, children aged 36 months to 15 years of age were randomly assigned, in a blinded manner according to community membership, to receive either inactivated trivalent influenza vaccine or hepatitis A. The primary outcome was RT-PCR confirmed influenza A and B infections. 1,053 Hutterite children in the 2009-2010 season and 1,014 in the 2010-2011 season received study vaccine and 2,805 non-study vaccine recipients in 2009-2010 and 2,840 in 2010 -2011 were followed. Due to the outbreak of 2009 H1N1 pandemic, data in 2009-2010 season were excluded from analysis.

**Results:** In a combined 2008-2009 and 2010-2011 analysis, among non-recipients of study vaccine, 66 of 2794 (2.4%) in influenza vaccine colonies and 121 of 2301 (5.3%) in hepatitis A colonies had RT-PCR confirmed influenza, for a protective effectiveness of 60% (95% CI, 6% to 83%; P = 0.04). Among all study participants, 125 of 3806 (3.3%) in the influenza vaccine colonies and 239 of 3243 (7.4%) in the hepatitis A colonies had RT-PCR confirmed influenza, for a protective effectiveness of 63% (95% CI, 5% to 85%; P = 0.04).

**Conclusion:** Vaccinating children with inactivated influenza vaccine consistently offers a protective effect among unimmunized community members.
Vaccine conspiracy beliefs across Canada
Gilla Shapiro, Anne Holding, Samara Perez, Rhonda Amsel, Zeev Rosberger

Introduction/Background: The human papillomavirus (HPV) vaccine programs are crucial for Canadian cancer prevention efforts; however, optimal uptake rates have not been consistently achieved. Parents’ vaccine attitudes influence their decision to vaccinate their child. Qualitative research indicates that vaccine conspiracy belief may be an important contributor to the decision to vaccinate one’s child with the HPV vaccine. The objectives of this research were to develop and validate the Vaccine Conspiracy Beliefs Scale (VCBS); determine whether this scale is associated with Canadian parents’ willingness to vaccinate their child with the HPV vaccine; and, compare endorsement of vaccine conspiracy beliefs across Canada.

Methods: Canadian parents completed an online survey where they responded to questions about their child. Participants were recruited by email invitations from Leger Marketing, a polling and market research firm. Measures included socio-demographic variables, HPV knowledge, health care provider recommendation, the VCBS, and parents’ willingness to vaccinate their child at two price points (‘free’ or ‘$300’).

Results: 1427 parents across Canada completed an online survey. The VCBS was one-dimensional and demonstrated internal consistency (α=.937). The most widely endorsed VCBS item was that ‘pharmaceutical companies cover up the dangers of vaccines’. Correlation analyses revealed that the VCBS was negatively associated with parents’ willingness to vaccinate their child when the vaccine was ‘free’ (r =-0.55, p<.001) and ‘$300’ (r =-0.23, p<.001). In Hierarchical regression analyses, the combination of covariates accounted for 31% of variance in parents’ willingness to vaccinate their children when the vaccine was ‘free’ (F(7,1233)= 79.92, p< 0.001), but only 12% when the vaccine was ‘$300’ (F(7,1233)=24.58, p<.001). A Oneway ANOVA analyses indicated that endorsement of the VCBS was significantly, though not importantly, different by province (F(9,1426)=3.23, p=.020).

Conclusions/Implications for immunization research and evaluation: The VCBS is a validated measurement tool that could be used to advance our understanding of the impact of vaccine conspiracy beliefs. The VCBS emerged as an important correlate of parents’ willingness to vaccinate their child with the HPV vaccine. The VCBS had a stronger relationship to parents' willingness to vaccinate their child when the vaccine was offered for ‘free’ compared to ‘$300’. There was a statistically significant difference between provinces’ endorsement of vaccine conspiracies beliefs; however, this effect size was small.

