



Oral Abstract Program
Programme des résumés oraux

ORAL PRESENTATIONS – SESSION 1

Tuesday 4 December

11:30 – 13:00

Room 205

Varicella breakthrough cases occurring in previously vaccinated children between 2000 and 2015 in the Canadian IMPACT centres

Tan B, Bettinger J, McConnell A, Thibeault R, Reyes Domingo F, Samson H, Severini A, Vaudry W, Halperin S

Introduction/Background: One-dose varicella vaccination programs began in 2000-06, and 2-dose programs in 2011-16. There are currently no Canadian data regarding previously vaccinated children hospitalized with varicella. Our study goal is to determine the proportion, clinical characteristics and outcome of hospitalized varicella ("breakthrough") cases from 2000 to 2015 (zoster excluded).

Methods: Vaccination histories of varicella cases from 12 IMPACT centers in 8 provinces from 2000-15 were reviewed. Breakthrough cases had illness-onset > 42 days after the last vaccine dose. We analyzed: age at admission, time from vaccination, underlying health conditions, complications reported, proportion requiring intensive care, duration of hospital stay, and clinical outcome. Determining antibody levels and differentiating between vaccine or wild-type virus was not performed.

Results and Analysis: Of 2,067 cases with known vaccination histories, 134 (6.5%) received 1-dose and 9 (0.5%) 2-doses of varicella-containing vaccines. For 1-dose recipients, mean age (\pm SD) was 6.7 (\pm 3.2) years, mean interval since vaccination was 4.6 (\pm 2.8) years, 78% were immunocompromised, 17% developed secondary bacterial infections and 46% other varicella complications, mean duration for hospitalization was 5.6 (\pm 4.1) days, and only 3 (2%) required PICU admission. Among 2-dose recipients, mean age was 8.2 (\pm 3.3) years, mean interval from last vaccine dose was 4.4 (\pm 3.2) years, 56% were immunocompromised, secondary bacterial infections and other complications occurred in 22% and 56%, respectively; mean hospital duration was 5.0 (\pm 1.3) days. There were no deaths in either 1-dose or 2-dose recipients.

Conclusions and implications for vaccinology: Breakthrough disease accounted for 7% of varicella admissions, with no deaths and rare PICU admission. The immunocompromised made up > 50% of cases. The low number of 2-dose recipients could be due to the more recent introduction of 2-dose programs. We could not determine if breakthrough was caused by vaccine or wild-type virus, or from waning immunity.

Pertussis vaccine effectiveness in a frequency matched population-based case-control Canadian Immunization Research Network study in Ontario, Canada 2009-2015

Crowcroft N, Schwartz K, Chen C, Johnson C, Li Y, Marchand-Austin A, Bolotin S, Deeks S, Jamieson F, Drews S, Russell M, Svenson L, Simmonds K, Mahmud S, Kwong J

Introduction/Background: Resurgences of pertussis linked to waning of immunity from acellular pertussis vaccines have occurred in several high income countries. The degree of waning immunity observed varies by study design and setting. In Ontario, pertussis has not shown a significant resurgence in the past decade.

Methods: We estimated pertussis vaccine effectiveness (VE) through a case-control study of 1,335 cases statutorily reported to public health in Ontario and occurring between January 1, 2009 to March 31 2015, compared with 5,340 randomly selected population controls, frequency-matched by age, primary-care provider and year of diagnosis. Pertussis cases met provincial case definitions requiring a confirmed case to have laboratory confirmation or an epidemiological link and at least one typical symptom, and a probable case to have at least 2 weeks' cough associated with paroxysms, whoop, vomiting or gagging, or apnea.

Results and Analysis: VE against pertussis was sustained between 92% (95% confidence interval (CI) 88 to 95%) in 2-3 year olds to 90% (95% CI: 80 to 95%) in 8-9 year olds, but fell rapidly to 49% (95% CI: 2 to 73%) in children 12-13 years of age. VE following the teenage booster given at 14 years in Ontario reached 82% (95% CI: 60 to 92%) in 14-15 year olds, and fell to 64% (95% CI: -69 to 92%) in 16-17 year olds. For children who are up-to-date,

VE fell from 87% (95% CI: 84 to 90%) during the first year to 74% (95% CI: 63-82%) by 8 years or more following the last dose of immunization.

Conclusions and implications for vaccinology: VE is high during the first decade of life but then falls rapidly. Protection is not fully restored by the teenage booster. Our findings are consistent with the localized outbreaks we observe in older children and underscore the importance of additional policies to protect infants, including through immunization in pregnancy.

The Effect of 16 years of Meningococcal Vaccination Programs in Canada

Le Saux N, Bettinger J, Sadarangani M, Morris S, Top K, Vaudry W, Halperin S, Tsang R, (IMPACT) M

Introduction/Background: Meningococcal conjugate vaccine (MCV) programs started in Canada in 2002. This study examines 16 years of surveillance for Invasive meningococcal disease (IMD) after infant meningococcal C (Men-C) and subsequent adolescent Men-C-ACWY vaccine programs.

Methods: Active, population-based surveillance was conducted by the 12 centers of IMPACT for hospital admissions related to *Neisseria meningitidis*, January 2002 – December 2017. Case definition required isolation of meningococcus or positive PCR test from sterile sites.

Results and Analysis: 1146 cases of IMD from 2002-2017 were reported. Significant incidence decreases indicated.*

Age	Overall Incident Rates per 100,000 (95% CI)	
	2002	2017
All Serogroups		
0-4 years	2.61 (1.66 - 3.92)	1.27 (0.65 - 1.72)
5-9 years	0.31 (0.06 - 0.90)	0.21 (0.03 - 0.48)
10-14 years	0.20 (0.02 - 0.71)	0.10 (0.00 - 0.31)
15-19 years	1.67 (0.97 - 2.67)	0.45 (0.15 - 0.74)*
> 19 years	0.48 (0.36 - 0.62)	0.17 (0.11 - 0.22)*
Serogroup W		
0-4 years	0.68 (0.25 - 1.41)	0.21 (0.03 - 0.47)
15-19 years	0.10 (0.00 - 0.45)	0.09 (0.00 - 0.29)
Serogroup Y		
0-4 years	0.23 (0.03 - 0.82)	0.11 (0.00 - 0.33)
15-19 years	0.29 (0.06 - 0.86)	0.09 (0.00 - 0.29)

Since 2013, no cases of serogroup C occurred in persons <19 years. Serogroup B was the most frequent: incidence in 2017 ranged from 0.74 (0.30 - 1.11) in children 0-4 years to a low of 0.10 (0.00 - 0.31) in children 10-14 years.

Conclusions and implications for vaccinology: Overall incidence of IMD has decreased in Canada over the last 16 years. Serogroup C disease was eliminated in children approximately eight years after implementation of Men-C programs and 5 years since the first IMPACT province introduced Men-C-ACYW in adolescents. Serogroup B is now the most prevalent serogroup, particularly among young children. Serogroups Y and W disease have decreased but continued surveillance will be required to fully evaluate effects of Men-C-ACYW vaccine.

The Emergence of Meningococcal W ST-11 Clone in BC, 2017

Naus M, David S, Hoang L, Pollock S, Goodison K

Introduction/Background: Meningococcal serogroup W has historically been a minor player in invasive meningococcal disease (IMD) in Canada. In British Columbia (BC) a clonal strain of W clonal complex 11 (ST-11 cc) caused an outbreak in one health region that resulted in an immunization campaign targeting adolescents. This outbreak occurred in the context of increased rates of sporadic W ST11 disease in the province.

Methods: IMD is reportable in BC. Case data are submitted by regional health authorities to the BC Centre for Disease Control (BCCDC), and all confirmatory testing is performed at the BCCDC Laboratory with further differentiation conducted at the National Microbiology Laboratory. Data from both sources are contained in a data base for epidemiologic analysis.

Results and Analysis: In the years 2006-2016, 0-2 cases of IMD W were reported annually in BC. In 2017, a total of 16 cases were reported, for an incidence of 0.54 per 100,000 population, and constituted 61.5% of the 26 IMD case reports. Seven of the W cases were aged 15-24, 7 were aged 40+, and 2 were in infants. Two were fatal, including one teen; these were the only W deaths in BC in the period 2001-2017. Of the 16 W isolates, 15 were ST-11 clonal complex/ ET37. Ten of the cases occurred in one health region; 3 of these were among 15-19 year olds associated with one school and an additional case within a month in the same age group and health service delivery area, leading to an immunization campaign without further cases subsequently.

Conclusions and implications for vaccinology: While the ST-11 cc had been recognized in Canada since its global dissemination in 2000 and has accounted for an increasing proportion of W strains since 2014, this was the first outbreak of this clonal complex in Canada. The potential for further outbreaks exists.

Nephrotic syndrome following four component meningococcal B vaccine (4CMenB)

De Serres G, Gariépy M, Billard M, Toth E, Landry M, Belley S, Gagné H, Roy M, Boucher F

Introduction/Background: In May 2014, individuals aged 2 months to 20 years old from the Saguenay–Lac-Saint-Jean region were vaccinated with the four component meningococcal B vaccine (4CMenB). An active surveillance of vaccine safety assessing adverse events following immunization (AEFI) up to six months after the last dose of vaccine identified three cases of nephrotic syndrome (NS) among ~10,000 participants for a preliminary incidence of nearly 60 per 100,000. Given an expected incidence of NS of 1 to 4 per 100,000, we conducted an investigation to assess the association of 4CMenB and NS.

Methods: Cases of NS were identified in the hospitalization and emergency room consultation databases based on diagnostic codes. To be confirmed a NS case had to have generalized edema, hypoalbuminemia < 30g/L and proteinuria ≥3 g/L.

Results and Analysis: The three initial cases were confirmed NS upon review of their medical charts. A fourth confirmed vaccinated NS case who did not participate to the active surveillance was also identified. All cases were aged 2 to 5 years. Two cases had their symptom onset between their 1st and 2nd dose. One patient was treated on an ambulatory basis. The incidence of NS in the 13 months following the onset of the campaign among vaccinated individuals aged 1-9 years was 16.3 per 100 000. Excluding the ambulatory case, the rate of hospitalization for NS was significantly higher in vaccinees (relative rate ratio 7.65, CI95% 1.02 to 57.1) than that observed in 1-9 year olds in that region during the eight years preceding the campaign.

Conclusions and implications for vaccinology: These four NS cases associated with 4CMenB constitute an important safety signal. However, despite statistical significance, with so few cases this association will have to be assessed in other jurisdictions before establishing causality.

ORAL PRESENTATIONS – SESSION 2

Tuesday 4 December

11:30 – 13:00

Room 206

Efficacy and Safety of an Adjuvanted Herpes Zoster Subunit Vaccine in Autologous Hematopoietic Stem Cell Transplant Recipients 18 Years of Age or Older: First Results of the Phase 3 Randomized, Placebo-Controlled ZOE-HSCT Clinical Trial

Widenmaier R, de la Serna J, Campora L, Chandrasekar P, El Idrissi M, Gaidano G, López Fauqued M, Oostvogels L, Schwartz S, Sullivan K, Szer J, Bastidas A

Introduction/Background: Autologous hematopoietic stem cell transplant (HSCT) recipients are at increased risk of herpes zoster (HZ). In adults ≥ 50 years of age (YOA), the recombinant zoster vaccine (RZV) containing recombinant varicella zoster virus (VZV) gE and AS01B Adjuvant System showed $>90\%$ vaccine efficacy (VE) in preventing HZ and a clinically acceptable safety profile. In a phase 1/2a study, RZV elicited robust immune responses in autologous HSCT recipients. Here, we report the VE of RZV in preventing HZ and postherpetic neuralgia (PHN), and its safety in adult autologous HSCT recipients.

Methods: In this phase 3, observer-blind, multicenter study (NCT01610414), adults ≥ 18 YOA were randomized 1:1 to receive 2 doses of RZV or placebo intramuscularly, 1–2 months apart, 50–70 days after autologous HSCT. The primary objective was to demonstrate overall VE of RZV against HZ. The safety and VE of RZV were analyzed in the total vaccinated cohort (TVC; N=1846) and modified TVC (mTVC; N=1721).

Results and Analysis: During a median follow-up of 21 months, at least 1 HZ episode was confirmed in 49 RZV vaccinees and 135 placebo recipients in the mTVC (respective incidences: 30.0/1000 and 94.3/1000 person years). RZV effectively prevented HZ (VE: 68.17% [95% CI: 55.56–77.53], $p < 0.0001$; primary objective met) and PHN (VE: 89.27% [95% CI: 22.54–99.76]). Solicited adverse events (AEs) incidence was higher in the RZV group, yet dose 2 compliance was comparable between groups (RZV: 94.7%, placebo: 93.3%). The most common local and general solicited AEs were injection-site pain and fatigue, respectively. The incidences of unsolicited AEs, serious AEs (SAEs; including fatalities), potential immune-mediated diseases (pIMDs), and underlying disease relapses were similar between groups.

Conclusions and implications for vaccinology: Administered early after autologous HSCT, RZV effectively prevented HZ (independent of age) and PHN. The safety profile of RZV in this population was clinically acceptable.

Funding: GlaxoSmithKline Biologicals SA

Prospective evaluation of diphtheria-tetanus-polio-Haemophilus influenzae type b (DTaP-IPV-Hib) and pneumococcal vaccination in children who completed chemotherapy for acute lymphocytic leukemia: A Canadian Immunization Research Network Study

Top K, Tapiero B, Vaudry W, Pernica J, Pham-Huy A, Gantt S, Rassekh S, Price V, Sung L, Morris S, McConnell A, Rubin E, Chawla R, Jadavji T, Halperin S

Introduction/Background: Children with acute lymphocytic leukemia (ALL) require prolonged chemotherapy, during which some lose immunity to vaccines received before diagnosis. There is no standard of care in Canada for re-immunization post-chemotherapy. We evaluated the safety and immunogenicity of an immunization protocol among children who completed ALL chemotherapy.

Methods: We conducted a multi-center open-label trial of children with ALL 6–12 months post-chemotherapy completion. We excluded children with infant ALL, relapsed ALL, and stem cell transplant. Participants received DTaP-IPV-Hib and 13-valent pneumococcal conjugate vaccine (PCV13) at visit 1, and 23-valent pneumococcal polysaccharide vaccine (PPV23) 8 weeks later. Serum was collected for tetanus, pertussis, and Streptococcus pneumoniae IgG levels pre-vaccination, 2 and 12 months after visit 1. Adverse events (AEs) were ascertained by telephone questionnaire on days 8 and 30. The preliminary analysis was descriptive.

Results and Analysis: From 2015-2017, 78 participants were enrolled at 9 centres (mean age: 9 years, SD 3.8). Participants were classified as standard risk ALL (54%), high risk ALL (36%), or very high risk ALL (9%). After DTaP-IPV-Hib and PCV13, 70% of participants reported injection site pain, erythema, or swelling. Systemic symptoms that interfered with daily activities were reported by 8% of participants on days 0-7 and 9% on days 8-30. Six participants (8%) sought outpatient care; 5/6 AEs were unrelated to vaccination. After PPV23, 64% of participants reported injection site symptoms, while 10% and 6% reported systemic symptoms that interfered with daily activities on days 0-7 and 8-30, respectively. Four participants (6%) sought medical attention (3 outpatient, 1 emergency department); 3/4 AEs were unrelated to vaccination.

Conclusions and implications for vaccinology: We implemented a post-chemotherapy immunization protocol at Canadian pediatric oncology centres. Adverse events requiring medical attention were common but none were serious and most were not causally related to vaccination. Analysis of vaccine immunogenicity is ongoing. The results will inform immunization guidelines for children with ALL.

An Enveloped Virus-Like Particle (eVLP) Cytomegalovirus (CMV) Vaccine is immunogenic and safe: preliminary results of a First-in-Humans (FiH) Canadian Immunization Network (CIRN) Clinical Trials Network (CTN) - VBI Vaccines study

Langley J, Grantt S, Quach C, McNeil S, Halperin S, DiazMitoma F, Anderson D

Introduction/Background: CMV is the most common cause of congenital infection and may result in permanent neurodevelopmental injury including vision and hearing loss. A vaccine to prevent transmission of CMV during pregnancy or to immunocompromised persons is a public health priority. Neutralizing antibodies (Nab) to the CMV envelope glycoprotein B(gB) in natural infection are thought to confer protection, but some vaccine candidates based on this protein alone have not been sufficiently immunogenic. In this FiH dose-ranging, controlled, observer-blinded study the safety and immunogenicity of an eVLP expressing the ectodomain of gB fused to transmembrane and cytoplasmic domains of the vesicular stomatitis virus G protein (gB-G) was evaluated.