Vaccine effectiveness against laboratory-confirmed influenza hospitalizations among community-dwelling older adults during the 2010/11 to 2013/14 influenza seasons in Ontario, Canada
Jeffrey Kwong, Hannah Chung, Michael Campitelli, Sarah Buchan, Kevin Schwartz, Natasha Crowcroft, Tim Karnoukh, Kevin Katz, Allison McGeer, Dayre McNally, David Richardson, Susan Richardson, Laura Rosella, Andrew Simor, Marek Smieja, George Zahariadis, Jonathan Gubbay

Introduction/Background: Annual influenza immunization is recommended for older adults but there is sparse evidence that influenza vaccines reduce laboratory-confirmed serious outcomes. Our objective was to evaluate seasonal influenza vaccine effectiveness (VE) against laboratory-confirmed influenza hospitalizations for older adults over 4 influenza seasons.

Methods: We conducted a test-negative case-control study of community-dwelling adults aged >65 years who were hospitalized and tested for influenza using nucleic acid amplification techniques during the 2010-11 to 2013-14 seasons in Ontario, Canada. We linked results of respiratory virus tests between September 2010 and May 2014 to hospitalization data. We determined receipt of seasonal influenza vaccines from physician and pharmacist billing claims. We used multivariable logistic regression, adjusting for age, sex, season, month of influenza test, comorbidities, and previous healthcare use, to estimate VE. We conducted several sensitivity analyses, including one to adjust for misclassification of vaccination (sensitivity=69%, specificity=90%) due to
individuals receiving influenza vaccine in settings other than physician offices and pharmacies. We also examined the impact of receipt of influenza vaccine during the previous season.

**Results:** Over 4 influenza seasons, we included 17,512 older adults, with 3012 (17.2%) testing positive for influenza, and 51.0% actively immunized. Adjusted VE estimates were 30% (95%CI 24%-35%) for the 4 seasons combined, 35% (95%CI 23%-45%) for 2010-11, 36% (95%CI 15%-52%) for 2011-12, 19% (95%CI 7%-29%) for 2012-13, and 39% (95%CI 28%-47%) for 2013-14. The sensitivity analysis correcting for exposure misclassification resulted in increased VE estimates: 50% (95%CI 47%-54%) for the 4 seasons overall, 55% (95%CI 48%-61%) for 2010-11, 59% (95%CI 46%-68%) for 2011-12, 36% (95%CI 28%-43%) for 2012-13, and 56% (95%CI 50%-62%) for 2013-14. VE for the 4 seasons overall was higher for those immunized in the current season only (38%; 95%CI 29%-47%) than those immunized in both the previous and current seasons (32%; 95%CI 25%-38%) and those immunized in the previous season only (17%; 95%CI 6%-26%). A similar pattern was observed for all seasons except 2013-14, when the VE point estimate was higher for those immunized in both previous and current seasons.

**Conclusions/Implications for immunization research and evaluation:** Receipt of influenza vaccine is associated with reduced risk of laboratory-confirmed influenza hospitalizations for older adults.

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**Vaccine effectiveness of non-adjuvanted and adjuvanted trivalent inactivated influenza vaccines (TIV) in the prevention of influenza-related hospitalization in Canadian seniors over the 2011/12 through 2013/14 season: A pooled analysis from the Serious Outcomes Surveillance (SOS) Network of the Canadian Immunization Research Network (CIRN)**

Shelly McNeil, Todd Hatchette, Melissa Andrew, Ardith Ambrose, Guy Boivin, Francisco Diaz-Mitoma, William Bowie, Ayman Chit, Gael Dos Santos, May ElSherif, Karen Green, Francois Haguinet, Scott Halperin, Barbara Ibarguchi, Jennie Johnstone, Kevin Katz, Joanne Langley, Jason LeBlanc, Philippe Lagace-Wiens, Bruce Light, Mark Loeb, Donna Mackinnon-Cameron, Anne McCarthy, Janet McElhaney, Allison McGreer, Andre Poirier, Jeff Powis, David Richardson, Makeda Semret, Vivek Shinde, Stephanie Smith, Daniel Smyth, Grant Stiver, Grant Taylor, Sylvie Trottier, Louis Valiquette, Duncan Webster, Lingyun Ye

**Introduction/Background:** While influenza vaccines provide important benefits and represent our best tool for preventing influenza-related morbidity and mortality, VE of TIV in seniors (≥65y) is suboptimal. An MF-59 adjuvanted TIV (TIVadj) developed to improve VE in seniors was authorized in Canada for patients ≥65y beginning the 2011/12 season. Citing lack of efficacy data and conflicting results from observational studies regarding effectiveness of TIVadj versus non-adjuvanted TIV (TIVnadj) products, Canada’s National Advisory Committee on Immunization did not provide a preferential recommendation for TIVadj in seniors. Here we provide estimates of the effectiveness of TIVadj and TIVnadj in the prevention of hospitalization of seniors over 3 influenza seasons.

**Methods:** From 2011/12 - 2013/14, the SOS Network conducted active surveillance for influenza among hospitalized adults ~1Nov- 30April each season in up to 45 hospitals in 7 provinces. A nasopharyngeal swab for influenza polymerase chain reaction (PCR) was obtained from patients admitted with any acute respiratory diagnosis or symptom. Cases were influenza PCR-positive; test-negative controls were enrolled and matched for date, enrolment site and age of the case (≥65y versus <65y). VE was estimated as (1 minus odds ratio of influenza in vaccinated versus unvaccinated patients) x 100 for cases and controls enrolled over three seasons. VE estimates were adjusted using multivariable logistic regression with stepwise backward selection of covariates with p-value of <.1 in univariate analysis.

**Results:** 2078 cases & 2939 controls ≥65y were enrolled. Over 3 seasons, overall matched, adjusted VE for all vaccines was 39.3% (95% Confidence Interval [CI]: 29.4, 47.8%). After adjustment for age, receipt of antivirals, frailty, smoking history and medications, VE of TIVadj (n= 286 cases/327 controls) was 61.3% (95% CI: 17.5, 81.9%) and adjusted VE of TIVnadj (n=1038 cases/1304 controls) was 32.5% (95% CI: 18.9, 43.7%).
Conclusions/Implications for immunization research and evaluation: Our findings over 3 influenza seasons indicated a trend suggesting that $TIV_{\text{adj}}$ may provide better protection against influenza-associated hospitalizations in seniors than $TIV_{\text{n-adj}}$ products currently used in Canada. While the study is observational in design, and therefore subject to confounding, we have adjusted extensively for baseline characteristics including underlying frailty, arguably the most important confounder in studies of VE in older adults.

Vaccine hesitancy: View from front line vaccine providers

Maryline Vivion, Devon Greyson, Julie Bettinger, Eve Dubé

Introduction/Background: Front line vaccine providers play an important role in vaccine uptake, but parental vaccine hesitancy may post challenges for practice. This project explored vaccine providers’ experiences with vaccine hesitancy, aiming to identify useful tools to facilitate vaccination decisions.

Methods: Participants were recruited from among health care worker respondents to a Delphi study of vaccine hesitancy. Nine semi-structured interviews were conducted (4 in Quebec, 4 in British Columbia, and 1 in Atlantic Canada). Mean length of the interviews was 27 minutes. Interviews were transcribed and thematically analyzed using NVivo 10 software.