Methods: Healthy CMV-seronegative 18-40 year olds at 3 CIRN CTN sites (Vancouver, Montreal, Halifax) were randomized to one of 4 dose formulations (0.5µg, 1µg, or 2µg gB content with Alum) or 1µg gB content without Alum, or placebo given on days 0, 56 and 168. Outcome measures were solicited and unsolicited adverse events (AE), severe AE, gB binding antibody titers and avidity assessment, nAB to CMV infection of fibroblast and epithelial cells. A Data Safety Management Board was in place.

Results and Analysis: Among 125 participants the most common solicited local and general AEs were pain and headache respectively. No SAEs or withdrawals occurred. A dose-dependent boosting of Nab titers was observed after doses 2 and 3, with the highest titers in the Alum adjuvanted 2.0 µg dose recipients. Epithelial cell nAb was correlated with higher gB binding titers.

Conclusions and implications for vaccinology: An eVLP CMV vaccine was immunogenic in healthy seronegative adults and no safety signals were seen. Alum adjuvantation increased immunogenicity as did higher antigen content and multiple doses. This phase 1 trial supports further development of this eVLP CMV vaccine candidate.

ClinicalTrials.gov NCT02826798

Viral genomic variation and vaccine effectiveness across consecutive influenza A(H3N2) epidemics in Canada, 2016-17 and 2017-18

Skowronski D, Chambers C, De Serres G, Winter A, Dickinson J, Chan T, Hickman R, Sabaiduc S, Gubbay J, Jassem A, Drews S, Charest H, Bastien N, Li Y, Kraiden M

Introduction/Background: The 2016-17 and 2017-18 influenza seasons included back-to-back A(H3N2) epidemics. For 2016-17, the influenza A(H3N2) vaccine was updated to newly include the A/Hong Kong/4801/2014 clade 3C.2a strain that was then unchanged for 2017-18. This egg-adapted A(H3N2) vaccine antigen bore three amino acid mutations believed to negatively affect immunogenicity. Vaccine effectiveness (VE) against influenza A(H3N2) is reported for 2016-17 and 2017-18 in the context of genomic variation between vaccine and circulating viruses.

Methods: The Canadian Sentinel Practitioner Surveillance Network (SPSN) assessed VE against A(H3N2) using a test-negative design. Influenza A(H3N2) was diagnosed by RT-PCR and characterized genetically by Sanger sequencing. Sequences were compared to the egg-adapted vaccine and phylogenetic analysis was used to assess clade variation among circulating viruses. Vaccination status was by self-report, VE analyses were adjusted for relevant confounders, and repeat vaccination effects were explored among patients ≥ 9 -years-old.

Results and Analysis: Analyses included 1940 participants in 2016-17 and 2354 participants in 2017-18 of whom most ($\geq 60\%$) were adults 20-64-years-old. Each season most participants ($\geq 85\%$) who reported current season's vaccination had also been vaccinated the prior season. In 2016-17, 423/574 (74%) sequenced viruses belonged to sub-clade 3C.2a1 distinguished by N171K with multiple other substitutions conferring substantial sub-group heterogeneity; only 81/574 (14%) viruses belonged to sub-clade 3C.2a2 distinguished by T131K+R142K+R261Q substitutions. Conversely, in 2017-18, 540/620 (87%) sequenced viruses belonged to sub-clade 3C.2a2 and just 39/620 (6%) to 3C.2a1.

In 2016-17, VE against A(H3N2) was 37%(95%CI=20-51%), comparable among recipients of both current and prior season's (differing) vaccines (45%;95%CI=26-59%) and those receiving current season's vaccine only (36%;95%CI=-16-64%). In 2017-18, VE was 15%(95%CI=-6-32%), lower among recipients of both current and prior season's (identical) vaccines (10%;95%CI=-17-31%) than current season's vaccine only (46%;95%CI=-4-72%).

Conclusions and implications for vaccinology: The potential effects of vaccine egg-adaptation mutations, viral genomic variation and repeat vaccination with unchanged vaccine should be further explored to explain low VE against consecutive A(H3N2) epidemics in Canada.

Vaccine effectiveness against lineage matched and mismatched influenza B viruses across 8 seasons in Canada, 2010-11 to 2017-18

Skowronski D, Chambers C, De Serres G, Winter A, Dickinson J, Chan T, Hickman R, Sabaiduc S, Gubbay J, Sabaiduc S, Gubbay J, Drews S, Fonseca K, Charest H, Martineau C, Hickman R, Chan T, Jassem A, Petric M, Bastien N, Li Y, Kraiden M

Introduction/Background: Vaccine effectiveness (VE) against influenza B is stratified by Victoria and Yamagata lineages for eight seasons in Canada during which trivalent influenza vaccine (TIV) containing a single lineage was predominantly used. Findings are interpreted in the context of lineage-level relatedness between consecutive seasons' vaccine components and circulating viruses.

Methods: Lineage-specific VE was assessed by a test-negative design using databases of the Canadian Sentinel Practitioner Surveillance Network (SPSN) spanning the 2010-11 to 2017-18 seasons. Influenza B was diagnosed by RT-PCR and lineage was determined by hemagglutination inhibition assay, PCR-based methods and/or sequencing. Vaccination status was based on self-report. VE analyses were restricted to respiratory specimens collected January to April and adjusted for relevant confounders.

Results and Analysis: Most (70-75%) participants were adults 20-64-years-old and most (>80%) who reported current season's vaccination were also vaccinated the prior season. Characterized viruses were predominantly Victoria-lineage in 2010-11 but Yamagata-lineage in 2013-14, 2014-15, 2016-17 and 2017-18, with dual-lineage circulation in 2011-12, 2012-13 and 2015-16.

Eleven lineage-specific VE estimates were derived across eight included seasons. VE was $\geq 50\%$ in 8/11 scenarios and $\geq 70\%$ in 4/11 scenarios regardless of lineage-level match or mismatch between TIV and circulating viruses. For example, with lineage-level match, VE was 70%(95%CI=37-86%) against Victoria viruses in 2011-12 and 74%(95%CI=57-84%) against Yamagata viruses in 2013-14. Similarly, and despite lineage-level mismatch, VE was 78%(95%CI=23-94%) against Victoria viruses in 2012-13 and 73%(95%CI=48-86%) against Yamagata viruses in 2016-17. VE was $< 50\%$ in 3/11 scenarios each of which involved vaccine that was unchanged from the prior season, including lineage-mismatch to Yamagata viruses in 2011-12 and 2017-18, and lineage-match (but clade-mismatch) in 2014-15. For the most recent and severe influenza B(Yamagata) epidemic of 2017-18, VE was 39%(95%CI=24-52%).

Conclusions and implications for vaccinology: TIV provides substantial cross- lineage protection against influenza B. VE may be lower with use of identical vaccine across consecutive seasons, with implications for both trivalent and quadrivalent formulations that warrants further monitoring and investigation.

ORAL PRESENTATIONS – SESSION 3

Tuesday 4 December

14:30 – 16:00

Room 205

Invasive pneumococcal disease burden after introduction of routine pediatric PCV13: Where do we go from here?

McGeer A, Toronto Invasive Bacterial Diseases Network

Introduction/Background: Since the authorization of the first pneumococcal conjugate vaccine (PCV) in 2001 and implementation routine infant PCV, the incidence of invasive pneumococcal disease (IPD) due to serotypes (STs) included in PCV has declined dramatically. We examined data from population-based surveillance in Toronto/Peel, Ontario, to assess remaining burden, and potential for prevention.

Methods: The Toronto Invasive Bacterial Diseases Network has performed population based surveillance for IPD in Toronto/Peel since 1995. All laboratories serving residents of the population area submit pneumococcal isolates from sterile sites to the central study laboratory, with annual audits to ensure complete reporting, and serotyping of all isolates. Clinical data are collected by patient/physician interview and chart review. Population denominators are from Statistics Canada.

Results and Analysis: From 1995 to 2017, 9923 episodes of IPD occurred; STs are available for 9102 (91%) and clinical data for 9430 (95%). The overall incidence of IPD was 11.3 per 100,000 (1.9 non-PCV13) in the 5y prior to PCV authorization, and was stable at 5.8 per 100,000 from 2015-2017 (3.7 nonPCV13). The overall decrease in incidence was 65% in children (<15y), 36% in adults aged 15-64y, and 44% in older adults. In 2015/17, isolates of PCV13-STs were associated with 21% of IPD in children, 37% of IPD in adults aged 15-64y, and 31% of IPD in older adults. Most (21/26, 81%) PCV13-ST disease in children occurred in vaccine-eligible children. Immunocompromised persons comprised 32% (323/1015) of IPD, and 14% of PCV13-ST IPD in adults aged 15-64y. 10% of IPD in children, and 11% of IPD in adults were of STs included in PCV15, and 29% and 24% of STs in PCV20.

Conclusions and implications for vaccinology: A substantial burden of IPD persists despite the success of pediatric conjugate vaccination programs. Targeted vaccination strategies will have limited impact on overall incidence. Extended ST conjugate vaccines may offer significant benefits.

Clinical features and outcomes of invasive Pneumococcal Disease in Canada between 1991 and 2015

Sadarangani M, Morris S, Kellner J, Le Saux N, Embree J, Vanderkooi O, Martin I, Demczuk W, Tyrrell G, Vaudry W, Halperin S, Bettinger J

Introduction/Background: A 5-10% case-fatality rate following pediatric pneumococcal meningitis with 25-35% of survivors suffering from long-term sequelae has been described, however other IPD outcomes are less well documented. We determined risk factors associated with death and intensive care unit (ICU) admission in children with IPD over 26 years (1991-2015).

Methods: Active, population-based surveillance was conducted by IMPACT, covering ~90% of the pediatric tertiary care beds in Canada. IPD cases included inpatients and outpatients aged 0-16 years with positive blood, CSF and/or sterile site culture and/or PCR for *Streptococcus pneumoniae*, with/without other manifestations of pneumococcal disease. Clinical details were collected from hospital records. Risk factors for death and ICU admission were analyzed by univariate and multivariable analyses.

Results and Analysis: 6,060 children were hospitalized with IPD between 1991 and 2015. The majority were aged <2 years (n=3,287, 54%). The most common manifestations were bacteremia (n=5,403, 89%), pneumonia (n=1,707, 28%), meningitis (n=991, 16%) and otitis media (OM) (n=953, 16%). Overall, 1,064 children (18%) were admitted to ICU. There were 182 deaths (3.0%). 87/991 (9.6%) with meningitis died. Median hospital length of stay was 7 days and median ICU admission was 3 days. ICU admission was independently associated (p<0.05) with meningitis (odds ratio[OR]=13.9), pneumonia (OR=2.5), bacteremia (OR=0.62), OM (OR=0.61), year of admission, hospital and age. Mortality was independently associated (p<0.001) with meningitis (OR=5.1) and OM (OR=0.26).

Conclusions and implications for vaccinology: This large study over a long duration demonstrates the significant burden of IPD, identifying risk and protective factors for bad outcomes, highlighting the poor prognosis of pneumococcal meningitis. High coverage of existing pneumococcal vaccines remains critical to disease prevention, as well as development of higher valency conjugate vaccines and other approaches to prevention of pneumococcal disease.

Potential impact of routine use of 13-valent pneumococcal conjugate vaccine on hospitalizations for pneumonia among older adults in Canada

Vojcic J, Dion S, Isturiz R, Laferriere C, Major M, Nepal R, Suaya J, McLaughlin J

Introduction/Problem definition that demonstrates the need for a policy change:

13-valent pneumococcal conjugate vaccine (PCV13) was licensed in Canada for the prevention of vaccine-type (VT) pneumonia in adults in July 2015. Herd effects from pediatric PCV13 program have historically led to reductions in VT disease in older adults, and there is currently no recommendation for a routine age-based PCV13 program for this age group. However, recent data suggest these indirect effects may have plateaued, leaving a persistent and substantial burden of potentially-preventable pneumococcal disease in older adults. We evaluated potential impact of PCV13 immunization program for Canadian adults aged ≥65 years on hospitalizations for community-acquired pneumonia (CAP).

Research Methods: We constructed a mathematical model based on Canada-specific burden of disease estimates and published estimates of PCV13 effectiveness and durability. We estimated the number of hospitalizations averted as the product of i) the size of Canadian population aged ≥65 years, ii) all-cause CAP incidence, iii) proportion of CAP that is VT, iv) PCV13 effectiveness, and v) duration of protection for PCV13 over a five-year time horizon. We assumed that rates of all-cause CAP, the proportion of VT CAP, and PCV13 effectiveness remained constant over the 5-year assessment period. We assumed a 5% annual all-cause mortality in the overall population. We estimated hospital days averted as the product of hospitalizations averted and median length of stay. Model assumptions are summarized in Table 1.

Results and Analysis: Based on model assumptions, PCV13 use in Canadian adults aged ≥ 65 years would lead to reduction of 62 (11–77) hospitalizations per 100,000 persons, per year. This reduction, applied to the entire Canadian population of older adults, would avert an estimated 17,274 (3,037–21,711) hospitalizations and 138,192 (24,298–173,690) hospital days over a 5-year period.

Recommendations and implications for practice: Despite herd effects from the routine pediatric program, direct PCV13 immunization of older adults in Canada could result in considerable additional reduction in hospitalizations for pneumonia.

Table 1. Model Assumptions

Parameter	Value	Source
Population size	6,195,500	Statistics Canada
Annual all-cause CAP incidence	1,692 per 100,000	Canadian Institute of Health Information Discharge Abstract Database
Percentage of all-cause CAP caused by PCV13 serotypes	5% (estimate)	LeBlanc et al. <i>Vaccine</i> 2017; 35(29):3647-3654 LeBlanc et al. Poster presented at ISPPD 2018
PCV13 effectiveness against hospitalization for VT-CAP	72.8% (12.8%-91.5%)	McLaughlin et al. <i>Clin Infect. Dis</i> 2018. doi: 10.1093/cid/ciy312
Duration of PCV13 effectiveness	5 years (i.e. no waning)	Patterson et al. <i>Trials Vaccinol.</i> 2016;5:92-96
Median length of hospital stay (pneumococcal CAP)	8 days	LeBlanc et al. <i>Vaccine</i> 2017; 35(29):3647-3654

The unique epidemiology of mumps in British Columbia, 2012-2017

Weingartl E, Naus M

Introduction/Problem definition that demonstrates the need for a policy change:

Following introduction of the 2nd dose of MMR in 1996 and a decade of low incidence years, a resurgence of mumps occurred in 2008 in BC, with subsequently higher endemicity with periodic outbreaks. The purpose of this analysis is to describe the evolving epidemiology in BC from 2012 to 2017 and consider the contribution of immunization policy and specific transmission events.

Research Methods: Mumps is a reportable disease for which additional variables are collected using case report forms. Enhanced surveillance has been conducted since the 2008 outbreak. Mumps laboratory diagnostic tests are conducted by the BCCDC Laboratory. Data on cases reported from 2012-2017 were extracted to examine trends and characterize the cases of mumps in BC.

Results and Analysis: A total of 485 cases (413 confirmed, 72 probable) have been reported from 2012-2017. The median age of cases was 27 years (range 1 year to 92 years). 56% of cases were male, although in the years 2015 and 2017, male cases accounted for 65% and 61%, respectively. Vaccine history was known for 46% of cases; of these, 33% received only one dose of mumps containing vaccine. There have been no deaths, and no major complications. Genotype G has predominated, with the genomic strains related to the MuVi/Sheffield.GBR/1.05 strain.

Recommendations and implications for practice: The epidemiology of mumps in BC during this period of resurgence has been different from that observed in the US where the median age of outbreak-associated cases is 21 years and for those with known vaccination status, 70% have received 2 doses of mumps vaccine. In BC the majority of cases have years of birth in the range 1974-1991 and have received only a single dose of mumps vaccine. The role of a 3rd dose of mumps vaccine in the BC context, as recommended by the US Advisory Committee on Immunization Practices, is limited.

Mumps outbreaks in post-secondary settings: Time for another dose of vaccine?

Arnason T, Coombs A

Introduction/Program need and objectives: As per the Canadian Immunization Guide (CIG), an individual is considered "immune" to mumps with a 2-dose mumps vaccination history (1-dose if born in/after 1970). Routine 2-dose childhood vaccination for mumps has been given in Canada since the 1990's; however outbreaks continue with a high-proportion of affected individuals considered immune by vaccination criteria. The objective of this study is to examine the characteristics of an outbreak of mumps in Nova Scotia for indicators of whether provision of an additional dose of vaccine in the post-secondary setting to students, considered adequately immunized, would assist in outbreak control.

Program methods and activities: Using a recent US study demonstrating effectiveness of an additional dose of vaccine in post-secondary mumps outbreak (Cardemil et al. 2017), we identified epidemiologic indicators of outbreak cases that suggest an additional dose of vaccine may have been similarly effective. We analysed the characteristics of an ongoing Nova Scotia outbreak for these indicators including age of cases, proportion of cases considered immune by CIG criteria, time elapsed from most recent immunization to onset of illness and proportion of cases known to be attending a post-secondary institution.

Program results or outcomes (including evaluation): We found a number of characteristics of this outbreak to suggest that provision of an additional dose of vaccine in post-secondary settings would be effective : the majority of individuals were vaccinated as per CIG criteria, average time elapsed from last known immunization to illness was longer than the comparator study and roughly 3/4 of those affected attended a post-secondary institution.

Implications for practice or policy: Providing an additional dose of vaccine in post-secondary settings is likely an effective option for public health practitioners managing mumps outbreaks in Canada. The cost-effectiveness of this approach should be evaluated before it is adopted as routine practice.

ORAL PRESENTATIONS – SESSION 4**Tuesday 4 December****14:30 – 16:00****Room 208****Implantation d'un programme provincial d'entretien motivationnel sur l'immunisation dans les maternités**

Auger D, Sicard N, Samson J, Landry M, Gagneur A

Introduction/Besoin et objectifs du programme : L'hésitation à la vaccination est une problématique en hausse pour laquelle peu d'interventions efficaces ont été étudiées. Les projets de recherche Promovaq et Promovac ont démontré que l'entretien motivationnel (EM) offert aux parents en maternité est efficace pour augmenter l'intention de vaccination et les couvertures vaccinales. L'objectif du programme est d'offrir aux parents de nourrissons une intervention d'EM sur l'immunisation dans les maternités du Québec basée sur les principes d'intervention démontrés efficace en recherche.

Méthode, activités et évaluation du programme : La transition à un programme provincial présente plusieurs enjeux. La phase 1 du programme vise les 13 maternités qui accueillent 55% des naissances annuellement dans la province. Cette phase comprend la mobilisation des parties prenantes, l'obtention du financement, le soutien aux instances impliquées, l'octroi des ressources matérielles et financières, la formation du personnel et l'élaboration d'un plan de suivi de l'implantation.

Résultats ou effets du programme : Le déploiement s'est principalement déroulé en fonction du plan d'implantation, toutefois l'embauche du personnel a connu certains délais. Un soutien individuel additionnel auprès des services des ressources humaines a parfois été nécessaire. D'autres ajustements au plan initial ont été bénéfiques, telle que la création d'une communauté virtuelle de pratique. Le monitoring évaluatif a permis d'identifier et solutionner des problématiques d'implantation en temps réel. L'acceptation parentale de l'intervention est très élevée (>95%), mais varie d'une maternité à l'autre. La participation des parents au suivi de l'implantation via des questionnaires de satisfaction est plus faible. Les résultats d'effets du programme,

notamment l'amélioration du score d'hésitation vaccinale des parents de 11%, sont disponibles dans une présentation distincte.

Répercussions pour les pratiques ou les politiques : Les données d'évaluation normative de la phase 1 permettront de dégager les facteurs facilitants et les barrières à l'implantation. Ces données éclaireront le déploiement de la phase 2. L'utilisation de l'EM en immunisation dans des maternités est une nouvelle stratégie de santé publique prometteuse qui pourrait être déployée plus largement.

Résultats préliminaires du programme EMMIE (Entretien Motivationnel en Maternité pour l'Immunisation des Enfants) : amélioration de l'intention de vaccination et diminution de l'hésitation des parents

Bergeron J, Gosselin V, Dubé È, Guay M, Sicard N, Auger D, Landry M, Samson J, Albert C, Farrands A, Ouakki M, Gagnon D, Gagneur A

Introduction/Contexte : Peu d'interventions ont été démontrées efficaces pour diminuer l'hésitation à la vaccination. Une intervention éducative auprès des parents en maternité utilisant les techniques de l'entretien motivationnel (EM) (stratégie PromoVac) a démontré son efficacité pour diminuer l'hésitation à la vaccination et augmenter les couvertures vaccinales. Le programme EMMIE, basé sur cette stratégie, est actuellement déployé dans 6 régions du Québec. L'impact du programme EMMIE sur les scores d'intention et d'hésitation à la vaccination chez les parents est en cours d'évaluation. Les détails de l'implantation du programme EMMIE sont disponibles dans une présentation distincte.

Méthode : Le programme EMMIE est implanté dans 13 maternités (>2500 naissances/an) du Québec depuis janvier 2018. Un questionnaire mesurant l'intention de vaccination et ses déterminants ainsi que le niveau d'hésitation à la vaccination a été rempli avant et après l'intervention par une sélection aléatoire de parents. L'intention des parents à faire vacciner leur enfant et leur score d'hésitation à la vaccination ont été calculés.

Résultats et analyse : Du 10 janvier au 26 mai 2018, 9022 parents ont bénéficié d'EMMIE et 2575 d'entre eux ont répondu aux questionnaires (2219 paires de questionnaires pré et post). Avant l'intervention, 76% (68% à 81% selon les maternités) des parents avaient une intention certaine de faire vacciner. Après l'intervention, une amélioration statistiquement significative de l'intention vaccinale a été observée dans chaque maternité avec une augmentation globale de 11,5% (76,3% vs 87,8%; $p < 0,01$). Une diminution significative des scores d'hésitation à la vaccination de 29% (25 vs 17,8%; $p < 0,01$) a également été mesurée après l'intervention.

Conclusions et conséquences pour la vaccinologie : Les résultats préliminaires du programme EMMIE indiquent qu'une intervention éducative basée sur les techniques de l'EM et administrée par du personnel spécifique auprès des parents permet de diminuer les hésitations vaccinales et d'augmenter l'intention de vaccination. Le programme EMMIE est une innovation prometteuse qui pourrait être déployée plus largement.

Renforcement des compétences en entretien motivationnel de conseillers en vaccination par la création d'une communauté virtuelle de pratique au pallier provincial

Landry M, Côté I, Sicard N, Auger D

Introduction/Besoin et objectifs du programme : Un nouveau programme est en déploiement au Québec : l'entretien motivationnel en maternité pour l'immunisation des enfants (EMMIE). Deux abrégés distincts décrivent le processus d'implantation de ce programme ainsi que les résultats d'effets obtenus à date sur l'intention et l'hésitation de vaccination des parents. Les conseillers en vaccination (CeV) utilisent des techniques basées sur l'EM lors de leurs interventions auprès des parents. Ils bénéficient d'une formation étoffée sur l'EM de deux jours en présentiel, suivi d'une 3e journée de formation puis de visites de supervision. Les compétences requises pour le poste sont complexes à acquérir et les CeV travaillent pour la plupart en solo au quotidien, sans un appui de leurs pairs.

Méthode, activités et évaluation du programme : La communauté virtuelle de pratique (CVP) a été conçue afin d'améliorer l'efficacité et l'efficience des interventions dans un nouvel environnement professionnel et de

renforcer l'identité professionnelle des CeV. La plateforme électronique est gérée provincialement et les activités sont animées par une experte des communautés de pratique. Rapidement il est apparu que les CeV avaient régulièrement des questions sur l'immunisation donc un médecin expert de ce contenu est également en appui à la CVP. La présentation orale décrira les différentes modalités de la CVP et présentera des exemples concrets de fonctionnement. Les résultats seront présentés en fonction d'un devis qualitatif.

Résultats ou effets du programme : L'analyse du fonctionnement de la CVP a permis de dégager les éléments positifs suivants : harmonisation des pratiques, partage d'astuces pour les situations complexes, entraide entre les pairs, décèlement de problématiques d'implantation à adresser, amélioration des connaissances en immunisation, partage rapide d'information lors de situations émergentes.

Répercussions pour les pratiques ou les politiques : La mise en œuvre de la CVP est une stratégie innovatrice pour ce nouveau programme et qui favorise le développement des compétences et la rétention du personnel en promotion de la vaccination. Cette stratégie pourrait être déployée plus largement dans d'autres programmes.

Accompagnement en organisation des services de vaccination pour les enfants de 0-5 ans au Québec

Guay M, Clément P, Landry M

Introduction/Besoin et objectifs du programme : Un modèle éprouvé d'organisation des services de vaccination (OSV) aux enfants québécois de 0-5 ans a été produit en 2015 par une recherche-action utilisant l'approche de l'*Appreciative Inquiry (AI)*. En suivi, un projet a été proposé visant à accompagner les responsables régionaux dans une démarche de révision de l'OSV et soutenir la mobilisation des parties prenantes du réseau de la santé pour réviser l'OSV.

Méthode, activités et évaluation du programme : Les apprentissages accomplis, le matériel, les outils et le modèle d'OSV produits lors de la recherche-action sont mis à profit. Le soutien est offert par deux accompagnatrices au fil de rencontres auprès d'un responsable de projet appuyé par un comité régional composé de représentants des constituantes impliquées dans l'OSV (ex. archives, services courants). Entre les rencontres, des travaux sont effectués selon quatre étapes de l'AI: 1-découverte : élaboration du portrait des services selon les 9 composantes du modèle d'OSV et identification des forces en place; 2-désir et 3-design : rencontre de groupe d'une journée, où les parties prenantes sont conviées afin d'esquisser un plan de travail par une mobilisation collective vers des objectifs et priorités communs; 4-devenir : rédaction et application d'un plan d'action pour améliorer l'OSV.

Résultats ou effets du programme : Depuis 2017, les responsables de 5 régions ont été accompagnés. Les accompagnatrices jouent divers rôles dont la forme et l'ampleur varie selon les besoins : coaching, animation de rencontres, transfert de connaissances, facilitation, réseautage et partage d'outils. Entre autres, des outils de formation basés sur les principes de l'entretien motivationnel ont été partagés, un renforcement des confirmations de rendez-vous avec une meilleure objectivation des données d'absentéisme aux rendez-vous de vaccination ont été effectués.

Répercussions pour les pratiques ou les politiques : L'accompagnement adapté employant l'AI facilite la gestion du changement. Il soutient la mobilisation et la collaboration entre les diverses instances impliquées pour permettre l'amélioration de l'OSV et ultimement la prévention des maladies évitables par la vaccination.

Développement d'indicateurs de couverture vaccinale à partir du registre de vaccination du Québec

Toth E, Auger D, Landry M, Boulianne N, Markowski F

Introduction/Besoin et objectifs du programme : Un registre de vaccination est en cours de déploiement depuis 2012 au Québec. Déjà, la majorité des centres de santé qui effectuent la plus grande proportion de la vaccination des nourrissons dans la province ont accès au registre. Bien que le registre ait été mis en place à des fins de santé publique et pour soutenir la pratique vaccinale, l'utilisation des données qu'on y trouve peut servir

à développer des indicateurs qui permettent le suivi de différentes activités du Programme québécois d'immunization.

Méthode, activités et évaluation du programme : Un des enjeux reliés à l'utilisation du registre de vaccination est le fait que ce dernier n'est pas un registre populationnel. Malgré cela, il a été possible de développer des indicateurs de couverture vaccinale (CV) à l'aide de différentes sources pour définir des dénominateurs. Ces derniers devront faire l'objet d'une évaluation continue en comparant par exemple avec celles obtenues par d'autres méthodes (enquêtes de CV) en vue d'améliorer la qualité de la mesure.

Résultats ou effets du programme : Plusieurs indicateurs automatisés de CV ont été développés dont ceux par cohorte d'âge (3, 7, 15, 24 mois), en milieu scolaire (primaire, secondaire) et ceux par raison d'administration (femme enceinte, résident en CHSLD).

Répercussions pour les pratiques ou les politiques : En plus d'être un outil très utile pour les vaccinateurs et les autorités de santé publiques dans le contrôle des maladies évitables par la vaccination, le registre de vaccination est une source importante de données pouvant servir à assurer le suivi et faire l'évaluation des programmes de vaccination dans une perspective populationnelle.

ORAL PRESENTATIONS – SESSION 5

Wednesday 5 December

11:00 – 12:30

Room 205

The use of an Electronic Medical Record (EMR) to improve opportunistic immunizations for inpatients at RCH Melbourne

Jenkins N, Elia S

Introduction/Program need and objectives: Every health care encounter provides an opportunity to review immunization status, which is particularly important for at-risk inpatients in hospital. An electronic medical record (EMR) has the ability to record a patient's immunization history, identify due/overdue vaccines and facilitate improved opportunistic immunization of inpatients. The Royal Children's Hospital (RCH) Immunization Service has utilized this opportunity.

Program methods and activities: Inpatient lists of children aged 6 weeks and <7 years is sent daily to the Immunization nursing team. This list of patients is then cross-referenced with the Australian Immunization Register (AIR) to determine immunization status, including special risk vaccines. Details of due/overdue vaccines are then placed in the patient's EMR problem list, to promote interdisciplinary communication amongst staff involved in the patient's care regarding immunization status. The problem is resolved once AIR is up-to-date.

Program results or outcomes (including evaluation): Prior to the implementation of the EMR, from 01 September 2013 to 31 January 2014, a total of 42% (352/831) of due/overdue inpatients were brought up-to-date with their scheduled immunizations within one month of their admission to RCH. This was either receiving catch-up vaccines or updating AIR with the parent held record of immunization. Since EMR, from 1st May 2016 to 30th December 2017, 57% (1,403/2,470) of inpatients were brought up-to-date. Using the Fisher's exact test, this result is statistically significant ($p < 0.0001$).

Implications for practice or policy: The implementation of the EMR has demonstrated a 15% increase in the opportunistic immunization of inpatients. Immunization is critical to protect both the individual and the population and the RCH Immunization service will continue to maximize opportunities within the EMR to improve in-patient immunizations.

Creation of data products from Panorama to inform local immunization program planning and service delivery

Fung C, Padhi S, Samra A, Rai A

Introduction/Program need and objectives: To achieve a 95% immunization coverage rate for 2 year-olds, regular, localized monitoring is required to identify areas of low coverage so as to target resources and assess the success of interventions. While canned reports from Panorama provide aggregate sub-regional coverage estimates, they do not identify under-immunized sub-populations within a municipality nor do they display longitudinal tracking of rates.

Program methods and activities: In Fraser Health, childhood immunization records are entered electronically into the Panorama Public Health System. Two-year old immunization rates are extracted every four weeks using canned reports and monitored through automated health unit level reports generated using Excel and SAS 9.4. Trends from previous periods are displayed graphically and forecasted coverage rates are provided. The immunization measures of up-to-date, up-to-date minus booster and no immunizations by postal code are also geocoded annually to generate neighborhood level maps using ArcGIS 10.5.

Program results or outcomes (including evaluation): Regular monitoring has permitted local leadership to understand regional context and generate hypotheses regarding immunization impediments, leading to improved and targeted service delivery while measuring the impacts of their actions. Comparison of up-to-date minus booster with up-to-date for age coverage rates reveal that many children behind at 2 years of age are mostly missing their booster shots at 18 months. Differences also exist in immunization coverage rates between neighbourhoods which may be explained by factors such as barriers to access, reporting issues or conscientious objections. Since implementing these data products, 2 year-old immunization coverage rates in Fraser Health have increased from 68.4% in 2014/15 to 77.3% in 2017/18.

Implications for practice or policy: Regular localized reporting and geospatial visualization of immunization rates assist in identifying areas that require directed efforts, generate insight into barriers and evaluate impacts from changes in service delivery. As many jurisdictions in Canada use Panorama, other practitioners may find these data products useful in their practice.

Real-Time Integration: Achieving complete immunization records for all First Nations children in Alberta

McDermott C, Bergstrom K, Richter D, Graham B

Introduction/Program need and objectives: Lack of access to a complete immunization record can result in missed opportunities or over-immunizing children. Immunizers must rely on a time-consuming patchwork of record transfers completed by phone or fax to create a best available immunization history. Immunizations delivered within First Nation communities were not recorded in the provincial immunization repository, nor easily accessible to external immunizers. Immunizers within communities faced similar challenges accessing records off-reserve.

Program methods and activities: Between 2011 and 2018, a road map was followed to achieve, for the first time in Canada, real-time immunization record integration between four First Nations communities in Alberta and the provincial health record (Netcare). Processes related to privacy, policy, practice and technical aspects were developed and implemented.

This significant public health accomplishment required partnership between First Nations, Alberta Health, Health Canada and a private Alberta-based social enterprise. This presentation will describe the key milestones as well as the benefits, challenges and learnings, from multiple partner perspectives.

Program results or outcomes (including evaluation): Health care practitioners in First Nations communities can query the provincial registry for a client's immunization records and download records into the point-of-care immunization record program. Records created at the First Nations communities can be submitted to the Alberta provincial repository. Access to use this process and technical requirements are governed by privacy and health information legislation.