Results: Front line vaccine provider reports indicate substantial regional variation in trends of vaccine hesitancy, with Eastern Canada providers observing increases in hesitancy and concerns regarding the MMR and influenza in particular, and West Coast providers perceiving that hesitancy has peaked and is now focused on newer vaccines, including those associated with sexually transmitted infections. Providers noted that addressing the concerns of hesitant parents requires time. While some parents are not open to discussion, many providers described taking a counseling approach that included exploring the reasons for hesitancy, attempting to correct misinformation, and sometimes sharing their personal and clinical experiences with vaccine-preventable diseases. Providers located in smaller communities or working in family practice settings described taking a long-term approach, working to build relationships of trust and respect with hesitant parents over time. In addition to tailored and convenient (e.g., online, continually updated) information resources, providers felt that training in communication techniques would be helpful in working with hesitant parents. Mass advertising campaigns and social campaigns that used immunization champions and empowered pro-immunization parents to speak out were identified as potential strategies to reduce hesitancy.

Conclusions/Implications for immunization research and evaluation: Vaccine hesitancy impacts clinical practice and front line vaccine providers face challenges dealing with hesitant parents. Regional cultural effects may influence the specifics of parental hesitancy. Effective tools and strategies are needed.

Vaccine hesitancy in Canada: Results of an online survey

Eve Dubé, Julie A. Bettinger, William Fisher, Dominique Gagnon, Devon Greyson, Shannon E. MacDonald, Manale Ouakki, Vineet Saini, Holly Witteman

Introduction/Background: Success in vaccination programs is dependent on a high vaccination coverage rate. The high rate of childhood immunization in Canada reflects general acceptance of this public health measure. Although there is a small minority of Canadian parents refuse all vaccines, and a majority of parents who accept all vaccines, a significant proportion of parents fall between these extremes and show some level of vaccine hesitancy. The main objective of this study was to measure the prevalence of vaccine hesitancy across Canada.

Methods: An online survey was conducted among Canadian parents or caregivers of at least 1 child aged 24-59 months of age using Leger Pooling Firm panel. The questionnaire included open- and closed-ended questions and was developed after a literature review and a pilot study in Alberta. A pre-test was done online with 40 parents. Responses to open-ended questions were submitted to content analysis and descriptive statistics were generated for all variables.
Results: Data were collected from March 7 to March 30 2016 and 2,013 parents were included in the analysis. The majority of parents (85%) said that their child has received all recommended vaccines since birth and 2% said their child has not received any vaccines. The main reason why parents decided to vaccinate was to protect their child against diseases and the main reasons why parents decided not to vaccinate was because of fear of adverse events or not perceiving vaccines as a necessity. Overall, 18% of the parents considered themselves to be vaccine-hesitant.

Conclusions/Implications for immunization research and evaluation: Although most of the children of parents surveyed were vaccinated, a considerable proportion of them held vaccine-hesitant attitudes.

Vaccine hesitancy in the Web 2.0 era
Maryline Vivion

Introduction/Background: Vaccination is considered to be one of the greatest achievements of public health. In Quebec, vaccination is not mandatory and relies on parent’s acceptance. Studies have shown an increase of negative attitude toward vaccination for parents and some of them are categorized as being hesitant regarding vaccination. Vaccine-hesitant parents may refuse some vaccines, but agree to others; they may delay vaccines or accept vaccines according to the recommended schedule, but be unsure in doing so. In Quebec, while less than 5% of parents have refused all vaccines for their children, one third could be categorized as being hesitant regarding vaccination. It is often argued that the omnipresence of anti-vaccination content on the Internet has contributed to the increase of vaccine hesitancy among parents. The aim of this doctoral project is to explore the link between Internet and vaccine hesitancy.

Methods: An online ethnography based on non-participant and participant observation has been conducted in 2015 on social media groups where discussion on vaccination occurred. (Facebook groups and Forums in websites for parents). In order to complete these observations, 18 interviews have been conducted with mothers from Quebec. Discussion threads from social media were downloaded and interviews were recorded and fully transcribed. Data collection has ended December 31st 2015. A content analysis is conducted with N’vivo 10 software.

Results: The Internet is now part of everyday life of every parent and the most common tool used by parents who want information about health. It is increasingly apparent that the Internet contributes to vaccine hesitancy. Moreover, with social media, parents can now be exposed to information on vaccination without having looked for it. On Internet groups, vaccination is a recurrent topic that can be sensitive. However, if some mothers take into consideration this information other mention that they cannot trust it.