Implications for practice or policy: This project realizes, for First Nations, one of the key recommendations of the National Immunization Strategy, creating a complete immunization record that can be viewed by any health professional in the province through the provincial electronic health record, Netcare. The process is being scaled across all communities in Alberta.

Nudging online reporting: Applying behavioural insights to vaccine reporting

Beckermann K, House J, Kirkpatrick B

Introduction/Program need and objectives: Online services provide opportunity to improve immunization programs' client service and operational efficiency. Ontario's new Immunization Connect Ontario (ICON) enables convenient updating of student immunization records online while also reducing transcription errors and required staff time. Despite these advantages of going online, uptake of similar public services is often slower than expected, delaying realization of intended program improvements. With some 350,000 students required to report immunizations to Toronto Public Health, nudging a proportion of them online, without removing traditional reporting options (e.g., phone, mail) for those who need them, could save thousands of hours of labour, thereby enabling other public health initiatives with extra capacity gained at no cost.

Program methods and activities: TPH collaborated with behavioral insights experts to conduct a prospective randomized field trial, involving 36,097 students from 143 schools in Toronto, evaluating the behavioural impact of three interventions across two communication media. Two of the interventions involved cost-free changes to the standard immunization audit letter, instructing non-compliant students to update their immunization record online, by telephone, mail, or fax. Both revised letters were simplified and designed to make the online service more salient, compared to the standard letter; and one also included a social norm statement. The third intervention involved high-resolution colour inserts, included with the audit letters, promoting the online service.

Program results or outcomes (including evaluation): Preliminary results show that both revised letters have statistically similar effects, increasing the likelihood of updating immunization records online more than threefold (OR=3.41, $p<.001$), compared to the standard letter. In contrast, the colour insert had no effects on online uptake (OR=0.95).

Implications for practice or policy:

1. A behavioral insights-driven approach can identify effective, simple and cost-free interventions to better serve our clients.
2. Collaborative research between program and behavioural science experts is feasible and valuable to test simple variations.

Effectiveness of interventions delivered through digital interventions at improving vaccine uptake and series completion: A systematic review and meta-analysis

Atkinson K, Wilson K, Murphy M, El-Halabi S, Kahale L, Laflamme L, El-Khatib Z

Introduction/Background: Recent outbreaks of vaccine preventable diseases (VPDs) have highlighted gaps in immunization coverage and the need for effective interventions which address vaccine uptake in children and adults. Digital technologies offer novel mechanisms by which to communicate with potential vaccine recipients. The aim of this study was to synthesize all available evidence on the effectiveness of digital interventions on vaccine uptake and series-completion.

Methods: A systematic search was conducted using Pubmed, MEDLINE, CENTRAL and Web of Science to identify all randomized controlled trials in which participants were adults (including pregnant women) or parents of adolescents and children eligible for vaccination and the outcome was vaccine uptake and/or series-completion. Digital interventions were defined as any messaging (recall-reminders, educational or other) delivered via SMS text messaging, email or web. Articles were screened by two independent authors, and data extracted into a

structured form with disagreements resolved by a third reviewer. References were managed using DistillerSR and analyses performed with CochraneReviewManagerV.5.1.

Results and Analysis: Out of 159 articles identified, 28 articles were included in a qualitative literature synthesis. These articles included 38 studies evaluating vaccine uptake(27,71%) and series completion(11,29%) targeting parents(20,53%), pregnant women(4,11%) and adults(14,37%). After exclusion of cluster RCTs, the meta-analysis summarized 19 articles(27 studies, 38,098 participants). 22(81%) studies evaluating vaccine uptake showed a total effect of 1.14[95%CI 1.09,1.20] and of the 5(19%) evaluating series-completion, an effect of 1.55[95%CI 1.15,2.09]. When the control condition was restricted to usual care, the effect was largest (1.64[1.45,1.85] and 1.73[1.27,2.36]).

Conclusions and implications for vaccinology: Preliminary results suggest that digital interventions have a modest, positive impact on vaccine uptake and series-completion. The largest effect was observed when compared to usual care which may indicate that digital interventions are most valuable when they are more efficient or cost-effective to deliver. More research is needed on the use of digital interventions and vaccination.

ORAL PRESENTATIONS – SESSION 6

Wednesday 5 December

11:00 – 12:30

Room 206

Communicating with new mothers about infant vaccination: An ethnographic study in British Columbia's Fraser Health Region

Greyson D, Gemmell I, Padhi S, Orth A, Bettinger J

Introduction/Background: Although a small percentage of new Canadian mothers hold strong anti-vaccination convictions, many others have some vaccine hesitancy and may be influenced by information they encounter. Knowing the best ways to reach hesitant new mothers with accurate and useful information about infant vaccination poses a challenge for Public Health. This study sought to understand the health information worlds of new mothers in pockets of known non-religiously-based vaccine hesitancy within the Fraser Health Authority in British Columbia, to inform vaccine promotion efforts in these contexts.

Methods: Using ethnographic observation of parent-infant community groups and in-depth individual interviews with new mothers and service providers, we explored the health-related information worlds of new mothers in 6 neighbourhoods within 2 cities. Qualitative thematic analysis was conducted by first applying a standardized deductive codebook, and subsequently coding inductively around emergent themes.

Results and Analysis: From January 2017 to April 2018, we observed 35 group meetings and interviewed 32 mothers and 8 service providers. Most mothers felt they had sufficient access to information about vaccination, but assessing information and deciding which sources to trust was challenging. Health care providers, particularly maternity providers such as midwives and OBGYNs, were well trusted. However, even seemingly-unrelated negative medical experiences (e.g., birth trauma) could create a sense of institutional betrayal that affected trust in vaccination.

Conclusions and implications for vaccinology: Public Health must understand who and what are the trusted sources for new mothers in specific communities with high hesitancy. Working with existing trusted sources, even if this means building new alliances (e.g., with religious leaders, alternative health providers) may be a useful strategy. Organizations should be mindful that interpersonal interactions with any staff member—even those not directly providing health services—may serve to build or reduce trust with the public.

Evaluation of new palivizumab recommendations in healthy term infants in Nunavik, Quebec

Gilca R, Billard M-N, Rochette M, Papenburd J, Charest H, Zafack J, Boucher F, Lorcy A, De Serres G

Introduction/Background: Healthy term (HT) infants <3 months old during the respiratory syncytial virus (RSV) season residing in the circumpolar region of Nunavik, Quebec, are considered at high risk of hospitalization due to RSV. In 2017, these children were added to the Quebec palivizumab immunoprophylaxis program. A quantitative and qualitative evaluation of the new recommendation was conducted.

Methods: Medical charts of Nunavik infants admitted between November 2013 and June 2017 for respiratory infection and palivizumab administration records were reviewed; files up to June 2018 will be reviewed in July 2018. All infants admitted with respiratory infection since January 2017 had a nasopharyngeal specimen tested by multiplex PCR.

Results and Analysis: During the three seasons pre-implementation, there were an average of 380 live births per year, with a mean of 90 (24%) respiratory admissions and 22 (6%) RSV-associated admissions; the latter all occurred between January and June. Of the 179 infants eligible for the new recommendations in 2017, 170 (95%) received at least 1 dose of palivizumab. The number of RSV-associated admissions between January and June in <3-month-olds decreased from a mean of 8 pre-implementation to 4 in 2017. However, similar reductions occurred in older infants not targeted by the new recommendation.

Among the 37 admissions with viral testing in 2017, 12 (33%) had an RSV infection, including 8 (22%) coinfecting with other respiratory viruses (ORV); 33 (62%) were infected with ORV only.

The number of RSV-associated admissions was lower in 2017 than in previous seasons both in targeted and in older infants. The majority of RSV infections were associated with ORV. These results are subject to great variability given the small population coupled with the variability between RSV seasons. The results of the 2nd year of evaluation will be available in early autumn 2018. Qualitative evaluation will be presented separately.

Conclusions and implications for vaccinology: The number of RSV-associated admissions was lower in 2017 than in previous seasons both in targeted and in older infants. The majority of RSV infections were associated with ORV. These results are subject to great variability given the small population coupled with the variability between RSV seasons. The results of the 2nd year of evaluation will be available in early autumn 2018. Qualitative evaluation will be presented separately.

Influenza vaccination status among Canadian households with young children, reasons for non-vaccination, and factors associated with non-vaccination for the 2017-2018 influenza season

Sherrard L, Silva A

Introduction/Background: Children under five years of age are at increased risk of severe outcomes from influenza. However, vaccination status, reasons for and factors associated with non-vaccination are not well described for this group.

Methods: As part of PHAC's Seasonal Influenza Vaccine Coverage Survey, parents/guardians of children aged 6-59 months (n=906) were interviewed using computer-assisted telephone interviewing technology, from January to February 2018. Respondents were interviewed about vaccination status and reasons for non-vaccination, for themselves and for the child. Simple and weighted proportions were calculated for vaccination status and responses. Simple and multiple logistic regressions were used to assess associations between non-vaccination and sociodemographic factors.

Results and Analysis: Among households where complete information on vaccination status was available (n=881), most parents (70%) and children (63%) were reported as non-vaccinated. In most households, parent and child vaccination status matched (80%); few households had unvaccinated parents with vaccinated children (13%), or vaccinated parents with unvaccinated children (7%). Overall, the most commonly cited reasons for

non-vaccination for children and parents were similar: "it doesn't work" (24, 23%), "it's not needed" (24, 21%), and "they just didn't" (18%, 15%). Few unvaccinated households (49%) gave a matching reason for both parent and child. When they did, "it doesn't work" (38%) was the most frequent. For children, the main factor associated with non-vaccination was parental non-vaccination. In households with non-vaccinated parents, factors associated with child non-vaccination were respondents perceiving their health as very good or better, being female, and living in a province where the vaccine is only funded for children aged 6 to 23 months.

Conclusions and implications for vaccinology: Overall, too few young children are vaccinated against influenza in Canada. Reported reasons for non-vaccination for parents and children were similar overall, but not necessarily within a household. Parental non-vaccination was the most important factor associated with non-vaccination in children, suggesting opportunity for intervention.

Where is the risk? Identification of geospatial hotspots of un-immunized children in Ontario

Bunko A, Li Y, Johnson S, Murray J, Wang S, Deeks S, Crowcroft N, Wilson S

Introduction/Background: Little is currently known about the extent and location of un-immunized children in Ontario. Our objectives were to: describe the geographic distribution of fully un-immunized children in Ontario, identify geographic clusters (hotspots) of un-immunized children and characterize the contribution of spatial effects on hotspots, where found.

Methods: Using data extracted from Ontario's Digital Health Immunization Repository (DHIR), we identified students 7 to 17 years-of-age in the 2016-17 school year and assigned them to Census Subdivisions (CSDs) and Dissemination Areas (DAs) based on residential postal code. We defined students as un-immunized if they had zero doses of any vaccine and a non-medical exemption recorded in the DHIR. Unadjusted proportions and prevalence ratios (comparing the observed proportion to the provincial proportion) of un-immunized students were calculated at the CSD level. The Bayesian spatial model, the Besag-York-Mollie (BYM) model, was used to identify areas with elevated risk (hotspots) of un-immunized students for further analysis. We flagged CSDs that had more than a 95% probability of having two times the proportion of un-immunized students than that of the provincial proportion.

Results and Analysis: We identified a total of 15,222 children who met our outcome definition, out of a DHIR-derived population of 1.61 million students, for an overall proportion of 0.94%. However, proportions varied greatly by geography, ranging from 0% to 21.5% at the CSD level. We identified 17 CSDs that met our >95% probability threshold which were clustered in 6 distinct areas, all located in southern Ontario.

Conclusions and implications for vaccinology: Our analysis found a relatively low proportion of un-immunized students, with six distinct hotspots located in southern Ontario. Further exploration of the contributions of area-level characteristics are planned. Future collaborative work with local Public Health Units will assist in interpretation and guide future actions from these analyses.

Immunization status and other characteristics of Ontario students with non-medical exemptions: 2016-2017 school year

Wilson S, Murray J, Bunko A, Buchan S, Johnson S, Loh L, Crowcroft N, Deeks S

Introduction/Background: Previous analyses of immunization exemptions in Ontario were limited to aggregate data. Following the transition to record-level analysis using the Digital Health Immunization Repository (DHIR), our goals were to quantify the number of students with non-medical exemptions (NMEs) and describe their characteristics, including immunization status.

Methods: Using the DHIR, we created a cohort consisting of Ontario students 7 to 17 years-of-age in the 2016-2017 school year. Students with NMEs were identified and classified into two groups: completely un-immunized and those who received > 1 vaccination of any type. Students were described by age, gender, school type and geography. Adjusted odds ratios (aORs) with 95% confidence intervals (CIs) were calculated using multivariable

logistic regression separately for the two groups. Finally, students with NMEs were assessed for immunization status by antigen.

Results and Analysis: The total cohort consisted of 1.65 million students; 39,703 (2.4%) had an NME. Of these, 39% were un-immunized and 61% had received ≥ 1 vaccine. Factors associated with increased odds of having an NME and being un-immunized included: attendance at private (aOR 3.47, 95% CI 3.30-3.65) or 'other' (aOR 7.09, 6.37-7.89) schools, rural residence (aOR 2.10, 2.01-2.19), and living in the South West (aOR 1.64, 1.56-1.72) or Central West (aOR 1.33, 1.27-1.39) regions. The odds of being un-immunized decreased with age (aOR for those aged 14-17: 0.59, 0.57-0.61). Similar factors were found in the analysis of children with an NME and receipt of >1 vaccine. Among all children with an NME, 1-36% were partially immunized and 19-48% were up-to-date, varying by specific antigen.

Conclusions and implications for vaccinology: DHIR data can be utilized to better understand the characteristics of children with NMEs. The integration of immunization and NME data is necessary to understand the true risk to herd immunity posed by children with NMEs as they have varying degrees of protection to vaccine-preventable diseases.

ORAL PRESENTATIONS – SESSION 7

Wednesday 5 December

11:00 – 12:30

Room 207

Determinants of non-vaccination for seasonal influenza in Canada

Roy M, Sherrard L, Dubé E, Gilbert N

Introduction/Background: In Canada, seasonal influenza vaccination coverage remains below the national coverage goal of 80% for those at risk of influenza-related complications. Understanding those who are not vaccinated and the reasons for non-vaccination suggest areas of intervention for health promotion activities. This study was undertaken to identify sociodemographic factors associated with non-vaccination against seasonal influenza and to describe self-reported reasons for non-vaccination among Canadian adults.

Methods: Data from the 2013-2014 cycle of the Canadian Community Health Survey (CCHS) were used. Respondents were divided into three groups: adults aged 18-64 years with and without a chronic medical condition (CMC) and adults aged 65 or more. Weighted proportions of non-vaccination and reasons for non-vaccination were determined for each group, and associations between sociodemographic factors and non-vaccination were measured by simple and multiple logistic regressions.

Results and Analysis: Proportions of non-vaccination in the 65+, 18-64 with and without CMC were 36.2%, 62.2% and 77.8%, respectively. Younger age, lower education and not having a family doctor were independently associated with non-vaccination in all groups. Excellent self-perceived health was associated with non-vaccination for those aged 65 and over and 18-64 with CMC. Lower household income was associated with non-vaccination in 65+ and in 18-64 without CMC. The belief that the vaccine is not necessary (66-74%) was the most frequently reported reason for non-vaccination in all groups.

Conclusions and implications for vaccinology: Too many Canadians do not get vaccinated against seasonal influenza. This study identified factors that were associated with non-vaccination in all groups. The main reason reported for not receiving the vaccine across all groups was the perception that it was not necessary. These results highlight the ongoing value of public education about the importance of the vaccine and the risk associated with influenza.

Addressing influenza vaccine hesitancy in Ontario community pharmacies: Identifying targets for action using behaviour change framework

Pullagura G, Waite N, Violette R, Houle S

Introduction/Background: Influenza vaccine hesitancy (IVH) in community pharmacy practice is a complex phenomenon, affected by multiple factors including, the practicing pharmacists' knowledge and skills, physical environment and societal trends, and reflective and automatic motivation processes to address this issue.

Using behavior change theory, this study aims to identify the behavioural change target and its determinants, and map these determinants to intervention components to inform strategies addressing IVH at the community pharmacy.

Methods: Data on practicing Ontario community pharmacists' experience of IVH, including their knowledge, attitudes, and behaviour were collected through a cross-sectional survey (N=885) and one-on-one telephone interviews (N=22). Quantitative descriptive analysis and iterative thematic analysis were performed respectively to inform selection of the behavioural target. The nature of this behaviour was analyzed using the COM-B model, followed by application of the theoretical domains framework to identify its determinants. Using validated linkages, specific behaviour change techniques were identified and refined through consensus.