Conclusions/Implications for immunization research and evaluation: This project will allow the development of appropriate communication strategies about vaccination that will correspond to Canadian parents’ needs and interests. The efficacy of vaccination promotion interventions online is based on our understanding of how parents use the Internet and its role in their decision.

Validating a ‘vaccine hesitancy’ instrument in a cohort of Alberta parents: A Canadian Immunization Research Network (CIRN) Study
Shannon MacDonald, Eve Dubé, Dominique Gagnon, Julie Bettinger, Holly Witteman, Vineet Saini, Suzanne Tough, for the CIRN investigators

Background: Parental attitudes toward childhood immunization range from active demand for vaccines to complete refusal of all vaccines. Even parents that vaccinate their children may exhibit ‘vaccine hesitancy’ and may cease to vaccinate in the future and/or promote vaccine concerns amongst other parents. Measuring the population prevalence of vaccine hesitancy is important in order to identify target populations for intervention and changing trends in hesitancy over time. However, such measurement is not straightforward, as vaccine
hesitancy is not directly related to vaccine uptake. Survey instruments to assess vaccine hesitancy in new parents have been developed and validated in the USA, but need to be validated and possibly adapted to other populations. The purpose of this study was to validate a previously developed vaccine hesitancy instrument in a Canadian setting with parents of older children.

**Methods:** We sampled 500 parents with children 4-5 years of age from an ongoing longitudinal cohort study in Calgary, Alberta. Participants completed a 15-item survey instrument previously tested and validated in the USA. Their child’s immunization status was abstracted from the provincial immunization registry. Parents’ responses to the survey instrument were summed to produce a score from 0 (no hesitancy) to 100 (highest level of hesitancy). Hesitancy scores were then compared (significance p<0.05) and tested for an association with immunization status using logistic regression.

**Results:** Of 200 respondents, 81% were parents of completely immunized children. The mean vaccine hesitancy score was 15 for parents of completely immunized children and 59 for those who were incomplete or had no vaccines (p<0.0001). As compared to parents who scored <40 (the natural breakpoint), those who scored 40-69 had 8.1 times higher odds (95%CI 2.47-26.63) of having an incompletely or unvaccinated child and those scoring 70-100 had 85.2 times higher odds (95%CI 22.183-326.985). Specific questions related to immunization intention and past behaviour were also strongly associated with vaccine uptake (e.g. If you had another infant today, would you want him/her to get all recommended vaccines?).

**Conclusions:** Parents’ scores on the vaccine hesitancy instrument were associated with vaccine uptake, but specific questions may be better measures of vaccine hesitancy than the total score in some contexts.

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**Variable effects of repeat vaccination against influenza B illness by season: 2010/11 to 2014/15**

*Catharine Chambers, Danuta Skowronski, Gaston de Serres, Anne-Luise Winter, James Dickinson, Suzana Sabaiduc, Naveed Janjua, Jonathan Gubbay, Kevin Fonseca, Steven Drews, Christine Martinneau, Alireza Eshaghi, Mel Kraijden, Martin Petric, Nathalie Bastien, Yan Li*

**Introduction/Background:** Influenza B viruses are more genetically conserved across Victoria and Yamagata lineages and have a slower evolutionary rate compared to influenza A(H3N2). We assessed the effects of receiving prior season’s trivalent influenza vaccine (TIV) containing a single influenza B antigen on current season’s TIV protection across five separate seasons (2010-11 to 2014-15) with variable circulation of both lineages.

**Methods:** Repeat vaccination effects were assessed in data collected from the Canadian Sentinel Practitioner Surveillance Network (SPSN) using a test-negative case-control design. Using logistic regression, the odds of medically attended, laboratory-confirmed influenza B illness was compared across self-reported vaccination categories for the current and/or prior season relative to those unvaccinated in both seasons. Vaccine effectiveness (VE) was derived as (1–odds ratio)*100%.

**Results:** Significant vaccine protection against influenza B illness was observed each season, including cross-protection from lineage-mismatched TIV. Among patients vaccinated in the current season, ≥80% on average had been vaccinated in the prior season. During the 2010-11 and 2011-12 seasons when the B/Brisbane/60/2008(Victoria) antigen was unchanged from prior season, variable repeat vaccination effects were observed. In 2010-11, when B/Brisbane/60/2008(Victoria) viruses predominated, positive interference (boosting) from prior season’s homologous vaccination was seen, whereas no effect was observed in 2011-12 when Victoria and Yamagata lineages co-circulated. Boosting from prior vaccination was also observed in 2012-13 when both lineages again co-circulated but the antigen was changed from B/Brisbane/60/2008(Victoria) to B/Wisconsin/1/2010(Yamagata). In contrast, negative interference (blunting) was observed in 2013-14 when the antigen was changed to B/Massachusetts/2/2012(Yamagata), representing a clade-level but not lineage-level switch, but clade-level mismatched B/Wisconsin/1/2010(Yamagata) viruses circulated. Similarly in 2014-15, blunting from prior vaccination was observed with unchanged
B/Massachusetts/2/2012(Yamagata) antigen against clade-level mismatched circulating viruses, with lower overall VE compared to 2013-14.

**Conclusions/Implications for immunization research and evaluation:** Heterogeneous effects of repeat vaccination on current season’s VE were found for influenza B, with suggestion that this may vary with antigenic and genetic relatedness between serial vaccine components and circulating viruses. However, further analysis across more seasons is required to clarify the pattern of positive or negative interference from prior vaccination on current vaccine protection, and the conditions potentially contributing to that, for influenza B.

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**Waning of measles maternal antibody in infants: A systematic literature review focusing on elimination settings**

_Fiona Guerra, Natasha Crowcroft, Shelley Deeks, Scott Halperin, Alberto Severini, Todd Hatchette, Shelly Bolotin_

**Introduction/Background:** Most infants are born immune to measles through maternal antibodies transferred in pregnancy, which decay over time. Timing of the first dose of measles vaccine at 12 months accounts for this, balancing the risk of infection with the assumption that infants are protected for most of the first year of life through passive immunity and herd immunity, and that the vaccine is less effective in the presence of maternal antibodies. However, recent evidence shows that in measles elimination settings, where measles does not circulate endemically and most immunity is from immunization rather than infection, maternal antibody levels are lower. As a result, infant immunity is lower, wanes earlier and the susceptibility gap between antibody decay and immunization is wider than in non-eliminated settings. We aimed to systematically quantify the impact of lower maternal measles antibody on the extent and duration of protection in infants in elimination settings.

**Methods:** We searched six databases for relevant studies. We included studies set in countries that eliminated measles for ≥3 years (indicating sustained elimination), and if the study cohort included healthy, full-term, unvaccinated infants ≤12 months, born to healthy mothers, and reported at least one of the following: proportion susceptible to or immune from measles, based on anti-measles antibody; proportion with any detectable anti-measles antibody; anti-measles antibody titres in serum or cord blood; or titres of anti-measles antibody in breast milk during the infants’ first year of life.

**Results:** The searches yielded 4,407 unique citations, seven of which met inclusion criteria. Included studies were set in the USA, Brazil, or Mexico. One study reported anti-measles antibody in cord blood, five reported antibody in infant sera, and one reported both. Two studies found that 80 and 100% of infants were protected from measles at birth. One study reported 0% protection amongst 4-7 month olds. The remaining studies reported the proportion of infants with detectable antibody but not proportion protected.

**Conclusions/Implications for immunization research and evaluation:** Although we assume most infants are protected from measles, these limited data suggest that in elimination settings they may become susceptible much earlier in their first year of life. Seroprevalence studies are required to evaluate this in Canada.