Results and Analysis: Vaccine conversations in the pharmacy space were primarily passive in nature, often initiated by the patient, therefore, improving 'pharmacist initiated patient engagement' was identified as the behavioural change target. The determinants to this behaviour belonged to the domains: (i)reinforcement: specifically poor remuneration, (ii)beliefs about consequences: perceived inability to influence vaccination decisions among those expressing IVH, and (iii)environmental context and resources, such as time and workload. Behaviour change techniques identified to address IVH at the pharmacy include provision of incentives (professional/fiscal) for documented engagement with vaccine hesitant individuals, persuasive communication strategies: reinforcing the need for patient engagement on IVH, and organizational enablement through workflow optimization.

Conclusions and implications for vaccinology: Existing tools to aid health professionals in addressing IVH rely on improving the 'capability' (knowledge/skills) component of the provider's behavior; however, our analysis suggests that interventions targeting the 'motivation' and 'opportunity' components may be more effective in the community pharmacy context.

Recurrent adverse events following vaccination with influenza vaccine can lead to vaccine hesitancy in adults: CANVAS 2017/18 results from the Canadian Immunization Research Network

Coleman B, DeSerres G, McCarthy A, Isenor J, Top K, Valiquette L, Vanderkooi O, Kellner J, Tai C, Bettinger J

Introduction/Background: There is a higher incidence of myalgia, arthralgia, malaise, and headache in adults receiving influenza vaccines compared with those receiving placebo in published RCTs. In a recent pilot study, 5.7% of Canadian adults reported recurring systemic adverse events following influenza vaccination. The goal of this study was to determine whether these findings could be replicated in a larger and more diverse population.

Methods: As part of Canadian National Vaccine Safety (CANVAS) network, adults (15 years and older) from 5 provinces were asked to complete online surveys about adverse events (AE) following vaccination with influenza vaccine in the fall of 2017. Those who reported an event severe enough to require consultation with a healthcare provider or time away from work/school/planned activities were asked about the occurrence of severe AE following previous influenza vaccinations and any impact on revaccination .

Results and Analysis: Of 25,786 adults responding to the survey, 656 (2.5%) reported a severe AE following the 2017 vaccine. Of these respondents, 173 (0.7%) also reported a similar AE after a previous vaccination with 46 (27%) reporting one after every vaccination. Adults <50 years (1.1% vs 0.4%; p<0.001) and females (0.8% vs 0.4%; p<0.001) were more likely to report a recurrent severe AE than older respondents and males, respectively.

Commonly reported recurrent severe AEs were feeling generally unwell: myalgia, arthralgia, malaise, headache with/without other symptoms (71%), symptoms of an acute respiratory illness (18%), and allergic-like reactions (9%). Most (69%) with recurrent severe AEs were hesitant about being revaccinated this year while 31% said previous reactions did not affect their decision. In comparison, 31% of people reporting a severe AE for the first time are hesitant about future vaccination ($p < 0.001$).

Conclusions and implications for vaccinology: Recurrent AEs severe enough to require healthcare provider consultation and/or absence from work/school/planned activities occurred in just less than 1% of adults who chose to be vaccinated in 2017. People vaccinating adults must be prepared to counsel those with severe AEs as many are hesitant about revaccination.

The challenges and needs of immunization program managers to improving vaccine acceptance and uptake

Sondagar C

Introduction/Background: Immunization programs in Canada have successfully reduced the prevalence of several infectious diseases. While the benefits of immunization are clear, challenges to improving vaccine coverage remain, as evident by recent and ongoing outbreaks of vaccine preventable diseases across Canada and globally.

To better understand the challenges immunization program/promotional managers (IPM) face in improving vaccine acceptance and uptake (VAU), the Canadian Public Health Association conducted a series of consultations with experts from across Canada. Findings from consultations identified several gaps and challenges, as well as areas where additional support is needed. The results will further be used to inform the development of a national bilingual online immunization resource centre, 'Canadian Vaccination Evidence Resources and Exchange Centre' (CANVax), which aims to offer access to the latest evidence-based products, resources and tools to support VAU in Canada.

Methods: A list of Canadian experts whose roles included the planning, development, implementation and promotion of immunization programs were identified and invited to participate in either a 45-60 min semi-structured key informant (KI) phone interview or a half-day focus group (FG) consultation. A snowball sampling technique was applied to identify additional participants.

Results and Analysis: A total of 13 KI interviews and 6 FG consultations (between 6-14 participants) were held. Results were analyzed and categorized into major and recurring themes 1) challenges in seeking and accessing information, 2) gaps and challenges in improving VAU and 3) emerging issues in immunization. Discussions with participants further highlighted the varying degree of informational needs, lack of understanding of how to operationalize evidence to action and feelings of uncertainty towards addressing challenges in improving VAU.

Conclusions and implications for vaccinology: Findings from KI interviews and FG consultations bring attention to knowledge gaps, complex challenges and varying needs of IPM. The feedback received will be important to understanding the tools and resources needed to equip IPM towards achieving optimal VAU.

Communication materials to enhance vaccine acceptance: Do existing tools adhere to best practices in risk communication? A study by the Canadian Immunization Research Network

Vivion M, Witteman H, Tustin J, Top K, Meyer S, MacDonald N, Jardine C, Guay M, Greyson D, Greenberg J, Graham J, Gagneur A, Fisher W, Driedger M, Crowcroft N, Corace K, Bunt A, Bettinger J, Dubé E

Introduction/Background: Public health professionals rely on effective communication to inform parents about vaccine recommendations. This study evaluated existing communication materials on childhood vaccination using best practices in risk communication.

Methods: We conducted an environmental scan to identify communication materials (e.g., websites, factsheets, posters, videos) for parents regarding childhood vaccination on websites of Canadian federal, provincial and

local public health agencies and medical associations. Using content analysis, we assessed the degree to which these materials respected best practices in risk communication (e.g., if harms and benefit information was provided, how qualitative and quantitative risks were presented, whether visual aids were used, etc.).

Results and Analysis: Thirteen websites, 20 videos, and 12 factsheets were included in the analysis. The most frequent risk communication approaches were: “debunking common myths about vaccination” or “answering common questions about vaccines.” Harm and benefit information focused primarily on the risks of vaccine-preventable diseases and the risks of adverse events following immunization. Most materials used qualitative terminology to describe risk (e.g., vaccines are among the safest tools, adverse events are rare). Very few materials provided numeric likelihood of harms and benefits. When numeric information was stated, they were unidirectional (e.g., presenting only the risks of the diseases or number of cases in an outbreak). The approaches used to debunk myths generally focused on the myth itself rather than the correct information. Few materials used visual aids (e.g., graphics, pictures, icons arrays, etc.) to convey important information.

Conclusions and implications for vaccinology: Existing communication materials could be improved to better align with best practices in risk communication. Given the availability of confusing and conflicting vaccine narratives, it is crucial that authoritative communication materials aim to build trust and support informed choices about vaccination.

ORAL PRESENTATIONS – SESSION 8

Wednesday 5 December

14:00 – 15:30

Room 205

Barriers and enabling factors of school-based HPV vaccination programs: Multi-provincial study conducted by the Canadian Immunization Research Network

Gagnon D, Bettinger J, Comeau J, Crowcroft N, Deeks S, Dubey V, Guay M, Kervin M, MacDonald N, MacDonald S, Naus M, Ogilvie G, Paragg J, Sauvageau C, Wilson S, **Dubé E**

Introduction/Background: Sub-optimal human papillomavirus (HPV) vaccine coverage is a challenge that is limiting progress in HPV prevention. The objective of this study is to identify barriers and enabling conditions of HPV vaccine acceptance and uptake at the demand-side (attitudes, knowledge and beliefs about HPV vaccination) and supply-side (the way that school-based vaccination programs are delivered).

Methods: A multi-site qualitative study, based on a study previously conducted in Quebec is being conducted in four other provinces (British Columbia, Alberta, Ontario, and Nova Scotia). The study involves environmental scans and semi-structured interviews. In each province, the sample includes key informants at the provincial level (decision-makers, public health experts) and regional level (immunization managers, school principals, school nurses, teachers, parents, and students – if 12 years or older).

Results and Analysis: As of June 2018, environmental scans at the provincial level have been conducted in two of the four participating provinces and are ongoing in the other sites. Preliminary findings indicate that HPV vaccine uptake is dependent on many interrelated factors at the individual and interpersonal level (e.g. knowledge and attitudes of the different players involved in the vaccination system, anti-vaccine groups), at the community level (e.g. social groups values and norms, media coverage around HPV vaccine), at the organizational level (e.g. allocated resources, information provision, consent process, immunization setting and environment) and at the policy level (e.g. changes in provincial HPV vaccine program).

Conclusions and implications for vaccinology: There are important gender, socio-economic, ethnic, school system, and geographic disparities in HPV vaccine uptake in and between Canadian provinces that are examined in this project. By identifying barriers and enabling conditions of HPV vaccine acceptance and uptake in students and user-informed strategies to overcome these barriers, policy makers can benefit from our findings to implement tailored interventions to improve HPV vaccine uptake.

Support for mandatory vaccination in British Columbia

Bettinger J, Greyson D, Carpiano R, Naus M, Hodson B, De Bruin P, Rubincam C, Aguiar I

Introduction/Background: Motivated by concerns of inadequate vaccination coverage and the potential for vaccine-preventable disease outbreaks, Canadian provinces have been discussing, implementing and tightening policies requiring documentation of vaccination for school enrolment. In this context, this study sought to understand the acceptability of potential vaccination policy nudges to British Columbians.

Methods: An online panel of 1,002 British Columbians was surveyed in April 2017. Respondents were representative of the BC population by gender, age, geographic residence and percentage of households with children younger than 19 years of age. Poisson regression was used to estimate predictors of policy endorsement.

Results and Analysis: A total of 1352 invitations were sent and 1002 participants responded (74% response rate). An additional 306 parents of children < 19 years of age participated for a total sample size of 1308. The majority of respondents (>80%) had positive attitudes towards immunization.

Female respondents and those with university education or higher were more likely to support requiring documentation of vaccination for school entry (PR=1.18, 1.04-1.36 and 1.28, 1.06-1.55 respectively), requiring parents who refuse vaccine(s) to sign a document (PR= 1.18, 1.04-1.34 and 1.21 1.01-1.44), and requiring parents who refuse vaccine(s) to attend an education session (PR=1.18, 0.98-1.41, 1.29, 1.01-1.64). Less punitive policies, such as mandatory documentation at school entry and requiring parental signature on a document outlining the risks of non-vaccination for those who refuse to vaccinate, were more favourably received than more punitive policies used in some other countries, such as denial of child tax benefits.

Conclusions and implications for vaccinology: This study provides evidence that the majority of British Columbians are supportive of vaccination and would be supportive of gentle policy nudges designed to increase uptake of vaccines.

Integrating values and science in vaccination policy: Results of a deliberative public engagement on childhood vaccination in Ontario

O'Doherty K

Introduction/Problem definition that demonstrates the need for a policy change: Although scientific evidence for the efficacy and safety of vaccines is compelling, the topic is controversial. The majority of Canadians are strongly supportive, a small minority is opposed, and a growing number is hesitant about childhood vaccination. There are important policy questions that cannot be resolved with scientific evidence alone. They require consideration of the values that should govern all Canadians. To date, there has been little or no public engagement about the values that should guide vaccination policy in Canada.

Research Methods: A random demographically stratified sample of 25 Ontarians with a diversity of opinions on vaccination was invited to attend a 4-day deliberation process. Participants received background information through an accessibly written booklet and 5 expert speaker presentations. Participants deliberated in small and large groups with the help of trained facilitators. Sample questions included:

- Should vaccination be mandatory?
- Should exemptions be allowed?
- What measures should be in place for AEFI?

Participants were tasked to develop recommendations for policy based on these questions.

Results and Analysis: Participants developed 20 recommendations. These included strong support for:

- Mandatory childhood vaccination in Ontario
- The establishment of a provincial or national compensation scheme for adverse events following immunization (AEFI)

Issues subject to persistent disagreement:

- Whether exemptions should be allowed for religious reasons or personal beliefs
- The consequences for individuals who do not have their children vaccinated without valid exemptions

Recommendations and implications for practice: Policy decisions about the degree to which vaccination should be enforced cannot be made with scientific evidence alone. The recommendations from this public deliberation provide support for policy measures to enforce vaccination compliance. However, even though the forum supported vaccination, there was strong disagreement about whether exemptions for religious and personal reasons should be allowed. More efforts are required to solicit and integrate informed public opinion on policy decisions that are sensitive to public values.

Exploring parents' reactions to emotional and non-emotional measles vaccination promotion messages: A qualitative analysis

Paradis A, Dubé E, Gagnon D, Greenberg J, Maier R, Sauvageau C, Vivion M, Driedger M

Introduction/Background: Effective communication interventions to address vaccine hesitancy are scarce. The use of emotionally evocative narratives in interventions to enhance vaccine acceptance is often proposed, but its effectiveness remains to be demonstrated. The objective of this study was to explore how parents of young children with diverse attitudes to vaccination perceive four variations of a measles vaccination promotion message. These messages, written as news stories, vary according to message type (emotional vs. non-emotional) and the source being interviewed (a mother vs. a doctor).

Methods: A qualitative study based on focus groups discussion with parents of young children was conducted. Participant selection aimed to recruit a diverse sample regarding vaccination behavior. A qualitative content analysis was used to classify participants' vaccination attitude and to compare their perceptions towards the different messages, by type and source.

Results and Analysis: Twenty-eight parents participated in four focus groups discussions. A non-emotional message in which a doctor is the primary source was generally preferred by most vaccine-hesitant parents who expressed value in having access to balanced information in order to make informed decisions. An emotional story, in which a mother talked about the hospitalization of her unvaccinated child for measles, was also respected by parents in general. However, two participants were put off by the emotional content of this message because they felt that it sought to manipulate them. Nonetheless, the two messages previously mentioned comforted several vaccine-favorable parents in their decision to vaccinate. Negative reactions were observed with respect to some aspects of the other two messages tested.

Conclusions and implications for vaccinology: Results suggest emotion-oriented messages might have their place in vaccine promotion, but further investigation is needed to ensure it is not off-putting to large portions of the population. Study results constitute a clear reminder of the importance of testing vaccine promotion messages before disseminating them.

Minimising Immunization Pain of childhood vaccines: The MIP Pilot Study

Jenkins N, Perrett K, Orsini F

Introduction/Background: Young children and adolescents undergo a series of injections during routine scheduled childhood and school immunizations. Sometimes the pain associated with these immunizations may result in distress and/or anxiety for the children and adolescents as well as their parents. Long-term effects of painful procedures may result in needle phobia or non-compliance with vaccination. It is therefore imperative that immunization service providers optimise effective pain management strategies in health care settings where immunizations take place in order to minimise pain and discomfort.

Methods: The MIP (Minimising Immunization Pain) Pilot study, was a four armed pilot project strategically set up to be done at the RCH Immunization Centre. The aim was to provide feasibility of study design and data for a

future large randomised controlled trial (RCT) to evaluate the efficacy of two novel devices (Coolsense® and Buzzy® (with or without cooling pads (wings)) versus standard care) to minimise pain during immunizations in young children aged 3.5 to 6 years of age inclusive.

Results and Analysis: Patients were sequentially randomised into four groups, 10 in each arm with a total of 40 participants. Recruitment was completed within 12 days and 70-80% of participants were compliant with the devices, demonstrating study feasibility. Even though the study was not statistically powered, it appears that the Buzzy® device without wings was associated with lower child reported pain scores.

Conclusions and implications for vaccinology: The Australian Immunization Handbook 10th edition, recommends the routine use of distraction techniques to reduce children's distress with immunization. A larger RCT in younger and older children is now needed to provide statistically significant results to inform practice for immunization providers to improve the vaccination experience.

ORAL PRESENTATIONS – SESSION 9

Wednesday 5 December

14:00 – 15:30

Room 206

Carriage of Haemophilus influenzae Type A among children in rural Northwestern Ontario

Ulanova M, Nix E, Tsang R, Eton V, McCreedy W

Introduction/Background: In the post-Haemophilus influenzae (Hi) type b vaccine era, serotype a (Hia) has emerged as an important cause of invasive disease, particularly in areas with high proportion of Indigenous people. Since 2002, we have identified Hia as a prevalent serotype causing invasive Hi disease in Northwestern Ontario, mainly affecting young children. Hia colonization rates have not been previously studied in Canada. Our goal was to study Hia carriage among healthy children in First Nations communities of Northwestern Ontario.

Methods: We collected nasopharyngeal anaesthetic tubes of healthy 3-5 year old First Nations children who underwent routine dental surgery under general anaesthesia in a regional hospital serving a population of 29,000 (82% First Nations). Detection of Hi and serotype characterization was performed using PCR amplification of capsular polysaccharide synthesis genes. Multilocus sequence typing was done via amplification and sequencing of 7 housekeeping enzyme genes; assignment of sequence types was done through the Hi MLST website.

Results and Analysis: 170 nasopharyngeal specimens were collected and analyzed between September 2015 and December 2017. Hi was identified in 82 samples (48%), with the majority represented by non-typeable forms (61, or 35.9% out of all analyzed specimens). Hia was the second prevalent type (13, or 7.6%), Hi of serotypes f, e, and c were present in 4 (2.3%), 3 (1.7%), and 1 (0.6%) specimens, correspondingly.

Conclusions and implications for vaccinology: In a rural First Nations population of Northwestern Ontario, Hia is carried by 7.6% of healthy 3-5 year old children that is comparable to the carriage rates of Hib among North American children in the pre-Hib vaccine era. To prevent invasive Hia disease in indigenous children it will be essential to stop the pathogen transmission. Pediatric immunization with a new conjugate Hia vaccine under development may potentially decrease overall circulation of the pathogen among susceptible populations and will hence reduce the burden of invasive disease.

Childhood immunization in an Alberta First Nations community: An institutional ethnography of nurse immunizers

MacDonald S, Graham B, Nelson G, Svenson L, Paragg J, Waters N, Kunyk D, McNeil D, Shea-Budgell M, Bedingfield N, Dube E, Foster-Boucher C, Alberta First Nations Information Governance Centre (AFNIGC)

Introduction/Background: Immunization coverage for First Nations children in Canada lags below the level needed to provide community protection from disease. The Truth and Reconciliation Commission has brought with it increasing awareness that health care services, such as vaccination, must be viewed in the context of

centuries of problematic interactions with the Canadian Government and healthcare system. As public health nurses are called upon to deliver care in ways that address inequities and honour the strengths and resilience of First Nations communities, a more comprehensive understanding of contextual, structural, and historical barriers and supports to immunization access and uptake is essential.

Methods: In partnership with a large Alberta First Nations community located in a rural context, we explored this issue from the perspective of nurses providing immunization services in the community. Using an institutional ethnography approach we: (a) observed immunization clinic appointments, (b) interviewed individuals involved in childhood immunizations, including parents, public health nurses, health centre leadership, and federal/provincial public health officials, and (c) reviewed immunization policies and clinical practice guidelines.

Results and Analysis: The work that nurses do in providing childhood immunizations in this First Nations community involves navigating multiple demands, including: parents' needs; clinic flow, processes, and resources; and institutional regulations arising from colonial policies. Specific challenges include balancing parental resources and shifting priorities with the rigidity of the recommended immunization schedule, standardized appointment bookings, and local/provincial/federal guidelines. An additional obstacle is the tracking and immunization consent processes for children in care of the child welfare system.

Conclusions and implications for vaccinology: The context, structures, and institutional regulations linked to vaccination work often constrain nurses' ability to respond to the needs of First Nations families. This requires the First Nations health centre and nurses to use flexibility and creativity in their approach to immunizing children in their community.

Immunization coverage in two-year-old First Nations children living on-reserve, 2011-2016

De Rubeis E, Aziz S, Grimard Ouellette N, Singh V, Trubnikov M

Introduction/Program need and objectives: To monitor immunization coverage among First Nations children and adolescents on-reserve, Indigenous Services Canada (ISC) uses immunization coverage data collected from its regional offices for program reporting purposes. While there are recognized limitations to this approach, including considerable variability in data collection and reporting practices across regions, there have been successes in assessing coverage among First Nations on-reserve, which this presentation intends to highlight.

Program methods and activities: Aggregate immunization coverage data for Diphtheria, Tetanus, acellular Pertussis, Inactivated Polio Vaccine, Haemophilus Influenzae type B (DTaP-IPV-Hib) and Measles Mumps Rubella (MMR) at 2 years for First Nations on-reserve is reported to ISC's regional offices on an annual basis. These data are collated and national estimates of the percentage of two-year-olds who are in receipt of the full number of valid vaccine doses required (up-to-date) for DTaP-IPV-Hib and MMR were calculated, and trends over time for these coverage rates were assessed for the years 2011-2016.

Program results or outcomes (including evaluation): Analysis of up-to-date two-year old immunization coverage rates for DTaP-IPV-Hib and MMR has shown that rates have been fairly consistent across this time period. In addition, in the most recent years, two more regions have made their DTaP-IPV-Hib and/or MMR coverage data available to ISC. As a result, ISC is now able to report on national immunization coverage rates for First Nations on-reserve living in 10 provinces.

Implications for practice or policy: Currently, ISC immunization coverage data collection processes combined with coverage reported by the British Columbia First Nations Health Authority (FNHA) represents the only national source of immunization coverage data for First Nations living on reserve in 10 provinces. These data are important for improving immunization uptake and improved health outcomes. In addition, ISC is continuously focused on improving immunization awareness by developing educational resources in collaboration with national Indigenous partners, including an "Immunization Infographic" and the "Don't Wait, Vaccinate!" educational products.

Epidemiology of a pertussis outbreak in Central Saskatchewan First Nations Communities

Allard-Johnson M, Udom E, Andkhoie M, Unteriner S, Kupchanko D, Ramsingh R, Claude N, Cyr C, Garner D, Mirasty J, Smith L, Kopp D, Fineday I, Dussion B, Bowen C, Henri P, Blocka J, St-Onge A, Bukassa Kazadi G, Khan I

Introduction/Background: The routine immunization of children and adolescents in south and central First Nations communities in Saskatchewan (SK) are tracked by community health care providers in First Nations bands and shared with First Nations and Inuit Health Branch (FNIHB-SK). These immunization coverage are reported as on-time and up-to-date based on the Canadian Immunization Registry Network national standards for immunization coverage in Canada. In 2017, central First Nations communities experienced an outbreak of pertussis. The purpose of this analysis is to determine whether the number and the timing of the pertussis vaccine doses among the outbreak population are associated with the odds of being diagnosed with pertussis.

Methods: Vaccination history of the cases and contacts were classified using "on-time", "up-to-date", "delayed" and "behind" coverage measures. Logistic regression was used to estimate the association between pertussis diagnosis and vaccination history.

Results and Analysis: During this outbreak, there were 22 cases and 304 contacts (n = 326) identified within the affected communities. Majority of the cases (74%) were aged between 2 and 17 years. Besides pertussis, laboratory diagnostics performed for the cases and contacts identified multiple infectious respiratory organisms including coronavirus NL63, adenovirus and influenza B. Among the outbreak population, those who had delayed (or were behind) for routine pertussis vaccination by 18-months of age had higher odds (4.92; CI: 1.02-23.76; p-value = 0.047) of being diagnosed as a case compared to those who were up-to-date or on-time.

Conclusions and implications for vaccinology: On-time pertussis vaccination is vital for the prevention of pertussis infection. Our findings show the need to reinforce the importance of adhering to the routine pertussis immunization schedule in the affected population and evaluate the need for similar approaches to reduce the incidence of pertussis.

Vaccine uptake among Indigenous People in Northern Ontario is influenced by geography and prior relationships with health care workers: Results of a prospective qualitative study sponsored by the Canadian Immunization Research Network

Burnett K, Sanders C, Ulanova M, Halperin D, Halperin S

Introduction/Background: As part of a larger project examining the development of a vaccine for invasive Haemophilus influenzae type a (Hia), we are exploring the knowledge of and perceptions about vaccines generally and Hia specifically, among First Nations people living in northern Ontario. Included within this exploration is an assessment of the experiences and understandings of health care practitioners that work primarily with First Nations populations.

Methods: Qualitative descriptive data collection began in February 2017 and is ongoing. Data have been collected in Thunder Bay, Sioux Lookout, and several nearby road-access communities. Data consist of one-on-one semi-structured interviews (N=5) with health care providers and semi-structured focus groups (N=10) with community members. Focus group participants have been primarily female and consisted of young parents, single adults, and Elders. Healthcare providers consisted of physicians, nurses working at community health centers and public health units, and community health educators.

Results and Analysis: Preliminary data suggest that geography and proximity to urban centers affect both access to health care and trust relationships between community members and healthcare providers. These factors, in turn, shape attitudes toward vaccines and vaccination schedules. Participants from urban centers reported having negative relationships with providers, while participants from road-access communities reported having more positive relationships. Distrust of state health and social services agencies also affected participants' attitudes and trust toward vaccines and vaccine schedules.

Conclusions and implications for vaccinology: Prior experiences affect the attitudes of Indigenous communities regarding vaccination. In order to improve vaccine coverage, Canada's health care system must work on building trust relationships with Indigenous communities.

ORAL PRESENTATIONS – SESSION 10

Wednesday 5 December

14:00 – 15:30

Room 207

Impact of moving the second dose of MMR from 18 months to school entry, British Columbia

David S, Treloar C, Mitroi J, Naus M

Introduction/Background: In January 2012, the British Columbia (BC) immunization schedule changed to introduce a second dose of varicella vaccine as combined measles/mumps/rubella/varicella (MMRV) at school entry (4-6 years of age). This resulted in a move of second MMR dose from 18 months of age to school entry. This evaluation assesses the impact on vaccine uptake and reports of adverse events following immunization (AEFI).

Methods: Using immunization registry data, we compared measles/mumps/rubella series completion (at least two doses of measles/mumps-containing vaccine and one dose of rubella-containing vaccine) by the seventh birthday among those offered MMRV at school entry (born July 1, 2010-March 31, 2011) to those offered MMR at 18 months of age (born January 1-December 31, 2009) for children living in three of BC's five regional health authorities. Using BC Public Health Data Warehouse data, we compared AEFI trends following the 18-month MMR with those following school-entry MMR+/-V.

Results and Analysis: Children in the 2010-11 cohort were significantly less likely to be up-to-date for measles/mumps/rubella by the seventh birthday compared to the 2009 cohort (70.4% vs. 79.4%; RR=0.89, 95%CI=0.88-0.89; p<0.0001). Of the 2009 cohort, 70.8% were up-to-date prior to the fourth birthday; an additional 8.6% were caught-up during school-entry immunizations. Fewer AEFI were reported following MMR+/-V at school entry in 2015-2017 compared to AEFI reports following the 18-month dose of MMR before the schedule change.

Conclusions and implications for vaccinology: A 9% decline in the proportion of children up-to-date for MMR by the seventh birthday coincided with the change in BC's immunization schedule. This may be due to one less opportunity for immunization by the seventh birthday assessment milestone. A decline in AEFI reports following the second dose of MMR-containing vaccine was also observed. These findings should be considered in concert to assess the best strategy to improve second dose completion for measles, mumps and varicella in children.

Outbreak of invasive meningococcal disease serogroup W in the Okanagan, British Columbia

Andrews M, Frosst G, Spence J, Mema S, Goodison K, de Bruin P

Introduction/Program need and objectives: From June to December 2017, five cases of invasive meningococcal disease (IMD) caused by *N. meningitidis* serogroup W were reported among 15-19 year olds in the Okanagan, British Columbia. At an incidence rate of 25.8 per 100,000 population, an outbreak was declared on December 13, 2017. An Incident Command Structure was implemented to guide the response.

Program methods and activities: A large-scale immunization campaign was immediately launched for Okanagan residents 15-19 years of age. Immunization clinics offered the Meningococcal Quadrivalent conjugate vaccine through secondary schools, Public Health units and post-secondary education sites. Selected pharmacies were also provided with vaccine as part of the campaign. The campaign was widely promoted through social media, secondary schools, radio announcements and newspaper articles. The outbreak was declared over and the publicly funded immunization campaign ended on February 14, 2018.

Program results or outcomes (including evaluation): A total of 11 417 immunizations were administered during the campaign. The campaign was considered to be successful with a population immunization coverage of 68% achieved among 15 - 19 year olds.

Particular challenges of the outbreak response included rapid mobilization of large quantities of vaccine, coordination of clinics across several communities in the days leading up to and throughout the holiday season, and data management related to vaccine uptake. Secondary school clinics were the most effective mechanism to reach and immunize the school-aged youth. Vaccine uptake was lower among 18-19 year olds who were no longer in secondary school.

Implications for practice or policy: Public health recommendations include consideration of the unique needs and characteristics of the target population during a geography-based immunization campaign in response to an outbreak. Dedicated support for data collection and data management is also recommended.

Preparedness for and response to meningococcal outbreaks: a Canadian Immunization Research Network (CIRN) Clinical Trials Network (CTN) randomized controlled trial (RCT) of two schedules of 4CMenB vaccine in adolescents and young adults

Langley J, Gantt S, Quach C, Bettinger J, Halperin S, Mutch J, McNeil S, Ward B, McKinnon-Cameron D, Ye L, Marty K, Scheifele D, Alcantara J

Introduction/Background: Emergency vaccination programs are often needed to control outbreaks of Meningococcal B (MenB) disease in university students. The 4CMenB vaccine (Bexsero[®], GlaxoSmithKline) is authorized for persons 2 months through 17 years in Canada, but limited data exist on safety and immunogenicity in persons >17 years or on various dosing schedules.

Methods: A RCT at 3 CIRN sites compared an accelerated 4CMenB (0, 21 days) to a standard schedule (0, 60 days) during the 2015/16 academic year in 17-25-year old students. The control was Hepatitis A vaccine (HAV). Human serum bactericidal (hSBA) titers to MenB strains 5/99, H44/76 and NZ98/254 were done on days (D) 0, 21, 42, 81 and 180. Adverse events (AE) and acceptability were measured with diary cards and tolerability questionnaires, respectively.

Results and Analysis: In 121 participants any solicited AE was more common in MenB recipients after all 3 doses (95% - 100%) Injection site pain occurred in 95% -100% after MenB v. 30% - 46.6% of HAV recipients. "Muscles aches" was the most common general AE (MenB:46.7% - 55.2% v. HAV: 11.7% - 24.1%). Protective titers (hSBA \geq 1:4) were present in \geq 95% participants at D21 and similar at D180. Participants would take the vaccine again, but up to 35% were "a little" anxious before vaccination. A "more painful" vaccine with "better protection" was preferred over one that was less painful and effective.

Conclusions and implications for vaccinology: In a rapid multi-center RCT in young adults in the fall of an academic year an accelerated MenB schedule had acceptable reactogenicity and similar immunogenicity compared to a standard schedule.

Impact of an adolescent booster dose on the incidence of pertussis in Quebec and British Columbia

Bellemare D, Brousseau N, Ouakki M, Amini R, Skowronski D, Clarke Q, Hoang L, Quach C, Rallu F, Gilca V, De Serres G

Introduction/Background: The duration of protection given by the adolescent booster dose of the acellular pertussis-containing vaccine (Tdap) is shorter than initially expected. The purpose of this study was to assess the impact of an adolescent booster dose of Tdap on the incidence of pertussis among 15-19 year olds in the province of Quebec, Canada following its introduction in 2004 at 15 years of age.

Methods: Cases of pertussis reported in the province of Quebec (population~8.2 million) between 2000 and 2016 were included in the analysis. Study periods (pre-intervention, 2000-2004; post-intervention; 2005-2008,

2009-2012, and 2013-2016) were based on the types of pertussis vaccines received by the 15-19-year-old cohort. Incidence rates were compared for various age groups and by study period. Data were also analyzed with a segmented regression using incidence rate ratios (IRRs) for the 15-19-year-old group (vs. other age groups) before and after Tdap introduction.

Results and Analysis: Incidence rates of reported cases were low ($< 8/100\ 000$ population) among the 15-19-year-old group for all study periods (pre- and post-intervention). The decreasing incidence of pertussis by age began earlier at 13-14 years old and this historical pattern preceded the introduction of the adolescent booster dose. Furthermore, there was a statistically significant upward trend in pertussis IRRs for adolescents 15-19 years old between 2013 and 2016 corresponding to ageing of birth cohorts whose complete pertussis immunization schedule was with acellular vaccine (slope=0.10, $p<0.0001$). The IRR in 2016 approximated those of the pre-intervention period (2000-2004).

Conclusions and implications for vaccinology: Decreasing pertussis trends by age in older children are temporally unrelated to the adolescent booster dose. The impact of the adolescent booster dose on the incidence of pertussis in Quebec appears to be minimal.

Mixed vaccination schedule with one dose of nonavalent and one dose of bivalent HPV vaccine versus two doses of nonavalent vaccine: Comparison of immunogenicity and safety

Gilca V, Sauvageau C, Panicker G, De Serres G, Ouakki M, Unger E

Introduction/Background: Limited data is available on the use of different HPV vaccines in the same subjects. We evaluated the immunogenicity and safety of a mixed vaccination schedule with one dose of nonavalent (9vHPV) and one dose of bivalent vaccine (2vHPV) administered in different order versus two doses of 9vHPV vaccine.

Methods: 371 girls&boys aged 9-10 years were randomized (1:1) to receive (I) two doses of 9vHPV or (II) a mixed schedule of 2vHPV+9vHPV or 9vHPV+2vHPV at 6 month interval. Anti-HPV were tested by ELISA in blood collected one or six months post-first and one month post-second dose.

Results and Analysis: Post-first dose of 9vHPV 99.4-100% of subjects were seropositive to 9HPV types included in the vaccine. GMTs varied from 5.0 to 73.6AU/ml depending on HPV type. Post-first dose of 2vHPV all subjects were seropositive to HPV16 and 18 and 50.0-76.7% were seropositive to 7 types not included in 2vHPV. GMTs varied from 0.3 to 17.5AU(IU)/ml. Post-second dose all subjects, regardless of the group, were seropositive to 9 HPV types included in 9vHPV. Anti-HPV16 and 18 GMTs were higher in subjects with the mixed schedule and for the other 7 types higher in subjects who received two doses of 9vHPV vaccine. A higher proportion of subjects who received 2vHPV reported local or systemic adverse events than those who received 9vHPV as the first dose. Post-second dose there were no differences in reported adverse events between the two vaccines.

Conclusions and implications for vaccinology: The results show the mixed HPV vaccination schedules used in this study are immunogenic and have an acceptable safety profile. Although the seroprotective threshold of antibodies remains unknown the 100% seropositivity to all 9HPV types included in 9vHPV and the increase of GMTs observed in all study groups post-second dose administration are reassuring and suggest protection might be achieved regardless of the schedule used.

ORAL PRESENTATIONS – SESSION 11

Thursday 6 December

11:00 – 12:30

Room 205

Immunogenicity of two compared with three doses of the quadrivalent HPV vaccine up to 10 years post-vaccination: Phase III postlicensure randomized trial

Donken R, Dobson S, Marty K, Cook D, Sauvageau C, Gilca V, Dionne M, McNeil S, Krajden M, Money D, Kellner J, Scheifele D, Kollman T, Bettinger J, Singer J, Naus M, Sadarangani M, Ogilvie G

Background: This study compared immunogenicity of 2-dose (2D) versus 3-dose (3D) schedules of quadrivalent HPV-vaccine (4vHPV) up to ten years (10Y) after the first dose.

Methods: Girls aged 9-13 years (n=520) were randomized to receive 2D or 3D of 4vHPV, and were compared to women aged 16-26 years (n=310) receiving 3D. Seropositivity rates and geometric mean titers (GMTs) for anti-HPV16 and 18 (cLIA mMU/mL) were compared at 2 years (2Y) and 10Y post-dose 1. Non-inferiority was defined as the lower bound of confidence intervals around the GMT ratios for 2D and 3D in girls compared to 3D in women >0.5.

Results and Analysis: A total of 103 participants were included in this analysis. Seropositivity for HPV16/18 at 2Y were for 2D-girls: 100%, 97%; 3D-girls: 100%, 95%; 3D-women 100%, 77%. HPV16 GMTs were 1561 (95%CI: 1118-2179) for 2D girls (n=35), 1472 (1063-2038) for 3D girls (n=38) and 978 (675-1418) for 3D women (n=30). For HPV18, values were respectively 187 (125-282), 315 (202-489) and 90 (54-150). At 10Y seropositivity for HPV16/18 were for 2D-girls: 100%, 83%; 3D-girls: 100%, 92%; 3D-women 97%, 60%. The respective GMTs were 692 (492-973), 571 (416-784) and 430(244-699) for HPV 16 and 74 (47-118), 103 (67-160) and 37 (21-65) for HPV 18. GMTs for both 2D (GMT ratio HPV16 1.61, 95%CI 0.91-2.85 and HPV18 2.02, 95%CI 0.99-4.10) and 3D in girls (HPV16 1.33, 95%CI 0.77-2.30 and HPV18 2.82, 95%CI 1.42-5.58) were non-inferior to 3D in women up to 10Y. No differences in the decline in antibodies over time were observed between the study groups.

Conclusions and implications for vaccinology: At 10Y post-first dose, GMTs for HPV16/18 after 2D or 3D of 4vHPV in girls were non-inferior to 3D 4vHPV in adult women group. This study demonstrates long-term immunogenicity of the 2D HPV vaccine schedule.

Rates of cervical intraepithelial neoplasia in women in British Columbia: A data linkage evaluation of the school-based HPV immunization program

Racey C, Albert A, Donken R, Smith L, van Niekerk D, Spinelli J, Pedersen H, de Bruin P, Masaro C, Krajden M, Sadarangani M, Naus M, Ogilvie G

Introduction/Background: HPV vaccines were highly efficacious in the prevention of cervical cancer precursors in large-scale trials. However, monitoring of population-based data is critical to understand real-world vaccine impact. Our analysis evaluated the impact of the school-based quadrivalent HPV immunization program on cervical dysplasia in British Columbia.

Methods: Data linkage was performed using records from the provincial Cervical Cancer Screening Program and immunization registries. In screened women born in 1994 through 2005, the relative incidence rates (RR) of precancerous outcomes based on cytology and histopathology (CIN2, CIN3 and CIN2+) using adjusted Poisson regression were compared between HPV vaccine recipients and unvaccinated women. A complete series was considered 2 doses for those born in 2003 or later, and 3 doses for those born in 1994 – 2002 per the provincial schedule.

Results and Analysis: There was a higher rate of CIN2+ in women who received a complete HPV series (all recommended doses based on schedule) starting at 15 years or older (n=1,312), compared to women with a complete series beginning at 9-14 years of age (n=12,910), RR 2.50 (95%CI 1.25-4.68). Women who received any HPV vaccine dose between the ages of 9 and 14 years (n=14,199) had a RR 0.51 (95%CI 0.35-0.75) for CIN2+ compared to unvaccinated women (n=12,762). There was no significant difference in the RR of CIN2+ in women

with incomplete series (i.e. not in accordance with recommended schedule at time of vaccination) compared to unvaccinated women.

Conclusions and implications for vaccinology: Women who received HPV vaccine at 9-14 years of age had half the rate of high-grade cervical lesions compared to unvaccinated women. Pre-adolescent immunization should be encouraged, as per the provincial schedule. Continued program monitoring will be important for measuring long-term population impact.

Healthcare provider perspectives on the uptake of human papillomavirus vaccine among newcomers to Canada: A qualitative study

Rubens-Augustson T, Wilson L, Murphy M, Parks M, Day P, Rahman S, Hui C, Pottie K, Wilson K

Introduction/Background: Human papillomavirus (HPV) is among the most common sexually transmitted infections in the world, with up to 70% of Canadians contracting the virus at some point in their lives. Vaccination is an effective primary prevention strategy to protect against HPV sub-types that commonly cause certain cancers and genital warts. Previous research has found that newcomers face numerous barriers to HPV vaccination. Given the crucial role of healthcare providers in promoting vaccination uptake, the aim of this qualitative study was to explore the experiences and perceptions of healthcare providers who discuss and administer the HPV vaccine to newcomers in Ottawa, Ontario.

Methods: Semi-structured interviews were conducted with 10 healthcare providers between March and April 2018. Data were analyzed at the manifest level using a Qualitative Content Analysis approach as described by Graneheim and Lundman (2004).

Results and Analysis: Six categories to describe barriers to HPV vaccination emerged: impediments to accessing healthcare; health illiteracy; an epistemological gap; a difference in beliefs, values, and norms; limited opportunities for engagement with newcomers; and competing priorities in newcomer health. Four categories emerged to describe facilitators: measures are starting to hit home; understanding the relevance of HPV vaccination; trusting the healthcare system; and responding to cultural diversity. Two overarching recommendations were to publicly fund the HPV vaccine, and enhance language and culturally-appropriate health promotion activities.

Conclusions and implications for vaccinology: Barriers to HPV vaccination are governed largely by a lack of access to quality healthcare. Language and culturally-appropriate information resources will be fundamental in developing targeted interventions. Publicly funding the HPV vaccine is likely to enhance healthcare provider recommendation which may improve uptake. Further research should explore informational desires and needs from the perspective of newcomers to inform strategies to guide the development of targeted interventions to promote equitable HPV vaccine coverage.

Investigation and response to the largest mumps outbreak in the City of Toronto in over 20 years

Ozaldin O, Shulman L, Stuart R, Dubey V

Introduction/Program need and objectives: In 2017, Toronto Public Health (TPH) investigated the largest community mumps outbreak in the City of Toronto in over 20 years with 143 cases. Toronto has an average of 5 mumps cases per year. The outbreak was identified after two cases were reported in unimmunized young adult siblings. The goal was to stop transmission through awareness, behaviour modification and vaccination.

Program methods and activities: Descriptive epidemiology was used to characterize the outbreak. A broad range of interventions were implemented to reach the target audience including case and contact management, communication campaigns, inspections of bars and school exclusions as per the the Immunization School Pupil's Act.

Program results or outcomes (including evaluation): Beginning January 1, 2017, 143 confirmed mumps cases were reported in Toronto. The outbreak was declared over on February 26, 2018, 14 months after it began. Most cases were 18-35 year olds and only 27% were adequately vaccinated, 11% were unimmunized, 23% received 1 dose and 39% had unknown vaccinations.

Initially, exposure sites included west downtown Toronto bars. As the outbreak progressed widespread community transmission occurred.

Vaccination messages were broadcast to the public and health care providers. From January to May 2017, at the height of the outbreak, orders for MMR were 10,000 higher compared to 2018. Mass immunization clinics were offered at schools with 2 or more cases and some students were excluded to prevent transmission in the school setting. At one school 160 students were immunized.

Implications for practice or policy: In Ontario, the young adult cohort, born from 1970 to 1992, prior to the implementation of the two dose MMR vaccine schedule, is at high risk for mumps transmission. This outbreak presented with unique challenges in case and contact tracing, messaging, and immunization, especially as the outbreak was not isolated to an institution. Addressing historic vaccination policy decisions during and following an outbreak of a vaccine preventable disease is necessary to prevent recurrence.

Effectiveness of an 'outbreak dose' of MMR vaccine during a mumps outbreak in two First Nations communities in northern Ontario

Majerovich J, Rudnick W, Gatali M, Wilson S, Deeks S

Introduction/Background: From December 2017 to May 2018, a mumps outbreak occurred in two remote and isolated First Nations communities in Ontario. An 'outbreak' dose of MMR vaccine was offered to individuals aged 8–48 years and an evaluation was conducted as part of the public health response.

Methods: Mumps cases were classified as confirmed or probable using an outbreak case definition. Population lists and immunization information were extracted from the communities' health information systems. The outbreak epidemiology was described. Hazard ratios (HRs) were estimated using penalized-likelihood Cox regression with outbreak dose receipt as a time-dependent variable in unadjusted and adjusted analyses.

Results and Analysis: Between 18-Dec-2017 and 5-May-2018, there were 47 confirmed and 8 probable mumps cases (attack rate: 17.5/1000 persons). Median case age was 24 (range: 11 months–59 years).

Before the outbreak, 58%, 34% and 8% of individuals aged 1–48 years had received ≥ 2 , 1 and 0 previous MMR doses, respectively. Median time since previous vaccination was 13 years (range: 5 days–45 years).

During the outbreak, 815 (32%) age-eligible individuals received an 'outbreak dose'. This was the third (or fourth) dose for 391 (48%) individuals, the second dose for 324 (40%), and the first dose for 100 (12%).

Higher attack rates were associated with more distant receipt of vaccine before the outbreak (adj.HR =4.2, P=.03 for >10 vs <3 years) and males (HR =2.7, P=.001). Individuals who had not received an outbreak dose had 3-times the rate of disease compared to those who received a dose, but the confidence interval was wide (adj.HR=3.3, 95%CI: 0.8–30.2).

Conclusions and implications for vaccinology: Persons who received an outbreak dose of MMR had a lower risk of mumps, but this did not reach statistical significance. Persons who received their most recent dose >3 years before the outbreak were at increased risk for disease, consistent with waning of vaccine-induced immunity.

ORAL PRESENTATIONS – SESSION 12

Thursday 6 December

11:00 – 12:30

Room 206

Point of care influenza vaccination for pregnant patients at a tertiary care centre: Patient experience

Castillo E, Santana M, Idarraga L, Nerenberg K, Metcalfe A, Van Der Kooi O, McCaughey D, MacDonald S, Manji S

Introduction/Background: There is limited uptake of the current recommendations for universal immunization in pregnancy against influenza and pertussis. Based on limited data, it appears that offering vaccines at the Point-Of-Care (POC), where pregnant patients receive prenatal care, may help to increase uptake. As part of a pilot program in Calgary, Alberta, influenza vaccination is offered at POC in outpatient obstetric clinics at a tertiary care center where approximately 1,000 pregnant women receive prenatal care during the flu season.

Methods: An anonymous online survey to explore patients' perception regarding POC was created using a secure web application (REDCap). It was offered by the clinic nurses of the two outpatient obstetric clinics between November 2017 and April 2018. The survey consisted of 15 questions using a Likert scale ranging from "strongly disagree" to "strongly agree" with the option to answer "Not applicable" in case the patient did not receive the vaccine. The questionnaire consisted mostly of closed-ended questions and it required about 8 minutes to be completed.

Results and Analysis: Out of the 119 responders, almost 82% reported receiving the flu shot this season and 60.7% received it in the past, but only 38.6% of those received the vaccine when pregnant. Nearly half of the women believed that having the vaccine available at the clinic impact their decision of receiving it, and 80% believed that the information provided was enough to make an inform decision. The main reason for receiving the vaccine was to protect their fetus (12.6%), while a small proportion (3.4%) believed that there is no difference between being immunized or not and that it is unnecessary to be exposed to this kind of substances.

Conclusions and implications for vaccinology: POC seems to positively influence pregnant patient's decision to receive influenza immunization in the outpatient setting. POC immunization in pregnancy is feasible and more than doubled vaccination rates in outpatient clinics in a tertiary care urban facility in the 2nd year after implementation.

Improving maternal and newborn health through the implementation of point of care vaccination for pregnant patients

Castillo E, Abbott R, Hanner K, Nerenberg K, McDonald S, Manji S, Idarraga L, McCaughey D

Introduction/Program need and objectives: There is limited uptake of the current recommendations for universal immunization in pregnancy against influenza and pertussis. Based on limited data, it appears that offering vaccines at the Point-Of-Care (POC), where pregnant patients receive prenatal care, may help to increase uptake. As part of a pilot program in Calgary, Alberta, influenza vaccination is offered at POC in both outpatient and inpatient obstetric units at a tertiary care center where up to 3,350 pregnant patients per year receive prenatal care during the flu season.

Objective: Evaluate the uptake of POC influenza immunization during pregnancy by determining:

1. Weekly offer rate: how often do OB care providers (nurses at outpatient and inpatient obstetric units) offer the vaccine to eligible patients?
2. Vaccination Uptake: what proportion of pregnant patients receive the vaccination?

Program methods and activities: The pilot study included multiple PDSA cycles (Plan, Do, Study, Act) to assess the uptake related to offering, administering and documenting vaccination within obstetric inpatient and outpatient units. Vaccine offer rates were measured through weekly chart audit (opportunistic sampling). A pre/post study design across four consecutive influenza seasons [2014-2015 and 2015-2016 (before POC implementation) and 2016-2017 and 2017-2018 (after POC implementation)] was used to determine changes in the vaccination rates amongst pregnant patients.

Program results or outcomes (including evaluation): Year 1 (2016-17): influenza vaccination uptake ranged from 15-21% -comparable to the 2 seasons prior to POC implementation. Year 2 (2017-18): Outpatient Clinics: vaccine offer and uptake rates were significantly higher: 58%-63% and 47-51% respectively. Inpatient (obstetric triage & antepartum ward): Vaccine offer and uptake rates were also higher ranging from 22%-38% and 19%-56% respectively.

Implications for practice or policy: POC immunization in pregnancy is feasible in both outpatient and inpatient obstetric units at a tertiary care center.

Low levels of detectable pertussis antibodies in a large cohort of pregnant women in Canada

Bell C, Brooks J, Gilbert N, Tunis M, Rotondo J, Ward B, Desai S

Introduction/Background: Newborns and infants less than 6 months of age are at highest risk of severe outcomes from pertussis infection. High levels of pertussis antibodies in mothers during pregnancy, due to recent vaccination or past infection, confer protection to newborns as a result of trans-placental transfer. This study was undertaken to measure the prevalence of pertussis antibodies in a cohort of pregnant women in Canada.

Methods: We used biobanked plasma samples collected in second trimester from a convenience sample of 1752 pregnant women enrolled between 2008-2011 in the Maternal-Infant Research on Environmental Chemicals (MIREC) study. IgG antibodies specific for pertussis toxin (PT) were measured by enzyme immunoassay (EIA) as a marker for maternal immunity. As per manufacturer's indications, titres <35 IU/ml were negative for recent maternal infection and the lower limit of detection was 5 IU/ml. There is no accepted threshold for anti-PT IgG titres above which individuals are considered as protected.

Results and Analysis: The median anti-PT IgG titre was 5.5 IU/ml. The proportion of women with titres <35 IU/mL (negative as per manufacturer's indications), <20 IU/ml and <10 IU/ml were 97.5%, 91.8% and 76.9%, respectively. Nearly half of the women in this study had titres below the assay's lower limit of detection.

Conclusions and implications for vaccinology: The majority of pregnant women in this large cohort had anti-PT levels low enough to suggest susceptibility to pertussis infection in both the mothers and by extension to their newborn infants. Vaccination during pregnancy, which has recently been recommended by Canada's National Advisory Committee on Immunization (NACI), is expected to reduce the incidence of pertussis infection among newborns and infants.

Prevalence of pertactin-deficient *Bordetella pertussis* isolates in Ontario, Canada from 2009 – 2017

Bolotin S, Marchand-Austin A, Tsang R, Shuel M, Crowcroft N, Schwartz K, Hughes S, Cronin K, Ma J, Van Domselaar G, Graham M, Tyler S, Jamieson F

Introduction/Background: Despite high vaccine coverage, a resurgence of *Bordetella pertussis* has been observed in recent years, particularly in countries that administer the acellular pertussis vaccine. In many jurisdictions, this resurgence has coincided with the emergence in 2011 of *B. pertussis* strains deficient in pertactin (PRN-N), a virulence factor that is a component of the acellular pertussis vaccine used in Canada and elsewhere. The objective of our study was to measure trends in the prevalence of pertactin-deficient strains in Ontario, from 2009-2017.

Methods: We characterized all available isolates from 2009-2017 using Western immunoblotting performed at the National Microbiology Laboratory and Public Health Ontario laboratories. We performed descriptive statistical analyses to assess whether any significant associations in PRN-N status existed by age-band, geography, or whole-cell vs. acellular pertussis vaccine program-eligibility.

Results and Analysis: Of the 413 isolates available for characterization, 34.6% (143/413) were PRN-N. These first emerged in 2011, reaching a maximum prevalence of 70.8% (34/48) in 2016, decreasing thereafter to 46.2% (30/65) in 2017. From 2011-2017, the <6 month age-group had the highest PRN-N prevalence at 36/69 (52.2%). From 2011, 26/59 (44.1%) isolates were PRN-N from individuals eligible for whole-cell priming vaccine,

compared to 78/189 (41.3%) isolates from individuals eligible for acellular vaccine priming ($p = 0.41$). PRN-N prevalence varied by Ontario region ($p < 0.0001$).

Conclusions and implications for vaccinology: PRN-N strains emerged in Ontario in 2011, coinciding with emergence in other jurisdictions globally; so far, PRN-N in Ontario remains lower in prevalence than is observed in some other jurisdictions. Although no statistical association was observed for PRN-N prevalence by vaccine program-eligibility, this may have been impacted by selection bias of available *B. pertussis* isolates, which are not always cultivatable. PRN-N strains were isolated from cases identified throughout Ontario. Future studies should include case vaccination history to elucidate the potential association between PRN-N strains and whole-cell vs. acellular vaccine priming.

The effect of timing of tetanus-diphtheria-acellular pertussis vaccine administration in pregnancy on the avidity of pertussis antibodies

Abu-raya B, Giles M, Kollmann T, Sadarangani M

Introduction/Background: Tetanus-diphtheria-acellular pertussis (Tdap) vaccination in pregnancy is currently recommended in Canada and other countries. The optimal timing of pertussis immunization in pregnancy is not well established, leading to different recommendations. We aimed to determine the effect of timing of vaccination with Tdap in pregnancy on the umbilical cord avidity (the binding strength of an antibody for an antigen) of immunoglobulin G (IgG) to pertussis toxin (PT).

Methods: Ammonium thiocyanate (NH₄SCN) was used as a bond-breaking agent to measure the avidity of anti-PT IgG using a range of concentrations between 0.25M (to measure low-avidity antibodies) and 3M (to measure very high-avidity antibodies). Anti-PT IgG levels achieved at each NH₄SCN concentration were calculated. Anti-PT IgG levels in cord blood of newborns of women vaccinated in early (28-32 weeks gestation [WG]) vs. late (33-36 WG) 3rd trimester, and between newborns of women vaccinated 5-12 vs. 1-4 weeks prior to delivery were compared using t-tests.

Results and Analysis: Newborns of women vaccinated with Tdap in early 3rd trimester ($n=43$) had higher levels of medium and high-avidity anti-PT IgG antibodies compared with newborns of women vaccinated in late 3rd trimester ($n=47$), 2.4 international units (IU)/ml vs. 1.9 IU/ml ($p=0.0073$) and 2.3 IU/ml vs. 1.7 IU/ml ($p=0.0354$), ($p=0.0073$ and $p=0.0354$, adjusted for gestational age at birth), respectively. Newborns of women vaccinated with Tdap 5-12 weeks prior to delivery had higher levels of high and very high avidity anti-PT IgG antibodies compared with newborns of women vaccinated within 4 weeks prior to delivery, 2.3 IU/mL vs. 1.2 IU/mL, 2.5 IU/mL vs. 1.5 IU/mL, (all $p<0.03$), respectively.

Conclusions and implications for vaccinology: Vaccination against pertussis during early 3rd trimester results in higher levels of high-avidity antibodies in newborns compared with vaccination in late 3rd trimester. High-avidity antibodies may confer greater protection to the neonate, supporting recommendations for vaccination at 28-32 over 33-36 WG.

ORAL PRESENTATIONS – SESSION 13

Thursday 6 December

11:00 – 12:30

Room 207

Influenza vaccine effectiveness in older adults with diabetes, 2010-11 to 2015-16 influenza seasons in Ontario, Canada

Kwong J, Shing E, Shah B, Buchan S, Campitelli M, Schwartz K, Crowcroft N, Campigotto A, Gubbay J, Karnauchow T, Katz K, McGeer A, McNally D, Richardson D, Richardson S, Rosella L, Simor A, Smieja M, Zahariadis G

Introduction/Background: Diabetes increases the risk of complications from influenza infection and it may decrease the effectiveness of influenza vaccines. The objective of this study was to estimate vaccine effectiveness (VE) against laboratory-confirmed influenza healthcare encounters in older adults with diabetes.

Methods: We used the test-negative design and linked health administrative and respiratory virus testing data to estimate VE among community-dwelling adults aged >65 years with diabetes. We used: 1) the Ontario Diabetes Database to identify patients diagnosed with diabetes between 1991 and 2016; 2) respiratory virus test results from a network of public health and academic hospital laboratories to identify influenza infection; 3) physician and pharmacist billing claims to assess influenza vaccination; and 4) Ontario Drug Benefits data to measure prescriptions for diabetes-related medications. We estimated the association between influenza vaccination and laboratory-confirmed influenza using multivariable logistic regression models.

Results and Analysis: We included 23,106 patients with diabetes, with 20% testing positive for influenza, 54% vaccinated, 23% taking insulin, and 52% taking oral hypoglycemic medications. After multivariable adjustment, VE against any influenza over the 6 influenza seasons was 22% (95% CI, 17%-27%), with notable season-to-season variability. Correcting for misclassification of vaccination status, we estimated VE to be 38% (95% CI, 32%-44%). VE was higher for patients aged 66-75 years (30%; 95% CI, 21%-37%) and 76-85 years (23%; 95% CI, 14%-30%) than for those aged ≥86 years (4%; 95% CI, -11% to 17%). VE appeared to be higher for patients with shorter duration since diabetes diagnosis, and for those taking insulin or oral hypoglycemic agents compared to those not taking any diabetes medications. VE was very similar for older adults without diabetes (22%; 95% CI, 17%-26%).

Conclusions and implications for vaccinology: Seasonal influenza vaccination was associated with reductions in laboratory-confirmed influenza healthcare encounters in older adults with diabetes. Improving vaccine coverage should decrease the burden of influenza in this patient population.

Estimation of burden of hospitalizations and deaths associated with influenza in Quebec

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Introduction/Background: The Comité sur l'immunization du Québec (CIQ) revised the provincial Influenza Immunization Program (QIIP). The main objective of the QIIP is the reduction of influenza-associated hospitalizations and deaths. We assessed that burden for the period 2011-2016

Methods: Sources of data were: a 5-year study conducted in four community hospitals serving ≈10% of Quebec population where patients were systematically tested for influenza using a multiplex PCR; administrative databases (hospitalizations and deaths), sentinel respiratory viruses laboratory surveillance data, notifications of influenza outbreaks in Quebec long-term care facilities (LTCF), IMPACT data for deaths associated with influenza in children and data extracted from the literature.

Results and Analysis: For the 5 influenza seasons, the average annual estimate for Quebec was 6,194 influenza-associated hospitalizations (76 per 100,000 population) and 417 influenza-associated deaths (5.2 per 100,000 population).

The majority of influenza-associated hospitalizations (80%) and deaths (92%) occurred in persons with comorbidities. Deaths in children were exceptional; a total of 2 deaths in children with influenza were reported by Quebec hospitals participating in the IMPACT network for 5 seasons. Rates of influenza-associated hospitalizations and deaths were ≈10 times lower in healthy children than in children with comorbidities.

The rate of influenza-associated hospitalizations in healthy persons 60-64 and 65-74 years was respectively 10 and 6 times lower than in those ≥75 years. The rate of influenza-associated deaths in persons 60-64 and 65-74 years was respectively 100 and 12 times lower than in those ≥75 years.

Approximately 40% of influenza-associated deaths occurred outside acute-care facilities. More than half of influenza-associated deaths occurred among residents of LTCF, including those admitted to acute-care hospitals. For more than 1/3 of deaths in seniors with influenza-confirmed infection, influenza was considered unrelated to death.

Conclusions and implications for vaccinology: Influenza-associated hospitalizations and deaths affects primarily individuals with comorbidities or 75 years and older. Healthy seniors aged 60-74 years were not at high risk for these outcomes.

Waning protection of influenza vaccine? Early vs. late season influenza vaccine effectiveness (VE) estimates over 3 seasons in Canada: An analysis from the Serious Outcomes Surveillance (SOS) Network of the Canadian Immunization Research Network (CIRN)

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Introduction/Background: To optimize protection against influenza and associated serious outcomes, influenza vaccines should be efficacious throughout the entire duration of the influenza season. As recent evidence has suggested influenza vaccine effectiveness (VE) may wane over the influenza season, we sought to assess the VE of the influenza vaccine for preventing hospitalization in early vs. late season over 3 seasons in Canada.

Methods: From 2011/12-2013/14, the CIRN (Canadian Immunization Research Network) SOS (Serious Outcomes Surveillance) Network conducted active surveillance for influenza among hospitalized adults ≥ 16 years (y) from ~ 1 Nov- 30 April each season in up to 45 hospitals in 7 provinces. A nasopharyngeal swab was tested for influenza using polymerase chain reaction (PCR) from all patients admitted with any acute respiratory diagnosis or symptom. Cases were PCR-positive for influenza; controls were test-negative and matched for date, enrolment site and age of the case (≥ 65 y vs. < 65 y). VE was estimated as $(1 - \text{odds ratio of influenza in vaccinated versus unvaccinated patients}) \times 100$ pooled over three seasons, stratified by season time (early/late season: patients enrolled before/after the median admission date of each season), as well as age and type/subtype. VE estimates were adjusted using multivariable logistic regression and reported with corresponding 95% confidence intervals (CIs).

Results and Analysis: Overall, pooled adjusted early season influenza VE was 49.6% (95% CI: 38.3-58.8) and late season VE was 33.1% (95% CI: 19.3-44.5). Among influenza A cases, pooled adjusted early and late season VE was 52.6% (95% CI: 40.9-62.0) and 36.7% (95% CI: 16.3-52.1), respectively; among influenza B cases early and late season VE was 23.2% (95% CI: -35.4-56.4) and 26.1% (95% CI: 4.3-42.9), respectively. The magnitude of VE difference from early to late season did not appear to differ between adults ≥ 65 y and < 65 y.

Conclusions and implications for vaccinology: Overall, a non-significant trend of waning VE was observed between late and early influenza seasons in Canada. Continued monitoring of trends in VE within seasons and between seasons is essential to inform influenza vaccine policy.

Analysis of relative effectiveness of high-dose versus standard-dose influenza vaccines using an instrumental variable method

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Introduction/Background: Observational studies regarding the relative effectiveness of influenza vaccines are essential for public health decision making. Their estimates, however, are subject to bias due to unmeasured confounders. Instrumental variable (IV) methods can control for observed and unobserved confounders.

Methods: We used linked Electronic Medical Record databases in the US Veterans Health Administration (VHA) as well as US Medicare administrative files to examine the relative vaccine effectiveness (rVE) of high-dose influenza vaccine (HD-TIV) versus standard-dose influenza vaccines (SD-TIV) in preventing hospitalizations among VHA-enrolled Veterans ≥ 65 years of age during 5 influenza seasons (2010-2011 through 2014-2015). Using multivariable IV Poisson regression modeling to address unmeasured confounding and bias, we analyzed the data by each season and through longitudinal analysis of all five seasons.

Results and Analysis: We included 3,638,924 person-influenza seasons of observation where 158,636 (4%) were among HD-TIV vaccine recipients and 3,480,288 (96%) were among SD-TIV vaccine recipients. Of the 1,728,562

Veterans, 1,702,824 (98.5%) were male and 1,299,412 (75%) were non-Hispanic white. Based on the longitudinal analysis of all five seasons, the IV-adjusted rVE estimate of HD-TIV vs. SD-TIV was 10% (95% CI, 8%-12%) against all-cause hospitalization; 18% (95% CI, 15%-21%) against cardiorespiratory-associated hospitalization; and 14% (95% CI, 6%-22%) against influenza/pneumonia-associated hospitalization. The findings by season were similar.

Conclusions and implications for vaccinology: Our analysis of VHA clinical data collected from approximately 1.7 million US Veterans 65 years and older during five seasons demonstrates that high-dose influenza vaccine is more effective than standard-dose influenza vaccines in preventing influenza- or pneumonia-associated hospitalizations, cardiorespiratory hospitalizations, and all-cause hospitalizations.

Influenza surveillance case definitions miss a substantial proportion of older adults hospitalized with laboratory-confirmed influenza: a report from the Serious Outcomes Surveillance (SOS) Network of the Canadian Immunization Research Network (CIRN)

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Introduction/Background: Influenza-Like Illness (ILI) and Severe Acute Respiratory Illness (SARI) case definitions are important for local and global surveillance efforts. Older adults often have atypical presentations of acute illness, and may therefore not meet these criteria, though this has not been systematically studied. Given that older adults are particularly vulnerable to influenza and its sequelae, the validity of case definitions in detecting illness in this population is particularly relevant. We therefore sought to assess the performance of ILI and SARI criteria in older adults.

Methods: The Canadian Serious Outcomes Surveillance (SOS) Network undertakes active surveillance for influenza among hospitalized older adults. Data from three influenza seasons (2011/12, 2012/13, 2013/14) were pooled. ILI and SARI criteria were defined using clinical data; influenza was laboratory-confirmed. Frailty was measured using a previously validated frailty index.

Results and Analysis: The SOS sample included 11,379 adult inpatients (7,254 aged 65+), of whom 4,942 (2,948 aged 65+) had lab-confirmed influenza. Mean age was 68.6 (SD 17.8) and 52.6% were women. Sensitivity of ILI criteria was 51.1 (95% CI: 49.6-52.6) for younger adults vs. 44.6 (95% CI: 43.6-45.8) for older adults ($p < 0.001$). SARI criteria were met by 1,279 (64.1%) of younger vs. 1,682 (57.1%) of older adults with lab-confirmed influenza. Compared with non-frail older adults, patients who were pre-frail, frail or most frail had lower sensitivity for both ILI and SARI criteria. Applying ILI criteria in patients aged 65 and older left a "surveillance gap" of 55%, who would be missed in influenza surveillance efforts.

Conclusions and implications for vaccinology: A substantial proportion of older adults, particularly those who are frail, are missed by standard ILI and SARI case definitions. This has important implications for influenza surveillance, diagnosis and management, and argues for more relaxed case definitions paired with active surveillance and a low threshold of suspicion for testing.